A study on Lichtenstein's hartebeest, *Alcelaphus lichtensteini* (Peters 1849), and its habitat in south-eastern Rhodesia.

by

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submitted in partial fulfilment of the requirements
for the degree of

M.Sc. (Zoology)

in the
Faculty of Science
University of Pretoria,
Pretoria

MAY 1980

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Abstract

Lichtenstein's hartebeest, Alcelaphus lichtensteini, is a rare and endangered species in the south eastern lowveld of Rhodesia. A detailed investigation into the past and present distribution of this species in Africa revealed that it is on the fringe of its natural distribution in the study area.

Due to its precarious status in Rhodesia, an investigation, leading to the proposal of a management policy, into the preferred habitat of this species in the south eastern lowveld of Rhodesia was initiated.

It is concluded that these hartebeest prefer a tall grass stratum habitat characteriesed by *Setaria anceps* and *Ischaemum afrum*. This habitat type is threatened by changes in the soil moisture balance which has resulted in invasions of woody vegetation.

Recommendations are put forward which may restore these tall grass habitats to a state beneficial to hartebeest.

POSTSCRIPT :

In the following text read Zimbabwe for Rhodesia.

Acknowledgements

I would like to express my sincere gratitude to the following:

The Conservation Trust of Rhodesia for its generous financial contribution enabling this project to be concluded: The South African Nature Foundation for its contribution and financial maintenance of the vehicle provided during this project;

Prof. J.D. Skinner and Dr. G.K. Theron, of the University of Pretoria for supervising this research, for their sustained interest in the project, and particularly Dr, G.K Theron for his stimulating and constructive criticism of the chapters relating to the vegetation of the study area;

Mr. R.L. Sparrow, for permission to work on his ranch in such trying times, and Mrs R.L. Sparrow, Edie and Megs the memory of whose hospitality and kindness I shall always cherish;

Laurie, Marcus and Norman Sparrow for their interest in the project and help with maintaining the vehicle during my stay on Lone Star Ranche, and their families for their help and encouragement;

Mr. G. Hall and Mr. R. Francis for their help during the aerial survey of Gona re Zhou National Park, and Lone Star Ranche, and Mr. A. Anthony who found time to accompany me on a short excursion into the Gona re Zhou National Park;

Dr. R.H.N. Smithers, of the Mammal Research Institute, Pretoria, for his valuable comments and criticism of the chapter on the distribution of Lichtenstein's hartebeest;

My colleagues at the Mammal Research Institute, Rolf Dieckmann, Phillip Richardson, Dick Carr and Rudi Van Aarde for their help and hospitality during my stay in Pretoria.

Miss B. Henning who typed the first draft of this dissertation, for her patience and perseverance.

To Lynne, for her interest in the study and her enthusiastic encouragement at all times.

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Chapter 1

Introduction

A few isolated herds of Lichtenstein's hartebeest, Alcelaphus lichtensteini (Peters 1852), are all that remain of a species that enjoyed a relatively wide distribution in Rhodesia at the turn of the century (Selous 1893, Millais 1899). Today this is probably Rhodesia's rarest antelope species and the closest to extinction. Were it not for the jealous protection provided by a handful of ranchers and conservationists in the south-eastern lowveld it would undoubtedly already have been exterminated.

The precarious status of this species in Rhodesia and the need for a detailed scientific investigation into the limiting factors affecting this antelope and subsequent management of remaining populations of Lichtenstein's hartebeest in the lowveld became a matter of priority to ensure their survival.

The decline of Lichtenstein's hartebeest in the lowveld has been closely monitored by the Lowveld Natural History Society over a number of years and it was through the efforts of this society that a breeding nucleus of hartebeest were released into Gona re Zhou National Park in 1972.

At the time of their release no knowledge of their ecological requirements was available. The hartebeest were released in an area having a similar vegetational composition to that on the adjacent Lone Star Ranche, which was known to carry the largest population of Lichtenstein's hartebeest in Rhodesia at that time (Ferrar and Sherry, 1969).

The objectives of the present study were to identify some of the habitat requirements of hartebeest in the south-eastern lowveld and reveal, where possible, any limiting factors which might hinder their survival in the future.

At the commencement of this project in March 1976 serious terrorist incursions into the south-eastern lowveld, and in particular, the study area, first came to the attention of the authorities.

Consequently, the Rhodesian security forces, in the course of their duty, imposed restrictions on the movement of personnel on the ranch in the form of dusk-to-dawn and 24-hour curfews, at various times during this study and for varying lengths of time. The fluid nature of the security situation in the immediate area and in the surrounding region as a whole necessitated that all personnel on the ranch take precautions and be armed at all times. These restrictions hampered movement on the ranch and the various interruptions seriously affected the overall progress of this project.

Previous studies on Lichtenstein's hartebeest in Africa

In spite of the wide distribution of Lichtenstein's hartebeest in countries such as Tanzania, Zambia and Mozambique, no thorough study of their ecology has, to my knowledge, been undertaken. Even general notes on the obvious characteristics of Lichtenstein's hartebeest are rare in the literature and those that are to be found provide superficial descriptions of herd size, herd structure and habitat preferences in the broadest terms. The most detailed studies which have been undertaken include those of Mitchell (1965), Dowsett (1966) and Wilson (1966).

Mitchell (1965) provides some information on the breeding, growth and ageing criteria of Lichtenstein's hartebeest, while Dowsett (1966) describes the behaviour and population structure of hartebeest in the Kafue National Park, Zambia. Wilson (1966) discusses the response of Lichtenstein's hartebeest to various tsetse control measures in eastern Zambia. More recently, Rodgers (1977) has discussed the seasonal changes in group size of Lichtenstein's hartebeest in the eastern Selous Game Reserve, Tanzania.

CHAPTER 2

History of Lone Star Ranche

It is possible that the presence of coal bearing strata in the southern and south-eastern parts of Rhodesia was known to the early trekkers and hunters from the Transvaal, but no written record of this fact exists (Swift, White, Wiles and Worst 1953). In 1901 Landman of the Consolidated African Copper Trust had carried out preliminary mining work at Malilongwe, where the headquarters of Lone Star Ranche are today. In 1902 this company was granted coal concessions at Malilongwe and on the west bank of the Sabi River, near Dotts Drift. By June 1903 the existance of three coal seams had been established at Malilongwe, although no coal was found at Dotts Drift (Swift *et al*. 1953).

It is possible that no further mining work was carried out after 1906 and in 1918, along with the Umkondo Mine both concessions were transferred to the General Rhodesian Goldfields Ltd., which finally relinquished the concessions over Malilongwe in 1939 (Swift *et al*. 1953).

In 1940 a scheme was proposed to produce pig-iron in the Sabi Valley, utilising the ironstone from Mayoka and Mangula (both on Lone Star Ranche), the coals of Malilongwe and the extensive limestone deposits at Mkwasini on the northern boundary of Gona re Zhou National Park. However, the scheme was considered impractical at the time. War prevented further investigation until 1947 when a project to extend investigations of the coal and iron bearing formations was shelved when the Southern Rhodesian Government decided on a much more extensive enquiry into the Sabi-Lundi catchment area (Swift _et al_. 1953).

This survey into the Sabi-Lundi potential was conducted by Sir Alexander Gibb (subsequently known as the Alexander Gibb report). The mineral and agricultural aspects of the region were the focal point of this report and a considerable sum was spent on drilling - the deepest hole having been drilled to 487m (1 600 ft), and which today is an artesian well on the ranch (Sparrow, pers. comm.).[1]

In 1949, Lone Star Ranche was first registered (Sparrow, pers. comm.). At that time the ranch included part of the present day Hippo Valley Estates. This part of the ranch was sold to this company and at a later stage additional land was acquired which today is represented by the basaltic flats. The numerous African names, either derived from the Shona language or of Shangaan origin, such as Malilongwe - derived from the Shona "Mariraengwe", meaning "cry/call of the leopard" or Chiloveka, referring to a place where millet or sorghum is immersed in the water to initiate sprouting prior to the preparation of native beer, bear testimony to the past history of the ranch, both faunistically and culturally.

Numerous Shangaan tribesmen were settled along the Chiredzi and Lundi Rivers when the ranch was first occupied. Squatters initially

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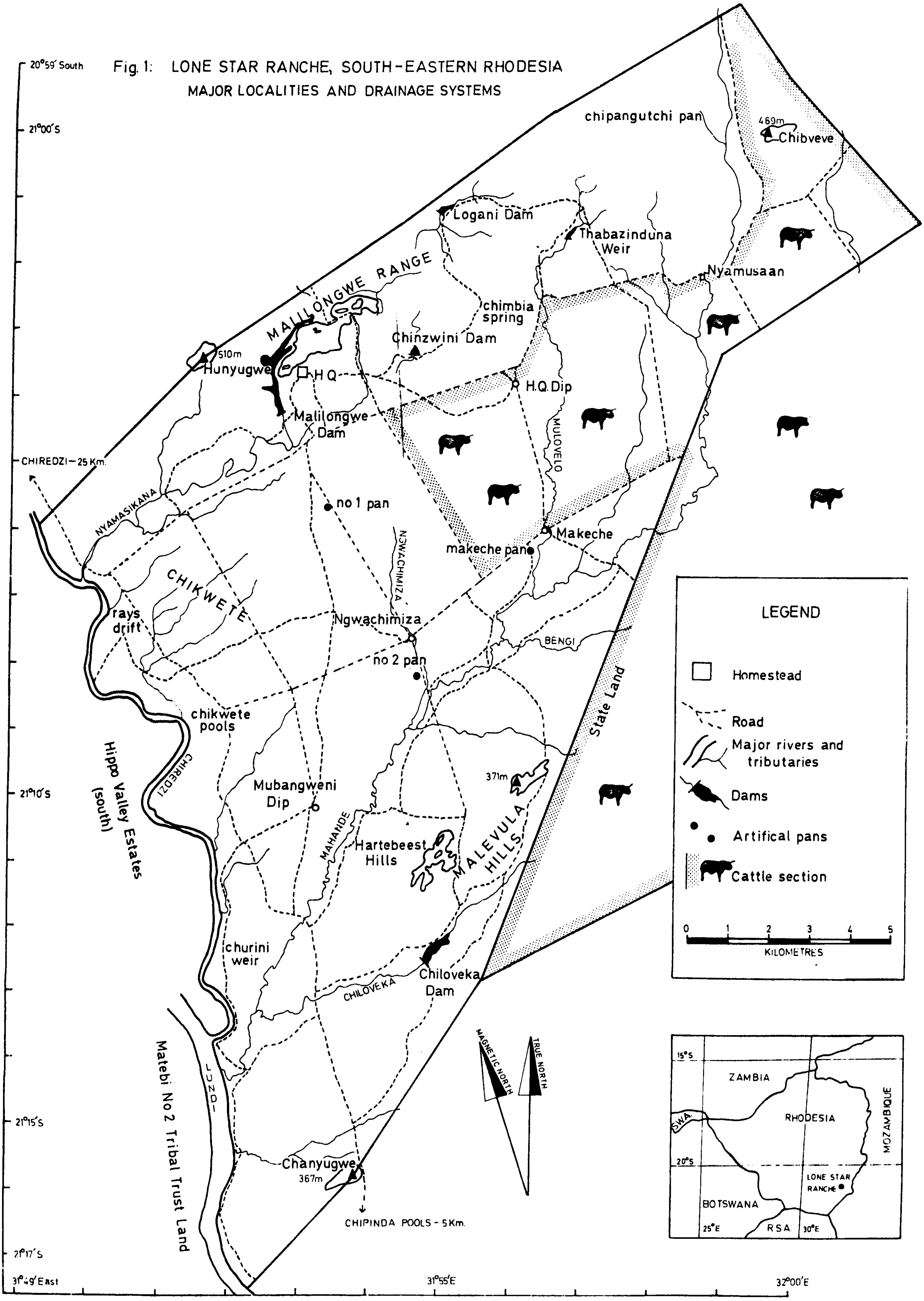
[1] R.L. Sparrow, Lone Star Ranche, P. Bag 7004 Chiredzi, Rhodesia.

settled along the foothills of the Malilongwe Range and evidence of their cultivated lands can still be seen in these areas (see Fig. 24). At a later stage these natives were moved to an area west of Malilongwe Dam and finally to a native settlement area near Nyamusaan on the ranch. Although agricultural crops are still cultivated by the natives employed by the ranch, the ranch has not initiated any large scale agricultural activity, which is a feature of the south-eastern lowveld. In 1964, an ambitious scheme to irrigate a series of lands, using the Malilongwe Dam as a source of water, had to be abandoned due to the inability of the dam to provide a constant and reliable water supply (Sparrow, pers. comm.).

Initially, during the 1950's, the ranch was developed for cattle ranching but the presence of tsetse fly, Glossina morsitans, made ranching difficult. Operations to eradicate the tsetse fly resulted in much of the flora and fauna being removed. In 1965 the cattle were removed from the ranch due to drought conditions prevailing, but more pertinently due to the estimated 50 percent infection of trypanosomiasis. The cattle were established on the adjacent State Land leased for this purpose, where the cattle section, with some 4 000 head, has remained until the present day although part of the original ranch is still used for cattle (Fig. 1).

The area has always been known for its large spectrum of game, so much so that, in the first ten years of occupation prior to tsetse fly operations, some 150 lions were accounted for in an effort to curb their predation on the cattle.

Fig. 1: LONE STAR RANCHE, SOUTH-EASTERN RHODESIA
MAJOR LOCALITIES AND DRAINAGE SYSTEMS



It is not surprising therefore, that Lone Star Ranche has embarked upon a policy of game ranching. In 1967 selected species were captured for export. These included Burchell's zebra (*Equus burchelli*), sable (*Hippotragus niger*), kudu (*Strepsiceros strepsiceros*), impala (*Aepyceros melampus*), klipspringer (*Oreotragus oreotragus*) and ostrich (*Struthio camelus*). This policy was abandoned later due to difficulties experienced with foot and mouth disease and international regulations pertaining to the export of wild animals. However, ostriches are still captured for export, together with young elephants (*Loxodonta africana*) rescued from population reduction exercises carried out by the Rhodesian Department of National Parks and Wild Life Management.

Judicious hunting of the fauna on the ranch ensured that the wildlife returned to its former status following the decimation by tsetse fly control operations. This is illustrated in Table 1 which is a record of the major species - both herbivore and carnivore - culled over a period of 10,5 years. Up until 1975, the wildlife on the ranch was culled according to a policy of sustained yield as directed by the Rhodesian Department of National Parks and Wild Life Management. From Table 1 it is clear that the policy of the ranch is to conserve wild game and crop conservatively, allowing those species which are poorly represented, such as sable, wildebeest, eland, hartebeest and buffalo, to increase.

Table 1: Record of culling operations over a 10,5 year period on Lone Star Ranche.

Species	1966	1967	1968	1969	1970	1971*	1972*	1973*	1974	1975	1976+
Grey duiker	40	71	18	52	45	14	3	1	2	18	3
Impala	40	105	78	54	81	117	79	110	322	237	164
Blue wildebeest	-	-	-	-	1	-	4	4	4	4	2
Burchell's zebra	1	9	5	19	1	4	20	16	98	39	15
Eland	-	-	-	1	-	-	1	1	19	9	2
Buffalo	-	-	-	-	1	-	2	4	7	4	1
Lion	-	-	-	-	-	-	-	-	1	5	1
Leopard	-	-	-	-	-	2	-	1	6	3	2
Hyaena	-	-	-	-	-	-	-	-	-	6	2
All species	81	185	101	126	129	137	109	137	459	325	192

* All hunting stopped for three months of the year due to foot and mouth quarantine.

\+ Record up until June 1976.

Faunistically, the ranch is particularly well populated today as a result of this policy. In addition to the rich variety of fresh water fish, amphibia, reptiles, birds and small mammals, the large mammals are also well represented. In Table 2, the taxa of the various large mammals and their estimated numbers are given.

This rich mammal fauna together with the ideal setting of the ranch, has lent itself to the establishment of a safari industry which started in 1970 when the Thabazinduna Hunting Lodge was built at the Thabazinduna Weir. The safari industry is the main occupation of the game section of the ranch. However, in 1976, this very successful operation had to be suspended due to terrorist activity in the south-eastern lowveld, when the safety of safari clients could no longer be assured.

The natural history of Lone Star Ranche, with such a rich flora and fauna, cannot hope to be understood after such a brief period in the field, especially since only a minute portion of the infrastructure of such an intriguing area was examined.

Table : 2 A summary of the larger mammal taxa and their respective population estimates, as derived from ground censusing for 1976 - 1977, on Lone Star Ranche, south-eastern Rhodesia. Nomenclature according to Dorst and Dandelot (1972).

Herbivores		Population Totals	Remark
Family :	Elephantidae *Loxodonta africana* (African elephant)	-	Subject to seasonal migration.
Family :	Rhinocerotidae *Ceratotherium simum* (White rhino)	7	Introduced in 1975 and breeding.
Family :	Equidae *Equus burchelli* (Burchell's zebra)	Estimated 1200	Subject to annual culling.
Family :	Suidae *Potamochoerus porcus* (Bushpig)	Probably less than 300	Status uncertain.
	Phacochoerus aethiopicus (Warthog)	Estimated 800	Population expanding rapidly.
Family :	Hippopotamidae *Hippopotamus amphibius* (Hippopotamus)	Estimated 150	Subject to annual culling.
Family :	Neotraginae *Rephicerus sharpei* (Sharpe's grybok)	Probably less than 100	Locally abundant in the hill areas.
	Raphicerus campestris (Steenbok)	Probably less than 200	-
	Ourebia ourebi (Oribi)	6 (?)	Vary rare. Subject to predation.
	Oreotragus oreotragus (Klipspringer)	Probably more than 100	Locally common in the hill areas.
Family :	Cephalophinae *Sylvicapra grimmia* (Grey duiker)	Probably more than 500	-
Family :	Reduncinae *Redunca arundinum* (Reedbuck)	Probably less than 20	Very rare. Subject to predation.
	Kobus ellipsiprymnus (Waterbuck)	8 (?)	Rare. Restricted to river frontage.
Family :	Antilopinae *Aepyceros melampus* (Impala)	Estimated 3000	Subject to annual culling.
Family :	Hippotraginae *Hippotragus niger* (Sable antelope)	Probably more than 200	Herds breeding well.

Herbivores		Population Totals	Remark
Family :	Alcelaphinae *Connochaetes taurinus* (Blue wildebeest)	Probably more than 400	-
	Damaliscus lunatus (Tsessebe)	4	Introduced. Subject to predation.
	Alcelaphus lichtensteini (Lichtenstein's hartebeest)	30 - 40	Population declining.
Family :	Tragelaphinae *Tragelaphus scriptus* (Bushbuck)	Probably more than 600	Locally abundant.
	Tragelaphus strepsiceros (Kudu)	Probably more than 500	Subject to annual culling.
	Taurotragus oryx (Eland)	Probably less than 450	Subject to periodic culling.
Family :	Bovinea *Syncerus caffer* (Buffalo)	Probably less than 400	Foot and mouth threat to be removed totally.
	Larger Carnivores		
Family :	Canidae *Canis mesomelas* (Black-backed jackal)	-	Locally common.
	Canis adustus (Side-striped jackal)	-	Locally common but less than black-backed jackal.
Family :	Hyaenidae *Crocuta crocuta* (Spotted hyaena)	-	Locally common in the hill areas.
Family :	Felidae *Acinonyx jubatus* (Cheetah)	-	Very rare. Status uncertain.
	Panthera pardus (Leopard)	Probably more than 75	Locally common in the hill areas.
	Panthera leo (Lion)	5 - 20	Subject to migration and annual culling.

CHAPTER 3

Locality, Physiography, Geology and Climate

Locality

Details of the localised areas on the ranch are given in the relevant chapters in this study and will receive no elaboration here. Lone Star Ranche is situated in the south-eastern lowveld of Rhodesia, henceforth also referred to as the lowveld (Fig. 1), and lies approximately between latitude $21^{0}00'S$ - $21^{0}15'S$ and longitude $31^{0}50'E$ - $32^{0}00'E$. The nearest town, Chiredzi, is 32km north-west of the ranch headquarters (Fig. 1). The ranch is triangular in shape with a total length along its longest axis of approximately 25km and an average width of 10km, although it is much broader along the southern river boundary than in the north-east (Fig. 1).

The boundaries of Lone Star Ranche are shown in Fig 1. The Ranch is bounded in the south by the Chiredzi and Lundi Rivers, the north-west by the Malilongwe Range (also known colloquially as Malilongwe Hills, henceforth also referred to as the hills) and by a cattle fence along the northern and north-eastern boundary.

Physiography

Topographically the area is one of low relief. The Malilongwe Range with the highest altitude, approximately 510m at Hunyugwe, is characterised by a steep western scarp with numerous faults forming a very broken country which gradually declines south-eastwards to form a plain (henceforth referred to as the basaltic flats, or the flats), varying in altitude from 320 - 360m.

Drainage, rivers, dams and pans.

The relief of the surrounding area being north-west to south-east, all major rivers and seasonal watercourses flow in a south-easterly direction. The Lundi and Chiredzi Rivers are the two major drainage systems in the area. Both rivers are characterised by high banks composed of alluvium and have very flat gradients although to the south, the Lundi River falls rapidly and cuts a gorge below Chipinda Pools forming the Chibirina Falls. Both rivers may be considered to be perennial although the flow diminishes considerably during the dry season and they may even cease flowing altogether during drought conditions.

The primary tributaries of these rivers are the Chiloveka, the Mahande and the Nyamasikana Rivers (Fig 1). All these tributaries are served by numerous minor drainage lines and as a whole form an integral part of the ecology of the area. The Mahande River is the most important of these tributaries and, although it only flows in the wet season after heavy rains, it does include a number of semi-permanent pools which retain water well into the dry season. The Chiloveka River was, at one time, served by an ancient artesian spring known as Kombendiro, which was never known to dry up. This spring is now submerged beneath the Chiloveka Dam and as a result of this spring, combined with seepage from the dam, the Chiloveka River does carry water all the year round, although the water is absorbed by the basaltic soils long before it reaches the confluence with the Lundi River. The waters of the Chiloveka River are brackish to the taste. The Nyamasikana River only carries water during the rainy season after heavy rains.

The Malilongwe Dam is built on this river at a point where it emerges from the Malilongwe Range (Fig. 1).

There are numerous natural pans in the basaltic flats and among the hills. The largest of these is Chipangutchi Pan (Fig. 1). These pans do not usually carry water for any length of time after the last rains.

In addition to the natural water supplies, a number of artificial water sources have been constructed to serve the area during the dry season. The Malilongwe Dam is the largest of these and other notable dams include Chinzwini, Logani and Thabazinduna Weir, while Hlamba-Mhlonga, Hunyugwe and Mapanzani Dams (not indicated in Fig. 1) are minor dams holding water for part of the year. Owing to the porosity of the basaltic soils on the flats, no dams other than Chiloveka Dam were built, but instead three concrete saucer-shaped pans - viz. No. 1, No. 2 and Makeche Pan were constructed. These pans are supplied with water from the Malilongwe Dam and a borehole and thus are able to provide water for the major sector of the flats throughout the year.

Geology

The geology of the south-eastern lowveld of Rhodesia has been intensively investigated in the past years, particularly with regard to the occurrence of coal-bearing strata and the interest of geologists in the Limpopo mobile belt (Mason 1973) and the Nuanetsi Igneous Province (Cox, Johnstone, Monkman, Stillman, Vail and Wood 1965). These workers together with Swift *et al.* (1953) have described the geology of the south-eastern lowveld in detail and a summary of these papers has been used to describe the geology of Lone Star Ranche and the surrounding area.

Outline of the geology

The geology of the region is summarized in Table 3. The oldest rocks in the area are the paragneisses, an intimately interbedded series of acid granulites containing garnet, pyroxene, hornblende and biotite, in addition to quartz-magnetite schists, marble, limestone and argillaceous rocks. Intrusive into them are the orthogneisses which range in composition from acid to ultra basic. The rocks of the basement complex were subjected to a deep seated metamorphism and then to a long period of erosion.

After a period of time the area was submerged under water and the rocks of the Umkondo system, a series of quartzites, limestones and sandstones which follow inconformably upon one another, were laid down. These rocks were then covered by extrusive basalts which, since they do not show pillow structure, were presumably poured out upon a land surface. A large sill of dolorite and granophyre has also intruded into the sandstones. A long period of erosion under sub-aerial conditions followed these events and over much of the area the Umkondo rocks were completely removed and the basement complex laid bare.

Table: 3 Geological formations in the south-eastern lowveld of Rhodesia (After Swift *et al*. 1953).

Recent		
	Alluvium	
	Mineralization, faulting and unconformity	
Intrusive Igneous Rocks		
	Dolerite Quartz veins Aplite, felsite and porphyry Granophyre and senite	
	Intrusive contact	
Intrusive Igneous Rocks		
	Dolerites, Nephelinites	
	Intrusive contact	
Karoo System		(Basalts
	Upper Karoo	(Ash (interbedded in basalts)
	(Stormberg)	(Sandstones
		(Grits
	(Lower Karoo	(Conglomerates
	(Beaufort)	(Shales, mudstones
		(Coals
		(Limestone
		(Basal beds
	Unconformity	
Intrusive Igneous Rocks		
	Dolerites, granophyre	
	Intrusive contact	
Umkondo system	Basalts Quartzites, sandstones Limestones	
	Unconformity	
Intrusive Igneous Rocks (age uncertain)		
	Dolerite Granophyre	
	Metamorphism	
Basement complex	Orthogneisses:-	Acid gneisses Basic schists and granulites Serpentines and allied basic rocks
	Paragneisses:-	Acid gneisses and granulites Marble and limestone Quartz - magnatite schists Argillaceous rocks

The surface of the terrain immediately prior to the deposition of the Karoo rocks was very uneven. During the Karoo period the land again became submerged and a period of sedimentation began. The encroachment of water took place gradually from the southerly direction, so that overlap of younger sediments beyond the limits of the older ones is a marked feature. The sediments laid down consist of a series of grits, shales, mudstones, coals, limestones and basal beds. Even when the water reached its maximum extent many of the higher points in the area were not submerged and must have formed islands, whilst in the Chidumo district the water must have been very shallow. The submergence and sedimentation took place in Beaufort times.

Shortly before the beginning of the Stormberg period, the sea of water began to decrease in size, and finally to dry out, the desiccation process spreading slowly from west to east. This process was the beginning of the desert period which lasted throughout the Stormberg period, in which the Upper Karoo sandstones were laid down. The sandstone beds were probably laid down in shallow water, but the bulk of the material is a massive aeolian sandstone in which dune-bedding is the only structure visable. Basalts were poured out onto the uneven surface of the sand while desert conditions still prevailed. Both Upper and Lower Karoo series are intruded by a suite of basic dykes and sills. These exhibit a considerable variety of texture and composition, but are all related, magmatically, to the Stormberg basaltic lavas. The term basalts is used here in a broad sense, as andesites and even nepheline-bearing rocks are to be found in the basaltic lavas.

The subsequent geological history of the region is somewhat obscure. Extensive faulting has taken place but it has not been possible to assign an age to it. Perhaps it occurred during the emplacement of the granophyre, although there is evidence from the Beit Bridge area that the faulting is pre-granophyre in age.

The extensive alluvium found along the Sabi and Lundi Rivers belongs to a relatively recent period. The Sabi River must have been dammed along its lower course forming a lake with perhaps an outflow into the Lundi River.

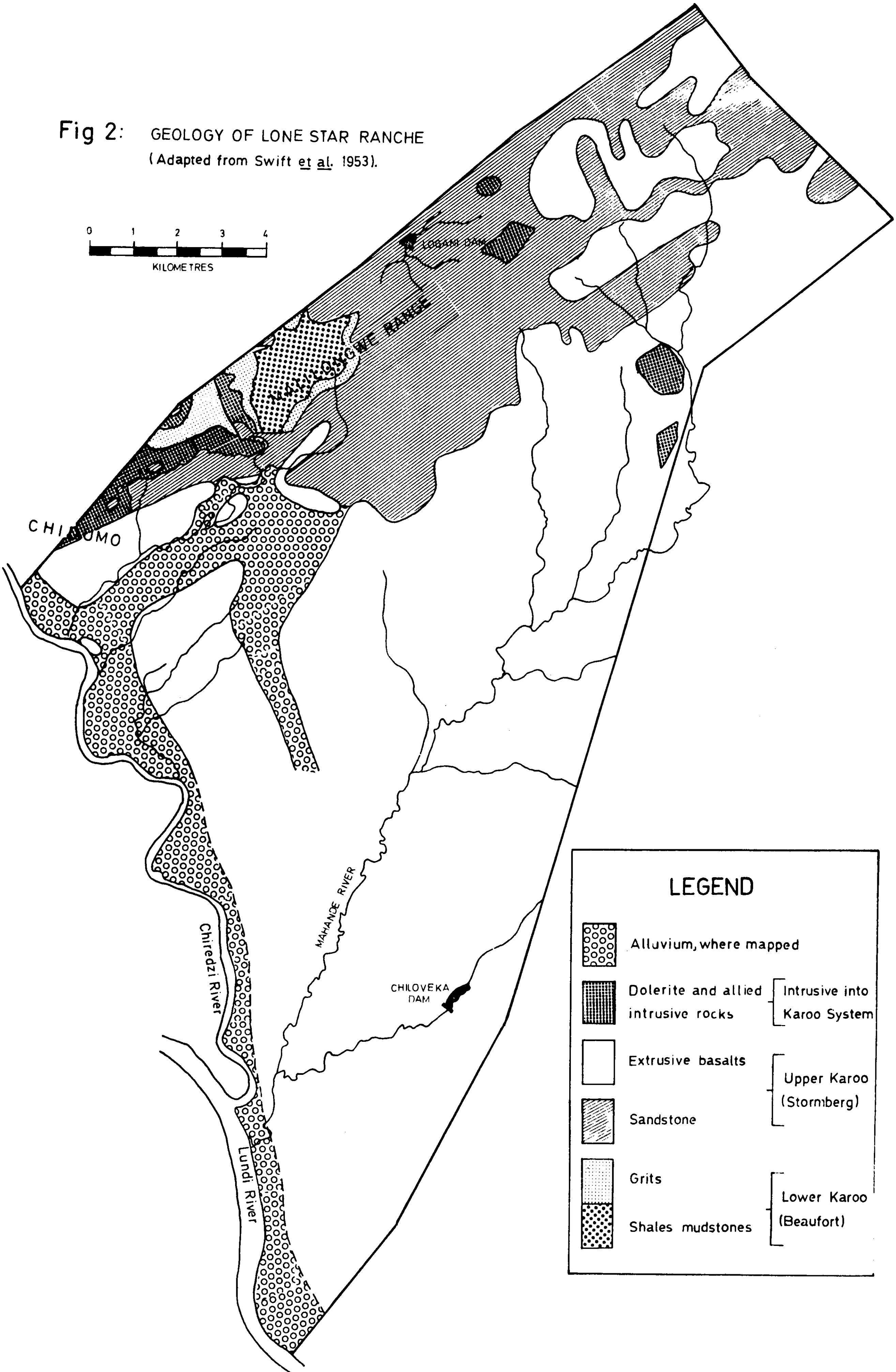
On Lone Star Ranche the greater portion of the area is covered by extensive basalts (Fig. 2). The Malilongwe Range forming the north-western boundary consists of Stormberg sandstone which is cut by numerous faults forming a very broken country. Intrusive into the Stormberg sandstone are dolorite sills while the area, which is today covered by the Malilongwe Dam, is formed of shales and mudstones which carry coal seams.

Climate

Madagascar Island, with its high mountainous east coast forms an effective barrier to the direct influences of the Indian Ocean on the coastal plain of Mozambique and Rhodesia lying inland. It is the interplay between the high pressure belts lying over the Asian mainland and the southern Indian Ocean, together with the subtropical low pressure zones in the interior of Africa and off the Zambezi Delta that have the greatest influence on the climatic conditions (Tinley 1977).

Fig 2: GEOLOGY OF LONE STAR RANCHE

(Adapted from Swift *et al.* 1953).



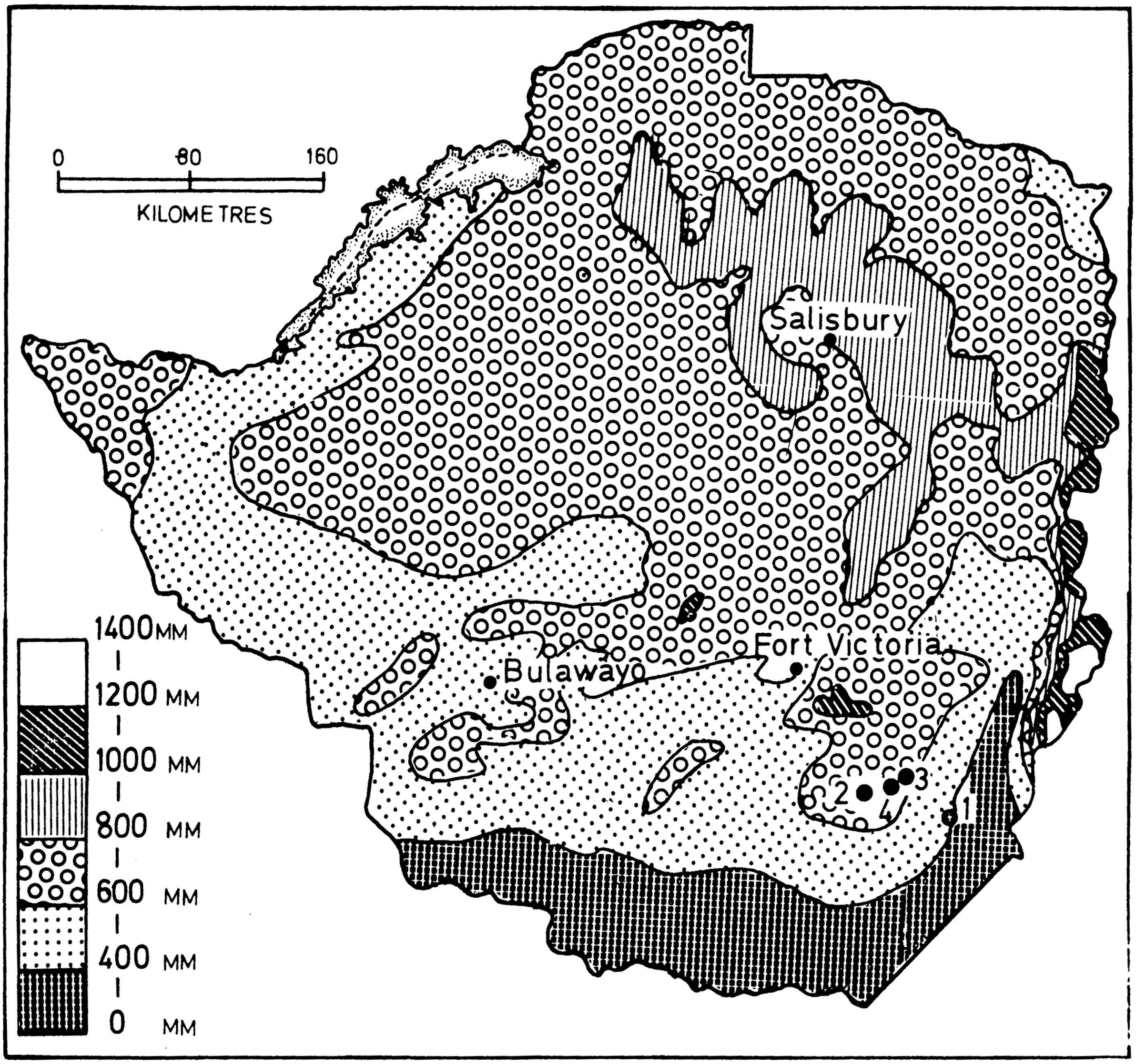
Due to its geographical position, Rhodesia is reached by the southern limits of the north-eastern monsoons, which together with influxes of moist "Congo Air" brings a higher, more widespread rainfall to the northern parts of Rhodesia. The south and south-east of the country are influenced by drier South East Trade winds and consequently receive less rain (Fig. 3). The topography of the country, together with the influences of the high and low pressure zones affecting Rhodesia, play an important role in the temperature experienced in the different parts of the country (Lineham 1965, Torrance 1965).

All climatic data discussed here have been supplied by the Rhodesian Meteorological Services, Salisbury, from selected weather stations which were closely allied to Lone Star Ranche. All these weather stations have been in existence for less than 30 years.

Rainfall

Throughout Rhodesia the rainy season is from November to March. The wettest month is usually January, although in the north-east and down the Sabi Valley December may be wetter. Rainfall outside the season is usually confined to some preliminary thunderstorms in October and showery spells of post-rainy season in April, May and June. July and August are the driest months (Lineham 1965).

The bulk of the rainfall in Rhodesia results from convective activity and occurs in the form of showers and thunderstorms, affecting small areas at a time. Such rainfall is most frequent in the afternoon and early evening. Widespread and continuous



Weather Station	Duration	Altitude	Grid Reference	
1. Lone Star Ranche	1951 — 1977	400 m.	21°03'S	31°53'E
2. Triangle Mill	1941 — 1971	421 m.	20°57'S	31°22'E
3. Ruware Ranch	1941 — 1971	440 m.	20°45'S	31°39'E
4. Crown Ranch	1953 — 1977	480 m.	20°54'S	31°33'E

Fig 3: The location of Lone Star Ranche and comparable weather stations in relation to the distribution of the mean annual rainfall (mm) in Rhodesia (after Lineham 1965).

rains over prolonged periods are rare, but are nearly always associated with a deep low pressure area, either formed in the equatorial trough in the Zambezi Valley, or the remains of a tropical cyclone which has originated in the Indian Ocean and crossed the Mozambique Channel and penetrated into the south-eastern lowveld during the period December - April. These cyclones give rise to a more intense heavy orographic rainfall than is normal (Lineham 1965, Tinley 1977).

The rainfall in the northern sector of Rhodesia is directly influenced by the more southerly position of the subtropical low pressure belt and the development of a low pressure zone (heat low) over the Kalahari which brings moist "Congo Air" from the Atlantic and the north-east monsoons from the Indian Ocean. The rainfall is often heaviest and most widespread when the "Congo Air", having been drawn south into Rhodesia by low pressure over South Africa, is displaced northwards by one of the incursions of cool moist air into south-eastern Rhodesia. The interface between these two air masses along an east-west trough is referred to as the Inter Tropical Convergence Zone (Lineham 1965, Hall-Martin 1972, Tinley 1977).

In Winter (May - August) a high pressure zone - the South African anti-cyclone - developes over southern Africa while the subtropical low pressure zone lies north of the Equator. The winds that blow from the high to this low pressure zone - known as the South East Trade Winds - are dry and therefore provide very little opportunity for rainy conditions to develop.

The south of the country is more persistently under the influence of the drier South East Trade Winds which are mostly confined to south of 18° latitude (Tinley 1977). These winds are forced to move northwards over the warm Mozambique Channel and inland via the Limpopo Valley into south-eastern Rhodesia by a high pressure zone that develops periodically along the south-east coast of South Africa. As the winds rise over the higher ground, condensation takes place resulting in rain.

During winter, the South African anti-cyclone shifts occasionally to the south-east coast and again forces winds to move into south-eastern Rhodesia after passing over the Mozambique Channel. This usually results in light showers and sometimes long lasting cold and drizzling rains. These conditions are locally known in Rhodesia as "guti" conditions and seldom penetrate further than the watershed.

In the south-eastern lowveld the longest available records from weather stations are Triangle Mill (1941 - 1971) and Ruware Ranch (1941 - 1971, Table 4). The rainfall pattern from these two stations follows a normal distribution (Rhodesia Meteorological Services, Salisbury) and data for the last 26 years (1951 - 1977) for Lone Star Ranche is comparable to these distributions and therefore accepted as being normal for that area (Fig. 4).

The geographical position of Lone Star Ranche in relation to the mean annual rainfall isohyets (Fig. 3) shows that its annual rainfall is under the direct influence of the South East Trade winds, which penetrate inland via the Limpopo and Sabi Valleys. It is for this reason that Lone Star Ranche receives rain in practically all months of the year (Fig. 4). It is interesting to note that the flat basaltic plains (represented by

Table : 4 Mean monthly and yearly rainfall, in millimetres, recorded at four official weather stations in the south eastern lowveld of Rhodesia (Rhodesian Meteorological Services, Salisbury). <u>Note</u>: "Lone Star Ranche" is the official weather station in the study area and is situated on the Malilongwe Range at the ranch headquarters. Data for Hartebeest Hills have been extracted from private records kept at the ranch.

Weather Station	Locality	Altitude	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Yearly mean
Triangle Mill	20°57'S-31°22'E	421m	1941-1971	128,9	106,5	81,9	25,2	7,2	12,7	4,6	4,1	8,3	18,9	77,1	111,0	586,3
Ruware Ranch	20°45'S-31°39'E	440m	1941-1971	155,8	129,3	77,9	30,2	8,4	13,1	4,0	3,7	8,0	24,7	84,2	124,9	664,8
Crown Ranch	20°54'S-31°53'E	480m	1953-1977	132,2	131,8	58,2	23,4	8,7	10,3	2,3	3,5	8,2	20,0	83,3	114,8	569,7
Lone Star Ranche	21°04'S-31°53'E	400m	1951-1977	124,8	122,9	48,2	28,1	9,0	9,3	3,4	4,6	10,9	19,5	74,2	110,3	565,2
Hartebeest Hills	-	320m	1968-1972	100,0	66,5	40,1	19,1	18,7	7,5	2,3	-	4,1	17,8	54,7	78,3	363,9

Hartebeest Hill, Fig. 4) receive less rain than the ranch Headquarters which are situated at a higher altitude on the Malilongwe Range (Table 4). This may be an important factor in determining the vegetational composition on the ranch (see p. 116).

Analyses of the rainfall records from the official weather station (Lone Star Ranche, Table 4) for the last 26 years reveals that the study area has a mean annual rainfall of 565,2mm and that 76% of the annual rainfall falls during the four months November - February. If monthly rainfall of less than 10,0mm can be ignored, it can be said that May to September are the driest months. The annual rainfall may show a strong seasonal variation, such as that which occurred in 1976 - 1977 when "Cyclone Emily" penetrated the lowveld between the 4th and 13th February 1977. A total of 321,5mm of rain was recorded at the ranch headquarters in 10 days which represented 57% of the mean annual rainfall for the area.

In times of drought, January is known to be almost rainless, and, although this month is in fact the wettest month (Fig. 4), the pattern of rainfall during the month is such that it appears as if this month is the driest month during the rainy season.

Temperature

The broad topographical features of Rhodesia:- a central plateau and watershed running SW - NE from Plumtree to Marandellas, a plateau running NW - SE from Karoi through Salisbury and Marandellas to Inyanga and the mountains along the eastern border

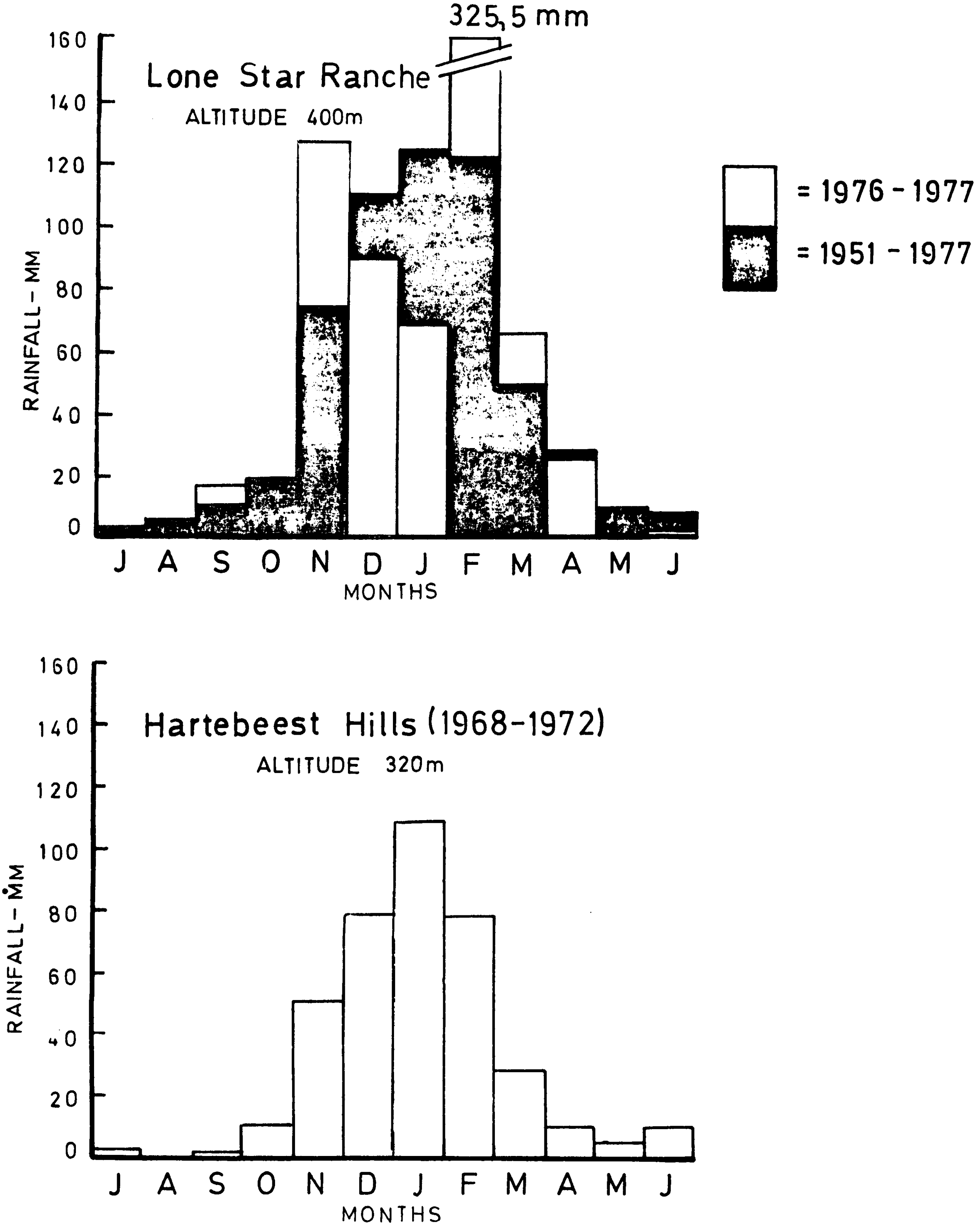


Fig 4: The monthly rainfall (1976-1977) and the mean monthly rainfall (1951-1977) on Lone Star Ranche compared with the mean monthly rainfall (1968-1972) recorded at Hartebeest Hills, representing the rainfall at different altitudes in the study area.

determines the main temperature pattern of the country. The relative accessibility to invasions of cold dry air from the south-east are also important. Overland invasions of cold dry air from the south-west are rare, but when they do occur the effects can be serious, causing severe "black frost"[1] (Torrance 1965).

In the south-eastern lowveld the occurrence of "black frost" is extremely rare and has never been known to occur on the ranch (Sparrow, pers. comm.), although similar conditions - as a result of wet, cold and windy conditions occurring out of season (November) - have caused severe losses in stock, both wild and domestic in the lowveld as a whole (Jubb 1969). Invasions of cool moist air from the south east, colloquially known as the "Relief of the Lowveld" occur at one to two weekly intervals in most months of the year and because of their associated cloudiness, they affect the temperature conditions materially. Depending on the strength of the invasion, the cool cloudy conditions may only blanket the lowveld or they may extend as far as the central watershed. Although the cold air often crosses the watershed, it thereafter moves into lower elevations of the north-eastern lowveld and is heated dynamically resulting in dispersion of the cloud cover. The central watershed therefore forms a natural weather boundary,

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[1] "Black frost":- the name is due to the blackened appearance of plants and it occurs when air has not yet cooled to saturation despite being cooled to below 0°C.

to the south-east of which cloudy conditions are more frequent than in the north-east and west. The net effect of this is that extreme temperatures are experienced on either side of the watershed, however, since the south-eastern lowveld experiences a greater frequency of cooler days, it is found that isotherms at comparable elevations are lower in the south-east than in the north-east of Rhodesia (Torrance 1965).

In the south-eastern lowveld there may be a daily variation of 15°C or more - both in summer and winter - during fine weather conditions. There is a gradual warming to a peak at 15h00 and then a noticeable drop between 17h00 - 20h00 before settling into a steady decline until 06h00 the next morning (Fig. 5 A.) In the rainy season (Fig. 5 B), the average daily variation is approximately 10°C, but diurnal variations are less regular. The temperature may fall sharply with the onset of rains. A third pattern (Fig. 5 C) is observed in all seasons during incursions of cool moist air, when cloud cover cuts off the sun's heat by day and reduces heat loss by radiation at night. Under such conditions the variation may be as little as 3°C (Lineham 1965).

The mean monthly and extreme temperatures as recorded at Triangle Mill and Hippo Valley Estates are given in Table 5. There are no long term data available in this regard for Lone Star Ranche that are comparable with these two stations, but data were recorded at Lone Star Ranche, using a mercury thermometer, which gives a crude indication of the monthly mean temperature from September 1976 until June 1977. The trend of the monthly mean temperature for Lone Star Ranche follows that of the other two stations given in Table 5.

Table : 5 Summary of air temperatures in ^{o}C measured daily at Triangle Mill (1944 - 1960) and Hippo Valley Estates (1959 - 1967, Rhodesian Meteorological Services, Salisbury) and **the mean monthly*** temperature recorded at Lone Star Ranche.

MONTH	MEAN MAX.		ABSOLUTE MAX.		MEAN MIN.		ABSOLUTE MIN.		MONTHLY MEAN		
	Tr.M+.	Hp.V+.	Tr.M.	Hp.V.	Tr.M.	Hp.V.	Tr.M.	Hp.V.	Tr.M.	Hp.V.	Lone Star ++
Jan.	32,0	35,5	42,3	41,8	19,9	21,1	11,0	12,6	25,9	26,9	-
Feb.	32,0	31,8	40,6	41,7	19,9	20,8	13,2	14,9	25,9	26,3	26,1
March	31,0	31,6	39,8	39,8	18,1	19,2	10,6	10,1	24,5	25,4	23,9
April	30,7	30,5	39,0	38,5	14,8	16,3	8,3	4,5	22,7	23,4	23,1
May	28,5	28,6	38,9	36,0	9,9	11,2	-1,1	4,2	19,2	19,4	22,7
June	25,7	26,1	35,0	34,1	7,0	8,7	-2,5	-0,9	16,3	17,4	19,0
July	26,3	26,0	35,0	34,2	6,0	8,2	-2,2	-0,4	16,1	17,1	-
Aug.	28,3	28,2	39,0	36,8	7,7	10,4	-1,1	2,9	18,0	19,3	-
Sept.	30,8	30,7	41,2	39,6	12,1	14,5	3,1	4,0	21,4	22,6	26,7
Oct.	33,6	32,8	43,7	43,4	16,8	18,3	6,1	7,9	25,2	25,5	27,1
Nov.	33,2	32,6	45,0	42,4	19,2	20,3	10,6	12,6	26,2	26,4	28,7
Dec.	32,9	32,8	43,3	41,5	19,6	21,7	12,7	12,9	26,2	26,9	28,7

*Monthly mean = $\dfrac{\text{Mean max } ^{o}T + \text{Mean min } ^{o}T}{2}$

$^{++}$Lone Star = Lone Star Ranche (1976 - 1977)

Absolute max = 42,0^{o}C (24-11-1976)

Absolute min = 10,0^{o}C (2-06-1977)

+Tr. M. = Triangle Mill (Alt. = 421m, 20^{o}03'S : 31^{o}53'E)

$^{+}$Hp.V. = Hippo Valley Estates (Alt. = 420m, 21^{o}10'S : 31^{o}40'E)

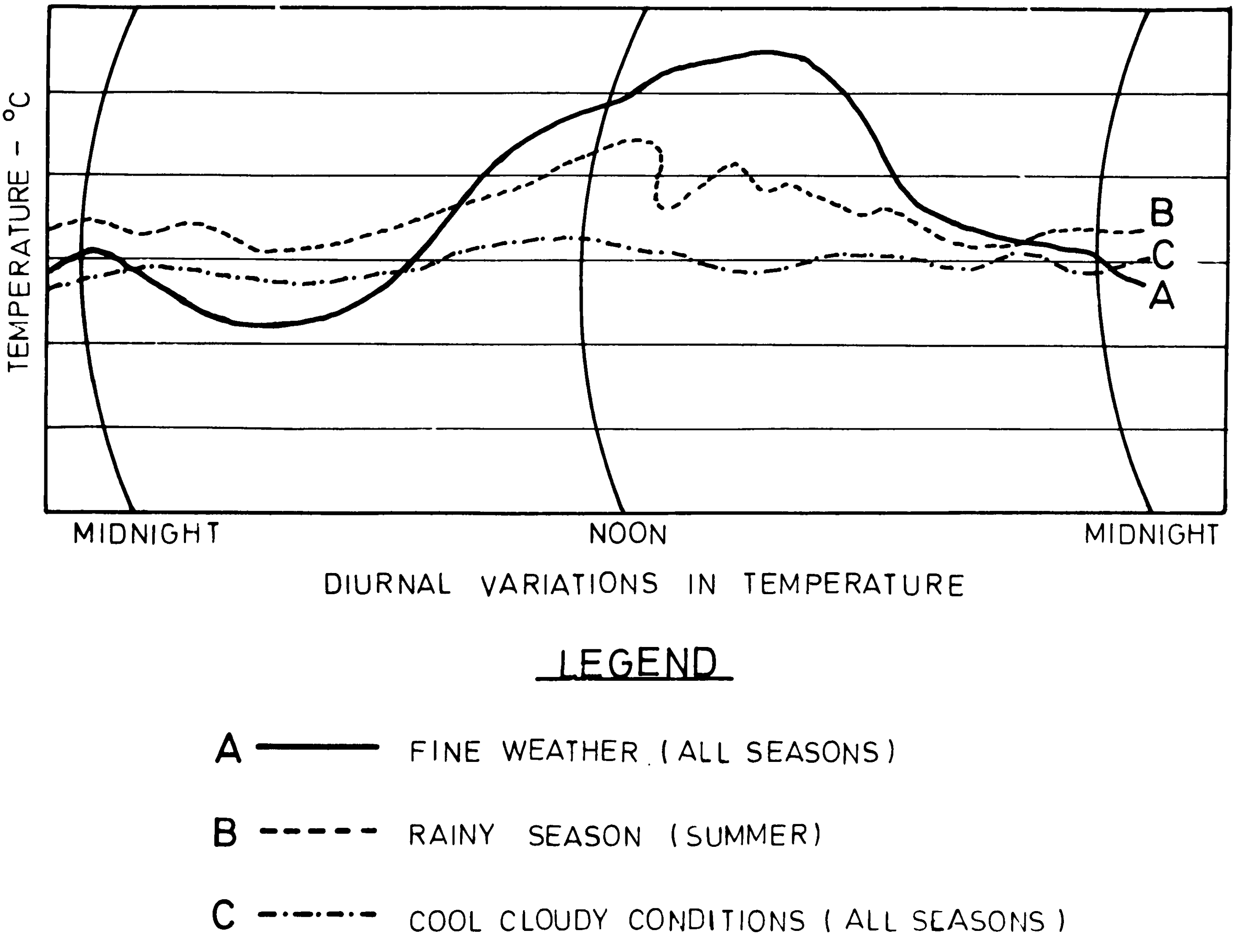

Fig 5: Variations in the mean diurnal temperatures during the various seasons in the south eastern lowveld are due to the direct influences of the prevailing weather conditions (after Torrance 1965).

The effect of low altitude - between 400 - 480m(Table 5) - is demonstrated in the high temperatures at the two representative stations (Table 5). The hottest period is from October to March, but temperatures above 30°C are recorded in all months of the year. During the hottest months, the mean monthly temperature averages approximately 25°C at both Triangle Mill and Hippo Valley Estates, with a mean maximum of 33,6°C (Triangle Mill) and an absolute maximum of 45,0°C (Triangle Mill).

It is usually cooler from April to September with a mean monthly temperature ranging from 16,1 to 22,7°C (Triangle Mill) with a lowest mean minimum of 6,0°C and an absolute minimum of -2,5°C (Triangle Mill, Table 5).

On Lone Star Ranche, the absolute maximum temperature recorded was 42,0°C and the absolute minimum temperature recorded was 10,0°C (Table 5). However, although figures are unavailable, it was generally known that the lower basaltic flats were much colder after nightfall than the Malilongwe Range. This was probably the result of local radiation from the basalts, causing a marked drop in ambient temperature while in the hills the local radiation from the rock masses had the net effect of increasing the ambient temperature after nightfall. This is probably one of the reasons why frost was never known to occur in the hills.

The wet and dry seasons are clearly associated with the high and low temperatures respectively (Fig. 6). The dry season temperatures, do, on occasions, fall low enough for frost to occur. Most frost observed resulted from loss of heat from

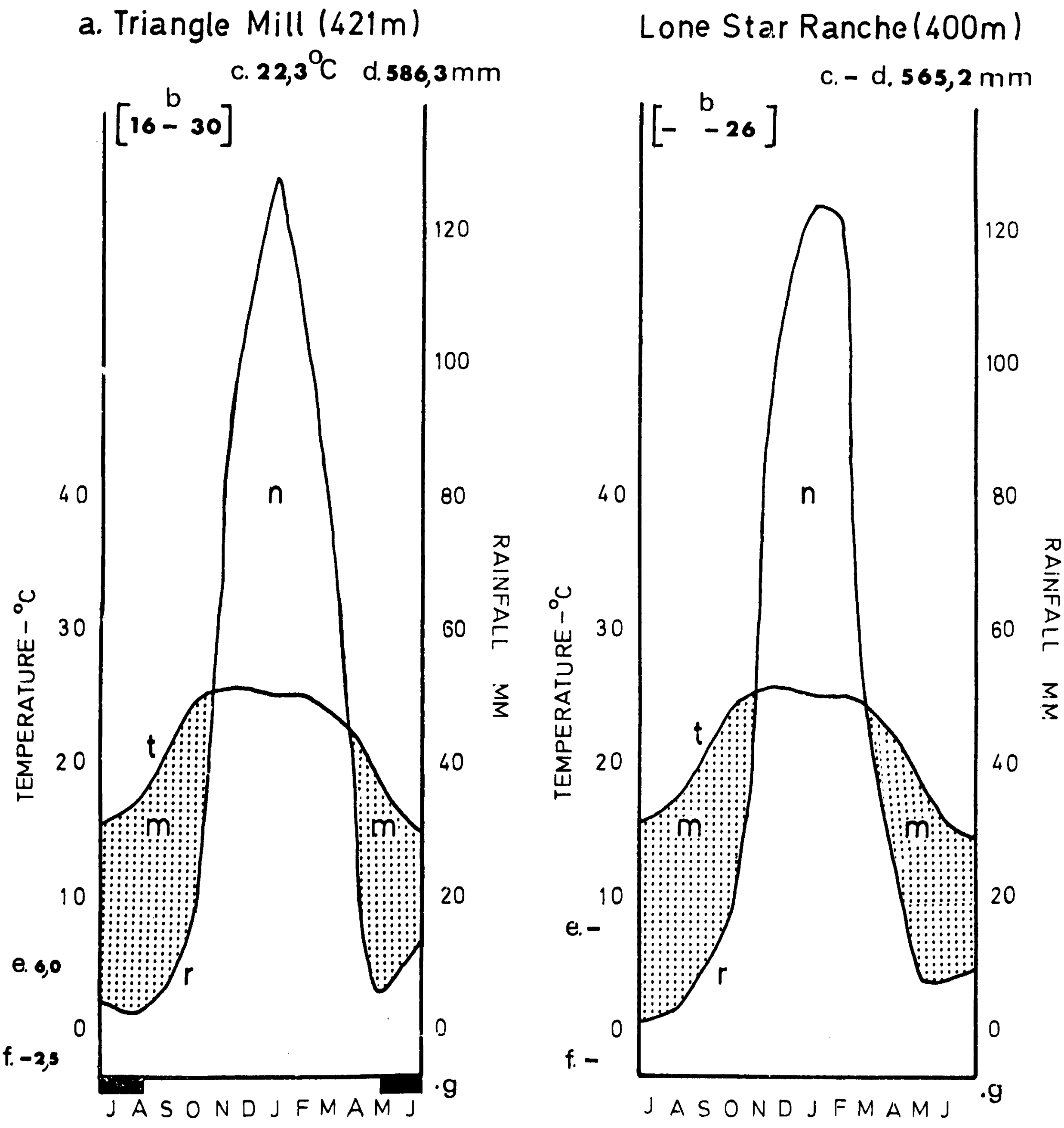

Fig 6 : Climatic diagram for Triangle Mill and Lone Star Ranche (after Walter 1963).

Note: The mean monthly temperature recorded at Triangle Mill is used in both diagrams in the absence of long term data for Lone Star Ranche.

a. ALTITUDE OF THE WEATHER STATION.
b. PERIOD OVER WHICH DATA HAS BEEN RECORDED (TEMPERATURE — RAINFALL) IN YEARS.
c. MEAN ANNUAL TEMPERATURE -°C.
d. MEAN ANNUAL RAINFALL - mm.
e. MEAN MONTHLY MINIMUM OF COLDEST MONTH °C
f. ABSOLUTE MINIMUM °C
g. MONTHS DURING WHICH ABSOLUTE MINIMUM FALLS BELOW 0°C.
m. ARID PERIOD.
n. HUMID PERIOD.
r. THE MEAN MONTHLY RAINFALL CURVE - mm.
t. THE MEAN MONTHLY TEMPERATURE -°C.

the earth's surface by radiation under clear skies and near calm conditions of winter nights. In the areas such as river valleys and other low-lying sites where the air tended to stagnate rather than drain away, frost was likely to occur - especially on the basaltic flats. The areas that were affected, however, were minimal and little damage was caused since most of the vegetation was in the dormant stage.

A modified Walter (1963) diagram effectively summarises the weather conditions recorded to give an overall picture of the yearly climate for Triangle Mill and Lone Star Ranche (Fig. 6). Since no data on the long term temperature means are available for Lone Star Ranche, the longest available period (Triangle Mill, 1944 - 1960) has been used as a base for comparison. The same scale for 10^{0}C and 20mm of rainfall is used to show the arid period prevailing when the rainfall curve falls below the temperature curve and the humid period when the rainfall curve rises above the temperature curve.

Humidity

No data are available on humidity from the above mentioned stations, however, for the country as a whole, the highest values are found over the mountainous Eastern Border. Elsewhere relative humidity is generally within five percent of 70% during the period November - April, apart from the dry Limpopo valley where rainfall is below 350mm annually. In the period May - October, however, there is a recognizable gradient with the highest records of humidity recorded from the Eastern Highlands and the lowest levels recorded towards Beit Bridge and Plumtree in the west (Lineham 1965). The periodic invasions of cool moist air into the south-eastern lowveld described elsewhere, maintain a slightly higher humidity average than is normal.

Data on cloud cover, insolation and evaporation are either not available or are too limited to provide any meaningful information.

CHAPTER 4

Taxonomy and Distribution

Taxonomy of Lichtenstein's hartebeest

At the turn of the century, the hartebeest were included in the genus *Bulbalis*. At least eight species were recognized which were regarded as being distributed throughout Africa. Naturalists found it interesting that the individual hartebeest species did not overlap with each other, although they were able to subdivide the eight species into four groups based on the formation of their horns (Sclater and Thomas 1894, Lydekker 1908). These groups were recognized as follows:

1. *Buselaphus - Major Group*

   Horn pedicle short, horns forming a "U" when viewed from the front .... *B.buselaphus*, *B.major*

2. *Tora Group*

   Horn pedicle moderate, horns forming an inverted bracket (⏟) when viewed from the front... *B.tora*, *B.swaynei*, *B.cokei*

3. *Lelwel Group*

   Horn pedicle extremely elongated, horns forming a "V" when viewed from the front .... *B.lelwel*, *B. caama*

4. *Lichtenstein Group*

   Horn pedicle extremely short and broad, horns much curved inward towards each other before final backward turn..... .... *B.lichtensteini*

However, when new species of hartebeest, such as *B.neumanni* and *B.nakurae*, were described at a later stage, it caused a certain amount of confusion amongst the naturalists since it was asserted by some that these new species were in fact hybrids (Ruxton and Schwarz (1929).

The possibility of hybridization having taken place had never been considered until Ruxton and Schwarz (1929) examined a collection of hartebeest skulls from the East African Rift Valley. They were impressed by the great variation in horn shape which embraced every stage from the true *B.jacksoni* (also known as *B. lelwel*) to the typical *B.cokei* i.e. from a very narrow horn formation of the Lelwel Group to the wider more antelopine style of the Tora Group. By comparing various cranial parameters from individuals considered to be hybrids of *B.jacksoni* and *B.cokei* with those taken from the "pure" race, Ruxton and Schwarz (1929) were able to show that hybridization had in fact taken place.

To explain how this hybridization had come about Ruxton and Schwarz (1929) accept that, at one time, Africa was occupied by a series of transitional forms of the then recently re-classified *Alcelaphus* group. Through the interference of man and more probably as a result of the effects of the changing physical conditions in Africa, various populations of hartebeest became isolated and were allowed to evolve along divergent lines. From this beginning Ruxton and Schwarz (1929) recognized three groups emerging. These were:

1. Buselaphus - Major Group
2. Lelwel Group
3. Tora Group

At some later time these three groups were able to extend their ranges and eventually overlapped providing the opportunity for hybridization to occur which resulted in the various forms of hartebeest evolving. These hartebeest were then ultimately subdivided on the basis of horn formation into the four groups recognized by the early naturalists (see above) and each group included one or more species. *Alcelaphus buselaphus*, which occurred in Algeria, Tunisia and Morocco, was thought to be extinct, but Ruxton and Schwarz (1929) considered it to be very closely related to *Alcelaphus major* which was extant in Upper Guinea and West Africa - hence the Buselaphus - Major Group. As regards to *Alcelaphus caama* and *Alcelaphus lichtensteini*, Ruxton and Schwarz (1929) accept that there was sufficient evidence to afford these two forms species status, although they do acknowledge that there was some connection between the Lelwel Group and *Alcelaphus caama* (Fig. 7).

