CHARACTERIZATION OF MAMMAL HAIRS AND THEIR APPLICATION IN DETERMINING DIET COMPOSITION OF LION (*PANTHERA LEO MASSAICA* NEUMAN) IN THE SALIENT REGION OF ABERDARE NATIONAL PARK, KENYA.

BY

PETER KINARO KIBANYA (BSc. Hons, NAIROBI)

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

21st June 1996

PETER KINARO KIBANYA **DATE**

This thesis has been submitted for examination with my approval as the University Supervisor:

Warui Karanja 21/6/96

DR. WARUI KARANJA **DATE**

DEDICATION

This thesis is dedicated to my dear parents whose idea to educate me was noble.

ACKNOWLEDGEMENTS

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Thanks to my supervisors, Drs. Warui Karanja and Vanden Berghe for their support and encouragement during the study and when writing up this thesis. Lydia Kigo of National Museums of Kenya, Nairobi assisted in analyzing lions' scats and preparation of hair microphotographs. To her I really express my appreciation. I cannot fail to thank Dr. Kock, the Chief Veterinary Officer of KWS for assisting me in procuring some of the mammal hairs which proved to be useful in the course of the study. Last but not least, I sincerely thank Mr. John Muhanga, Senior Warden of Aberdare National Park for his great assistance and cooperation in the course of the study.

ABSTRACT

This study sought to determine the diet composition of lion in the salient region of Aberdare National Park by analysis of hairs obtained from their scats. Monthly counts of potential lion prey species were carried out in order to see whether there was a relationship between the abundance and their level of predation by lion.

There was no significant difference in diet composition of lion in areas A, B and C of the salient region or even during the wet and dry seasons. The lions were found to have a broad diet and showed preference for bushbuck *Tragelaphus scriptus*, suni *Neotragus moschatus* and buffalo *Syncerus caffer* in that order. Bushbuck constituted about 45.9% of the lion diet while the suni and buffalo constituted 18.8% and 6.9% of their diet, respectively. Bushbuck was the most abundant species in the salient region and this might explain why it dominated the lions' diet. Both buffalo and elephant *Loxodonta africana* were also abundant but they were not important prey species for the lion. In spite of the low abundance of suni, it was the second most important prey species for the lion and this may be due to the fact that it was more preferred in relation to other species. The other prey species were taken in very low proportions in relation to those common in the diet.

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

1.0 INTRODUCTION

The Lion, *Panthera leo*, is one of the largest mammalian carnivores. According to Guggisberg (1961) and Lowie (1966), the distribution of free ranging lion has greatly changed and is therefore mostly confined to Africa. The carnivore has disappeared from its ranging habitats in Europe and most of Asia (Guggisberg 1961; Saba 1974). In view of this, studies on the biology and ecology of lion have mostly been done in Africa. In Kenya, the distribution of lion has also changed mainly due to hunting and loss of habitat. Most studies on lion appear to conentrate on populations found in Eastern and Southern Africa where the species is abundant. Some of these studies have only described the general biology of the lion (e.g. Stevenson-Hamilton 1954) and feeding behaviour (e.g. Eloff, 1964; Mitchell *et al.*, 1965; Kruuk and Turner, 1967; Hirst, 1969 and Pienaar, 1969). Other studies have provided information on the ecology and social behaviour of the lion (e.g. Rudnai, 1970; Schaller, 1970 and Berthram 1973).

1.1 TAXONOMY AND DISTRIBUTION OF LION

From the head to the rest ot the body, a lion measures between 1 8-2.4 m and weighs between 181-227 Kg (Walker, 1968). Although there is remarkable basic uniformity among the members of the cat family, there is a lot of confusion in their taxonomy due to variation in size and body colour pattern. Haltenorth (1953) recognized four sub-families of the Felidae, mainly: the Lyncinae, Pantherinae, Felinae and Acynonichinae. The Pantherinae is made up of two genera; *Uncia* and *Panthera*. Linnaeus in his book Systema Naturae (1758) placed these two genera in the genus *Felis*, but this was changed later by Pocock (1917) who placed them into the sub-family Pantherinae. However, Herschkowitz, (1949), cited by Mazak (1965) maintains that the genus *Leo* (Brehm) should be used instead of the genus *Panthera* which is universally accepted. The jaguar *Panthera onca*, leopard, *Panthera pardus*, tiger and lion belong to the genus *Panthera*. The lion is one of the biggest members of the cat family (Felidae), although the tiger, *Panthera tigris*, is slightly bigger in size.

The lion is similar to other felids in its lithe, muscular, deep chested body with rounded and shortened head and reduced dentition. It has a total of thirty (30) teeth with the dental formula being:-

$$\frac{3\ 1\ 3\ 1}{3\ 1\ 2\ 1}$$

The carnassials are well developed while the canines are elongated, recurred and somewhat larger on the upper than the lower jaw. A number of sub-species of lion have been proposed based on colour, body size and growth pattern of the mane (Guggisberg, 1961). These include:-

Cape lion - *Leo leo melanochaitus* (Hemsmith) or

- *Leo leo capensis* (Fischer)

Masai lion - *Leo leo massaicus* (Neumann)

Barbary lion - *Leo leo leo* (Linnaeus)

Indian lion - *Leo leo goojratensis* (Smee)

Senegal lion - *Leo leo senegalensis* (Meyer)

Kruger lion - *Leo leo krugeri* (Roberts)

Kalahari lion - *Leo leo vernayi* (Roberts)

Panthera leo occurred in nearly the whole of Africa and some parts of Asia, Europe and East India. However, this species totally disappeared in Europe around the 1st Century AD due to extinction (Meyer, cited by Mazak, 1965). It also disappeared from the Middle East and North Africa during the last 100 years (Guggisberg, 1961). Today, the species is now found in Africa only south of the Sahara and in the Gir Forest Wildlife Sanctuary in India (Guggisberg, 1961).

Figure I.1(a) and I.1(b) show the distribution of the *Panthera leo* in the early 19th Century and later in the mid 20th Century respectively. During the former period, the lion was spread in a large portion of Africa, except in the Sahara and West African rain forests. However, as shown by Figure I.1(b), there occurred a reduction in the species range largely because of human activities especially agriculture which has claimed large area which acted as habitats for the lion. With increased human population and subsequent increase in cultivated land, the range will continue to decrease. Figure 1.2 shows the present distribution of lion in Kenya and those areas where it has been eliminated since 1885. This distribution continues to change as human population increases with subsequent encroachment of the lion's habitats.

The size of their social group or pride depend on the availability of prey and the nature of the vegetation (Ewer, 1973). Therefore the largest social groups are mostly found in areas where the terrain is quite open and the prey is abundant (Guggisberg, 1960). Various authors (for example, Schaller, 1968b, 1969c; Schaller and Lowther, 1969; Rudnai, 1970, 1974; Saba, 1974) have made detailed studies on the social organization of the lion. These studies have

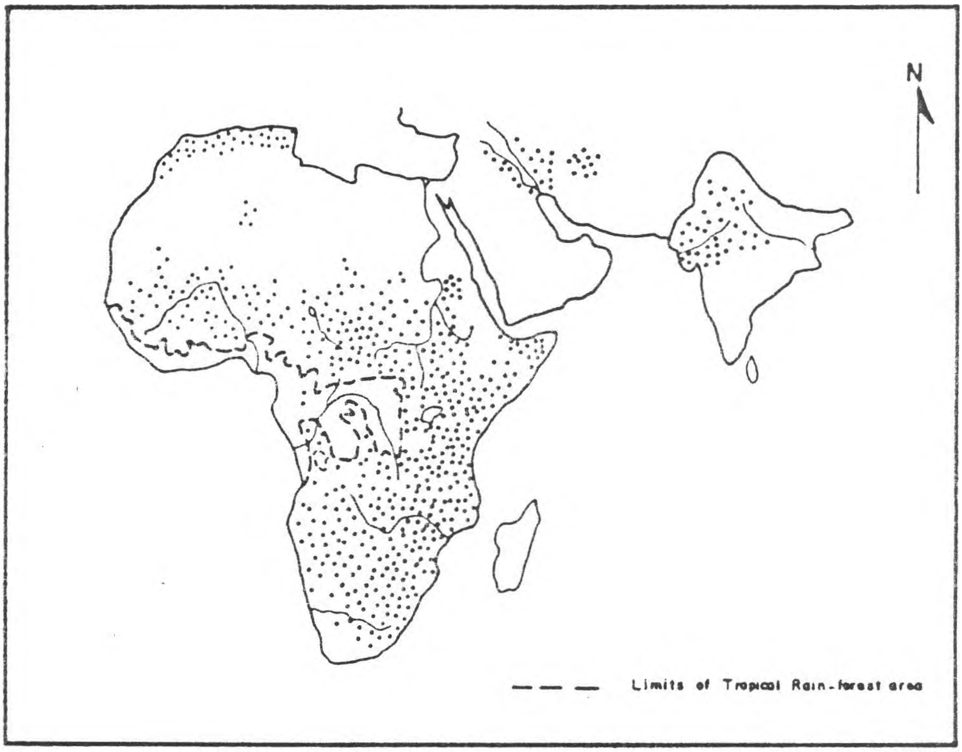


Fig.1.1a: Lion distribution in the first half of the 19th century.

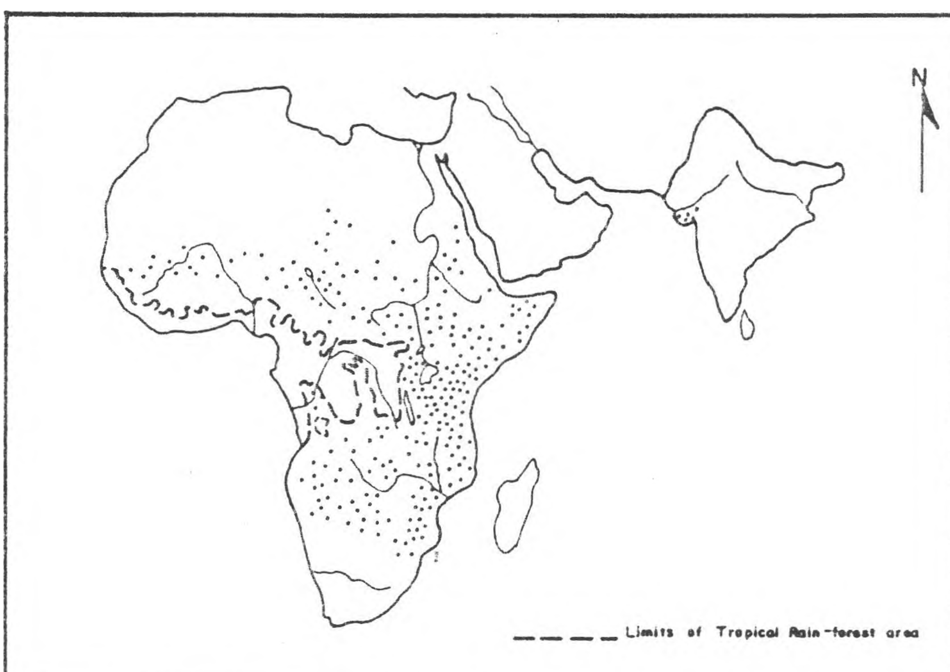
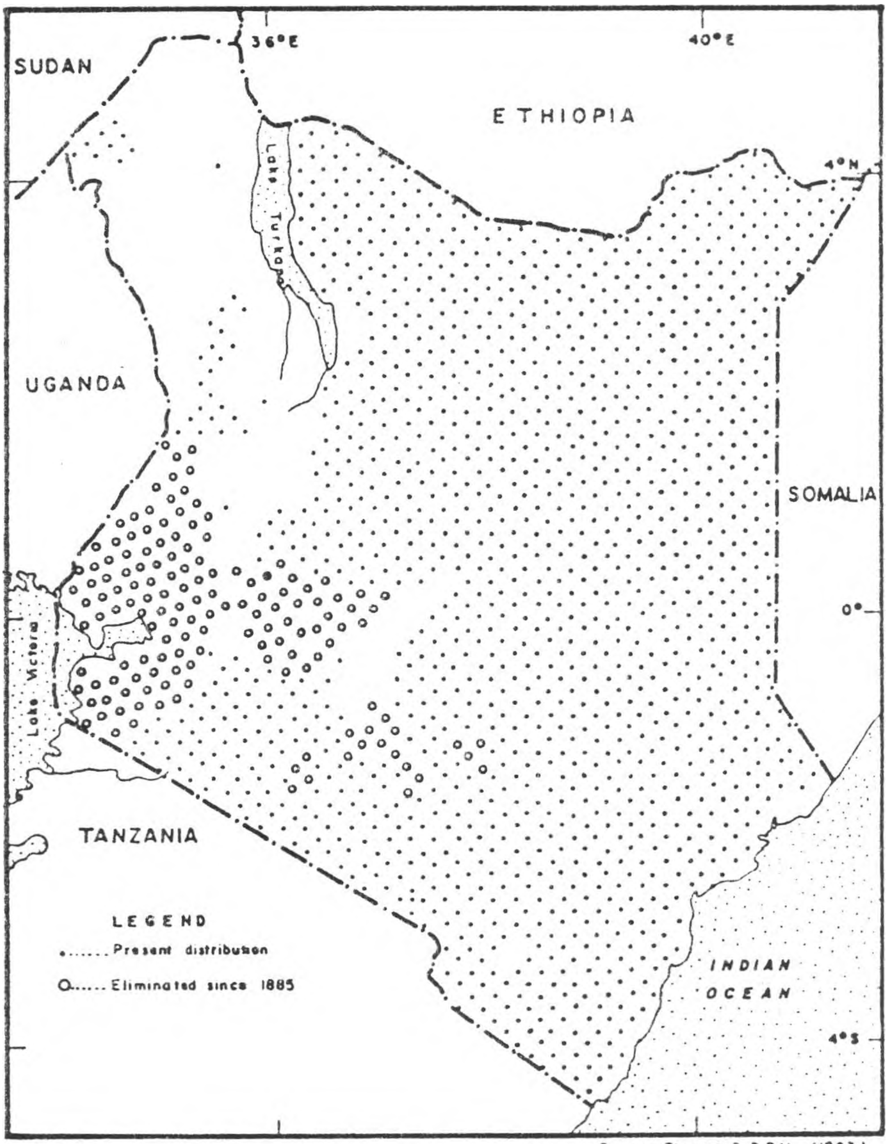


Fig. 1.1b: Lion distribution in the middle of the 20th century.



Source: Stewart & D.R.M. (1963)

Fig. 1.2: Distribution of Lion in Kenya.

show that the lion's social organization is similar irrespective of the locality. The studies have also shown that there are differences in pride sizes and these according to Guggisberg (1961), can be attributed to differences in habitats where the different populations are found. In general, pride size have been found to be quite similar in different open habitats (Eloff, in Ewer, 1973). In certain situations, large lion prides have been seen to be a reflection of an adaptation to combacting a high scavenger population (Rudnai, 1970).

Among lions, social organization is to a certain extent quite loose (Ewer, 1968). Therefore, members of a pride are rarely together at all times and they separate and re-unite quite frequently and males in particular wander a lot from one pride to the other (Schaller, 1968b, 1969c; Schaller and Lowther, 1969). In summary it can be said that there is no conclusive evidence as to which factors influence pride size in lions.