Ruxton and Schwarz (1929) were able to show that each of the three groups (Buselaphus - Major, Lelwel and Tora) were related. Within these groups the shape of the frontal bone in the skull - a characteristic which also served to distinguish the various groups - could be traced from the Tora Group through the North African Buselaphus and related Major Group to the Lelwel Group. Furthermore, within these groups those forms with narrow foreheads were regarded as being more primitive than those forms with broader foreheads since the broader frontal portion of the skull served as an efficient pedicle for the more developed horns.

Thus from a systematics point of view Ruxton and Schwarz (1929) rejected the older classification system suggesting that there were eight species of hartebeest and proposed that the harebeest could be grouped into three species of the genus *Alcelaphus*.

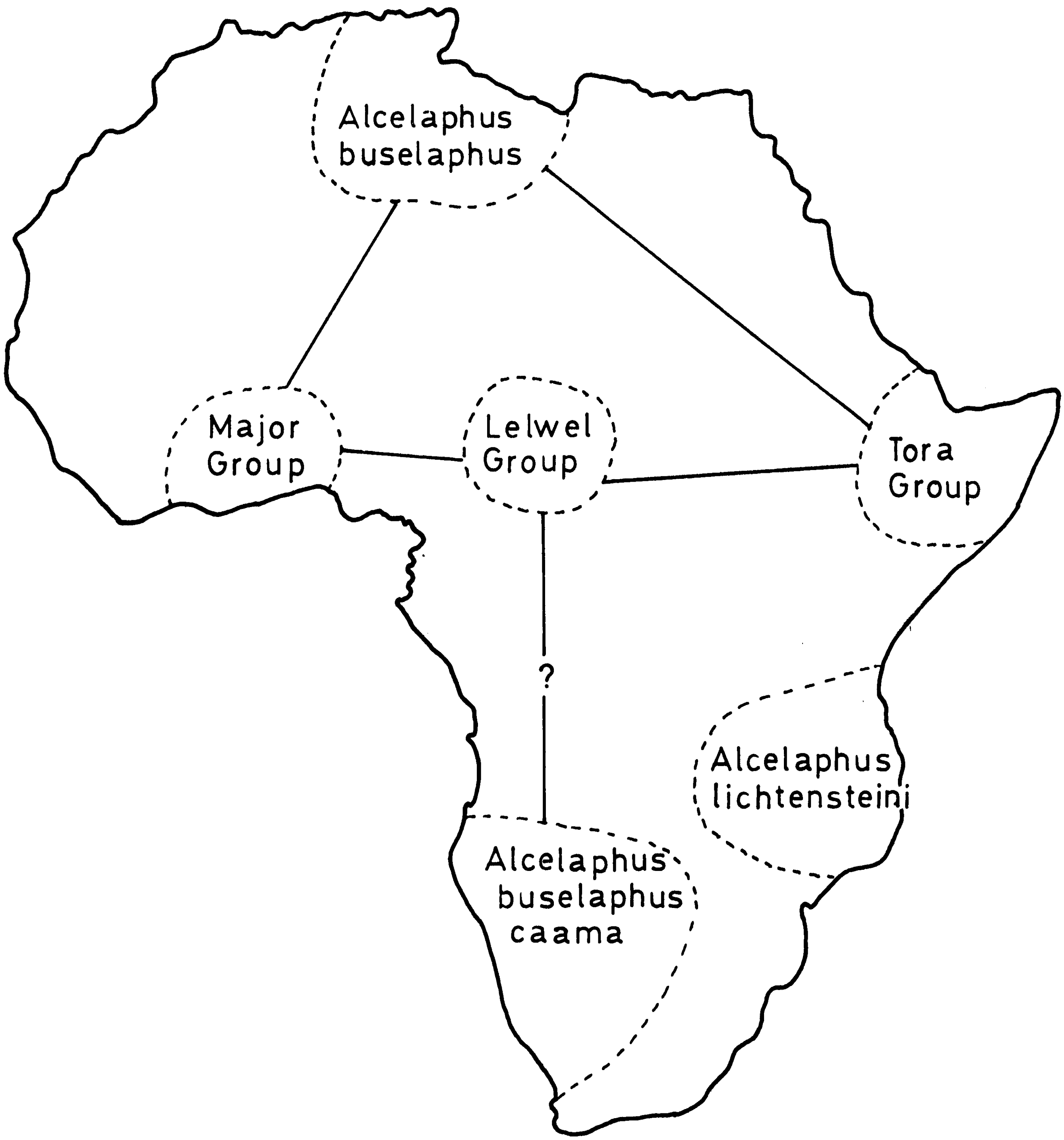

Fig 7: The location of the various groups of hartebeest indicating the taxonomic status of the genus Alcelaphus in Africa. Each group is characterised by the horn formation and may include one or more species or subspecies of hartebeest

These were :

1. *Alcelaphus buselaphus*
2. *Alcelaphus caama*
3. *Alcelaphus lichtensteini*

Most taxonomists agree with this classification (Allen 1939, Sidney 1965), although others believe that *A. buselaphus* and *A. caama* are conspecific and dispute the claim by Ruxton and Schwarz (1929) that the difference in the direction of hair currents on the face is sufficient to afford *A. caama* separate species status (Ellerman, Morrison-Scott and Hayman 1953, Walker 1964, Ansell 1971) since the South African *A. caama* resembles the East African *A.b.lelwel* except for some details in colour formation. Haltenorth (1963) and Walther (1968) go further and add *A. lichtensteini* to the *A. buselaphus* group. However, the majority of taxonomists agree that Lichtenstein's hartebeest is completely different from the remainder of the groups.

None venture a statement as to whether Lichtenstein's hartebeest is a more specialized form or not, but if it is accepted that the principle of a broad forehead is a specialized feature, then Lichtenstein's hartebeest could be regarded as the most specialized of all the hartebeest species.

Although the different groups of hartebeest are regarded as being the result of "hybridization", no comment has been made on the possible ancestor of the common hartebeest or the affinities of Lichtenstein's hartebeest to the transitional forms which were thought to have occupied North Africa. That Lichtenstein's hartebeest is in contact with *Alcelaphus buselaphus cokei* in Central Tanzania and do not inter-breed (Ansell 1971) suggests that Lichtenstein's hartebeest could probably be one of the transitional forms that evolved earlier than the rest and is itself a possible ancestor of the hartebeest group, however there is no evidence to suggest that this is true.

Thus, accepting the classification of Ruxton and Schwarz (1929), the genus *Alcelaphus* consists of three species viz. *A. buselaphus*, which includes all the hartebeest of East Africa, *A. caama*, which occurs in southern Africa and *A. lichtensteini* which occurs in central Africa. However it is felt that a more accurate classification is given by Ansell (1971) who classifies the genus *Alcelaphus* as follows :

Order: Artiodactyla
Suborder: Ruminatia
Superfamily: Hippotragine
Tribe: Alcelaphini
Genus: *Alcelaphus*
Species: *lichtensteini*
buselaphus
Subspecies: *caama*
buselaphus
cokei
jacksoni
lelwel
major
tora
swaynei

The numerous intergrades of hartebeest that have been described are explained by Ruxton and Schwarz (1929) as being hybrids between *Alcelaphus buselaphus* subspecies wherever they overlap. Some of those described include *Alcelaphus cokei kongoni*, *Alcelaphus cokei nakurea*, *Alcelaphus buselaphus rothchildi*, *Alcelphus tora rahatensis*, *Alcelaphus neumanni* and *Alcelaphus tora degglei*. All these hybrids have a very limited distribution and doubts are held as to whether any "pure" forms of these hybrids still exist (Sidney 1965).

Past and present distribution of Lichtenstein's hartebeest in Africa

Introduction

Towards the end of the last century it was fashionable to produce books dealing with the hunting and distribution of African game for the "sportsmen". Many of these early authors were handicapped by inadequate accurate knowledge concerning the distribution and identification of many species. Hartebeest were no exception, especially since the genus includes a variety of species, subspecies and hybrids. Added to this was the certain degree of confusion with the related tsessebe (*Damaliscus lunatus*), which often led to incorrect identification being reported in the field (Sclater and Thomas 1894 - 1900, Bryden 1899, Lydekker 1908, Vasse 1909).

Many of these naturalists relied on early explorers for information on the various species and there has been a tendency amongst the former to restate what has been said without expanding on existing knowledge.

Haagner (1920) and Shortridge (1934) were the first to review comprehensively the distribution of mammals in southern Africa; they were followed by Sidney (1965) and du Plessis (1969) but with the rapidly changing situation in Africa these reviews are now almost out of date.

The original distribution of *Alcelaphus buselaphus* was discontinuous in three separate areas in Africa: in the south west of Africa; in eastern Africa, thence north of the Lowland Forest Zone westwards to Senegal; and in northern Africa, north of the Sahara. *Alcelaphus lichtensteini* occupies the intervening area between the south western and eastern populations (Ansell 1971). A summary of the distribution, as quoted by Sidney (1965), is given in Fig.8.

It is doubted if the North African hartebeest, *Alcelaphus buselaphus buselaphus* still survives today. Sidney (1965) states that the last specimen was recorded from the eastern Moroccan mountains in 1933, although Smithers (pers. comm.)[1] believes the last specimen was killed in 1926 on the outskirts of Outal el Hah (Haute Moulouza) in Morocco. Others such as the Western hartebeest, *Alcelaphus buselaphus major* and Swaynes hartebeest, *Alcelaphus buselaphus swaynei*, have been reduced to the brink of extinction while the interesting Nakuru intergrade population has been wiped out (Gosling 1969).

The remaining members of this genus are still to be found over much of their former range, although recent information on their present status is difficult to procure.

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[1] R.H.N. Smithers, Mammal Research Institute, University of Pretoria, Republic of South Africa.

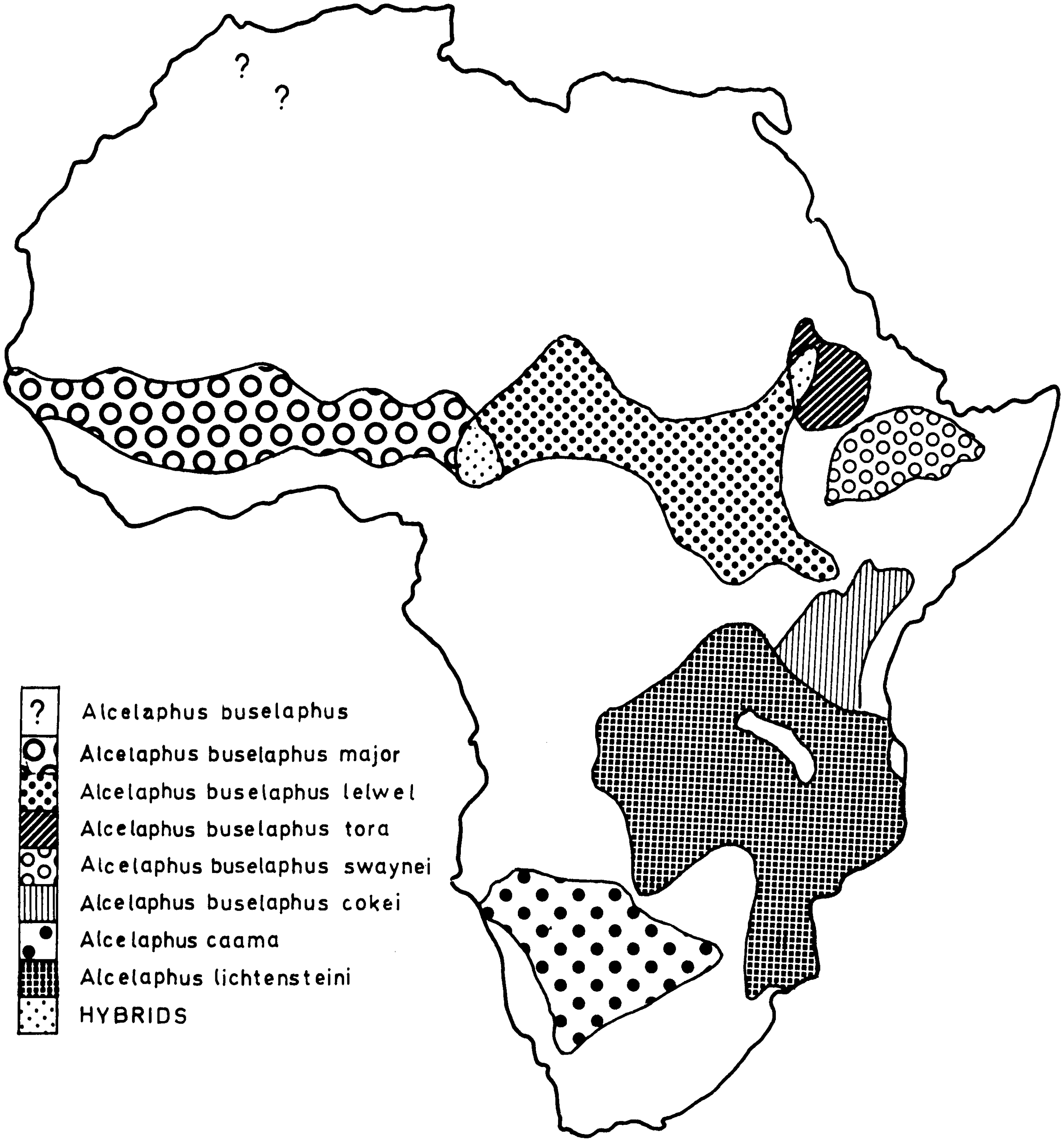

Fig 8: The distribution of the genus Alcelaphus in Africa (after Sidney 1965).

In an investigation on the past distribution of a species, it is important to assess the reliability of the information that is available in the light of our knowledge of the species at the present time. Many early explorers were apt to be confused by mammals having a similar appearance such as Lichtenstein's hartebeest, red hartebeest and tsessebe.

In order not to confuse the situation any further, every facet of the general ecology of the species must be taken into account. Two factors which impose severe natural limitations are temperature and aridity. Temperatures in Africa are nowhere extreme, and, although in many parts of Africa are burdensome to man, more usually because of associated high humidity, in fact are near optimum for highly developed and profuse plant and animal life. Aridity therefore is a key factor and rainfall, in all its facets, is the most important meteorological element in determining the distribution of plant and animal life.

Lichtenstein's hartebeest has been described as one of the few truly endemic "miombo" (_Brachystegia_ sp.) woodland animals, its range being contiguous with that of the "miombo" habitat (Rodgers, 1969a). In Fig. 9 the distribution of Lichtenstein's hartebeest in relation to the distribution of the _Brachystegia_ Woodland Savanna (after Keay 1959) is shown. It is clear that Lichtenstein's hartebeest are almost confined to the range of this savanna woodland habitat. However, since they are grazers, the grasslands and in particular the "dambo" associations within this habitat, are the final delimiting factors.

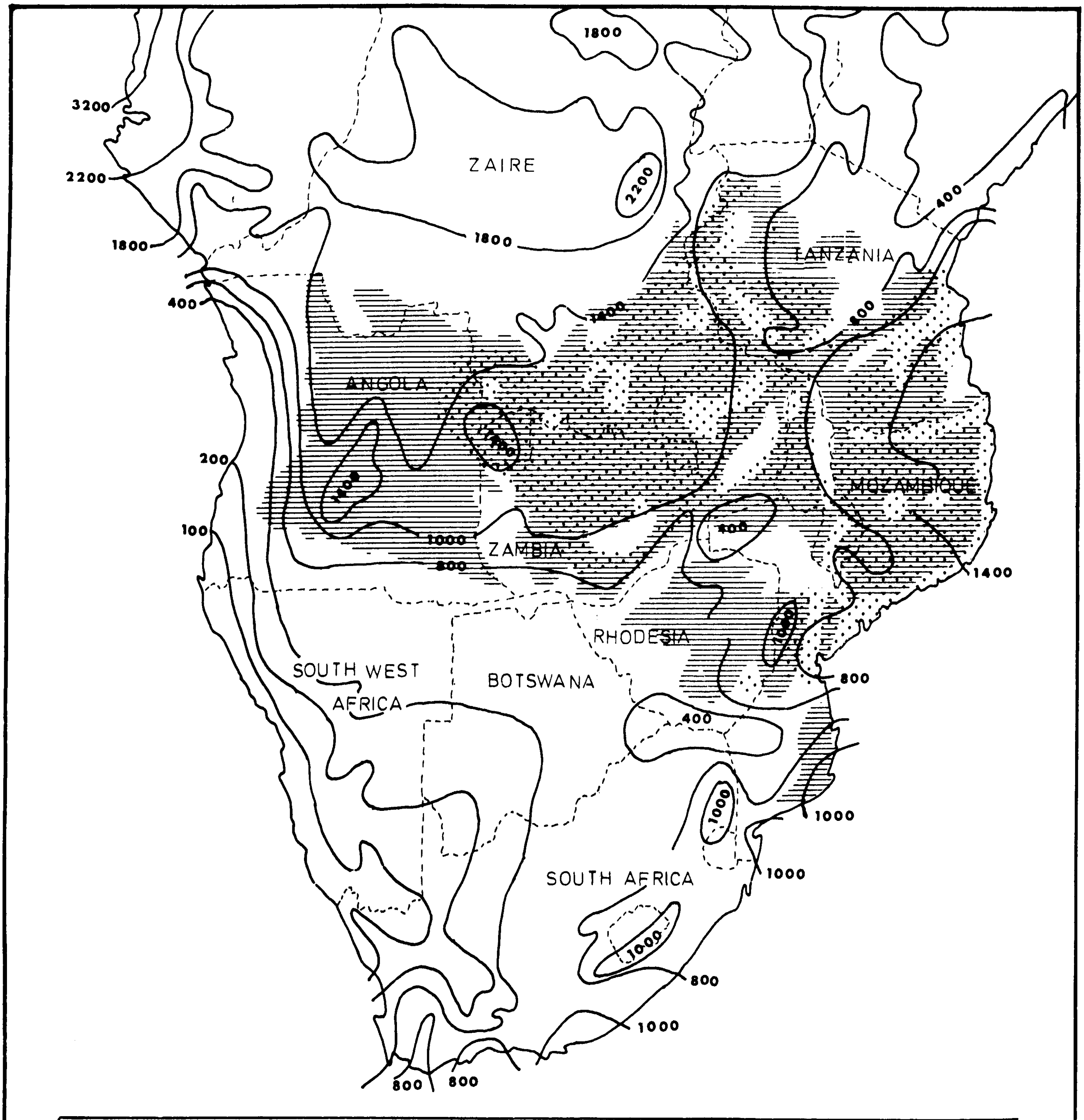

Fig 9: DISTRIBUTION OF LICHTENSTEIN'S HARTEBEEST IN RELATION TO THE *BRACHYSTEGIA* WOODLAND SAVANNA AND MEAN ANNUAL RAINFALL IN SOUTH CENTRAL AFRICA.

▤ — DISTRIBUTION OF *BRACHYSTEGIA* WOODLAND SAVANNA (after KEAY 1959).

⁙ — THE PRESENT DAY DISTRIBUTION OF LICHTENSTEIN'S HARTEBEEST.

800 — THE RAINFALL ISOHYETS (mm).

The physiognomic and vegetational composition of these "dambo" associations are determined by the available moisture content in the environment (see p.128) and thus the prime factor which is of importance is the availability of water in the habitat. It has been shown in the present study (p.89) that Lichtenstein's hartebeest is water dependent and drinks daily. There is also evidence to suggest that the availability of a reliable water source may be an important factor in determining their choice of habitat.

In Fig. 9 the distribution of Lichtenstein's hartebeest in relation to the mean annual rainfall in Africa indicates that they are confined to between the 800 - 1400mm isohyets. It is possible that the dry regions such as that lying across the border of Rhodesia, Botswana, Mozambique and South Africa (i.e. the 400mm isohyet) have been, together with the lack of suitable habitats, natural barriers which have prevented them from extending their range.

Nonetheless, compared with the other species and subspecies of this genus, Lichtenstein's hartebeest enjoys the greatest distribution of all the hartebeest in Africa (Fig. 8). Its range includes Tanzania, Zambia, Zaire, Angola, Malawi, Mozambique and Rhodesia. It is thought to have occurred in the Republic of South Africa although there is no definite evidence for this. Each country will be dealt with separately and where possible the past and present distribution, together with its present day status discussed.

Tanzania

According to Swynnerton and Hayman (1951), three members of the genus *Alcelaphus* occurred in Tanzania. These are Jackson's hartebeest, *A.b.jacksoni*, Coke's hartebeest, *A.b.cokei* and Lichtenstein's hartebeest, *A.lichtensteini*.

Jackson's hartebeest are common in the Bukoba district in the north-western part of the country. Coke's hartebeest is confined to the open savanna bushland and plains country of the Northern and Lake provinces. Their range is limited by the "miombo" woodland and the most southern record of this species is Mbulu ($7^{0}33$'S : $36^{0}38$'E, Swynnerton and Hayman 1951).

At the beginning of the century Lichtenstein's hartebeest was reported to have ranged throughout the "miombo" woodland of the Western, Central, Eastern and Southern Provinces of Tanzania, approximately as far north as Biharamulo, where from north of about $2^{0}00$'S, at Karagwe ($1^{0}15$'S : $31^{0}50$'E) it was replaced by Jackson's hartebeest. They were found in suitable habitat in most areas south of the Wami River and along the eastern shores of Lake Tanganyika (Fig. 10, Swynnerton and Hayman 1951, Sidney 1965).

Lichtenstein's hartebeest are limited by the distribution of the *Brachystegia* Woodland Savanna habitat. In the Western Province, they range from the northern end of Lake Rukwa and the Rungwa River, through the Ugalla and Malagarasi Rivers up to the Kibondo and Kahama latitudes. The species also occurs on the Wembere

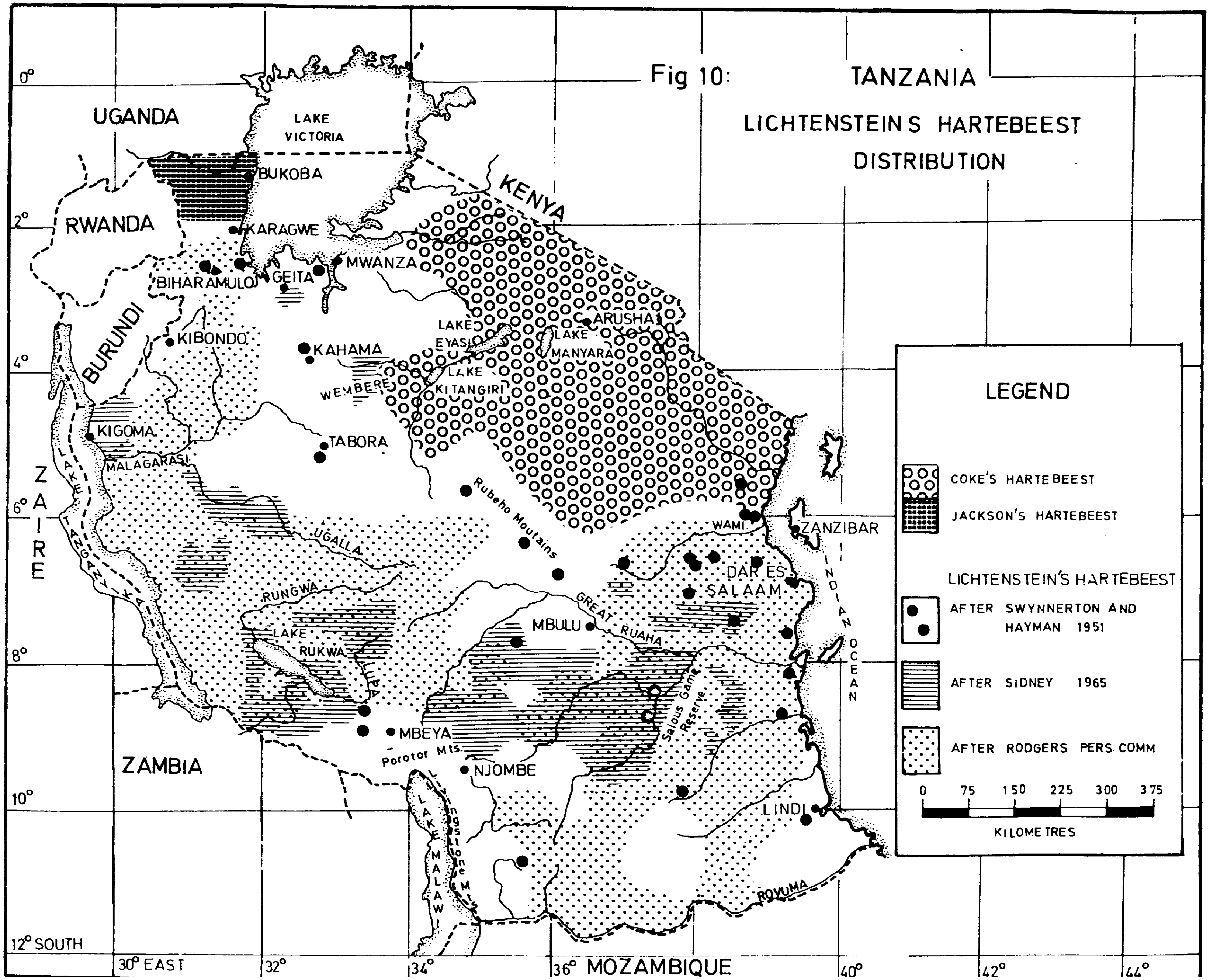

Fig 10: TANZANIA LICHTENSTEIN'S HARTEBEEST DISTRIBUTION

($3^{0}45'$ - $5^{0}10'$S : $33^{0}40'$ - $34^{0}45'$E) where they are replaced eastwards by Coke's hartebeest in the region south-west of Lake Kitangiri.

In the Southern Province, Lichtenstein's hartebeest occurs in much of the northern part of the Province. They do not occur north of Lindi or in the south-easterly direction towards the Ruvuma River, although Swynnerton and Hayman (1951) give a site record from Lindi. They are also absent in the west of the Province along the border of Lake Malawi and do not occur again until Lake Rukwa and the Lupa River in the Southern Highlands. They were fairly common in the Rukwa area, but poaching has seriously diminished their numbers (Vesey-Fitzgerald 1964).

In the Eastern Province they are common throughout, particularly along the Great Ruaha River and along the lower Mbarangundu River (Sidney 1965). The northern most limit of Lichtenstein's hartebeest was given as Karagwe by Sclater and Thomas (1894 - 1900) while Sidney (1965) gives the Geita district and Rodgers (pers. comm.)[1] says that they do not occur north of latitude $2^{0}00'$S. Sidney (1965) concludes that in Tanzania their range had remained fairly static over the last 50 years although when the distribution described by Swynnerton and Hayman (1951) and Sidney (1965) is compared with that provided by Rodgers (pers.comm.) it appears

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[1] A. Rodgers, University of Dar es Salaam, Dept. of Zoology, P.O. Box 35064, Dar es Salaam, Tanzania.

that Lichtenstein's hartebeest has disappeared from many parts of the country, particularly in the north-west in the area of Kahama and Tabora and in the south in the area of Mbeya and Njombe. However the former two authors do not include the south-eastern region in their distribution as given by Rodgers (pers. comm., Fig. 10).

In general the species is well represented in Tanzania and occurs in reasonable numbers in reserves such as the Selous Game Reserve and the Miombo Research Centre (Rodgers 1977).

Zambia

Zambia probably represents the centre of the Lichtenstein's hartebeest distribution. Selous (1893) records that they were plentiful on the road to Monze ($16^{0}17'S$: $27^{0}29'E$) and along the Ungwesi River. Pitman (1934) found them to be common in all the provinces, recording them between the Litapi and Lukolwe Rivers near the Angola border; on the Luli and Kangangwe Rivers; Mobesi and Lutali Rivers (all tributaries of the Kabompo River in the Balovale district); in the Senga district on the Kakengi and Lumba Rivers; in the Sesheke district on the Njoko River (where Selous (1893) also recorded the species); in the Mumbwa and Namwala district and the Kafue National Park. Shortridge shot two specimens in the Kalomo district and in the Namwala district (Kershaw 1922). They were also recorded as being widely distributed in the Serenje and Mpika district (Pitman 1934), while Lloyd (1916) recorded them along the edge of the unburnt vlei near the Kanchibia River.

Ansell (1978) states that the species originally ranged over most of Zambia, (Fig. 11), with the following exceptions. West of the Zambezi River, the Luambiamba River is the southernmost proven limit and there does not appear to be any records from the Mongu district. There are no records of them from the middle Zambezi Valley between Livingstone and the Kafue River confluence, nor from the Mazabuka district. In the montane areas there is no record from the Zambian side of the Nyika Plateau (though a few are known to occur on the Malawi side) nor from the Makutu and Mafinga Mountains.

Sidney (1965) discusses the distribution of the species in all the Provinces of Zambia. In the Eastern Province it was feared that they were becoming extinct. The reasons for this are not given, although Wilson (1966) describes the measures taken to control the hartebeest movement in an effort to reduce the spread of tseste fly in this Province.

In the Petauke district only one herd was known to exist in the northern sector of the Chilingezi Game Reserve, while in the Fort Jameson (= Chipata) district they were rare, probably as a result of tseste fly operations in the district between 1942 - 1959 (Wilson 1966). Ansell (1978) does not indicate any viable populations or former occurrences of the species in this area. In the Lundazi district they were found in small numbers along the foothills and valleys, although not on the Lundazi plateau itself. A few were found in the Lukusuzi Game Reserve.

In the Northern Province approximately 250 were thought to occur in the southern section of the Luangwa Game Reserve and Munyemadzi

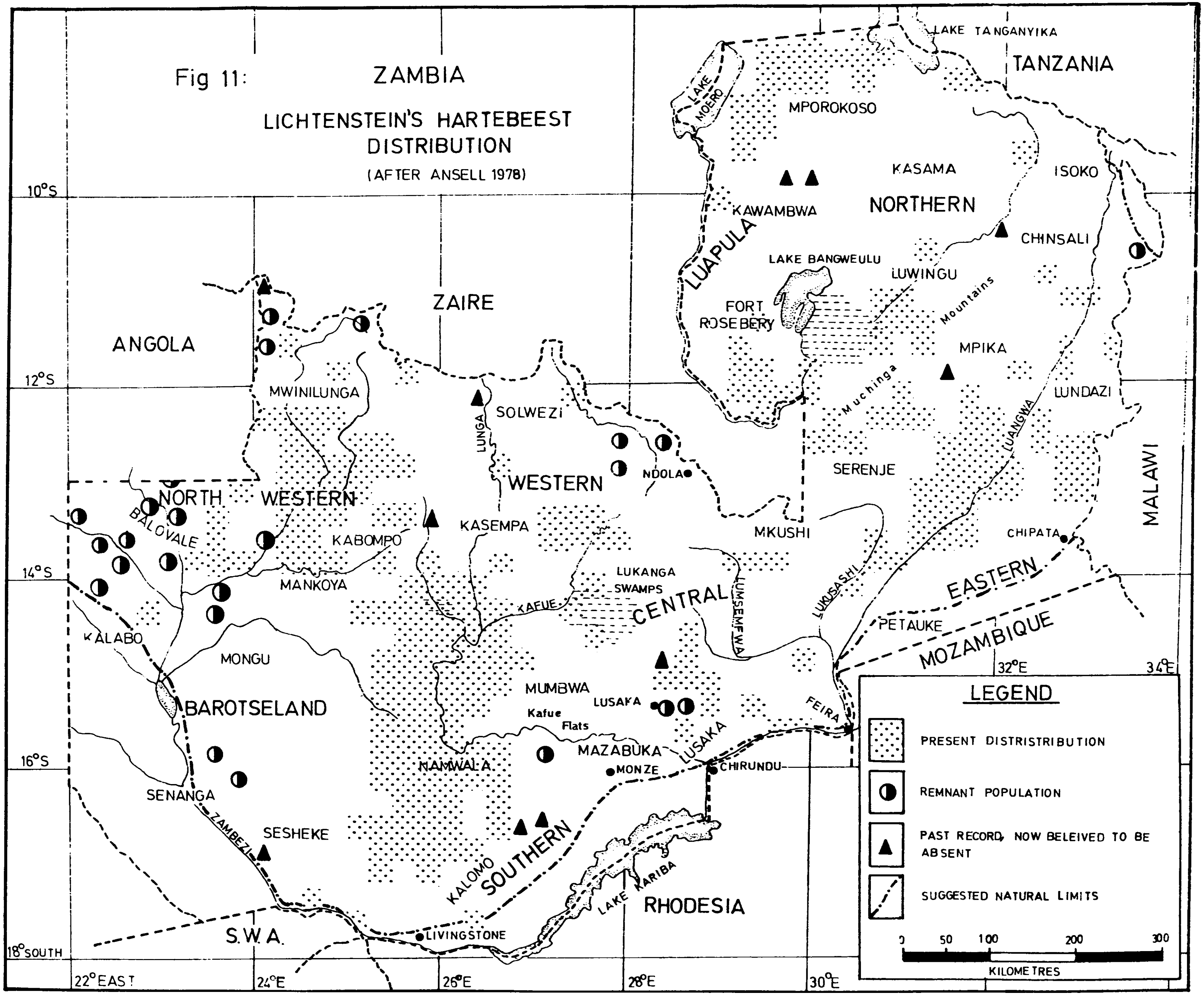

Fig 11: ZAMBIA LICHTENSTEIN'S HARTEBEEST DISTRIBUTION (AFTER ANSELL 1978)

Controlled Hunting Area. Ansell (1978) states that in the Luangwa Valley they are only occasionally found by the main river, but they are known to be locally common in the Brachystegia Woodland Savannas and dambos of the valley away from the riparian belt.

Scattered groups were found on the Mpika plateau, particularly south-east of Lake Bangweulu. They are also recorded in small numbers in the extreme north of the country in the Mweru Marsh (9°00'S : 31°00'E, Sidney 1965).

In the Central and Southern Provinces they occurred in large numbers throughout the Mumbwa-Namwala district east of the Kafue Flats. They do not occur on the Kafue Flats (15°32'S : 27°00'E) although they once occurred along the fringes in the woodlands (Ansell, pers comm.)[1] nor do they occur in the Lukanga Swamp (14°15'S : 27°30'E). In the Lusaka district they had all but disappeared with the exception of a few in the Chainamo Hills and the plateau area south of the Fort Jameson (Chipata) road as far east as the Rufunsa River (15°04'S : 29°34'E). There are no records of them occurring in the Zambezi Valley from Chirundu to Feira, or in the lower Luangwa Valley except for a report of four hartebeest seen about half a mile east of the lower Chakwenga stream and two miles (three kilometres) from the Zambezi (15°36'S : 29°40'E, Morris 1966), and from the

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[1] W.F.H. Ansell, Trendrine, Zennor, St. Ives, Cornwall, England.

Muskika stream some eight kilometres from the Zambezi (Ansell 1978). In the Chisomba Controlled Area, along the lip of the Luano Valley ($14^{0}40$'S : $30^{0}00$'E) which joins the plateau areas of Kabwe (Broken Hill) and Mkushi districts, there existed a sparse population of hartebeest as far north as the Kapiri M'Poshi - Serenje road ($13^{0}59$'S : $28^{0}43$'E) and as far east as the Mkusi - Lukusashi watershed. Ansell (1978) says that Lichtenstein's hartebeest are thought to be scarce in the Lukusashi and Luano Valleys. In the Serenje district, where Pitman (1934) described them as being common, they have disappeared completely except for the area around Kasanka Game Reserve and the Mukulu area.

In the Kafue National Park more hartebeest were found in the southern sector than in the north. The area south of the Mumbwa - Mankoya road contained hartebeest, as did the Namwala district but even in 1965 this area was being heavily poached. In the Sichifula Controlled Area and south of the Sichifula River between it and the Ngwezi River ($17^{0}15$'S : $26^{0}00$'E) they were common. A few may have survived on the Simaraha Flats in the south-west (Sidney 1965).

In the Western Province of Zambia the hartebeest were more widely distributed than in any of the previously mentioned Provinces. They were common in the Balovale and Kabompo districts, where they occurred sympatrically with the tsessebe (unpublished report, Northern Rhodesia Game Department, undated). In the Mwinilunge district, south between the Lunga ($13^{0}30$'S : $26^{0}30$'E) and the Kabompo Rivers (in the Lunga Game Reserve) hartebeest occurred where suitable habitat was available. South of the Solwezi - Mwinilunga road they were generally distributed and it was reasonably certain that they extended over the border into Angola here, as well as into the Kabompo district.

Around Mwinilunga itself and to the north they probably occurred but were scarce. In the Solwezi district they were common, especially in the south-east and south-west away from the roads and in this district they extended over the border into Zaire. Ansell (1978) however, gives only one record of hartebeest in this region (Fig. 11).

On the Copperbelt game in general is scarce as can be expected in an industrial area. In the Ndola area hartebeest did occur while in the Kasempa district they were widely distributed, being most numerous east of the Lunga River between the Kabompo and Dongwe junction (13°55'S : 24°20'E). In Barotseland, hartebeest may have occurred, although there are no reliable records of any having occurred there. Ansell (1978) quotes a dubious record of hartebeest from the Kulonga Plain, near the Mashi River in the extreme west of the Senanga district. In 1959, says Ansell, a District Commissioner's report states that hartebeest were common throughout the Mankoya district. Ansell (pers. comm.) suggests that the probable natural limit of Lichtenstein's hartebeest distribution in this district is the Zambezi River (Fig. 11). Selous (1893), Pitman (1934) and Shortridge (1934) recorded hartebeest in the Sesheke district.

Ansell (1978) concludes that Lichtenstein's hartebeest are no longer common in Zambia and have disappeared from many areas altogether.

Other records (after Ansell 1978) include:
Saisi Flats, Ifuluta Pan, Namukokoba Stream, Luambimba River and on the east bank eight miles (12,8 kilometres) downstream from Mbumi confluence. There is also a wildlife guard's report of 15 hartebeest seen in the Mbumi area in 1971.

Zaire

Two species of hartebeest are reported to occur in Zaire, Jackson's hartebeest, A.b.jacksoni (= Lelwel's hartebeest, A.b.lelwel) and Lichtenstein's hartebeest, A. lichtensteini (Schouteden 1945). Jackson's hartebeest is reported to be confined to the north-eastern part of the country near the Sudan border. Lichtenstein's hartebeest is confined more to the southern part of the country in the Shaba Province (Fig.12).

Ansell (in Sidney 1965) claimed that the distribution of Lichtenstein's hartebeest extended across the border from Zambia into the Solwezi district of Zaire. Verheyen (1951) found Lichtenstein's hartebeest on the Kibora plateau as well as small herds in the Upemba National Park, while they were described by Schouteden (1945) as being characteristic of the fauna of the Katanga (= Shaba) Province and were met up with as far north as the Luama River (4^o33'S : 27^o40'E), north west of Lake Tanganyika. Jobaert (1954) found them in Tshofo south east of the Kabinda Enclave.

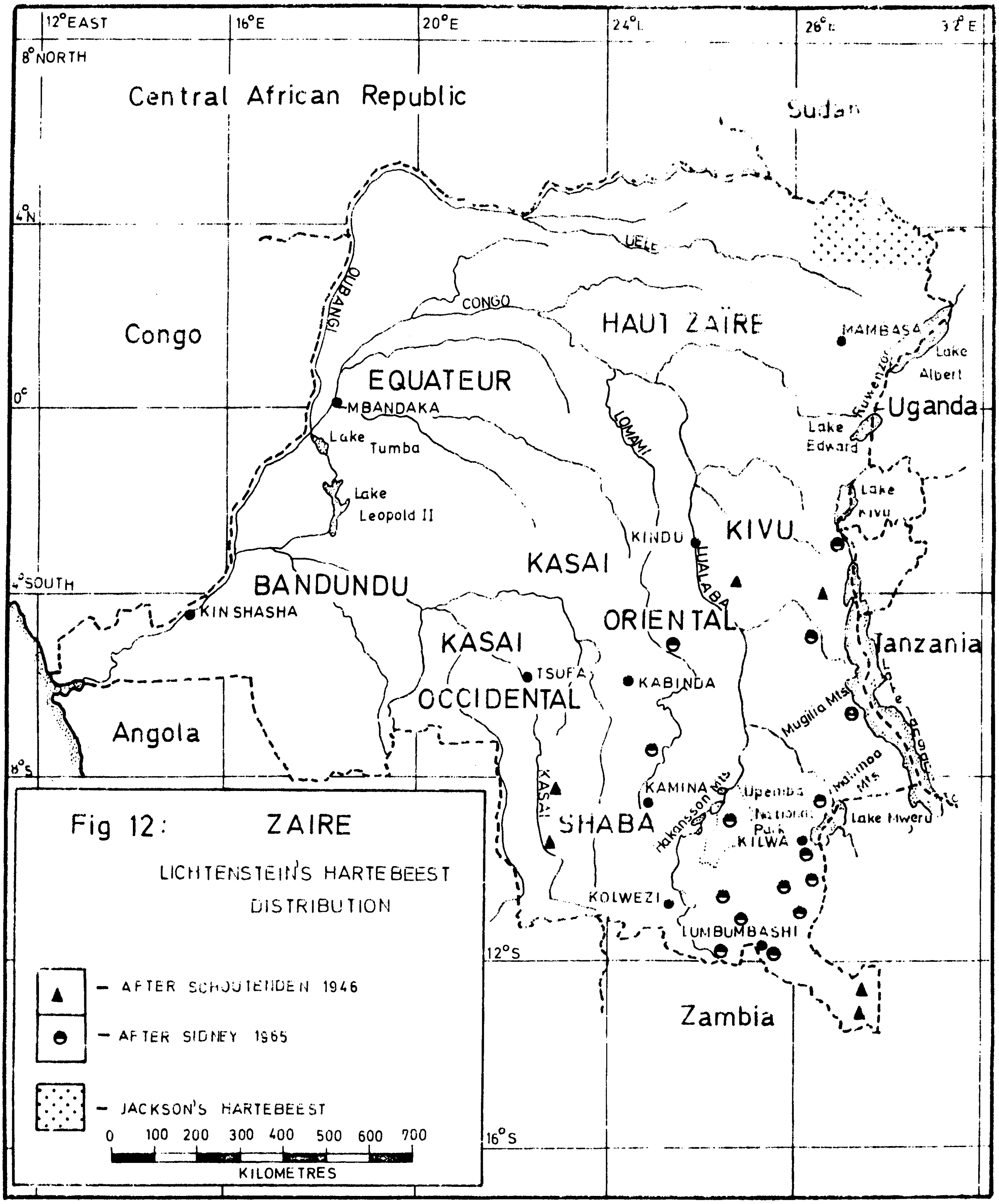

Fig 12: ZAIRE

LICHTENSTEIN'S HARTEBEEST DISTRIBUTION

Schouteden (1945) lists the following localities from which Lichtenstein's hartebeest has been recorded:

Kivu District	Uvira	3°22'S : 29°03'E
Tanganyika District	Mpala	6°45'S : 29°31'E
	Kiamba	7°20'S : 28°01'E
	Niemba	5°57'S : 28°26'E
	Marunga (Tanzania)	3°44'S : 30°48'E
Upper Katanga	Lukonzolwa	9°38'S : 28°19'E
	Kilwa	9°28'S : 28°19'E
	Kibalashi (Kiberashi River?)	5°23'S : 27°26'E
	Pokoro River	?
	Kasenga	10°22'S : 28°38'E
	Mulando, Luapula River	9°26'S : 28°33'E
	Biano (Biaro?)	0°14'N : 25°24'E
	Kipushia	0°46'N : 27°14'E
	Mongwe-Sapwe	10°57'S : 28°10'E
	Lumbombo	?
	Futwe	?
	Mivabo-Mumima (Mumena?)	11°34'S : 26°55'E
Lualaba District	Kinda	9°18'S : 25°04'E
	Kapiri	?
	Lukafu	10°34'S : 27°55'E
	Kamulongo	?
Sankuru District	Tshofa (Tshofo?)	5°08'S : 25°08'E

Sidney (1965) provides the following localities where mention is made of Lichtenstein's hartebeest:

Guba Plains	$10^{0}40'$S : $26^{0}26'$E
Lumma (Limma or Luama River?)	-
Dogodo River	-
Kundelungu	-
Bakonnana	-

There is no recent information on the status of the wild fauna in Zaire and thus it is not possible to make any valid assessment of the survival status of the species there. Ansell (pers. comm.) believes that they may still be present in the more remote parts of the Shaba Province, though doubtless very badly reduced in the South-eastern Shaba Province where there is more settlement.

Angola

Hill and Carter (1941) did not record the presence of Lichtenstein's hartebeest at all in Angola, although Ansell (1959) recorded that they extended into Angola from the Balovale district (Zambia), both westward of $22^{0}00'$ east and northwards of $13^{0}00'$ south on both banks of the Zambezi River. Machado (1969) confines the distribution of Lichtenstein's hartebeest to the Lunda district near the Zaire border and in the Moxico district in eastern Angola (Fig. 13).

Both Ansell (pers. comm.) and Huntley (pers. comm.)[1] believe that this species may still survive in these remote areas, although no-one could be certain of this owing to the total lack of inform-

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[1] B.J. Huntley, CSIR, P.O. Box 395, Pretoria 0001, Republic of South Africa.

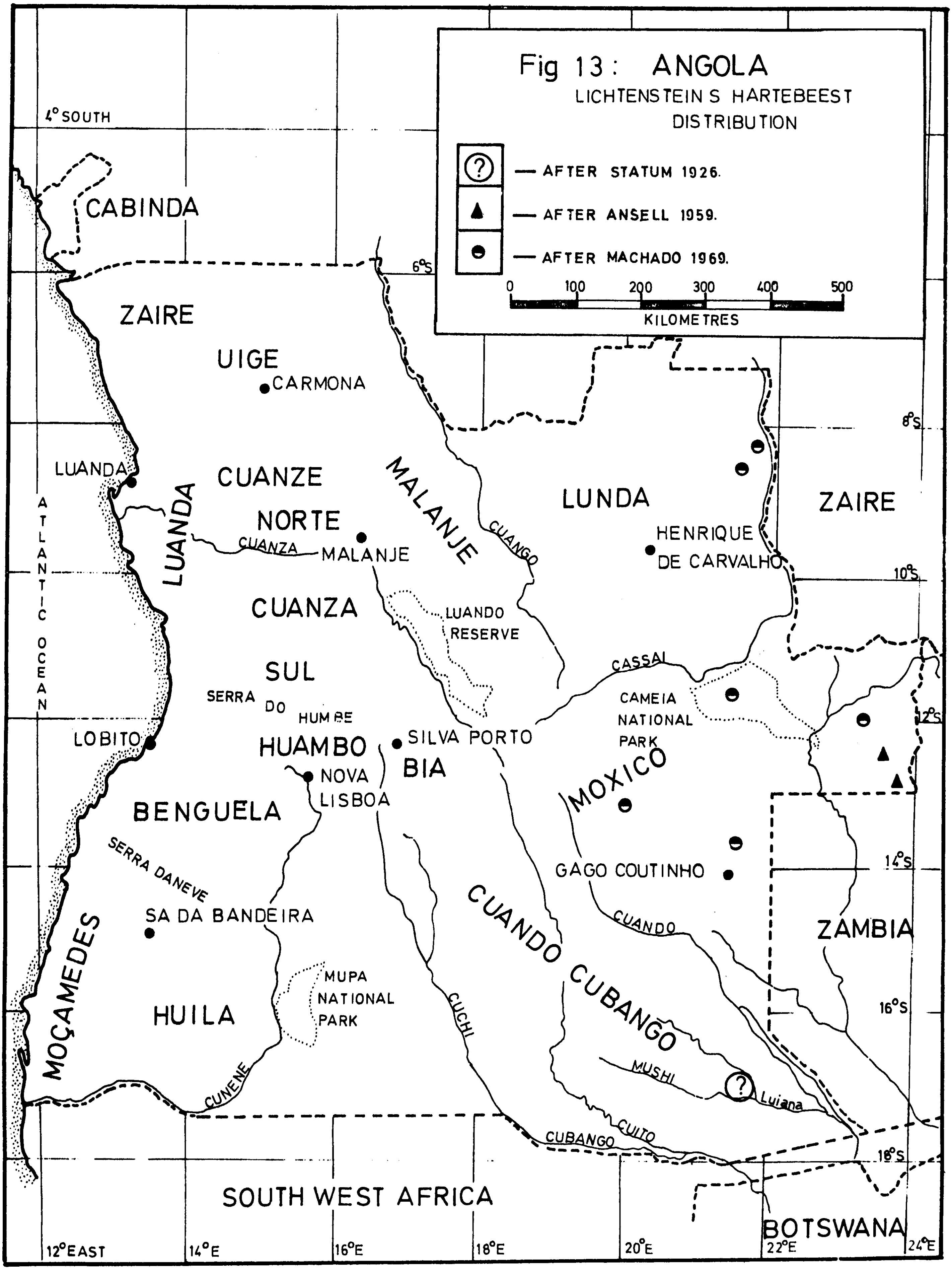

Fig 13: ANGOLA
LICHTENSTEIN S HARTEBEEST
DISTRIBUTION

ation on the status of all antelope in Angola.

Ansell (1978) discusses the record of Statham (1926) who recorded Lichtenstein's hartebeest from the confluence of the Luiana and Mushi Rivers. It is thought that this may have been an incorrect sighting, confusing Lichtenstein's hartebeest with tsessebe or red hartebeest (Ansell; In Meester and Sestzer 1971) although Statham was familiar with the latter two species. There is no record of either red hartebeest or tsessebe from the area - the former are concentrated between the Cunene and Cubango Rivers, while tsessebe range from the Cameia National Park and neighbouring areas of Moxico district southwards through the Cuando-Cubango district to the border with South West Africa/Namibia (Newton Da Silva ; In Mellon 1975).

If this identification is correct, then it would presumably have referred to an isolated population of Alcelaphus lichtensteini distinctly separated from the main range. Ansell (1978) discounts Stathams record especially since there is only one single and unconfirmed record of such a conspicuous animal.

Malawi

The broken nature of much of Malawi, together with the diversity of its climate has resulted in a wide range of vegetation types, ranging from an alpine zone on the Nyika Plateau to Brachystegia Woodlands which cover three quarters of the country. The low lying country along the shores of Lake Malawi and down the Shire Valley is characterised by a mixture of Acacia and Combretum while Colophospermum mopane Woodland is only found along the valley floor of the Shire River. The only open plains are found in the region of Lake Chilwa (Mitchell 1953).

The Brachystegia Woodland, in its various forms, ranges in altitude from little more than 150 m above sea level up to the margins of the montane forests and grasslands. This woodland is intersected by open dambos - the term "dambo" refers to a formation which is so very characteristic of central Africa and is recognized as that part of a valley or drainage line from which most trees are excluded by a high water level in the soil during the rainy season.

These dambos have been quoted numerous times (Dowsett 1966, Rodgers 1969a) as being a favoured habitat of Lichtenstein's hartebeest and therefore it is not surprising that they were once an abundant species in Malawi. However by the turn of the century they were no longer common (Lyell 1912) and by 1940 they were confined to the more remote and undeveloped areas, while others were protected in game reserves and "non-shooting" areas (Mitchell 1953, Hayes 1953).

In the Southern Province they were numerous in the Chikwawa district ($16^{\circ}02'S : 34^{\circ}50'E$), particularly on the west side of the Kwanga River towards the Mozambique border (Sidney 1965). They were found in the Mijete non-shooting area (Hayes 1953) as well as being common in the Kasungu National Park and Kota-Kota Game Reserve. In the Northern Province they are found in the Nyika National Park and around Lake Kazumi and Voisa Marsh. Cater (1953) reported two individuals on the Nyika Plateau (Fig.14).

Mitchell (1953) gives the following areas from which hartebeest have been recorded: Lengwe, Mwabvi, Kasungu National Park,

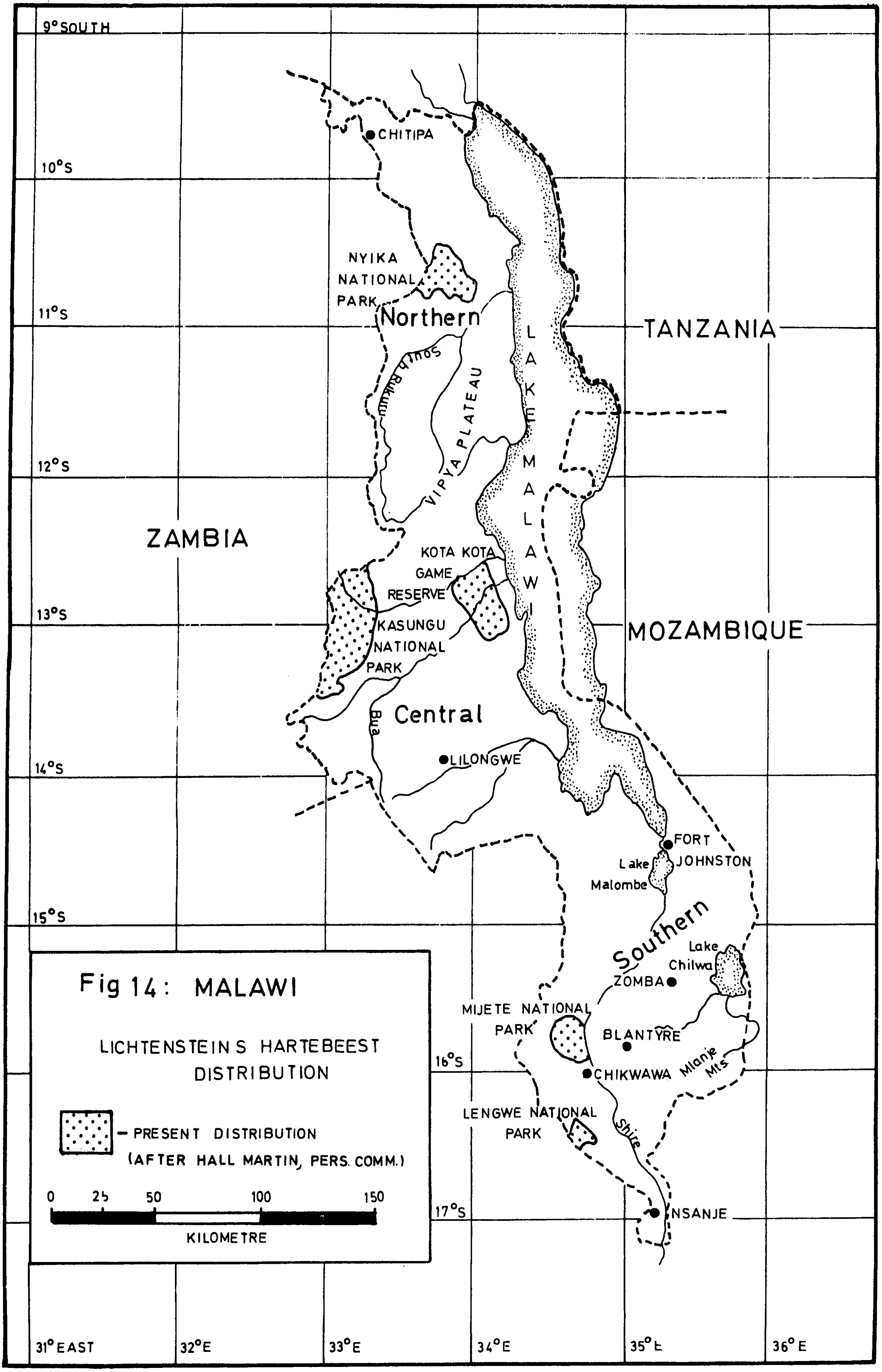

Fig 14: MALAWI

LICHTENSTEIN S HARTEBEEST DISTRIBUTION

Kota-Kota Game Reserve and the Mijete and Nyika non-shooting areas. Hall-Martin (pers. comm.)[1] comments that by 1970 this species had been exterminated over a large area and were only to be found in reasonable numbers in the National Parks and immediate surrounding areas, while remnant populations were found in the Kota-Kota Game Reserve and the Mijete National Park. A few stragglers were seen in the Lengwe National Park.

No reliable information is available on the present day status of this species in Malawi.

Mozambique

Lichtenstein's hartebeest was first discovered in 1852 by the German explorer, Peters, in the Sena District of the lower Zambezi and was named by him after his compatriot, Lichtenstein, who travelled extensively in the Cape Province of South Africa in the early 1800's.

Of this species Selous (1893) says:

> "I had myself seen and shot these animals near Kafukwi River north of the Zambezi, and believe it to be the common species of hartebeest met with in south-central and East Africa."

Sidney (1965) interprets the Selous records of this species as occurring in Mozambique, where in fact the only time Selous mentions this species as occurring in Mozambique is on the Pungwe River (In Bryden 1899). If one correlates the name places given by Selous on the map in "Travels and Adventure

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[1] A.J. Hall-Martin, Nature Conservation, Kruger National Park, Private Bag X 404, Skukuza 1350, Republic of South Africa.

in South East Africa" with a modern day map, it is apparent that his experiences with this species occurred in Zambia.

Lichtenstein's hartebeest occur throughout Mozambique north of 24°00' south (Sidney 1965), although Ansell (In Meester and Sestzer 1971) quotes Tello who gives the southern most distribution as being Mopwhere (22°00'S : 35°00'E). This is supported by Tinley (pers. comm.)[1] and Sparrow (pers. comm.) who both have first hand knowledge of this species on the Mbanyini (22°00'S : 33°00'E). Smithers and Tello (1976) believe that they were very common between the Save and Limpopo Rivers (Fig. 15), although Von Alvensleben (In Dalquest 1965), who has been associated with this region for many years, states that they are not as common to the south of the Save River as they are to the north. Unfortunately there is no written record of the fauna that occurred between the Save and Limpopo Rivers. Vasse (1909) intended travelling into this region but was put off by his natives who claimed that the region did not support a large amount of wildlife. It is therefore difficult to determine the early distribution of Lichtenstein's hartebeest in this region. Shortridge (1934) and Tinley (pers. comm.) believe that this species extended in the past as far south as northern Zululand, part of eastern Swaziland and the south-eastern Transvaal. There is no evidence to support this and considering that Lichtenstein's hartebeest is confined to the Brachystegia Woodland habitat elsewhere in Africa, and that this region between the Save and Limpopo Rivers falls into a low rainfall area (see Fig. 9), it

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[1] K. Tinley, Blue Bend, P.O. Box 2021, Beacon Bay, 5205, Republic of South Africa.

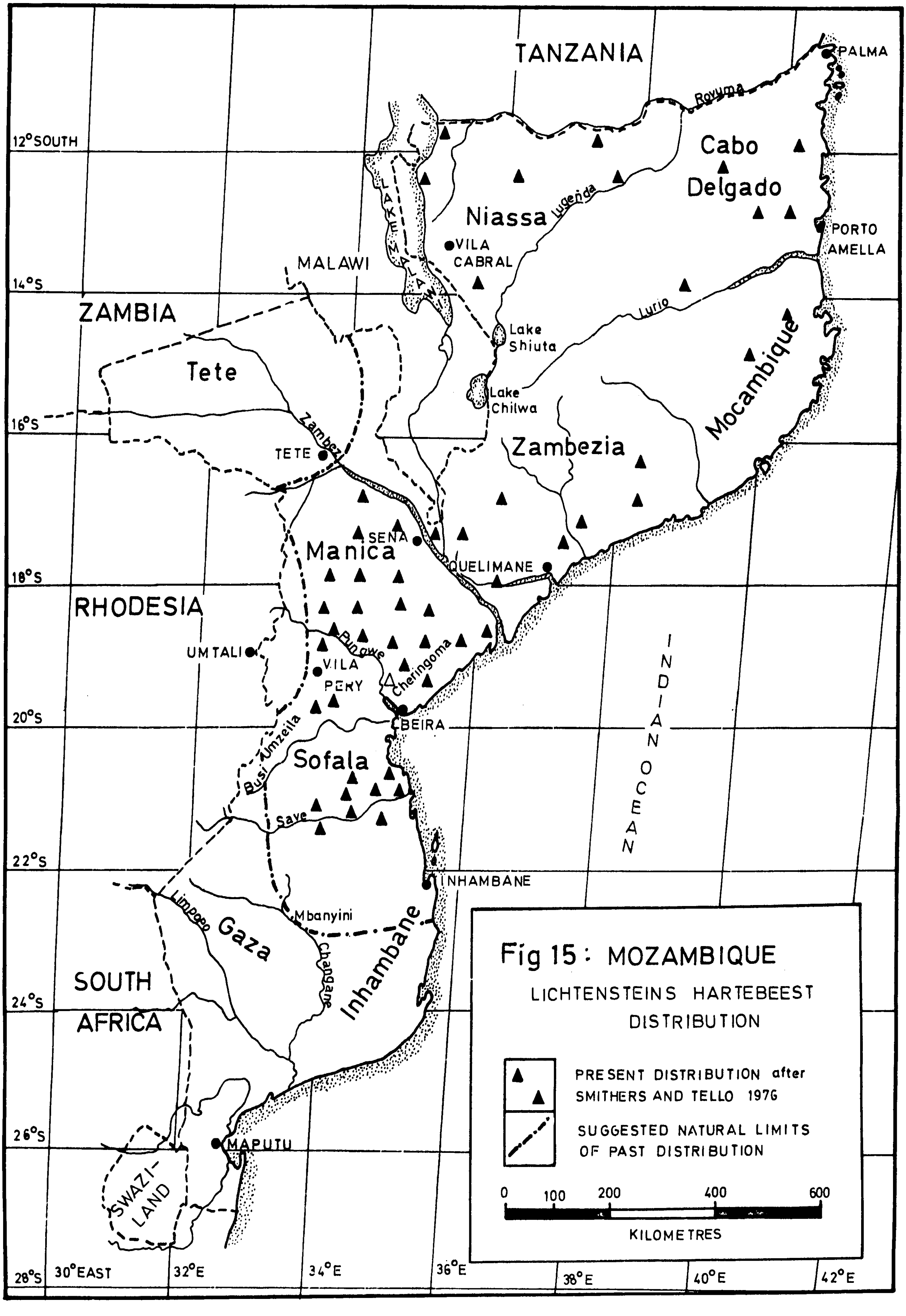

Fig 15: MOZAMBIQUE

LICHTENSTEINS HARTEBEEST DISTRIBUTION

is unlikely that Lichtenstein's hartebeest extended into this region in any great numbers. This issue will be discussed further in the section dealing with South Africa.

Elsewhere in Mozambique, Lichtenstein's hartebeest was well represented in the past. Nicholls and Eglington (1892) record that they were plentiful in "Umzeila's" country which lay between the Buzi and Lusitu Rivers (Swynnerton 1920), who also confirms this observation, stating that Lichtenstein's hartebeest was present in large numbers east of the Sitatonga Ridge (20^{0}18'S : 33^{0}12'E).

Kirby (1899) recorded Lichtenstein's hartebeest in the Gorongoza district where he found them on the Injobou and Inkambedsi Rivers and throughout the Mozambique Province in the open hill country in the Lumwi, Injerezi, Ingundungwa and Chingwari ranges. The hartebeest did not seem to penetrate the Chiringoma plateau, but preferred the hilly country along the base of the plateau. Findley (1903) who hunted in the Gorongoza district records shooting Lichtenstein's hartebeest on the outskirts of the "Chiringomá Forest" and again on the banks of the Mwaredzi River.

Vasse (1908) states that they were the most abundant "game" in the country, although his travels were limited to the central province south of the Busi River and as far north as the Sena District. Lyell (1910) found them to be common in the regions north of the Zambezi River east of Lake Chiuta (= Shiuta).

More recently, Smithers and Tello (1976) recorded this species on the north bank of the Save River northwards in the eastern parts of Vila Pery and Beira districts to the Zambezi River. In the south, a relic population was thought to occur in the extreme north-eastern part of the Inhambane district, although Von Alvensleben (pers. comm.)[1] reports that this is no longer the case. Smithers and Tello (1976) also give two sight records south of the Save River (Fig. 15). Apparently these records are of two small hartebeest populations that were captured north of the Save River and released in this area by Von Alvensleben in order to enhance the spectrum of game available for his safari industry in this district (Von Alvensleben, pers. comm.) as they did not occur there naturally.

North of the Zambezi, Smithers & Tello (1976) give visual records from Zambezia, eastern Mozambique, Cabo Delgado and Niassa districts. There were no records of them from the Tete district, although the original type specimen was secured in this area (Peters 1852). It was probably shot, however, south of the Zambezi River south-east of Tete in the Sena district where this species still occurs today. Tinley (pers. comm.) says that, according to natives in this district, Lichtenstein's hartebeest occurred north of the Zambezi River in the Tete district, although Ansell (1978) does not give a sight record from Zambia in this area and questions whether this species occurred along the Mozambique/Zambia border at all (see Fig. 11, Zambia). Added to

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[1] Baron W. von Alvensleben, Flat A208, Riepen Hall, 16 Argyle Avenue, Riepen Park, Sandton, 2199 Transvaal, Republic of South Africa.

this, there is once again some correlation between aridity in this region of the Zambezi Valley (Fig. 9) and the suitability of the available habitat (dominated by Colophospermum mopane, Kaey 1959) which would prevent its occupation by Lichtenstein's hartebeest.

The status of this species in Mozambique at the present time is unknown although Tinley (pers. comm.) comments that they are still plentifull in the National Park areas.

Republic of South Africa

The distribution of Lichtenstein's hartebeest was established with some certainty by early authors as far as the regions north of the Save River in Mozambique, however, south of that river, its presence was suspected but never confirmed (Bryden 1899, Sclater and Thomas 1894 - 1900). Lydekker (1908) sums up these early authors and gives the distribution as "East Africa, north of the Sabi River, throughout Nyasaland (Malawi) and Mozambique to Usagara (Tanzania)".

Lichtenstein's hartebeest are thought to have occurred in the north-eastern Transvaal (Haagner 1920) and northern Zululand (Shortridge 1934). There is no doubt that they occurred south of the Save River in Mozambique, however, there is no evidence to suggest that they occurred as far south as the Mozambique/ Swaziland/South African borders.

The sole evidence for their occurring in the Transvaal rests on a specimen, supposedly from the Lydenburg district (25°10'S : 30°29'E), cited by Roberts (1914). No record of this specimen or other data appertaining to it could be traced in the Transvaal

Museum (Ansell; In Meester and Setzer 1971).

Kirby (1896) gives a list of the various species he encountered in the Kahlambo-Limbombo region (24°00'S : 30°00'E) and makes no mention of hartebeest, although of tsessebe he says;

> "This antelope is more partial to the open plains than the bush country..... it is commonly found in the bush about Swinga, Nguanetsi and Timbabati Rivers".

Stevenson-Hamilton (1947) says of hartebeest;

> "In the true hartebeest the peculiarities of the genus are very marked. The horns are heavily ringed for the greater part of their length and more or less sharply twisted back about the middle. Eight species are recognized in the Ethiopian region, of which only one species exists in the Union".

Of the red hartebeest (Alcelaphus caama) he states;

> "The species has apparently never existed in the Transvaal lowveld where its place is taken by its distant relative the tsessebe.... there is a small herd (of hartebeest) said to represent a slightly divergent type preserved on a private farm in Natal".

He gives the range of tsessebe as;

> "..... extending throughout Southern Rhodesia, westward to north of Lake Ngama and eastward through the north-eastern Transvaal, Gazaland and P.E.A., generally south of the Zambezi. The Inkomati River appears to be its southern limit".

Stevenson-Hamilton (1912) writes that Lichtenstein's hartebeest are seldom found south of the greater Sabi River. This should be interpreted as being the Sabi River of Rhodesia and the Save River of Mozambique and not that of the eastern Transvaal. It is true that early hunters and authors may have confused red hartebeest, tsessebe and Lichtenstein's hartebeest, however, in reviewing the albeit scant evidence and correlating it to the influence of vegetation and climate on the overall distribution of Lichtenstein's hartebeest, it is doubted whether this species ever occurred in the Transvaal. As Kettlitz (In Meester and Sestzer 1971) points out, if Lichtenstein's hartebeest had occurred in the Transvaal, there would be more evidence to support it. It is possible that the early hunters and prospectors that travelled into the south-eastern lowveld of Rhodesia (see p.4) acquired a specimen of Lichenstein's hartebeest horns and brought them back after the hunting trip. This seems a more logical explanation for the specimen recorded from Lydenburg.

When considering the possibilities of their occurrence in northern Natal, the confusion is even greater. There is no doubt that a hartebeest species occurred in Natal and northern Zululand, however, in none of the references except that of Delegorgue (1847; In Bigalke 1966) who refers to *Acronotus caama* (= *Alcelaphus caama*), is this species named.

The "Zululand hartebeest" which is usually credited as being the red hartebeest, has also been interpreted as being the tsessebe or "Bastard hartebeest" of the early Dutch settlers (Bryden 1899). Shortridge (1934) believes that the "Zululand hartebeest" may have been Lichtenstein's hartebeest which extended as far south as Swaziland.

There are several records of hartebeest occurring in Natal. Drummond (1875) gives an account of hunting hartebeest on the north-western grass plains of Zululand. He describes up to 40 animals in a herd, which is more easily explained as being red hartebeest than Lichtenstein's hartebeest which seldom occur in herds of more than 20 animals.

Van Oordt (1894) who was the first ranger to the now defunct Pongola Nature Reserve (see Bigalke 1966, the Pongola Nature Reserve was situated in the enclave between Swaziland, Natal and Transvaal - Fig. 16) records both tsessebe and hartebeest as occurring in the reserve. However no mention is made of the hartebeest species involved.

The Natal Parks Board (Poggenpoel, pers. comm.)[1] has researched the occurrence of hartebeest in Natal (Fig. 16). None of the records refer to a specific species, however Handley (1950) speaks of personal experiences with red hartebeest in Natal. With regard to their distribution, he claims that they were found on "the rolling middleveld flats" in the Eston area, on the Dalton Flats, the area from Seven Oaks to Greytown and a troop on the Elandslaagte Flats and Vryheid area (Fig. 16).

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[1] Mrs. B. Poggenpoel, Natal Parks, Game and Fish Preservation Board, P.O. Box 662, Pietermaritzburg, Republic of South Africa.

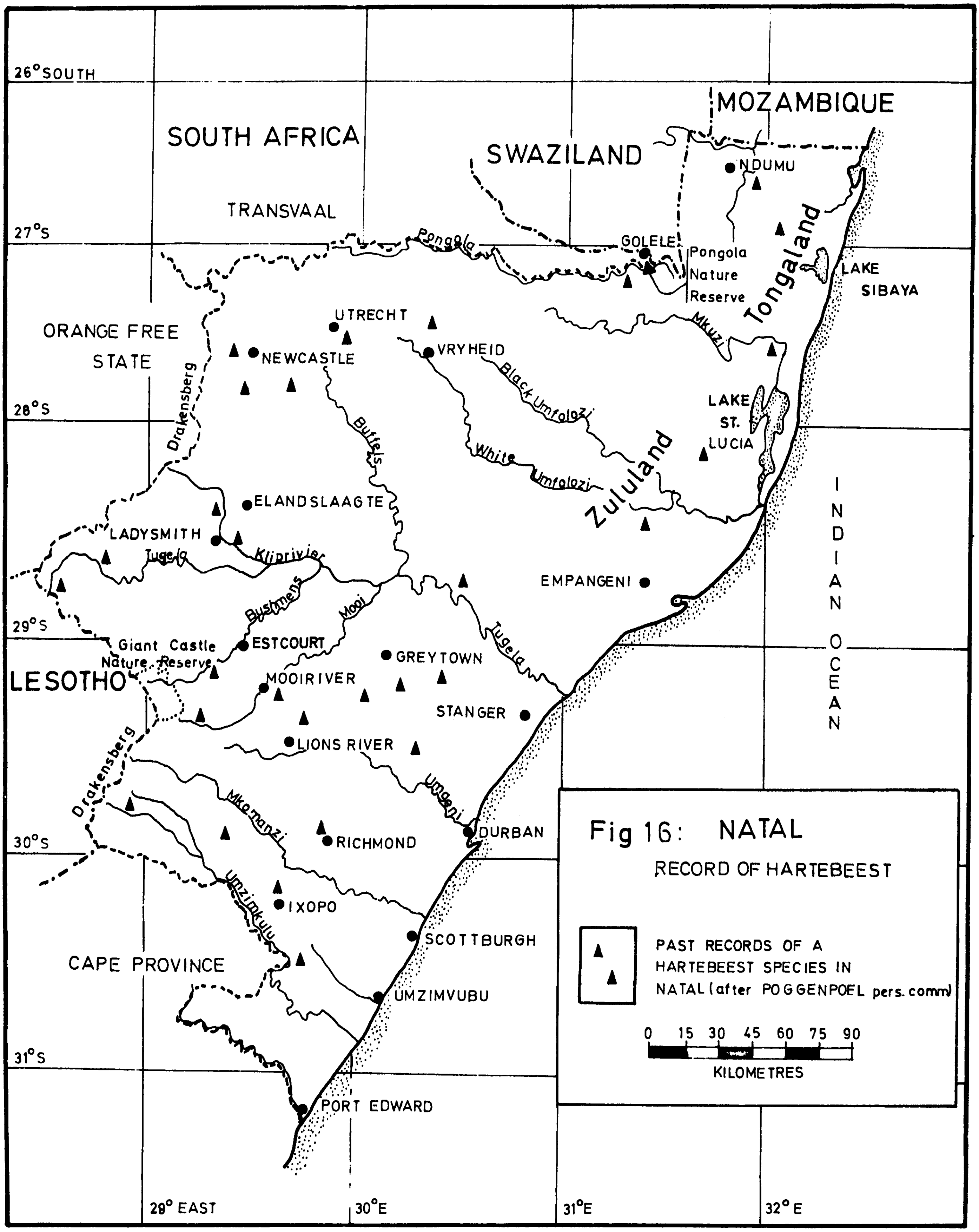

Fig 16: NATAL

RECORD OF HARTEBEEST

▲ PAST RECORDS OF A HARTEBEEST SPECIES IN NATAL (after POGGENPOEL pers. comm)

Pringle (1963) points out that since the earliest game laws were passed in Natal, the red hartebeest has always been regarded as "Royal Game". He goes on to quote several people who had personal experiences with the red hartebeest in Natal and Adendorff (1961) comments on a cross between a red hartebeest and a blesbok in the Ermelo district ($26^{0}31'S$: $29^{0}59'E$) near the Swaziland border.

The confusion that has arisen as to whether the hartebeest that occurred in Natal was the red hartebeest or Lichtenstein's hartebeest has been enhanced by the lack of unequivocal evidence as to which species actually occurred there. This confusion has been carried further in cases where the tsessebe has been referred to as the "Zululand hartebeest" which was later interpreted as being Lichtenstein's hartebeest.

It is interesting to note that the Swazi refer to tsessebe as "Mzansi" (Kirby 1896, Bryden 1899) while the Shaangan of Mozambique refer to Lichtenstein's hartebeest as "Mzasi" or "Mzanzi" (Sparrow, pers. comm.).

Northern Zululand was the favourite hunting ground of many early hunters and it is unlikely that those hunters, who succeeded in shooting just about everything that roamed in that region (Stevenson-Hamilton 1903), would have missed an ungulate such as Lichtenstein's hartebeest. I believe it would be wise in this instance to rely more on the older reports of game distribution in this region than those at the beginning of the century, for by this time the game in Natal had been heavily exploited which probably led to much of the confusion that exists with respect to hartebeest.

Sclater and Thomas (1894 - 1900) quoting Buckley's paper (1876), "Geographical distribution of South African mammals" says this of Alcelaphus caama:

> "He observed it only on three or four occasions during his journey into the interior - once just before reaching the Crocodile River and once or twice in the Colony of Natal. In the south-east, he says a few then still remained in Zulu country, but he could not hear of its occurrence in Swaziland, where its place seemed to be taken by the Sesseby".

Buckley was familiar with Lichtenstein's hartebeest, for in the same paper he says that he ".... met with it in the rough grassy plains of the upper Pungwe valley...." (Sclater and Thomas 1894 - 1900).

It is apparent that in Natal, the red hartebeest was never very common, being more predominant in the southern part of Natal and probably occurring at the extreme limit of its range in northern Zululand. It is possible that, in regard to Litchenstein's hartebeest in Zambia and to a lesser extent in Angola, Rhodesia and Mozambique, that tsessebe have replaced Lichtenstein's hartebeest and probably a similar situation has arisen between the red hartebeest and tsessebe in Zululand and Swaziland. Furthermore, since Lichtenstein's hartebeest shows a preference for the Brachystegia dominated woodlands throughout its distribution elsewhere in Africa, it is unlikely that it would diverge from this norm elsewhere and thus it is highly unlikely that Lichtenstein's hartebeest ever occurred in Natal in historical times.

Rhodesia

The literature concerning the distribution of Lichtenstein's hartebeest in Rhodesia covers two periods. Prior to the turn of the century, authors such as Selous (1881, 1893), Churchill (1893), Millais (1899) and Hyatt (1914) provide some information. From the early 1900's, the only sources of information are from the unwritten records of the early pioneers who settled in many parts of the south-eastern lowveld of Rhodesia.

The earliest records of hartebeest are those of the Bushmen (Cooke 1964). Two paintings occur in Matabeleland which probably represent the red hartebeest while in Mashonaland there are 22 paintings - mainly north of Umtali - Salisbury road and in the Lomagundi district - which dipict what is interpreted as Lichtenstein's hartebeest (Fig. 17). On "Gloverholm" farm in the Marandellas district there are paintings of hartebeest together with those of kudu, reedbuck and duiker (Ford, pers. comm.)[1] Cooke (1964) believes that Lichtenstein's hartebeest did occur in these areas, since the habitat is very similar to that cross the border in Mozambique where hartebeest do occur. However care should be exercised when interpreting such paintings since it is not clear whether the Bushmen painted what they actually saw in the immediate area or were illustrating to others what they had seen in distant places. However, there is a strong possibility that Lichtenstein's hartebeest were present in this region.

Fredrick Selous (1881) was the first to bring to the attention of the Zoological Society in London, that there was a hartebeest

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[1] Mr. T.H. Ford, P.O. Box 371, Marandellas, Rhodesia.

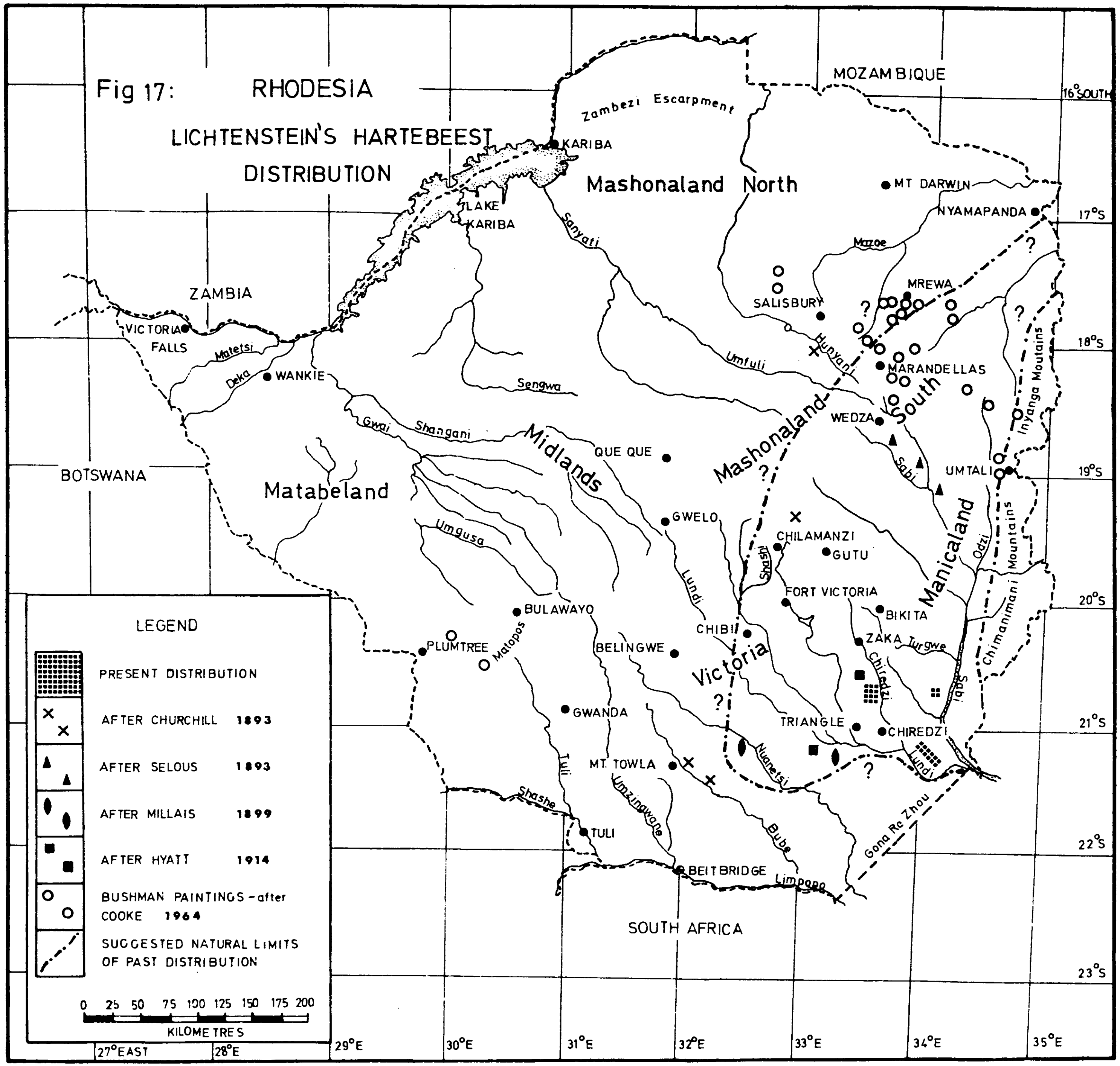

Fig 17: RHODESIA LICHTENSTEIN'S HARTEBEEST DISTRIBUTION

found in the neighbourhood of the Sabi River in Mashonaland, known as the "Umkwila Nondo". He expressed doubts as to whether the "Umkwila Nondo" and the "Konze", which he had shot north of the Zambezi were one and the same animal.

Up until that time, Lichtenstein's hartebeest was only represented in Europe by specimens brought back from Mozambique by Peters of the Museum of Natural History in Berlin (Selous 1893). In 1883 Selous (1893) travelled to the eastern bank of the Sabi river as far south as the Masheke (= Macheke) River (19°00'S : 31°00'E) and went to the limit of the "Fly" country. He was unsuccessful in his search for Lichtenstein's hartebeest and unable to go further into the "Fly" country, he returned to his base camp. It was not until 1885 that he successfully obtained five specimens in the area of the Sungwezi/Sabi River junction (19°10'S :32°05 E) - if the route map given by Selous (1893) is examined. Selous (in Bryden 1899) goes on to say:

> "This is a fine antelope, whose range is now known to extend over large areas of country to the north of the Zambezi in Central and East-Central Africa, as well as over considerable areas of South-East Africa to the south of that river...."

> "This species of hartebeest is found throughout the greater part of the low-lying coast country between the Zambezi and Sabi river, and, although its range has not been accurately determined in this direction, it very probably extends into certain districts to the south of the lower course of the latter river. It is fairly common on both sides of the central and upper course of the Sabi River as far south as

> a point some 50 miles (80,5km) south of Mount Wedza and from there eastwards it may be met with to within a few miles of Massikessi (Mozambique). Westwards from the Sabi a few stragglers range as far as and even beyond the Lundti river..."

Our knowledge of it's distribution in what is today the Rhodesian south-eastern lowveld is almost nil, for travel in that region was restricted by tseste fly and malaria. Millais (1899) was probably the first author to penetrate the lowveld. He encountered Lichtenstein's hartebeest near the Bubye River and writes:

> "Lichtenstein's hartebeest has not previously been known to extend nearly so far west as this; in fact, it is seldom found westward of the plains of the Sabi, Busi, Gorongosa and Pungwe Rivers (in Mozambique). I found a small troop west of the Nuanetsi and again near the Lundi (in Rhodesia)...."

Mention is also made of these animals at Mpapa's ($21^{0}12$'S : $31^{0}15$'E) and the "Ndule Mountain" (which Saunders (1969) speculates may have referred to the Sabi/Lundi River junction).

Churchill (1893) provides some interesting information in this regard. He first encountered hartebeest whilst travelling through Bechuanaland, but as with the remainder of his narrative, he does not refer to any particular species. Each reference to hartebeest must, therefore, be treated on merit and a decision taken as to whether he refers to red, Lichtenstein's hartebeest or tsessebe.

His experiences in Bechuanaland (Botswana) undoubtedly refers to red hartebeest, however, when his party reached the vicinity of the Bubye River ($21^{0}20$'S : $30^{0}05$'E), the party split up to enjoy some hunting. Churchill travelled towards Mt. Towlu (= Towla, 21°20'S : 30°55'E) which was about six miles (10 km) from his camp, while the remainder of his party went in the opposite direction and "... Capt. Williams had been equally unsuccessful, having had a long and difficult shot at a hartebeest".

Besides Millais' (1899) record, this must be the furthest record west of the occurrence of a hartebeest. It is open to speculation whether what Williams shot at was a hartebeest, i.e. was a positive identification made, especially considering that it was a "long and difficult shot". It is unlikely that this record referred to Lichtenstein's hartebeest for Gawler (pers. comm.)[1] - ranch manager of Liebig's Ranch with headquarters at Towla - states that there is no trace or knowledge of this species from the region. Child and Savory (1964) state that tsessebe are common along the Bubye River and no doubt it was this species that Churchill refers to.

Churchill mentions hartebeest again north of Fort Victoria, probably near Fort Charter ("I saw from the road and examined through a telescope two fine herds of hartebeest...."). This statement is supported by Hyatt (1914), who was a trader in the area south of Fort Victoria at the turn of the century. His stores were situated at Chivamba (probably Chivamba Business Centre today, 20°43'S : 31°25'E) and at Mbendese (= Bendezi,

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[1] Mr. M.D. Gawler, Ranch Manager, Liebig's Ranch, Private Bag N 5245, Bulawayo, Rhodesia.

$21^{\circ}10$'S : $31^{\circ}05$'E). While at Chivamba the natives were keen to show him Lichtenstein's hartebeest which, he says, were found throughout the area, particularly where the country was more open.

On reaching Salisbury, Churchill (1893) hunted between the Umfuli and Hunyani Rivers where; "..... hunting down the course of the Hunyani.... Lee described a solitary hartebeest grazing". Later Churchill moves down to Hartley Hill (= Hartley) where again he records hartebeest which appeared to be plentiful in the area.

This latter reference most probably refers to tsessebe, rather than hartebeest, which were common in the Hartley district. The reference to hartebeest along the Hunyani River may be correct, for Selous (In Lydekker 1908) states that in 1885 a small herd of six hartebeest appeared near the Hunyani River some 20 miles (32 km) north-west of where Salisbury now stands, and Johnson (1940) records "..... On our way there, where the railway station now stands (in Salisbury) there galloped out a small troop of mixed Lichtenstein's hartebeest and Burchell's zebra, with an easy shot at about 100 yards I dropped one of the former, my first of that particular type, for it was not found south of the Sashi River" (20° 00'S : $30^{\circ}43$'E). Again it is not clear whether Johnson is referring to the Shashe River along the border with Botswana, in which case he is referring to red hartebeest or the Shashi River which is north of Fort Victoria. If the latter is correct, then he is referring to

Lichtenstein's hartebeest for Sparrow (pers. comm.) states that Lichtenstein's hartebeest did occur in the Mushandike Valley ($20^{0}15$'S : $31^{0}35$'E).

Flemming (In Shortridge 1934) states that Lichtenstein's hartebeest occurred in the Chilamanzi, Victoria, Gutu, Bikita, Chibi, Ndanga and Nuanetsi districts. This probably sums up the past distribution of Lichtenstein's hartebeest in Rhodesia. From this time on, the hartebeest were drastically reduced in numbers and exterminated on the highveld. Pioneer ranchers to the south-eastern lowveld could remember when this species was common (Somerville 1976). Styles (quoted by Saunders 1969) tells of Lichtenstein's hartebeest being well represented in the area along the Turgwe River ($20^{0}05$'S : $31^{0}30$'E) in the 1930's while some 50 hartebeest were known to exist on Buffalo Range (Fig.19) in 1950. Between the great wars, Lichtenstein's hartebeest appeared to be well represented in the area now covered by Samba, Bangala, Faversham, Chiredzi, Crown and Eaglemont Ranches and in the Bikita Tribal Trust Land (Allison 1968). They also occurred along the Mkwasine River and on Essenby Ranch (Gillett, pers. comm.)[1]

The plight of Lichtenstein's hartebeest in Rhodesia was brought to the notice of the public in 1968 and as a result a survey was conducted to establish the status of the species in the south-eastern lowveld. It was clear that the hartebeest had

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[1] G.K. Gillett, 9 Murambi Drive, Umtali, Rhodesia.

vanished from the highveld and that those that remained survived on a few private ranches. Ferrar and Sherry (1969) conducted the survey of these ranches and the results are given in Table 6.

No survey of the Gona re Zhou National Park was conducted at this time although a few hartebeest were known to occur along the Gologi River (31°20'S : 31°55'E) and on the Makakweti Plateau (Gillet, pers. comm.)

In 1972 a total of 66 hartebeest were captured north of Gorongosa National Park, at Kangantore in the Contala area of Mozambique and all of them released into the Gona re Zhou National Park. In 1977 an aerial survey was conducted in the Gona re Zhou National Park to establish how successful this population was, together with a survey of the surrounding ranches to establish the status of Lichtenstein's hartebeest in the lowveld. The results of these surveys are given in Table 7.

These surveys covered several more ranches that were not included in the 1969 survey. The conclusions of these surveys (1969 and 1977) were:

a. The distribution of hartebeest in the lowveld had not altered considerably over the last 40 years.

b. Although the 1977 surveys show an increase of 99 animals since 1969, the 1969 survey did not take into account those animals in Gona re Zhou National Park, nor the 66 animals released in 1972. Furthermore, in 1977, several more ranches were covered in the survey than in 1969.

Table: 6 The population estimate of Lichtenstein's hartebeest on private land in the south-eastern lowveld of Rhodesia in 1969 (after Ferrar and Sherry 1969).

Ranch	Number seen during survey	Population estimate
Lone Star Ranche	66 (81)*	75
Impala Ranch	20	25
Ruware Ranch	6 (8)	8
Eaglemont Ranch	-	25
Sabi-Limpopo National Land	-	10
Wheat Scheme Land	-	5
Total	92	c.150

*Numbers in parenthesis indicate actual sightings before correction for double counting.

Table: 7 The population estimate of Lichtenstein's hartebeest on private land and in the Gona re Zhou National Park in January 1977, and whether or not the individual populations are subject to poaching.

Ranch	Population Estimate	Degree of Poaching
Lone Star Ranche	39(+ 12 calves)	x
Impala Ranch	21(+ 6 ")	xxx
Chiredzi North and South Ranch	-	-
Ruware Ranch	15 (19?)*	xx
Hippo Valley Estates	-	xxx
Ndanga Ranch	34 (?)	?
Chiredzi Ranch	2 (6?)*	?
Eaglemont Ranch	5 (?)	xxx
Gona re Zhou National Park	75 (± 7)	xx
Total	191 (± 15)	

* These figures have been supplied by the respective land owners.

x = sporadic poaching

xx = moderate poaching

xxx = heavy poaching

The nett result of these findings is that the status of the hartebeest populations in the south-eastern lowveld is very precarious and only careful monitoring in the future will determine whether the population is increasing or declining.

Conclusion

The present day distribution of Lichtenstein's hartebeest, as shown in Fig. 18, should be interpreted with the following qualifications. All available information - referring both to the past and present distribution of this species - must be carefully and critically analysed in order to arrive at the most accurate description of the distribution of this species.

Lichtenstein's hartebeest, by virtue of its ungainly features, is a conspicuous animal, however, by nature it is an inconspicuous animal which can be easily overlooked in its chosen tall-grass stratum habitat. This was a confounding factor for the early naturalists who attempted to describe the distribution of this species, for its conspicuous features allowed it to be easily confused with closely associated species such as the red hartebeest and tsessebe, although this problem does not appear to have arisen in East Africa where Lichtenstein's hartebeest, Coke's hartebeest, Jackson's hartebeest and topi (Damaliscus korrigum) occur in close proximity.

There is a tendency for Lichtenstein's hartebeest to survive in areas that are isolated from the main distributional range. In Tanzania, Lichtenstein's hartebeest occur on the Wembere away from their main distributional range (Fig. 10). Indeed, Lichtenstein's hartebeest are effectively isolated in the south-

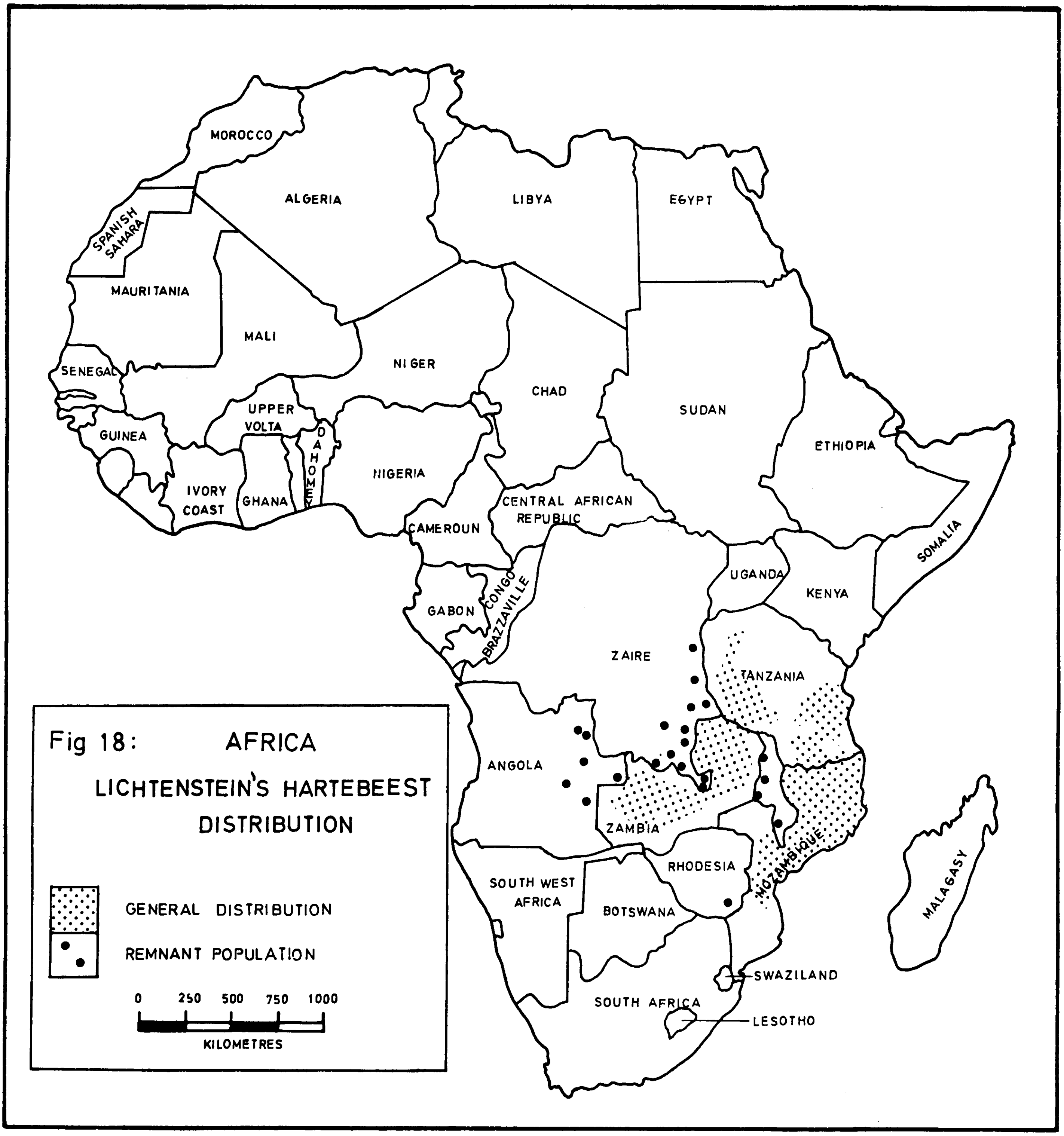

Fig 18: AFRICA LICHTENSTEIN'S HARTEBEEST DISTRIBUTION

eastern lowveld of Rhodesia from the main distributional range in Mozambique.

Although these instances are probably more directly the result of the interference of man, a marked feature that has arisen in the discussion of their past distribution are the numerous references to this species occurring in isolation away from the main distributional range, with no other apparent literature to support these claims. In Zambia Ansell (1978) comments on the reports that this species was common in the extreme west of the Senanga district although there is no positive evidence to support this claim. Ansell (1978) also discounts Statham's report that Lichtenstein's hartebeest occurred at the confluence of the Liuana and Moshi Rivers in Angola. It is thought that Lichtenstein's hartebeest occurred in the south-eastern Transvaal and Northern Zululand - even though there is no concrete evidence to support these claims. In Rhodesia, Millais (1899) was surprised at the occurrence of Lichtenstein's hartebeest as far west as the Lundi River, while the records of Churchill (1893), Selous (In Lydekker 1908) and Johnson (1940) of the occurrence of Lichtenstein's hartebeest in the Salisbury area are intriguing.

In most cases these claims have been refuted through the lack of evidence, however it is felt that many of these references should be critically reviewed in the light of our knowledge of the general ecology of this species today. In order to do this however, ecologists should strive to provide more accurate descriptions of the type of habitat occupied by a particular species.

No longer are species confined to "Brachystegia Woodland habitats" but rather a particular floristic community within that overall broad habitat type. Furthermore, the environmental factors that influence that particular floristic community - such as temperature, aridity and topography - should be clearly defined.

Information such as this can and has been effectively used as a tool to form a baseline from which it is possible to assess more accurately the obscure reports of a species that occurs outside its recognized distributional range.

In the case of Statham's report in Angola, there is no other evidence to support the claim, while in Rhodesia it is suggested that Lichtenstein's hartebeest has been confused with tsessebe. In both instances, these records refer to regions where Lichtenstein's hartebeest are on the fringe of their range and where they would naturally have occurred in low numbers. This, together with the inconspicuous nature of the species and the fact that the species occurred in remote parts of southern African only serves to enhance the doubt cast upon these records.

With information on the floristic communities of these regions it would be possible to extrapolate the results obtained in this study and assess the probability of the occurrence of this species in these areas. That the records refer to regions dominated by Brachystegia Woodland (Fig. 9) does raise the possibility that this species did occur in these areas.

Furthermore, there appears to be a distinct correlation between the distribution of the closely allied members of the Alcelaphini family. This is most obvious between the tsessebe and Lichtenstein's hartebeest. In Zambia, west of the Zambezi River, tsessebe replace Lichtenstein's hartebeest, which explains the lack of evidence from the Senanga district (Ansell 1978) for it is more likely that Lichtenstein's hartebeest was confused with tsessebe. In Rhodesia, although less obvious, it appears that the distribution of Lichtenstein's hartebeest merges with that of tsessebe. In Tanzania there is evidence to suggest that the topi, Damaliscus korrigum, a close relative of the tsessebe, Damaliscus lunatus, replaces Lichtenstein's hartebeest in the Rukwa Valley (Vesey-Fitzgerald 1964). It is postulated here that a similar relationship may exist between the red hartebeest, tsessebe and blesbok (Damaliscus dorcas phillipsi) in South Africa. The reasons for this are not clear and are probably controlled by numerous subtle environmental factors which are difficult to identify, such as the deficiency of trace elements in the habitat that probably determines the distributional range of Hunters hartebeest, Damaliscus hunteri (Harthoorn 1970).

The most intriguing distributional aspect related to Lichtenstein's hartebeest is the belief that it previously occurred in Northern Zululand, Natal. There is no doubt that a species of hartebeest did occur in Natal and the evidence supporting the fact that this species was the "Natal red hartebeest" and not Lichtenstein's hartebeest is substantial (Handley 1950, Pringle 1963). Nevertheless, it is incredible that there is so little recorded about the existence of hartebeest in Natal, although the last remnant of the population is reported to have disappeared from that province in 1955 - in spite of desperate efforts by Handley (1950) and Pringle (1963) to alert the authorities to its plight.

Handley (1950) quoting from the book "Sanctuary", states that the Natal red hartebeest were the last true remnants of the Cape red hartebeest, of which those in the Kalahari were a closely related subspecies, the Northern red hartebeest.

The validity of the Northern red hartebeest, Alcelaphus bulbalis selborne - Lydekker 1913, has been refuted and has been regarded as synonymous with the red hartebeest, Alcelaphus caama (Dolan 1965). There is a tendency throughout the Alcelaphini tribe to form "hybrids" and many subspecies and races are recognized (Ruxton and Schwarz 1929). Although taxonomically the red hartebeest is not recognized as having any subspecies, it is interesting to note that Stevenson-Hamilton (1947) refers to a "slightly divergent type" of hartebeest that survived in Natal.

The question raised here is whether it is not possible that a subspecies or race of the red hartebeest did exist in Natal and the degree of divergence from the norm - as with the Northern red hartebeest - was so slight that taxonomists,with the methods then at their disposal,were unable to distinguish a subspecies?

The early colonists of Natal and the Cape Province paid little attention to the wildlife of the colonies and without forethought, shot out vast numbers of game and probably effectively removed any evidence that may have pointed to the possibility of subspeciation amongst the red hartebeest of South Africa.

This aspect of the taxonomy of the genus Alcelaphus could be rewarding if investigated further.

Nevertheless, what has emerged from the present investigation is that, in general, the distribution of Lichtenstein's hartebeest as given by Sidney (1965, Fig. 8), has been drastically altered in the last 19 years. The role of international boundaries, agricultural development and population growth is more evident in influencing the distribution of large mammal species such as hartebeest and no longer can terms such as "generally distributed" be used to describe the occurrence of the large mammal species in many African countries. It would be more accurate to rely on information such as that provided by Smithers and Tello (1976) or as shown in Fig. 19 of the Rhodesian lowveld.

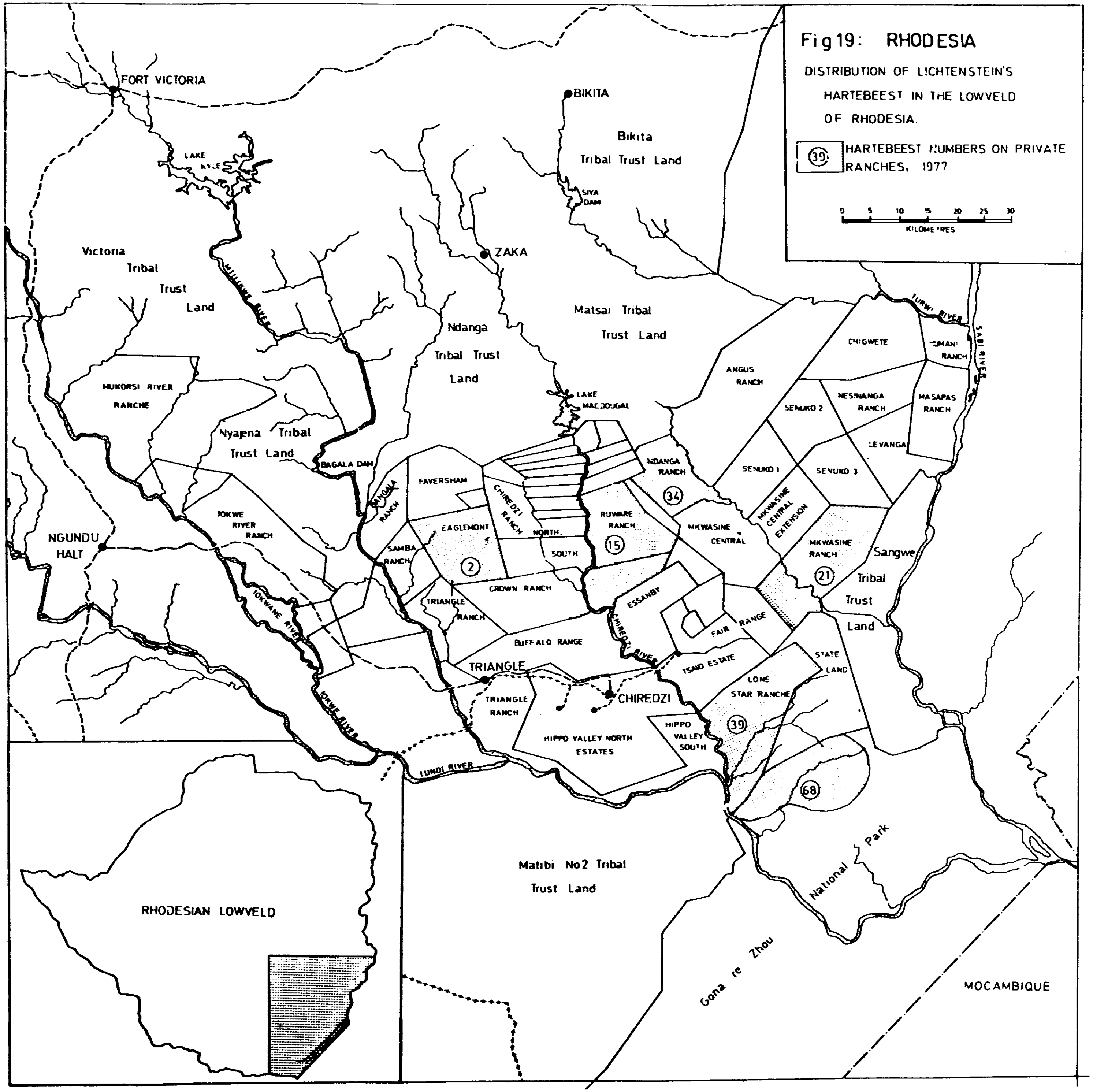

Fig 19: RHODESIA

DISTRIBUTION OF LICHTENSTEIN'S HARTEBEEST IN THE LOWVELD OF RHODESIA.

Chapter 5

Data on the ecology, social behaviour, distribution and status of Lichtenstein's hartebeest in the study area.

Introduction

The prime objective of this project was to identify, in as far as it was possible, the preferred habitat of Lichtenstein's hartebeest in the study area. No accurate,published information was available indicating what the "preferred habitat" might be. Wilson (1966) defines Lichtenstein's hartebeest as an edge species occupying the ecotones of dambos, while Rodgers (1969a) says of this species that it is a "truly endemic 'miombo' (Brachystegia sp.) woodland animal, its range contiguous with that of the 'miombo' habitat." Dowsett (1966) probably approaches the true situation in describing the "ideal" hartebeest habitat as savanna woodland interspersed with small dambos.

At the commencement of this project, the type of habitat hartebeest were selecting was unknown. Therefore it was essential to establish the status of hartebeest and their distribution in the various habitat types in the study areas. However, it is also important to take into consideration factors such as territoriality, herd structure and social behaviour when interpreting the manner in which Lichtenstein's hartebeest utilise their habitat.

Unfortunately under the circumstances pertaining while this project was in progress and the difficulties experienced in monitoring the activities of the hartbeest, it is not possible to discuss in any detail or compare the ethology of this species with that of other members of the Alcelaphines. Moreover there have been no detailed investigations into the ecology and behaviour of *Alcelaphus lichtensteini* other than that of Mitchell (1965), Dowsett (1966) and Wilson (1966) who discuss some superficial aspects of their ecology and social behaviour. Other members of the Alcelaphines have been investigated in some detail, especially the blue wildebeest - *Connochaetes taurinus* (Estes 1969), black wildebeest - *Connochaetes gnou* (von Richter 1972), blesbok - *Damaliscus dorcas phillipsi* (Lynch 1971), bontebok - *Damaliscus dorcas dorcas* (David 1970), Coke's hartebeest - *Alcelaphus buselaphus cokei* (Gosling 1974) and red hartebeest - *Alcelaphus buselaphus caama* (Kok 1975).

All available data on the ecology and social behaviour of *Alcelaphus lichtensteini* are presented, together with the distribution and status of Lichtenstein's hartebeest in the study area, and discussed in this chapter. This information does lead to a greater understanding of the manner in which hartebeest herds utilise the various habitat types described in the study area.

Herd structure, sex ratio and density of Lichtenstein's hartebeest

Lichtenstein's hartebeest rarely occurs in groups larger than six to ten individuals, and seldom are more than 20 individuals ever concentrated together. Rodgers (pers. comm.) comments that

89,30% of all herds of hartebeest in southern Tanzania vary between one and ten individuals, while only 9,60% are larger - the largest herd recorded consisted of 22 individuals. In Zambia there is a record of 65 individuals (17 males, 36 females and 12 juveniles) seen in August on the Tondwa Plain, although it is possible that the observer had inadvertently grouped together all the individuals seen on the plain. The same observer has provided records of 31 and 26 individuals in single herds, but otherwise the largest number is 20 from this area (Northern Rhodesia Game Department, unpublished records, undated). In Mozambique, a record of 29 individuals (of which 50% were bulls) was decribed from Kangantore in the Contada area by members of the Rhodesian Department of National Parks and Wild Life Management during capture operations in August 1972. Tinley (1977) states that two peaks - one of six and one of 12 - were observed in the mean group size of Lichtenstein's hartebeest in Gorongosa National Park, Mozambique, while large concentrations - 72 individuals recorded in one herd - were reported to have occurred in October.

In Rhodesia the largest herd observed consisted of 16 individuals (4 bulls, 9 cows, 2 sub-adult cows and one sub-adult bull) - which at the time were the only hartebeest in the study area - observed during September 1976.

The occurrence of large herds appears to be unusual for this species, although red hartebeest, Alcelaphus buselaphus caama, are known to form spectacular congregations which may number up to 10 000 at certain times of the year (May, August, December), which Smithers (1971) describes as being related to rainfall.

Gosling (1974) does not mention whether Coke's hartebeest, *Alcelaphus buselaphus cokei*, display a similar congregational pattern. However a significant feature of Lichtenstein's hartebeest is that the majority of these large congregations have been observed in August/September, but the reasons for this are not clear. Congregations occur just prior to the calving season in October - November (Luangwa Valley, Ansell 1960, Lone Star Ranche, Gona re Zhou National Park, present study), which is closely followed by the rut in which there is fierce fighting between the bulls (Dowsett 1966).

The reasons for such congregations may be related to the quality of the diet or more probably to the reproductive behaviour of Lichtenstein's hartebeest as, outside the rutting period, the lack of overlap between territories virtually prevents any contact between members of the different groups (Dowsett 1966, present study).

For the remainder of the year, the mean group size of the family unit, which consists of a herd male, females, sub-adults (both sexes) and juveniles, remains fairly constant (Fig, 20), although the herd itself may vary considerably in composition (Table 8). Sub-adult cows normally remain in close association with the parent group (Gosling, 1974, comments on a similar association existing between cows and female calves in Coke's hartebeest), but are usually expelled from (leave ?) the parent group after a period of 15 - 18 months. The young bulls however, Table : 8 Summary of the mean herd size and sex ratio (male : female) of Lichtenstein's hartebeest, Alcelaphus lichtensteini, in central and southern Africa.

Mean herd size	Reference
5,40	Eastern Selous Game Reserve, Tanzania - Rodgers (1977)
4,65	Western Selous Game Reserve, Tanzania (October) - Rodgers (pers. comm.)*
5,70	Rungwa Game Reserve, north-western Tanzania (September) - Rodgers (pers. comm.)
6,17	Biharamulo Game Reserve, north-western Tanzania (October) - Rodgers (pers, comm.)
8,00	Kangantole, Mozambique - Department of National Parks and Wild Life Management, Rhodesia, unpublished data
2,90	Eastern Zambia - Wilson (1966)
6,20	Kafue National Park, Zambia - Northern Rhodesia Game Department, unpublished data
5,90	Kafue National Park, Zambia (breeding herd) - Mitchell (undated)
3,80	Kafue National Park, Zambia (bachelor herd) - Mitchell (undated)
8,20	Kafue National Park, Zambia - Dowsett (1966)
3,00	Lone Star Ranche, south eastern Rhodesia - present study
5,30	Gona re Zhou National Park, south eastern Rhodesia - present study
5,40 (± 1,6) -	Mean (± Standard deviation)

Sex ratio (male : female)	Reference
1 : 2,40	Eastern Selous Game Reserve, Tanzania - Stobart (1970)
1 : 3,70	Eastern Selous Game Reserve, Tanzania - Stobart (1970)
1 : 3,00	Eastern Zambia - Wilson (1966)
1 : 2,00	Eastern Zambia (foetuses) - Wilson (1966)
1 : 2,08	Kafue National Park, Zambia - Northern Rhodesia Game Department, unpublished data
1 : 2,50	Kafue National Park, Zambia - Dowsett (1966)
1 : 1,42	Lone Star Ranche, south eastern Rhodesia - present study
1 : 2,60	Gona re Zhou National Park, south eastern Rhodesia - present study
1 : 2,37	Mean

* A. Rodgers, University of Dar es Salaam, P. O. Box 35064, Dar es Salaam, Tanzania

Fig: 20 The social family group of Lichtenstein's hartebeest consisted of a harem bull, adult cows and juveniles. Note the cow on the extreme left with a torn ear. Natural characteristics such as this enabled the various herds to be indentified.

are expelled after 10 - 12 months (Mitchell undated, Dowsett 1966, present study).

It was also noted that the adult cows of the various herds would leave one group and join another for a brief period and then return to the original group. This activity was first noted in April and again in August and corresponded with the period during which the hartebeest began to migrate (see p.176). Dowsett (1966) comments on a similar behaviour with hartebeest groups in the Kafue National Park, Zambia. Normally the family group was stable although the herd bull may be deposed during the rut, and a few younger females were perhaps taken away by young bulls that had established new territories. However, in the Kafue National Park, a cow and calf was observed to leave the harem and remain on their own for a few days before returning to the family group. Another female joined a solitary territorial male and in another two herds, one or more females left the harem for a day or two but later returned.

It was not known what prompted such behaviour. It is possible therefore that the cows are responsible for initiating the migratory behaviour and that this behaviour may be prompted by a) the quality of the diet and b) reproductive behaviour.

Bachelor males were usually found alone and rarely congregated to form bachelor herds (Dowsett 1966, Wilson 1966, Rodgers 1977). Mitchell (undated) quotes a mean group size of 3,8 for bachelor groups in the Kafue National Park, while Wilson (1966) quotes 2,9 of which up to 35% were solitary males, in eastern Zambia (where they were hunted extensively). Dowsett (1966) believes that this is atypical, however on Lone Star Ranche, Rhodesia, 38% of the individuals observed in 1976 (Table 12) were solitary bachelors (Fig. 21) and only one bachelor herd of three individuals was observed which soon disbanded. In 1977 all of the bachelor bulls observed were solitary, while in the Gona re Zhou National Park only two solitary males out of a total of 14 groups of hartebeest (14,20%) were positively identified during an aerial survey. Rodgers (pers. comm.) comments that 17,30% of all hartebeest seen in southern Tanzania during a 14 month period were solitary males, which was confirmed by Stobart (1970) in the Selous Game Reserve, Tanzania.

There have been reports of females without any attendant adult males. In the Kafue National Park 11 out of 54 reports were of female herds accompanied by juveniles. In the Gona re Zhou National Park, a single herd of three cows, all with less than one week old calves at foot, was observed, while on Lone Star Ranche a solitary cow was observed. This cow was suspected of joining various herds in the study area for a short while and then leaving. In the Kafue National Park there are two records of lone cows (one of which was found to be pregnant with a fully developed foetus - 14th June, Northern Rhodesia Game Department, unpublished records, undated). It was suspected the lone cow on Lone Star Ranche may also have been pregnant, although from its physical condition, it appeared to be extremely old. This cow was not seen again in the study area after July 1977.

Fig: 21 The sub-adult males were usually expelled from the harem herd at approximately 10 to 12 months of age. The young bulls then remained alone rarely forming bachelor herds.

The sex ratio of male to female is given in Table 8. The overall mean sex ratio was 1 : 2,37 although Stobart (1970) has recorded a sex ratio of 1 : 3,70 in the eastern Selous Game Reserve, Tanzania. On Lone Star Ranche, the sex ratio was close to parity being 1 : 1,42.

The density of Lichtenstein's hartebeest varies a great deal in central and southern Africa. The highest density per km^2 was recorded in the eastern Selous Game Reserve ($3,5/km^2$, Table 9) while the lowest ($0,15/km^2$, Table 9) was recorded from the Kafue National Park. The density figures for Lone Star Ranche ($0,25/km^2$) and the Gona re Zhou National Park ($0,30/km^2$) in south eastern Rhodesia are approximate, for these figures are calculated on the assumption that only that portion of the ranch or National Park over which the hartebeest were distributed constituted suitable habitat for this species. If these figures are related to the entire area (both Lone Star Ranche and Gona re Zhou National Park north of the Lundi River), then these figures can be re-adjusted to give a rough estimate of 0,04 hartebeest/km^2 indicating the rarity of this species in the south eastern lowveld of Rhodesia.

Territoriality

On Lone Star Ranche no activity that could be directly related to territorial behaviour was observed. Dowsett (1966) provides

Table : 9 Summary of the density (km^2) of Lichtenstein's hartebeest, _Alcelaphus lichtensteini_, in various regions of central and southern Africa.

Density (km^2)		Reference
3,50	-	Eastern Selous Game Reserve, Tanzania - Rodgers (pers. comm.)*
1,50	-	Selous Game Reserve (total), Tanzania - Rodgers (pers. comm.)
2,00	-	Western Selous Game Reserve (wet season), Tanzania - Rodgers (pers. comm.)
4,70	-	Western Selous Game Reserve (dry season), Tanzania - Rodgers (pers. comm.)
0,50	-	Rungwa Game Reserve, central Tanzania - Rodgers (pers. comm.)
0,55	-	Biharamulo Game Reserve, north-western Tanzania - Rodgers (pers. comm.)
0,15	-	Kafue National Park, Zambia - Dowsett (1966)
0,21	-	Rift Valley of Gorogosa ecosystem - Tinley (1977)
0,25	-	Lone Star Ranche, south eastern Rhodesia - present study
0,30	-	Gona re Zhou National Park, south eastern Rhodesia-present study

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the most information on territorial behaviour of a population of hartebeest in the Kafue National Park.

The population was markedly territorial, each family and bachelor group occupying an exclusive area. There was no overlap between areas and the territories appeared to incorporate all the suitable habitat available in the Park. There appeared to be some correlation between the quality of the habitat comprising a territory and the size of the family group therein. Smaller harem groups (a bull and 3 - 4 cows) occupied what appeared to be inferior habitats, comprising either too great a proportion of open dambo, or areas bordering on heavy woodland forest or thickets. What seemed to be ideal hartebeest habitat (savanna woodland interspersed with small dambos) supported herds comprising a bull and 8 - 9 cows. These bulls were regarded as being the most dominant in the area since they were able to defend the most ideal habitats. Furthermore, it appeared that Lichtenstein's hartebeest bulls, together with their cows, would occupy a territory throughout the year, and for several seasons in succession, as long as the herd bull was able to defend it.

It would appear that the bachelor groups do not establish a territory, however the solitary bachelors do. On Lone Star Ranche a bachelor group, comprising three individuals (Table .12, p. 96) was observed never to remain in any one particular area for any length of time but to move over considerable distances in the study area before it disbanded. However the mature solitary bulls appeared to establish a territory and remain in the area for a longer period of time. This is supported by observations in the Kafue National Park (Dowsett 1966) where a solitary bull established a territory and excluded other hartebeest from it. This bull later challenged and was successful in capturing the cows of an adjacent harem bull. The cows were herded back to the bachelor bull's territory but later this bull became established in an area that included part of the former harem bull's territory - which in turn had established a bachelor territory in the remaining area.

Gosling (1974) comments that the most dominant Coke's hartebeest bulls appear to defend the most suitable habitat for a considerable period of time.

The rutting period in the Kafue National Park appears to extend from mid-October to early January, although on Lone Star Ranche this period must have been later because calves were only born in September - November giving an estimated breeding season from mid-November to early February. According to Dowsett (1966) the mature bachelor males leave their territories during the rut and try to take over a harem, resulting in fierce fighting between harem males and bachelor bulls, often to the point of exhaustion. A certain amount of fighting may also occur between the females in a harem during the mating season, but this fighting was usually of a very low key (Dowsett 1966).

No fighting or capture of harem herds by bachelor bulls was recorded on Lone Star Ranche during the study period, nor have hartebeest bulls ever been recorded fighting or chasing one another (Sparrow, pers. comm.). Furthermore, there did not appear to be any increase in the number of sightings of lone bulls between November and February that might have suggested that these individuals had become more active or were trying to establish new territories. Indeed, when considering the spatial distribution of the various herds in the study area, it is doubted if the various herds made regular contact during the year at all. It is for this reason that it is thought that the annual migration towards the end of the dry season and the formation of larger than normal herds may be related to the reproductive behaviour of this species.

There is very little evidence available on the manner in which Lichtenstein's hartebeest demarcate their territories. Von Richter (1972) compares the territorial behaviour and challange rituals of the Alcelaphini tribe, with more emphasis on the black wildebeest. He points out that there were numerous stereotyped behaviour patterns in the repertoire of the genus *Alcelaphus* that were directly associated with territorial defence. Amongst these, pawing and horning the ground was most conspicuous and had an intimidatory effect, although rolling after pawing and horning was not observed. On Lone Star Ranche, a solitary bull was seen standing in an open clearing devoid of all grass, with numerous dung piles, pawing at the ground. It is doubted that the dung piles represented a territorial boundary, since the bull was only seen in this area on one occasion.

The most conspicuous body movements of hartebeest in the study area were the head-to-flank movement, whereby the head is rubbed against the shoulder, and a head-flagging movemenent, in which the hartebeest shook its head up and down vigourously when alarmed. A similar head-flagging movement is observed in Coke's hartebeest when two territorial males meet along a common boundary (Gosling 1974). In the bontebok David (1970) assumes that this head-flagging display serves as an appeasement, while Lynch (1974) interprets it as a displacement activity similar to Estes' (1969) alarm display in the blue wildebeest. On Lone Star Ranche this behaviour was observed when a herd of hartebeest was approached on foot or disturbed by some unseen factor. The male would walk towards the intruder and display head-flagging behaviour for various lengths of time, periodically stamping the front feet on the ground and flicking the tail before turning to flee. The females were also observed displaying this activity on some occasions. On one occasion a herd of zebra approached the hartebeest whilst resting. The bull got up, approached the zebra, displayed head-flagging, stood with its head held high and watched the zebra for a short while before returning to the shade and lying down.

Other stereotyped activities not observed in Lichtenstein's hartebeest, but observed in Coke's hartebeest included a head-up posture, a defaecation-encounter, in which the dominant male grooms or adopts some other non-threatening behavioural activity such as grazing, and a forward-parellel grazing activity between two territorial males along a common boundary (Gosling 1974).

These behavioural activities were probably not observed in Lichtenstein's hartebeest due to the low frequency of encounters between different groups, although it is possible that a feature of Lichtenstein's hartebeest territoriality is the fact that there is very little overlap of territories and thus the need for elaborate territorial defence behaviour, as witnessed in other members of the Alcelaphines, is not needed and therefore not highly developed.

Gosling (1974) comments that the main method adopted by Coke's hartebeest for marking a territory, was through dung piles, and a similar method was employed by red hartebeest (Kok 1975). However in the study area it was never established with any degree of certainty that Lichtenstein's hartebeest actively deposited dung piles to mark the boundary of a territory. On several occasions a territorial bull (both harem and bachelor bulls) were observed in the vicinity of a dung pile which was normally occupied by a territorial wildebeest bull. These areas were characterised by a shallow depression which was formed as a result of the pawing and horning of the ground by wildebeest (Estes 1969). Whether the hartebeest used the same area to defaecate and horn the earth is not known.

Dung piles were also observed on a bare patch of ground on the edge of a dambo that was frequently used by the hartebeest. Although hartebeest spoor was seen amongst the dung piles on several occasions, the hartebeest were never observed to defaecate or show any other territorial activity such as horning the earth, which would indicate that this area was a territorial boundary marker, on any occasion throughout the year. Dowsett (1966) states that the method of demarcation, both by males and females, was through horning the earth, in which a hartebeest went down on its knees, turning its head from side to side thus digging up the earth with its horns. After examining a number of skulls of both sexes collected in the Gona re Zhou National Park, it was noted that either the right or left horn was 150 - 200mm shorter in each case. This could have been caused by horning activity. On one occasion only was it found that the verge of a road had been recently horned in the study area and a herd of hartebeest were nearby, although no soil could be seen clinging to the horns of any of the individuals, nor was this observed in any of the other hartebeest in the study area, although this was seen in both Coke's hartebeest (Gosling 1974) and red hartebeest (Kok 1975).

The role of the preorbital gland and the interdigital gland in the Alcelaphine tribe is not clear. Von Richter (1972) states that Coke's hartebeet actively mark twigs with the preorbital gland and also mark while rubbing their faces on the ground during horning sessions. Gosling (1974) states that the role of the preorbital gland and the interdigital gland in Coke's hartebeest in territorial demarcation is not clear since, besides the male, the female and juveniles were observed marking at least as frequently as the territorial males.

Estes (1969) states that by pawing and rubbing the forehead on the ground, the wildebeest bull is presumed to impregnate the ground with scents of his interdigital and preorbital glands as well. By frequently rolling on the stamp, the bull's pelt becomes impregnated with his own particular bouquet, which further serves to waft his smell about his premises. His scent must also be transferred to other wildebeest that lie on the stamp. Kok (1975) believes that the preorbital gland fulfils a similar function in red hartebeest. Backhaus (1959) states that in the related Alcelaphus buselaphus lelwel, the preorbital glands were not "well developed" and he considered that the secretions played no part in demarcating territories.

Lichtenstein's hartebeest possess well developed preorbital glands, which consist of a bare invaginated orifice below the eye. That of a dead specimen found in the study area exuded a whitish secretion on applying pressure, but did not have any noticeable smell. Dowsett (1966) comments that the sticky secretion exuded by these glands leaves a dark smudge on each side of the hartebeest above the shoulder when the side of the face is rubbed against it. An interesting point about these secretions and marks is that they are not observed on all individuals throughout the year. Selous (In Lydekker 1908) was the first to draw attention to this. He found that an adult male and female had a patch of dark grey, about 150mm in diameter, about a hand's breadth behind each shoulder; but in two other full grown males shot in the same locality (north of the Kafue/Zambezi River confluence) these patches were absent. On Lone Star Ranche, these grey patches were evident on some of the individuals of a group but not on all of them (Fig. 22). The individuals comprising the Makeche Herd were first noticed to have these marks in August and all members of the group, including the young of the year (4 - 6 months of age) displayed these marks in early September. Ansell (In Dowsett 1966) recorded a definite smudge on the side of a juvenile two to three months of age in the Lunga Game Reserve (Zambia) during October, indicating the early activity of the face glands.

The role of these glands is obscure. Wilson (1966) observed a territorial bull rubbing its preorbital glands on the hind quarters of a female just prior to mounting. That these glands appear to be more active nearer the beginning of the rut suggests that they may play a role in reproductive behaviour. In the study area the hartebeest were never observed physically marking either vegetation or the ground. These secretions and smudge marks are thought to be related to territorial demarcation, although how this functions is not known (Dowsett 1966, Gosling 1974, Kok 1975). It is suggested here that the role of these glands may be in passively marking the territory of Lichtenstein's hartebeest. It is possible that the secretions of the preorbital glands are deposited onto the grass stratum whilst the hartebeest are feeding, thus should a foreign group venture into the feeding area it would detect the presence of the resident group and thus avoid a confrontation.

The role of the interdigital gland in the behaviour of Lichtenstenstein's hartebeest is also obscure. The pedal glands are more developed on the front feet than in the hind feet (Pocock 1910, Ansell 1966), and in general resemble those of Alcelaphus

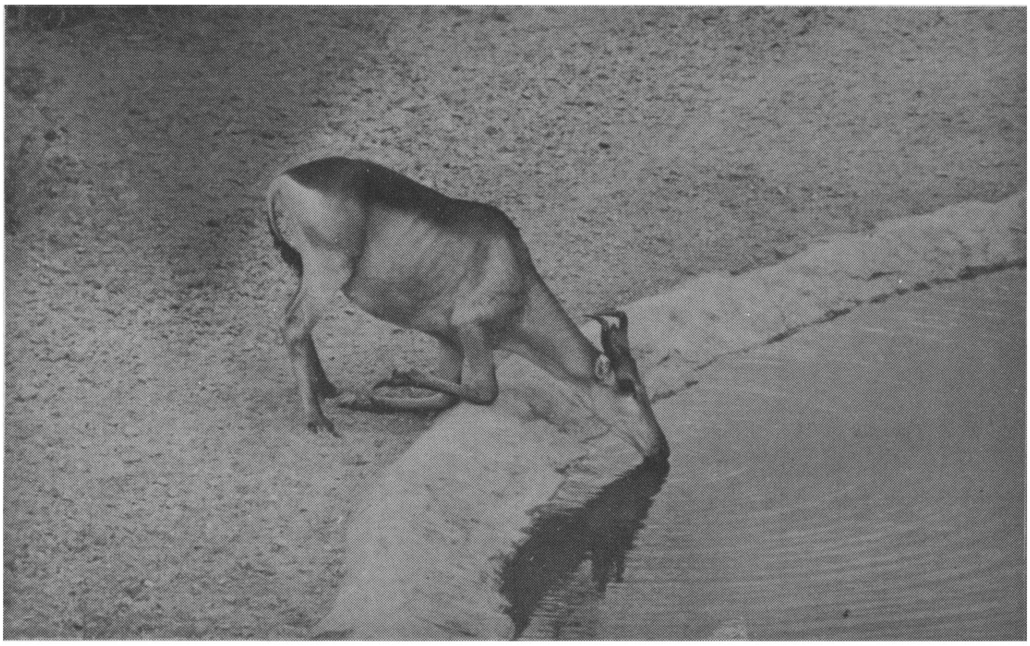


Fig: 22 The characteristic drinking position of Lichtenstein's hartebeest. During certain periods of the year it was observed that the hartebeest did not display the characteristic dark smudge behind the shoulder blades, as seen in this cow.

buselaphus caama. That pawing of the ground is a conspicuous behavioural trait in this group (Kok 1975) does suggest that the pedal glands are in some way associated with territorial demarcation. There is also the possibility that this gland may serve to alert the remainder of the herd when danger threatens. It was observed that when a herd of hartebeest were approached in the study area, the bull (or cow) would display head-flagging and occasionally stamp the front feet against the ground. This action may serve to release the secretions of the pedal glands and alert other members of the group. Furthermore, it is usually this individual that is first to flee and it is possible that the release of this secretion during the flight may leave a trail that would aid the other members of the herd, particularly the young, to maintain contact should they become separated.