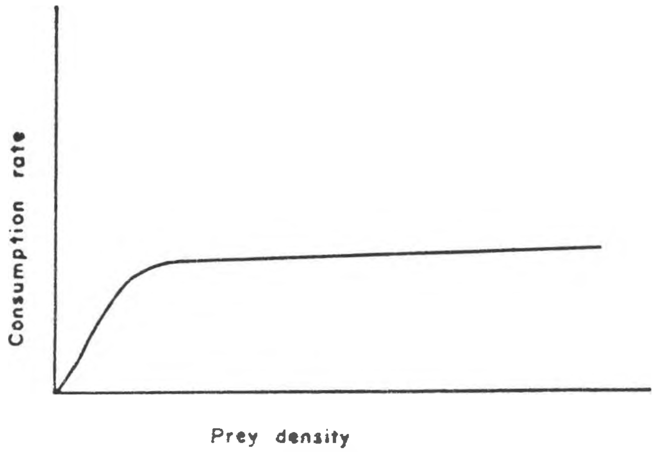
1.2 LITERATURE REVIEW

The lion is the only member of the cat family (Felidae) that leads a social life (Rudnai, 1970, 1974; Saba, 1974; Schaller 1966; Ewer, 1973). To a certain extent, the population of predators is limited by the availability of prey in a density dependent manner (Hairstone *et al.*, 1960). However, social factors are also important in regulating populations of predators (Stevenson-Hamilton, 1937; Schaller, 1967). According to some authors for instance Wright (1960) and Schaller (1967), what limits a predator population is not very much the prey availability but rather its vulnerability. Therefore few prey species in broken terrain can support a high population of predators in a similar way to a situation where you have open plains (Rudnai, 1970).

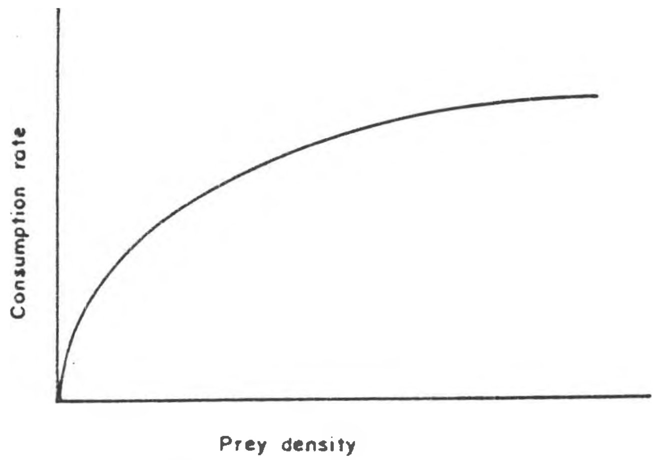
Predators can either be monophagous, oligophagous or polyphagous although most of them have a relatively broad diet. Some are however specialized in their feeding habits. In nature, predators rarely exterminate their source of food (i.e. the prey) since they have co-evolved in the same environment unless there are natural or man incurred interferences live poaching and disease epidemics (Begon *et al.*, 1986).

Food availability and density is very crucial to the survival of a consumer since the greater the density and availability of food, the more the consumer will eat up to a certain threshold (Solomon, 1949). This has been referred by Solomon (1949) as "functional response". According to Holling (1959), there are three types of functional responses. Type one functional response is found in a situation where the predator's consumption rate of a prey increases linearly up to a maximum as prey density increases upon which it remains at a maximum irrespective of any further increase in the abundance of the prey (Figure 1.3a). The type 2 functional response is a situation where the predator's consumption rate of a prey increases as prey density increases but it gradually decreases irrespective of prey abundance (Figure 1.3b). This is the most common type of functional response. The last type of functional response is called type 3 response (Figure 1.3c) and this is quite similar to type 2 response at high prey abundance. But with this type of response, at low prey densities, there is an acceleration phase where an increase in prey abundance leads to a more-than-linear increase in the rate of prey consumption and this produces an S-shaped curve typical of situations where a predator "switches" its prey preferrence depending on its availability and abundance.

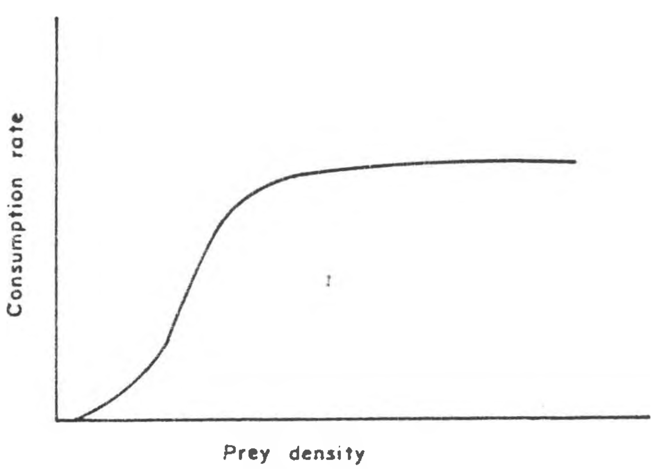
Fig. 1.3: The three types of functional responses by predators.



(a) The type 1 functional response



(b) The type 2 functional response



(c) The type 3 functional response

A number of authors have studied the feeding ecology of lions in Africa (e.g. Pienaar, 1969; Schaller, 1972; Rudnai, 1970, 1974; Saba, 1974). These studies showed that lions only feed on certain prey species among a wide variety of potential prey species. Differences in the mode of catching and killing the prey among lions has been reported. For example, Eloff (1964) reported that in most cases lions of Southern Africa killed their main prey, the Gemsbok, *Oryx gazella*, by breaking its neck. On the other hand Rudnai (1970) and Schaller (1972) reported that in general, lions of East Africa normally killed their prey either by inflicting neck bite or by suffocation.

The diet of lions in different parts of Africa has extensively been studied e.g. Schaller (1972) in Lake Manyara National Park; Tanzania, Rudnai, (1970, 1974) in Nairobi National Park, Kenya, Pienaar (1969) in Kruger National Park, South Africa; and Saba (1974) in Masai-Mara National Reserve, Kenya. These studies have shown that lions normally fed on medium sized herbivore species and that they are quite selective in their feeding habits. Table 1.1 gives a summary of lion diet composition that has been studied in different parts of Africa. Most of the studies carried out on the feeding ecology of lions have been based on direct observations of lions feeding in their habitats (e.g. Schaller, 1972; Pienaar, 1969; Rudnai, 1970, 1974; Saba, 1974; Zubiri and Gottelli, 1987). The problem with this method is that to a certain extent it might not show in detail the diet of lions in a given study area. This means that some prey species which could significantly contribute to the lion's diet might be missed out and thus underestimate their contribution to a lion's diet. In view of this, if one is to establish the diet of free ranging lions it is important to combine both direct observations with indirect methods, like using prey hairs contained in their scats to speculate on the observed spatial differences. If this is done carefully, then one can almost accurately determine the diet of

TABLE 1.1: PERCENTAGE FREQUENCY OF OCCURRENCE OF PREY SPECIES IN LION DIET FOR SOME AFRICAN CONSERVATION AREAS

PREY SPECIES	AREA OF STUDY						
	A	B	C	D	E	F	G
WILDEBEEST	2.0	48.3	25.0	6.1	23.6	34.7	34.1
ZEBRA	16.0	20.7	14.6	7.3	15.8	21.6	16.4
IMPALA	11.0	2.7	0.9	2.0	19.7	0.3	-
WATERBUCK	1.0	-	-	5.9	10.5	0.08	0.5
ELAND	-	1.8	1.7	2.9	0.5	1.1	0.5
HARTEBEEST	-	10.5	34.5	16.3	-	0.5	3.2
WARTHOG	-	8.7	6.9	9.5	1.9	1.8	3.6
GIRAFFE	2.0	3.9	1.7	-	3.9	0.8	3.6
BUFFALO	62.0	-	-	30.5	9.2	5.5	34.5

KEY TO STUDY AREAS

A- LAKE MANYARA NATIONAL PARK- SCHALLER (1972)

B- NAIROBI NATIONAL PARK- FOSTER & KEARNEY (1967)

C- NAIROBI NATIONAL PARK- RUDNAI (1970)

D- KAFUE NATIONAL PARK- MITCHELL ET AL. (1965)

E- KRUGER NATIONAL PARK- PIENAAR (1969)

F- SERENGETI NATIONAL PARK- SCHALLER (1972)

G- MASAI-MARA GAME RESERVE- SABA (1974)

lions.

Previous studies on diet composition of lions have relied on direct observations, this study sought to determine the diet of lions using prey hairs contained in their scats. No literature is available on studies that have been carried out to determine the diet of lions using this method. However, the method has been used to study other predators, for example Zubiri and Gottelli (1987) on hyaena, Wambuguh (1990), on hyaena, Day (1966) on stoats and weasels and Gamberg and Atkinson (1988) on ermine *Mustela erminea*. The studies have shown that hairs contained in predator scats can be used to estimate composition of their diet. This study aimed at determining the diet of lions in the salient region of Aberdares National Park by the same method. The specific objectives of the study were :-

(a) To establish the hair characteristics of various mammal species fed on by lions in the salient region of the park.

(b) To develop a data base in form of microphotographs of hairs of different mammal species which can be used in determining lion diet.

(c) To estimate the diet composition of lions in the salient region of the park.

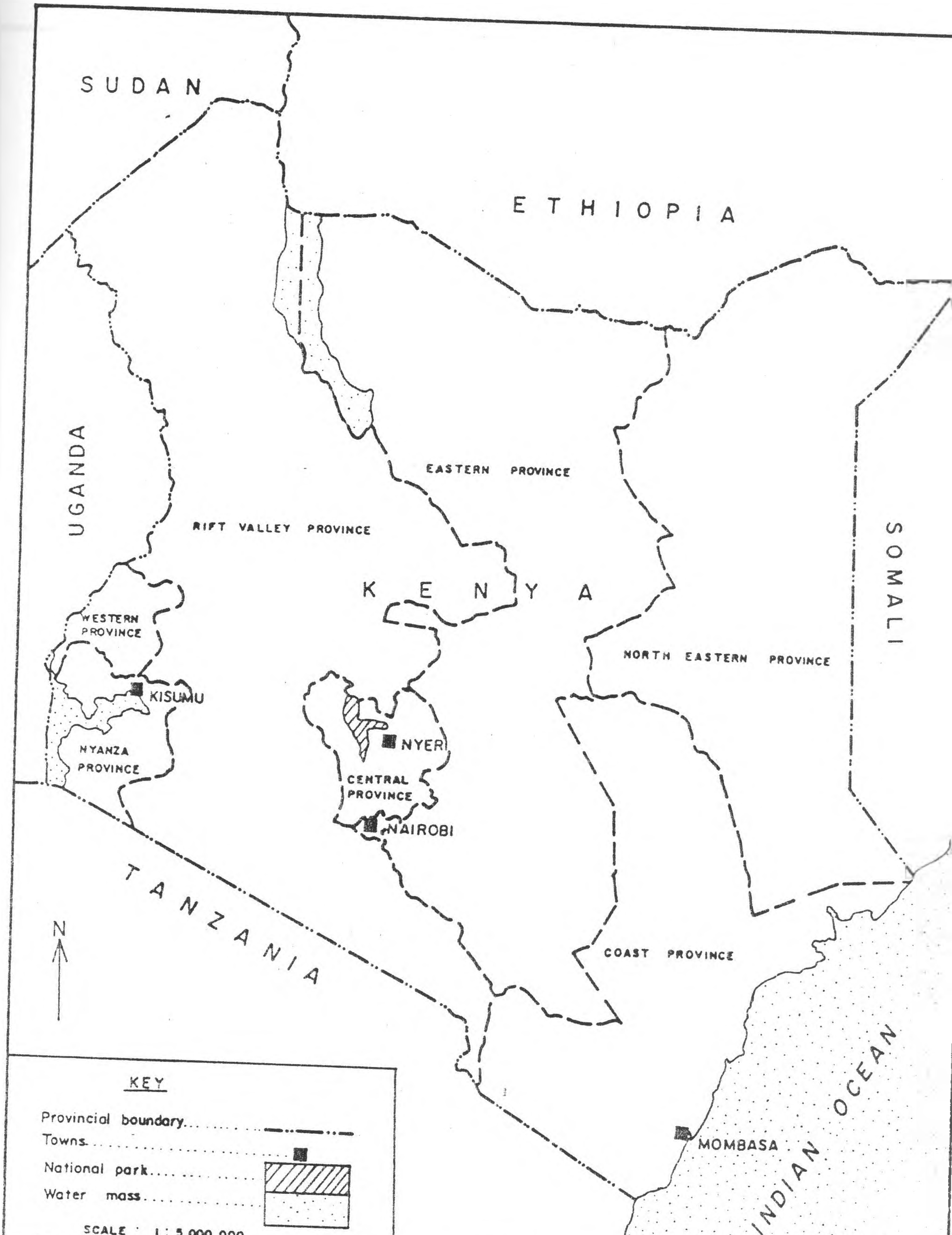
(d) To determine the abundance of potential lion prey species in the salient region of the park.

1.3 STUDY AREA

This study was carried out in Aberdares National Park whose area is about 767 Km^2. The park was gazetted in 1950 and shares boundaries with Muranga, Nyeri and Nyandarua Districts of Central Province and mainly comprises the Aberdare Mountains (Nyandarua Ranges). Geographically, the park is located about 17 Km from Nyeri town and 171 Km North of Nairobi City (Fig 1.4 and 1.5). It lies between longitudes 36°31' East and 36°57' East and latitudes 0°08' South and 0°42' South. The park was gazetted in order to protect its diverse biodiversity. Of particular interest is the protection of black rhino *Diceros bicornis* and bongo, *Tragelaphus eurycerus* which are endangered species (1991-96 - Park Management Plan). Other species which are worth conserving are the elephant, *Loxodonta africana* and the lion, *Panthera leo*. Currently, there is a proposal to fence about 22 Km of the park. Once this fence is completed it will prevent destruction of adjacent small scale farms and this will alleviate conflict between farmers and the wildlife. Figure 1.6 shows the infra-structure of the park.