Reproductive behaviour

Kenneth and Ritchie (1953) give the average gestation period for Lichtenstein's hartebeest as 240 days, and Asdell (1964) cites 237 days. These figures are supported by field observations on copulation and subsequent births of the first calves (Dowsett 1966, Wilson 1966). The females are sexually mature after 16 - 18 months. Mitchell (1965) remarks that a female, due to have given birth to her first calf at 24 months of age, must have mated at 16 months. Wilson (1966) reports that a female approximately 20 months old was pregnant (crown - rump length of foetus = 1 016mm) which meant that it must have been mated at approximately 16 - 18 months of age. Dowsett (1966) comments that in the Kafue National Park, no more than two females in a group appeared to be on heat at the same time. Rodgers (pers. comm.) comments that the births are synchronised within the herds and this was also observed in the present study, both on Lone Star

Ranche and in the Gona re Zhou National Park.

The calving period in the Kafue National Park, and Zambia in general, occurred between June and September with a peak in July and August (Table 10), although in the Luangwa Valley (Zambia) the peak calving period was in October - November (Ansell 1960). Rodgers (pers. comm.) gives mid-August to early December, with a peak period in September for southern Tanzania. Mitchell (1965) suggests that late births (September - October) in the Kafue National Park may be due to heifers calving for the first time.

This corresponds closely to that observed in the present study, where all the herds observed during an aerial survey had calves at foot in September. In addition to this, many of the hartebeest captured in Mozambique in August 1972 gave birth to or aborted their near full term calves in the first week of September (Rhodesian National Parks and Wild Life Management Departmental records, unpublished, undated), suggesting that a similar calving period occurs in Mozambique. This is confirmed by Tinley (1977) who gives the peak calving period as September (Table 10) in Mozambique.

Whether Lichtenstein's hartebeest cows hide their young at birth and for some time thereafter is not clear, and the evidence on this point is conflicting. Mitchell (1965) claims that they do not conceal their newborn young for extended periods as do Coke's hartebeest (Gosling 1974) and red hartebeest (Kok 1975), but may bed them down and leave them - frequently in open burnt country -

Table : 10 Summary of the record of appearances of Lichtenstein's hartebeest calves, less than four weeks old, in different regions of central and southern Africa.

Reference	June	July	August	Sept	Oct	Nov	Dec
Mitchell (1965), Zambia	1	162	95	3	2	-	-
Wilson (1966), Zambia	-	5	3	-	-	-	-
Southern Province, Zambia*	-	30	8	-	11	-	-
Central Province, Zambia*	1	10	13	-	1	-	-
North western Province, Zambia*	-	16	12	2	1	-	-
Western Province, Zambia*	-	-	5	-	-	-	-
Northern Province, Zambia*	-	7	14	-	-	-	-
Luangwa Valley, Zambia*	-	-	-	-	1	4	-
Gorogosa National Park, Mozambique (Tinley 1977)	-	-	x	xx	x	x	x
Lone Star Ranche, Rhodesia** (Present study)	-	-	-	?------12-------?			-
Gona re Zhou National Park, Rhodesia (Present study)	-	-	-	13	-	-	-
Total	2	230	150	18	28	4	-

*Northern Rhodesia Game Department records, unpublished, undated

**Born between September and November - month uncertain while grazing or when the herd goes to water. Ansell (1960) states that the infant calves are concealed after birth for a short period of time, while a cow remains on guard nearby. Two or more may thus be hidden, and may be left on their own - even after they are capable of accompanying the herd. Ansell (1970) describes several instances in which young hartebeest calves were found on their own in the Kafue National Park, while it was reported that a newly born calf was deliberately hidden in a patch of unburnt grass on the Tondwa Plain, while the rest of the herd (10 adults) moved off (Northern Rhodesia Game Department records, unplubished, undated).

No calves were observed in the study area until they were estimated to be 1 - 2 months old, and the calves were never recorded on their own. However, it is suspected that the calves were left together on occasions, in the company of a solitary female. On one occasion (31/5/76) a cow from the Makeche Herd was seen accompanied by three calves. No other hartebeest were found in the immediate area, even after a thorough search. Sparrow (pers. comm.) recalls a similar occasion when several calves were seen accompanied by a solitary cow and a bull. Ansell (1960) states that there was some evidence of twins having been recorded, but this has never been substantiated.

There is no information on the survival rate of calves in any of the localities discussed above. In Gona re Zhou National Park, practically every herd observed had a 100% calf crop, but this population has not increased significantly in the last ten years indicating a high mortality level. Similarly on Lone Star Ranche the population is declining. Only two sub-adults (9,09%) from a potential breeding herd of 22 adult females survived in the first year of this study, although this figure should be treated with caution when considering the difficulties experienced in monitoring the hartebeest in the study area.

Predation

Lichtenstein's hartebeest was one of the most important prey species in the Kafue National Park, Zambia. Mitchell, Shenton and Uys (1965) record that of all the hartebeest kills recorded in the Park, lions were responsible for 66,25%, leopards 11,68%, cheetahs 3,89% and wild dogs 18,18%. The wild dogs concentrated on the juveniles and past prime adults, while the lions took more of the mature animals. There were two records suggesting that female hartebeest were killed during the act of parturition. Gosling (1974) comments that Coke's hartebeest are similarly susceptible to predation during the parturition period.

Undoubtedly the young hartebeest calves were preyed upon by one or more of the larger predators during the present study. It is suspected that leopards were mainly responsible for calf deaths, although there was no evidence suggesting that the adults were preyed upon by lions or hyaenas in the study area. There were no wild dogs in the south eastern lowveld of Rhodesia.

Lichtenstein's hartebeest also fell prey to human predation. Sparrow (pers. comm.) comments that poachers, using dogs on a moonlit night found it easy to bay up this species and spear it. A sub-adult male was snared during this study period.

Other behaviour

Within the family group the herd bull was very much the leader and was usually found grazing or standing between 50 - 100m away from the rest of the herd. The bull seemed to rely on keen sight during sentry duty, and although this was not observed in the study area, the bulls are known to make use of anthills as a lookout (Dowsett 1966, Kok 1975). When the herd was disturbed, it usually ran off in single file, and usually one particular adult female led the herd away with the herd male bringing up the rear. It was found that the herd followed a zig-zag pattern whilst fleeing and then stopped, thus whilst following up, the pursuer was invariably seen by the herd whereupon the herd would once again make off.

When in flight, all the calves remained together, as was the case while grazing and resting. There was some evidence suggesting that sub-adults remained in close proximity to their parent, but away from other members of the herd and when alarmed, the sub-adults would move towards their respective parents. In general, the herds were constantly on vigil and rarely were all the hartebeest seen actively grazing at the same time - each individual, especially the cows, would keep a listening watch for a brief period whilst the rest of the herd grazed.

The hartebeest normally kept to themselves, but were seen to associate with zebras, wildebeest, eland, impala and sable. Reedbuck were usually found in the dambo associations together with the hartebeest. Similar associations were noted in Zambia, where Lichtenstein's hartebeest were seen together with reedbuck, oribi, tsessebe, kudu and grey duiker (Northern Rhodesia Game Department records, unpublished, undated).

A herd may stand and utter a "sneeze-snort" through the nostrils when alarmed. Each snort is accompanied by a violent flick of the tail, and on occasions the hartebeest would stamp the ground with the forelegs, before trotting or "gallumphing" away, tail swinging from side to side. On becoming aware of danger an individual may stand in a defaecating position, i.e. half squatting with the hind legs apart, tail curled stiffly to one side or horizontally backwards, apparently as an alarm signal, which readily alerted the rest of the herd (Dowsett 1966). It is possible that the strikingly coloured hind quarters of the hartebeest, dark tail against a bi-coloured white and brown rump, increase the effect of the signal.

Lichtenstein's hartebeest has excellent eyesight, hearing and sense of smell, although Dowsett (1966) claims that the olfaction was not well developed.

The activity periods of Lichtenstein's hartebeest in the study area were related to the ambient temperature. During the summer the herds would retire to the shade shortly after 09h00 and commence grazing after 17h00 in the afternoon, whereas in winter the herds were active for longer periods of time, but never during the heat of the midday period. In general the hartebeest were active from sunrise to approximately 10h00 - 11h00, and again after 15h30 until sunset. Wilson (1966) and Dowsett (1966) found a similar pattern in Zambia.

Wilson (1966) records that from 32 observations of Lichtenstein's hartebeest at water holes, 89,0% were recorded between 06h00 - 09h00, while Dowsett (1966) comments that the hartebeest drank daily, usually in the early morning. In the present study, the hartebeest were observed at water holes at all hours of the day, except between 01h00 - 06h00, however, statistically, the data are too limited to draw any conclusions on the peak watering periods. Lichtenstein's hartebeest appears to be water dependent. It was interesting to note that during an aerial survey in the Gona re Zhou National Park, each herd that was located was associated with some water source - usually a pan - and no other hartebeest herds were seen in the vicinity. It is suggested that a reliable water source may be an important prerequisite of the hartebeest when selecting and establishing a territory.

Body weights and measurements

Wilson (1966, 1968) discusses the weights and body measurements of Lichtenstein's hartebeest from specimens collected in Zambia and Malawi. In Table 11 a summary of the average weights of foetuses and adults is recorded. An adult male hartebeest averages 168,73 - 179,10 kg (Table 11), while the adult females average 144,80 - 173,72 kg, (Table 11). A single adult female found hours after death, and estimated to be 16 years of age after examination of cementum lines of the molars, weighed 133,00 kg.

Mitchell (1965) discusses a crude method of age determination, based on cranial measurements. No data are available on this subject from the present study.

Table : 11 summary extracted from various reference sources of foetal and adult body weights (kg) of Lichtenstein's hartebeest in central and southern Africa.

Date	Foetal weight kg (sex)	Reference
		<u>Zambia</u>
10/1	0,005 (-)	Wilson (1966)
21/2	0,005 (-)	Wilson (1966)
21/2	0,04 (f)	Wilson (1966)
24/4	1,80 (f)	Wilson (1966)
30/4	1,80 (m)	Wilson (1966)
30/4	1,80 (f)	Wilson (1966)
15/5	0,68 (f)	Wilson (1966)
8/7	13,60 (f)	Wilson (1966)
15/7	11,79 (f)	Wilson (1966)
		<u>Tanzania</u>
25/4	0,70	Rodgers, (pers. comm.)*
14/7	1,60	Rodgers, (pers. comm.)
22/8	7,70	Rodgers, (pers. comm.)
17/9	8,10	Rodgers, (pers. comm.)
		<u>Rhodesia</u>
6/9/72	9,00 (f)	Present study**
6/9/72	7,00 (m)	Present study
10/9/72	10,00 (m)	Present study
11/9/72	10,00 (f)	Present study
12/9/72	9,00 (f)	Present study
14/9/72	10,00 (f)	Present study
16/9/72	11,00 (f)	Present study
16/9/72	10,00 (m)	Present study
8/11/72	13,00 (f)	Present study

Adult weights - kg (Average) Male	Female	Age+	Reference
			<u>Zambia</u> + <u>Malawi</u>
149,23 - 199,12 (168,73)	152,00 - 189,60 (173,72)	-	Wilson (1968)
			<u>Tanzania</u>
165,00 - 203,00 (179,10)	131,00 - 153,80 (144,80)	-	Rodgers, (pers. comm.)*
-	32,00	3	Rodgers, (pers. comm.)
-	105,00	12	Rodgers, (pers. comm.)
-	132,00	24	Rodgers, (pers. comm.)
107,00	-	12	Rodgers, (pers. comm.)
130,00	-	16	Rodgers, (pers. comm.)
			<u>Rhodesia</u>
-	125,00 - 177,00 (153,40)	-	Present study **

* A. Rodgers, University of Dar es Salaam, P. O. Box 35064, Dar es Salaam, Tanznaia.

** Data collected from recorded calf and adult mortalities in Gona re Zhou National Park, Rhodesia.

\+ Age in months

Distribution and status of Lichtenstein's hartebeest in the study area

Distribution

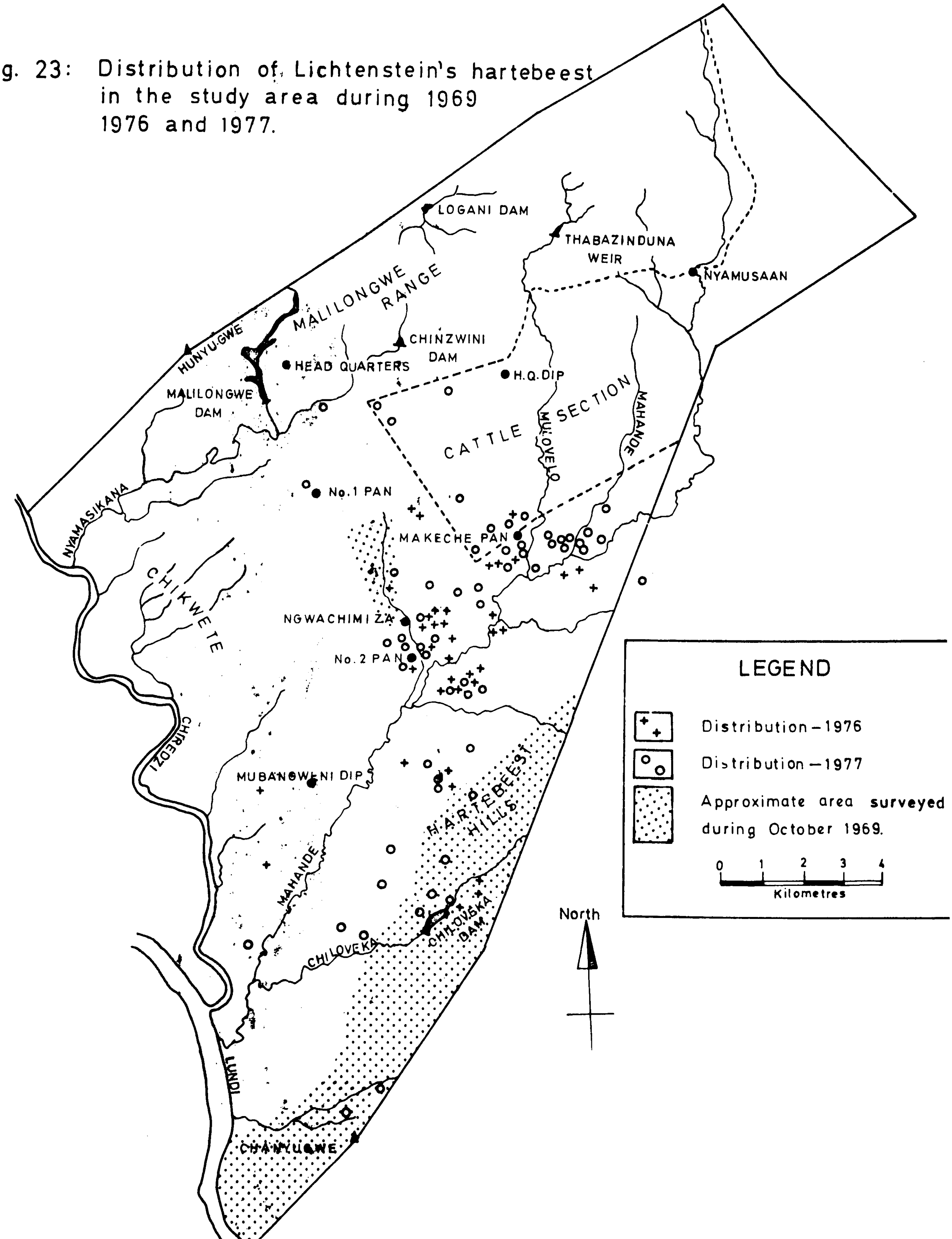
No previous distribution records of this species on the ranch have been kept other than the local knowledge that hartebeest were usually found in such-and-such an area. The general impression was that the hartebeest were confined to the Malevula Hills area, which were colloquially known as "Hartebeest Hills".

In 1969 a survey was conducted to establish the status of the hartebeest on the ranch (Ferrar and Sherry 1969). In all a total of 81 hartebeest were counted, however it is difficult to establish the exact localities where these hartebeest were seen. The survey was restricted to the Hartebeest Hills area (Sparrow, pers. comm.) and following the description given in the report, most sightings were made along the Gona re Zhou National Park boundary fence incorporating the following areas:- southern end of Hartebeest Hills, northern end of Hartebeest Hills near borehole, southern corner near the Lundi River/ranch boundary junction, south of Chiloveka dam towards Chanyugwe Hill, between the northern end of Hartebeest Hills and boundary fence and near Ngwachimiza drainage line (Fig. 23).

For reasons that will become apparent later,these areas are thought not to represent the "preferred habitat" of the hartebeest in the study area.

Therefore in order to establish the whereabouts of hartebeest on the ranch, a systematic search of the area was conducted.

Fig. 23: Distribution of Lichtenstein's hartebeest in the study area during 1969 1976 and 1977.



This search took the form of regular foot patrols, whenever possible, in all areas known to have harboured or which did harbour hartebeest on a regular basis, as well as in areas where hartebeest were not normally known to have regularly occurred. Patrols were also made by vehicle along roads through the study areas where it was known that hartebeest occurred at that particular time.

Sightings made by other members on the ranch, and by African rangers while on anti-poaching patrols, were checked out whenever possible. An aerial survey of the ranch was carried out on two occasions, but these were not as effective as anticipated. In this way, almost the entire basaltic region was covered either on foot or by vehicle on a regular basis. All sightings were marked on a 1 : 50 000 map of the study area and records kept of: time of day, herd structure, activity (grazing, walking, standing, resting) and the type of vegetational community in which the hartebeest were seen.

An attempt was made to monitor the whereabouts of a herd on a daily basis. This proved difficult as the hartebeest are sensitive to disturbances and if regularly disturbed, would invariably move off to a new area. Only actual sightings of every individual/herd seen over the two year period were marked on the map. These sightings included those of the same individual/ herd that were observed on two or more occasions on the same day, but in different localities.

The distribution of the population of Lichtenstein's hartebeest in the study area over the two year period is given in Fig. 23. From this it can be seen that the distribution during 1976 - 1977 differed quite considerably from the area surveyed during 1969. In general the hartebeest were confined to the basaltic flats, and were not seen, nor were they ever known to have occurred in the hills along the southern boundary of the ranch in all the years that the ranch has existed. A herd of hartebeest was known to have occurred in the Makeche cattle paddock in the vicinity of H.Q. Dip (See Fig. 23). On one occasion during the dry October of 1976, when this herd had moved from the area, a solitary hartebeest was found in the cattle paddock and it appeared that this individual was unable to cross the 1,2m high, four-strand, barbed wire, cattle fence. It eventually escaped through an open gate and shortly thereafter was seen again near a small dam (Mapanzani Dam) near the ranch headquarters - presumably seeking water, but was never seen again. This was the closest any hartebeest ventured near the hills. On another occasion a herd of four hartebeest - suspected as being those from the Makeche cattle paddock - were seen at No. 1 Pan where they remained for 2 - 3 days before moving on to Ngwachimiza, where they were last observed.

Hartebeest were never recorded from the Chikwete area, and they were rarely found along the Lundi and Chiredzi River frontage. A herd was located on three occasions in the Mubangweni Dip area, and a single individual was recorded near Churini Weir. It was suspected that these hartebeest may have crossed over from Hippo Valley Estates. They were not seen in these areas again. In the triangle below Chanyugwe, where hartebeest were recorded during the 1969 survey, a solitary bull was seen, although poachers succeeded in snaring a sub-adult bull in this region in July 1976.

The area along the boundary of the ranch, from Chanyugwe northwards as far as the Mahande River was not known to harbour hartebeest except in an area surrounding Chiloveka Dam to which the population gravitated during the annual migration (see p. 176). The Phantom Herd was suspected of using this area and for crossing to the Gona re Zhou National Park, although no evidence for this was found.

The Cattle Section, on the adjacent State Land, was not known to harbour hartebeest. This vast area was systematically searched on a regular basis by staff on the ranch during routine cattle round-ups, and the specific request to report any hartebeest in the area met with no response during the entire period except for a solitary individual seen near the boundary of the ranch above the Bengi River.

It should be mentioned here that the frequency of sightings was erratic, for, although it was thought that Lichtenstein's hartebeest were territorial and occupied an area throughout the year (Mitchell 1965, Dowsett 1966), this was not the case on Lone Star Ranche. The various isolated herds exhibited a local migration which necessitated a systematic search of the entire area in order to follow their movements. Often various herds were not located for several days or weeks - in some instances a group of hartebeest were seen in particular habitat only on one occasion during the entire study period.

Status of Lichtenstein's hartebeest in the study area

Initially it was thought that there were in excess of 100 hartebeest on Lone Star Ranche, but a thorough search of the study area revealed that this was incorrect. However, determining the status of hartebeest in the study area proved to be extremely difficult for a number of reasons, primarily because of the difficulty of recognising specific individuals in the population.

Marking hartebeest, using conventional methods such as neck collars, was considered too risky both by the owner and the authorities; previous exercises in translocating this species from the ranch had resulted in the deaths of several hartebeest. (In retrospect it is doubted whether the time and the expense of such an operation would have been justified). Therefore, an attempt was made to identify specific individuals or groups of individuals, using natural characteristics such as scars, torn ears or horn deformities, but this proved to be only partially successful.

Hartebeest in the study area were rare and difficult to locate and observe for any length of time. Contrary to observations made elsewhere (Dowsett 1966, Wilson 1966), the hartbeest in the study area could not be regarded as curious and slow to move off in the face of danger. The average time an observer had to watch a herd varied between 2 - 5 minutes once the herd was aware of one's presence.

Nevertheless two methods proved to be most successful in observing the hartebeest for any length of time. In the initial stages, before any predictions could be made as to where the hartebeest might be found, the most successful method of observation was to find a herd unobserved by them, and then avoid detection.

However Lichtenstein's hartebeest have excellent eyesight and a keen sense of smell. The herd was constantly vigilant and it was usually not long before the observer's presence was detected. The disadvantage of this method was the fact that the location of a herd was never assured and often the herds were located in the tall grasslands (1,2m) of the dambo associations, which precluded any direct observations.

However, once an understanding of the general distribution and activity pattern of a specific herd was established, the most successful method of observation was to seek an observation post in a tree at least five metres above the ground, in a likely study area. The hartebeest were usually then unperturbed by the observer's presence provided their attention was not drawn to this fact and they had not been interfered with too frequently in the past.

Attempts to observe the hartebeest from a vehicle were unsuccessful, for, although the hartebeest did not flee, they would stare at the vehicle, continually alert and ever watchful for any signs of movement which would hasten their departure.

Following up the herd after it had fled proved fruitless, for once the hartebeest were alarmed, they continued to flee on being approached. This usually resulted in that particular herd not returning to the area for some time - on some occasions abandoning it completely. Moreover one of the conditions of being allowed to work with this population was to cause as little disturbance as possible.

A further factor which complicated the identification and determination of the status of the hartebeest in the study area was the irregular sight records. Most often a particular group were not observed for several days, even weeks or a strange group or single individual would suddenly appear and disappear with equal rapidity, confusing the situation considerably if a positive identification were not possible. There was also evidence suggesting that the cows, some of whom provided the key to identification of a particular group, moved between harem herds and remained in these herds for various lengths of time. This fact caused gross misinterpretations of herd movement, especially if it was not known that a second group of hartebeest had moved into the area.

In general the hartebeest were extremely wary and every effort had to be taken to avoid disturbing them if data were to be gathered. It is for these reasons that it was impossible to determine whether an individual or group of hartebeest seen in 1976 in a particular area was the same individual/group seen again in 1977. Therefore in Table 12, the status and population structure of the various herds of hartebeest are given separately for 1976 and 1977.

The population varied in number throughout the two year period, and, although all efforts were made to avoid double counts, it is suspected that two or more of the "herds" represented in Table 12 are one and the same. Without a fool-proof means of identification, this problem was difficult to avoid under the circumstances.

Table : 12 Summary of the population structure of Lichtenstein's hartebeest in 1976 and 1977 on Lone Star Ranche, south eastern Rhodesia.

AUGUST - 1976

Herd	Status	Structure		
		Male	Female	Y.Y.*
Makeche	Harem	1	3	-
Phantom	Harem	1	3	2
Playground	Harem	1	3	-
Ngwachimiza	Harem	1	1	1
Mubangweni	Harem	1	2	1
No. 9	Harem	1	3	-
Hartebeest Hill	Harem	1	2	1
No. 11	Harem**	1	1	-
One Horn	Bachelor	3	-	-
Mahande	Bachelor	1	-	-
Bengi	Bachelor	1	-	-
No. 7	Bachelor	1	-	-
Chiloveka	Bachelor	1	-	-
Total		15	18	5

SEPTEMBER - 1977

Herd	Status	Structure		
		Male	Female	Y.Y.*
Makeche	Harem	1	3	1
Phantom	Harem	1	5	2
3	Harem	1	2	-
4	Harem	1	3	-
5	Harem	1	1	1
6	Harem	1	3	1
7	Harem**	1	1	-
8	Harem	1	3	-
9	Bachelor	1	-	-
10	Bachelor	1	-	-
11	Bachelor	1	-	-
12	Bachelor	1	-	-
13		-	1	-
Total		12	22	5

Y.Y.* = Young of year

Harem** = Possibly a bachelor herd ?

Note : Due to the difficulties in identifying the various groups in the study area, it was impossible to determine whether individuals seen in 1976 in one area were the same individuals seen again in 1977.

In March 1976, a total of 39 hartebeest and 12 young of the year were recorded in the initial seach, but by August this figure was adjusted to 15 males, 18 females and five young of the year, giving a total of 38 animals. Of the 13 groups recognized in 1976, it is suspected that the Makeche Herd, Playground Herd and No. 9 Herd were one and the same, but there was no absolute proof to support these suspicions. All the herds were located in different areas and without being able to establish the location of all three herds simultaneously there was no way of telling if these were separate herds. Similarly, the One Horn Herd, which was seen on three occasions, was thought to have split up. Two individuals - the Mahande Herd and Bengi Herd - remained in the area, while the One Hord individual disappeared altogether. The Mubangweni Herd and Hartebeest Hills Herd may have been one and the same, each herd was only located on two and three occasions respectively. Herd No. 11 was suspected of consisting of a sub-adult bull and cow, although it is quite possible that this represented a bachelor herd. Sexual dimorphism was not apparent until hartebeest had matured, and distinguishing between sexes was often difficult.

In 1977, population numbers again fluctuated, at the end of the study the population consisted of 12 males, 22 females and five young of the year. These figures include sub-adults from the previous year, but unless a clear view of all the individuals was obtained, it was difficult to distinguish between the various age classes - especially between cows. During 1977, the only herds that could be identified with certainty from the previous year were the Makeche Herd and the Phantom Herd - the latter being the largest in the study area. The Makeche Herd proved the most stable herd from which the most consistant data were obtained. The activities of this herd will form the basis for the discussion on utilisation of the habitat (see p. 201).

Conclusion

Hartebeest in the study area were rare and proved difficult to find, especially in the initial stages when it was not clear where they were likely to be found. This, and the fact that the hartebeest were not found in any one particular area for any length of time meant that it could not be guaranteed that the habitat the hartebeest enjoyed at any particular time was a "preferred habitat".

Added to this there were interruptions during the study period caused by both natural and unnatural conditions. First heavy rains during February 1977 turned the basaltic flats into a sticky quagmire, which remained impassable to even four-wheeled-drive vehicles until the beginning of April. Secondly, on several occasions, follow-up and systematic searches for various groups of hartebeest were curtailed by the security situation in the area. This resulted in an incomplete record on movement of the herds of hartebeest in the study area which has made interpreting the manner in which they utilised the habitat in the various seasons of the year difficult.

Therefore in order to arrive at some conclusions regarding the preferred habitat of Lichtenstein's hartebeest in the study area, a technique was required that would encompass the description of the vegetation of the entire area, but would also ultimately lead, through a process of elimination, to a description of the preferred habitat of the hartebeest.

The following chapters are devoted to a description of the vegetation of the study area and the manner in which hartebeest utilise the habitats of the survey area.

CHAPTER 6

Vegetation of Lone Star Ranche

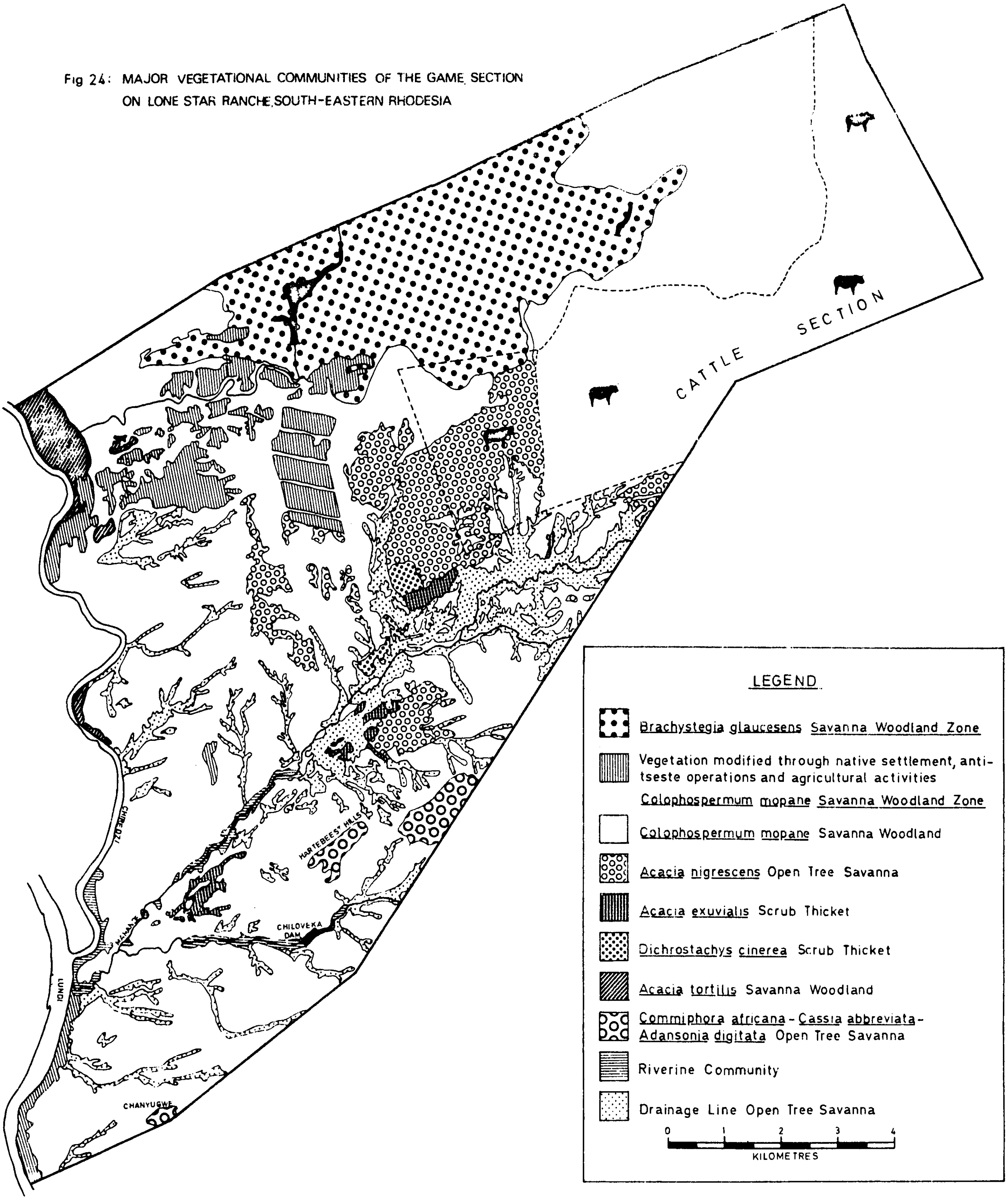
Lone Star Ranche lies in the *Colophospermum mopane* zone of Keay (1959). Studies on the vegetation in the surrounding area have been made by Rattray and Wild (1955) who classified the vegetation of the alluvial basin of the Sabi Valley according to the soil types encountered. Wild (1955) provides some information on the vegetation of the Sabi-Lundi junction and the Chiwonja Range. More recently Farrell (1968) has discussed the vegetation of the Sabi-Lundi Basin, which includes Lone Star Ranche, and provides a broad vegetation map of the area. These papers have been drawn upon in the following text where they help to elucidate the overall pattern of the vegetational physiognomy in the study area.

For the purpose of this study the vegetation of Lone Star Ranche has been divided into two ecotype zones - the *Brachystegia glaucescens* dominated Karoo sandstone zone (referred to as the *Brachystegia glaucescens* Savanna Woodland Zone) and the *Colophospermum mopane* dominated Karoo basaltic zone (Fig. 24).

The *Brachystegia glaucescens* dominated zone is treated as a whole and no effort has been made to differentiate between the various communities that exist within this zone. The *Colophospermum mopane* dominated zone has been subdivided into a number of communities. These include :

1. *Colophospermum mopane* Savanna Woodland
2. *Acacia nigrescens* Open Tree Savanna
3. *Acacia exuvialis* Scrub Thicket

Fig 24: MAJOR VEGETATIONAL COMMUNITIES OF THE GAME SECTION ON LONE STAR RANCHE, SOUTH-EASTERN RHODESIA



4. Dichrostachys cinerea Scrub Thicket
5. Acacia tortilis Savanna Woodland
6. Commiphora africana - Cassia abbreviata - Adansonia digitata Open Tree Savanna
7. Riverine Community
8. Drainage Line Open Tree Savanna, incorporating the Dambo Associations.

It was not the intention in the present study to provide a detailed botanical account of the vegetation of Lone Star Ranche. Therefore within each of the major communities described here, the botonist would find reason based on density, stratification and even species composition to allow further subdivision of these communities. To have done this would have only detracted from the main objective of this study which was to establish,as far as possible,the preferred habitat of Lichtenstein's hartebeest. No information was available to indicate what this habitat might be and, added to this, it was not clear whether the hartebeest that occurred in the study area had a choice of a "preferred habitat" or simply survived in an area of sub-optimal habitat that afforded them protection.

With this in mind, a broad description of the major vegetation communities is discussed here, with more attention given to the communities occurring on the basaltic flats, and in particular the Drainage Line Open Tree Savanna, since these areas are closely associated with the "preferred habitat" occupied by the hartbeest. Descriptions of those areas either far removed from or of no importance to the hartebeest in their choice of habitat, are treated more superficially.

Methods

With the aid of a series of aerial photographs (Chiredzi North, 1 : 25 000, 1974) the broad vegetational communities were located on the ground and mapped. These were then transferred to a 1 : 50 000 map with the aid of a stereoscope. The recognition of each separate community was based on the fact that a particular community had easily identifiable characteristics. This usually took the form of a dominant and conspicuous woody species, for example, *Colophospermum mopane* in the *Colophospermum mopane* Savanna Woodland, or a conspicuous physical feature such as the flat open topography associated with the drainage lines of the Drainage Line Open Tree Savanna.

The physiognomic classification of the vegetation is based on that proposed by Tinley (1975), although descriptions given by Kuchler (1949), Keay (1959), Rattray (1961), Cole (1963) and White (1965) proved useful. The classification of the grasslands is based upon that proposed by Vesey-Fitzgerald (1963).

Tinley (1975) defines the vegetation physiognomy as follows:

Thicket: Usually stratified, very dense almost impenetrable tree and/or large scrub community. Shade grasses discontinuous or absent. Thickets shorter than five metres should be referred to as Scrub-Thicket.

Savanna Woodland: Stratified or single storied stands of trees with crowns spaced from less than one crown diameter apart to crowns interlocking or overlapping, with shrubs, grassland and/or forb groundlayer. Typical examples include *Brachystegia* sp. Savanna Woodland and *Colophospermum mopane* Savanna Woodland.

Tree Savanna: Stratified or unstratified stands of trees spaced from about one to three crown diameters apart. Crowns interlock where local aggregations occur. With shrubs, grassland and/or forb groundlayer. The spacement of trees is intermediate between savanna woodland and the Open Tree Savanna in which stratified or unstratified stands of trees are spaced more than three crown diameters apart. The term "savanna" is used for the wooded grasslands between the equatorial rain forests and the grasslands.

Grasslands: Vesey-Fitzgerald (1963) has used a phytosociological approach to classify the different grasslands, which were treated as being entities believed to have a past history, present status and possible future development. The definitions and descriptions of the various grasslands will be dealt with in the section dealing with the Drainage Line Open Tree Savanna (see p.122).

The vegetation communities present are considered to be the result of circumstances which actually prevail, or have prevailed in the environment. The environmental factors which were apparently most important were included under; climate, topography, biology and history.

Climate is obviously of paramount importance to the vegetation in any area, although some of the indirect effects of climate may be considered under the heading of topography which includes the following important elements; elevation, aspect, drainage and soil. Biological factors include the effects of man's activities, mainly fire and cultivation, and the effects of grazing by both domestic stock and wild game. Historical factors are sometimes difficult to recognise and assess. The immediate past history is obviously important in determining the present state of any vegetational environment, but ancient history of the area is also of importance and consideration of this may sometimes explain the existence of certain vegetational communities which might be difficult to fit into place in the general pattern otherwise.

Using this physiognomic classification of the vegetation enabled the various communities to be defined. In the present study, "community" is defined as the "vegetation proper to a definite type of environment", for example Colophospermum mopane Savanna Woodland. An "association" is defined as forming a division of a community, which is characterised by certain known species, one or more of which may exhibit different degrees of dominance. The term "dominance" implies the species with the highest density or the most conspicuous woody species. In these circumstances a compromise is necessary. The apparent density may be influenced temporarily by various conditions such as fire or grazing. Thus the more conspicuous plant will be called dominant, even though it may not be the most numerous. The term "facies" is defined as an aspect of a community or association which differs locally usually in density within that community or association. An organismal view of the community has been taken, because the object of the investigation is to establish the various communities and their suitability as a habitat for animals.

For the purpose of this study, all the communities representing the woody vegetation will be divided into three strata:

1. the upper or A - stratum
2. the middle or B - stratum
3. the lower or C - stratum

Differentiation between trees and shrubs was subjective and merely relied on height. All woody growth forms, either single or multi-stemmed up to 1,50m were regarded as shrubs and those over 1,50m as trees.

Soil Types

The grouping of soils into eluvial, colluvial and illuvial types is based on that used by Vesey-Fitzgerald (1963). The soils conform to the usual red to black catena which is related to the drainage. The red soils are mainly eluvial in nature, that is to say that they are well-aerated soils in which the movement of water is predominantly downwards, resulting in the profile being leached of silica and/or bases. The black soils on the other hand are seasonally inundated and illuvial in nature, that is to say they receive drainage water from elsewhere due to their topographical position and accumulate all or part of the dissolved silica and bases. Colluvial soils are somewhat intermediate in character. If they are highly leached they might be considered as a subdivision of the eluvial type, but where there is an accumulation of bases they could be regarded as illuvial. Colluvial soils develop on material transported by gravity and not necessarily aided by water movement. This category is not the same as alluvium which refers to material actually carried in suspension by rivers and deposited later in areas of slow water movement.

The methods used to gather quantitative data on the different vegetational communities will be discussed in the relevant chapter (see p. 142).

Brachystegia glaucescens Savanna Woodland Zone

This zone is confined to the Stormberg sandstone formation and granite outcrops along the north-western boundary of the study area. The topography of this area and the greater variety of soil types and plant species added to the complexity of this zone, would justify the subdivision of this zone into a number of plant communities.

However, this zone was not associated with the habitat of Lichtenstein's hartebeest and thus will be dealt with superficially.

Wild (1951) distinguishes two ecotypes of Brachystegia glaucescens:- the high-altitude ecotype, with 15 - 25 pairs of leaflets, occupying escarpments and hill tops in areas of higher rainfall, while the low altitude ecotype with seven pairs of leaflets, is found on more level sites in hot, dry areas. On Lone Star Ranche the higher rainfall experienced on the Malilongwe Range supports the higher altitude ecotype which varies in height from 10 - 12m on deep eluvial soils of the Stormberg sandstone and more stunted (3 - 5m) on the granite outcrops (Fig. 25).

Brachystegia glaucescens contributes almost entirely to the A - stratum, although other species include Adansonia digitata and Kirkia acuminata. The trees have circular canopies which in places overlap while in others they are spaced up to one canopy apart, forming a mosaic canopy cover. There is little understorey

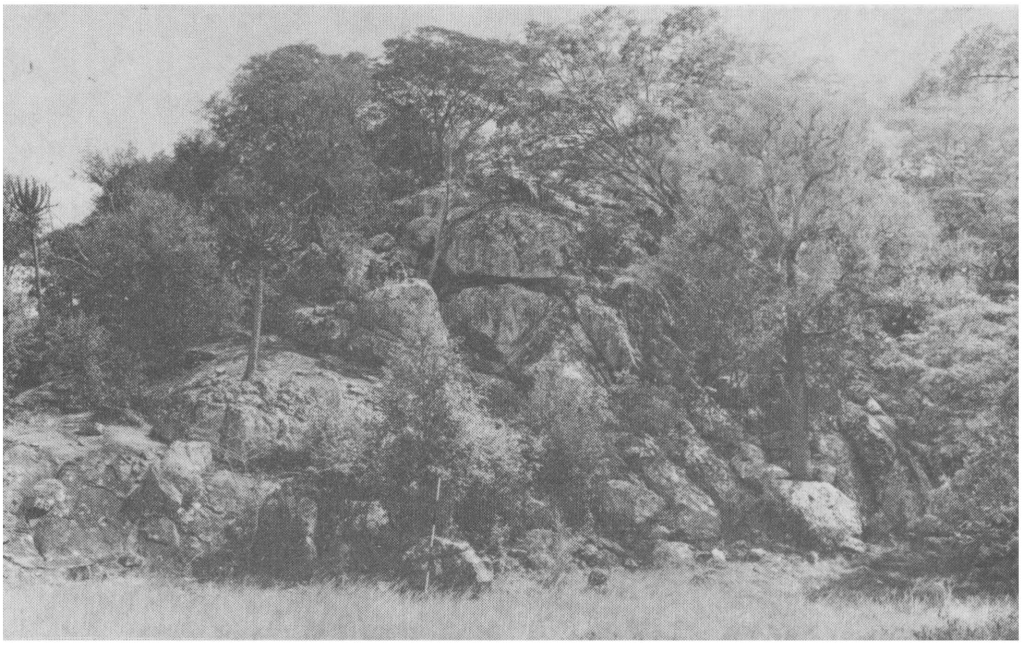


Fig: 25 An example of a granite outcrop with the *Brachystegia glaucescens* Savanna Woodland zone, illustrating the rich variety of plant species to be found in this zone. These include *Euphorbia cooperi*,*Ficus* sp., *Kirkia acuminata* and *Terminalia sericea*. At the base of such outcrops dense stands of *Digitaria milanjiana* and *Pongonarthria squarrosa* are to be found. *Note*. In this and all subsequent vegetational illustrations, the scale is represented by means of a three metre rod graduated in 0,5m intervals.

forming the B - stratum. Scattered shrubs include *Monodora junodii* and *Vangueria infausta*. The grass cover is characteristically sparse with frequent patches of exposed sandy soil. *Digitaria milanjiana* forms a good cover in some places, while highveld grasses such as *Pogonarthria squarrosa* and *Perotis patens* also occur (Farrell 1968), together with *Aristida* sp., *Panicum maximum*, *Eragrostis* sp. and *Heteropogon contortus*, which also occurs on the basaltic flats.

In the area surrounding Hunyugwe (Fig. 1) the understorey on the dolerite and Stormberg sandstone is composed of *Commiphora africana* together with *Grewia* sp. The rocky soils support a poor grass cover, composed almost entirely of *Aristida* sp. and patches of *Urochloa mosambicensis*, *Heteropogon contortus* and *Bothriochloa radicans*. Along the foothills of the Stormberg sandstone outcrops, on the deeper Stormberg sandstone soils, dense stands of *Coffea racemosa* and *Dalbergia melanoxylon* occur, while the Lower Karoo grits, where they meet up with the Upper Karoo (Stormberg) sandstones (See Fig.2) are dominated by *Terminalia sericea* which average 10 - 12m in height. Along the boundary between the *Brachystegia glaucescens* Savanna Woodland zone and the *Colophospermum mopane* dominated zone, species such as *Albizia harveyi*, *Commiphora glandulosa*, *Spirostachys africana*, *Grewia* sp., *Coffea racemosa*, *Brachystegia glaucescens*, *Colophospermum mopane* and *Dichrostachys cinerea* occur.

Floristically, this zone dominated by *Brachystegia glaucescens*, is undoubtedly the most complex and interesting of all the communities in the study area, having the greatest diversity of plant species. Some of those which are characteristic of this zone include:

Adansonia digitata, *Adenium obesum*, *Afzelia quanzensis*, *Albizia harveyi*, *A. antunesiana*, *A. versicolor*, *Androstachys johnsonii*, *Brachylaena rotundata*, *Brachystegia tamarindoides*, *B. glaucescens*, *Coffee racemosa*, *Combretum molle*, *C. zeyheri*, *Commiphora africana*, *C. glandulosa*, *Dalbergia melanoxylon*, *Dichrostachys cinerea*, *Euphorbia cooperi*, *E. ingens*, *Ficus capensis*, *F. ingens*, *F. soldanella*, *F. sycomorus*, *Grewia* sp., *Kigelia africana*, *Kirkia acuminata*, *Lannea stuhlmannii*, *Newtonia hildebrandtii*, *Pachypodium saundersii*, *Pterocarpus rotundifolius*, *Spirostachys africana*, *Strychnos spinosa*, *Tabernaemontana elegans*, *Terminalia pruniodes*, *T. sericea*, *Xemenia caffra*, *Xylia torreana*.

Colophospermum mopane Savanna Woodland Zone

Colophospermum mopane Savanna Woodland

Colophospermum mopane is a characteristic vegetation type of the south-eastern lowveld (Henning and White, 1974). On Lone Star Ranche this community covers almost 75% of the study area (Fig. 24). The prevention of fires in the study area in the past 20 years has resulted in the development of the *Colophospermum mopane* communities from what is usually defined as "scrub-savanna" (Tinley, 1975) i.e. short woody cover up to five metres in height, to more mature woodland communities in which a third or more of the trees are five metres or more in height, reaching a maximum of 15 - 20m. Therefore a great diversity is found from one area to the next, varying from savanna woodland to open tree savanna.

The *Colophospermum mopane* Savanna Woodland is confined in the main to the basaltic flats (Fig. 24) and is poorly represented on the Karoo sandstones. Two variations are recognizable within the overall *Colophospermum mopane* Savanna Woodland. Where this community occurs on the degraded alkaline clays of the alluvium, it forms a tall woodland 15 - 20m high (Fig. 26). In this tall woodland, *Colophospermum mopane*, is without exception, the main contributor to the A-stratum. The middle or B-stratum, which forms a sub-canopy, which is more continous than the upper stratum, varies from 0,5 - 5,0m in height. In the B-stratum younger specimens of *Colophospermum mopane* are an important contributor, although species such as *Dalbergia melanoxylon*, *Dichrostachys cinerea*, *Euclea divinorum*, *Grewia* sp., *Pterocarpus rotundifolius* and *Commiphora africana* are all conspicuous.

The C-stratum or ground layer consists almost entirely of grasses which are mostly annuals. The most characteristic of these are: *Aristida* sp., *Cenchrus ciliaris*, *Heteropogon contortus*, *Pennisetum setaceum*, *Pogonarthria squarrosa* and *Urochloa mosambicensis*. The second variation is recognized where *Colophospermum mopane* occurs on the black clays overlying the basalts. Here it is found as a small tree and occurs as dense coppices, or as a suffrutex where thin branches are produced from an underground stock (Fig. 27). As mentioned earlier, no fires have been permitted in the study area for the last twenty years and as a result *Colophospermum mopane* in these areas has grown to a height of 2 - 6m.

Here again *Colophospermum mopane* is a primary contributor to the A-stratum although species such as *Acacia nigrescens*, *Albizia harveyi*, *Combretum imberbe*, *Combretum apiculatum*, *Lonchocarpus capassa* and *Sclerocarya caffra* are also to be found.

Fig: 26 The *Colophospermum mopane* Savanna Woodland with *Colophospermum mopane* reaching a height of ten to fifteen metres on alluvial soils. Species such as *Euclea divinorum* and *Grewia* sp. contributed to the lower stratum, while the grass stratum consisted predominatly of *Aristida* sp.

Fig: 27 On the black clay soils of the basaltic flats, Colophospermum mopane was stunted, reaching heights of two to six metres. Often the species occurred in dense coppices, or as a suffrutex where thin branches are produced from the underground stock. Note in the immediate right foreground a stunted specimen of Lonchocarpus capassa surrounded by a dense sward of Setaria anceps, while beneath the Colophospermum mopane the grass sward consists mainly of Urochloa mosambicensis.

The B-stratum consists of species such as *Acacia exuvialis*, *Dalbergia melanoxylon*, *Dichrostachys cinerea*, *Pterocarpus rotundifolius* and *Ziziphus mucronata*, which vary from 2 - 3m in height. In a few wetter locations, small pockets of *Hyphaene benguellensis* var.*ventricosa* are also to be found contributing to this stratum, although tall-stemmed specimens are rarely seen.

The C-stratum is dominated by *Aristida* sp., especially on calcareous substrates where *Commiphora africana* also occurs forming a low (0,5 - 1,0m) rambling multi-stemmed scrub bush. Where open clearings are encountered and the soil is deeper, *Urochloa mosambicensis* and *Cenchrus ciliaris* grow in almost pure localised stands, where as in rocky areas, particularly in the Hartebeest Hills area, *Bothriochloa radicans* is dominant together with *Aristida* sp.

The boundaries of the *Colophospermum mopane* Savanna Woodland are well defined, especially along the course of the drainage lines. Only rarely is *Colophospermum mopane* found growing in the open drainage line areas, either as an isolated aggregation or single specimens. The grass species along the ecotone between the *Colophospermum mopane* Savanna Woodland and the Drainage Line Open Tree Savanna include *Enneapogon cenchroides*, *Eragrostis capensis*, *Digitaria milanjiana* and *Heteropogon contortus*.

Ischaemum afrum, characteristic of the dambos, occurs in isolated patches in this community, especially where water accumulates during the rainy season in shallow depressions.

In general the habit and density of this community is highly variable. A number of facies occur in the community, differing in species composition density and physiognomy.

Acacia nigrescens Open Tree Savanna

Acacia nigrescens is wide spread in the south-eastern lowveld, being a component of communities on many soil types on all geological formations (Farrell 1968). On Lone Star Ranche, the *Acacia nigrescens* Open Tree Savanna is confined to the heavy clay soils of the basalts (Fig. 24).

Acacia nigrescens, which varies in height from 10 - 15m, contributes almost entirely to the A-stratum (Fig. 28) although *Colophospermum mopane* also occurs occasionally. The B-stratum varies in height from 2 - 5m and is dominated by *Dichrostachys cinerea* and *Dalbergia melanoxylon* while *Acacia exuvialis* is also to be found. *Combretum imberbe*, where it occurs in this stratum, forms a multistemmed bush, but on occasions single stemmed trees of this species, taller than five metres, are encountered and contribute to a stratum roughly midway between the A- and B-strata.

Combretum imberbe was favoured for making fence posts when the ranch was in the developmental stage and thus this aspect of the vegetation may have been modified. Other species contributing to the B-stratum include *Lonchocarpus capassa* and *Acacia tortilis*.

The C-stratum is characterised by the presence of *Cenchrus ciliaris* and *Urochloa mosambicensis*. In some areas within the *Acacia nigrescens* Open Tree Savanna, there are areas, known locally as "playgrounds" (Fig. 29), which have hardly any grass

Fig: 28 The open nature of the Acacia nigrescens Open Tree Savanna, characterised by tall specimens of Acacia nigrescens (10,0 - 15,0 m) with very little understorey. The major grass species is Cenchrus ciliaris.

Fig: 29 A feature of the *Acacia nigrescens* Open Tree Savanna is areas known as 'playgrounds'. These areas support a poor grass stratum characterised by *Urochloa mosambicensis*, *Cenchrus ciliaris* and *Aristida* sp. and weeds such as *Solunum incanum*. The woody species, such as *Dichrostachys cinerea*, are often stunted and dead specimens of *Combretum imberbe* (centre foreground) are common.

cover at all - even in an above average rainy season as was experienced during the course of this study. These "playgrounds" are characterised by *Solanum incanum* and grasses such as *Urochloa mosambicensis*, *Aristida congesta*, *Cenchrus ciliaris*, *Bothriochloa radicans* and rarely *Eragrostis* sp. These grasses are often stunted to a tenth of their height in other areas. *Dichrostachys cinerea*, which usually grows to a height of 2 - 5m in other areas of this community occurs as a multi-stemmed shrub rarely higher than 1,0m, while dead trees of *Combretum imberbe* are common (Fig. 29).

These "playground" areas are often centres of congregation for zebra, eland, wildebeest and impala, particularly during the midday period and it is possible that these "playgrounds" are subjected to a heavy grazing pressure by both browsers and grazers alike. It is also possible that these areas carry a high content of the clay mineral 'montmorilonite' which has the effect of choking the root systems of trees and which may result in the stunting of their growth. This clay also moves, resulting in the root systems being broken. This could be a cause of death to species such as *Combretum imberbe* (Broderick, pers. comm.)[1]

Other grasses found in this community are *Ischaemum afrum*, and *Setaria anceps*. These species normally grow in the drainage line areas, however in the *Acacia nigrescens* Open Tree Savanna, they are not associated with a drainage line of any sort and grow in fairly dense stands on level ground. This suggests that in some

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[1] T.J. Broderick, Ministry of Mines, Private Bag 7709, Causeway, Salisbury, Rhodesia.

areas of this community the soil is impervious to water and carries a relatively high water table. This factor may play a role in the selection of this habitat by Lichtenstein's hartebeest.

Acacia exuvialis Scrub Thicket

Acacia exuvialis is not referred to as being present in the south-eastern lowveld by any of the previous authors or as representing a community (Rattray and Wild 1955, Wild 1955, Farrell 1968). On Lone Star Ranche the *Acacia exuvialis* Scrub Thicket is mainly confined to the basaltic region of the study area and is only found occupying small areas where it can be identified as a "community" (Fig. 24).

This community is, in places, very dense and almost impenetrable, averaging 3,0m in height, with an absent or discontinuous grass-cover. Where this community occurs as almost uniform stands, usually only two strata are discernable. The "broomlike" bushy crowns, in places, overlap to produce an almost complete canopy cover, beneath which little or no grass occurs. That which does exist is usually *Aristida congesta* subsp. *barbicollis*.

Where *Acacia exuvialis* forms a discontinuous distribution a dense ground layer of *Urochloa mosambicensis* exists with species such as *Ischaemum afrum* and *Cenchrus ciliaris* scattered throughout the area where conditions are suitable for their existence. In one area along the road between Ngwachimiza and Makeche Pan (Fig. 30) a dense stand if *Ischaemum afrum* and *Setaria anceps* occurs, forming the grass cover amongst a discontinuous distribution of *Acacia exuvialis*. These two grass species are normally associated with

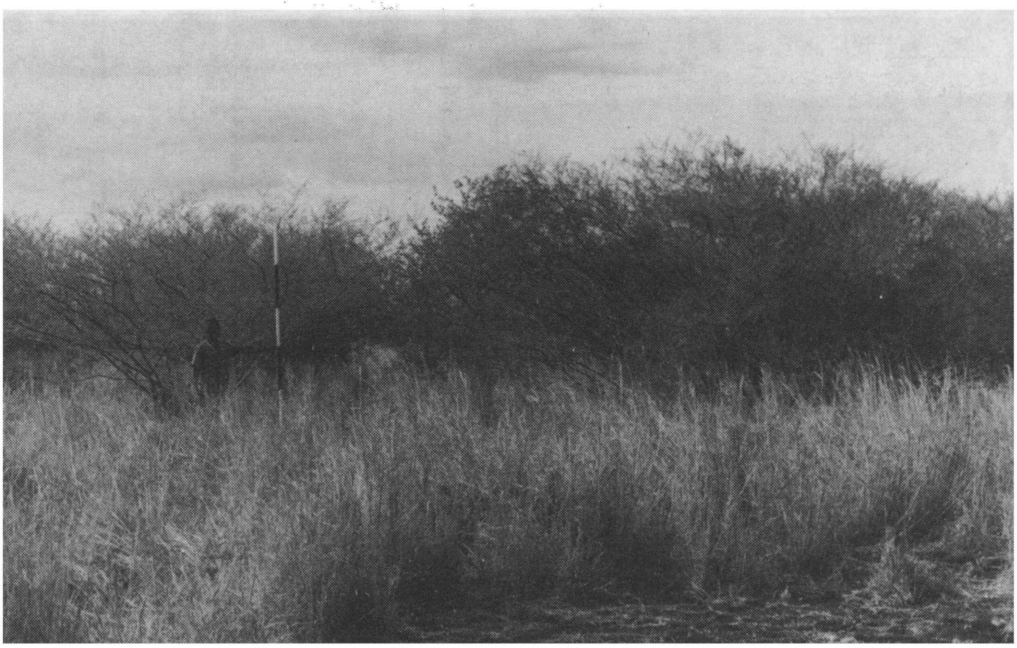


Fig: 30 The Acacia exuvialis Scrub Thicket, with the branches of neighbouring Acacia exuvialis individuals intermingling and forming a dense thicket. The grass stratum consists mainly of Ischaemum afrum and Setaria anceps, with Urochloa mosambicensis occurring in some places.

the dambos in the drainage line areas. In this area there are no shallow depressions which resemble the dambo systems. This suggests that this area was at one time probably a large dambo which has since silted up and has been invaded by *Acacia exuvialis*.

In another area, and unique to this community in the study area, there is an isolated patch of *Paspalum scrobiculatum* - a species which favours a moist environment (Chippindall and Crook, 1976 - 1978).

Other woody species found in this community include *Dichrostachys cinerea*, *Acacia nigrescens*, *Combretum imberbe* and *Sclerocarya caffra*.

Dichrostachys cinerea Scrub Thicket

What is said of the *Acacia exuvialis* Scrub Thicket applies to this community as well. In only one area does this species form a dense inpenetrable scrub thicket (Fig. 24). Clumps of *Dichrostachys cinerea* are found in many other communities, especially on the edges of the Drainage Line Open Tree Savanna community.

Usually this community consists entirely of *Dichrostachys cinerea* and only rarely do isolated individuals of *Dalbergia melanoxylon* occur within this community. This community cannot be divided clearly into an A- or B-stratum (Fig. 31). The *Dichrostachys cinerea* Scrub Thicket, which usually averages between 3 - 5m in height, has no grass cover except for isolated patches of *Aristida congesta* subsp. *barbicollis*. The reason for this is not clear. It is possible that this species may inhibit the growth of grass species beneath its canopy.

Acacia tortilis Savanna Woodland

Bush clearing in the anti-tsetse operations in the 1960's has modified the vegetation in some places of the south-eastern lowveld.

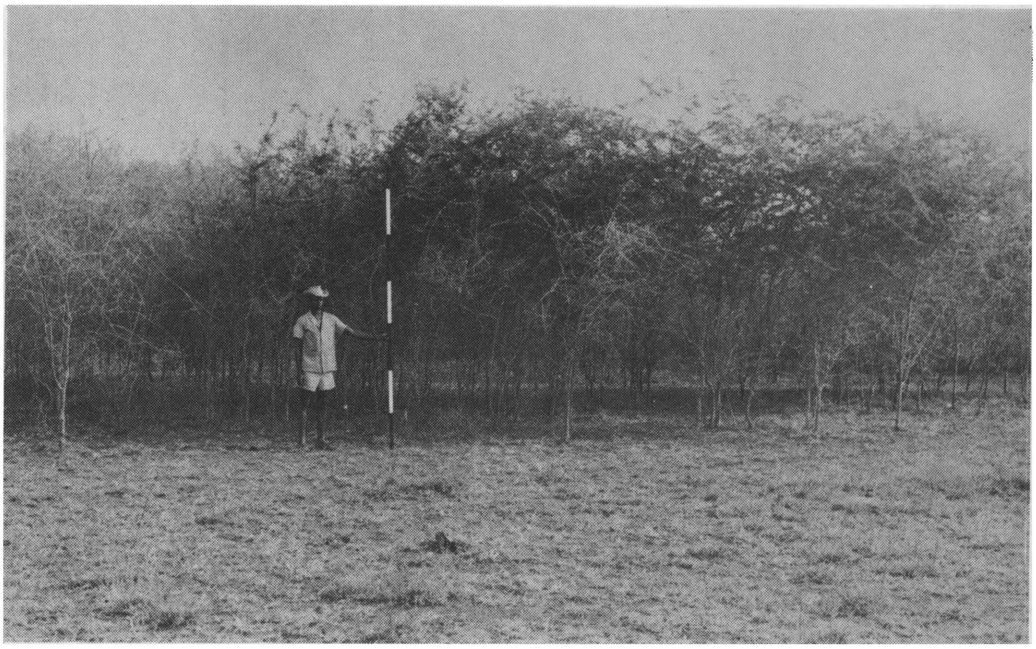


Fig: 31 An example of the dense, uniform inpenetrable *Dichrostachys cinerea* Scrub Thicket. Very few grass species are encountered in the *Dichrostachys cinerea* Scrub Thicket, the most common species being *Aristida congesta* subsp. *barbicollis*.

In the exercise, riparian forests and other communities, including the *Acacia tortilis* Savanna Woodland, were cleared from parts of the Sabi, Chiredzi and Lundi Rivers (Farrell 1968).

As a result the savanna communities of *Acacia tortilis* along these rivers vary in physiognomy from an open tree savanna, in which this species forms almost pure stands, to dense savanna woodland composed of several species, as is found along the Sabi River (Farrell 1968).

On Lone Star Ranche this community encroaches into the western corner of the study area and as such forms a minor contribution to the overall vegetation of the study area (Fig. 24).

Almost pure stands of *Acacia tortilis* (10 - 12m in height) are found on the alluvial soils along the Chiredzi River and there is very little understorey. A few grass species that are found include *Urochloa mosambicensis*, *Aristida* sp., *Eragrostis* sp. and *Panicum* sp. These grasses are heavily grazed by ungulates, notably zebra and impala, and bare patches of ground are common (Fig. 32).

Where this species has been removed through anti-tsetse fly operations, subsequent recolonization has taken place. Species such as *Maytenus heterophylla*, *Dichrostachys cinerea*, *Ziziphus mucronata*, *Gardenia* sp. and the exotic bush, *Lantana camara*, are found. These species vary in height from 1 - 5m and it is notable that *Acacia tortilis*, where they have survived, have reached a height of 10 - 15m with specimens of the same species forming a ragged B-stratum of 3 - 5m in height, indicating that this species is re-establishing itself in the area.

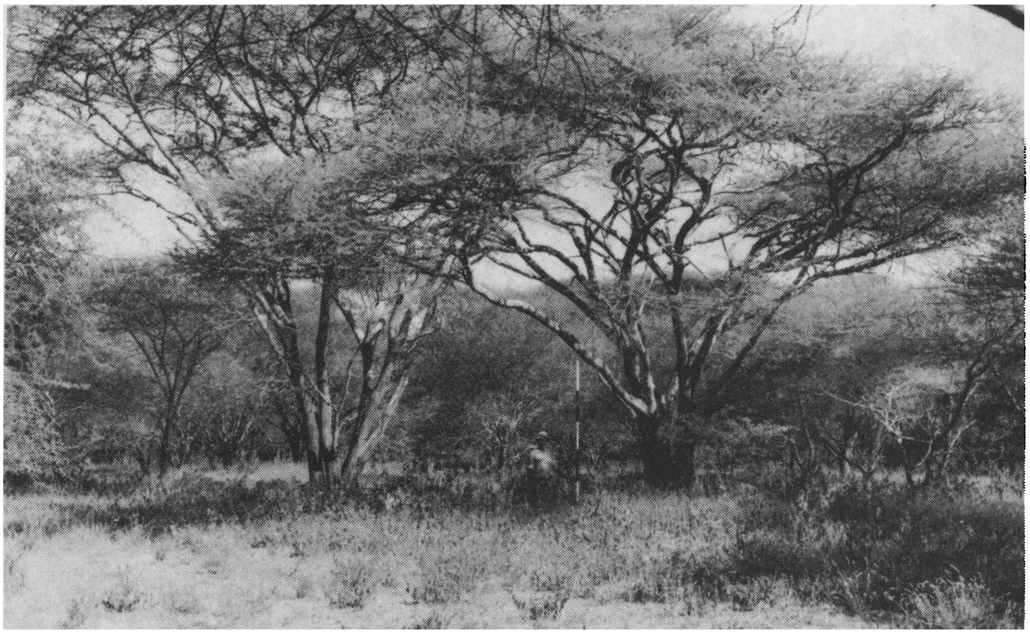


Fig: 32 A characteristic feature of the _Acacia tortilis_ Savanna Woodland are the tall trees, with very little understorey, giving this community a 'parkland' effect. Few grass species are to be found, most of which are heavily grazed by wild herbivores that concentrate along the Cheredzi River. Note the high incidence of _Solunum incanum_ specimens beneath the canopy of the trees.

The grasses in this area include Urochloa mosambicensis, Panicum sp., Pogonarthria squarrosa, Eragrostis sp. and Digitaria sp.

Commiphora africana - Cassia abbreviata - Adansonia digitata Open Tree Savanna.

Along the eastern border of the study area the low range of rocky hills are known as Malevula or "Hartebeest Hills" and Chanyugwe which forms the only high ground within the basaltic flats (Fig. 24). The vegetation of Lone Star Ranche and the immediate surrounding area is influenced by the manner in which the Chiwonja Range in Gona re Zhou National Park, and, to a lesser extent, the Malilongwe Range, affect the rainfall in the area.

Wild (1955) indicates that the hilly areas of the lowveld receive more rainfall than the intervening plains. This fact is illustrated in the rainfall distribution for Lone Star Ranche (Fig. 4). Since most of the rainfall is brought into the south-eastern lowveld on moist winds penetrating up the Lundi, Sabi and Limpopo valleys, the two ranges act as a barrier which results in the windward side receiving more rainfall than the leeward side. Although the evidence for this is very slim, it is reflected in the vegetation encountered on either side of these ranges.

On the eastern side of the Chiwonja Range, near the Sabi - Lundi junction, Wild (1955) describes a change from Colophospermum mopane Woodland on level ground to Brachystegia tamarandoides on the rocky hills. On the western side or leeward side of the range on Lone Star Ranche, species such as *Cassia abbreviata* and *Adansonia digitata* occur on the rocky hills which rise from the basaltic plain. These species are normally associated with a drier environment. Similarly, travelling from Hartebeest Hills towards the Malilongwe Range, there is a subtle change in the vegetation in that nearer the Range, the vegetation is taller and more lush than that nearer the eastern boundary.

The poor rocky soils of these hills in the study area support a poor flora (Fig. 33). The A-stratum on the plateau of the hills (average height 360 - 370m above sea level) is composed of species such as *Commiphora africana*, *Cassia abbreviata*, *Adansonia digitata* and *Kirkia acuminata* which average 10 - 15m in height. The B-stratum consists of *Pterocarpus rotundifolius*, *Colophospermum mopane* in the suffrutex form and *Grewia* sp. which vary in height from 2 - 3m.

The poor rocky soils support few grasses and bare patches are common. *Aristida* sp. are characteristic of this community together with patches of *Bothriochloa radicans*. Where the soil attains any depth, *Urochloa mosambicensis* and *Heteropogon contortus* are found.

The Riverine Community

As mentioned earlier, bush clearing in anti-tsetse fly operations has modified the vegetation in some areas along the river courses. On Lone Star Ranche the riverine communities are associated with the various water courses and natural pans in the study area.

Fig: 33 The Hartebeest Hills, supporting the Commiphora africana Cassia abbreviata - Adansonia digitata Open Tree Savanna receives less rainfall than the Malilongwe Range in the study area. This is reflected in the plant species to be found in this community which include Commiphora africana, Kirkia acuminata, Adansonia digitata and Grewia sp. The rocky soils support a poor grass stratum dominated by Aristida sp., Heteropogon contortus and Bothriochloa radicans.

The Lundi and Chiredzi Rivers are perennial and subject to flash floods during the rainy season. At the height of the rainy season both these rivers are fairly fast flowing and much of the vegetation is submerged. In June the Lundi and Chiredzi Rivers usually contain little water and occupy a narrow channel midst a broad, dry, sandy bed except where there are rapids. The Chiredzi River has a number of pools along its course, viz. Chikwete Pool and at one point a weir (Churini Weir) has been constructed to create a pool. These pools are occupied by resident herds of hippopotamus (Hippopotamus amphibius) which vary from 1 - 30 in number.

The dry river beds appear very barren of vegetation at first sight (Fig. 34) but closer inspection reveals a wide variety of plant species which are often procumbent in habit and can withstand submergence when the river is in spate. These species are discussed in greater detail by Wild (1955) who lists the following as being the more important species; Helichrysum pachyrhizum, Indigofera microcarpa, Hibiscus schinzii, Jussiaea erecta, Heliotropium ovalifolium and Phyllanthus pentandrus.

Occupying the more stabilised sand spits and sand banks by the waters edge are Phragmites mauritianus. This particular species occurs in almost pure stands and attains a height of five metres or more. Its bamboo-like stems are widely used by the local Shangaan natives for constructing fish traps and temporary fences.

Fig: 34 The Chiredzi and Lundi Rivers have cut through the deep soils of the basalts to form steep banks fifteen to twenty metres high. These rivers do not carry a great volume of water for most of the year, but are subject to flash floods during the rainy season. The Riverine Community is confined to the steep banks and along the edge of the river bed. *Phragmites mauritianus*, *Combretum erythrophyllum* and *Acacia schweinfurthii* var. *schweinfurthii* are common.

The fringing riverine vegetation is not developed to any extent, for the river cuts its way through the alluvium soils forming high banks (Fig. 34). Some of the larger trees, which attain a height of 20,0m in some cases, include *Acacia xanthophloea*, *Balanites aegyptiacae* and *Cordyla africana*.

Other species which reach heights of between 10 - 12m include *Afzelia quanzensis*, *Albizia harveyi*, *Berchemia discolor*, *Diospyros africana*, *Gardenia spatulifolia*, *Kigelia africana*, *Phoenix reclinata*, *Piliostigma thonningii* and *Ziziphus mucronata*. On the steep river bank itself, *Combretum erythrophyllum* is conspicuous together with *Acacia schweinfurthii* var. *schweinfurthii*.

The tributaries of the Lundi and Chiredzi Rivers include the Nyamasikana, Mahande and the Chiloveka Rivers. These rivers rely on seasonal flooding during the rainy season, although the Chiloveka River carries a small, but constant stream of water as a result of seepage from the natural spring submerged by the Chiloveka Dam (see p. 10). These rivers rarely flood their banks, but this can occur whenever there are flash floods during the rainy season and usually lasts no longer than 24 hours. The drainage from the surrounding hills in the Malilongwe Range permits many small riverlets to flow for most of the year. Most of these streams end in a vlei of some sort which remain waterlogged.

Along the Nyamasikana, Mahande and Bengi Rivers, pools are formed during the rainy season which contain water for part of the dry season, although this does not last long due to the heavy concentration of game at such places. Wherever these pools occur, the vegetation is more luxuriant and trees such as *Ziziphus mucronata* and *Albizia harveyi* are found reaching a height of 10 - 12m or more. Undergrowth is usually non-existent having been trampled flat by the game.

These tributaries, with the exception of the Chiloveka River also have relatively high banks, up to 5,0m. In most cases the vegetation along the river banks differs very little from that of the surrounding country which the rivers disect (Fig. 35). In some places where the river has flooded its bank and deposited alluvial soils, dense groves of *Colophospermum mopane*, averaging 5 - 10m in height occur. These stands of *Colophspermum mopane* are taller on average than comparable specimens in the immediate surrounding area. Along the remainder of the river courses, the trees average 5 - 12m and include *Acacia xanthophloea*, *Albizia harveyi*, *Berchemia discolor*, *Diospyros africana*, *Gardenia spatulifolia*, *Hyphaene benguellensis* var. *ventricosa*, *Phoenix reclinata*, *Kigelia africana*, *Piliostigma thonningii* and *Ziziphus mucronata*.

In the upper course of the Chiloveka River on the alluvial soils above Chiloveka dam and to a lesser degree below the dam wall there is a dense grove of *Hyphaene benguellensis* var. *ventricosa* (Fig. 36). Those specimens above the dam wall are subject to annual flooding when the dam fills. This grove differs from those specimens of *Hyphaene benguellensis* encountered elsewhere in the drainage line areas which are of the acaulescent type. The tall-stemmed specimens reach a height of 5 - 7m and are associated with *Ziziphus mucronata* which forms an understorey.

Fig: 35 The Riverine Community along the Mahande River does not differ significantly from the surrounding country through which it meanders in most places. However, where such a community can be recognised, species such as *Lonchocarpus capassa*, *Dichrostachys cinerea*, *Gardenia spatulifolia* and *Kigelia africana* are common.

Fig: 36 A dense grove of Hyphaene benguellensis var. ventricosa serves to indicate the presence of a natural spring now submerged beneath the Chiloveka Dam.

Along the Nyamasikana River tall specimens (10 - 12m) of *Newtonia hildebrandtii* with an understorey of *Grewia* sp. and *Ziziphus mucronata* are encountered. In some places along the river bank, the rambling *Acacia schweinfurthii* subsp. *schweinfurthii* forms a dense undergrowth.

The natural pans, which are scattered throughout the study area, do not carry a vegetation which could be associated with a riverine community. Chipangutchi Pan is the largest pan in the study area. This pan carries water into the early part of the dry season. It is not known whether this pan was formed from impermeable saline soils, as is found elsewhere in the south-eastern lowveld (Farrell 1968). The vegetation surrounding this pan includes *Ziziphus mucronata*, *Grewia* sp., *Pterocarpus rotundifolius* and *Xemenia caffra*. The remainder of the pans are often relatively small and soon dry out. Occasionally species such as *Acacia nilotica* have established themselves on the periphery but in general the vegetation differs very little from that surrounding the pan. Once again much of the surrounding vegetation is destroyed through trampling by the wild game utilising the pans.

The last sources of riverine vegetation are the artificial dams that have been built in the study area. Malilongwe Dam is the largest of these (Fig. 37). In each case, no clear vegetation community has established itself during the years that these dams have been in existence. Along the edge of the Malilongwe Dam, *Phragmites* sp. have established themselves, while in

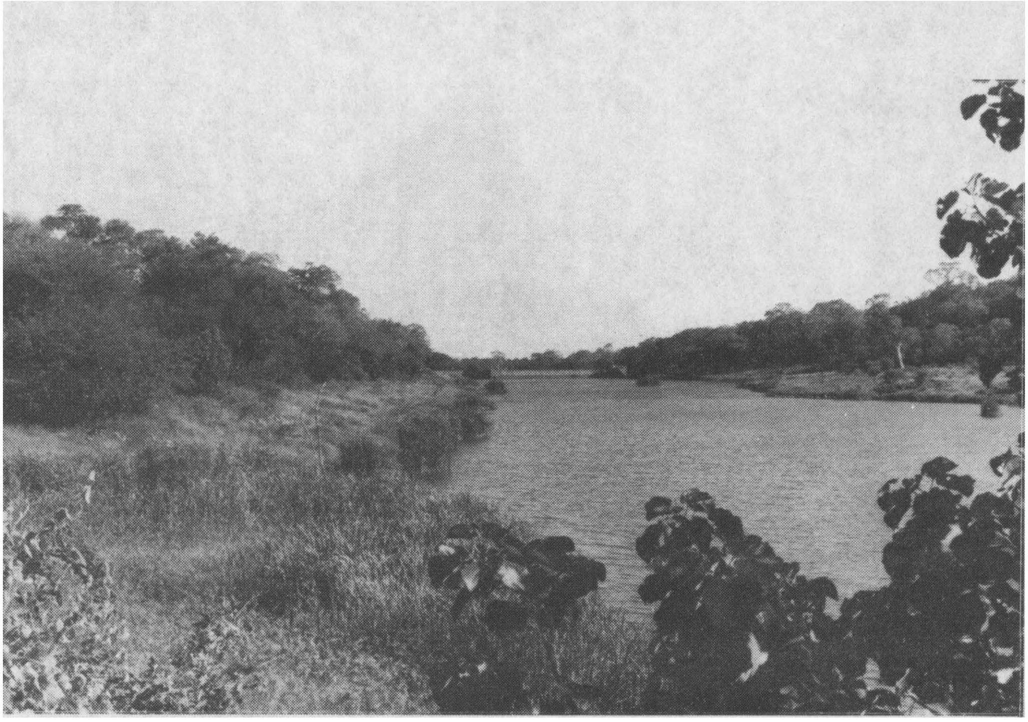


Fig: 37 The Malilongwe Dam was built on the course of the Nyamasikana River where it emerges from the granite hills. The vegetation along the waters edge is characterised by Phragmites sp. otherwise the vegetation does not differ significantly from the Brachystegia glaucescens Savanna Woodland zone flanking either side of the dam.

Chinzwini and Logani Dams, water lilies such as *Nymphaea caerulea* and *Nymphoides indica* have become well established. Otherwise the vegetation of the surrounding communities frequently approaches almost to the waters edge where often dead trees are encountered as a result of the high water table.

The Drainage Line Open Tree Savanna

This community, and in particular the dambo associations found within this community, forms the pivot of this study. In the communities discussed thus far, the recognition of each community is based on the presence of a dominant and/or conspicuous woody species characteristic of that particular community. In this, the Drainage Line Open Tree Savanna, the recognition is based upon physical characteristics - namely the open nature and the presence of drainage line systems supporting a grassland association, which has been created as a result of the topography and edaphic characteristics of the area.

Previous workers, notably Wild (1955), have preferred to include this community in association with the riverine vegetation or more loosely as a floodplain community developed on alluvial soils (Rattray and Wild 1955, Farrell 1968).

Vesey-Fitzgerald (1963) has attempted to classify the grasslands associated with rivers by starting at the headwaters of the drainage lines and noting changes in the floristic and physiographic characteristics along the courses of the drainage lines. In this way the natural groups into which the valley grasslands could be divided were ascertained. The three main divisions of the valley grassland complex are represented in Fig. 38.

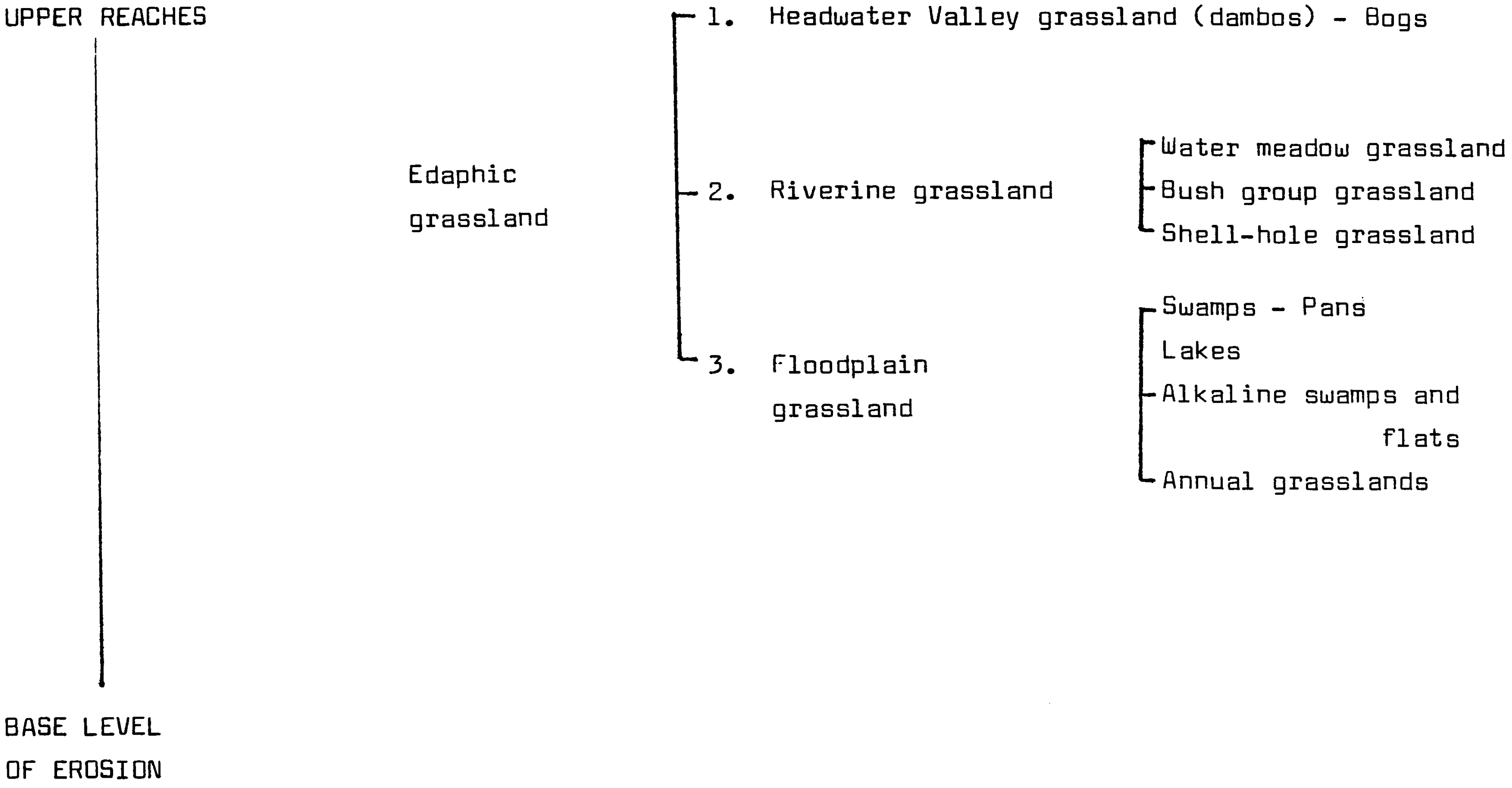


Fig. 38: The classification of the valley grasslands complex along a drainage line as defined by Vesey-Fitzgerald (1963).

These three groupings tend to be arranged in a regular series from the upper reaches of the catchment area to the lower valleys, which have reached their base level of erosion. It must be appreciated that the divisions between the different communities are never clear-cut and in nature the various associations tend to grade into each other.

Using the classification of Vesey-Fitzgerald (1963) the Drainage Line Open Tree Savanna cannot be defined as a "flood-plain grassland", for such areas are flooded during the wet season and dry out completely during the ensuing dry season. The floodplain is usually wider than long and the vegetation tends to be concentrically zoned in relation to a central swamp area rather than longitudinally zoned in relation to the drainage line.

A more accurate definition of the community occurring on Lone Star Ranche would be a Riverine Grassland, and in particular a "Bush-group grassland" as opposed to a "Water meadow grassland" or a "Shell-hole grassland" (Fig. 38). The "Water meadow grassland" occupies level plains which are seasonally inundated. An even, semi-floating grass sward forms which collapses, and then forms a dense mattress, when the flood recedes. *Acroceras macrum* is the characteristic grass of the "Water meadow grassland" and commonly associated species include *Hemarthria* sp., *Echinochloa stagnina*, *Leersia* sp. *Panicum repens*, *Paspalum commersonii* and *Sacciolepis* sp.

A "Shell-hole grassland" is a peculiar formation which is characterised by evenly spaced circular depressions alternating with low mounds. They occur either on the drier edges of the present day drainage lines, or in areas of obsolete drainage. Three main grass associations are present. On the mounds tall grasses such as *Hyparrhenia* sp., *Bothriochloa* sp. *Setaria* sp. and *Vetiveria* sp. occur, while on the level ground close to the rims of the depressions species such as *Loudetia simplex*, *Trachypogon* sp. and *Themeda* sp. are found. In the depressions themselves, tall grass species with affinities towards the floodplain grasslands occur. These include *Hyparrhenia rufa*, *Echinochloa* sp., *Setaria* sp. and *Paspalum* sp.

On Lone Star Ranche, the Drainage Line Open Tree Savanna differs from the definition of the "Bush-group grassland" in some respects and these differences will be referred to following this general description of the "Bush-group Grassland" (after Vesey-Fitzgerald 1963).

The "Bush-group grassland" is a type of edaphic grassland which covers areas in valleys of low relief in the vicinity of both rivers and swamps. In some cases it appears that the rivers flanked by bush-group grasslands represent reduced trickles of formerly (pluvial period) more important drainage lines. It is liable to become inundated during the wet season and becomes completely dry and usually burns during the dry season. The drainage is always bad and flooding results from local precipitation and overflow, and inflow from local drainage lines. The soil is of an illuvial type and is usually dark grey or black. The texture varies from sandy-clay to clay, becoming sticky when wet and very compact when dry. The ground between the bush-groups is covered by treeless edaphic grasslands. Several species of fine leaved bunch grasses are usually mixed together, or one species may be most abundant over considerable areas, or, at a certain season and then be replaced by another. Later in the wet season taller species of grass may be more in evidence, and there is often a mosaic arrangement of taller and shorter species associated with slight variations in level. Sometimes a sluggish drainage line system is developed which is marked by a distinct grass association. Vesey-Fitzgerald (1963), drawing on examples in Zambia, gives _Loudetia simplex_ as the most characteristic grass species, with _Andropogon_ sp., _Setaria_ sp., _Trachypogon_ sp. and _Themeda_ sp. also occurring.

The Drainage Line Open Tree Savanna on Lone Star Ranche is directly associated with the drainage system of the Mahande and Bengi Rivers, in particular, and to a lesser extent with the Chiloveka, Chiredzi and Lundi Rivers (Fig. 24). As discussed earlier (Riverine Community, p.117), the tributaries rely on seasonal rainfall and on rare occasions flood their banks as a result of flash floods. These floods are only likely to occur after exceptionally heavy rains have fallen in the catchment areas of these tributaries and since the study area lies in a semi-arid climatic zone, the heavy rains likely to cause such flooding are rare. None of the drainage lines can be classified as streams or riverlets but rather as zones into which the run-off from the surrounding high ground gathers and seeps away. However, the drainage of this community is poor and the heavy black clay soils remain wet and sticky for some time after heavy rains.

In no area of this community can a "bush-group" be identified, but rather there are open savannas with scattered trees and shrubs with a characteristic A-, B- and C-stratum (Fig. 39).

The A-stratum is composed of trees 5 - 12m tall. Rarely do the canopies of the trees overlap, which allows for a very open and sporadic canopy cover. The species contributing to the A-stratum include Lonchocarpus capassa, Combretum imberbe, Hyphaene benguellensis var. ventricosa, Acacia tortilis, Acacia nilotica and Albizia harveyi. With the exception of Hyphaene benguellensis all these species had a definite tree trunk with a multibranched canopy of more or less circular form.

Where a B-stratum could be identified it varied from 1 - 3m in height and consisted of Dichrostachys cinerea, Lonchocarpus capassa (which may be stunted as a result of frost), Maytenus heterophylla, Dalbergia melanoxylon, Colophospermum mopane, Acacia exuvialis and Ziziphus mucronata. The malala palm Hyphaene benguellensis var. ventricosa, also contributes to this stratum in the form of a sterile acaulescent shrub, with leaves rising from ground level. Wild (1955) attributes this form of growth to a much shallower layer of alluvium. It is possible

Fig: 39 The characteristic feature of the Drainage Line Open Tree Savana is its open nature and low abundance of woody species, with a well developed grass stratum predominated by *Urochloa mosambicensis*. Note the woody species such as *Lonchocarpus capassa* (right foreground) and *Combretum imberbe* (left foreground) are represented by single stemmed specimens with a multibranched rounded canopy.

that these clumps of malala palms are the result of new vegetative growth. Van Wyk (1972) states that this species propagates by means of underground suckers and therefore always occurs in groups. In the early years of the ranch, the local natives used to tap the tall stems of this species for its sap and this behaviour eventually led to the death of the tall plant. The ranch put a stop to this action when it became apparent that this particular species was being eliminated from the area. No information is available on the rate of growth of this species and it is possible therefore that in future these "sterile" shrubs will give rise to the characteristic tall trunks bearing fruit and flowers.

The C-stratum in most areas is formed almost entirely of *Urochloa mosambicensis* which covers a considerable area in some places. This grass stratum averages 0,50 - 0,60m in height. In some places the grasses tend to form a mosaic of diffuse colonies (areas where one species is dominant, alternating with other areas where another species is dominant). In these areas species such as *Cenchrus ciliaris* and *Bothriochloa radicans* are the most common species. Where the shrub form of *Hyphaene benguellensis* var. *ventricosa* exists, or around the periphery of *Maytenus heterophylla* and beneath the canopy of *Combretum imberbe*, *Albizia harveyi* and *Lonchocarpus capassa*, species which favour shady areas such as *Panicum maximum* and *Eragrostis* sp. are encountered. At the interface between the deeper basaltic soils and the gravelly soils supporting the *Colophospermum mopane* Savanna Woodland there is a change in the grass species encountered and those found include *Digitaria milanjiana*, *Heteropogon contortus*, *Pogonarthria squarrosa* and *Enneapogon cenchroides*.

The last grass association contributing to this C-stratum includes those defined as "mini-dambos" in this study (see p. 131) and which Vesey-Fitzgerald (1963) defines as having occurred as a result of a sluggish or completely static drainage system. This grass association will be dealt with in more detail in the following section.

The Dambo Association

Descriptions of dambo grasslands in the literature are rare and those that are found are of a superficial nature. Mitchell (1953) defines a dambo as "that part of a valley or drainage line from which most trees are excluded by a high water level during the rainy season." Hall-Martin (1972) discusses the interplay between the height of the water level in the dambo systems and the invasion of the system by woody species. He points out that the presence of *Dalbergia melanoxylon* along the periphery of the dambo is an indication of the possible drying out of the system. More recently Joubert and Bronkhorst (1977) have discussed the physiognomic and structural features of the broad drainage valleys in the *Colophospermum mopane* Community in the Kruger National Park in relation to the selection of this habitat by tsessebe.

Vesey-Fitzgerald (1963) provides the most comprehensive description and practical definition of this particular grassland association. For the purpose of this study the dambo associations (or "Headwater valley grassland") will be treated as forming part of the Drainage Line Open Tree Savanna and not as a separate community as is laid down in the classification given by Vesey-Fitzgerald (1963, Fig. 38).

Dambos are a characteristic vegetation community which are frequently encountered on the plateau of Zambia and in the Rift Valley in Tanzania at elevations between 1 200 - 2 000m. This community occasionally covers extensive areas but more usually occurs as long belts in the drainage system where the flow of water is impeded but ultimately connected with the through drainage system of the country. There are many variations related to details in the topography and to the state of the drainage, however all have been found to share the following characteristics (Vesey-Fitzgerald 1963).

Their relief is low, either gently sloping towards the drainage line or actually lying in flat-bottom lands. The water table is high and in parts the ground may remain boggy throughout the year. The drainage is bad, and consequently the valleys tend to become flooded during the rains. The sites of springs remain wet throughout the dry season.

The soils of these sites usually belong to the illuvial complex and are black, very dark grey, dark grey to neutral grey or, occasionally, dark brown. The soil texture varies from sand to clay but with a high colloidal content and becomes very sticky when wet. In structure the surface soil is single grained, spongy when moist but becomes very compact when dry. These soils are normally acid (pH 5 - 6). Variations in these soil characteristics appear to be mainly dependent on differences in the drainage conditions.

The vegetation of the dambo grasslands is usually a medium dense, mixed, herb mat of rather uniform appearance and height. The mat is composed of fine-leaved perennial bunch-grasses and frequent flowering herbs which together afford a 100% ground cover (canopy). That is to say the ground is usually shaded and obscured by the intermingling foliage of the plants but beneath the leaf table unoccupied ground exists between the grass bunches and may account for 25 - 30% of the area. The grass bunches may be cushion-like or tussocky and they are often composite. The leaf table tends to be a uniform height, c. 0,5 - 0,7m and the flowering culms extend above this to about one metre or even 1,5m, but variations occur with a mosaic of long and short species.

The grasses vegetate and come into flower during the rains. Some species are early flowering while others are usually later flowering. There is, therefore, a succession of flowering during the season in this type of grassland. After the rains the whole grass sward usually dries off and becomes burnt. Following fire there is a rather sparse growth of green grass with the main regrowth period occurring after the first rains have commenced.

At the perimeter, the contact with the tree line is normally very distinct. There is frequently an ecotone here between the woodland and the established valley grassland which has all the characteristics of a secondary grassland, representing seral communities related to a succession towards the climatic climax vegetation, or subclimax communities conditioned by fire (Vesey-Fitzgerald 1963). Frequently the ecotone represents an ecological "hiatus" where bare patches occur and the surface soil is sheet eroded. In the lowest part of the dambo grasslands a flowing stream may occur. If this is the case, additional zones of vegetation related to the free drainage line will be evident.

The associations identified as "dambos" in the study area closely fitted this description and the classification of a "Headwater valley grassland" given by Vesey-Fitzgerald (1963). In the study area two criteria were required to define a dambo association in the Drainage Line Open Tree Savanna. These were a depression of the topography or a drainage line which allowed an accumulation of water and/or a raising of the water level, and a grass stratum dominated by *Ischaemum afrum* and/or *Setaria anceps*.

In most cases these depressions and drainage lines started and ended without draining directly into one of the primary tributaries in the study area, which was due to the fact that the banks of the primary tributaries were frequently higher than the surrounding country.

Three forms of dambos were recognized:

Mini-dambos

These are characterised by their small size. Most often these "mini-dambos" are found in the Drainage Line Open Tree Savanna in the areas which are dominated by a short grass stratum of

Urochloa mosambicensis, and rarely exceed 50m^2 in size. A variation of this association also occurs in the *Colophospermum mopane* Savanna Woodland where the "mini-dambo" can be recognized as a circular depression carrying a grass stratum of *Ischaemum afrum* and *Setaria anceps*, with an abrupt ecotone between it and the surrounding woody vegetation (Fig. 40).

Occasionally woody species are encountered, such as stunted examples of *Lonchocarpus capassa*, *Combretum imberbe* and *Albizia harveyi* (Fig. 40), but usually these "mini-dambos" are composed entirely of a grass stratum that is often trampled down and overgrazed.

Tongue-like dambos

These can be recognized as minor drainage lines which form tongue-like intrusions which drain the immediate surrounding country (Fig. 41). These dambos frequently occur along the lower course of the Mahande River and towards the confluence of the Chiredzi and Lundi Rivers. They are often very narrow (15 - 25m wide) and vary in length, either merging into the Drainage Line Open Tree Savanna, ending in one of the primary tributaries, or are blind-ending. The black to dark-grey soil of these narrow drainage lines varies from colluvial to illuvial. When wet, they are very sticky and there is an abrupt change between this and the more gravelly soils of the *Colophospermum mopane* Savanna Woodland.

Very few trees and shrubs are found in these narrow drainage lines, although species such as *Combretum imberbe* and *Acacia nilotica* averaging 2 - 3m in height are encountered. At the

Fig: 40 An example of a "mini-dambo" association which are characterised by their small size. A variation of this association occurs in the *Colophospermum mopane* Savanna Woodland as a circular depression supporting a dense sward of *Ischaemum afrum* and *Setaria anceps*. Note that woody species such as *Lonchocarpus capassa* (immediate foreground) and *Combretum imberbe* (centre foreground)have invaded this dambo.

Fig: 41 An example of a tongue-like dambo in a drainage line that drains the immediate surrounding country. These grasslands, dominated by Setaria anceps, are characterised by an abrupt change between this and the surrounding woody vegetation.

headwaters of such drainage lines, species such as *Colophospermum mopane* and *Ziziphus mucronata* are also found, and there is usually a small area which resembles a "playground", as discussed earlier (see p. 111), with bare ground supporting *Aristida* sp. and *Solanum incanum*, together with *Dalbergia melanoxylon* and *Dichrostachys cinerea*. Along the ecotone between the drainage line and adjacent woodland - where such an ecotone can be recognized - species such as *Dalbergia melanoxylon* and *Dichrostachys cinerea* are also found varying in height between 2 - 3m.

The grass stratum consists of a central core of *Ischaemum afrum* and *Setaria anceps*, together with species of *Urochloa mosambicensis* and *Heteropogon contortus*. Along the edges of this central core, forming a narrow ecotone, species such as *Enneapogon cenchroides* and *Aristida* sp. are common.

Wide dambos

The third type of dambo recognized is characterised by a shallow depression, 300 - 500m wide, forming a more extensive dambo system at the headwaters of a drainage system or at some point along its length (Fig. 42). These dambos are extensively used by the hartebeest and are the favoured choice of habitat.

Within the dambo systems, a sparse cover of woody vegetation occurs, which can be subdivided into two strata, although this is not always obvious in the "mini-dambo" or tongue-like dambo. In the wide dambo systems, the upper stratum consists of woody species and is dominated by *Combretum imberbe* and *Dichrostachys cinerea*. In the case of *Combretum imberbe*, the growth form of the tree is that of a multistemmed bush reaching a height of

Fig: 42 An example of a wide dambo, characterised by a shallow depression usually at the head of a drainage line. These dambos carry a dense grass stratum of Ischaemum afrum and Setaria anceps and are invaded by multi-stemmed specimens of Combretum imberbe and Acacia exuvialis.

five metres or more in some places. This is unlike the single stemmed form elsewhere in the Drainage Line Open Tree Savanna (see Fig. 39). It was observed that towards the end of the dry season, browsers such as kudu and eland would venture into the dambo associations and feed from the greener leaves of this species at that time of the year. When this occurred branches of *Combretum imberbe* were broken, especially by eland, in their effort to reach the leaves. It was thought that this may have been a factor that maintained this species in its bush form. It is also possible that the moister environment may have played a greater role in this respect.

The remainder of the species which form the upper layer vary in height from 2 - 5m and all take on the form of a multistemmed bush. These species include *Albizia harveyi*, *Acacia exuvialis*, *A. nilotica*, *A. nigrescens*, *A. polyacantha*, *Cassia* sp., *Combretum imberbe*, *C. apiculatum*, *Colophospermum mopane*, *Dalbergia melanoxylon*, *Dichrostachys cinerea*, *Euclea divinorum*, *Hyphaene benguellensis* var. *ventricosa*, *Lonchocarpus capassa*, *Maerua edulis*, *Maytenus heterophylla* and *Ziziphus mucronata*.

It is possible that these species are at an intermediate stage of their growth. As mentioned earlier no fires have been permitted on the ranch for the last 20 years. It is suggested with reservation, that these species would have been destroyed in their early stage of growth if these associations had been burnt regularly.

The lower stratum of the dambo association is composed of grass and woody species. The dominant grass species within the dambo are *Ischaemum afrum* and *Setaria anceps*. These grasses take on a tussocky form with a uniform leaf table of 0,9 - 1,2m in height and the flowering culms extend above this to a height of 1,2 - 1,5m and in some cases up to a height of 2,0m. Flowering occurs during most of the rainy season. Other species contributing to the dambo associations are *Cenchrus ciliaris* and *Urochloa mosambicensis*. These grasses vary in height from 0,5 - 0,7m in height and occur in isolated patches within the central core of some of the dambos, but usually mark the perimeter of the dambo association within the Drainage Line Open Tree Savanna. Other species of grass to be found in the dambo and along the periphery include *Heteropogon contortus*, *Hyperthelia dissoluta* and *Digitaria* sp.

Since the average height of the grasses in the dambos is 1,0m, the woody species, with an average height of less than one metre, are quite often not visible unless found by physically walking onto them. Species representing this woody composition include *Lonchocarpus capassa*, *Acacia nilotica*, *Acacia exuvialis* and *Cassia* sp.

The contact of the dambo association with the tree line,usually with *Colophospermum mopane* Savanna Woodland, is distinct. The ecotone between the two communities is usually very narrow and difficult to ascertain in some places. Species found within the ecotone include *Grewia* sp. and *Maytenus heterophylla* representing the woody species, and *Heteropogon contortus*, *Aristida* sp., *Enneapogon cenchroides* and *Urochloa mosambicensis* representing the grass species. Bare patches of soil are frequently encountered along the ecotone, although only a few incidences of erosion of a minor nature were observed.

Taking cognisance of the fact that the study area falls into a semi-arid zone, and the topography does not permit any appreciative run-off during the rainy season, it is not surprising that in these dambo associations in the study area there is an invasion of woody species. In Fig. 42 this is evident and reveals the major difference between the dambo associations in the south-eastern lowveld of Rhodesia, the Kruger National Park, South Africa and those described in Zambia, Tanzania and Malawi.

In the Kruger National Park, Joubert and Bronkhorst (1977) have found that woody species have invaded the dambo systems amongst which are *Combretum imberbe*, *Lonchocarpus capassa*, *Acacia nigrescens*, *Hyphaene crinata*, *Acacia xanthophloea* and *Acacia polyacantha*. The grass species recorded in these dambo associations include *Sporobolus robustus*, *S. schlechteri*, *S. nitens*, *Ischaemum brachyatherum*, *Sorghum versicolor*, *S. verticilliflorum*, *Cynodon dactylon*, *Chloris virgata* and a number of unidentified sedges.

In Malawi, Hall-Martin (1972) states that the invasion of the dambo communities in that country by *Dalbergia melanoxylon* and *Urochloa mosambicensis* in an otherwise uniform sward of grass dominated by *Setaria palustris*, *Ischaemum brachyatherum* and *Ischaemum afrum* is indicative of the drying out of these systems. In Tanzania and Zambia, the dambo communities do not have many, if any, woody species in their floristic composition but they do carry a larger variety of grasses and sedges than the dambo associations encountered in the Rhodesian lowveld and South Africa. Vesey-Fitzgerald (1963) gives the commonest grasses as *Andropogon shirensis*, *Hyparrhenia bracteata*, *H. newtonii*, *H. diplandra*, *H. pachystachya*, *Loudetia simplex* and occasionally *L. superba*. Commonly associated with these species are *Acroceras* sp., *Aristida* sp., *Arundinella* sp., *Ctenium* sp., *Echinochloa colonum*, *Eragrostis atrovirens*, *E. capensis*, *Leersia* sp., *Monocymbium* sp., *Panicum dregeanum*, *P. repens*, *Sacciolepis huillensis*, *S. typhura*, *Setaria angustifolia*, *S. sphacelata*, *Schizachyrium* sp., *Trichopteryx dregeana* and *Tristachya hispida*.

The differences in the vegetational composition of the dambo systems in these different regions is not unexpected and indicates clearly the interplay between the water level of the dambo system, the rainfall in the region and the invasion of these systems by woody species. The Rukwa valley in Tanzania and the Zambia plateau receive a higher rainfall (750 - 1 275mm annually) than the semi-arid zone in which Lone Star Ranche (mean = 560mm annually) and the Kruger National Park (375 - 560mm annually) are situated.

Lichtenstein's hartebeest is common both in Tanzania and Zambia, although not so numerous in the Rukwa Valley. In both countries the dambo communities form an important part of their habitat requirements. The differences in vegetational composition between the north and south no doubt holds the key to the success and limited distribution of this species in Rhodesia.

CHAPTER 7

The physiognomic parameters of the vegetation in the survey area.

Introduction

Understanding the dynamic nature of a habitat and the predilection of an animal for a particular type of habitat poses one of the greatest challenges to the wildlife ecologist. Choosing a technique that leads to a description of the composition and structure of the habitat that is accurate, efficient and simple is equally challenging.

The difficulty is compounded even further by the total lack of knowledge of what the "preferred habitat" of various species might be. Although numerous references to habitat types, as related to specific species, are cited in the literature (Dorst and Dandelot 1972), thegeneral approach has been of a subjective nature, merely referring to habitats in broad and often poorly defined terms. None of the descriptions give a precise account of the exact habitat selected by the species, nor any reasons for this choice, or the duration of the use of such a habitat throughout the year. In fact detailed analyses of wildlife habitats are few and very often the reference to habitat choice applies to a single species with no mention of the inter-relationships and influences that other species may have on the choice of habitat.

The key to the preferred habitat of Lichtenstein's hartebeest appeared to be the dambo associations/communities found within the distributional range of this species (Dowsett 1966, Wilson 1966).

On Lone Star Ranche the problem immediately encountered was that no vegetational association could be described as being representative of the broad grass-covered depressions, known as "dambos", which were characteristic of the *Brachystegia* sp. woodlands of central Africa.

Thus a technique was required that would lead to a description of the physiognomy of the various habitat types, and in particular the physiognomy of the dambo associations. Furthermore, the technique had to be flexible enough to allow comparisons to be drawn which would elucidate the salient features of what the "preferred habitat" of Lichtenstein's hartebeest might be in the study area.

Only recently have detailed studies of habitats been made in which different aspects of the habitat are correlated with the amount of utilisation by various ungulates and the habitat preferences of each species is then determined by means of principle component analysis (Ferrar and Walker 1974, Hirst 1975). Using simpler techniques, Joubert (1976) has isolated those factors which are probably decisive in determining the acceptability of an area by roan antelope (*Hippotragus equinus equinus*). These approaches have provided a greater understanding of the choice of habitats by different species, and the essence of these approaches lies in the clarity with which the botanical analytical techniques elucidate and define the complex structure of the habitats in relation to the ungulate species utilising them.

The majority of botanical analytical techniques have been developed in the temperate regions of the world and only recently has their applicability been evaluated (Walker 1970). The almost universal acceptance of the quadrat method has provided a wealth of data and is regularly employed to determine vegetational characteristics such as frequency, density and abundance. However, most of these methods (described by Walker 1970) are of the most mundane nature, and, although they provide valuable information to the botanist, they are of little value when the information thus gathered is applied to the understanding of the choice of habitats by the ungulates in Africa.

Coetzee and Gertenbach (1977) have broached this problem in developing and perfecting the Variable Quadrat Plot method. This method has proved extremely sensitive in monitoring subtle differences in what would appear to be a uniform vegetational community. Similarly Walker (1976) has instigated a long term method which is designed to monitor the changes in the composition and utilisation of woodland and savanna vegetation by African ungulates. Although still in the nascent period, these methods will no doubt prove to be useful tools in future ecological research.

The main objection to these techniques is that they require a great deal of time and demand a trained team of persons and ultimately sophisticated computation of the data in order to arrive at satisfactory conclusions.

The techinuqes chosen were thus designed to allow a single worker to accumulate data over a large area on all the major parameters usually associated with the description of the structure and composition of the vegetation in the study area.

Methods

As information on the distribution of hartebeest in the study area became available, six study sites or habitat types were identified which were likely to be occupied by hartebeest at one time or another during the year.

The six habitat types were, vegetationally, of a homogeneous or heterogeneous nature, depending on whether one or more of the vegetational communities discussed in the previous chapter were included in the habitat type or not. The boundaries of these habitat types were arbitrary, although an attempt was made to utilise natural boundaries such as rivers or, as in most cases, the roads surrounding a particular habitat type. These habitat types were not separate entities, but tended to merge into each other.

Two methods were employed to gather data from these habitat types. These were a Plant-to-Plant Distance Measure and a Step-Point Quarter method which were modified to meet the prevailing conditions.

Plant-to-Plant Distance Measure Method

The use of spacing distances for sampling plant communities has certain advantages when compared to the standard plot method, since they are more efficient in terms of results obtained per man-hour expended, especially where large areas are under examination (Cottam and Curtis 1956). Cottam (1947) first introduced a distance measuring method when he described a random pairs method for sampling forest trees. Subsequent investigations have been concerned with the use of distances either for determining density or for the study of randomness in plant communities (Skellam 1952, Cottam, Curtis and Wilde Hale 1953, Hopkins 1954, Moore 1954, Clark and Evans 1954).

In the present study a series of transects were used to monitor the physiognomic parameters of the six habitat types. The term "transect" is defined as being a route chosen to transverse all or part of the habitat type along no predetermined compass course, but which incorporates all or a representative part of the vegetational communities in the particular habitat type. The route of the transect was therefore determined by the relative locations of the various vegetational communities in the particular habitat type, which meant that the direction and length of the transect varied considerably depending upon the density or "openness" of the vegetation.

The series of transects in each habitat type were laid out in the following way. From an aerial photograph of the survey area, an easily recognizable feature, such as a drainage line or an interface between two vegetational communities which occurred at any point along the boundary of the habitat, was chosen as a reference point. Using the vehicle odometer (calibrated in tenths of a kilometer), the subsequent starting points were then plotted roughly equidistant on either side of this reference point transect along the chosen boundary. The number of transects and the distance between each transect varied from one habitat type to another. This depended upon whether a heterogeneous habitat, i.e. more than one community, was present or a homogeneous habitat was being examined. The distance between transects in heterogeneous habitats varied from 100 - 500m apart, while those in homogeneous habitats varied from 400 - 600m apart.

In this way a rough idea was obtained of the vegetational communities that would be traversed and where the transect would emerge or end within the habitat type. Being familiar with the habitat types and using an aerial photograph of the area, it was relatively simple to plot the route of the transect through the habitat type on the aerial photograph.

At each transect starting point, the nearest tallest tree within 30m of the point was taken as the start of the transect. From this point, walking at right angles to the boundary (where feasible), the number of paces to the next nearest tree or shrub was paced out and this procedure repeated until the distance between the first 120 trees/shrubs had been recorded. In dense vegetation, more than 120 trees/shrubs were recorded in order to obtain a representative sample of the vegetation in the habitat type. Each 120 trees/shrubs was regarded as a sample, thus for the 53 transects chosen, a total of 90 samples of 120 trees/shrubs were recorded from all habitat types.

The following data were recorded at each tree/shrub encountered along the transect (Fig. 43A):-

1. Species of tree/shrub.
2. Height class.

   The tree/shrub was placed in one of five height classes chosen to reflect the stratification of the vegetation. These were 1,0m; 1,5m; 2,0m; 3,0 - 4,0m and 4,1 - 5,0m.

   Shrubs lower than 1,0m were ignored and included in the grass stratum. Shrubs of 1,0m and 1,5m high were therefore regarded as the lowest shrub stratum. The 1,5m and 2,0m height classes were selected to reflect that stratification layer of the vegetation which would obstruct the vision of hartebeest while the 3,0 - 4,0 and 4,1 - 5,0m and taller height classes were selected to reflect the stratification of the upper levels of the vegetation.

3. The distance measured in paces from one plant to the next (seven paces were roughly equal to five metres).
4. A record of all _visual_ grass species encountered between and surrounding the tree/shrub. Thus, when crossing from one point to the next, each grass species seen was recorded. For instance from point A to point B, _Cenchrus ciliaris_, _Urochloa mosambicensis_ and

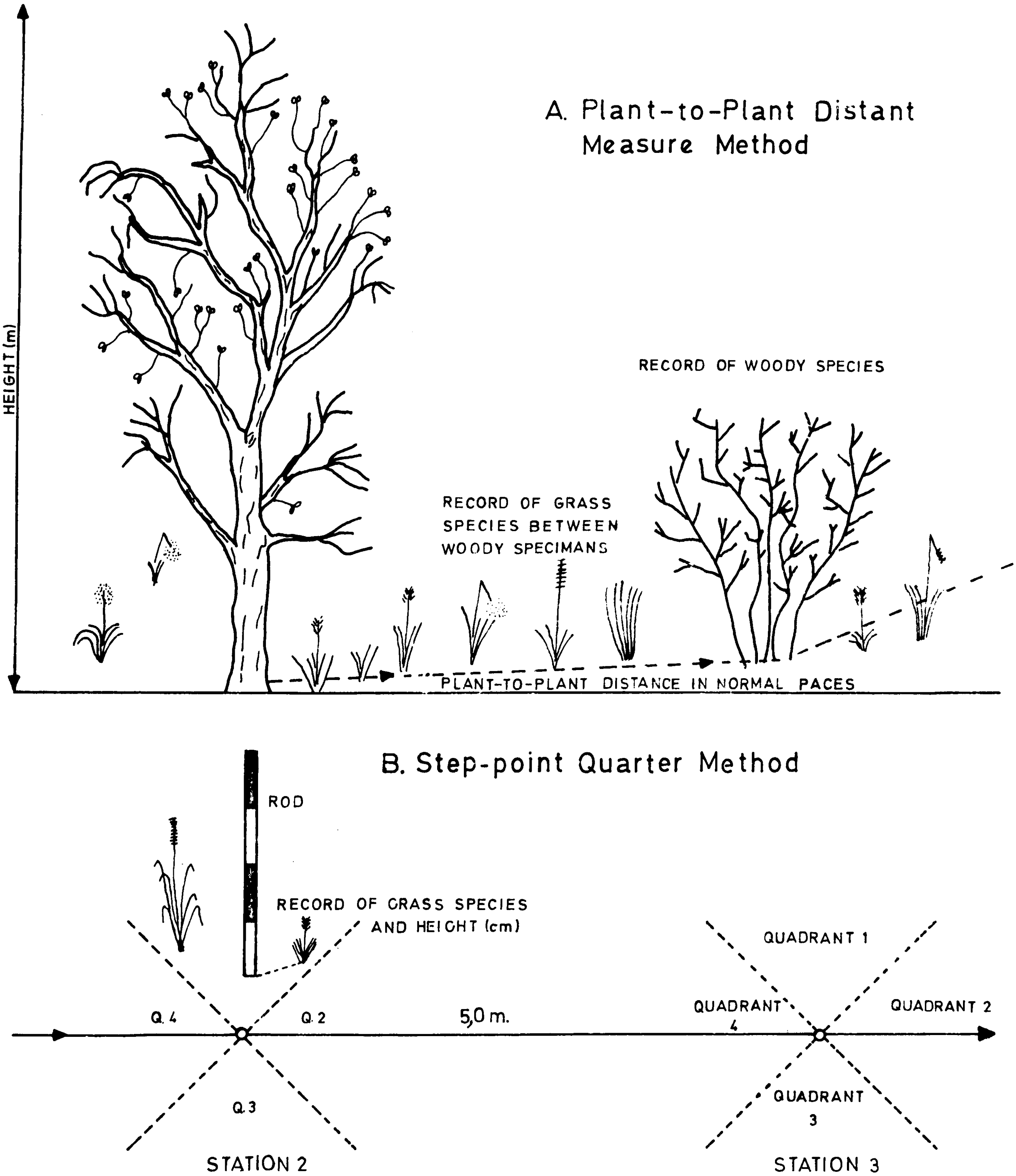


Fig. 43: An illustration of the methods used to gather vegetative data in the survey area.

Ischaemum afrum were recorded, and then from point B to point C, Urochloa mosambicensis, Seteria anceps and Ischaemum afrum were recorded.

The approach in this survey obviously originated from the many methods which have been described in which distance between trees and shrubs plays an important role (cf. Clark and Evans 1954, Cottam and Curtis 1956, Dix 1961, Joubert 1976).

Step-point Quarter Method

As more information became available on the utilisation of the survey area by the hartebeest, it was apparent that the dambo associations found within the Drainage Line Open Tree Savanna were being used extensively for much of the year and a method was required which would facilitate the description of the physiognomy of these grasslands.

The method used was an adaption of the Step-Point Method proposed by Evans and Love (1957). This is a simple, rapid, accurate and objective method for determining the botanical composition and total cover of the herbaceous vegetation. The method has been used to inventory herbaceous cover relative to soil types, woody vegetation cover, aspect and slope, and other environmental factors (Evans and Love 1957).

In this study three areas within the Drainage Line Open Tree Savanna were chosen for comparison. Two areas, the Makeche Dambo and the Mahande Dambo, representative of the Wide Dambo associations, were extensively utilised by the hartebeest whilst the third area, an open short grassland representative of the grass cover surrounding the edge of the drainage line system in the Drainage Line Open Tree Savanna (see Fig. 51 p. 201), was used infrequently by the hartebeest.

In all three areas to be surveyed, a series of straight line transects, each 15m apart, were laid out at right angles to the boundaries of the areas. The boundaries of each area were determined as follows. In the first instance, the characteristic grass stratum of the dambo associations demarcated the boundary, whilst the short grassland of the Drainage Line Open Tree Savanna lay between the <u>Colophospermum</u> <u>mopane</u> Savanna Woodland and the Mahande River. The number of transects in each dambo association varied with their size - there being 11 in the Mahande Dambo, 13 in the Makeche Dambo and 12 transects in the short grassland area.

Along each transect, at 5,0m intervals, a station was created and divided into four imaginary quadrants (Fig. 43B). The following procedure was adopted to record the following data.

At each station, while facing in the opposite direction to the quadrant, the point of a 3,0m long rod was lowered at random over the shoulder into each of the four quadrants in turn.
In each quadrant it was noted whether the point of the rod struck a tuft of grass directly or not. A "hit" was recorded if the rod point struck the tuft directly or glanced off the tuft whilst being lowered to the ground. This latter problem only arose in the long grass stratum of the dambos where the nature of the tufts were such that the rod was easily directed off the tuft.

A "miss" was recorded if the point of the rod was placed on bare ground or was placed next to a tuft of grass onto bare ground <u>without</u> being deflected from the tuft.

Where the rod touched the ground, a note was made of the species of grass under or nearest to the point of the rod together with the height of the species. A note was also made of the nearest woody species within 5,0m of the station and its height. If the same woody species was nearest to the following station, it was disregarded and the next nearest woody species was recorded.

Thus from 10 transects, with 20 stations each, a total of 800 quadrants were examined. The percentage basal cover of each area was then calculated thus:-

$$\text{Percentage Basal Cover} = \frac{\text{Total No. hits from all quadrants}}{\text{Total No. quadrants examined}} \times 100$$

Throughout the remainder of this study, the following definitions are adhered to:-

$$\text{Percentage Frequency (F)} = \frac{\text{No. of samples}^{*}\text{ in which a species occurs}}{\text{Total no. of samples examined}} \times 100$$

* See p.144 for definition of a sample.

$$\text{Percentage relative frequency (f)} = \frac{\text{Frequency of Species A}}{\sum \text{Frequency values for all species}} \times 100$$

Percentage relative abundance (A) =

$$\frac{\text{No. of individuals of Species A}}{\text{Total number of all species}} \times 100$$

(after Curtis and MacIntosh 1950)

Importance Value:-

This is an arbitrary value derived by listing in descending order, the individual percentage relative abundance values (A) for each of the woody and grass species recorded during the survey of the vegetation. This parameter was chosen in preference to the percentage frequency values (F) for, although the independent values of F for the individual woody species were sufficiently differentiated to allow them to be listed in descending order, this was not so for the individual grass species (see Table 13 and Table 15).

By comparing the importance values (I.V.) of the various species with the percentage relative frequency (f) graphically, a clustering pattern is revealed which helps explain the physiognomic characteristic of the vegetation in the survey area.

Results and discussions

From the sight records (see Fig. 23) obtained during the study period, it was found that hartebeest confined themselves to a particular part of the study area. This area formed the survey area and it was decided that the overall vegetational habitat in this survey area could be subdivided into six habitat types. These habitat types were recognized as follows (Fig. 48):-

1. Colophospermum mopane Savanna Woodland habitat type (CmSW)
2. Colophospermum mopane - Acacia nigrescens - Drainage Line Open Tree Savanna habitat type (Cm-An-DL)
3. Acacia nigrescens Open Tree Savanna habitat type (AnTS)
4. Acacia exuvialis Scrub Thicket habitat type (AeST)
5. Colophospermum mopane - Drainage Line Open Tree Savanna habitat type (Cm-DL)
6. Drainage Line Open Tree Savanna habitat type (DLTS)

Each of these habitat types is characterised by the presence of one or more of the major vegetational communities that occur in the study area. Initially it was not known that the hartebeest were seeking out the dambo associations that occurred in these habitat types. It was hoped that a comparison of these habitat types would reveal some of the probable reasons why the hartebeest selected these various habitat types at different times of the year. However, in order to understand the differences in these six habitat types, it is necessary to discuss the overall physiognomic characteristics of the survey area.

Mean distance between trees and shrubs in the survey area

The mean distance between all woody growth forms was 6,88 ± 54,33m. Although the data collected in this survey do not permit the calculation of the density of the trees and shrubs per unit area directly, the mean distance between the woody individuals does give an indication of the "denseness" of the vegetation in the survey area (Fig. 44).

From the limited information available, a factor in the choice of habitat by the hartebeest appears to be the "openness" of the vegetation. Without being able to compare the results obtained in this study with two or more areas occupied by Lichtenstein's hartebeest elsewhere, it is difficult to assess when the proximity of woody individuals begins to "close" the habitat and render it unsuitable for their occupation.

Equally it is difficult with a survey of this nature to put a value on the cut-off point where the mean distance between woody individuals renders the vegetation too "dense" or too "open" without having a reference point from an area regarded as being "ideal" Lichtenstein's hartebeest country. However it is significant to note that 90% of all the woody individuals in the survey area are between 0,1 - 15,0m apart, while only 10% are between 15,1 - 75,0m apart.

Trees and shrubs in the survey area.

In all 10 184 trees and shrubs, comprising 18 different species, were examined in the survey area. Of these, the ten most common species, based on percentage frequency (F), were *Colophospermum mopane*, *Dichrostachys cinerea*, *Combretum imberbe*, *Lonchocarpus capassa*, *Dalbergia melanoxylon*, *Acacia exuvialis*, *Grewia* sp., *Acacia* sp. (cf. *Acacia nilotica*, *A. polyacantha*, *A. tortilis*), *Ziziphus mucronata* and *Hyphaene benguellensis* var.

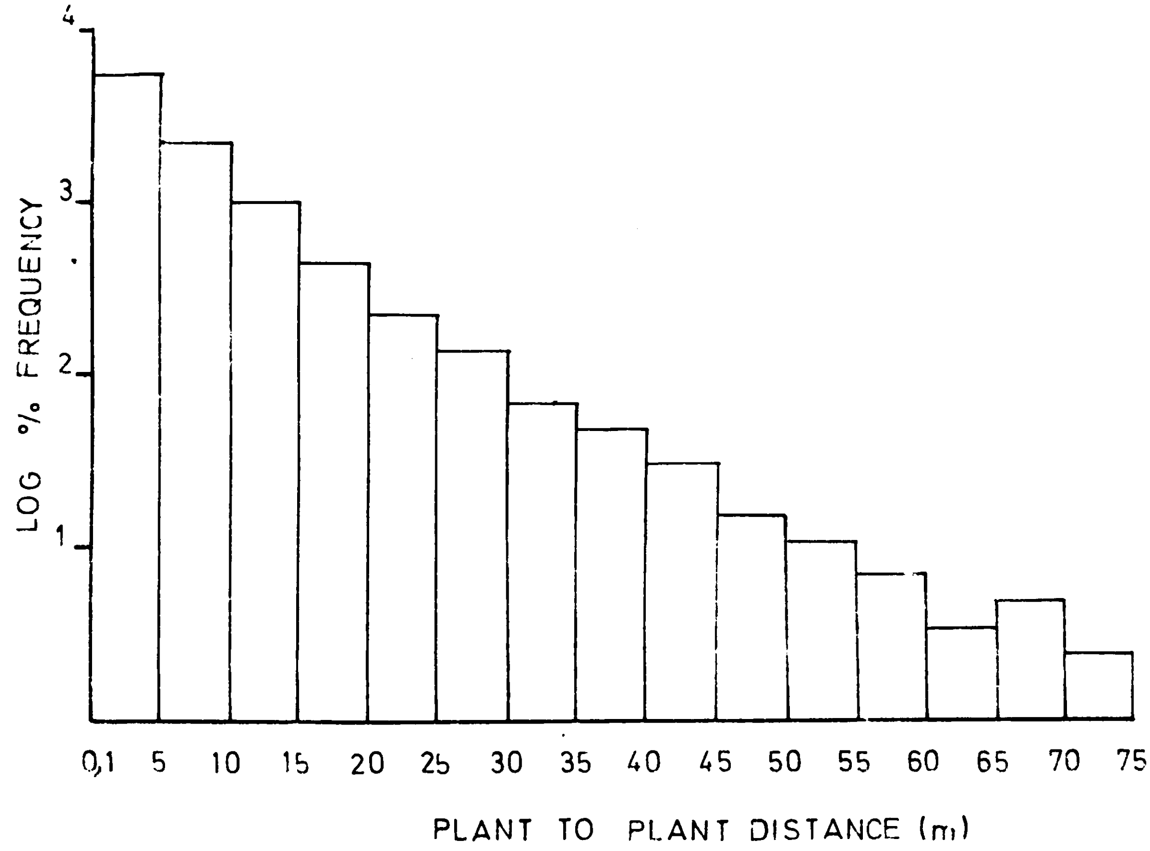


Fig. 44: The close nature of the vegetation in the survey area is reflected in the frequency of the number of woody individuals 10m and taller within the various distance classes.

ventricosa (Table 13). However the ten most important species based on percentage relative abundance are Colophospermum mopane, Dichrostachys cinerea, Acacia exuvialis, A. nigrescens, Combretum imberbe, Lonchocarpus capassa, Dalbergia melanoxylon, Hyphaene benguellensis var. ventricosa, Albizia harveyi and Commiphora africana (Table 13).

It is difficult to assess which environmental factors have had the greatest influence on the development of the vegetation in the past. On Lone Star Ranche, a single factor that has not played a significant role in the density of the vegetation development for the last 20 years is fire, and this is reflected in the rank order of the ten most important species in the survey area. Colophospermum mopane is the key woody species defining the woody vegetation of the south eastern lowveld of Rhodesia (Henning and White 1974), together with Acacia nigrescens and Combretum imberbe (Farrell 1968). It is not surprising therefore to find that these species feature prominantly in the vegetational composition of the survey area. However, two exceptions are Dichrostachys cinerea and Acacia exuvialis, which are species normally associated with bush encroachment. These two species are recorded as being the second and third most important species in the survey area and it is debatable whether these two species would have been destroyed by fire.

However, it is not within the context of this study to debate whether the presence of these species is indicative of bush encroachment, or representative of the natural composition of the vegetation that has developed under the prevailing environmental

Table: 13 Summary of the percentage frequency (F), percentage relative frequency (f), percentage relative abundance (A) and the importance value (I.V.) of 18 woody species in the survey area.

	Plant species	Number of individuals examined	F	f	A	I.V.
a.	Colophospermum mopane	4 208	71,11	10,63	41,31	1
b.	Dichrostachys cinerea	1 755	67,77	10,13	17,23	2
c.	Acacia exuvialis	691	46,66	6,97	6,78	3
d.	Acacia nigrescens	643	25,55	3,82	6,31	4
e.	Combretum imberbe	619	63,33	9,46	6,07	5
f.	Lonchocarpus capassa	476	55,55	8,30	4,67	6
g.	Dalbergia melanoxylon	408	50,00	7,47	4,00	7
h.	Hyphaene benguellensis var. ventricosa	214	32,22	4,81	2,10	8
i.	Albizia harveyi	206	26,66	3,98	2,02	9
j.	Commiphora africana	188	20,00	2,99	1,84	10
k.	Pterocarpus rotundifolius	177	25,55	3,82	1,73	11
l.	Acacia species	149	34,44	5,14	1,46	12
m.	Maytenus heterophylla	129	18,88	2,82	1,26	13
n.	Grewia species	112	40,00	5,98	1,09	14
o.	Ziziphus mucronata	90	34,44	5,14	0,88	15
p.	Euclea divinorum	58	21,11	3,15	0,56	16
q.	Combretum apiculatum	36	24,44	3,65	0,35	17
r.	Sclerocarya caffra	25	11,11	1,66	0,24	18

conditions. Sparrow (pers. comm.) comments that in the 1950's aggregations of these species were a component of the overall vegetation. It is difficult to assess whether these species have increased over the years, although there is evidence on the ranch that Dichrostachys cinerea has encroached onto roads. It is also significant to note that these species are not regarded as being major contributors to the overall vegetation in the lowveld in general (Rattray and Wild 1955, Wild 1955).

Other notable exceptions between the ten commonest and ten most important species is the absence of Grewia sp. and Ziziphus mucronata in the latter group. These have been replaced by Commiphora africana and Albizia harveyi respectively. All four of these species are contributors to the B-stratum of the various communities, although in terms of rank order it appears that Commiphora africana and Albizia harveyi are of more importance to the stratification in the survey area.

Comparing the percentage relative frequency (f) with the importance values (I.V.) of the 18 woody species (Fig. 45) and 15 grass species (Fig. 46) graphically gives an indication of the physiognomic relationships of the various species in the survey area, and allows various species to be grouped together. This grouping does not indicate that the various species are associated or occur together in the field. The groupings are dependent on the species having similar percentage relative frequency values, but not necessarily importance values, and similar ecological requirements. The resulting spatial distribution of the groups, as represented graphically, allows conclusions to be drawn regarding the relationships of the various species in the field and helps to facilitate the physiognomic description of the veget-

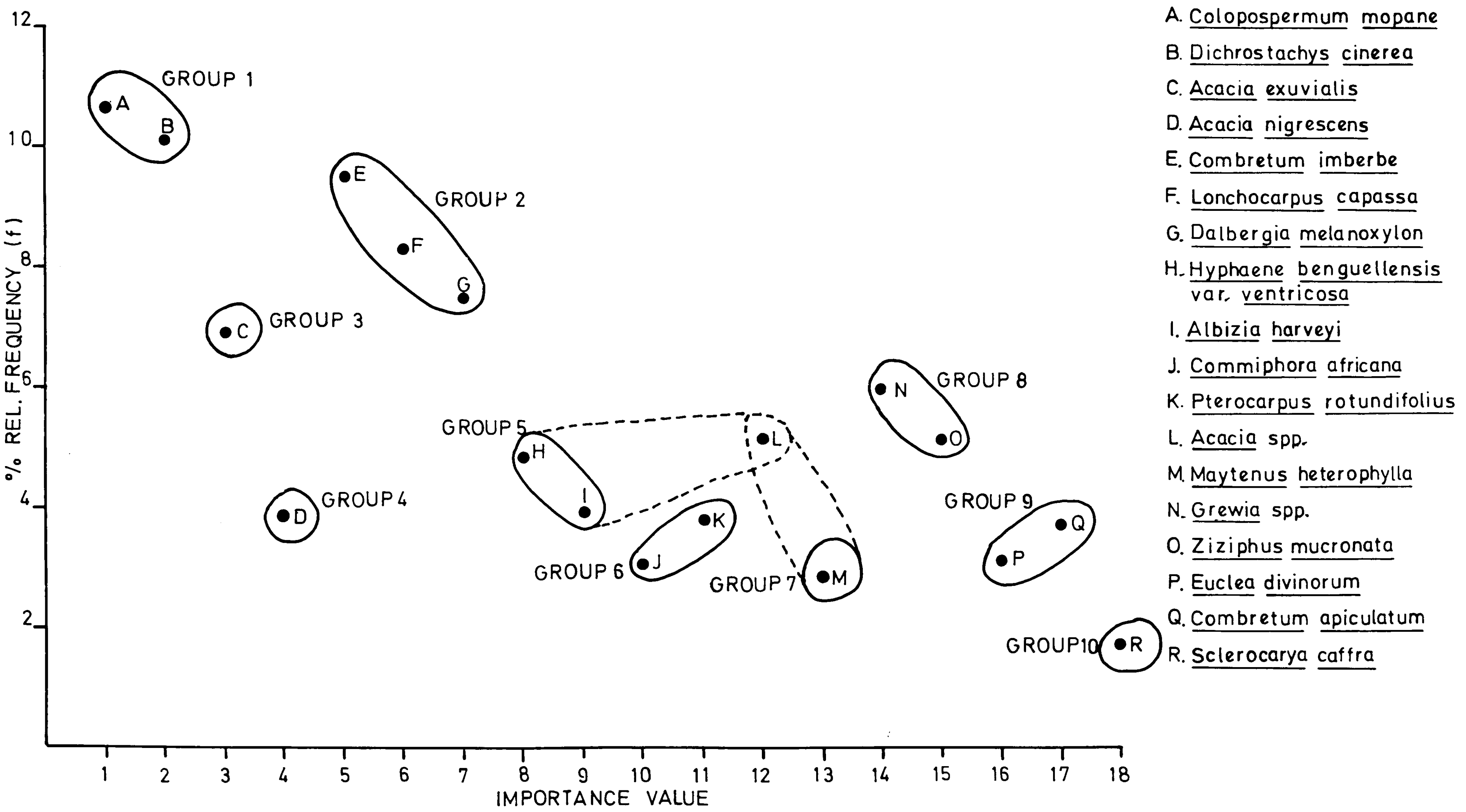


Fig. 45: The relationship between the percentage relative frequency (f) and the importance value of 18 woody species indicating the pattern of distibution of these species in the survey area.