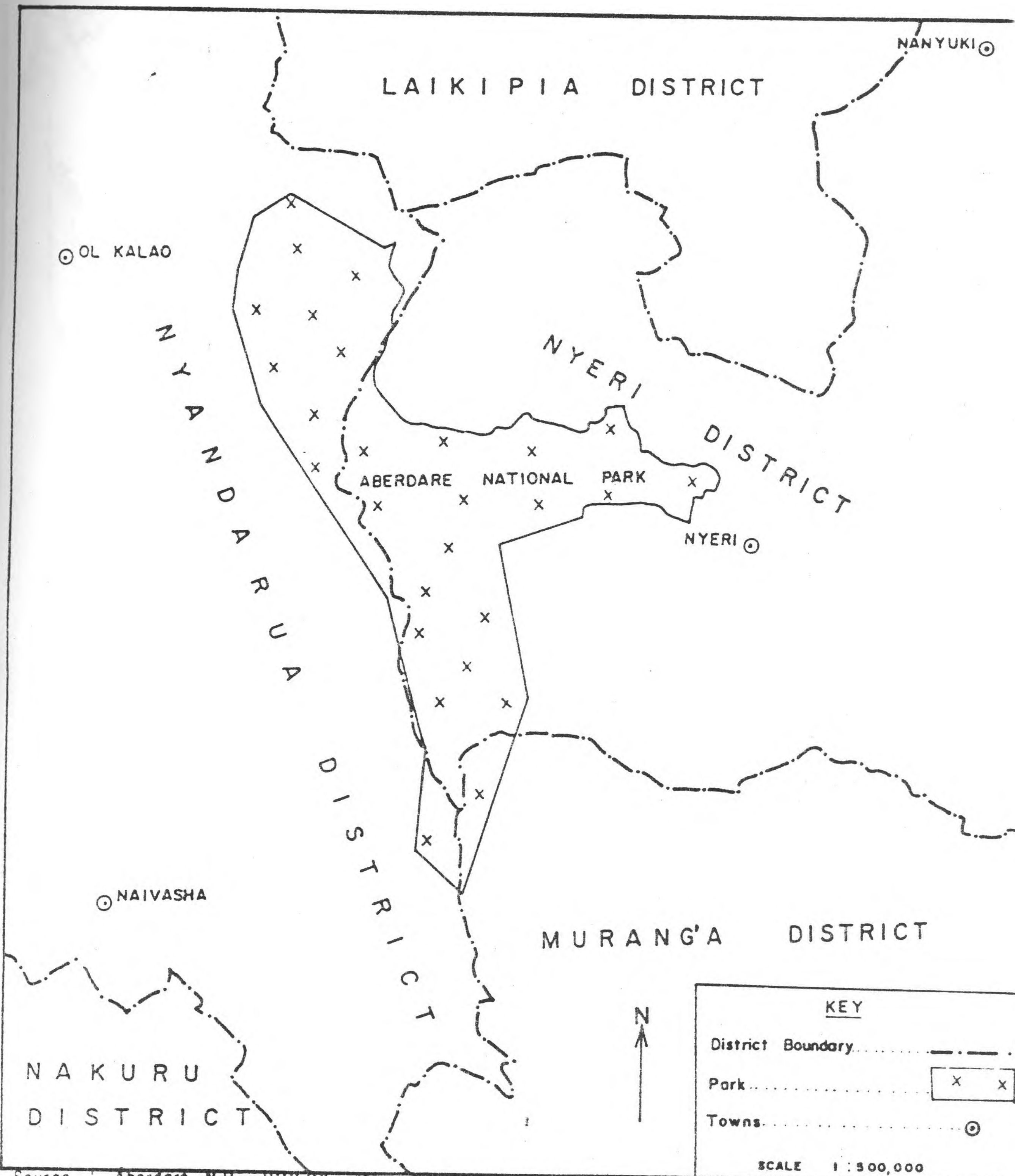
1.3.2 CLIMATE

There are variations in the climate of the park also depending on location and altitude. Around the park headquarters (at Mweiga) the amount of rainfall is about 900 mm per year but this increases to slightly above 200 mm per year at Kiandongoro Gate near the Central Moorlands (1991-1996 - Park Management Plan). Rainfall pattern is bimodal with long rains occurring around April-May while the short rains occur around November-December. However, although the park also experiences out of season wet and dry spells, dry spells are not common. Since the park forms part of the Aberdare Mountains (Nyandarua Ranges), temperatures are relatively low and the mean minimum temperature is slightly less than 6°C



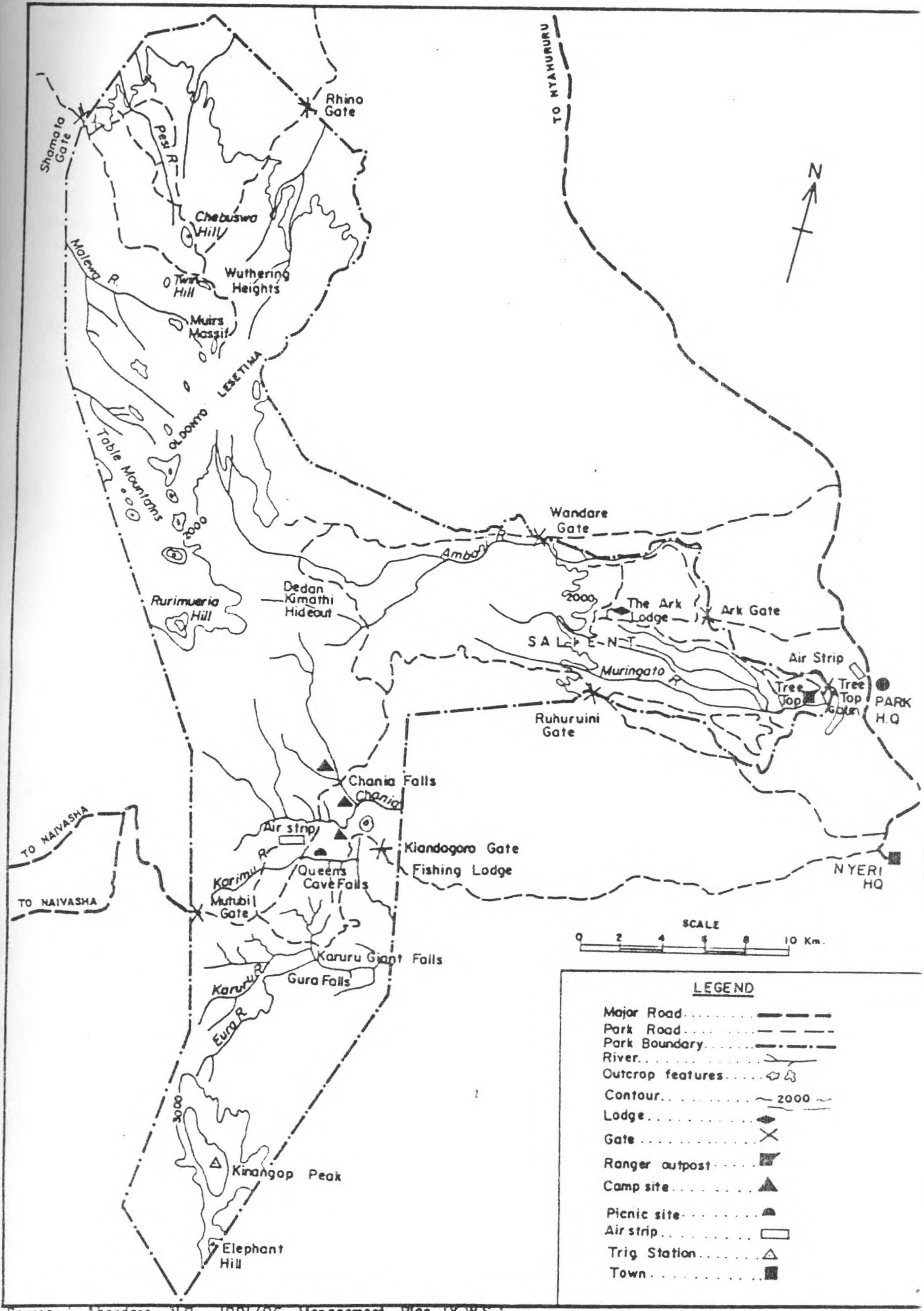
Source : Aberdare N.P. – 1991/96 Management Plan (K.W.S.)

Fig. I.4: Aberdare National Park: National setting.



Source : Aberdare N.P. – 1991/96 Management Plan (K.W.S.)

Fig. 1.5: Aberdare National Park: Administrative and Regional setting.



Source : Aberdare N.P. — 1991/96 Management Plan (K.W.S.)

Fig.1.6: Aberdare National Park: Infra-Structure and Rivers.

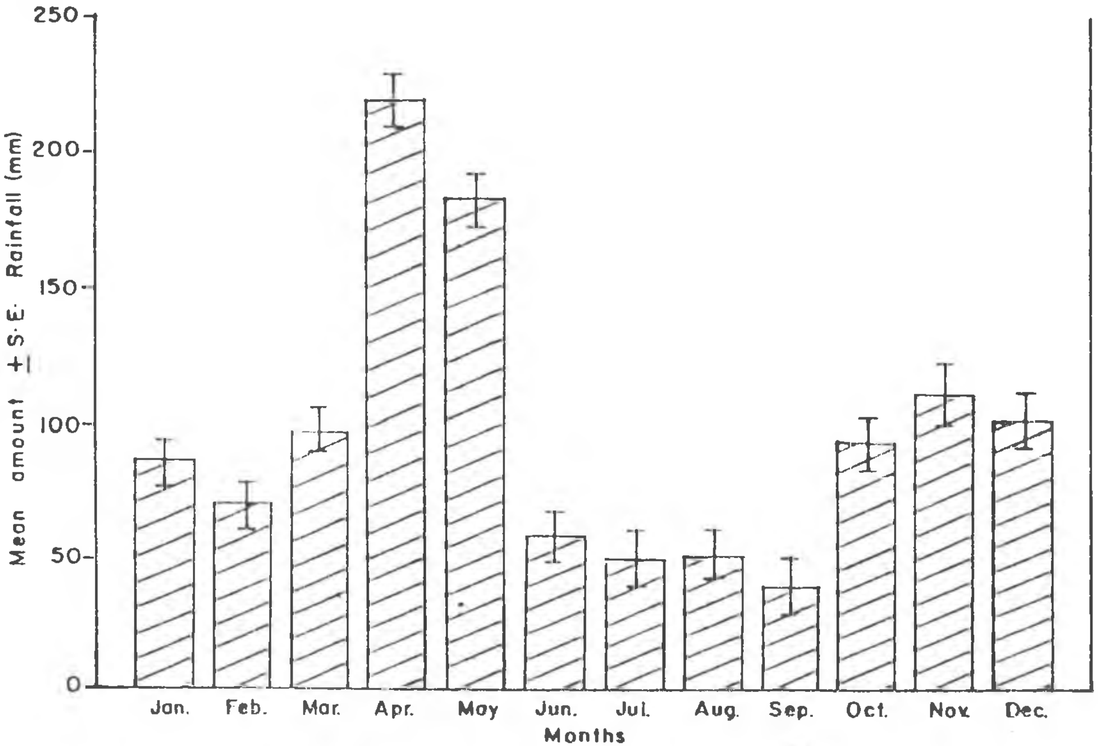


Fig. 1·7 : Mean ± S·E· rainfall (mm) for Aberdare National Park (1973—1992) while the maximum temperature is lower than 18°C (National Atlas of Kenya).

1.3.3 PHYSIOGRAPHY

1.3.3.1 HYDROLOGY

Aberdares National Park is an important water catchment area and contributes significantly to the waters of the Athi and Tana Rivers and a section of the Central Rift Valley drainage basin. The Ewaso Nyiro River which drains into the Northern part of Kenya, the Tana River and River Malewa which drains in to Lake Naivasha all originate from the Aberdares National Park. Within the park there are several small streams whose water drains into the main rivers (Fig. 1.6). The moorland together with the agro-alpine zones contain a number of bogs which act as a source of small sized rivers.

1.3.3.2 TOPOGRAPHY

Since the park forms part of the Aberdare Ranges, its topography is quite varied (Figure 1.7). Rock outcrops, V-shaped valleys and steep hills are some of the topographic features that are found within the park. Undulating plains are also found at the Northern sections of the park and certain areas of the lower salient region.

1.3.4 GEOLOGY AND SOILS

Aberdare Ranges were formed by a combination of faulting which lead to the formation of the Great Rift Valley and to a certain extent volcanic eruption. Most of the rocks found in this area are alkaline in nature although ryholites and basalts are also common (Fig. 1.8 shows the geology of the Park).

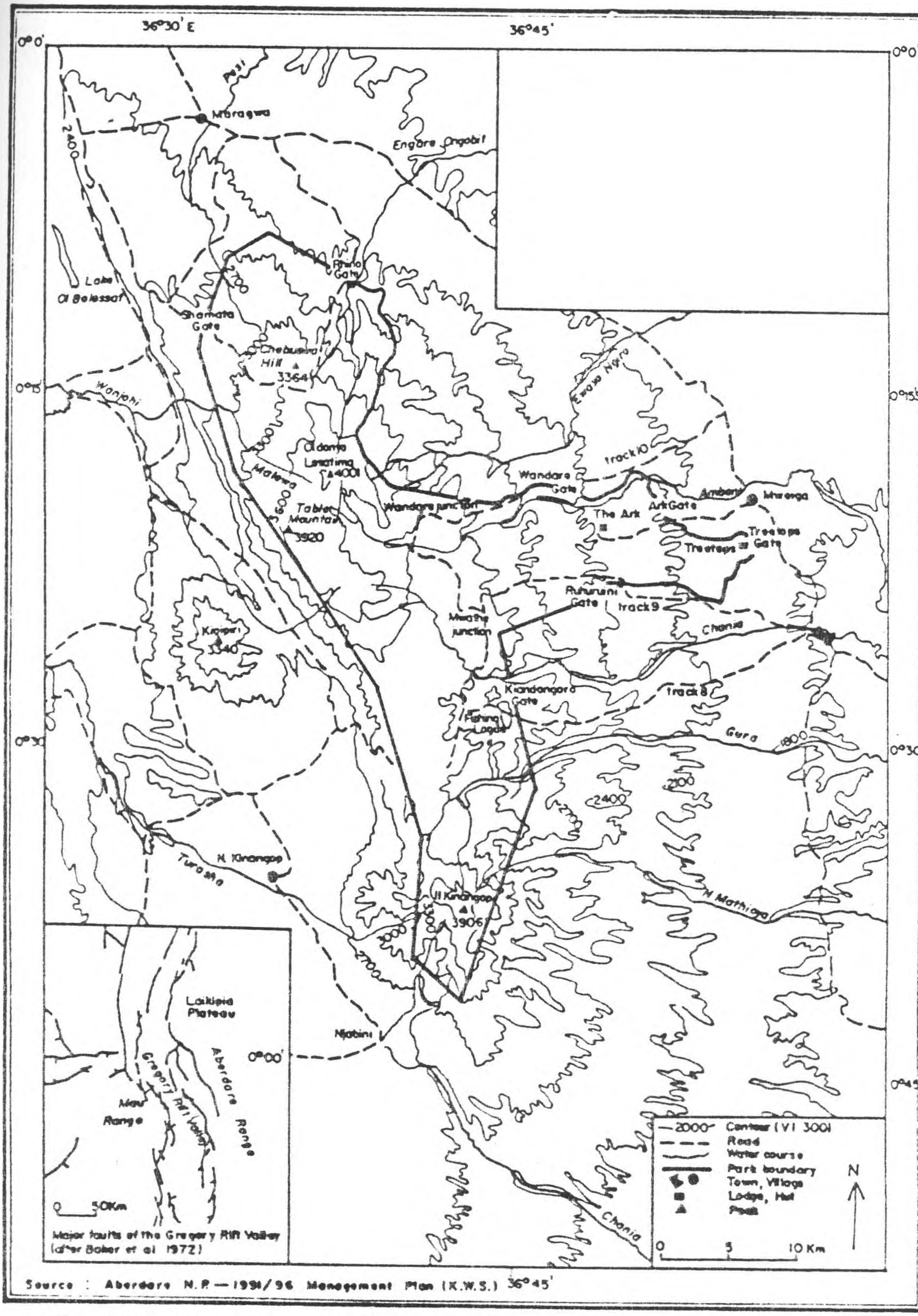


Fig. 1.8: Aberdare National Park: Topographic Features.