In all a total of ten groups are recognized in Fig. 45. Group 1 is represented by *Colophospermum mopane* and *Dichrostachys cinerea*. The close graphical relationship of these two species is interesting in that *Colophospermum mopane*, being the most important species in the survey area, should be associated with a species which is not recognized as forming a separate facies of the vegetation of the lowveld, although in the study area *Dichrostachys cinerea* is recognized as a separate community in some places.

The interpretation of this is that although *Colophospermum mopane* is the major vegetaional community with the greatest relative abundance, individual specimens of *Dichrostachys cinerea* were frequently encountered in the vegetation, indicating the wide dispersion of this species throughout all the vegetational communities in the study area.

The second group is represented by *Combretum imberbe*, *Lonchocarpus capassa* and *Dalbergia melanoxylon*, which are all characteristic components of the more open areas, such as the Drainage Line Open Tree Savanna. An interesting feature here is that *Combretum imberbe* is usually associated with the woody vegetation components of the dambo associations while *Lonchocarpus capassa* is associated with country surrounding the drainage line systems within the Drainage Line Open Tree Savanna. The presence of *Dalbergia melanoxylon* in this group illustrates its importance as an indicator of the desiccated nature of the drainage line system (Hall-Martin 1972).

Although Group 3 is illustrated as not having close relationships with any of the remaining groups, Acacia exuvialis could be said to be associated with Group 2 which is representative of the Drainage Line Open Tree Savanna. It is suggested that this species may have invaded the dambo associations at some stage thus replacing this association with its own characteristic community (see p. 113), and it is possible that this species is in the process of invading the dambo associations. This species is the third most important species in the survey area (Table 13) and together with Dichrostachys cinerea, is associated with bush encroachment (Farrell 1968), which is further evidence of a possible bush encroachment problem in the study area. However, these two species appear to be ecologically separated for Acacia exuvialis shows a preference for the moister drainage line systems whereas Dichrostachys cinerea is widely distributed throughout all the vegetational communities in the area.

These species themselves may not be the centre of the problem, which is probably a combined effect of all the woody species in the study area.

Group 4, represented by Acacia nigrescens, can be regarded as a separate entity without any close affiliations with other groups. However, should an attempt be made to associate this species with the other groups, some interesting points begin to emerge. If it is associated with Groups 2 and 5, some speculation on the past history of the survey area may be entered into. Group 2 has already been discussed and shown to be associated with the

the drainage system in the survey area. Group 5, as represented by *Hyphaene benguellensis* var. *ventricosa* and *Albizia harveyi*, is associated with the Riverine Community and the Drainage Line Open Tree Savanna. In both instances, Groups 2 and 5 are in some way associated with the drainage system of the survey area. When examining the vegetation map (see Fig. 24), there is an apparent association between the *Acacia nigrescens* Open Tree Savanna and the Drainage Line Open Tree Savanna. It is postulated here that in the past the topography of the study area was such that the area presently covered by *Acacia nigrescens* was at one time part of the existing Drainage Line Open Tree Savanna which has been invaded by a series of woody species culminating in the *Acacia nigrescens* Open Tree Savanna.

It is difficult to speculate on what the succession might have been. It is possible that the Riverine Community, represented by species such as *Hyphaene benguellensis* var. *ventricosa* and *Albizia harveyi*, has been replaced in part by some of the *Acacia* sp. such as *Acacia polyacantha*, *Acacia nilotica* and *Acacia tortilis*. It is for this reason that the *Acacia* sp. were probably encountered in the survey area in such low numbers (A = 1,46, Table 13), although *Acacia tortilis* is represented by a small community along the banks of the Chiredzi River and *Acacia polyacantha* and *Acacia nilotica* are encountered in the dambo associations. It is possible that the success of these species depends on the availability of water and as such are poorly represented in the drier Drainage Line Open Tree Savanna.

However, Acacia exuvialis (Group 3) may not be so stringent in its water requirements and it is this species which has invaded the dambo systems and is ultimately being replaced by Acacia nigrescens.

Groups 6, 8 and 9 are represented by Commiphora africana, Pterocarpus rotundifolius, Grewia sp., Ziziphus mucronata, Euclea divinorum and Combretum apiculatum which are all species which contribute to the B-stratum of the various communities. With the exception of Ziziphus mucronata, which occurs in the B-stratum of the Acacia nigrescens Open Tree Savanna, all the remaining species are associated with the Colophospermum mopane Savanna Woodland. That these species are associated with each other in various groups illustrates the point made earlier in which it was suggested that the Colophospermum mopane Savanna Woodland could be sub-divided further into associations and/or communities and these groups are perhaps indicative of unexposed facies of the overall community.

Group 7 is represented by Maytenus heterophylla, which was poorly represented in the survey area (A = 1,26%, F = 18,88%, Table 13). In the Kruger National Park, this species is found on a wide variety of soil types, forming thickets along streams and rivers (Van Wyk 1972). In the survey area this species is also associated with the Riverine Community and encroaches into the dambo associations, although its position in Fig. 45 does not indicate its relationship with other groups associated with the drainage system in the survey area, with the possible exception of the Acacia sp., which, if they do require a moist habitat, could be associated with Group 7. It is possible that insufficient data were gathered in the survey area on this species and an inherent bias has resulted in it being misplaced, although, if, as is suspected, the drainage system is not sufficiently moist, these species may not be able to thrive in the survey area in any great numbers.

Group 10 is represented by Sclerocarya caffra, which is poorly represented in the survey area (A = 1,66%, F = 11,11%, Table 13) and again insufficient data have probably influenced the position of this species in relation to the other groups. Farrell (1968) indicates that in the lowveld this species is usually associated with Combretum apiculatum on the slopes of paragneiss geological formations, whereas Rattray and Wild (1955) associate this species with Acacia sp. - Colophospermum mopane - Combretum sp. - Adansonia digitata - Commiphora sp. Woodland both on granite and paragneiss. In the study area, Sclerocarya caffra is associated with species listed by Rattray and Wild (1955), especially in the rocky Hartebeest Hills area and thus is an important species in areas other than that surveyed.

Stratification of the vegetation in the survey area

The five height classes (1,0m; 1,5m; 2,0m; 3,0 - 4,0m and 4,1 - 5,0m) were chosen with two objectives. First to reflect the stratification of the vegetation and secondly it was hoped that obstructed vision would influence the choice of habitat by hartebeest.

It was decided that shrubs lower than 0,9m would be included in the grass stratum since in most cases the grass stratum averaged 0,6 - 0,7m and in the dambo associations where the grass stratum averaged 1,2m, the smaller shrubs were easily overlooked. A bias in favour of the 1,0m height class was noted in cases where a decision was required as to whether a specimen should be included in the 1,0m or 1,5m height class. However, this bias, it is felt, does not affect the overall result significantly and an accurate assessment of the stratification in these height classes has been achieved. Both these height classes were chosen to indicate the layer of vegetation which would obstruct the vision of hartebeest which had a shoulder height of 1,2m. The remainder of the height classes were chosen to reflect the stratification of the upper vegetational layers. It was considered impractical to include specimens taller than 5,0m in a separate height class, especially since the majority of the woody species in the survey area fell between 4,1 - 5,0m. Specimens taller than 5,0m were, however, included in the 4,1 - 5,0m height class.

It must be emphasized that the overall contribution to the stratification of the vegetation by the various woody species is directly related to the percentage relative abundance of each individual woody species in the habitat, for, although a species may have ranked as the most important contributor to a particular height class by virtue of the fact that the majority of the specimens monitored in the survey area fell into this particular category, the species may not have been well represented in the area and thus its overall contribution was insignificant.

Similarly a species may only have been important in a particular community or a facies of that community where it was well represented, and of no significance in any of the other communities in the survey area.

In Table 14 the percentage frequency of each of 18 woody species in each of the five height classes, indicating their contribution to the overall stratification of the vegetation in the survey area, is given.

1,0m height class.

The most prominent species in the 1,0m height class and all remaining height classes are Colophospermum mopane and Dichrostachys cinerea by virtue of the fact that these two species are the most abundant in the study area (Table 13). However in selected vegetational communities, certain species feature prominently although they are poorly represented in the study area as a whole.

In the Colophospermum mopane Savanna Woodland 75,53% (Table 14) of Commiphora africana specimens fall into the 1,0m height class while in the Riverine Community Maytenus heterophylla (67,44%, Table 14) and Albizia harveyi (32,03%, Table 14) feature prominently. Similarly Lonchocarpus capassa which is important in the Drainage Line Open Tree Savanna, is well represented in this height class (38,02%, Table 14). This

Table: 14 Summary of the percentage contribution by woody individuals, represented by 18 woody species, to five height classes (in metres) reflecting the stratification of the vegetation in the survey area.

Plant species	Number of Individuals examined	Height classes(m)				
		1,0	1,5	2,0	3,0 - 4,0	4,1 - 5,0
a. Colophospermum mopane	4208	11,55(486)*	8,69(366)*	22,21(934)*	23,71(998)*	33,84(1424)*
b. Dichrostachys cinerea	1755	24,04(422)	12,90(226)	20,56(361)	21,42(376)	21,08(370)
c. Acacia exuvialis	691	8,15(56)	4,92(34)	22,53(156)	34,87(241)	29,53(204)
d. Acacia nigrescens	643	2,79(18)	3,59(23)	6,84(44)	13,53(87)	73,25(471)
e. Combretum imberbe	619	3,55(22)	4,03(25)	13,85(86)	25,56(158)	53,00(328)
f. Lonchocarpus capassa	476	38,02(181)	8,40(40)	15,12(72)	6,93(33)	31,53(150)
g. Dalbergia melanoxylon	408	37,99(155)	14,23(58)	24,75(101)	15,44(63)	7,59(31)
h. Hyphaene benguellensis var. ventricosa	214	54,59(117)	13,05(28)	8,60(18)	20,66(44)	3,10(7)
i. Albizia harveyi	206	32,03(66)	7,76(16)	20,38(42)	13,59(28)	26,24(54)
j. Commiphora africana	188	75,53(142)	1,06(2)	8,53(16)	2,12(4)	12,76(24)
k. Pterocarpus rotundifoilius	177	43,50(77)	10,73(19)	32,76(58)	6,24(11)	6,77(12)
l. Acacia species	149	8,05(12)	8,05(12)	7,10(10)	13,89(21)	62,91(94)
m. Maytenus heterophylla	129	67,44(87)	26,35(34)	6,21(8)	-	-
n. Grewia species	112	10,72(12)	8,03(9)	42,85(48)	31,25(35)	7,15(8)
o. Ziziphus mucronata	90	20,00(18)	16,67(15)	17,77(16)	25,56(23)	20,00(18)
p. Euclea divinorum	58	37,94(22)	18,96(11)	32,75(19)	10,35(6)	-
q. Combretum apiculatum	36	22,22(8)	8,31(3)	25,00(9)	22,22(8)	22,22(8)
r. Sclerocarya caffra	25	-	-	-	-	100,00(25)

* Actual Number Woody Individuals Examined In Each Height Class.

species either occurs as a single stemmed tree 10 - 12m or more in height, or more commonly as a stunted shrub along the periphery of the dambo associations, but is poorly represented in the remaining height classes.

1,5m height class.

Besides Dichrostachys cinerea (12,90%, Table 14), which features in all vegetational communities in the study area, species such as Maytenus heterophylla (26,35%), Euclea divinorum (18,96%) and Ziziphus mucronata (16,67%, Table 14) all contribute to the stratification of selected communities in the study area, although in each case, their low percentage relative abundance (Table 13) means that their overall contribution is unimportant.

Maytenus heterophylla contributes to the stratification of the dambo associations, while Euclea divinorum occurs in the Colophospermum mopane Savanna Woodland and a few isolated specimens were recorded from the Drainage Line Open Tree Savanna. Ziziphus mucronata occurs in the Acacia nigrescens Open Tree Savanna and the Drainage Line Open Tree Savanna.

The species of most importance is Dalbergia melanoxylon which contributes 14,23% (Table 14). This species is frequently encountered in the dambo associations where it may obstruct the vision of hartebeest in this habitat type.

2,0m height class.

The species which have the greatest overall influence on the stratification in this height class are Colophospermum mopane

(22,21%) and *Dichrostachys cinerea* (20,56%, Table 14). However, *Grewia* sp., *Pterocarpus rotundifolius* and *Euclea divinorum* are all major contributors to this height class, but are restricted to the *Colophospermum mopane* Savanna Woodland (Table 14).

In the Drainage Line Open Tree Savanna and in particular the dambo associations the following species feature prominently in this height class; *Combretum apiculatum*, *Dalbergia melanoxylon* and *Combretum imberbe* (Table 14.). *Acacia exuvialis*, which has not been an important contributor to any of the previous height classes, features prominantly in this height class (22,53%, Table 14) and is an important contributor to the stratification in the dambo associations.

3,0 - 4,0m height class.

The most important species both in terms of percentage relative abundance and percentage contribution to the stratification in this height class, *Combretum imberbe* (25,56%), and *Acacia exuvialis* (34,87%, Table 14), are both components of the Drainage Line Open Tree Savanna and in particular the dambo associations.

Combretum imberbe occurs in a greater variety of communities than does *Acacia exuvialis*, although in the dambo associations it takes the form of a multistemmed bush. *Acacia exuvialis* occurs in all instances as a multistemmed bush, and this type of habitat presents a visual obstruction, especially where this species forms dense impenetrable thickets.

Grewia sp., contributing 31,25% (Table 14) to this heigh class, are restricted to the *Colophospermum mopane* Savanna Woodland and thus are only important to the stratification of this community. The significance of *Colophospermum mopane* (23,71%, Table 14) as a component of the stratification is first realized in this height class, reflecting the development of this species in the absence of the influence of fire, from the "scrub-form" which is characteristic of the south eastern lowveld (Henning and White 1974), to a relatively tall stemmed tree.

4,1 - 5,0m height class

The most important species contributing to this height class is *Colophospermum mopane*, not only through its high percentage relative abundance in the survey area (A = 41,31%, Table 13), but also because the majority of the specimens of this species monitored in the survey area were between 4,1 - 5,0m tall (33,84%, Table 14).

However in the *Acacia nigrescens* Open Tree Savanna, *Acacia nigrescens* is the most prominant contributor (73,25%, Table 14) while other notable contributors in the Drainage Line Open Tree Savanna are *Combretum imberbe* (53,00%), *Lonchocarpus capassa* (31,53%) and *Albizia harveyi* (26,24%, Table 14).

Although species such as *Sclerocarya caffra* (100,00%) and *Acacia* sp., such as *Acacia tortilis*, *Acacia polyacantha* and *Acacia nilotica* (62,91%, Table 14) are major contributors to this height class they are very poorly represented in the survey area (A = 0,24% and 1,46% respectively, Table 13), and thus their respective contributions is unimportant.

The remaining species contributing to this height class are of little importance to the overall stratification, for if their percentage contribution is relatively high, they are poorly represented in the survey area and vice versa. Among the species represented are *Dalbergia melanoxylon*, which is only rarely found in this height class in the dambo associations, *Grewia* sp., *Pterocarpus rotundifolius*, which is confined to the *Colophospermum mopane* Savanna Woodland, and *Hyphaene benguellensis* var. *ventricosa*, which is found in the Drainage Line Open Tree Savanna.

Thus the stratification of the vegetation in the survey area is influenced in some way, in varying degrees, by all the 18 woody species monitored in the survey area. However, the degree to which the various woody species contribute to the stratification of the vegetation is directly dependent on the percentage relative abundance of the species in the survey area, and in this regard the most important overall contributors to the stratification are *Colophospermum mopane* and *Dichrostachys cinerea*.

Grasses of the survey area

The most comprehensive descriptions of the grass cover associated with the various woody species communities in the south eastern lowveld of Rhodesia, are given by Rattray (1957, 1961). The descriptions are included here to facilitate a broader understanding of the grass stratum of the study area and the Sabi-Lundi River region in general.

The grass association of the region incorporating Lone Star Ranche, is defined as a "*Cenchrus ciliaris* - Other Species Veld", which is restricted to soils derived from paragneiss or basalt at altitudes below 600m, where the average rainfall is in the region of 300 - 400mm annually. The grass cover is characterized by the species *Cenchrus ciliaris*, together with *Pennisetum* sp., *Panicum maximum*, *Schmidtia pappophoroides*, *Chloris roxburghiana* and *Enneapogon cenchroides*. Other characteristic grasses on the black soils are *Ischaemum* sp., *Sorgum versicolor*, *Setaria* sp. and *Urochloa panicoides*.

In 1961 Rattray revised the physiognomic classification of the Rhodesian vegetation and now recognizes numerous subdivisions within the older classification systems, which gives a more refined description of the vegetation.

Applying the physiognomic classification of Rattray (1961) the vegetation on the ranch may be included in the broad categories of "Tree Savanna (Deciduous or evergreen unstratified savannas of various types)" and/or in the category of "Tree/Bush Savannas (Deciduous stratified tree savannas of various types, the stratification resulting from 'adult' bushes of different species of varying stature or from secondary growth of 'cut-over' trees)".

Under the category of "Tree Savannas" two vegetation types are recognizable:-

1. On heavy black clays derived from basalts, where *Acacia nigrescens* occurs in pure stands, or with *Sclerocarya caffra* as co-dominant (as in the Sabi Valley), the grass cover is characterised by *Setaria* sp., *Ischaemum* sp., *Sorgum versicolor* and *Brachiaria eruciformis*.

2. Where *Colophospermum mopane* is dominant or co-dominant over extensive areas and where it has reached its maximum development, the grass cover may vary from one which is predominantly perennial to one which is almost entirely annual depending largely on past management or treatment. Common perennials are *Eragrostis rigidior*, *Cenchrus ciliaris*, *Schmidtia pappophoroides* and *Urochloa* sp., while the annuals are *Enneapogon cenchroides*, *Aristida* sp., *Eragrostis viscosa*, *Dactyloctenium aegyptium* and *Urochloa* sp.

Under the category of "Tree/Bush Savannas", three vegetation types are recognized:-

1. *Acacia* sp. type.

   This type varies according to soil type. Where a combination of Acacia sp. with *Colophospermum mopane*, *Adansonia digitata*, *Schlerocarya caffra*, *Commiphora africana* with or without species of Grewia occurs, the grass cover, generally, comprises *Enneapogon cenchroides*, *Urochloa* sp., *Panicum maximum* *Dactyloctenium aegyptium*, *Chloris roxburghiana*, *Cenchrus ciliaris*, *Aristida* sp. and *Eragrostis* sp.

2. *Combretum* sp. type

   This type is dominated by species such as *Combretum apiculatum*, *Combretum hereroense* and *Combretum imberbe*, associated with species such as *Colophospermum mopane*, *Terminalia sericea*, *Sclerocarya caffra*, *Acacia nigrescens*, *Kirkia acuminata*, *Afzelia guanzensis*, *Grewia* sp. and *Albizia* sp. The grass cover is dominated by *Eragrostis* sp., *Brachiaria nigropedata*, *Urochloa pullulans*, *Pogonarthria squarrosa* and *Digitaria* sp.

3. *Colophospermum mopane* type.

   The associated species common in the *Colophospermum mopane* "Tree/Bush Savanna" include *Sclerocarya caffra*, *Acacia nigrescens*, *Combretum apiculatum*, *Kirkia acuminata*, *Commiphora* sp., *Acacia* sp., *Terminalia prunioides*, *Adansonia digitata* and *Grewia* sp.

   The grass cover varies from annual to perennial. On sandy soils derived from granite and paragneiss *Eragrostis rigidior*, *Eragrostis superba*, *Eragrostis jeffreysii*, *Heteropogon contortus*, *Brachiaria nigropedata*, *Urochloa pullulans*, *Pogonarthria squarrosa*, *Digitaria* sp. and *Chloris roxburghiana* are common perennials while on the basalts, *Setaria* sp., *Ischaemum* sp., *Digitaria milanjiana* and *Bothriochloa insculpta* are more frequent. Common annuals are *Enneapogon cenchroides*, *Aristida* sp., *Dactyloctenium aegyptium*, *Dactyloctenium giganteum*, *Eragrostis viscosa*, *Urochloa* sp. and *Tragus berteronianus*.

In the context of this study, no attempt has been made to distinguish between annual and perennial grass species. The prevalence of perennial and and annual grasses in a sward is intimately related to annual rainfall and temperature conditions. In the low-lying, hot and dry lowveld, the annual species often predominate almost to the exclusion of the perennials (Rattray 1961). However, the geographical position of Lone Star Ranche, situated on the boundary of the 400 - 600mm isohyet (see p.15), the rainfall on the ranch being influenced by the Chihonja and Malilongwe Ranges (see p. 17) and the topography of the ranch, has greatly influenced the grass cover of the study area.

The description given by Rattray (1961) gives a broad indication of the grass cover on Lone Star Ranche, however, as with any investigation of this magnitude, there are bound to be local variations in the overall pattern. It is not the intention here to give a detailed account of the grass stratum in the study area and it must be emphasized that only *visual* grass species, usually identified from the flowering heads, were recorded. No doubt if a systematic collection were made in the survey area, the resulting list of grass species would far exceed the 15 grass species discussed here (Table 15).

These 15 species were regarded as being characteristic of the grass cover in the overall survey area, and in all a total of 14 015 individual records were made on the grass cover in the survey area. The seven most common species, based on percentage frequency, were *Urochloa mosambicensis*, *Cenchrus ciliaris*, *Panicum* sp., *Aristida* sp., *Heteropogon contortus*, *Setaria anceps* and *Ischaemum afrum* (Table 15), although the seven most important species, based upon percentage relative abundance, were *Urochloa mosambicensis*, *Cenchrus ciliaris*, *Aristida* sp., *Ischaemum afrum*, *Panicum* sp., *Setaria anceps* and *Bothriochloa radicans* (Table 15).

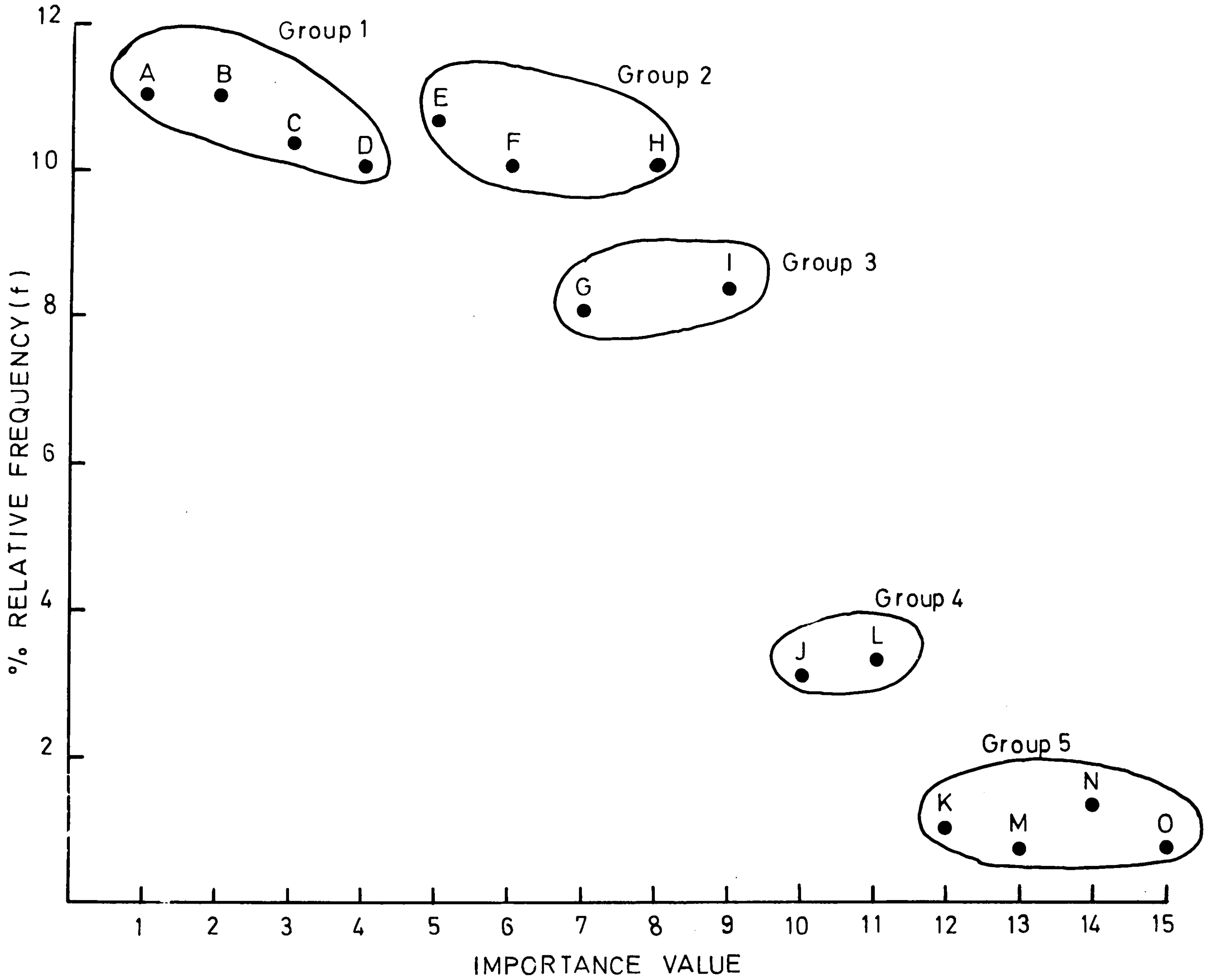
Table : 15 Summary of the percentage frequency (F), percentage relative frequency (f), percentage relative abundance (A) and importance value (I.V.) of 15 grass species recorded in the survey area.

Grass Species	Number of individuals examined	F	f	A	I.V.
a. Urochloa mosambicensis	3462	97,0	11,07	24,70	1
b. Cenchrus ciliaris	2661	97,0	11,07	18,98	2
c. Aristida species	1679	91,0	10,39	11,98	3
d. Ischaemum afrum	1592	88,2	10,06	11,35	4
e. Panicum species	1359	94,1	10,73	9,69	5
f. Setaria anceps	1346	88,2	10,06	9,60	6
g. Bothriochloa radicans	631	70,6	8,05	4,50	7
h. Heteropogon contortus	497	88,2	10,06	3,54	8
i. Enneapogon cenchroides	434	73,5	8,38	3,09	9
j. Digitaria milanjiana	140	26,5	3,02	0,99	10
k. Sporobolus pyramidalis	80	8,8	1,00	0,57	11
l. Eragrostis species	74	29,4	3,35	0,52	12
m. Paspalum scrobiculatum	29	5,9	0,67	0,20	13
n. Chloris gayana	17	11,8	1,34	0,12	14
o. Hyperthelia species	14	5,9	0,67	0,09	15

Although there are not significant differences between the seven most frequent and most important species, there are some notable exceptions. Rattray (1957) described *Cenchrus ciliaris* as being the characteristic species of the region, while Farrell (1968) recognizes *Setaria* sp. as being the characteristic grass in the study area, although in this study, *Urochloa mosambicensis* is regarded as the most important species, being associated with almost every community described in the study area. Another notable exception is the exclusion of *Heteropogon contortus* and the inclusion of *Bothriochloa radicans*, a species which, through its aromatic flavour, is unpalatable to most herbivores (Chippindall and Crook 1976 - 1978).

A greater understanding of the pattern of distribution of the various grass species in the study area is illustrated in Fig. 46. In all, five groups were recognized. Groups 1, 2 and 3 are all closely related graphically, and between them represent the nine most important species in the survey area.

Group 1, representing *Urochloa mosambicensis*, *Cenchrus ciliaris*, *Aristida* sp. and *Ischaemum afrum*, includes those species which may be regarded as being characteristic of one or more of the vegetational communities described in the study area. *Urochloa mosambicensis* (A = 24,70%) occurs in all the communities, with the exception of the *Dichrostachys cinerea* Scrub Thicket and the Riverine Community, and is the most abundant grass species in the Drainage Line Open Tree Savanna.



A. *Urochloa mosambicensis*
B. *Cenchrus ciliaris*
C. *Aristida* spp.
D. *Ischaemum afrum*
E. *Panicum* spp.
F. *Setaria anceps*
G. *Bothriochloa radicans*
H. *Heteropogon contortus*
I. *Enneapogon cenchroides*
J. *Digitaria milanjiana*
K. *Sporobolus pyramidalis*
L. *Eragrostis* spp.
M. *Paspalum scrobiculatum*
N. *Chloris gayana*
O. *Hyperthelia* spp.

Fig. 46: The relationship between the percentage relative frequency(f) and importance values of 15 grass species indicating the pattern of distribution of these species in the survey area.

Cenchrus ciliaris (A = 18,98%), although not as widely distributed in the vegetational communities as *Urochloa mosambicensis*, is equally important, especially in the *Acacia nigrescens* Open Tree Savanna and the Drainage Line Open Tree Savanna. The *Aristida* sp., of which *Aristida congesta* is probably the most abundant, are characteristic of the *Colophospermum mopane* Savanna Woodland, which Rattray (1961) indicates may be the climax grass community in areas where *Colophospermum mopane* has reached its maximum development, especially in areas which are subject to regular droughts and low rainfall. *A. congesta* however, is a pioneer grass species.

Ischaemum afrum (A = 11,35%) is the characteristic species associated with the drainage lines or with soils exhibiting poor drainage. This species is found in all the vegetational communities, with the exceptions of the *Brachystegia glaucescens* Savanna Woodland zone, *Dichrostachys cinerea* Scrub Thicket, *Acacia tortilis* Savanna Woodland and the Riverine Community.

Group 2 is represented by *Panicum* sp., *Setaria anceps* and *Heteropogon contortus* which may be regarded as species which are more specialized in their habitat requirements than the species included in Group 1.

The *Panicum* sp., of which *Panicum maximum* is probably the most abundant, are usually associated with the shaded, moist areas. These species are least common in the *Colophospermum mopane* Savanna Woodland and in the *Commiphora africana* - *Cassia abbreviata* - *Adansonia digitata* Open Tree Savanna in the rocky areas of the study area, but are frequently encountered in the Riverine Community.

Setaria anceps is a species usually associated with Ischaemum afrum. Unlike Ischaemum afrum, which occurs both on relatively flat surfaces exhibiting poor drainage and in the drainage lines, Setaria anceps is only found in the shallow depressions and drainage lines forming dambos, suggesting that, this species is more exacting in its water and habitat requirements than Ischaemum afrum.

Heteropogon contortus is regarded as an important fodder grass, although the sharp seeds can cause irritation to ungulates (Lightfoot 1975). This species, which is widespread in Rhodesia, reaches its optimum development in the 500 - 625mm rainfall zone at an altitude between 600 - 1 200m (Rattray 1957). This once again underlines the complex geographical situation of Lone Star Ranche in relation to altitude and rainfall.

That this species is not included as one of the seven most important species may be the result of heavy grazing pressure. In drier areas of Heteropogon contortus veld where this species is grazed it is usually replaced by Eragrostis sp. or a perennial Aristida sp. (Rattray 1957). In the survey area, this species is usually associated with the ecotone between the drainage line and the adjacent woodland communities, where it is associated with such species as Aristida congesta and Enneapogon cenchroides. Although no record of the "grazing pressure" on this species was kept, moisture availability is probably more influencial in determining the success of this species.

Group 3, representing *Bothriochloa radicans* and *Enneapogon cenchroides*, is closely associated with Group 2. As discussed in the previous section, *Enneapogon cenchroides* is closely associated with the ecotonal zones and appears to exploit the drier conditions in these zones to the exclusion of *Heteropogon contortus*.

Similarly, in the rocky Hartebeest Hills area, *Bothriochloa radicans* appears to replace *Heteropogon contortus*. Usually *Heteropogon contortus* is found around granite outcrops where it benefits from the "run-off" during the rainy season (Rattray 1957). On Lone Star Ranche, the Hartebeest Hills area receives less rainfall than the higher Malilongwe Range (see p. 17), and, although *Heteropogon contortus* is found in the rocky hills in areas where the soils trap a little extra moisture, the characteristic grass species is *Bothriochloa radicans*.

Bothriochloa radicans is also found growing in isolated patches, often together with *Cenchrus ciliaris*, in the *Acacia nigrescens* Open Tree Savanna and the Drainage Line Open Tree Savanna, possibly indicating the dry nature of these communities.

Group 4 represents *Digitaria milanjiana* and *Eragrostis* sp. which are poorly represented in the survey area, although both species are important contributors (together with *Pogonarthria squarrosa*) to the grass cover in the *Brachystegia glaucescens* Savanna Woodland zone and on the alluvial soils associated with the Riverine Community of the Chiredzi and Lundi Rivers.

In the survey area isolated occurrences of these two species were recorded, mostly from the drainage Line Open Tree Savanna and especially along its interface with the Riverine Community associated with the Mahande River.

Group 5, represented by *Sporobolus pyramidalis* and *Paspalum scrobiculatum*, *Chloris gayana* and *Hyperthelia* sp., represents, together with Group 4, the least common and least important species in the survey area.

All the species of Group 5 are, in some way, associated with a moist environment such as a drainage line. *Sporobolus pyramidalis* and *Paspalum scrobiculatum* are associated together in an isolated area within the *Acacia exuvilais* Scrub Thicket, where the soils often remained waterlogged for some time after the rains. The area in which these species are found resembles a wide dambo, however the tough unpalatable nature of *Sporobolus pyramidalis* (Chippindall and Crook 1976 - 1978) precluded any of the herbivores, including hartebeest, from utilising these regions in the study area.

Chloris gayana is occasionally found along the periphery of the dambo systems, although it is more common on the Karoo sandstone soils of the *Brachystegia glaucescens* Savanna Woodland zone.

Hyperthelia sp. (*Hyperthelia dissoluta*, *Hyperthelia finitima* and *Hyperthelia fillipendula*, Chippindall and Crook 1976 - 1978) are poorly represented in the wide dambo associations (F = 5,9%, A = 0,09%). Although the importance of these species in the dambos is probably negligible, they may indicate a moister environment in some of the dambos, for these species are normally associated with the verges of vleis (Chippindall and Crook 1976 - 1978).

In conclusion, it must be noted that the study area had received three years of above average rainfall which no doubt had a beneficial influence on the success of the grass stratum.

The availability of moisture, determined by the interplay of such environmental factors as rainfall, temperature, topography and the edaphic characteristics of the soil, has enabled the various grass species to take advantage of these conditions and flourish. In all, the delicate ecobalance of the study area could be easily upset and in times of drought exhibit a totally different situation from that found during the study period.

The complex nature of the grass stratum, incorporating the physiognomic characteristics and the basal cover of the grasslands, will be discussed later (see p. 223).

CHAPTER 8

Physiognomy of six habitat types utilised by Lichtenstein's hartebeest in the study area

Introduction

As more information on the distribution of hartebeest in the study area became available, more time was apportioned to the areas known to be frequented by hartebeest on a more regular basis. In all, six study sites or habitat types were identified (Fig. 47). These six habitat types, collectively known as the survey area (as opposed to the 'study area' which encompassed the entire ranch) were most likely to be occupied by the hartebeest at one time or another during the year.

Although these habitat types are distinguished by terms which have been applied to identify the major vegetational communities in the study area, these terms are used here to facilitate the description of the various habitat types which are determined by these major vegetational communities.

In Fig. 48 the number of observations of hartebeest in each of the six habitat types over the two year period is given. Clearly the hartebeest tended to favour the Drainage Line Open Tree Savanna habitat type, for 34,96% of all the observations were made in this habitat type, followed by the *Colophospermum mopane* - Drainage Line Open Tree Savanna habitat type (23,58%), *Acacia exuvialis* Scrub Thicket habitat type (13,83%), *Colophospermum mopane* Savanna Woodland habitat type (13,00%), *Acacia nigrescens* Open Tree Savanna habitat type (11,38%), and lastly the

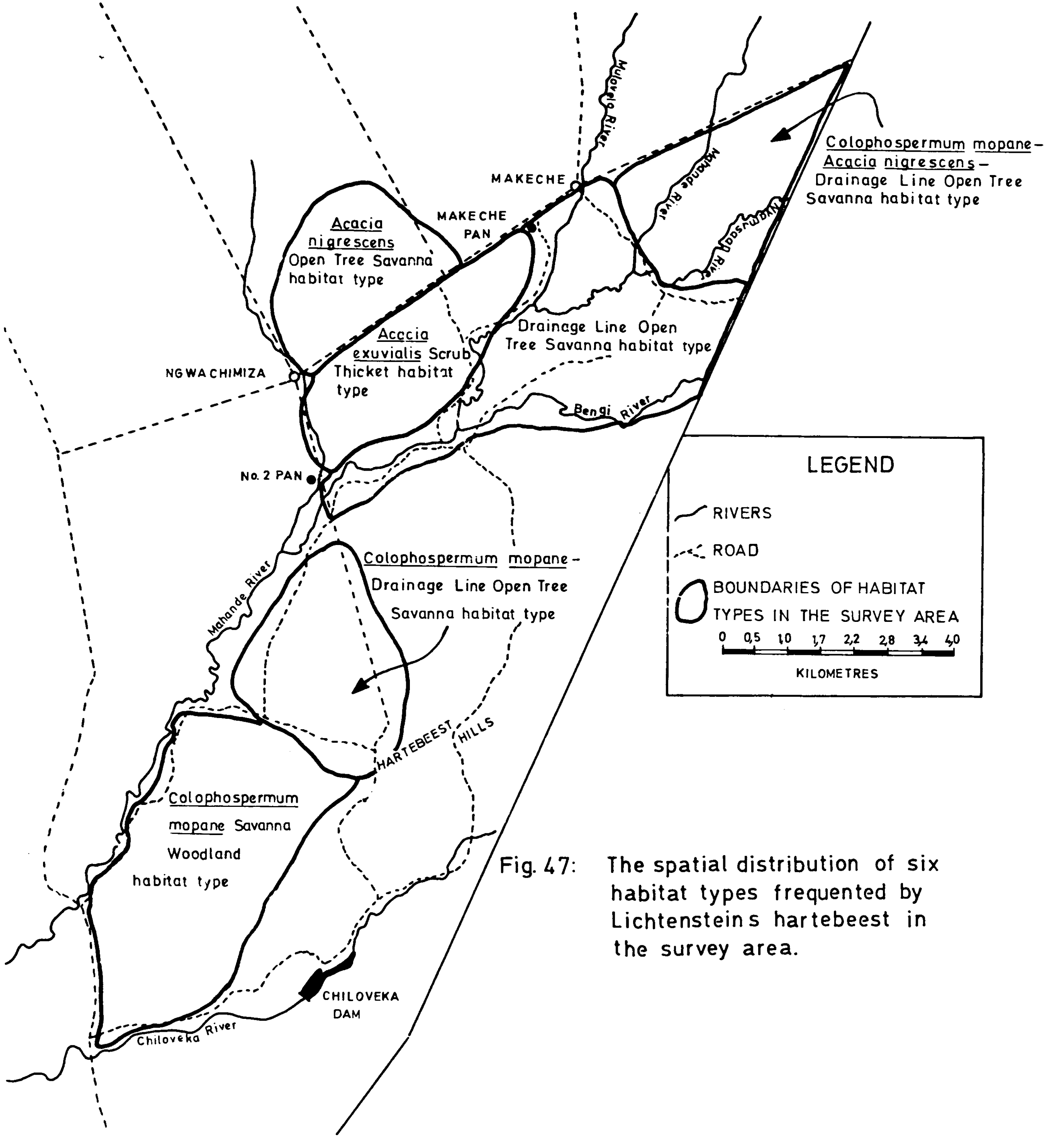


Fig. 47: The spatial distribution of six habitat types frequented by Lichtensteins hartebeest in the survey area.

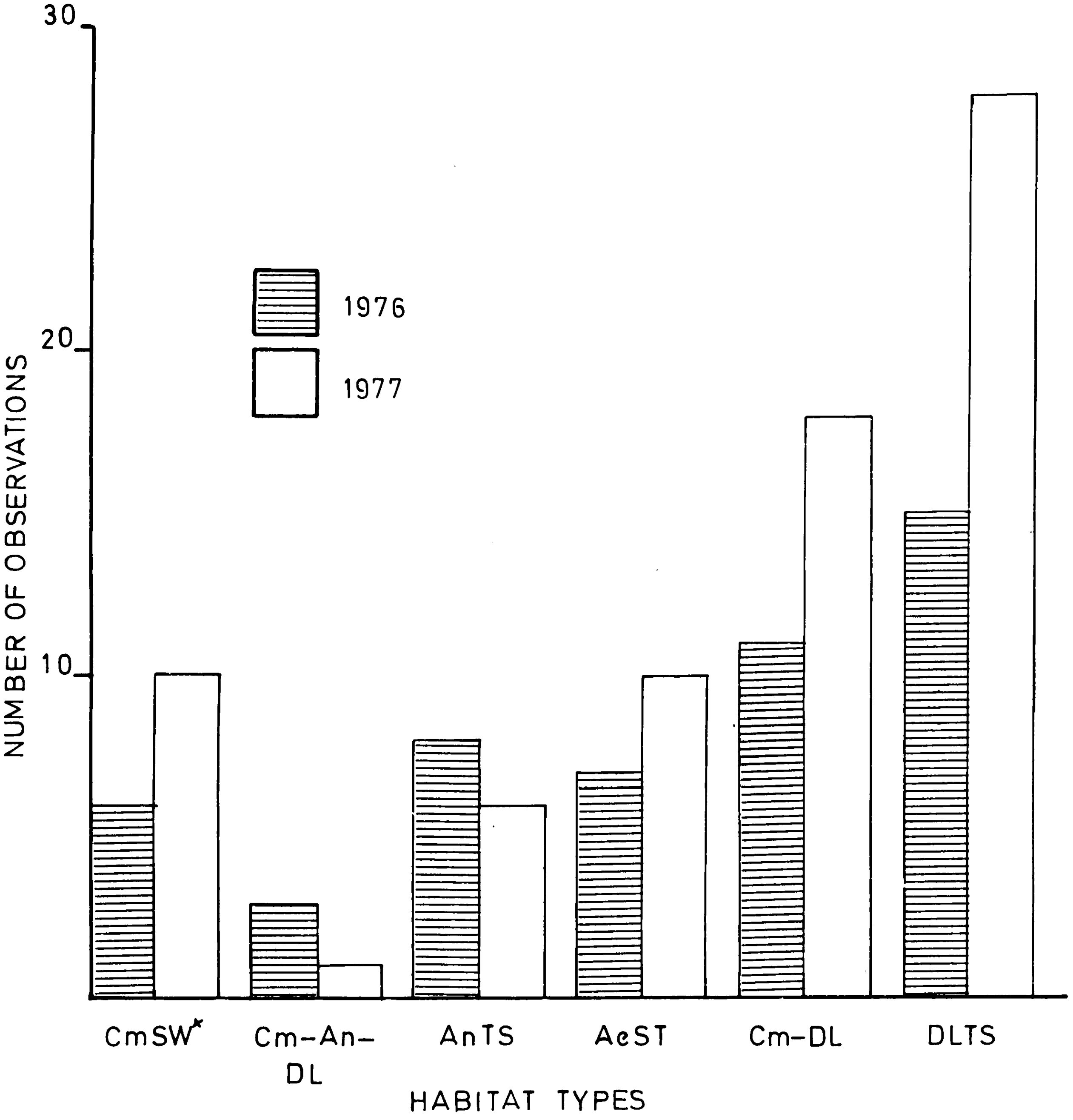


Fig. 48: Summary of the number of observations of Lichtenstein's hartebeest in six habitat types in the survey area over a two year period. (CmSW*: see text p. 150 for abbreviations)

Colophospermum mopane - Acacia nigrescens - Drainage Line Open Tree Savanna habitat type (3,25%).

It must be emphasized however that although hartebeest tended to utilise the Drainage Line Open Tree Savanna habitat type more frequently than any of the other habitat types, they did move into and remain in each of these areas for various lengths of time as the year progressed.

In Table 16 a summary of this migration from one habitat type to another during the months of the year is illustrated. Generally the hartebeest moved into the Drainage Line Open Tree Savanna habitat type at the beginning of November soon after the first rains of the season. The herds remained in this habitat type for a major part of the rainy season and rarely moved any great distance out of this habitat type. When this did occur, it was usually the result of being disturbed either by humans or carnivores, such as lions or leopards, and the herd usually returned after a short while.

As the dry season progressed, the herds began to move about more frequently and further away from the Drainage Line Open Tree Savanna habitat type. This movement commenced roughly in April and gradually increased until by mid-June/July, the hartebeest were rarely found in the Drainage Line Open Tree Savanna habitat type, but were distributed throughout the remaining habitat types where they never remained in any one area for any length of time, but moved over great distances - up to 20km in one day in some instances - before returning to the Drainage Line Open Tree Savanna habitat type (often to

Table : 16 Summary of the number of observations of Lichtenstein's hartebeest in the six habitat types in the study area over a two year period (o = 1976, x = 1977, ? = suspected occurrence), indicating the annual migration.

Month	DLTS*	Cm-DL	AeST	AnTS	Cm-An-DL	CmSW
Jan	x x xx xx	x				xx
Feb	x oo ? ? o ?					
March	? o x ? ?	o				o
April	x xxxx xx x	o x		x		x o
May	xxx o x o ? xx	xxx o o	x xx o	o o	x	
June.	? x xx x o		o x o		oo o	
July	o o x oo	x oo o xx	o x o xx	o o		
Aug	x	xxoooo x	o	o x x		x x
Sept	o	x xxx xx x	x xx	x o xx o		x xx o x x
Oct			o			? ? o ? o
Nov	oo ? o			o		o
Dec	? ? ? ?					

DLTS* = See text p. **160** for abbreviations.

the same locality that that specific herd or animal occupied the season before) at the commencement of the rains again in November.

In the Gorongosa National Park, Mozambique, Tinley (1977) comments on a similar migratory pattern. Here it was observed that sable and Lichtenstein's hartebeest preferred ecotones of savannas with dambos and floodplain grassland. In the wet season the sable would move up from the Rift Valley floor into the miombo (*Brachystegia* sp.) savannas of the midlands and the Chiringoma Plateau, while the hartebeest moved down from these areas and into the Rift Valley floor. In the dry season the process was reversed, however, unlike sable, Lichtenstein's hartebeest were "inveterate followers of burnt grassland, feeding on the toasted basal parts and first post-fire flush" (Tinley 1977).

A similar pattern between sable and Lichtenstein's hartebeest was observed on Lone Star Ranche, where sable invaded the dambos towards the end of the dry season after the hartebeest had left the area. However, the hartebeest association with burnt grassland may be incorrect and it is possible that what was observed was the hartebeest moving back to their former, now destroyed, territories - as do reedbuck (Ferrar and Walker 1974).

This migration therefore suggests that the definition of the habitat type selected by Lichtenstein's hartebeest is dependent on a number of factors, which are found in a number of different habitat types and whose importance to hartebeest varies at different times of the season.

Analysis of the physiognomic characteristics of each of the six habitat types utilised by the hartebeest and then examination in detail as to how a specific hartebeest herd (the Makeche Herd) moves through these habitat types has revealed some salient features which may play a role in habitat selection. These are discussed below.

Colophospermum mopane Savanna Woodland habitat type (CmSw)
This habitat type is confined to the west of Chiloveka Dam and lies between it and the Mahande River (Fig. 47). In Table 17 the percentage relative abundance of the various woody species is given, while in Fig. 49 the overall contribution of all woody individuals to five height classes reflecting the stratification of the vegetation is illustrated.

The most prominent species in this habitat type is Colophospermum mopane (A = 73,72%) while the remaining species are poorly represented, although Commiphora africana (A = 5,80%) and Pterocarpus rotundifolius (A = 3,32%, Table 17) are important in that these species are the primary contributors to the B-stratum of this habitat type.

As mentioned earlier (p. 151) it is virtually impossible to give an indication as to when the density of the vegetation begins to affect the hartebeest's selection of habitat, without having a reference point to work from. There appears to be some correlation between the choice of habitat type and the mean plant - to - plant distance reflecting the "openness" of the habitat type. It was therefore decided to choose three arbitrary classes which would allow a comparison to be drawn

Table : 17 Summary of the percentage relative abundance (A) of the various woody species 1,0m and taller in the six habitat types frequented by Lichtenstein's hartebeest in the study area.

	CmSW*		Cm - An - DL		AnTS	
	Species	A	Species	A	Species	A
a.	Colophospermum mopane	73,72	Colophospermum mopane	48,00	Dichrostachys cinerea	30,38
b.	Commiphora africana	5,80	Acacia nigrescens	10,00	Acacia nigrescens	29,00
c	Acacia exuvialis	4,50	Dichrostachys cinerea	9,80	Colophospermum mopane	10,38
d.	Pterocarpus rotundifolius	3,32	Combretum imberbe	9,43	Combretum imberbe	9,38
e.	Dichrostachys cinerea	2,77	Acacia exuvialis	3,90	Dalbergia melanoxylon	8,00
f.	Dalbergia melanoxylon	2,20	Pterocarpus rotundifolius	3,30	Acacia species	3,30
g.	Combretum imberbe	2,00	Dalbergia melanoxylon	2,60	Lonchocarpus capassa	3,10
h.	Lonchocarpus capassa	2,00	Maytenus heterophylla	2,60	Albizia harveyi	2,00
i.	Hyphaene benguellensis var. ventricosa	1,20	Albizia harveyi	2,43	Acacia exuvialis	1,30
j.	Grewia species	0,81	Grewia species	1,90	Euclea divinorum	0,76
k.	Acacia nigrescens	0,60	Hyphaene benguellensis var. ventricosa	1,90	Grewia species	0,60
l.	Combretum apiculatum	0,42	Lonchocarpus capassa	1,90	Pterocarpus rotundifolius	0,60
m.	Acacia species	0,32	Ziziphus mucronata	0,74	Hyphaene benguellensis var. ventricosa	0,40
n.	Ziziphus mucronata	0,20	Combretum apiculatum	0,50	Ziziphus mucronata	0,30
o.	Sclerocarya caffra	0,14	Acacia species	0,40	Sclerocarya caffra	0,30
p.			Sclerocarya caffra	0,40	Combretum apiculatum	0,20
q.			Euclea divinorum	0,20		

	AeST		Cm - DL		DLTS	
	Species	A	Species	A	Species	A
a.	Dichrostachys cinerea	32,90	Colophospermum mopane	32,00	Dichrostachys cinerea	17,60
b.	Colophospermum mopane	24,80	Acacia exuvialis	21,00	Lonchocarpus capassa	17,14
c.	Acacia exuvialis	12,80	Dichrostachys cinerea	11,30	Colophospermum mopane	15,43
d.	Dalbergia melanoxylon	6,31	Lonchocarpus capassa	8,10	Acacia exuvialis	12,70
e.	Combretum imberbe	5,44	Hyphaene benguellensis var. ventricosa	7,23	Combretum imberbe	10,88
f.	Lonchocarpus capassa	4,54	Combretum imberbe	5,42	Albizia harveyi	6,20
g.	Albizia harveyi	2,62	Dalbergia melanoxylon	3,20	Hyphaene benguellensis var. ventricosa	6,20
h.	Hyphaene benguellensis var. ventricosa	2,22	Commiphora africana	2,92	Maytenus heterophylla	4,10
i.	Acacia nigrescens	1,77	Pterocarpus rotundifolius	2,40	Ziziphus mucronata	2,00
j.	Acacia species	1,70	Albizia harveyi	1,52	Acacia species	1,82
k.	Ziziphus mucronata	1,40	Combretum imberbe	1,30	Euclea divinorum	1,50
l.	Commiphora africana	1,10	Euclea divinorum	1,11	Acacia nigrescens	1,20
m.	Grewia species	1,00	Ziziphus mucronata	1,00	Commiphora africana	1,00
n.	Euclea divinorum	0,80	Acacia nigrescens	0,70	Combretum apiculatum	0,90
o.	Sclerocarya caffra	0,35	Sclerocarya caffra	0,40	Grewia species	0,60
p.	Combretum apiculatum	0,25	Grewia species	0,30	Dalbergia melanoxylon	0,43

*CmSW = See text p. 150 for abbreviations.

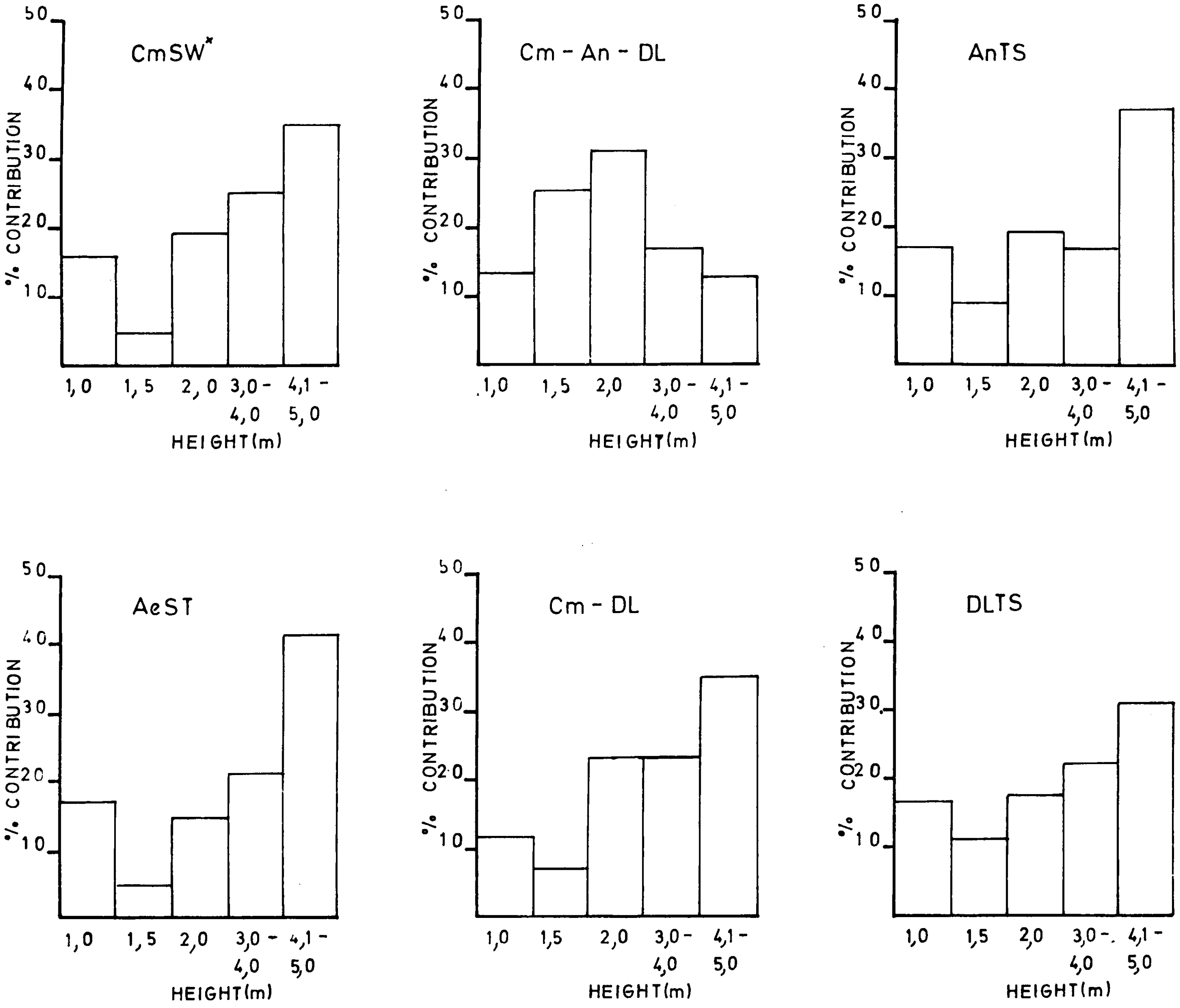


Fig 49: The percentage contribution of all trees and shrubs to five height classes reflecting the stratification of the vegetation in six habitat types frequented by Lichtensteins hartebeest in the survey area.
(CmSW*: see text p. 150 for abbreviation).

between the habitat types and would thus illustrate the degree of "openness" by which the various habitat types differ. These classes are defined as follows. Habitat types with a mean Plant-to-Plant distance of 0,1 - 15,0m apart are defined as 'close,' 15,1 - 30,0m apart are defined as 'moderate' and 30,1 - 50,0m apart are defined as 'open'.

This habitat type is therefore characterised by a close, dense structure which is reflected in the mean inter-plant distance of 4,30m (Table 18). The habitat type is therefore defined as being a 'close' habitat with 98,36% of the woody individuals 0,1 - 15,0m apart (Table 18), and with a relatively high percentage of trees and shrubs between 1,0 and 2,0m in height (Fig. 49) in the lower stratification of the vegetation. These woody individuals would therefore interfere with the field of vision of the hartebeest if this were a factor affecting the choice of habitat.

In Table 19 the percentage relative abundance of the grass species encountered in this habitat type is given. The most abundant species are Cenchrus ciliaris (A = 29,36%), Aristida sp (A = 26,97%) and Urochloa mosambicensis (A = 14,78%). Both Cenchrus ciliaris and Urochloa mosambicensis grow in the open and seldom occur underneath the canopy of the woody vegetation, whilst Aristida sp. are found mainly beneath Colophospermum mopane. Species such as Ischaemum afrum (A = 2,63%) and Setaria anceps (A = 1,35%) which enjoy a moist environment are poorly represented in this habitat type, while Heteropogon contortus (A = 10,40%) occurs in relatively high abundance.

Table : 18 A summary of the number of observations of Lichtenstein's hartebeest in each of six habitat types in the survey area. The "openness" of the vegetation in each habitat type is reflected in the percentage number of woody individuals, 1,0m and taller, in three major classes (close, moderate and open - defined below), and the overall mean distance in metres between woody individuals.

Habitat type*		CmSW	Cm-An-DL	AnTS	AeST	Cm-DL	DLTS
Number of observations of Lichtenstein's hartebeest in each habitat type	1976 :	6	3	8	7	11	15
	1977 :	10	1	6	10	18	28
	% Total :	13,00	3,25	11,38	13,83	23,58	34,96
The percentage number of woody individuals in three classes reflecting the "openness" of the vegetation in each habitat type.	close :	98,36	94,94	93,49	89,42	87,85	79,86
	mod.:	1,64	4,56	6,51	9,00	9,33	15,78
	open :	-	0,50	-	1,58	2,82	4,36
Mean distance (in metres) between woody individuals.		4,30	5,73	5,75	7,05	7,86	9,71

*CmSW = *Colophospermum mopane* Savanna Woodland habitat type
Cm-An-DL = *Colophospermum mopane* - *Acacia nigrescens* - Drainage Line Open Tree Savanna habitat type
AnTS = *Acacia nigrescens* Open Tree Savanna habitat type
AeST = *Acacia exuvialis* Scrub Thicket habitat type
Cm-DL = *Colophospermum mopane* - Drainage Line Open Tree Savanna habitat type
DLTS = Drainage Line Open Tree Savanna habitat type
Close : - Interplant distance of 0,1 - 15,0m apart
Moderate:- Interplant distance of 15,1 - 30,0m apart
Open : - Interplant distance of 30,1 - 50,0m apart

Table : 19 Summary of the percentage relative abundace (A) of the grass species encountered in each of five habitat types (data for the <u>Acacia nigrescens</u> Open Tree Savanna habitat type are not available) utilised by Lichtenstein's hartebeest in the study area.

CmSW *	A	Cm - An - DL *	A	AeST *	A
a. Cenchrus ciliaris	29,36	a. Cenchrus ciliaris	26,44	a. Urochloa mosambicensis	30,11
b. Aristida species	26,97	b. Aristida species	20,20	b. Cenchrus ciliaris	17,11
c. Urochloa mosambicensis	14,78	c. Urochloa mosambicensis	18,93	c. Ischaemum afrum	12,00
d. Heteropogon contortus	10,40	d. Ischaemum afrum	11,40	d. Setaria anceps	10,48
e. Bothriochloa radicans	7,57	e. Setaria anceps	6,85	e. Panicum species	10,25
f. Digitaria milanjiana	5,20	f. Heteropogon contortus	5,30	f. Aristida species	10,05
g. Ischaemum afrum	2,63	g. Enneapogon cenchroides	3,84	g. Bothriochloa radicans	4,60
h. Setaria anceps	1,35	h. Panicum species	3,60	h. Enneapogon cenchroides	2,70
i. Enneapogon cenchroides	0,98	i. Bothriochloa radicans	3,14	i. Heteropogon contortus	2,00
j. Eragrostis species	0,76	j. Eragrostis species	0,30	j. Chloris gayana	0,40

Cm - DL *	A	DLTS*	A
a. Urochloa mosambicensis	19,10	a. Urochloa mosambicensis	28,00
b. Cenchrus ciliaris	16,50	b. Panicum species	17,40
c. Panicum species	13,34	c. Cenchrus ciliaris	15,00
d. Setaria anceps	12,60	d. Ischaemum afrum	12,90
e. Ischaemum afrum	11,73	e. Setaria anceps	12,00
f. Aristida species	10,43	f. Sporobolus species	3,70
g. Bothriochloa radicans	7,00	g. Aristida species	3,60
h. Enneapogon cenchroides	4,00	h. Bothriochloa radicans	2,20
i. Sporobolus species	2,50	i. Heteropogon contortus	1,53
j. Paspalum species	1,32	j. Eragrostis species	1,20
k. Heteropogon contortus	0,88	k. Enneapogon cenchroides	1,00
l. Digitaria milanjiana	0,30	l. Paspalum species	0,87
m. Eragrostis species	0,30	m. Hyperthelia species	0,30
		n. Digitaria milanjiana	0,20
		o. Cymbopogon excavatus	0,10

*DLTS = see p. 150 for abbreviations of the habitat types.

This habitat type is well watered during the wet season, mainly by natural pans, but in the dry season the nearest available water is the Chiloveka Dam and the lower course of the Chiloveka River. Nonetheless, 13,00% of all the hartebeest sightings were made in this habitat type.

Colophospermum mopane - Acacia nigrescens - Drainage Line Open Tree Savanna habitat type (Cm-An-DL)

This habitat type is confined to the northern sector of the game section of the ranch (Fig. 47) and includes elements of the Colophospermum mopane Savanna Woodland, Acacia nigrescens Open Tree Savanna and the Drainage Line Open Tree Savanna (see Vegetation Map Fig. 24, for details of this region).

The percentage relative abundance of the various woody species in this habitat type is given in Table 17. The presence of Colophospermum mopane, Acacia nigrescens, Dichrostachys cinerea and Combretum imberbe in relatively great abundance is indicative of the three major vegetational communities in the habitat type.

Only 13,28% of all the woody individuals measured fall into the 4,1 - 5,0m height class of which Acacia nigrescens, Combretum imberbe and Lonchocarpus capassa are the dominant contributors, while 16,32% fall into the 3,0 - 4,0m height class of which the majority are Colophospermum mopane. The remaining species representing 70,40% of all the woody individuals measured, contribute to the 1,0m; 1,5m and 2,0m height classes (Fig. 49).

The primary contributors to these height classes are Acacia exuvialis and Maytenus heterophylla.

The mean plant-to-plant distance of 5,73m (Table 18) is influenced by the presence of isolated dense patches of Colophospermum mopane and Dichrostachys cinerea at one extreme, and the more open nature of the Drainage Line Open Tree Savanna on the other.

In Table 18 it is seen that 94,94% of the woody individuals, 1,0m and taller are between 0,1 - 15,0m apart, whereas only 0,50% of the woody individuals are between 30,1 - 50,0m apart. Thus, although this habitat type includes elements of the Drainage Line Open Tree Savanna, the overall structure of the vegetation tends to be 'closed' rather than 'open'.

The percentage relative abundance of the various grass species in this habitat type is given in Table 19. The abundance of the various grass species is directly dependent on the degree to which the various vegetational communities contribute to the habitat type. Cenchrus ciliaris (A = 26,44%), Urochloa mosambicensis (A = 18,93%) and Ischaemum afrum (A = 11,40%) are representative of the primary grass species occurring in the Acacia nigrescens Open Tree Savanna, while Aristida sp. (A = 20,20%) are well represented in the Colophospermum mopane Savanna Woodland. Setaria anceps (A = 6,85%) a species defining the dambo associations in the Drainage Line Open Tree Savanna also occurs in this habitat type.

This habitat type had water available well into the dry season along the Mahande and Nyamusaan Rivers, however water is available all the year round at Makeche Pan. Although large herds of zebra, wildebeest, eland and impala move into this area during the rainy season, hartebeest were very rarely found here, and only 3,25% of all observations were made in this habitat type.

Acacia nigrescens Open Tree Savanna habitat type (An TS)

This habitat type (Fig. 47) is confined to the *Acacia nigrescens* Open Tree Savanna. In Table 17 the percentage relative abundance of various woody species in this habitat type is given, while in Fig. 49 the overall contribution of all woody individuals to five height classes reflecting the stratification of the vegetation is illustrated.

The predominant woody species in this habitat type are *Dichrostachys cinerea* (A = 30,38%), *Acacia nigrescens* (A = 29,00%), *Colophospermum mopane* (A = 10,38%) and *Combretum imberbe* (A = 9,38%). As discussed earlier (p. 159) there is probably an inherent bias in the sampling technique affecting the 1,5m height class and this bias may be accentuated in reflecting the stratification of the *Acacia nigrescens* Open Tree Savanna habitat type.