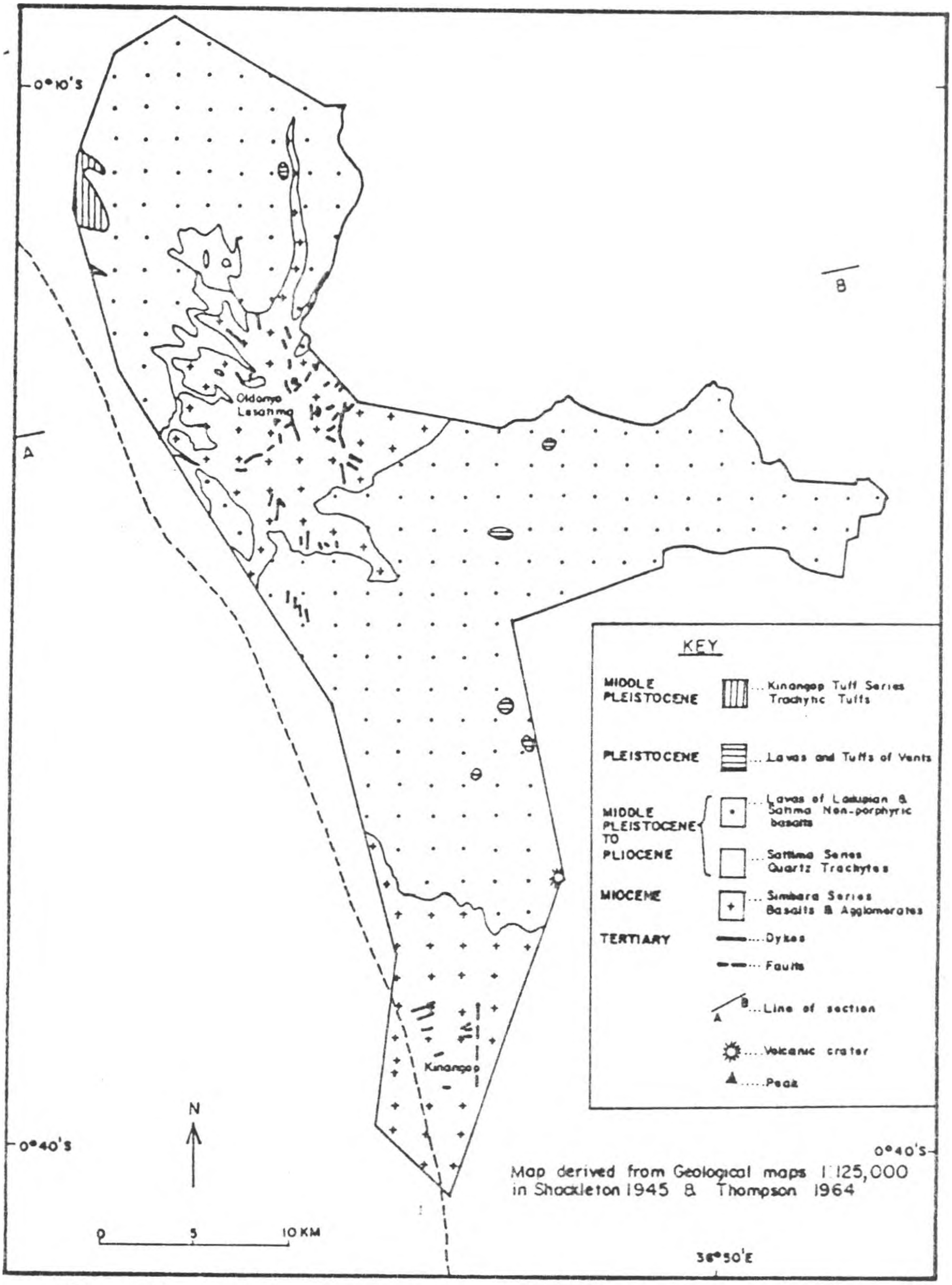


Fig. 1.9: Geology of Aberdare National Park.

The park soils are mainly of volcanic origin and during the dry season they quickly loose their moisture due to evaporation and therefore become quite dry. On the other hand during the wet season, they become extremely sticky, soggy and waterlogged. The lower sections of the park are mostly dominated by deep clay soils, but as one moves to the higher sections, clay and granulated sandy soils become dominant.

1.3.5 FLORA

Information on the flora of Aberdares National Park dates back to 1883 and 1884 when Thomson collected the first plants from the Aberdares Highlands. A list of 140 plant species collected by Thompson was later published by Hooker in 1885. More information on the park's flora was then published, by Jeannel (1950) based on previous visits to the region in 1912 and 1913. Klaus (1991) gave detailed information on the park's flora where he has presented a check list of different vascular plant species that were identified between March 1986 and September 1988. His list comprises of 778 plant species, sub-species and plant varieties belonging to 421 genera and 128 families.

Four types of plant communities can be identified in Aberdares National Park. These are salient shrub, bamboo forest, forest and moorland.

1.7.1 BAMBOO FOREST

This vegetation type occupies about 170 Km^2 of the total park area. It's dominant plant species is the bamboo *Arudinaria alina* but various shrub species are also present.

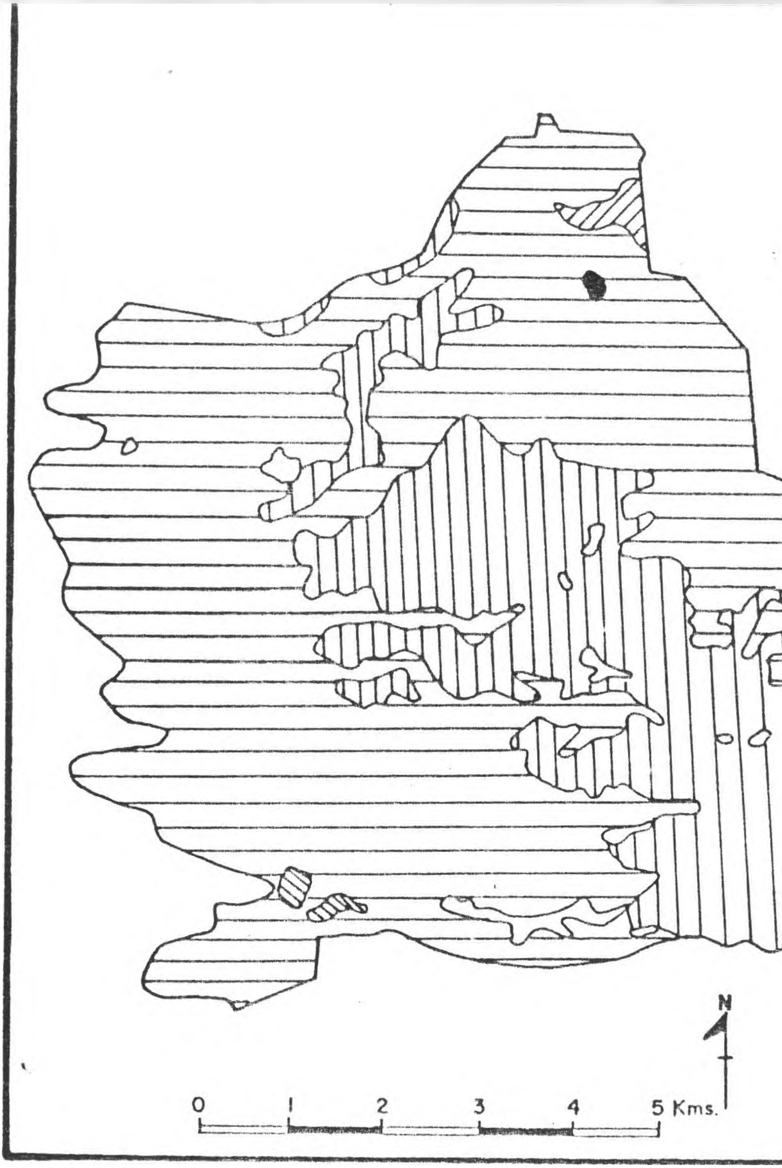
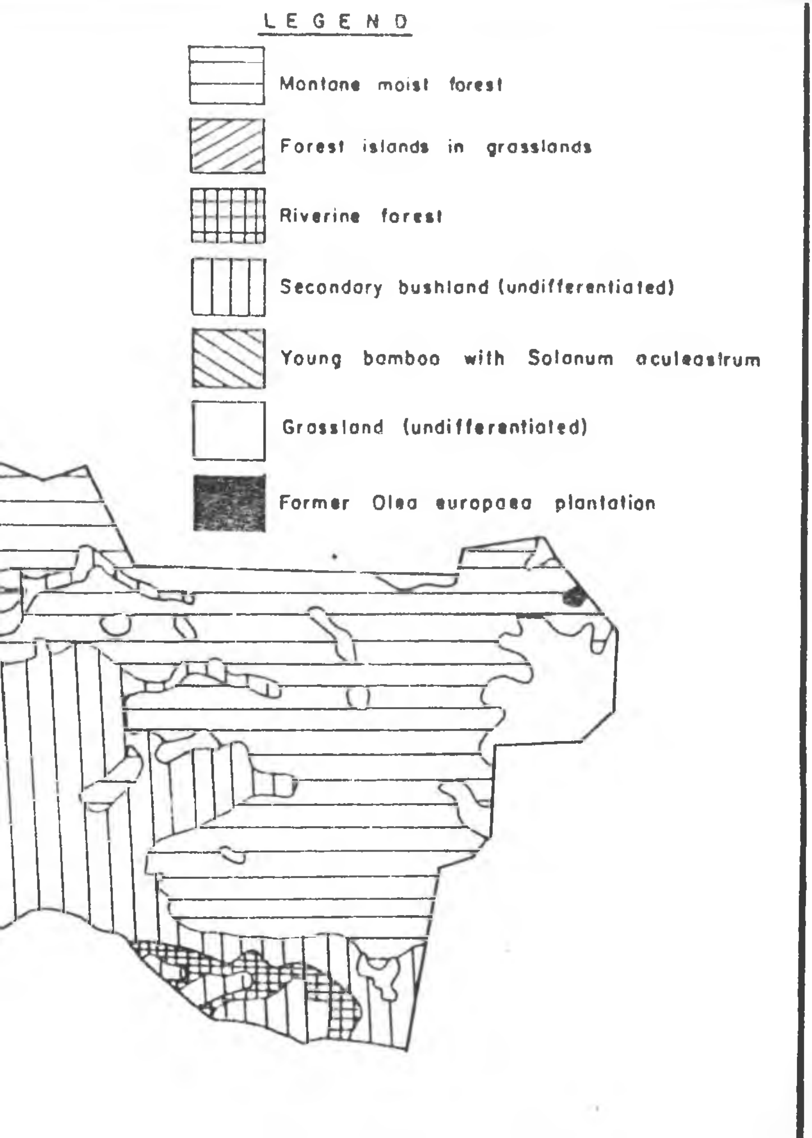


Fig. 1·10 : Vegetation Communities of the Salient region.


LEGEND
Montane moist forest
Forest islands in grasslands
Riverine forest
Secondary bushland (undifferentiated)
Young bamboo with Solanum aculeastrum
Grassland (undifferentiated)
Former Olea europaea plantation

1.7.2 FOREST

The forest covers nearly 158 Km^2 of the park area but has been modified to a certain extent. The most common tree species are *Juniperus procera* and *Podocarpus* sp.

1.7.3 MOORLAND

This is the most extensive vegetation type and occupies about 372 Km^2 of the park. The giant heather, *Erica arborea* is the most common plant species in the dense moorland. The open moorland on the other hand is made up of various sedge and grass species. Unlike the dense moorland, shrubs are almost absent in the open moorland.

1.7.4 SALIENT SHRUB

This vegetation occupies 67 Km^2 of the park and is mostly composed of various shrub species that came about as a result of shifting cultivation and fire. Plant species such as *Hypoestes verticillaris, Ocimum suave, Toddalia asiatica* and *Cynodon dactylon* are quite common in this vegetation community.

1.8 FAUNA.

The park's fauna though little studied is quite diverse. Most of the information available on the fauna is general by authors like Fey (1959), McLaughlin *et al.* (1973), Muiruri (1977) and Prickett (1981). However, some studies of fauna species have been carried out in the near past such as Hebrad *et al.*, (1982) who studied the chameleon, *Chamaelea hohnelii* and skink, *Mabuya varia.* Hillman (1983) studied the bongo., Zubiri and Gottelli (1987) studied the spotted hyaena, *Crocuta crocuta* while Odongo (1987) and Blom *et al.* (1990) studied the elephant.

Most of the park fauna is found in the forest reserve. Elephants, buffalo *(Syncerus caffer)*, black rhino and bongo are some of the large herbivores found in the park. The lion is the most common large carnivore and most of its population is made up of introduced individuals. The colobus, sykes monkey, bushbaby and olive baboon are some of the primates found in the park.

Information on the reptiles is quite scanty, with the Hinds mountain viper being the most known of the reptile species in the park. The park avi-fauna is quite diverse and William (1981) has compiled a list of 204 bird species that are commonly found in the Aberdares. The most common bird species include African Goshawk, Eagles, Francolins, Plovers and Sparrow hawks. Although information on indigenous fish species of is not available, some fish species mainly the Brown and Rainbow trout are known to occur in the streams and rivers of the park. These two fish species were however introduced around the 20th century. A check list of the park fauna is provided on appendix 1.

CHAPTER TWO

HAIR AS A MEANS OF DETERMINING CARNIVORE'S DIET

2.0: INTRODUCTION

All mammals possess hair on their body which chemically belongs to the keratin group of scleroproteins; and this distinguishes them from other vertebrates. However, other mammals may have hair on their body which does not belong to the keratin group. Hairs play varied functions among mammals. In most cases, they play a major role in temperature and heat regulation, while in other cases they serve as a protective device against abrasive action of an animal's environment. They may also function as tactile organs since the hair follicles have a network of nerves at their base. In certain cases, hairs have been modified to act as defence weapon against any attack; for example the spines of hedgehogs and the quills of the porcupine, *Hystrix* spp.

In most cases, mammals possess a double layer of hair which is made up of long, coarse and thick outer hairs and short fine underhair (Figure 2.1a) (Dearson, 1939; Day, 1966; Ryder, 1973). The long and coarse hair are known as guard hairs while the short hairs are known as fine hairs (Day, 1966; Ryder, 1973). The former grow in primary follicles while the latter grow in secondary follicles (Ryder, 1973).

A typical guard hair has a long, narrow proximal shaft portion with no constrictions and this is followed by a broad, flattened shield section which finally narrows in form of a fine tip

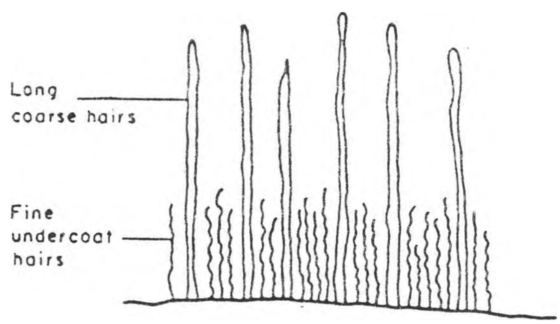


Fig. 2.1a: The double coat typical of deer, wild sheep, goats and probably many more mammals. Source: Ryder (1973)

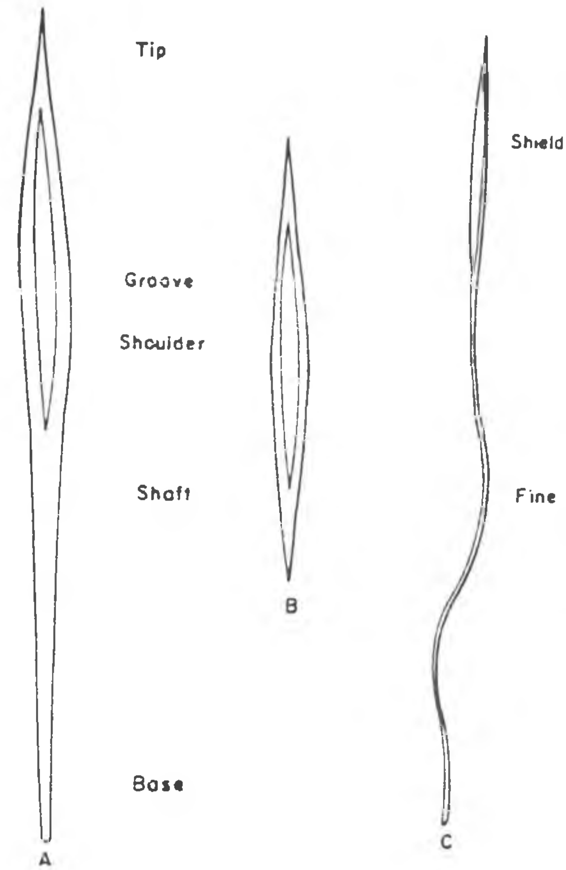


Fig. 2.1b: Hair forms (A) Nonsymmetrical guard hai (B) Symmetrical guard hair; (C) Intermed hair. Source: Perrin and Campbell (1980

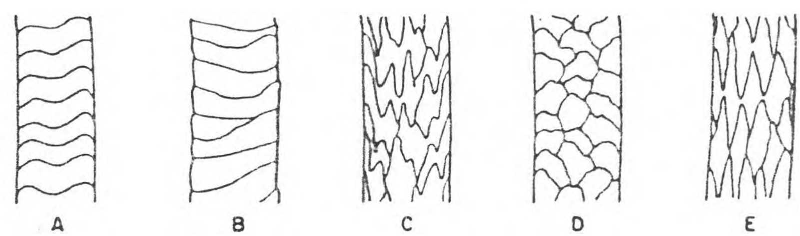


Fig. 2.1c: Cuticular scale patterns. (A) Cupped; (B) Coronal; (C) Chevron; (D) Petal; (E) Pectinate. Source: Perrin and Campbell (1980).

(Day, 1966) (Fig. 2.1b). On the other hand, fine hairs or underhairs are more numerous than guard hairs and their shield section is less pronounced while the shaft is often constricted, but this is not always the case (Day, 1966).

The underhairs normally have a regular diameter, prominent scale edges, an oval rectangular cross-section and their medulla is ladder type (Ryder, 1973). While guard hairs often have a smocth outline and multi-serial medulla. They have an irregular outline which is flattened and frequently dumb-bell shaped in the shield. (Ryder, 1973).

classified hair types as :-

1. Guard hairs which are long and coarse. These include:

(a) Spines which are long and often used in defence.

(b) Awns which are coarse hairs often with a flattened tip and finer base.

(c) Bristles which are stiff and heavily pigmented which is typical of protective outer hairs.

2. Under hairs which are fine and less pigmented. These include:

(a) Wool which is long, soft and often curly

(b) Fur which is thick, fine and short to a certain extent.

(c) Reclus which is the shortest and finest hair.

The coloration of hair is due to the pigment melanin which occurs in the granular. Pigmentation occurs in the cortex, cuticle and the medulla, but more so in the cortex. However, pigmentation ?occurs along the length of a 'single hair. There is evidence that seasonal variation in pigmentations are associated with temperature change. For example, Perry *et al.*, (1985) found out that horses kept indoors had a darker coat than those kept outside during winter.

Both guard and fine hairs have three layers of keratin although there are exceptions (Day, 1966). They include a very thick scaly cuticle which surrounds the hair, a cortex can also be found of varying thickness depending on the type of animal and medulla which is the innermost layer made up of loosely packed cells often containing hair. However, the medulla has three layers and they are herein described briefly.

(a) Cortex

Cortex cells are visible after treatment with the proteolytic enzyme trypsin which isolates the individual cortical cells. They measure about 100 micrometres long and 5 micrometres wide. It is suspected that there are some variations in the thickness of the cortex among different mammals although this has not been fully described (Ryder, 1973).

(b) Medulla

This is only found in thick hairs and the thicker the hair, the greater is the width of the medulla. Latticed medulla are wider, the internal structure of which is the lattice work of struts of keratin separating gas filled pores (Ryder, 1973). This pattern is often found in the coarse outer coat hairs of goats and sheep. Non-latticed medullae is interrupted by the cortex once the diameter of the hairs decreases. They are common on the hairs of man, cow and camel. Ladder type of medulla is found in animals which possess fur. They appear as a series of evenly spaced sub-rectangular elements separated by bridges of cortex.

(c) Cuticle

The cuticle is the thin outer covering of hairs and is made up of flat cells known as cuticular scales. These are difficult to see on the hair itself and the best method of seeing their pattern is to make a cast of the hair in gelatin, celloidin or a resin (Day, 1966). Coarser hairs tend to have a thicker cuticle due to cuticular scale overlap. There are variations in the arrangement and shape of cuticular scales (Figure 2.1c). Their pattern varies both between hair types and mammal species. Studies of human hair suggest that there is individual variation of the cuticular scale pattern which seem to be inherited in a mendelian fashion.

Cuticular scale patterns can be described using three characteristics (Stoves, 1957).

These are:-

(a) The form of the scale margin, for instance smooth, crenated, (i.e. having shallow indentations), and rippled (i.e. having deep indentations)

(b) The distance between the scale margins, for instance, close, intermediate and distant.

(c) The overall scale pattern, for instance, mosaic, woven, petal, (which resembles the overlapping of flowers) and pectinate (i.e. comb-like pattern).

The already described hair characteristics can be used to determine the diet composition of carnivores after isolating the prey hairs contained in the scats and regurgitates. Various authors have therefore used hair remains from faeces and regurgitates to determine the diet of carnivores (e.g. Day, 1966; Kruuk, 1972; Bearder, 1977; Theodore *et al.*, 1978; Zubiri and Gottelli, 1987, Wambuguh, 1990). All these studies have relied on the fact that hair from prey species consumed by carnivores is well preserved and retains its characteristics even after it has passed through the alimentary canal. Therefore, if hair samples are recovered from either faeces or regurgitates of carnivores, they can be identified under a microscope and depending on their characteristics, they can be assigned a specific animal species from which they came from. This is however only possible when reference microphotographs of hairs of possible prey species of a given carnivore are already prepared. The collected hairs are then identified and assigned specific prey species using the prepared microphotographs obtained from hairs of known mammal species.

This study therefore sought to determine the prey species or diet of lion in the salient region of the Aberdares National Park. Before this could be done, hair microphotographs of various potential mammalian prey species were prepared. These were then used to determine the prey species consumed by the lion from hairs collected from their faeces.

2.1 METHODS

Before the study began there was a need to prepare hair microphotographs of potential lion prey species. However, since it was not possible to get a representative sample of live mammal (prey species) hairs which could then be used to prepare microphotographs, hairs of preserved dead mammals found in National Museums of Kenya (Nairobi) were used and their cuticle and medulla thickness compared with some hairs obtained from some live mammal species. This was done in order to find out whether there was any significant difference between the medulla and cuticle thickness compared of dead preserved mammals at the National Museums of Kenya (Nairobi) and some hairs obtained from live mammals.

From each animal species (i.e. dead preserved museum mammals and some live mammals) ten hairs were mounted on a microscope slide using DPX as a mounting media and then observed under a microscope (magnification x 400). Their cuticle (lower and upper) and medulla thickness were then measured in micrometers. The data obtained was then subjected to MANOVA in order to find out whether there was any significant difference between the cuticle and medulla thickness hairs obtained from dead preserved museum mammals and live mammals. Microphotographs of the mounted hairs were prepared and these were to be used as a reference when determining the diet of the lion after observing hairs obtained from their scats. The structural appearance of the observed hairs was described.

2.2 RESULTS

Table 2.1 and 2.2 show the cuticle and medulla thickness of hairs obtained from dead mammals preserved in the National Museums of Kenya, Nairobi and some live mammals respectively. Statistical analysis showed that there was no significant difference between the cuticle and medulla thickness of the hairs (MANOVA, $F = 0.286$ for upper cuticle, $F = 0.095$ for lower cuticle and $F = 0.845$ for medulla, $P > 0.05$). Based on this statistical test, hairs obtained from dead preserved mammals in the museum were used to prepare hair microphotographs and describe their structural appearance. These microphotographs were used to identify hair samples collected from lion scats in the Salient region. This information was then used to determine the diet of lion. Table 2.3 shows the description of the structural appearance of hairs that were observed under the microscope in this study. Their microphotographs are also attached (see plate 1-14).

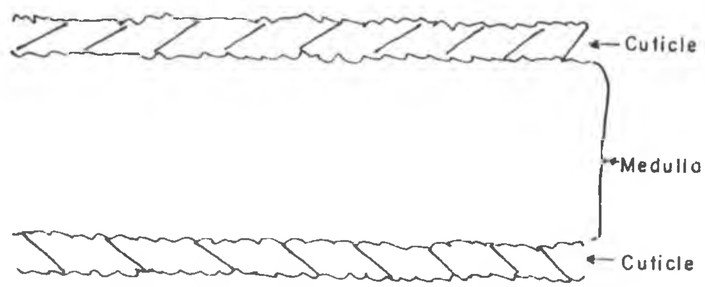


Fig. 2·2 : A generalised structure of mammalian hairs used in this study.
(Source : Author)

Table 2.1: Cuticle and medulla thickness (in micrometers) of hairs obtained from dead preserved mammals at the National Museums of Kenya, Nairobi.

Species	Age	Sex	Upper Cuticle	Lower Cuticle	Medulla
Bushbuck	A	F	0.95	1.00	2.36
	A	M	0.89	0.89	2.38
	A	M	1.00	1.06	2.42
	A	M	0.87	1.04	2.40
	J	F	0.96	1.02	2.37
	J	F	0.96	1.05	2.33
	A	F	0.99	1.06	3.00
	A	F	0.86	1.00	2.96
	J	M	1.00	1.02	2.94
	J	M	0.90	1.00	2.90
Buffalo	A	M	0.82	0.89	1.21
	A	M	0.87	0.79	1.12
	A	F	0.92	0.86	0.99
	J	M	0.79	0.99	1.00
	J	M	0.89	1.00	1.99
	A	M	0.87	0.99	1.89
	A	M	0.78	0.87	2.1

	J	M	0.99	0.89	1.99
	A	F	1.00	0.99	1.89
	A	M	0.98	1.00	1.87
Steinbok	A	M	0.25	0.52	1.88
	A	F	0.50	0.41	1.90
	J	M	0.65	0.38	2.11
	J	M	0.45	0.37	1.99
	A	M	0.39	0.41	1.90
	A	F	0.41	0.40	1.92
	J	M	0.51	0.27	1.96
	A	M	0.39	0.31	1.89
	A	F	0.43	0.27	2.0
	J	F	0.45	0.29	1.98
Suni	A	M	0.50	0.50	2.23
	J	F	0.29	0.39	2.43
	J	F	0.31	0.36	1.92
	A	F	0.41	0.42	1.99
	A	M	0.42	0.34	2.01
	A	M	0.33	0.35	2.34
	J	M	0.30	0.49	2.46
	J	F	0.50	0.51	1.98

	A	F	0.44	0.46	2.04
	A	M	0.45	0.39	2.82
Waterbuck	A	M	1.92	1.29	2.30
	A	F	1.89	1.88	2.11
	J	F	1.79	1.89	1.99
	J	M	1.86	1.99	1.89
	A	M	1.97	2.31	2.36
	J	M	1.98	2.04	2.34
	A	M	1.99	2.05	1.98
	A	F	2.01	1.98	1.88
	J	F	2.11	1.89	2.12
	A	M	1.99	1.99	1.98
Bongo	A	F	0.99	0.89	1.21
	A	M	1.01	0.79	1.31
	A	M	1.04	0.78	1.10
	J	F	0.88	0.69	0.99
	J	F	0.79	0.99	0.98
	A	M	0.98	1.01	0.88
	J	M	1.11	1.13	0.89
	J	M	1.01	1.14	1.01
	A	F	1.12	1.01	1.03
	A	F	0.99	0.99	0.99

Bushpig	A	F	0.11	0.10	3.91
	A	M	0.21	0.20	3.89
	F	M	0.13	0.14	2.99
	A	F	0.70	0.15	3.31
	A	F	0.15	0.10	3.49
	J	F	0.16	0.11	3.58
	A	M	0.11	0.14	3.87
	J	M	0.10	0.15	4.02
	A	M	0.10	0.18	4.06
	A	M	0.11	0.19	3.99
Impala	A	F	0.19	0.21	3.92
	A	F	0.21	0.29	3.19
	J	M	0.29	0.11	3.40
	A	M	0.31	0.14	3.81
	A	M	0.41	0.19	4.02
	J	M	0.29	0.21	4.11
	J	F	0.36	0.42	3.66
	J	F	0.44	0.39	3.54
	A	M	0.34	0.41	
	A	F	0.29	0.51	3.62

Mt. Reedbuck	A	M	0.25	0.26	2.11
	A	F	0.29	0.37	2.32
	J	M	0.33	0.39	2.49
	J	M	0.45	0.43	1.99
	J	M	0.75	0.57	2.01
	A	F	0.55	0.63	2.14
	A	F	0.62	0.44	2.30
	A	F	0.66	0.55	1.89
	A	M	0.47	0.45	1.98
	J	M	0.49	0.52	2.32
Warthog	J	M	0.11	0.14	1.09
	J	M	0.25	0.23	1.29
	J	F	0.31	0.44	1.99
	A	M	0.26	0.29	2.11
	A	M	0.19	0.20	2.31
	A	M	0.21	0.24	2.14
	A	F	0.24	0.29	2.18
	A	M	0.31	0.34	2.92
	J	M	0.24	0.26	2.14
	A	F	0.26	0.29	1.99

Duiker	A	M	1.29	1.42	2.11
	A	M	1.42	1.92	2.34
	J	F	1.09	1.02	2.19
	J	F	1.21	1.19	2.49
	J	M	1.39	1.39	1.99
	A	F	0.99	1.42	1.98
	A	F	1.01	1.44	2.14
	A	M	1.04	1.35	2.13
	A	M	1.15	1.63	2.15
	A	F	1.31	1.49	2.19
Dik dik	J	M	1.90	1.90	2.90
	A	M	1.86	1.88	2.88
	J	F	1.88	1.86	2.92
	J	M	1.86	1.88	3.00
	J	F	2 00	1.90	2.98
	A	M	1.80	1.86	2.96
	A	F	1.85	1.88	2.98
	J	F	1.90	1.90	2.90
	A	F	1.82	1.92	2.90
	A	M	1.88	1.93	3.01

Olive baboon	A	M	1.99	2.01	1.29
	A	M	2.10	2.19	1.33
	A	F	1.89	1.99	1.29
	J	F	2.11	2.16	1.42
	J	M	2.14	2.15	1.15
	J	F	2.19	2.11	1.61
	A	M	1.98	2.01	1.25
	A	F	2.01	2.11	1.26
	J	F	2.04	2.06	1.31
	A	M	2.42	2.31	1.42

Table 2.2: Cuticle and medulla thickness (in micrometers) of hairs obtained from live mammals.