In this habitat type a total of 62,17% of all the woody individuals measured contribute, in near equal proportions except in the 1,5m and 4,1 - 5,0m height classes, to the 1,0, 2,0 and 3,0 - 4,0m height classes (Fig. 49). *Combretum imberbe*, and to a lesser extent *Dichrostachys cinerea* and *Colophospermum mopane*, are the major contributors to the 3,0 - 4,0m height class, while *Dichrostachys cinerea* is the primary contributor to the remaining height classes with the exception of the 4,1 - 5,0m height class which is dominated by *Acacia nigrescens*.

Since the *Acacia nigrescens* Open Tree Savanna habitat type consists primarily of one major vegetational community, there is not the great variation in inter-plant distances, as is found in the *Colophospermum mopane* - *Acacia nigrescens* - Drainage Line Open Tree Savanna habitat type, although the overall impression gained is that this habitat type is less dense than the mean inter-plant distance of 5,75m (Table 18) suggests. This is a result of aggregations of *Dichrostachys cinerea*, which tend to reduce the mean inter-plant distance and thus 93,49% of the woody individuals are between 0,1 - 15,0m apart, defining this habitat as being 'closed'.

Gathering quantitative data on the grass species occurring in the *Acacia nigrescens* Open Tree Savanna habitat type had to be terminated since at the time of the general survey in this area, the majority of the grasses had ceased flowering and the area had been heavily grazed by zebra and wildebeest in particular, making positive identification of the grass species present unreliable. The grass species that do occur in this habitat type include *Cenchrus ciliaris*, *Urochloa mosambicensis*, *Ischaemum afrum*, *Setaria anceps*, *Panicum* sp., *Aristida* sp. and *Bothriochloa radicans*. The most common species is *Cenchrus ciliaris*, which covers extensive areas within the habitat type.

Ischaemum afrum, and to a lesser extent Setaria anceps grow in isolated patches throughout the habitat type, although not beneath the canopy of Acacia nigrescens, and, of these two species, Ischaemum afrum is the more abundant.

This habitat type does not have any long term natural pans so that water is at a premium in the dry season. However, water is freely available all the year round at Makeche Pan, Ngwachimiza and No. 2 pan. Hartebeest were observed in this habitat type, although it is suspected that only one herd tended to utilise the area, nonetheless 11,38% of all observations were made in this habitat type.

Acacia exuvialis Scrub Thicket habitat type (Ae ST)

This habitat type is confined to the Acacia exuvialis Scrub Thicket and lies between the Mahande River and the Ngwachimiza - Makeche road (Fig. 47). The percentage relative abundance of the various woody species in this habitat type is given in Table 17, while in Fig. 49 the stratification of the vegetation determined by the percentage contribution of all the woody individuals to each of five height classes is illustrated.

The Acacia exuvialis Scrub Thicket is one of the minor vegetational communities in the area, and, although it is identified as an area which is utilised by the hartebeest, this habitat type does include elements of the Colophospermum mopane Savanna Woodland and the Drainage Line Open Tree Savanna. This is reflected in the five most abundant woody species in the habitat type (Table 17) which are Dichrostachys cinerea (A = 32,90%), Colophospermum mopane (A = 24,80%), Acacia exuvialis (A = 12,80%), Dalbergia melanoxylon (A = 6,31%) and Combretum imberbe (A = 5,44%).

In this habitat type, the majority of the woody individuals (41,88%) are between 4,1 - 5,0m tall and a few individual trees are even taller than this (Fig. 49). The major contributors to this height class are Colophospermum mopane, Combretum imberbe and, to a lesser extent, Acacia exuvialis. The last mentioned species is also an important contributor to the 3,0 - 4,0m height class together with Dichrostachys cinerea. In the lower strata, the major contributors are Dalbergia melanoxylon and Acacia exuvialis and to a lesser extent Dichrostachys cinerea and Colophospermum mopane.

This habitat type can be defined as a moderately closed habitat type as 89,42% of the woody individuals are between 0,1 - 15,0m apart (Table 18), although the mean plant-to-plant distance of 7,05m suggests that this habitat type is of an 'open' nature. The presence of Acacia exuvialis tends to 'close' the habitat as a result of its growth form. The species is cone-shaped, from the apex of which arise numerous branches, which may extend up to 5,0m on either side of the base of the tree. Thus although the bases of these individual specimens of Acacia exuvialis may average 7,05m apart, their branches intermingle with neighbouring specimens forming a dense impenetrable thicket in some places.

In Table 19 the percentage relative abundance of grass species encountered in this habitat type are given. That this habitat type does include elements of the *Colophospermum mopane* Savanna Woodland and the Drainage Line Open Tree Savanna communities is reflected in that the most abundant grass species are *Urochloa mosambicensis* (A = 30,11%), *Cenchrus ciliaris* (A = 17,11%), *Ischaemum afrum* (A = 12,00%), *Setaria anceps* (A = 10,48%), *Panicum* sp. (A = 10,25%) and *Aristida* sp. (A = 10,05%).

Urochloa mosambicensis grows in areas of deep soil with good drainage, whereas *Ischaemum afrum* and *Setaria anceps* occur in localised areas or "mini-dambos", although these associations are difficult to recognize since they have been invaded by *Acacia exuvialis* and occasionally *Combretum imberbe*. *Cenchrus ciliaris* and *Aristida* species are confined to the *Colophospermum mopane* Savanna Woodland component of this habitat type.

This habitat type has water supplies in the form of natural pans during the wet season, but game in this area has access to water all the year round at Makeche Pan, Ngwachimiza and No. 2 Pan. Hartebeest tend to use this habitat type more in transit from one habitat type to the next during the period May - September (Table 16), rather than establishing themselves in the area for any length of time, however, 13,83% of all the observations were made in this habitat type (Table 18).

Colophospermum mopane - Drainage Line Open Tree Savanna habitat type (Cm - DL)

This habitat type is confined to an area immediately below Hartebeest Hills (Fig. 47) and for reasons that will become apparent later (see p. 219) this habitat type is regarded as being the most suitable for the hartebeest, although this habitat type was not the most frequently utilised (23,58%, Table 18).

This habitat type is formed from elements of the Colophospermum mopane Savanna Woodland, a representative sample of the Drainage Line Open Tree Savanna, and in particular the dambo associations. This is reflected in the percentage relative abundance of the various woody species in this habitat type (Table 17). Colophospermum mopane (A = 32,00%) followed by Acacia exuvialis (A = 21,00%), Dichrostachys cinerea (A = 11,30%) and Lonchocarpus capassa (A = 8,10%) are the most abundant woody species in this habitat type.

Colophospermum mopane and Dichrostachys cinerea are confined to the Colophospermum mopane Savanna Woodland, while Acacia exuvialis and Lonchocarpus capassa are confined to the Drainage Line Open Tree Savanna and Combretum imberbe (A = 5,42%) together with Dalbergia melanoxylon (A = 3,20%) are confined to the dambo associations within this habitat type.

The structure and density of this habitat type is therefore influenced by the two major vegetational communities of which the Drainage Line Open Tree Savanna is the more dominant. However, this habitat type is not as 'open' as would be expected. This is partly due to the presence of dense aggregations of *Colophospermum mopane*, but also to the greater abundance of woody individuals occurring in the element of the Drainage Line Open Tree Savanna present than is found elsewhere in the study area. This is reflected in the mean inter-plant distance of 7,86m (Table 18) and the "overcrowding" of the habitat is primarily due to the presence of *Acacia exuvialis* and *Dichrostachys cinerea* which occur in localised aggregations within the habitat type.

Individuals of these species therefore define the stratification of the vegetation (Fig. 49) in which 35,96% of the woody individuals of *Colophospermum mopane*, *Lonchocarpus capassa*, *Combretum imberbe* and to a lesser extent *Acacia exuvialis* fall into the 4,1 - 5,0m height class. Roughly equal portions of the woody individuals, 22,0%, occur in the 2,0m and 3,0 - 4,0m height classes. In the 3,0 - 4,0m height class *Dichrostachys cinerea*, and to a lesser extent *Colophospermum mopane* and *Acacia exuvialis*, are the most important contributors in the areas represented by the Drainage Line Open Tree Savanna, while in the *Colophospermum mopane* Savanna Woodland the most important species are *Grewia* sp. and *Pterocarpus rotundifolius*.

Only 18,04% of the woody individuals in this habitat type contribute to the lower 1,0m and 1,5m strata, whereas more individuals of these heights occur in the *Colophospermum mopane*

Savanna Woodland, such as Commiphora africana, than in the Drainage Line Open Tree Savanna. This habitat type therefore consists of aggregations of dense vegetation with a definite stratification in all levels, such as that experienced in the Colophospermum mopane Savanna Woodland, which is interspersed by more open areas represented by the Drainage Line Open Tree Savanna, in which there is very little understorey in the lowest stratification levels. This habitat type is defined as being moderately open, in which 87,85% of the woody individuals are between 0,1 - 15,0m apart, 9,33% are between 15,1 - 30,0m apart and 2,82% are between 30,1 - 50,0m apart (Table 18).

The percentage relative abundance of the various grass species in this habitat type is influenced by the two major communities represented in this area (Table 19). Urochloa mosambicensis (A = 19,10%) and Cenchrus ciliaris (A = 16,50%) are common to both vegetational communities while species such as Aristida sp. (A = 10,43%), Bothriochloa radicans (A = 7,00%) and Enneapogon cenchroides (A = 4,00%) are associated with the Colophospermum mopane Savanna Woodland. A significant feature of this habitat type is the higher percentage relative abundance of Setaria anceps (A = 12,60%) as compared to Ischaemum afrum (A = 11,73%). This factor will be enlarged upon in the following chapter, but attention is drawn to it here for it is felt that in the past, under different environmental conditions, the greater abundance of Setaria anceps in this area may have had an important bearing on the success of Lichtenstein's hartebeest in the study area.

The major disadvantage of this habitat type is the lack of permanent water, even during the rainy season. Small pools are to be found near the Mahande River, but these soon disappear after the rains have stopped. The nearest water therefore, is No. 2 Pan and Chiloveka Dam. However, the importance of this area to hartebeest is reflected in the high number of observations (23,58%, Table 18) made in this habitat type.

Drainage Line Open Tree Savanna habitat type (DLTS)

This habitat type is confined to the western side of the Mahande - Bengi River drainage system and lies between the Acacia exuvialis Scrub Thicket habitat type and the Colophospermum mopane - Acacia nigrescens - Drainage Line Open Tree Savanna habitat type (Fig. 47). This habitat type is composed specifically of the Drainage Line Open Tree Savanna and includes the dambo associations frequently utilised by the hartebeest.

The percentage relative abundance of the various woody species in this habitat type is given in Table 17. The five most abundant species in this area are Dichrostachys cinerea (A = 17,60%), Lonchocarpus capassa (A = 17,14%), Colophospermum mopane (A = 15,43%), Acacia exuvialis (A = 12,70%) and Combretum imberbe (A = 10,88%). Of these species Dichrostachys cinerea, Lonchocarpus capassa and Colophospermum mopane are associated with the short grass areas surrounding the drainage lines, which incorporate the dambo associations where species such as Combretum imberbe and Acacia exuvialis occur.

This habitat type represents the most open type of habitat in which 79,86% of the woody individuals are between 0,1 - 15,0m apart, 15,78% are between 15,1 - 30,0m apart and 4,36% are between 30,1 - 50,0m apart (Table 18). However, the vegetation in this habitat type is more open than the mean inter-plant distance of 9,71m would suggest. This is due to the habit of the woody species occurring in this habitat type.

The majority of the woody individuals, 31,63%, are in the 4,1 - 5,0m height class (Fig. 49) in which *Lonchocarpus capassa* and *Combretum imberbe* and to a lesser extent *Hyphaene benguellensis* var. *ventricosa* are the most important contributors. The habit of these species - isolated individual single stemmed trees with a rounded canopy and very little understorey - means that the line of vision is not impeded for considerable distances, in some places for 500 - 800m, by the presence of "clumps" of vegetation in the lower strata. However the occurrence of species, such as *Colophospermum mopane*, *Dichrostachys cinerea* and, to a lesser degree, the scrub form of *Hyphaene benguellensis* var. *ventricosa*, does impede the line of vision, as these species exhibit little or not stratification, growing in dense uniform aggregations from ground level upwards to their respective heights (see Fig. 31 as an example).

Urochloa mosambicensis (A = 28,00%), *Panicum* sp. (A = 17,40%), *Cenchrus ciliaris* (A = 15,00%), *Ischaemum afrum* (A = 12,90%) and *Setaria anceps* (A = 12,00%) contributed 85,30% to the overall percentage relative abundance of the grass species in this habitat type (Table 19), and there is a marked decline in the percentage relative abundance of the majority of the remaining species. This habitat type is characterised by extensive areas of Urochloa mosambicensis and grassland associations of Ischaemum afrum and Setaria anceps.

Water is freely available throughout the year in this habitat type, either from natural pans or pools along the Bengi and Mahande Rivers or from No. 2 and Makeche Pans.

The importance of the grass species in this habitat type to the hartebeest, and the higher number of observations (34,96%, Table 18) of hartebeest from these areas forms the basis of the following chapter and will not be discussed further at this point.

Conclusions

Lichtenstein's hartebeest is almost exclusively a grazer and thus the presence or absence of specific woody species in the habitat has little or no direct influence upon their food requirements. However, the specific woody species composition interrelated with the stratification of the vegetation and the mean inter-plant distance does define the type of habitat in which the hartebeest occur, for it is these factors that determine whether the vegetation is of an "open" or "closed" nature and ultimately influences the selection by the harebeest for a particular type of habitat.

By comparing these parameters collectively and individually, and referring to each of the habitat types independently, some significant differences are revealed which may be related to a choice of habitat by hartebeest.

In the first instance the two extreme habitat types being dealt with are the Drainage Line Open Tree Savanna habitat type and the Colophospermum mopane Savanna Woodland habitat type. The Drainage Line Open Tree Savanna habitat type with a mean distance between woody individuals of 9,71m represents the least dense habitat, where 79,86% of the woody individuals are between 0,1 - 15,0m apart (Table 18), whereas the Colophospermum mopane Savanna Woodland habitat type represents the most dense habitat type in which 98,36% of the woody individuals are 0,1 - 15,0m apart and the mean inter-plant distance is 4,30m. The remaining habitat types fall within these two extremes.

Furthermore, the degree to which a particular woody species dominates a habitat type decreases when progressing from an almost uniform Colophospermum mopane Savanna Woodland habitat type, where Colophospermum mopane contributes 73,72% to the overall percentage relative abundance of the woody species in the habitat type (Table 17), to the Drainage Line Open Tree Savanna habitat type in which the percentage relative abundance of all the various woody species contributing to the vegetational composition in the habitat type are similar to a greater or lesser degree (Table 17).

Whilst comparing the stratification of each of the habitat types (Fig. 49), the only habitat type to differ from the overall pattern is the Colophospermum mopane - Acacia nigrescens

- Drainage Line Open Tree Savanna habitat type where the greater proportion (57,00%) of the woody individuals are between 1,5m and 2,0m tall, whereas in the remaining habitat types, the greater proportion of the woody individuals are between 4,1 - 5,0m tall. However, although the general pattern of the stratification may appear similar in each habitat type, i.e. more individuals contributing to the higher stratification levels, the mean inter-plant distance plays an important role in determining to what extent the field of vision is interrupted as a result of the stratification of the vegetation.

There appears to be some correlation between the choice of habitat type and the mean plant-to-plant distance. According to Table 20 the percentage occurrence of hartebeest in a particular habitat type decreases as the mean inter-plant distance decreases, and the vegetation changes from an "open" to a "closed" habitat type. The exception to this pattern however, is the more frequent occurrence of hartebeest in the denser Colophospermum mopane Savanna Woodland habitat type, than in the less dense Acacia nigrescens Open Tree Savanna habitat type and the Colophospermum mopane - Acacia nigrescens Drainage Line Open Tree Savanna habitat type (Table 20).

The reasons for this are not immediately clear. A possible explanation may be that the hartebeest tend to move away from the hills, and thus away from these habitat types, towards Chiloveka dam and thus the hartebeest move into a region dominated by Colophospermum mopane.

Table : 20 Summary of the relationship between the percentage number of observations of Lichtenstein's hartebeest in each of six habitat types and the mean plant-to-plant distance together with the degree to which the different habitat types are "open" or "closed".

Habitat Type	% Number of observations +	Degree of "openness"	Plant-to-Plant distances (m)
CmSW*	13,00	98,36% - closed	4,30
Cm-An-DL	3,25	94,94% - closed	5,73
AnTS	11,38	93,49% - closed	5,75
AeST	13,82	89,42% - mod. closed	7,05
Cm-DL	23,58	87,85% - mod. open	7,86
DLTS	34,96	79,86% - open	9,71

+Mean number of observations = 1976 + 1977

*CmSW = Colophospermum mopane Savanna Woodland habitat type.

Cm-An-DL = Colophospermum mopane - Acacia nigrescens - Drainage Line Open Tree Savanna habitat type.

AnTS = Acacia nigrescens Open Tree Savanna habitat type.

AeST = Acacia exuvialis Scrub Thicket habitat type.

Cm-DL = Colophospermum mopane - Drainage Line Open Tree Savanna habitat type.

DLTS = Drainage Line Open Tree Savanna habitat type.

However the most likely reason for this is probably more directly related to the grass stratum of each habitat type. There are only a few isolated records where Lichtenstein's hartebeest have actually been observed browsing. Rodgers (pers. comm.) reports that in the Selous Game Reserve, Tanzania, there was no record of any browse material from the stomach contents of a large number of hartebeest, of both sexes, examined. In an unpublished report from Zambia, from a total of 83 recorded observations, on only two occasions were hartebeest seen to browse - both records are from the Kalomo District in southern Zambia.

On one occasion the hartebeest were observed browsing on the following shrubs in a clump of Colophospermum mopane veld:- Markhamia acuminata, Lonchocarpus capassa and (?) Jasminun sp., while on another occasion the following species were reported as being eaten:- Baphia sp., Grewia sp., Dichrostachys cinerea and Capparis sp. It was also reported that "green dambo grasses" were grazed on 46 occasions, sprouting grass from newly burnt areas on 22 occasions, "Lwelo" grass once, Loudetia sp. six times and Hyparrhenia sp. six times (Unpublished Report, Northern Rhodesia Game Department, undated).

From the stomach contents of hartebeest taken from the same area an adult female hartebeest was found to have taken only "course ripe perennial grasses and a few mopane leaves". This individual apparently was from a herd that was seen on a flush of green grass only 16 days previously, where the herd was observed apparently licking up the fresh black ash.

In a second individual examined, 90% of the stomach contents was "ripe grass, with some young grass, the stomach lining was black with ash". There is also a solitary observation of a herd of hartebeest "eating some subsoil which appeared to contain salt minerals from an open hole made under an anthill" (Unpublished Report, Northern Rhodesia Game Department, undated).

In eastern Zambia Wilson (1966), states that grass made up 95% of the plant material in 52 hartebeest stomachs examined over all months of the year. Browse material identified included five records of *Combretum molle*-leaves, eight records of *Diplorhynchus condylcarpon*-leaves, two records of *Pseudoloichnostylis maprouneifolia*-fruits and one individual had eaten five *Ximenia caffra*-fruits.

In Mozambique Tinley (1977) lists the following grass species as being part of the diet of Lichtenstein's hartebeest during the wet season (November - April):- *Urochloa mosambicensis*, *Heteropogon contortus* (including burnt stems, leaves and basal parts), *Cymbopogon excavatus* and *Themeda triandra* (including burnt parts and post fire flush), while in the dry season (May - October) the following species were recorded:- *Chloris gayana*, *Digitaria milanjiana*, *Echinochloa* sp. cf *haplaclada*, *Echinochloa stagnina*, *Enteropogon macrostachyus*, *Heteropogon contortus*, *Hyparrhenia rufa*, *Hyparrhenia* (*Hyperthelia*) *dissoluta*, *Hyparrhenia dichroa*, *Panicum Maximum*, *Panicum coloratum*, *Paspalum scrobiculatum*, *Setaria eylesii* (including green leaves and burnt parts), *Sporobolus* pyramidalis, Sporobolus ioclades, Themeda triandra and Urochloa mosambicensis. The sedge Maerua brunnescens was also recorded in the diet.

In the study area in Rhodesia, Lichtenstein's hartebeest have been observed, during times of drought, to browse on the low, rambling form of Commiphora africana which occurred in the Colophospermum mopane Savanna Woodland (Sparrow, pers. comm.), although this was not observed during this study. The stomach contents of an adult female hartebeest, found a few hours after death (22/08/1977) consisted almost entirely of grass material with a few leaves from Dalbergia melanoxylon and Acacia nigrescens. These leaves may have been consumed unintentionally whilst the hartebeest was grazing.

The two predominant grass species identified in the stomach contents were Ischaemum afrum and Setaria anceps, and it is possible that other grass species were present, but no attempt was made to identify any of these. The hartbeest tend to graze near the floor of the dambos to a height of 500mm above the ground and thus their heads are usually obscured. It is therefore impossible to identify the particular grass species, by means of observation, on which the hartebeest are grazing whilst in the tall grass of the dambo associations. Only on one occasion was a solitary adult female seen to seek out the young green leaves of Setaria anceps near the floor of the dambo, and on the same occasion it was observed that the hartebeest would break off the course stems and leaves of Ischaemum afrum. On two other occasions, the hartebeest were seen to take *Urochloa mosambicensis* and *Cenchrus ciliaris*.

This paucity of direct observations on the grazing preferences of Lichtenstein's hartebeest in the study area therefore precludes any listing of preferred grass species. Nevertheless it is the presence of certain grass species in a habitat which attracts a herbivore species to a specific area.

The most striking feature on the grazing preferences of Lichtenstein's hartebeest is the fact that "long ripe perennial grasses", which are all, in some way, associated with a moist environment such as that found in a dambo association, are a feature of their diet; such grasses may even be preferred to a post-fire flush of green grass.

In Fig. 50 the percentage relatative abundance of *Ischaemum afrum* and *Setaria anceps* in each of the five habitat types (there being no quantitative data available for the *Acacia nigrescens* Open Tree Savanna habitat type, see p.183) is given, as these two species were the key to the identification of the dambo associations in the study area.

Taken individually, there is little significant difference in the overall composition of the grass species in each habitat type (Table 19). However, what is of significance is that *Urochloa mosambicensis*, *Cenchrus ciliaris*, *Aristida* sp. and *Panicum* sp. contribute nearly 60% to the overall percentage relative abundance of the grass stratum in all the six habitat types.

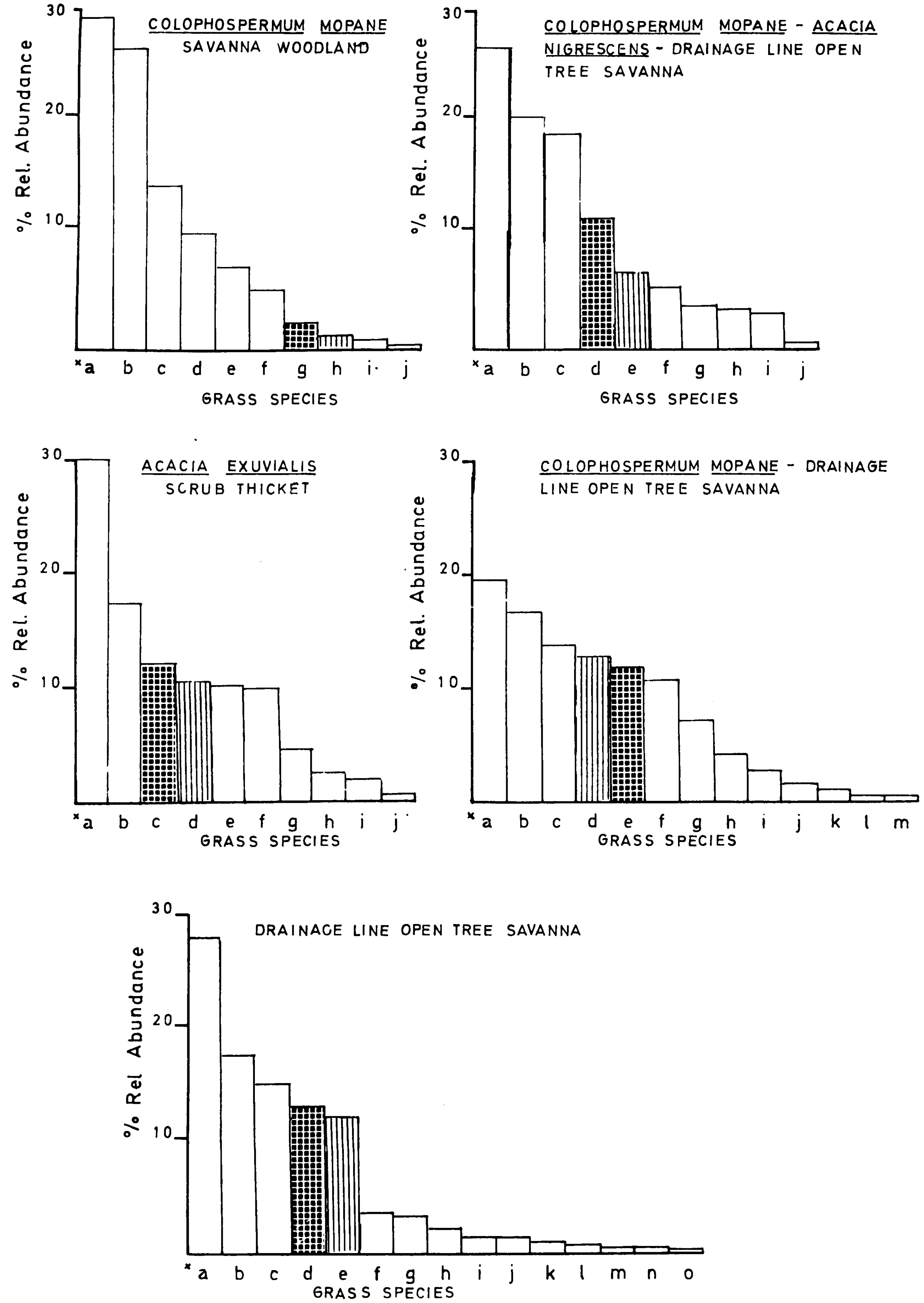


Fig. 50: The percentage relative abundance(A) of Ischaemum afrum(▦)and Setaria anceps(▥) in relation to the other grass species occurring in five habitat types frequented by Lichtenstein s hartebeest in the survey area.
(*a: see Table 19 for abbreviations)

In the Colophospermum mopane Savanna Woodland habitat type, there is a relatively low abundance of Ischaemum afrum and Setaria anceps (Fig. 50) indicating the low occurrence of vegetational associations that can be described as "dambos". This means that the hartebeest are not able to move into a habitat type supporting similar dambo associations as those found in the Drainage Line Open Tree Savanna habitat type, which are used extensively by hartebeest during the wet season. This probably also explains why the hartebeest never remain in one area of the Colophospermum mopane Savanna Woodland habitat type for any length of time. The reason why the hartebeest move into this habitat type must be sought elsewhere.

In the remaining habitat types, it would appear that the greater percentage relative abundance of Setaria anceps and, to a lesser extent, Ischaemum afrum in the habitat is associated with a higher percentage occurrence of hartebeest in the particular habitat (Table 21).

As pointed out earlier (see p. 171), Ischaemum afrum and Setaria anceps appear to be ecologically separated in the environment and this separation appears to be dependent on the water balance of the dambo associations. It is therefore apparent that the dambo associations in the Colophospermum mopane - Drainage Line Open Tree Savanna habitat type are probably related to the lack of available surface water.

It would appear therefore that the hartebeest tend to select a habitat type that is "open", but are not adverse to moving

Table : 21 A summary of the relationship between the percentage relative abundance of _Ischaemum afrum_ and _Setaria anceps_ and the percentage number of observations of Lichtenstein's hartebeest in each of five habitat types in the study area.

Habitat Type	Percentage relative abundance		% Number of Observations
	Ischaemum afrum	_Setaria anceps_	
CmSW*	2,63	1,35	13,00
Cm-An-DL	11,40	6,85	3,25
AeST	12,00	10,48	13,82
Cm-DL	11,73	12,60	23,58
DLTS	12,90	12,00	34,96

* CmSW = _Colphospermum mopane_ Savanna Woodland habitat type.

Cm-An-DL = _Colophospermum mopane_ - _Acacia nigrescens_ - Drainage Line Open Tree Savanna habitat type.

AeST = _Acacia exuvialis_ Scrub Thicket habitat type.

Cm-DL = _Colophospermum mopane_ - Drainage Line Open Tree Savanna habitat type.

DLTS = Drainage Line Open Tree Savanna habitat type.

into a habitat type that is more dense, provided that that habitat type is able to offer whatever is needed to satisfy their immediate requirements. Thus, although the "openness" of the vegetation is a factor affecting the choice of habitat, it is not the most significant factor in this regard, but rather the grass composition of the dambo associations.
The importance of this parameter will form the basis of the following chapter.

CHAPTER 9

Habitat utilisation by Lichenstein's hartebeest on Lone Star Ranche.

It has been established (p. 176) that hartebeest tend to favour the Drainage Line Open Tree Savanna habitat type more than any of the other habitat types recognized in the study area, and furthermore the hartebeest tend to move away from the Drainage Line Open Tree Savanna habitat type into the *Colophospermum mopane* Savanna Woodland habitat type as the dry season progresses. The reason(s) for this movement is not clear, but it is suspected that it may be related to the quality of the habitat, or some factor associated with reproductive behaviour.

By monitoring the activity and locality of the Makeche Herd as closely as possible over the year, it was found that the herd not only tended to favour the Drainage Line Open Tree Savanna habitat type, but more precisely two particular dambo associations within this habitat type. These were recognized as the Makeche Dambo and the Mahande Dambo. In Fig. 51 the locality of these dambos, together with a third area, a *Urochloa mosambicensis* dominated grassland (referred to as "Grassland" in the following text and tables) representative of the short grass stratum of the Drainage Line Open Tree Savanna and an area that was not frequently utilised by the hartebeest, is illustrated.

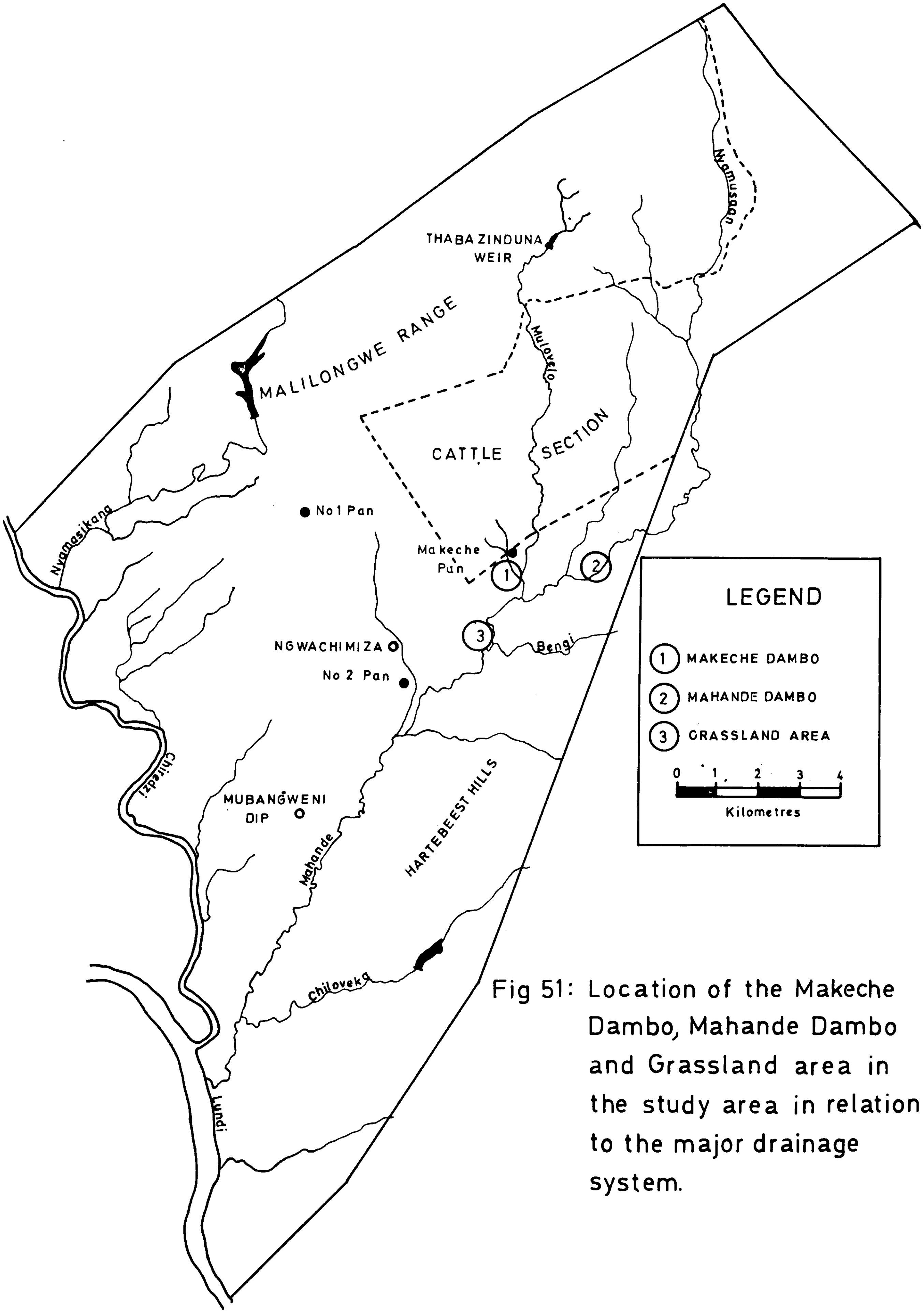


Fig 51: Location of the Makeche Dambo, Mahande Dambo and Grassland area in the study area in relation to the major drainage system.

By comparing the physiognomic parameters of these three areas in some detail, it was hoped that the salient factors responsible for the discrimination of the hartebeest in their choice of this habitat - as well as the reasons why the hartebeest move out of this habitat type as the dry season progresses - might be revealed.

Occupation of the various habitat types by the Makeche Herd in the study area.

The exact composition of the Makeche Herd or its distribution within the study area was not accurately known for some time after it was located in July 1976. At that time it was thought that the Makeche Herd consisted of six individuals and there was some confusion between the identification of this herd, the Playground Herd and the No. 9 Herd (see p.97). In August 1976, a group of seven hartebeest was seen on only one occasion in the Mahande Dambo, and later, at the beginning of September 1976, the herd was seen in the *Colophospermum mopane* Savanna Woodland habitat type, however it was not possible to follow the progress of this herd further due to military activitites during September and October 1976.

When the herd was observed in September 1976 the presence of the cow with a torn ear was first recorded and the herd consisted of one bull, two adult females and a sub-adult female. In Fig. 52 a summary of the movements of this herd from one habitat type to another between September 1976 and August 1977 and the duration that the hartebeest occupied each habitat type in relation to the annual rainfall is given.

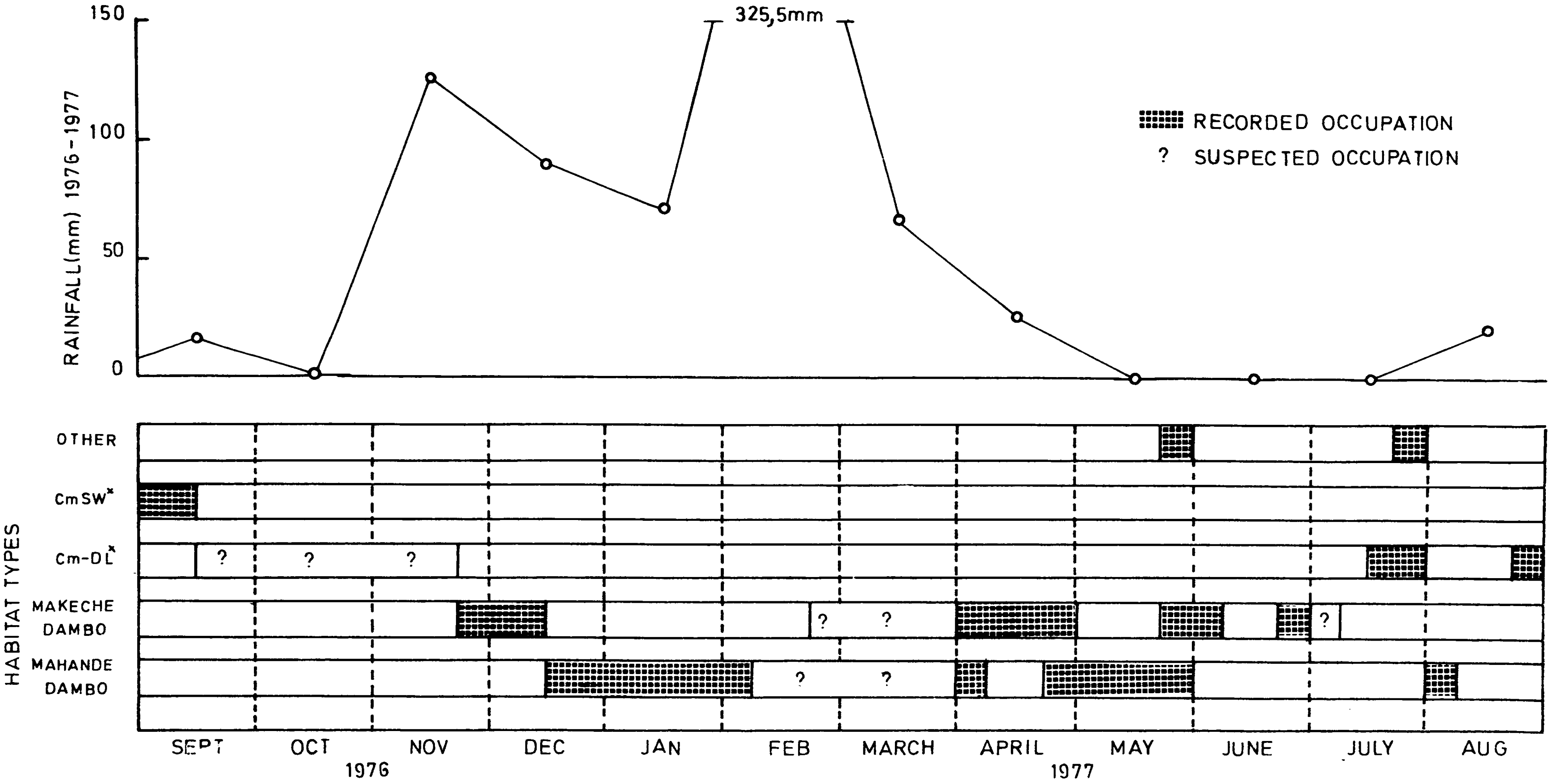


Fig. 52: Summary of the period of time that the Makeche Herd occupied the various habitat types in the survey area in relation to the annual rainfall. (CmSW* - see p. 150 for abbreviation)

Although personal movement was restricted during September and October, it was suspected from the reports received that the Makeche Herd moved from the Colophospermum mopane Savanna Woodland habitat type to the Colophospermum mopane - Drainage Line Open Tree Savanna habitat type some time in October and remained in this area until about mid-November. Shortly after the first rains in November 1976 the herd was located in the Makeche Dambo. The herd structure had not altered and no calves were observed. The herd remained in the Makeche Dambo until mid-December, when two calves were first recorded and estimated to be 4 - 6 weeks old. The herd them moved across to the Mahande Dambo and ramained in this area until the end of January. During this time one of the calves disappeared. It was suspected that it had fallen prey to a leopard that had been seen in the area a short while before, although no carcass was ever found.

The herd was observed in the Mahande Dambo at the beginning of February, however exceptionally heavy rains during February made it impossible to work in the area. Nevertheless periodic sightings of this herd were recorded at various times during this period, and it appeared that the herd remained in the Mahande Dambo for most of February and March, although it was suspected of paying periodic visits to the Makeche Dambo.

When the herd was relocated in April, the herd structure had not changed, and the calf displayed straight horns approximately 150mm long. Form mid-April onwards the herd became more restless. Up until this time, the herd was observed to remain within the confines of one or other of the dambos for several days in succession. These dambos do not cover an extensive area (see Fig, 54 for a plan of the Makeche Dambo). The only time that the hartebeest were observed outside of the dambo was when moving to water, moving from one dambo to the next, or when disturbed in or frightened out of the area. It is not known whether the hartebeest were active at night, although Dowsett (1966) believes that the hartebeest bed down for part of the night. Observations of spoor in the study area suggested similar behaviour in the present study.

In May the herd was observed in the _Acacia exuvialis_ Scrub Thicket habitat type for a brief period, before returning to the Makeche Dambo. In June, by which time the rains had ceased, the movements of the herd were difficult to follow, and, although located in the Makeche Dambo on two occasions, it was not known where the herd had moved to. Towards the end of July, the torn-ear cow was seen with a herd of hartebeest in the _Colophospermum mopane_ - Drainage Line Open Tree Savanna habitat type, but this was not the Makeche Herd, which was located elsewhere in the same habitat type at the same time. This was the first record suggesting that individual cows may move between different herds. This took place on two occasions in August and in turn, the Makeche Herd was joined by two other cows for a brief period, when the herd moved back to the Makeche Dambo towards the end of August. The reason(s) for this is not clear.

The herd then disappeared for a period and was eventually located in the Colophospermum mopane - Drainage Line Open Tree Savanna habitat type where it had joined up with several other hartebeest. The herd then moved about quite extensively between the Colophospermum mopane Savanna Woodland habitat type and the Colophospermum mopane - Drainage Line Open Tree Savanna habitat type and it is suspected that the hartebeest crossed through the Gona re Zhou National Park and the ranch boundary game fence during this period, although there is no direct evidence to support this.

Following up the progress of this herd after leaving the study area in October 1977, it was found that the herd had returned to the Makeche Dambo in November soon after the first rains. The herd structure then consisted of a bull and two cows (including the torn-ear cow) and two calves.

It would appear therefore that the hartebeest follow a definite cycle as the season progresses and return to the same habitat type (home range) each year, which supports the observations made by Dowsett (1966) in the Kafue National Park, Zambia.

The role of the soil moisture balance in determining the structural and vegetational composition of the dambo associations on Lone Star Ranche.

It has been suggested that certain woody and grass species, notably *Acacia exuvialis*, *Dichrostachys cinerea*, *Heteropogon contortus*, *Setaria anceps* and *Ischaemum afrum*, are ecologically separated in the study area and that this separation is probably directly related to the availability of edaphic water resources in the habitat (see p. 171). These conclusions are based upon personal observations correlating the topography of the study area with the occurrence of the various plant species. Both time and circumstances did not permit an in depth study into this aspect of the ecology in the study area. In fact it is surprising how rarely this aspect - that the excess of soil moisture is a major factor determining the presence of open grasslands (Tinley 1977) - is referred to in ecological research of this nature.

Therefore, in order to gain a greater understanding of this most crucial aspect of any ecosystem, and thus an understanding of the physiognomy of the dambo associations in the study area, a brief synopsis of the findings of Tinley (1977) is given here.

Tinley (1977) states that although plant species composition in various communities may be influenced by soil properties such as nutrient status, pH, salinity and texture, the overall most important factor determining the spatial distribution of forest savanna and grasslands is soil moisture balance. This factor seems to orchestrate from below the possible opportunities and constraints on a community's evolution in a particular time and place. Thus forests occur on high water retaining, but relatively well drained sites, and grassland and savanna on both gley soils or deep horizonless sands, which exercise some seasonal extremes in moisture availability.

In a situation such as a dambo association or natural pan, there is an impervious clay layer, known as a "pan horizon", which acts as a moisture barrier (Tinley 1977). When the pan horizon becomes waterlogged, drainage is lateral in this horizon and in the porous soils immediately overlying the impermeable layer. If the pan is overlain by loamy or sandy clay material, water is more easily lost by evaporation from the soil surface than if it is covered by loose sand. In addition surface runoff is minimal and almost all the annual rainfall is trapped by such duplex sands (Tinley 1977).

The distance of the pan horizon from the surface as determined by depth, and microrelief of the covering soil, plays a fundamental role in the moisture balance and ultimately in the vegetational cover. The distance affects the amount of saturation possible, while the texture of the soil determines the amount of water remaining in the soil after the rains and subsequent evaporation. Thus the distance of the pan horizon, together with the texture of the soil determines the extent of moisture retention and this therefore, is far more important than the amount of rainfall received.

A high moisture level, determined by an excess of soil moisture on a perennial or seasonal basis leads to the development of open grasslands, but it is not only excessive waterlogging during the growing season, but also excessive drying out of the soils in the dry season that kills back any woody plant root development and maintains the open grasslands. A drop in the level of the moisture content leads to an invasion of the grasslands by woody species and allows these species to develop a deep root system that will survive the dry period and thus become established. This then is the beginning of a "bush encroachment problem" - which very often is the direct result of bad land management policies, but can also be the result of natural causes.

Therefore, the presence or absence of a pan horizon, its distance from the surface, and soil permeablility to rain, which is a function of texture and relief, are the most important factors governing soil moisture content and thus the spatial distribution of woody cover and grasslands (Tinley 1977).

On Lone Star Ranche, the dambo associations lie in shallow depressions forming drainage lines and thus naturally receive runoff and lateral underground drainage from the surrounding higher ground resulting in a moister enviroment.

However the degree to which the various dambos are "moister" or not is dependant on the topography of the immediate area and their locations relative to the major drainage systems in the study area. In the survey area, the Mahande Dambo is situated in a minor drainage line along the edge of the

Mahande River. This river represented the major tributary of the drainage system draining the basaltic flats. Its head waters and catchment area are situated at the northern end of the Malilongwe Range (Fig. 51) and as such received a higher annual rainfall than the basaltic flats (see p. 17). The Mahande River therefore carries a larger volume of water than any of the remaining tributaries in the basaltic flats.

Although no quantitative data are available it is possible that during the rainy season, water drains laterally into the minor drainage lines along the course of the river, such as the Mahande Dambo, when the river floods and thus the moisture balance is increased enabling these areas to retain a higher moisture level for a longer period after the rains have stopped.

However, the Makeche Dambo, although it lies in the Mulevelo River, does not receive a large volume of water along its course since the river is dammed at its head waters by the Thabazinduna Weir (Fig. 51). Furthermore, this river passes through a cattle paddock which is occupied by cattle for most of the year. Thus water collecting in pools along its course is usually drunk by the cattle with the result that this water is lost to the underground water table. The end result is that the soil moisture balance of the drainage lines further down the river is altered. In fact, the Makeche Dambo is probably more reliant on water from two minor drainage lines associated with this dambo than from the Mulevelo River (Fig. 51).

On Lone Star Ranche it is believed that this factor - the soil moisture balance - may explain some of the reasons why Lichtenstein's hartebeest choose to remain in the Mahande Dambo 45,18% of the time, the Makeche Dambo 32,25% of the time and in all the remaining habitat types 22,57% of the time (calculated from 31 weeks of observations). The role of the soil moisture balance is revealed when comparing the structure and vegetational composition, particularly that of the grass stratum, of the Makeche Dambo, Mahande Dambo and the Grassland area within the Drainage Line Open Tree Savanna.

Percentage relative abundance of the woody species and the stratification of the vegetation in the Makeche Dambo, Mahande Dambo and the Grassland area.

The overall physiognomic characteristics of the Drainage Line Open Tree Savanna have been discussed elsewhere (see p. 122).

There do not appear to be any significant differences in the structure and herbaceous composition between the Makeche Dambo and the Mahande Dambo on first inspection. Both dambos occupy a shallow depression at the head of minor drainage lines on the basaltic flats and are characterised by a tall grass stratum of *Ischaemum afrum* and *Setaria anceps* and in both cases there is evidence of bush encroachment. However when compared to the Grassland area, the most significant difference is the presence of a short grass stratum of *Urochloa mosambicensis* with little evidence of bush encroachment (Fig. 53).

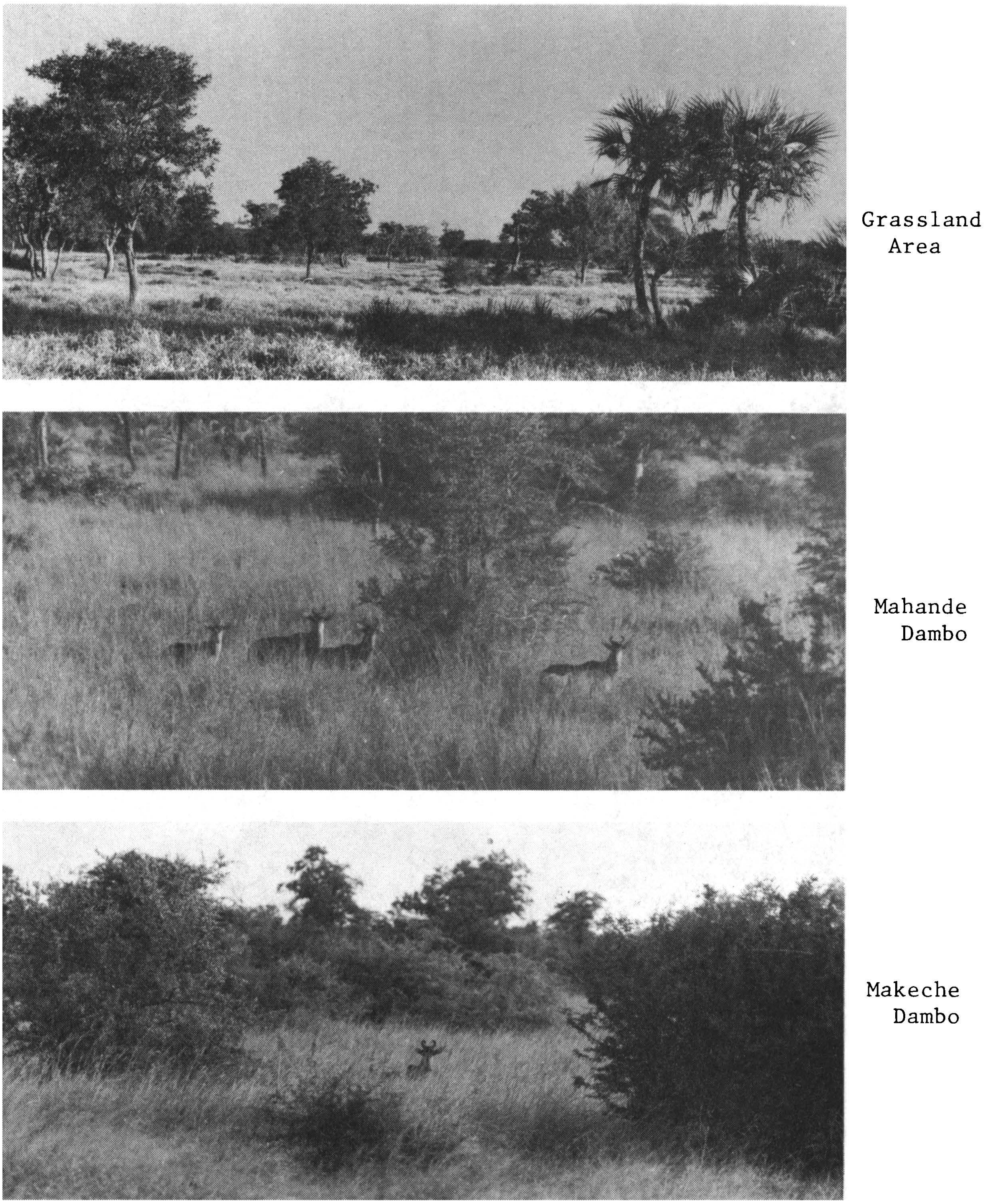


Fig: 53 The most significant difference between the Dambo and Grassland areas, is the tall grass stratum of *Ischaemum afrum* and *Setaria anceps* that is to be found in the dambo associations, while the Grassland area is characterised by a short grass stratum dominated by *Urochloa mosambicensis*. The tall grass stratum of the dambo associations often conceals the hartebeest completely while grazing.

In Table 22 the percentage relative abundance of the various woody species in the three areas is summarised, while in Table 23 the number of individuals of different woody species that contribute to the overall stratification of the vegetation is given.

As is expected, there are major differences in the overall composition and percentage relative abundance of the five most important woody species in each of the three areas. It is interesting to note that *Combretum imberbe* is found predominantly in the dambo associations, while *Lonchocarpus capassa* is the major woody species in the Grassland area. Another notable exception is the complete absence of *Colophospermum mopane* in the Mahande Dambo, although this species is an important component of the woody vegetation in the Makeche Dambo and Grassland area.

However the most important differences between each of the three areas is the stratification of the vegetation, and it is the inter-relationship between the relative abundance of the various woody species and their contribution to the various height classes, that describes the degree to which the woody species have encroached into the dambo associations and the Grassland area.

The Makeche Dambo displays the most striking difference in stratification, in which the various woody individuals contribute in equal proportions (17,70%,Table 23) to the 1,0m, 1,5m and 4,1 - 5,0m height classes while the majority of woody individuals (26,85%, Table 23) contribute to the 3,0 - 4,0m

Table : 22 A summary of the percentage relative abundance (A) of the major woody species 1,0m and taller in the Makeche Dambo, Mahande Dambo and Grassland area, frequented by Lichtenstein's hartebeest in the Drainage Line Open Tree Savanna.

Makeche Dambo Species	A	Mahande Dambo Species	A	Grassland Species	A
Combretum imberbe	41,14	Combretum imberbe	22,16	Lonchocarpus capassa	31,45
Lonchocarpus capassa	11,50	Maytenus heterophylla	20,54	Hyphaene benguellensis	
Maerua edulis	11,42	Lonchocarpus capassa	16,75	var. ventricosa	21,14
Dichrostachys cinerea	9,71	Cassia species	13,51	Dichrostachys cinerea	13,14
Colophospermum mopane	4,57	Acacia polyacantha	4,32	Maytenus heterophylla	8,45
Acacia nigrescens	2,85	Dichrostachys cinerea	4,32	Colophospermum mopane	7,98
Combretum apiculatum	2,85	Hyphaene benguellensis		Combretum imberbe	4,69
Dalbergia melanoxylon	2,85	var. ventricosa	4,32	Acacia nilotica	3,75
Ziziphus mucronata	2,85	Maerua edulis	3,78	Acacia nigrescens	2,34
Acacia nilotica	2,28	Acacia nilotica	3,24	Acacia polyacantha	1,87
Acacia polyacantha	2,28	Acacia exuvialis	2,16	Albizia harveyi	1,00
Maytenus heterophylla	2,28	Acacia nigrescens	1,62	Commiphora africana	0,93
Acacia exuvialis	1,71	Combretum apiculatum	1,52	Maerua edulis	0,93
Albizia harveyi	0,57	Ziziphus mucronata	1,12	Ziziphus mucronata	0,93
Euclea divinorum	0,57	Grewia species	0,54	Acacia tortilis	0,50
Grewia species	0,57			Diospyros africana	0,46
				Gardinia spatulifolia	0,46

Table : 23 A summary of the number of individuals of woody species, 1,0 m and taller contributing to the various height classes, indicating the overall stratification of the vegetation in the Makeche Dambo, Mahande Dambo, and the Grassland area frequented by Lichtenstein's hartebeest in the study area.

	Makeche Dambo					Mahande Dambo					Grasslands				
	HEIGHT CLASS (m)					HEIGHT CLASS (m)					HEIGHT CLASS (m)				
Plant Species	1,0	1,5	2,0	3,0-4,0	4,1-5,0	1,0	1,5	2,0	3,0-4,0	4,1-5,0	1,0	1,5	2,0	3,0-4,0	4,1-5,0
Combretum imberbe	2	10	19	23	18	1	1	13	22	4	-	2	3	3	2
Lonchocarpus capassa	16	2	-	-	2	22	5	3	-	1	45	4	1	7	10
Maerua edulis	5	13	2	-	-	1	5	1	-	-	-	1	1	-	-
Dichrostachys cinerea	-	1	3	10	3	2	2	3	1	-	1	2	11	14	-
Colophospermum mopane	-	-	1	2	5	-	-	-	-	-	4	-	2	7	4
Acacia nigrescens	-	1	1	3	-	-	-	2	1	-	2	1	-	1	1
Combretum apiculatum	-	1	1	1	2	-	-	2	1	-	-	-	-	-	-
Dalbergia melanoxylon	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Ziziphus mucronata	-	1	-	3	1	-	-	1	1	-	-	-	1	1	-
Acacia nilotica	1	-	-	3	-	4	-	-	2	-	7	-	-	1	-
Acacia polyacantha	-	2	2	-	-	5	2	-	-	1	1	-	1	-	2
Maytenus heterophylla	2	-	2	-	-	18	12	7	1	-	11	6	1	-	-
Acacia exuvialis	1	-	1	1	-	-	-	4	-	-	-	-	-	-	-
Albizia harveyi	1	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Euclea divinorum	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grewia species	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-
Hyphaene benguellensis var. ventricosa	-	-	-	-	-	5	2	-	1	-	24	16	2	-	3
Commiphora africana	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
Acacia tortilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Cassia species	-	-	-	-	-	22	3	-	-	-	-	-	-	-	-
Diospyros africana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Gardinia spatulifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Percentage Total	17,70	17,70	20,05	26,85	17,70	43,24	17,29	20,02	16,21	3,24	45,50	15,02	11,26	15,00	12,26

height class. Within this latter height class, Combretum imberbe and Dichrostachys cinerea are the most prominant contributors (Table 23). Both these species grow in the form of a multistemmed bush which naturally obscure the line of vision. However a more important feature of these species is their "crowding effect" in the dambo associations. By virtue of the fact that their growth habits are bushy and that they occur in clumps throughout the dambos, they tend to reduce the area available for the growth of grass species such as Ischaemum afrum and Setaria anceps on which the hartebeest are probably dependant. Added to this is the impact made by all the remaining woody individuals whose effect on the stratification and "crowding" in the dambos is negligible singly but is significant in combination.

In the Mahande Dambo, this effect is not immediately appreciated since on first examination it does not appear to be as "crowded" as the Makeche Dambo. This is because the greater majority of woody individuals (60,53%, Table 23) are between 1,0m and 1,5m tall and as such are submerged in the long grass stratum which has an average height of 1,2m while there are only relatively few individuals between 3,0 - 4,0m (16,21%) and 4,1 - 5,0m (3,24%, Table 23). However the most important difference between the Mahande Dambo and the Makeche Dambo is the relatively high percentage relative abundance of Maytenus heterophylla (A = 20,54%, Table 22) in the Mahande Dambo and its relatively low percentage relative abundance (A = 2,28%, Table 22) in the Makeche Dambo.

Although Maytenus heterophylla is a relatively unimportant species (I.V. = 13, Table 13) in the survey area, it is an important contributor to the 1,0m and 1,5m strata in the dambo associations. It also grows in the form of a muti-stemmed bush and this exhibits a similar "crowding effect" in the Mahande Dambo. *Combretum imberbe* also contributes to this "crowding effect". Furthermore *Combretum imberbe* is the major contributor to the 2,0m and 3,0 - 4,0m height classes and thus hinders the line of vision, although there are not as many woody individuals in the 4,1 - 5,0m height class in the Mahande Dambo as there are in the Makeche Dambo (3,24% as opposed to 17,70%, Table 23), and as such the Mahande Dambo, is, optically, more "open" than the Makeche Dambo.

This "crowding effect" may not seem important but since the Makeche and Mahande Dambos are relatively small (approximately 30 000m^2 and 27 000m^2 respectively) and the fact that this type of habitat is at a premium in the study area, any physical effect that is detrimental to the grass sward in the dambos seriously affects the availability of a suitable habitat for hartebeest.

Of further interest is the fact that while discussing the species relationships in the overall survey area, it was pointed out that *Maytenus heterophylla* was closely associated with the Riverine Community (p. 157). The high abundance of this species in the Mahande Dambo and not in the Makeche Dambo is one of the several factors indicating that the Mahande Dambo supports a higher soil moisture balance than the Makeche Dambo and this may be an important factor influencing the hartebeest's choice of habitat. Other woody species indicating this moister environment and which occur in greater abundance in the Mahande Dambo include *Cassia* sp. (which do not occur in the Makeche Dambo), *Acacia polyacantha*, *Hyphaene benguellensis* var. *ventricosa* and *Acacia exuvialis*, while the presence of *Dalbergia melanoxylon* in the Makeche Dambo and not in the Mahande Dambo further serves to indicate its drier environment (Hall-Martin 1972). Another notable difference is the fact that there are less woody species in the Mahande Dambo where the four most abundant species are found in roughly equal proportions, whereas in the Makeche Dambo there are more woody species and this area is dominated by *Combretum imberbe* (A = 41,14%). A possible reason for this may be that the moister Mahande Dambo inhibits the growth of the woody species.

When compared to the Grassland area, the Makeche and Mahande Dambo are seen to differ considerably - both in vegetational composition and stratification. The most significant differences are the presence of a short grass stratum of *Urochloa mosambicensis* in the Grassland area (Table 25) as apposed to the tall grass stratum of *Ischaemum afrum* and *Setaria anceps* in the dambo associations together with the relatively high percentage relative abundance of *Lonchocarpus capassa* (A = 31, 45%, Table 22) and *Hyphaene benguellensis* var. *ventricosa* (A = 21,14%, Table 22), which are either lacking or represented in low abundance in the dambo associations.

The stratification of the Grassland area does not differ considerably from that of the Mahande Dambo in which 45,50% of woody individuals are 1,0m tall, 15,02% are 1,5m tall, 11,26% are 2,0m tall, 15,0% are 3,0 - 4,0m tall and 12,26% are 4,1 - 5,0m tall (Table 23).

However, physically there is a marked difference since the woody individuals producing the stratification of the Grassland area are of a different growth form and contribute more to the stratification as a result of the low grass stratum.

In the 1,0m and 1,5m heights classes *Lonchocarpus capassa* and *Hyphaene benguellensis* var. *ventricosa* are the major contributors (Table 23). *Lonchocarpus capassa* grows in the form of a single stemmed shrub or tree, while *Hyphaene benguellensis* var. *ventricosa* grows as an acaulescent shrub, and as such this last mentioned species is the only one guilty of a "crowding effect" in the Grassland area.

In the remaining height classes, the majority of the woody species such as *Combretum imberbe* and *Lonchocarpus capassa*, are single stemmed trees with a rounded multi-branched canopy, beneath which there is very little undergrowth that can impede the line of sight. However there are species such as *Dichrostachys cinerea* and *Colophospermum mopane* which, although they occur in relatively low abundance (13,14% and 7,98% respectively, Table 22), do hinder the line of sight since their growth form is a multistemmed bush.

The net effect of these species on the stratification in the Grassland area is that the vegetation is "open" with little vegetation impeding the line of vision in the lower strata, - whereas in the dambo associations the line of vision is not impeded by woody species, but rather by the tall grass stratum. However in the higher stratification levels (above 2,0m), the woody species do impede the line of vision in the dambo associations.

Whether the line of vision and the "crowding effect" are important factors influencing the type of habitat chosen by hartebeest is difficult to assess without knowing what the physiognomic characteristics of the dambos, in places such as Zambia and Tanzania, are. However Wilson (1966) comments that the densest concentrations of hartebeest occurred in and along the drainage lines that had been cleared of woody vegetation during tsetse fly bush clearing operations. It is possible that the hartebeest were moving away from an area of the reserve that had been resettled by natives; but, since there was no fence or natural barrier (between 1962 and 1963) which would have prevented the hartebeest from moving further, it is suspected that the hartebeest congregated in these areas voluntarily.

It is felt that the presence of woody species in the dambo associations does have a detrimental effect in influencing the type of habitat selected by the hartebeest. Lichtenstein's hartebeest show a distinct preference for a habitat with a long grass stratum and remain in the tall grass for considerable lengths of time. This means that the hartebeest are at a distinct disadvantage if they are unable to see over the top of the grass and when their line of vision is impeded by woody species.

Since Lichtenstein's hartebeest are grazers, it is possible that the hartebeest select a particular grass species and the "crowding effect" of the woody species results in the replacement of those grass species which are of importance to the diet of hartebeest. If true, this is then a further indication that the presence of woody species is detrimental to the suitability of the habitat and thus plays an important role in influencing the choice of the habitat by the hartebeest.

Percentage relative abundance of the various grass species in the Makeche Dambo, Mahande Dambo and the Grassland area.

The overall grass species composition of the south eastern lowveld, incorporating Lone Star Ranche, has been discussed elsewhere together with the pattern of distribution of the various grass species in the survey area (see p.164). In Table 24 the percentage relative abundance of the various grass species in the three areas under investigation is given. In general, two major grass associations can be recognized - a *Urochloa mosambicensis* - *Cenchrus ciliaris* association, occupying the drier areas of the Drainage Line Open Tree Savanna, and an *Ischaemum afrum* - *Setaria anceps* association, occupying the moister dambo associations in the Drainage Line Open Tree Savanna.

There is little difference in the overall grass species composition and several grass species are common to all three areas, however of importance are the differences in the percentage relative abundances of the various grass species in each of the three areas.

The major difference between the Makeche Dambo and the Mahande Dambo - and probably the most significant factor in this study - is in the percentage relative abundance of *Ischaemum afrum* and

Table : 24 Summary of the percentage relative abundance of the various grass species occurring in the Makeche Dambo, Mahande Dambo and Grassland area in the Drainage Line Open Tree Savanna.

Plant Species	Percentage relative abundance		
	Makeche Dambo	Mahande Dambo	Grassland
Urochloa mosambicensis	27,56	30,08	78,46
Cenchrus ciliaris	8,80	4,72	4,63
Ischaemum afrum	37,84	29,02	6,09
Setaria anceps	21,87	32,50	6,99
Aristida species	2,08	0,32	0,20
Heteropogon contortus	0,76	0,65	0,13
Digitaria milanjiana	0,20	-	0,06
Eragrostis species	0,39	-	0,83
Bothriochloa radicans	0,20	-	1,03
Enneapogon cenchroides	0,30	-	-
Pogonarthria squarrosa	-	-	0,20
Panicum maximum	-	-	1,38
Hyperthelia dissoluta	-	0,86	-
Cymbopogon excavatus	-	1,85	-

Setaria anceps. It was suggested that *Ischaemum afrum* and *Setaria anceps* are ecologically separated in the study area (see p.171) and that this separation was dependant on the moisture content of the soil. It would appear that the moisture content of the soil in the Mahande Dambo is dependant on the topogrpahy of the habitat and the fact that this dambo lies along the drainage course of the Mahande River. As a result the soil moisture balance is higher than the surrounding country and this is reflected in the grass species composition with 32,50% of the grass individuals present consisting of *Setaria anceps* (Table 24) while only 29,02% are represented by *Ischaemum afrum*. In the Makeche Dambo, the complete opposite is found, where *Setaria anceps* only contributes 21,87% to the overall grass composition while *Ischaemum afrum* contributes 37,84% (Table 24), indicating the drier enviroment of this dambo.