Species	Age	Sex	Upper Cuticle	Lower Cuticle	Medulla
Bushbuck	A	M	1.01	1.04	2.41
	A	M	1.21	1.13	2.32
	A	M	0.92	0.95	2.14
	J	F	0.93	1.14	2.40
	J	M	1.14	1.06	2.33
	A	M	0.98	0.99	3.01
	A	F	0.97	1.11	3.14
	J	F	0.95	0.12	2.95
	A	M	1.00	1.14	2.49
	A	M	0.92	0.96	2.67
Buffalo	A	M	0.86	0.89	1.30
	A	M	0.92	0.93	1.12
	A	F	1.01	0.99	1.14
	A	M	1.00	1.01	1.27
	J	F	1.10	1.12	1.92
	J	F	0.89	0.98	1.89

	A	F	0.86	0.89	1.90
	A	M	0.88	1.00	1.87
	A	M	0.99	1.00	1.88
	A	M	1.00	0.99	1.79
Steinbok	A	M	0.27	0.54	1.99
	A	M	0.29	0.49	2.11
	J	F	0.51	0.39	2.01
	A	F	0.55	0.41	2.13
	A	F	0.65	0.51	1.98
	A	M	0.40	0.42	1.89
	J	M	0.52	0.49	1.99
	A	F	0.43	0.36	2.0
	A	M	0.49	0.52	1.98
	A	F	0.39	0.45	2.10
Suni	A	M	0.61	0.58	1.92
	A	M	0.34	0.36	2.41
	A	F	0.35	0.45	2.39
	J	M	0.49	0.52	1.99
	J	M	0.50	0.53	2.01
	A	M	0.48	0.51	2.04
	A	F	0.37	0.39	1.98

	J	M	0.38	0.41	1.97
	A	M	0.44	0.49	2.02
	A	M	0.49	0.42	2.61
Waterbuck	A	M	2.01	1.99	2.41
	A	M	1.93	1.98	2.51
	A	M	1.94	2.01	1.99
	J	F	1.78	1.99	2.11
	J	F	1.86	1.92	1.98
	A	M	1.98	2.10	2 39
	A	M	1.96	2.00	1.88
	A	M	2.01	1.98	2.12
	A	F	2.14	2.10	2.14
	A	M	1.97	2.0	2.19
Bongo	A	M	1.10	1.13	1.31
	A	M	1.21	1.14	1.24
	A	F	0.98	1.00	0.99
	A	M	0.99	1.01	0.98
	A	M	1.11	1.13	0.88
	A	F	1.01	1.12	0.89
	A	M	1.12	1.14	1.01
	A	M	0.99	0.98	1.12

	A	F	1.14	1.11	1.31
	A	M	1.12	1.01	0.99
Impala	A	F	0.29	0.24	3.19
	A	M	0.18	0.24	3.82
	A	F	0.21	0.20	4.03
	J	F	0.25	0.29	4.10
	J	F	0.31	0.24	3.67
	A	M	0.30	0.26	3.54
	A	F	0.34	0.31	3.62
	A	F	0.42	0.38	3.40
	A	M	0.41	0.40	3.54
	A	F	0.40	0.41	3.29
Warthog	A	M	0.13	0.15	1.99
	A	M	0.29	0.27	1.92
	A	M	0.32	0.29	2.11
	J	F	0.19	0.21	2.32
	A	M	0.21	0.24	2.91
	A	M	0.24	0.27	2.19
	A	F	0.36	0.30	1.99
	J	M	0.32	0.29	2.27
	A	M	0.32	0.33	2.14
	A	M	0.14	0.36	2.19

Table 2.3: Description of structural appearance of hairs of potential lion prey species.

Species	Structural description of hairs
Suni	Medulla is fragmental. Fairly regular diameter scale margins. Dense pigmentation.
Steinbok	Medulla has a regular diameter with continuous lattice. Scale margins protruding slighlty.
Buffalo	Fairly thin cuticle with fine lattice. Dense pigmentation.
Bushbuck	Regular diameter. Medulla with a continuous lattice.
Waterbuck	Fairly regular diameter with prominent scale margins. Medulla with a continuous lattice.

Bongo	Regular diameter. Fairly smooth. Thin cuticle. Dense pigmentation.
Bushpig	Fairly thin cuticle. Scale margins prominent. Medulla continuous.
Impala	Thin cuticle. Dense pigmentation. Fragmental lattice.
Mt. Reedbuck	Fairly thin cuticle Regular diameter. Medulla with wide lattice. Sparse pigmentation
Warthog	Fairly thin cuticle. Dense pigmentation. Irregular diameter. Medulla with wide, continuous lattice.
Duiker	Thin cuticle, regular diameter with prominent scale margins. Sparse to dense pigmentation.

Dik dik	Fairly thin cuticle, regular diameter, scale margin farily prominent. Dense pigmentation towards the cuticle and sparse near medulla. Medulla continuous with polygonal cells.
Olive baboon.	Thick cuticle. Regular diameter. Fragmental medulla. Sparse pigmentation.

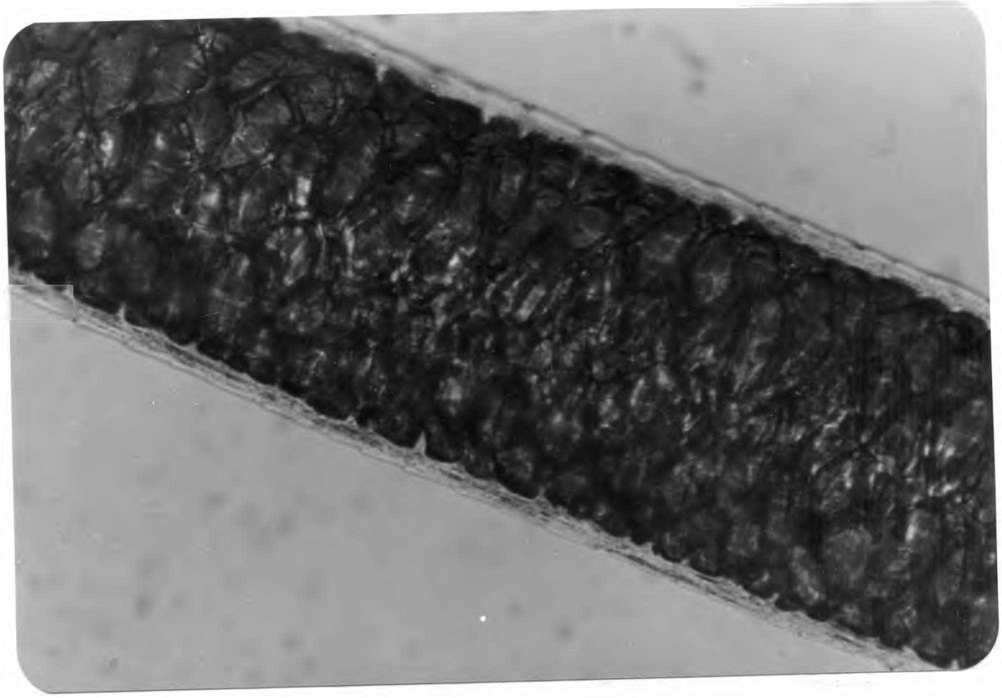


Plate 1 : Hair Structure of Suni (X 400)

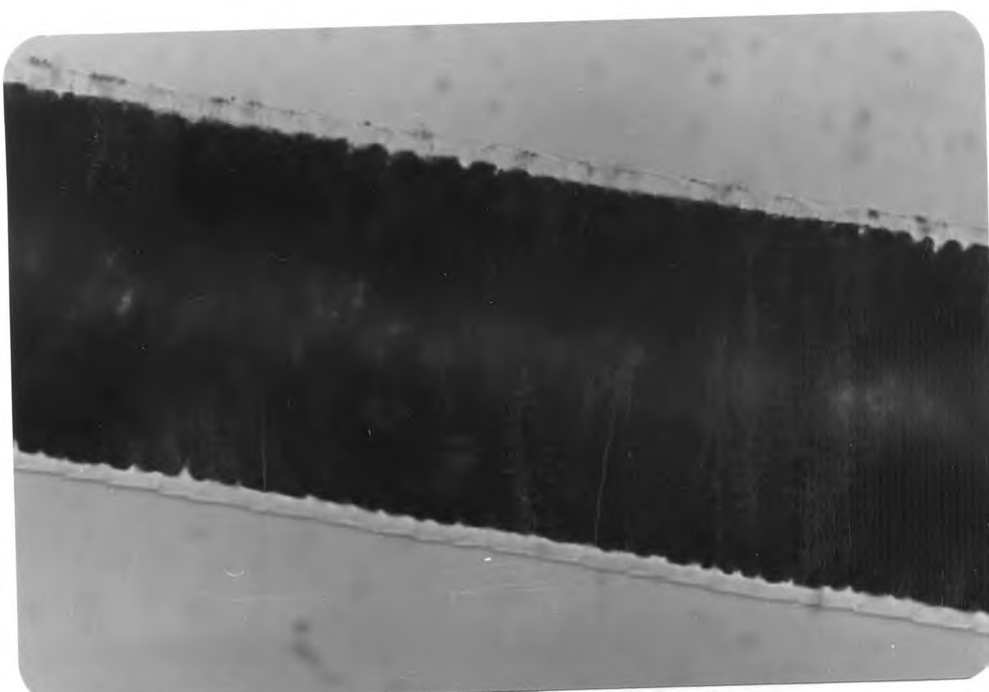


Plate 2 : Hair Structure of Steinbok (X 400)

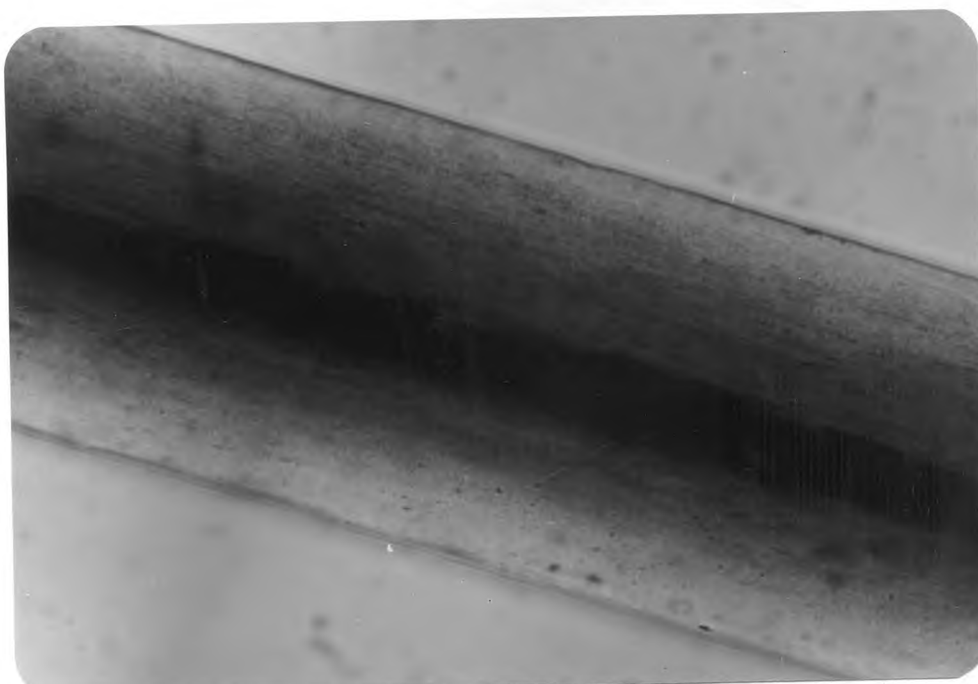


Plate 3 : Hair Structure of Buffalo (X 400)

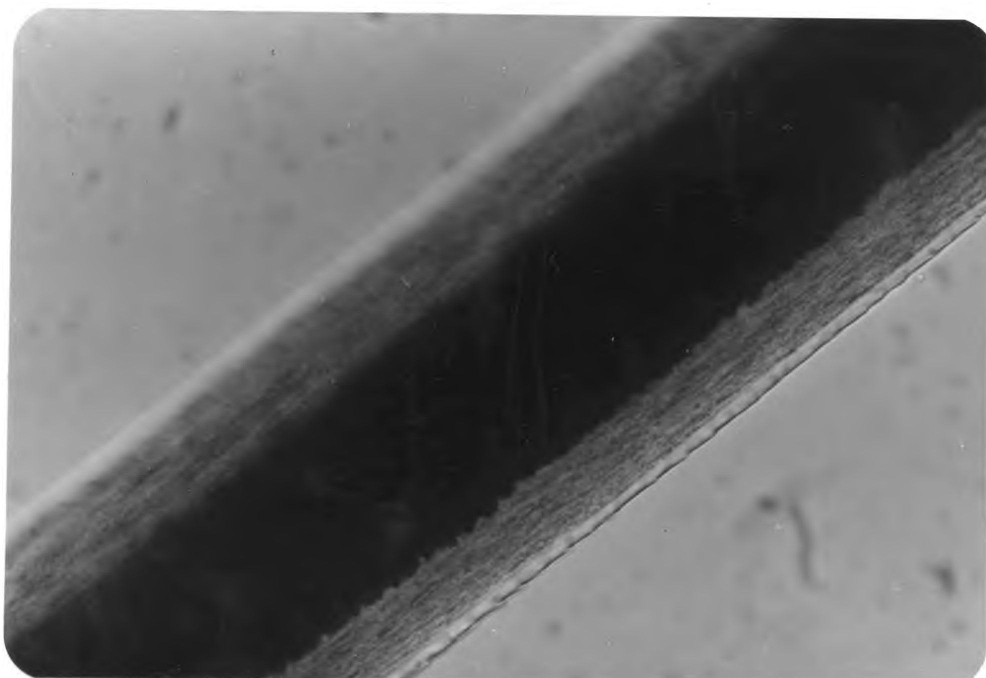


Plate 4 : Hair Structure of Bushbuck (X 400)

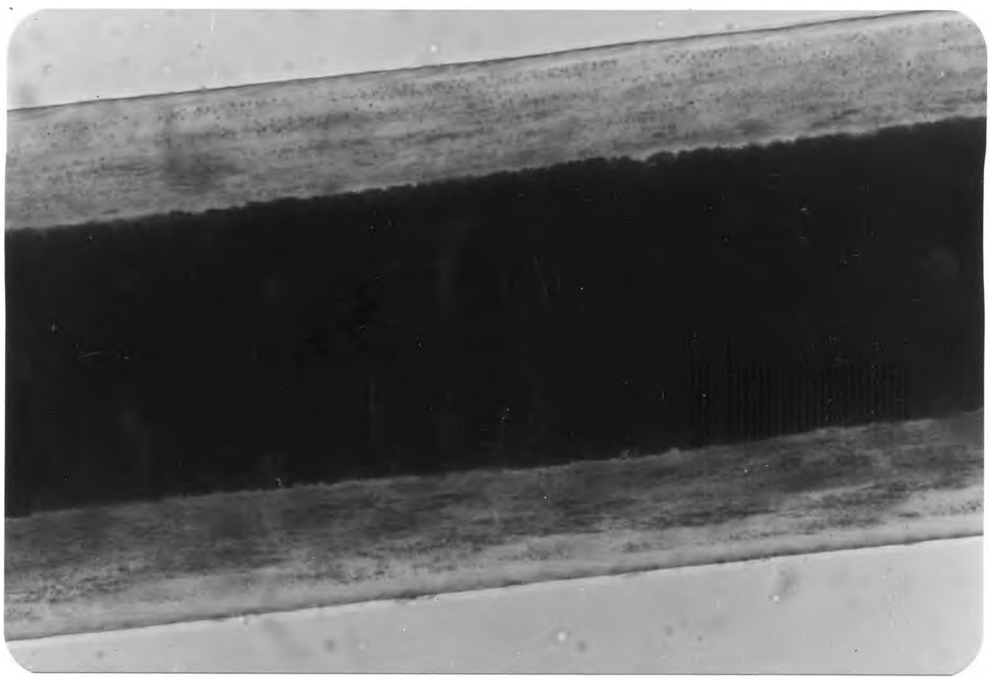


Plate 5 : Hair Structure of Waterbuck (X 400)

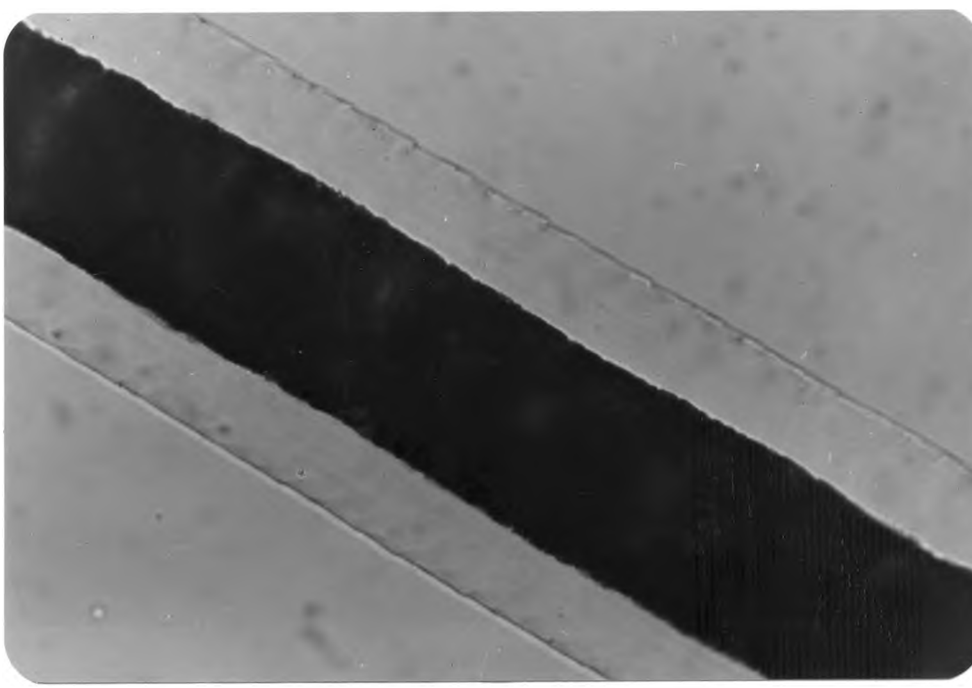


Plate 6 : Hair Structure of Bongo (X400)

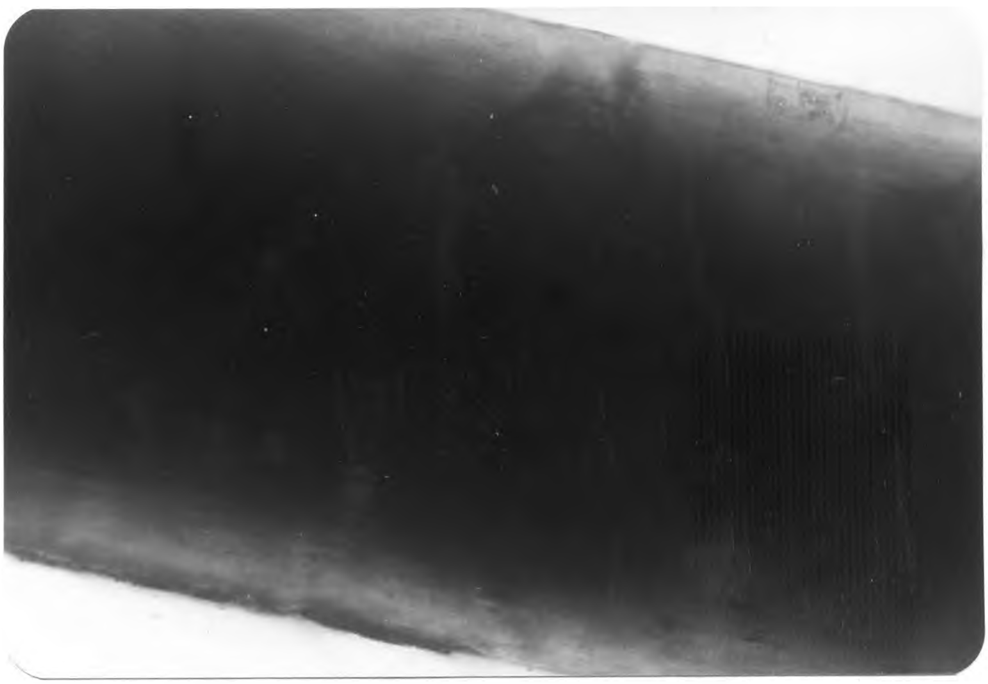


Plate 7 : Hair Structure of Bushpig (X 400)

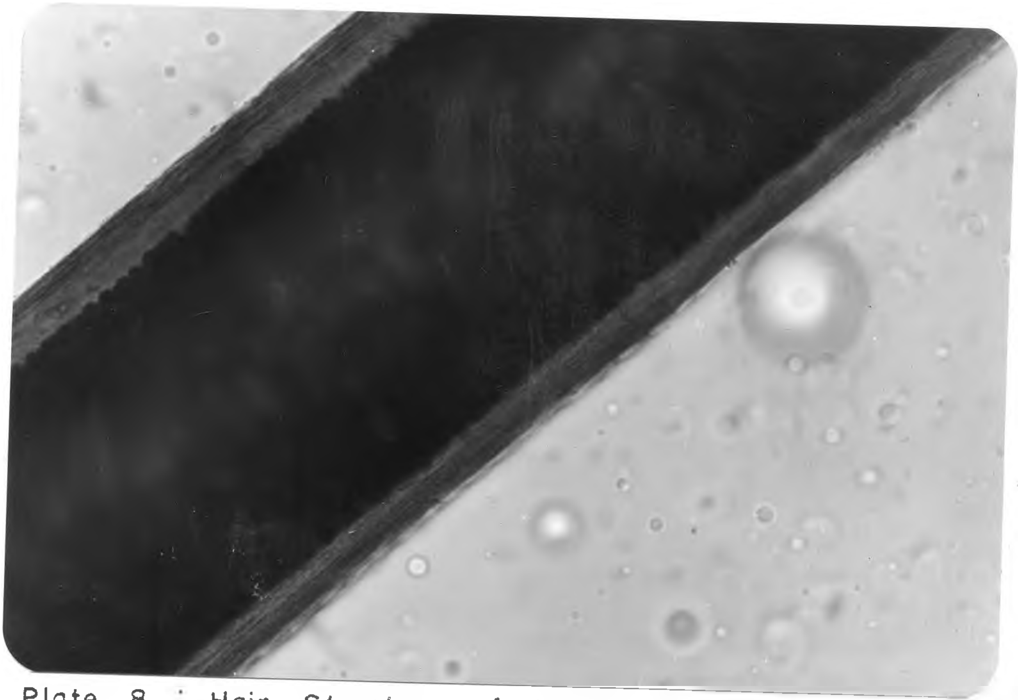


Plate 8 : Hair Structure of Impala (X 400)

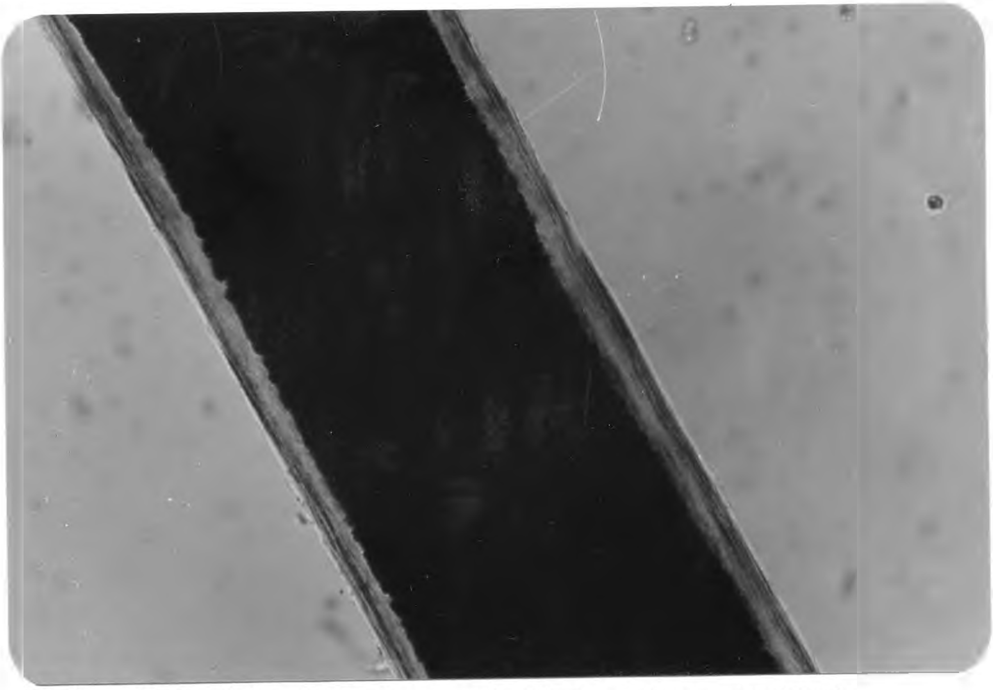


Plate 9 : Hair Structure of Mt. Reedbuck (X 400)

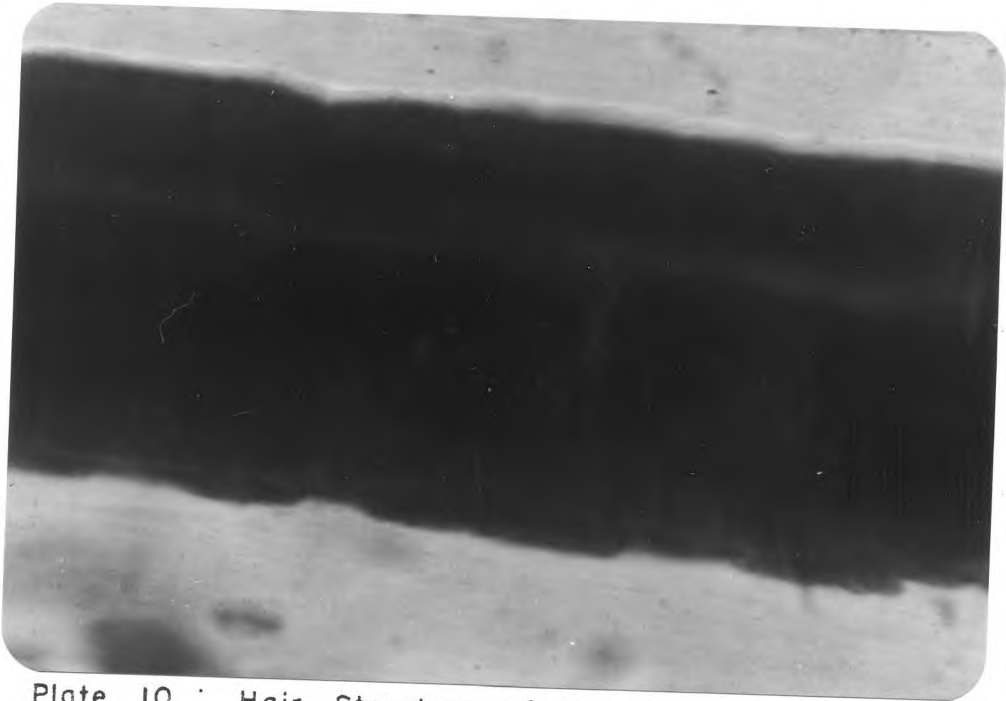


Plate 10 : Hair Structure of Warthog (X 400)

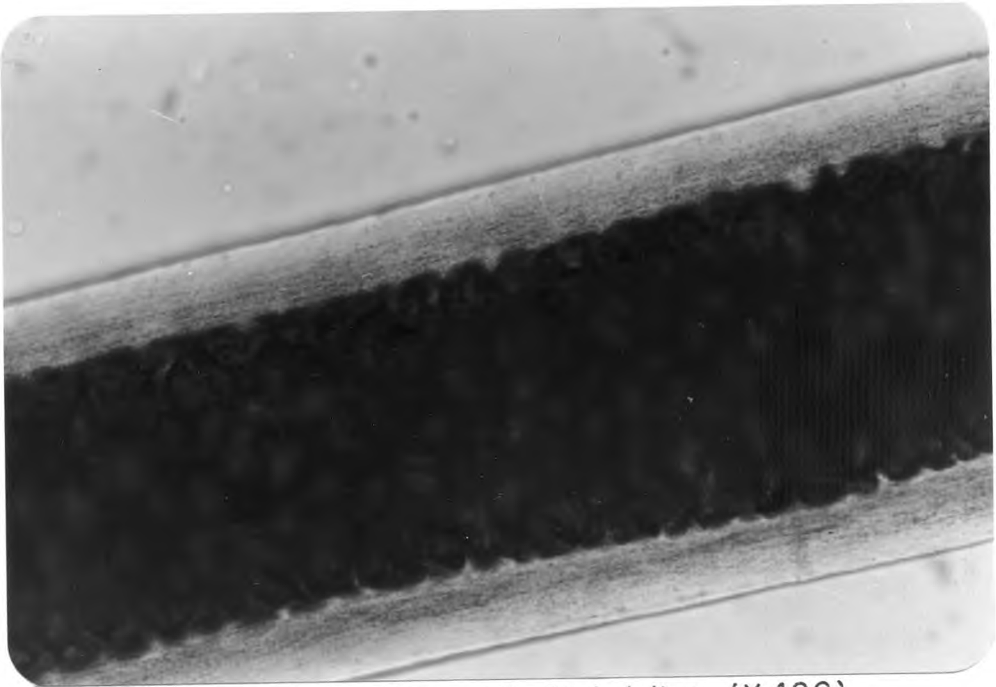


Plate II : Hair Structure of Red duiker (X 400)