Ischaemum afrum is found growing on relatively flat surfaces where there is poor drainage (possibly in areas where the 'pan horizon' is not far beneath the soil surface ?), but this species also grows in shallow depressions provided the soil moisture balance does not exceed some undetermined amount. When this moisture level is exceeded the conditions are favourable for *Setaria anceps* (again related to the depth of the 'pan horizon' ?), but again if the conditions suitable for *Setaria anceps* are exceeded then the conditions become favourable for species such as *Hyperthelia dissoluta* (and *Sporobolus* sp. in other areas of the survey area - see p.173).

Thus in the Mahande Dambo the soil moisture balance, determined by the topography and the drainage course of the Mahande River, is such that it favours the growth of species such as *Setaria anceps*, *Hyperthelia dissoluta* and *Cymbopogon excavatus* (Table 24), while in the Makeche Dambo, the soil moisture balance is influenced by the water availability along the drainage line course and thus conditions tend to favour species such as *Ischaemum afrum* and *Urochloa mosambicensis* rather than *Setaria anceps*.

Further evidence supporting the hypothesis that the Makeche Dambo is drier than the Mahande Dambo is revealed when considering the percentage relative abundance of other grass species that occur in the dambo associations. *Aristida* sp. which are normally associated with the drier *Colophospermum mopane* Savanna Woodland are well represented in the Makeche Dambo (A = 2,08%, Table 24), together with species such as *Digitaria milanjiana*, *Eragrostis* sp., *Bothriochloa radicans* and *Enneapogon cenchroides* - all of which are associated with a drier environment (see p.172). These species are not found at all in the Mahande Dambo (Table 24).

It was for this reason that it was suggested earlier that the *Colophospermum mopane* - Drainage Line Open Tree Savanna habitat type, lying below Hartebeest Hills, be regarded as the most favourable habitat type available to the hartebeest (see p.187). The drainage lines representing the dambo associations in this area receive runoff from the high ground represented by Hartebeest Hills. In fact, in the vicinity of the Mahande River, and in an area covered by the *Acacia exuvialis* Scrub Thicket, there is a small area supporting a tall grass stratum of *Sporobolus pyremidalis* and a substratum of *Paspalum scrobiculatum* - two species that prefer the waterlogged soil that is found in this area and which remains wet for a considerable period after the rainy season. This waterlogging may be due to the lateral drainage of the underground water level which originates along the Hartebeest Hills.

Time and circumstances did not permit any detailed quantitative surveys to be conducted in this area, however in general, the dambos in this habitat type support a greater abundance of *Setaria anceps* as compared with *Ischaemum afrum* (see Cm-DL, Fig. 50) and furthermore there are far less woody species in these dambos as compared with the Mahande Dambo and Makeche Dambo.

The reason why the hartebeest do not use this area extensively is probably due to the lack of surface water. In 1967 an artificial water pan at the foothills of Hartebeest Hills was removed, which means that the nearest available water is at Chiloveka Dam some five kilometers away. This means that hartebeest have to leave their territories in order to reach water, and although No 2 Pan was commissioned in 1972, this has not relieved the problem for the pan is approximately six kilometers away.

On one occasion a solitary hartebeest bull was seen approaching No 2 Pan, but turned and trotted back towards Hartebeest Hills without drinking. Later in the afternoon a solitary individual was seen near Hartebeest Hills and assumed to be the same individual seen earlier, which suggests that the bull was reluctant to leave its territory, and in order to reach water it had to encroach on the territory of another herd in which the No 2 Pan was incorporated. The hartebeest that utilise the Hartebeest Hills area probably establish a territory, but are unable to remain in the area through the lack of water and so move on. It is possible therefore that the hartebeest in the south eastern lowveld of Rhodesia require a reliable water source within a habitat before they are able to establish a territory.

If the hartebeest are seeking a habitat characterised by a tall grass stratum, as represented by *Setaria anceps* and *Ischaemum afrum*, then the reasons the hartebeest do not utilise the Grassland area in the Drainage Line Open Tree Savanna habitat type are understandable. In Table 24 *Ischaemum afrum* and *Setaria anceps* contribute 6,09% and 6,99% respectively to the overall percentage relative abundance of the grass species in the Grassland area. These two species are confined to the "mini dambos" that occur in this area, but are usually trampled down by the larger herbivores in the study area. They are therefore of no use to the hartebeest since they are often too short and/or often destroyed.

The major grass stratum defining the Grassland area is *Urochloa mosambicensis* which contributes 78,46% to the overall percentage relative abundance of the grass species in the area. The hartebeest were observed to graze on this species in the study area, but the short nature of this grass (500 to 600mm tall) precluded it as an area suitable for the hartebeest, however, the reason(s) why the hartebeest migrated was not clear. This movement can not be related to water availability since water was freely available (and utilised by the hartebeest) both at Makeche and No 2 Pan which are no great distance from the respective dambos.

The most striking feature regarding the hartebeest is the fact that the herds utilise a relatively small area of tall grass land, such as the Makeche and Mahande Dambos, for a considerable period of the year. In Zambia it was observed that even though Lichtenstein's hartebeest were observed on burnt grassland, the stomach contents revealed that they had fed on tall grass species associated with dambos (see p. 196). On Lone Star Ranche, the Makeche Dambo was burnt in October 1978 soon after the Makeche Herd had returned to the area. The Hartebeest remained in the area for a few days and then left the area altogether and had not returned by February 1979 (Sparrow, pers. comm., personal observation).

The dambo associations, by virtue of their topography, are a moister environment than the surrounding Grassland area and thus are able to support a certain amount of "green pick". Similarly, the trees and shrubs in these associations, such as Combretum imberbe, are able to provide a source of green material towards the end of the dry season (September - October).

Normally very few of the major herbivores utilise the dambo associations as a source of food - besides reedbuck whose low numbers (Table 2) do not constitute a threat to the hartebeest. However, towards the end of the dry season, the dambo associations are invaded by herds of zebra and to a lesser extent sable which seek out the greener species of *Urochloa mosambicensis* and *Cenchrus ciliaris*, whilst the browsers, such as kudu and eland, utilise the woody species that occur in the dambos, as a source of food. Tinley (1977) observed a similar pattern in the Gorongosa National Park, Mozambique, where herds of zebra concentrated in the areas of post fire flush and dambo associations towards the end of the dry season.

Since the hartebeest show a distinct preference for a tall grass stratum habitat type, it is possible that at a certain stage, the height of the grass stratum is reduced through the action of other herbivores in the study area to the point where the dambos are no longer suitable to the hartebeest. It is suspected therefore that the migratory movement is related to the physical structure of the dambos and the manner in which this changes as the dry season progresses.

The structural characteristics of the grass stratum of the Makeche Dambo, Mahande Dambo and Grassland area.

A plan of the Makeche Dambo (Fig. 54), drawn from aerial photographs, is used to illustrate the localities where hartebeest

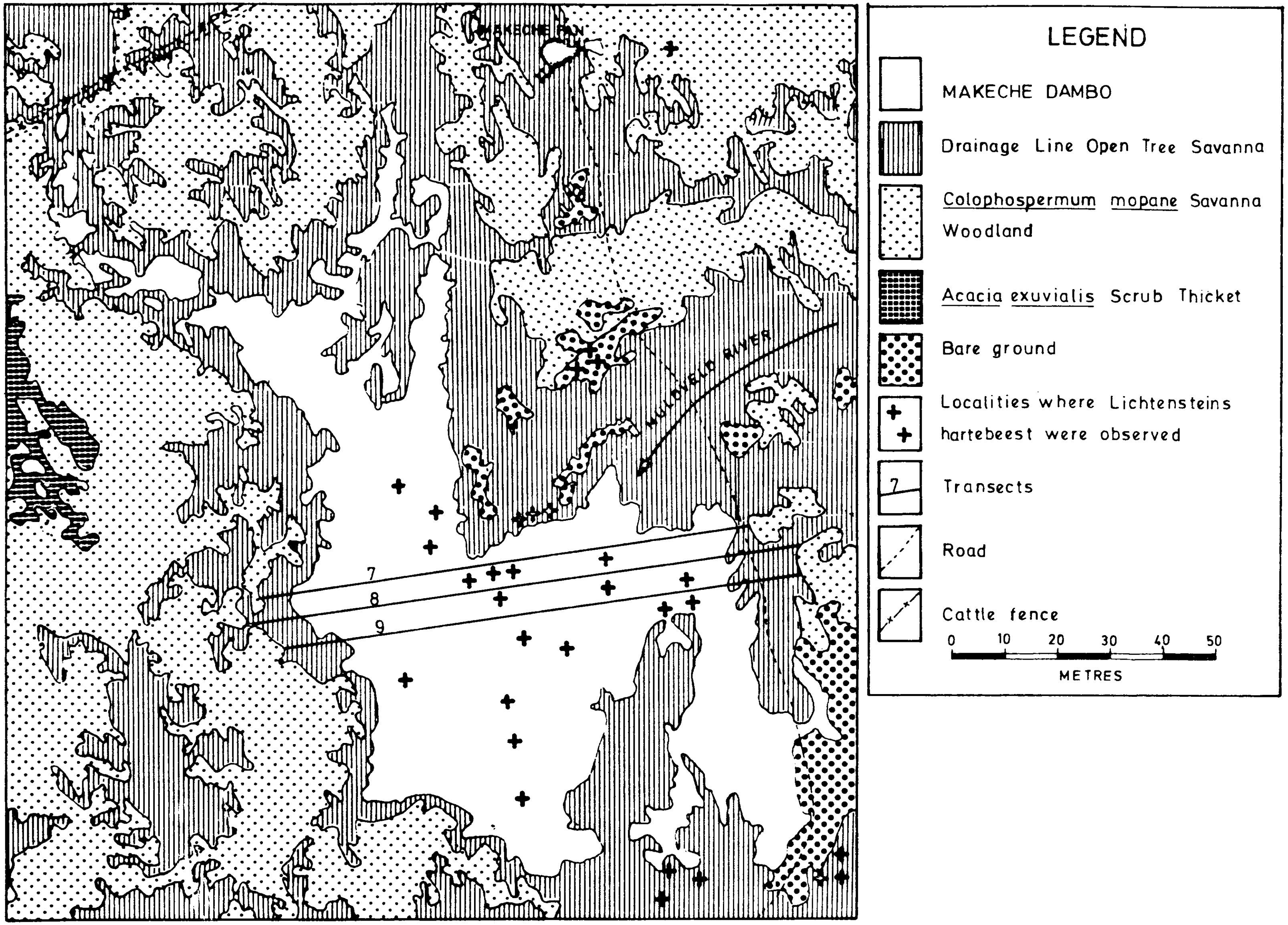


Fig. 54: A plan of the Makeche Dambo, dominated by *Ischaemum afrum* and *Setaria anceps*, illustrating its position in relation to the surrounding vegetation and the localities where a herd of hartebeest were observed grazing during the wet season.

were observed grazing and the position of the dambo relative to the surrounding vegetation. In general the dambo is surrounded by elements of the Colophospermum mopane Savanna Woodland and Drainage Line Open Tree Savanna on the higher ground. Within the drainage line itself, the periphery of the dambo consists of a zone of Urochloa mosambicensis and Cenchrus ciliaris which flanks an inner core of Ischaemum afrum and Setaria anceps - which forms the dambo proper.

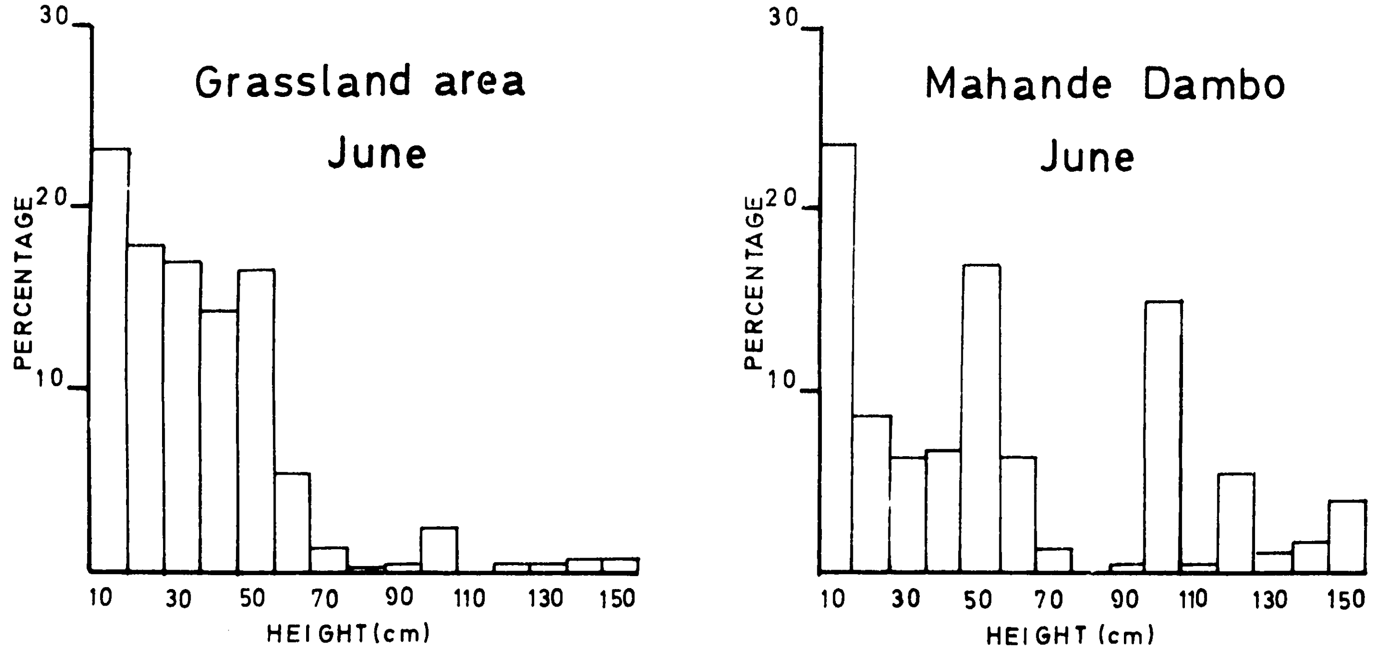
A series of transects were used to gather data on the grass species composition and the physical structure of the grass stratum (see p.146 for methods). In Table 25 the mean height of the four major grass species in the Makeche Dambo and the Grassland area at the end of the rainy season (April) is given. Urochloa mosambicensis and Cenchrus ciliaris were, on average, taller in the Grassland area than in the Makeche Dambo (Table 25), but Ischaemum afrum and Setaria anceps were, on average, shorter (1,10m and 0,98m as opposed to 1,24m and 1,14m, Table 25). By the middle of the dry season (June), the height of the grass species in the Makeche Dambo, Mahande Dambo and Grassland area had been considerably reduced (Table 25). In the Makeche Dambo, Urochloa mosambicensis had been reduced by 23,90%, Cenchrus ciliaris by 25,50%, Ischaemum afrum by 42,70% and Setaria anceps by 48,90%.

The net effect of this reduction in the overall height of the various grass species was to alter the stratification of the grass stratum. This is illustrated in Fig. 55 in which the stratification of the grass stratum at the end of the rainy season (April) and at the height of the dry season (June) is

Table : 25 The mean height (in metres) of the four major grass species occurring in the Grassland area, Makeche Dambo and Mahande Dambo at the end of the rainy season (April) and in the middle of the dry season (June) on Lone Star Ranche.

Plant Species	Height (m)				
	April		June		
	Makeche Dambo	Grassland Area	Makeche Dambo	Mahande Dambo	Grassland Area
Urochloa mosambicensis	0,46 (0,06)*	0,50 (0,04)	0,35 (0,15)	0,27 (0,16)	0,27 (0,15)
Cenchrus ciliaris	0,51 (0,11)	0,61 (0,08)	0,38 (0,15)	0,41 (0,19)	0,46 (0,18)
Ischaemum afrum	1,24 (0,16)	1,10 (0,07)	0,73 (0,38)	0,82 (0,47)	0,63 (0,29)
Setaria anceps	1,14 (0,11)	0,98 (0,09)	0,71 (0,37)	0,55 (0,40)	0,50 (0,26)

*Standard deviation



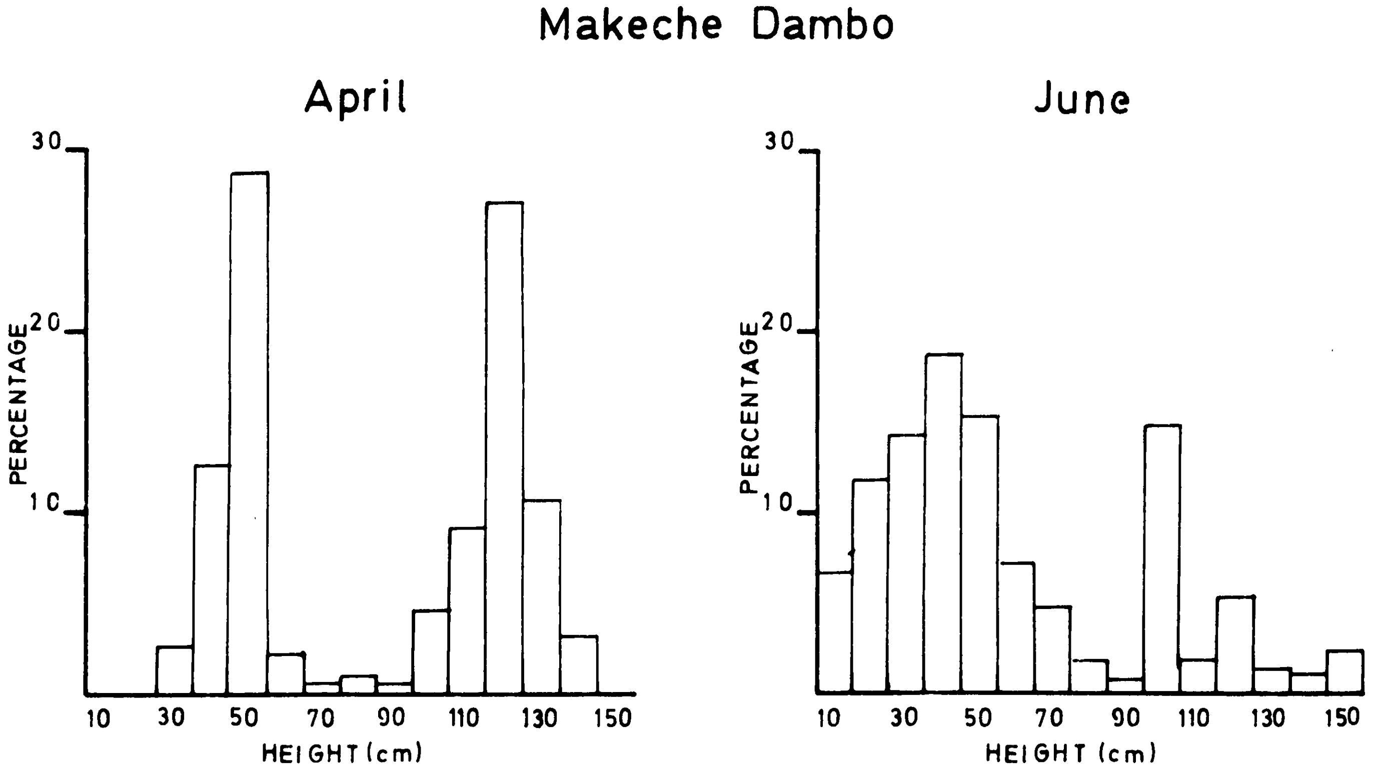


Fig 55: The percentage frequency of all grass species in various height classes recorded in the Grassland area(June), Mahande Dambo(June) and Makeche Dambo (April, June).

recorded.

In the Grassland area, the predominat species is Urochloa mosambicensis (A = 78,40%, Table 24) and thus the overall structure of the grass stratum is determined by this species. Towards the end of the rainy season (April) the average height of the grass stratum was 0,5m (Table 25) and the only interruption in this otherwise uniform grass stratum occurred where "mini-dambos" were encountered. In these "mini-dambos" the height of the grass stratum varied between 0,98 - 1,10m. However, by June, the overall height of the grass stratum had been reduced by an average of 40%. As a result the height classes of all the grasses in the Grassland area followed a positive skew distributional curve between 0,1 - 1,5m (Fig. 55), indicating that more specimens of grass were in the lower height classes than in the taller height classes.

This effect is illustrated in Fig. 56, where the appearance of the structure of the grass stratum along three consecutive transects through the Grassland area is considered. In general, the characteristic of the grass stratum is one of a short uniform height. In some places the height of the grass stratum is seriously reduced - especially where a road or game trail passes through the area - or it may be above average, especially where "mini-dambos" occur.

However, in comparing the Makeche Dambo and the Mahande Dambo, the structure of the grass stratum differs considerably as well as differing from that of the Grassland area. In the

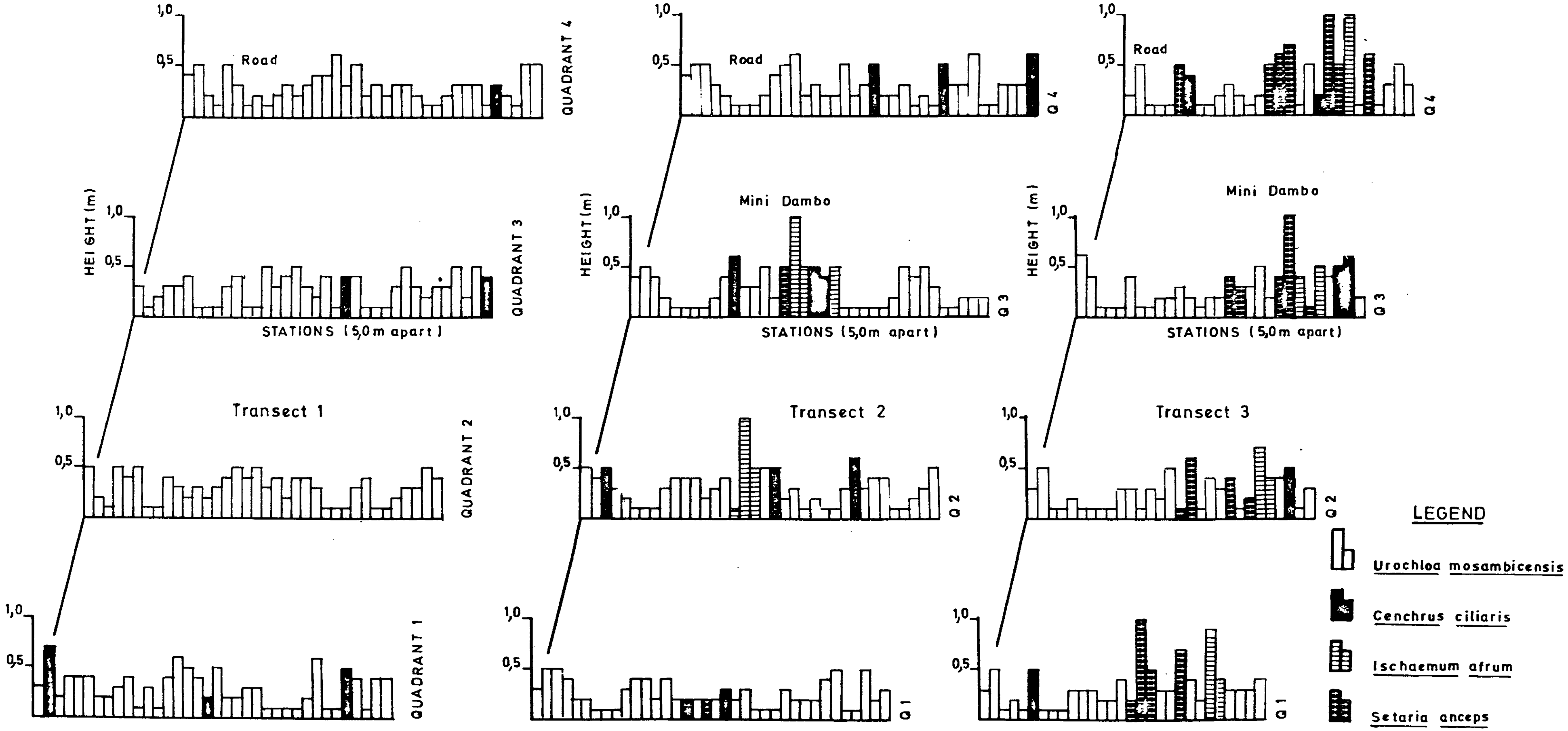


Fig. 56: The spatial distribution and height (m) of various grass species in each of four quadrants along three consecutive transects 15,0m apart illustrating the physical structure of the grass stratum in the Grassland area (June).

Makeche Dambo, the height of the grass stratum up to the end of the wet season (April) produced two peaks - one between 0,1 - 0,9m and a second between 1,0 - 1,5m high (Fig. 55). The lower height class peak was represented by species such as *Urochloa mosambicensis* and *Cenchrus ciliaris*, whereas the taller height class peak was represented by species such as *Setaria anceps* and *Ischaemum afrum*. At the height of the dry season in June, the majority of the grass species had been reduced to between 0,1 - 0,7m, while only a few specimens were taller than 1,0m (Fig. 55).

The net effect on the physical appearance of the grass stratum is illustrated in Fig. 57. The overall appearance at the height of the dry season is one of a patchy distribution of tall and mediumly short grass specimens. However the most important factor in the grass stratum of the Makeche Dambo is the presence of *Urochloa mosambicensis* and *Cenchrus ciliaris* growing in isolated patches within the dambo proper. Towards the end of the dry season, these species are sought after by zebra in particular and are grazed to a relatively short height (see Table 25). As a result, areas of open short grass patches develop within the dambo (Fig. 58), which creates a similar effect, although on a smaller scale, to that found within the Grassland area. If, as is suspected, Lichtenstein's hartebeest avoid short grass habitat types and prefer a long grass habitat type, it is possible that the development of these open areas within the dambo are the cause of the hartebeest moving out of these areas.

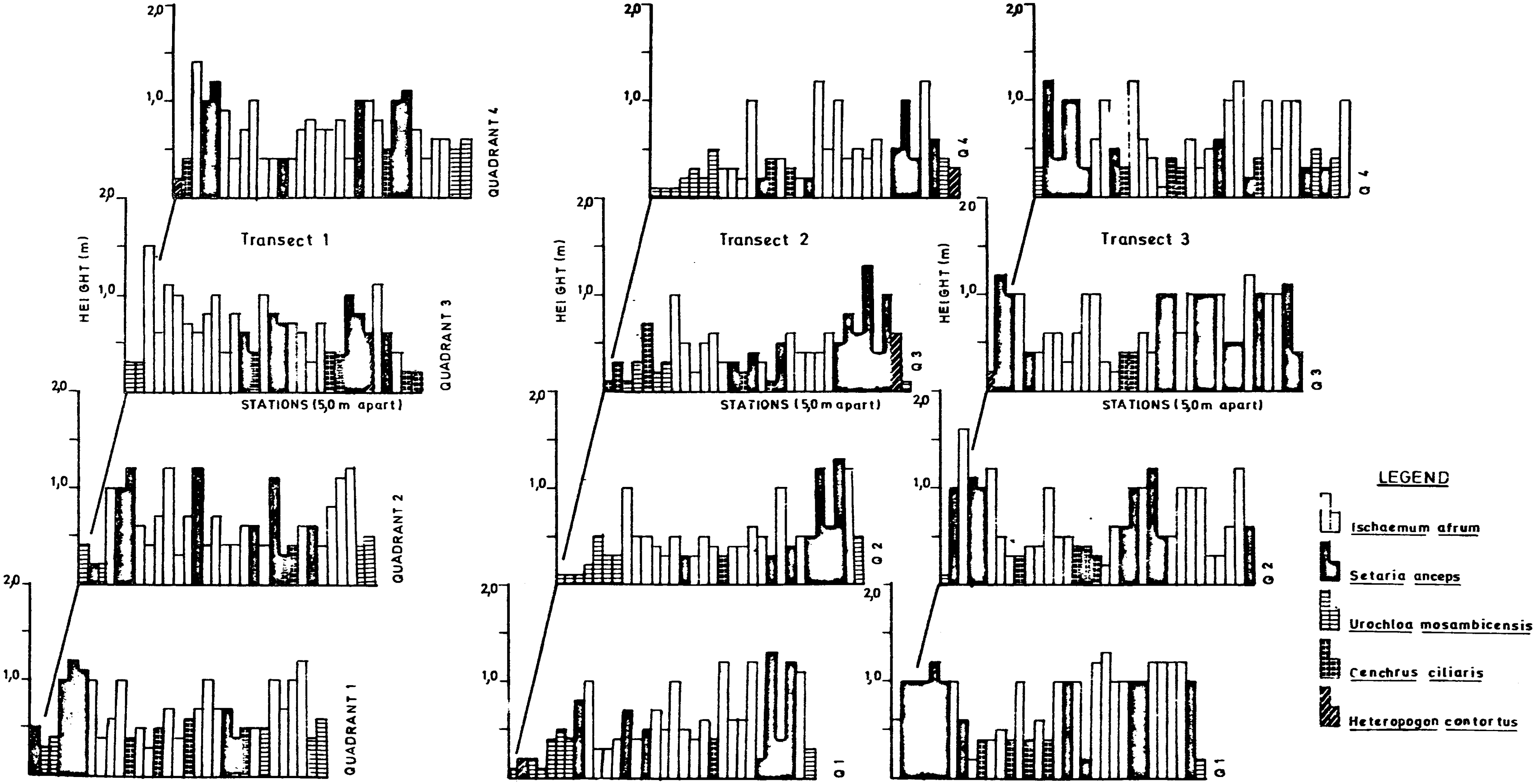


Fig. 57: The spatial distribution and height (m) of various grass species in each of four quadrants along three consecutive transects 15,0 m apart illustrating the physical structure of the grass stratum in the Makeche Dambo (June).

Fig: 58 An example of an area where the presence of *Urochloa mosambicensis* and *Cenchrus ciliaris* in the Makeche Dambo has attracted zebra that have grazed these species to a relatively short height in the otherwise tall grass stratum of the dambo.

A much more serious effect produced as a result of the physical actions of zebra, is found when considering the structure of the grass stratum of the Mahande Dambo. The heights of the various grass species in June in the dambo follow a positive skew distributional curve between 0,1 - 0,9m (Fig. 55). This curve is interrupted by a peak at 0,5m which is a result of the predominance of Setaria anceps (A = 32,50%, Table 24), with a mean height of 0,55m (Table 25), in this dambo. A similar positive skew distributional curve to that found in the Makeche Dambo between 0,9 - 1,5m, is found in the Mahande Dambo during June.

These curves are a result of a greater number of grass specimens falling into the lower height classes of both distributional curves - which in turn is primarily the result of the spatial distribution of the various grass species in the Dambos. In the Mahande Dambo, Urochloa mosambicensis and Cenchrus ciliaris do not occur in the middle of the dambo proper (Fig. 59), as they do in the Makeche Dambo (Fig. 57), but rather along the periphery of the dambo. However, the physical appearance of the Mahande Dambo does differ markedly from that of the Makeche Dambo. In general, the structure of the grass stratum in the Mahande Dambo follows two extremes - either it is tall or very short. These extremes are not the direct result of grazing pressure, but rather a result of the physical effect that a herd of zebra have on the grass stratum when it moves through the dambo. A possible reason why zebra move into the dambo is that they are searching for

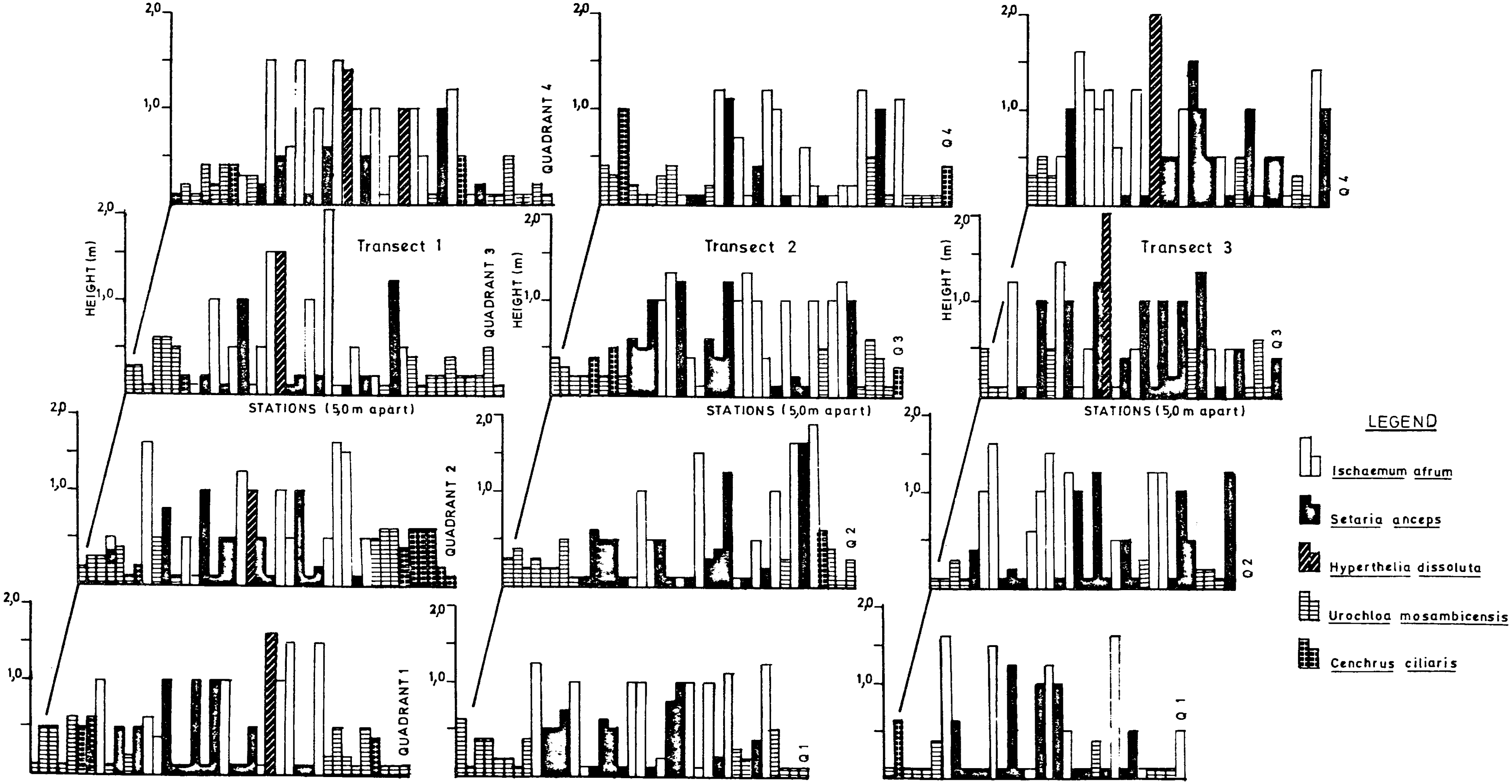


Fig. 59: The spatial distribution and height (m) of various grass species in each of four quadrants along three consecutive transects 15,0m apart illustrating the physical structure of the grass stratum in the Mahande Dambo (June).

the greener, soft-leaved grass species such as Urochloa mosambicensis and Cenchrus ciliaris. But these species only occur in those dambos where the soil moisture balance in the dambo permits their growth and therefore where they remain greener for a longer period of time.

However zebra still move into these dambos (such as the Mahande Dambo) even though the moister environment does not permit such species as Urochloa mosambicensis and Cenchrus ciliaris to thrive. The net effect is that zebra move about in the dambo in search of these grasses and literally trample down the taller grass species, such as Ischaemum afrum and Setaria anceps, and create "footpaths" through the dambos.

The Mahande Dambo supports a far denser grass stratum (basal cover = 25,00%, Table 26) than the Makeche Dambo where the basal cover was 18,58%. Thus, if a herd of zebra move across, or feed in these dambos, they trample more grass down in the Mahande Dambo than in the Makeche Dambo and thus destroy the tall grass stratum on which the hartebeest are dependant.

Although no concrete evidence is available on the preferred grass species in the diet of the hartebeest in the study area, it is suspected that the hartebeest seek a tall grass habitat type that supports a greater proportion of Setaria anceps than Ischaemum afrum. Setaria anceps is a less robust species of grass when compared to Ischaemum afrum, and thus more susceptable to being trampled down. This is evident when considering the percentage number of specimens of both species that contribute to five height classes in the grass stratum in the dambo associations. In the Makeche Dambo, both Ischaemum afrum and Setaria anceps contribute nearly equal proportions to the 0,1 - 0,3m height class (Table 26). However, when it is considered that Setaria anceps only contributes 21,87% to the overall percentage relative abundance of the various grass species in the Makeche Dambo (Table 24), then it is appreciated that the greater proportion of this species is trampled and destroyed. This is more evident in the Mahande Dambo where Setaria anceps is in greater abundance (A = 32,50%, Table 24). Here 45,65% of all the specimens of this species were between 0,1 - 0,3m tall and 28,83% were between 0,31 - 0,6m tall (Table 26). The net result is that hartebeest may not have been able to utilise this species of grass and thus moved out in search of better grazing.

In conclusion, the tall grass stratum of the dambo associations is the habitat type most preferred by Lichtenstein's hartebeest in the study area, but the suitability of this habitat type is directly influenced by the topography of the drainage line which determines the level of the soil moisture balance and ultimately the vegetation cover that will survive in the dambo, and indirectly influenced by the grazing pressure and physical effects exerted by the other major herbivores that utilise these dambos at certain

Table : 26 The percentage number of specimens of Setaria anceps and Ischaemum afrum in each of five height classes (in metres) and the total percentage basal cover in the Makeche Dambo, Mahande Dambo and the Grassland area in the survey area.

Height class (m)	Percentage number of specimens					
	Makeche Dambo		Mahande Dambo		Grassland area	
	Ischaemum afrum	Setaria anceps	Ischaemum afrum	Setaria anceps	Ischaemum afrum	Setaria anceps
0,10 - 0,30	11,76	11,95	22,83	45,65	7,69	40,92
0,31 - 0,60	40,64	31,52	22,83	26,83	53,87	36,36
0,61 - 0,90	11,22	7,62	0,78	1,44	-	9,09
0,91 - 1,20	34,25	45,65	35,45	23,91	38,44	13,63
1,21 - 1,50	2,13	3,26	18,11	2,17	-	-
Total % basal cover	18,58%		25,00%		16,11%	

times of the year.

Resulting from this, at a certain time of the year, the tall grass stratum habitats, represented by the wide dambos in the study area, are no longer able to afford protection to the hartebeest nor are they able to meet their feeding requirements. This forces the hartebeest to move into new areas, such as the Colophospermum mopane Savanna Woodland habitat type, although this habitat type is not regarded as being one that is utilised "voluntarily" but rather out of necessity and is an aspect of the ecology of Lichtenstein's hartebeest on Lone Star Ranche that requires further investigation.

Chapter 10

Management considerations and recommendations

As a result of the changing political events and the fact that Lichtenstein's hartebeest is a rare and endangered species in the south eastern lowveld of Rhodesia, the approach to this study had to be reviewed from time to time. The final objective was to achieve a foundation on which future research, for which there is an urgent need if this species is to survive in Rhodesia,could develop. However the ultimate objective in a study of this nature is to determine which factors should receive careful consideration if successful survival of this species is to be ensured in the future.

Notwithstanding these considerations, under the conditions pertaining to Lone Star Ranche, the objectives of the game section on the ranch have also to be taken into account. Lone Star Ranche is not primarily a sanctuary for Lichtenstein's hartebeest, but rather an area geared to the economic exploitation of the wide variety of wild game utilising the area. Thus any managerial policy must, of necessity, take this into account and try to avoid any repercussions that would be detrimental to the viability of the ranch as a whole.

Research into the migratory behaviour of hartebeest is essential as this migration is probably crucial to the their survival. If would appear that it is probably related to changes in soil moisture balance occurring along the Mahande River - Gologi River drainage system.

Spatial distribution of Lichtenstein's hartebeest herds in the Mahande River - Gologi River basin in the south eastern lowveld.

In Fig. 60 the spatial distribution of Lichtenstein's hartebeest herds in relation to the major drainage systems of the Malilongwe Range and Chihonja Range is illustrated. The sightings given here represent all herds recorded during all seasons for the year and no attempt has been made to record the annual migration of any one particular herd.

The importance of the Mahande and Gologi Rivers as the major drainage system of the region is illustrated in Fig. 60. Furthermore it is evident that the spatial distribution of Lichtenstein's hartebeest is intimately related to the drainage system.

Tinley (1977), in his critical review of the framework of the Gorongosa ecosystem in Mozambique has revealed that the Gorongosa massive is vital in determining the soil moisture balance of the Urema valley floor and ultimately the future of the flora and fauna of the region. It has been pointed out in the present dissertation that the Malilongwe Range receives a higher rainfall than the basaltic flats and that the subtle change in vegetation is probably related to the mean annual rainfall in these two areas (see p.116).

The role of the soil moisture balance on Lone Star Ranche should receive urgent attention in any future research programme and all future policies regarding the wildlife of the area, particularly where this is related to

Lichtenstein's hartebeest, should take this into account.

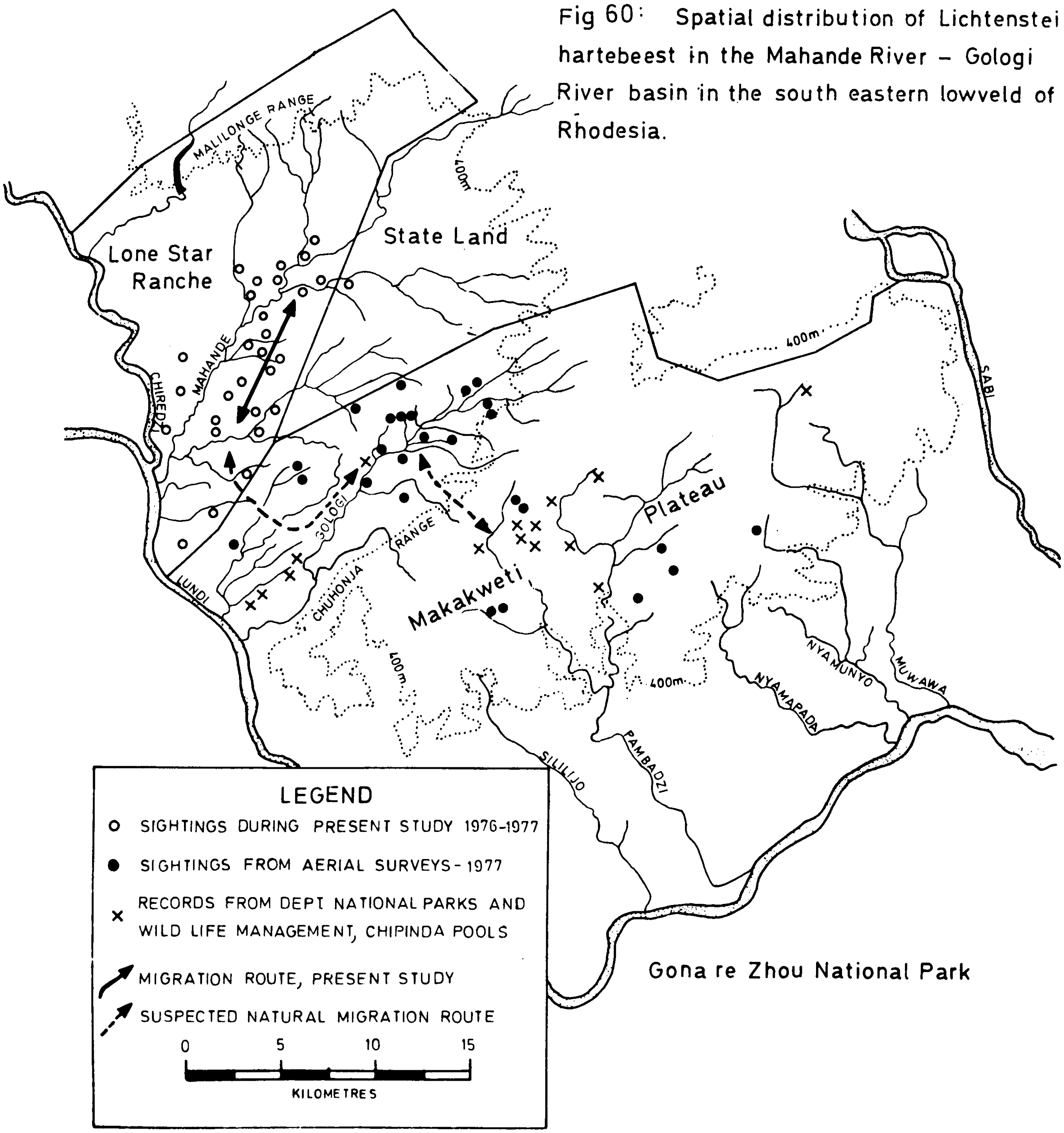
It is felt that the change in the soil moisture balance of this region is responsible for the annual migration of the hartebeest and the following hypothesis is advanced.

Lichtenstein's hartebeest appears to seek out a tall grassland habitat type characterised by species such as *Ischaemum afrum* and *Setaria anceps*. These grasslands appear to be directly dependant on the soil moisture balance of the dambos in which they occur. At the commencement of the rains in November, Lichtenstein's hartebeest are found in these dambos - in this case at the headwaters of the Mahande River - where they remain until autumn (April/May) when they begin their migration.

The dambos on Lone Star Ranche rely on the drainage system of the area for moisture, which in turn is reliant on the catchment area of the Malilongwe Range. As the dry season progresses, the water table gradually begins to recede. This results in fewer green shoots being available in the dambos, until a point is reached where the dambos are no longer acceptable to the hartebeest.

They then move down the gradient of the drainage system and into areas that have not yet been affected by the receding moisture level and thus gradually, as the dry season progresses, the various herds begin to congregate into larger herds in areas where there is a suitable grassland habitat.

Fig 60: Spatial distribution of Lichtensteins hartebeest in the Mahande River - Gologi River basin in the south eastern lowveld of Rhodesia.



It is suspected that the construction of a game fence between the ranch and the Gona re Zhou National Park has effectively cut off the natural migration routes through to the drainage system of the Gologi River, which, unlike the Mahande River, contains water all the year round (Sparrow, pers. comm., Francis, pers. comm.).[1]

This aspect of the ecology of Lichtenstein's hartebeest requires further investigation, for the development of any water system such as building weirs or dams, on Lone Star Ranche and in the Gona re Zhou National Park, could lead to serious inbalances of the soil's moisture levels which could be detrimental to the survival of hartebeest.

Management considerations and recommendations

Two managerial policies are suggested that will hopefully promote an increasing population of Lichtenstein's hartebeest in the study area.

Short term policy

This policy should be aimed at making full use of all the suitable habitat available to Lichtenstein's hartebeest in the study area; determining which dambo associations and/or drainage lines are suitable for occupation by hartebeest; and providing suitable open water in these areas in the form of artificial pans. Roads should be rerouted to avoid passing

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[1] R. Francis, Warden, Chipinda Pools, Chiredzi, Rhodesia

through or along drainage lines that could constitute a suitable habitat for hartebeest. Furthermore the use of roads and other disturbances should be reduced to a minimum in areas that are known to support a hartebeest herd during the wet season thus promoting security within the herd.

Many of the dambo associations suitable for hartebeest have been invaded by woody vegetation. This has resulted indirectly through the exclusion of fire in the study area. Nevertheless it is not recommended that fire be used as a tool to rid these grasslands of woody vegetation at this stage, for the following reasons.

1. On Lone Star Ranche there is a large population of zebra, wildebeest and impala. Burning these areas will attract large numbers of these herbivores to the post-fire flush which could lead to overgrazing and erosion.
2. Lone Star Ranche lies within a semi-aridrainfall zone and as such is subject to periodic droughts which would adversely affect the grazing in the burnt out areas. In addition, if the rains are below average, it is unlikely that the tall grass sward of the dambo associations will develop, as the grass will be kept short by grazing pressure from zebra and wildebeest. This will be detrimental to the hartebeest.
3. It is doubted whether fire will destroy many of the woody species that have invaded the dambo associations since many of these trees have become deep rooted and attained a height of three metres or more.

It is recommended therefore that all the woody vegetation in the dambos and drainage lines be removed, including the root systems, physically by hand or mechanical means. This should lead to a slight rise in the water table of the dambo associations and ultimately promote a grass sward better suited for occupation by hartebeest.

Long term policy

Although it is felt that the short term policy will result in a rapid improvement in conditons for hartebeest, this policy will not ensure that the hartebeest continue to flourish in the study area. In order to achieve this, it is essential that a long term critical investigation be undertaken in order to gain an understanding of the ecology of the ecosystem in the area for this will not only be beneficial to hartebeest, but to all ungulates in the area.

Tinley (1977) believes that for any meaningful habitat management to be effectively achieved, the ungulate population must be low-which would mean that a more stringent culling programme would have to be embarked upon in the study area. Such a programme will have to be based upon accurate knowledge of seasonal movements and population numbers. On Lone Star Ranche these data are lacking - in fact it is possible that the ungulate population has been grossly over or underestimated. However, it is impossible to predict what subsequent chain of events may follow if one of the primary consumers, such as zebra, was to be removed.

Culling zebra may lead to prevention of excessive damage to the tall grasslands. However zebra may move into the long grass areas at the approach of the dry season for two reasons. First, this may be a natural response and in fact the hartebeest may move out of these dambos anyway long before the zebra appear if the hartebeest were able to follow their natural migratory routes or were able to move into some other suitable habitat type in the study area. Nevertheless the probable reason for the zebra moving into the dambo associations at the height of the dry season is their dependence on the surface water in the artificial pans which obviates the need for the zebra to mova back to the river frontage.

On Lone Star Ranche the riverine zone, comprising the Chiredzi and Lundi Rivers has in effect been "extended" into the hinterland by the introduction of artificial pans and dams. This has resulted in an increase in the ungulate population which is either forced back to the riverine areas, due to a lack of suitable pasture, or, as in the case of zebra, is forced into the dambo associations in search of greener grazing during the dry season.

The objective of installing the pans was to attract the ungulate population away from the river frontage where they were subject to poaching by inhabitants from the adjacent

Tribal Trust Land. Although this objective is logical in the light of the economic factors, it could lead to serious complications in the event of a serious drought, as the ungulate population would be forced back to the riverine zone anyway through a lack of suitable grazing. An investigation into the role of the artificial pans in relation to the distribution of the ungulate population at the height of the dry season is therefore required.

This information could then be applied in designing a series of pan systems which could be installed in the hinterland. A programme could then be initiated to control the movement of game by allowing certain pans to dry up midway through the dry season, thus forcing the ungulate population to move into areas such as Chikwete, Hartebeest Hills and Chanyugwe, which were previously avoided through lack of water. These pans would then encourage any hartebeest herds that would normally migrate to the Gologi basin to move into adjacent areas.

However, stocking rates will ultimately have to be related to the dry season riverine carrying capacity so that undue destruction of these zones is avoided. Until this information is available it would be irresponsible to embark upon any drastic culling programme. All that may be required is a redistribution of the ungulate population in order to make full use of the available habitat.

With regard to bush-clearing operations in the dambos and drainage line systems on Lone Star Ranche, the long term effects will only be beneficial if the soil moisture balance is restored. However, this will be difficult to achieve for the following reason.

Lone Star Ranche lies in a semi-arid climatic zone and as such does not receive a high enough mean annual rainfall to keep the soil moisture balance at a sufficiently high level to prevent woody species from invading the dambo grasslands in the wet season. Added to this, the dry season is subject to invasions of cool moist south easterly winds, which on occasions result in "guti" conditions. As a result the dambo grasslands do not dry out sufficeintly in winter (June/July) to kill off any primary root development of the woody species.

Every effort should be made to restore a high soil moisture balance to prevent deep rooted savanna trees from becoming the dominant vegetational cover. To increase the soil moisture balance considerations should be given to construction of sills or weirs that would redirect the flow of water into the drainage system, or the dambo associations could be scooped out to increase the degee of runoff into these areas. However care should be taken with this latter exercise not to destroy any 'pan horizon' that might exist in such drainage lines, for removal of the pan horizon would defeat the object of increasing the soil moisture balance.

It is possible that fire could be used to maintain the grasslands once they have been cleared of all woody vegetation, however the only time fire could be used effectively is when the ungulate population is sparse thus ensuring an adequate growth of rank grass to fuel a late season fire (Tinley 1977). However fire should be avoided at all costs until a thorough understanding is gained of herd movements, population numbers and the response of burnt out areas to low rainfall.

Any future research on the ecology of Lichtenstein's hartebeest in this region should also take into account that the Gona re Zhou National Park hartebeest population and the population on Lone Star Ranche are probably interrelated and any managerial policies initiated in either of these areas will therefore affect both regions.

Summary

Lone Star Ranche is situated in the south eastern lowveld of Rhodesia and is approximately $275km^2$ in area. It is bounded by the Chiredzi and Lundi Rivers, the Malilongwe Range, Tribal Trust Land, State Land and the Gona re Zhou National Park. There are two major physiographic regions in the area:- a rough and broken range of hills consisting of lower Karoo grits, shales and mudstones, and Upper Karoo sandstones, and a gently undulating basaltic plain which lies unconformably over Karoo sandstones. The altitude varies from 320m on the basaltic plain to 500m above sea level along the Malilongwe Range. The Chiredzi and Lundi Rivers are the major perennial rivers draining the region and these are served by the Nyamasikana, Mahande, Bengi and Chiloveka Rivers - which from the main drainage system of the study area. For the greater part of the year surface water is restricted to small pools, natural pans, artificial pans and dams.

The climate of Lone Star Ranche is governed by its position within the Sabi-Limpopo Valley which is subject to invasions of cool moist south - easterly winds originating over the Mozambique Channel. There is a hot, wet season from November to April, a cool, dry season from May to August and a hot, dry season from September to November. The mean annual rainfall is higher on the Malilongwe Range (565,2mm) than on the basaltic flats (363,9mm) and 76% of the annual rainfall is precipitated during the months November - February. Although long term temperature records are not available for Lone Star Ranche, the temperature in the region may vary from

- $2{,}5^{0}C$ to $45^{0}C$ (at Triangle Mill) while the mean monthly termperature varies from $16{,}1^{0}C$ to $26{,}2^{0}C$ (at Triangle Mill).

Lone Star Ranche has an economy based on the cattle and wild game industry. The ranch supports the largest herd of Lichtenstein's hartebeest (Alcelaphus lichtensteini) on private owned land in Rhodesia.

This species is threatened with extinction in Rhodesia and the primary objective of this study was to identify what the "preferred habitat" of hartebeest in the study area might be, with the aim of formulating a management policy.

Since no previous detailed research had been conducted on this species in the past, the approach to the project was based upon a process of elimination in the hope that as more and more information became available, so the "preferred habitat" of this species in the study area would be exposed.

To determine whether this species occupied an area that was on the fringe of its natural distribution in central and southern Africa, or if it occupied an "available" habitat in Rhodesia, a detailed investigation into the past and present distribution of this species in Africa is discussed, including all available data regarding its ecology and social behaviour.

Using aerial photgraphs, the vegetation of the game section of the study area was mapped and divided into two broad vegetational zones; the *Brachystegia glaucescens* Savanna Woodland zone, which was confined to the Malilongwe Range, and the *Colophospermum mopane* Savanna Woodland zone confined to the basaltic flats. Hartebeest were only to be found along the drainage system of the basaltic flats and thus the vegetation in this region received closer attention than that along the Malilongwe Range and was subdivided into the following communities:

1. *Colophospermum mopane* Savanna Woodland
2. *Acacia nigrescens* Open Tree Savanna
3. *Acacia exuvialis* Scrub Thicket
4. *Dichrostachys cinerea* Scrub Thicket
5. *Acacia tortilis* Savanna Woodland
6. *Commiphora africana* - *Cassia abbreviata* - *Adansonia digitata* Open Tree Savanna
7. Riverine Community
8. Drainage Line Open Tree Savanna incorporating the dambo associations.

The classification used is supported by floristc data. Based on data gathered regarding the distribution of hartebeest throughout the study period, the study area was subdivided and a survey area was recognised comprising six habitat types, which were utilised by hartebeest at some stage during the year. These habitat types included elements of one or more of the vegetational communities described and were identified as follows:

1. Colophospermum mopane Savanna Woodland habitat type (CmSW)
2. Colophospermum mopane - Acacia nigrescens - Drainage Line Open Tree Savanna habitat type (Cm-An-DL)
3. Acacia nigrescens Open Tree Savanna habitat type (AnTS)
4. Acacia exuvialis Scrub Thicket habitat type (AeST)
5. Colophospermum mopane - Drainage Line Open Tree Savanna habitat type (Cm-DL)
6. Drainage Line Open Tree Savanna habitat type (DLTS)

A Plant - to - Plant Distance Measure method and a Step-Point Quarter method were used to gather quantitative data on the floristic composition and structure of the vegetation in the six habitat types. The physiognomy of the vegetation in the overall survey area is discussed while the physiognomy of each of the six habitat types is compared and discussed in relation to the annual migration exhibited by the hartebeest.

The reason(s) for this migration is unknown and it is suspected that it may be related to reproductive behaviour or prompted by changes in soil moisture balance which affect the quality of the diet in the dambo associations.

The conclusions arrived at from this investigation are that the tall grassland areas, characterised by the presence of Ischaemum afrum and Setaria anceps are the most preferred habitat type for Lichtenstein's hartebeest. However these habitat types are being invaded by woody vegetation which may be responsible for rendering the dambos unsuitable for hartebeest occupation.

This invasion of woody species into the dambos is related to the soil moisture balance and changes in this aspect of the ecology of the study area has led to changes in the grass composition. Furthermore physical destruction of the dambos occurs as a result of other ungulates, notable zebra, using these grasslands as a source of food in the dry season and this may be one of the factors prompting the annual migration.

Based on the information available - and it is stressed that a great deal further investigation is required - short term and long term management policies have been suggested in the hope that these may enhance the prospects of survival for hartebeest in the lowveld.

OPSOMMING

Lone Star Ranche is in die suidoostelike laeveld van Rhodesië geleë, beslaan ongeveer 275km^2 en word begrens deur die Chiredzi en Lundiriviere, die Malilongwebergreeks, Stam-trustgebied en die Nasionale Gona re Zhou Nationale Park. Daar kom twee hooffisiografiese streke in die gebied voor; 'n ruwe en gebroke reeks heuwels bestaande uit Laer-Karoogruis, skalies en moddersteen en Hoër-Karoosandsteen, en 'n golwende basaltagtige vlakte onreëlmatig gelee bo-op Karoosandsteen. Die hoogte wissel vanaf 320m op die basalt-vlakte tot 500m bo seespieël in die Malilongwebergreeks. Die Chiredzi - en Lundi riviere is die vernaamste standhoudende riviere wat water uit die gebied afvoer en word gevoed uit die Nyamasikana-, Mahande-, Bengi-, en Chilovekariviere - hierdie vorm die hoofdreineringsisteem van die studie-gebeid. Gedurende die grootste gedeelte van die jaar is bogrondse water beperk tot klein poeletjies, natuurlike panne en damme.

Die klimaat van Lone Star Ranche word bepaal deur die feit dat dit geleë is in die Sabi- Limpopovallei waar die koel, vogtige suidoostelike winde vanaf die Mosambiekkanaal ondervind word. Daar word 'n warm, nat seisoen vanaf November tot April ondervind, 'n koel, droe seisoen vanaf Mei tot Augustus en 'n warm droë seisoen vanaf September tot November. Die gemiddelde jaarlikse reënval is hoer op die Malilongwebergreeks (565,2mm) as op die basaltvlakte (363,9mm) en 76% van dié vanaf November tot Februarie. Alhoewel langtermyn temperatuur-aantekeninge vir Lone Star Ranche nie beskikbaar is nie, wissel dit vanaf -2,5°C tot 45°C (by Triangle Meule) terwyl die gemiddelde maandelikse temperatuur varieer vanaf 16,1°C tot 26,2°C (by Triangle Meule).

Op Lone Star Ranche word daar met beeste en wild geboer en die grootste kudde vaalhartbeeste (Alcelaphus lichtensteini) op privaat eiendom in Rhodesië word hier aangetref.

Hierdie dier word as 'n bedreigde spesie in Rhodesië beskou en die hoofdoelstelling van hierdie studie was om die "voorkeur-habitat" van die vaalhaartbees in die studiegebied te identifiseer en om sodoende ook 'n bestuursbeleid te kan formuleer.

Aangesien geen uitvoerige navorsing in die verlede op die spesie gedoen is nie, is daar in die projek van die eliminasieproses gebruik gemaak met die hoop dat, soos meer en meer gegewens beskikbaar word, die "voorkeur-habitat" van die spesie sal uitkristaliseer,

Ten einde vas te stel of hierdie spesie 'n gebied op die rand van hul natuurlike verspreiding in sentraal en suidelike Afrika bewoon, en of hulle in 'n "beskikbare" habitat in Rhodesië voorkom, word 'n uitvoerige ondersoek na die vroeëre en huidige verspreiding van hierdie spesie in Afrika bespreek. Alle beskikbare gegewens wat betrekking her op die ekologie en die sosiale gedrag van die spesie, word ingesluit.

Deur gebruik te maak van lugfoto's, is die wildgedeelte van die studiegebied gekarteer en in twee breë plantegroeistreke verdeel; die Brachystegia glaucescens - savanne-boomveldstreek wat beperk is tot die Malilongwebergreeks, en die *Colophospermum mopane*-savanne-boomveldstreek op die basaltvlakte. Hartbeeste is slegs in die dreinerings gebied van die basaltvlakte aangetref en daarom het die plantegroei hier meer aandag geniet as die van die Malilongwebergreeks en is dit onderverdeel in dié volgende gemeenskappe:

1. *Colophospermum mopane* - savanne-boomveld.
2. *Acacia nigrescens* - oop boomsavanne
3. *Acacia exuvialis* - ruigte
4. *Dichrostachys cinerea* - ruigte
5. *Acacia tortilis* - savanne-boomveldstreek
6. *Commiphora africana* - *Cassia abbreviata* - *Adansonia digitata* - oop - boomsavanne.
7. Rivieroewergemeenskap.
8. Dreineringslyn oop boomsavanne wat die 'dambo' - assosiasies insluit.

Die klassifikasie wat gebruik is, word ondersteun deur floristiese gegewens. Deur gebruik te maak van gegewens oor die verspreiding van hartbeeste gedurende die hele studietydperk, kon die studiegebied verder gereduseer word tot 'n opname-gebied bestaande uit ses habitat-tipes waarvan die hartebeeste gedurende een-of-ander tyd van die jaar gebruik gemaak het.

Hierdie habitat-tipes sluit elemente van een of meer van die plantegroeigemeenskappe wat beskryf is, in en is as volg geidentifisser:

1. Colophospermum mopane - savanne - boomveldstreek habitat-tipe.
2. Colophospermum mopane - Acacia nigrescens - dreineringslyn oop boomsavanne habitat-tipe.
3. Acacia nigrescens - oop boomsavanne habitat-tipe.
4. Acacia exuvialis - ruigte habitat-tipe.
5. Colophospermum mopane - dreineringslyn oop boomsavanne habitat-tipe.
6. Dreineringslyn oop boomsavanne habitat-tipe.

'n Plant-tot-plant afstandmetingsmetode en die stappunt-kwartmetode is gebruik om kwantitatiewe gegewens oor die floristiese samestelling en struktuur van die plantegroei in die ses habitat-tipes te verkry. Die fisionomie van die plantegroei in die hele opname-gebied word bespreek terwyl die fisionomie van elk van die ses habitat-tipes vergelyk word en met betrekking tot die jaarlikse migrasie van die hartebees bespreek word.

Die rede vir hierdie migrasie is onbekend en dit word vermoed dat dit verband hou met die voortplantingsgedrag of aangespoor ord deur veranderinge in die grondvogbalans wat die gehalte van die dieet in die "dambo" - assosiasies beinvloed.

Die gevolgtrekking wat na hierdie ondersoek gemaak word, is dat die lang-grasveldgebiede, gekenmerk deur die aanwesigheid van Ischaemum afrum en Setaria anceps, die habitat-tipe is waaraan die vaalhartbees die meeste voorkeur gee. Hierdie habitat-tipes word egter ingedring deur houtagtige plantegroei wat die "dambo" ongeskik vir die hartbees mag maak.

Hierdie indringing van houtagtige spesies hou verband met die grondvogbalans en veranderinge in hierdie aspek van die ekologie van die studiegebied lei tot veranderinge in die grassamestelling. Verdere fisiese vernietiging van die "dambo" vind plaas as gevolg van die feit dat ander hoefdiere, veral bont kwaggas, hierdie grasvelde in die droee seisoen as voedselbron gebruik. Hierdie mag een van die faktore wees wat die jarrlikse migrasie veroorsaak.

Met die beskikbare inligting in gedagte - en dit word beklemtoon dat heelwat verdere ondersoeke nodig is - word 'n kort-en langtermyn bestuursbeleid voorgestel met die hoop dat dit die oorlewingsvooruitsigte van die hartbees in die laeveld sal verhoog.

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