Plate 12 : Hair Structure of Common duiker (X 400)

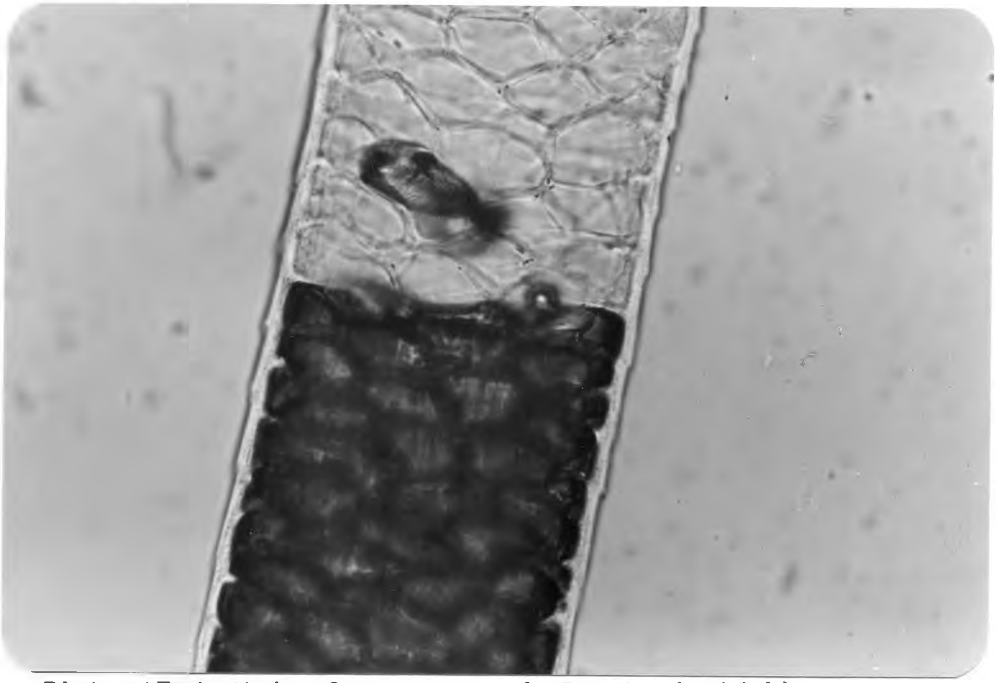


Plate 13 : Hair Structure of Dikdik (X400)

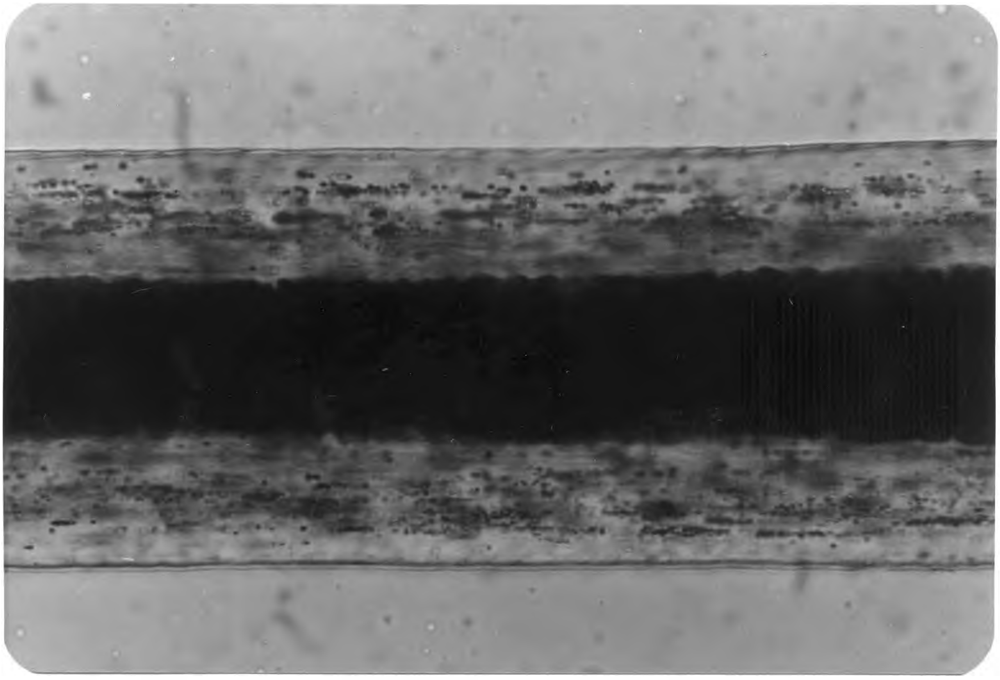


Plate 14 : Hair Structure of Olive Baboon (X400)

2.3 DISCUSSION

From the results obtained in this study, a key was prepared from which hair samples hair samples obtained from lion scats could be identified and therefore help to determine their diet composition in the salient region. Although for each mammal species ten hairs were studied in order to describe their diagonistic criteria, it would be unrealistic to assume that all hairs from all individuals show the same characteristics. For example, Keogh (1975) investigated experimentally the effects of diet, age, season and sex of individuals on cuticular scale patterns of rodents hair. He found out that of all the four characteristics considered, age was the only one which caused significant scale pattern variation. He however concluded that after a period of six months, the cuticular scale pattern of the rodent hair remained unchanged throughout life. In another study, Day (1966) found out that in small mammals, the cuticular scale pattern of the hairs of sub-adults were similar to those of adults. In agreement with Keogh (1975), Dreyer (1966) found out that the sex of individuals of the greater kudu Tragelaphus strepsiceros had no effect on the cuticular scale patterns of their hairs.

Most of the hair samples used to prepare diagnostic criteria and microphotographs to identify hair samples from lion scats were obtained from dead preserved mammals. These hair samples were found not to be different from hairs obtained from live mammals. This finding was in agreement with other studies (Keogh (1975) and Mayer (1952)) which have found out that there is negligible effect on mammal hair characteristics after storage in museums. These findings were a pointer to the fact that hair characteristics from museum preserved mammals can be used to identify prey species consumed by lion in the salient region using hairs obtained in their scats. This could finally assist me to determine the diet composition of the lion.

However, sometimes there are a number of shortcomings of using hair characteristics contained in the scats of predators as a means of determining their diet composition. Variation in hair characteristics can occur depending on the part of the body they are obtained. For example, Day (1966) found out that the hairs of the head, feet and other parts of the body of small mammals had similar but reduced form to the cuticular scale patterns of body hairs. Geographical variations of animals can also give rise to variation in hair morphology and characteristics (Perrin and Campbell, 1980). Another source of variation in hair characteristics is variation between individuals of a particular species (Perrin and Campbell, 1980).

In view of the already mentioned shortcomings, the use of other features of hair morphology in addition to cuticular scale pattern might enable the determination of other definite criteria to differentiate between mammal species with similar scale patterns. Therefore, some workers like Hausman (1920), Mathiak (1938) and Mayer (1952) used a wide range of morphological characteristics of hair in the formation of keys for identification. Mathiak (1938) and Mayer (1952) used hair diameter and length as criteria of hair identification in their keys. There has also been some use of hair pigmentation as a criteria for their identification (Perrin and Campbell, 1980). Hair pigmentation shows variation depending on the age of an animal and even the part of the body from which the hair is obtained. Furthermore, the interpretation of colour is somewhat subjective despite the publication of colour keys to eliminate their variation (Mayer,1952). Mathiak (1938) found hair pigmentation to be altered to some extent by digestive processes rendering this feature unsuitable for use in scat analysis.

Two features of hair morphology that might provide additional information are the gross sectional shape of the hair and structure of the medulla. Day (1966) used both of these characteristics along with cuticular scale patterns in preparation of his key to hair identification. Other workers who have used medulla as a feature of identifying hairs include Hausman (1920), Mathiak (1938) and Day (1966). From the aforegoing discussion and available literature, it is quite evident that it is not possible to specifically use a single charateristic in the identification of hairs. Therefore, for better hair identification it is important to have several diagonistic characteristics.

CHAPTER 3

ABUNDANCE OF POTENTIAL LION PREY SPECIES IN THE SALIENT REGION

3.0 Introduction

Aberdares National Park has a diverse mammalian community. Some of the wild animal species include hyaena, lion, waterbuck, elephant, bongo, bushpig, baboon, colobus monkey among others (see Appendix 1 for a full check list of mammals found in the park). The main aim of counting or determining the number of wild animals in the salient region was to find out if there was any relationship between their abundance and the level of their predation by the lions. It was therefore argued that by carrying out a census of wild animals in the salient region, then it would be possible to relate their level of predation by lion and their availability or abundance. From this kind of data, then it would be easy to draw a conclusion as to whether certain animals were preferred over others by lion. This aim was further strengthened by available literature, for example, by Schaller (1972), Kruuk (1972), Eaton, (1974) and Beader (1977) which has shown that the type and abundance of prey species in a given area determines the composition of diet of predators. Furthermore there has been fears that the population of the bongo in the salient region has in the last few years drastically declined, (Hillman, 1983) and this is a threat to its future. A number of reasons have been proposed to account for this decline (Hillman, 1983) and these include:-

(a) An outbreak of a mysterious disease which broke up towards the end of 1982 which led to mass death of bongo and other wildlife species like buffalo.

(b) increased predation of bongo by hyaena whose population had greatly increased.

(c) increased predation of bongo by lion especially following the increase of the latter from Solio Game Ranch and

(d) increased levels of poaching of bongo by the local people.

3.1 METHODS

Various methods are available for estimating population size of large mammals. The method chosen in any given area is dependant on a number of factors such as the behaviour of the species being counted, availability of resources, cost involved, purpose of the estimates, the size of the study area, terrain and the type of the vegetation cover (Norton-Griffiths, 1978).

For this study total counts of the different wild animals found in the salient region were used because road counts could not be carried due to poor visibility as a result of the nature of the vegetation. Each month from December 1992 to October 1993, I carried out total counts of wild animals in the salient region using a vehicle and the existing roads. The region was sub-divided into three blocks based on the terrain and vegetation thickness, and in each of these, total counts of wild animals found in them were carried out. In most cases counting started around 0730 hrs. Whenever an animal or a herd of animals was encountered in each block, the vehicle was stopped and using a pair of binoculars, the observer recorded the species name and the number of individuals after counting. After this the vehicle then moved to a new site within the block and the same procedure was repeated until all the blocks had their animals counted. Counts for all blocks were then summed up per species and this gave a monthly total count for each species. From the obtained data, the mean (± S.E) population size and density of each species was calculated for both the wet (Dec, 1992 - May, 1993) and dry (June 1993 - Oct. 1993) seasons. The dry and wet season density of the animals was subjected to Mann-Whitney test to see whether they were significantly different.

When carrying out the census, I made the following assumptions:-

(a) Each block was well searched and all animals in it located and counted accurately.

(b) The animals never moved before detection and none were counted twice or more.

(c) Counting in each month was carried out in uniform habitats and weather conditions and,

(d) All animals were uniformly conspicuous to the observer.

3.2 RESULTS

Table 3.1 shows the monthly counts of the different mammal species sighted in the salient region during census. A total of 26 mammal species were encountered and had their population size and density estimated. Three large herbivores, mainly elephants, buffalo and bushbuck had the highest mean population size and density compared with the other species (Table 3.2.). They were therefore the most abundant in the salient region. Statistical test showed that there was no significant difference between wet and dry seasons density of the different mammal species that were sighted (Mann-Whitney 2-tailed test, $U = 350.5$, d.f. = 26,26, $P > 0.05$). Therefore their densities were similar irrespective of the season.

3.3. DISCUSSION

The population size and density estimates in this study are an indication of the abundance of wildlife in the salient region. The counts were to a certain extent similar to those conducted

Table 3.1: Monthly Counts of Mammals in the Salient Region.

Species		1992				
		Dec	Jan	Feb	Mar	Apr
1.	Mt. Reedbuck	4	6	-	4	3
2.	Bushbuck	725	820	690	790	620
3.	Dik dik	3	4	5	4	5
4.	Buffalo	560	620	710	602	510
5.	Waterbuck	40	22	33	42	32
6.	Black rhino	18	22	-	-	25
7.	Duiker	11	15	-	16	10
8.	Eland	2	4	-	-	5
9.	Elephant	420	570	578	433	392
10.	Bongo	-	-	-	3	-
12.	Suni	52	61	47	57	52
13.	Mongoose	8	6	-	-	7
14.	Giant Forest Hog	5	4	-	-	4
15.	Colobus monkey	69	70	51	49	61
16.	Sykes monkey	21	18	15	20	-
17.	Baboon	18	19	26	22	-
18.	Ant-eater	1	-	-	1	-
19.	Giant rat	3	4	5	-	-
20.	Galago	2	3	-	-	2
21.	Steinbok	6	7	8	5	7
22.	Hedgehog	1	2	3	-	-
23.	Blue monkey	4	6	-	-	7
24.	Tree hyrax	10	8	7	-	--
25.	Hare	8	7	9	10	-
26.	Warthog	18	11	12	16	20

1993

May	Jun	Jul	Aug	Sep	Oct
5	-	4	-	4	6
702	560	517	575	590	507
6	5	2	-	4	3
630	490	510	487	600	526
29	25	27	25	37	35
29	-	20	21	26	24
-	8	11	12	-	13
-	4	6	7	-	-
410	417	512	451	367	531
-	-	-	-	-	-
68	37	41	49	31	37
8	-	-	9	8	6
6	7	-	-	6	5
53	58	69	70	61	52
-	18	20	21	-	21
19	21	22	19	-	18
1	-	-	1	1	1
6	7	2	-	3	4
3	-	2	3	4	5
-	8	7	6	5	4
-	4	5	2	-	-
3	-	-	4	5	7
6	8	-	9	10	6
11	10	-	11	12	8
8	-	15	17	11	12

Table 3.2: Mean (S.E) Population Size and Density of Mammals in the Salient Region during the Wet and Dry Seasons.

Species	Mean population size - wet season	S.E	Density (wet season) (Km^2)	Mean pop. size. (Dry season)	S.E	Density (Dry season) (Km^2)
1. Mt. Reedbuck	4	0.5	0.04	5	0.7	0.05
2. Bushbuck	725	29.0	7.25	550	16.0	0.05
3. Dik dik	5	0.4	0.05	4	0.6	0.04
4. Buffalo	605	28.0	6.05	523	21.0	5.23
5. Waterbuck	33	3.0	0.33	30	3.0	0.30
6. Black rhino	24	2.0	0.24	23	1.0	0.23
7. Duiker	13	1.0	0.13	11	1.0	0.11
8. Eland	4	0.9	0.04	6	0.9	0.06
9. Elephant	447	29.0	4.47	456	30.0	4.56
10. Bongo	3	0.1	0.03	0	0.0	0.09
11. Bushpig	5	0.6	0.05	7	1.0	0.07
12. Suni	56	3.0	0.56	39	3.0	0.39
13. Mongoose	7	0.5	0.07	8	0.9	0.08
14. Giant Forest Hog	5	0.5	0.05	6	0.6	0.06
15. Colobus monkey	59	4.0	0.59	62	3.0	0.62
16. Sykes monkey	19	1.0	0.19	20	0.7	0.20
17. Baboon	21	1.0	0.21	20	1.0	0.20
18. Ant-eater	1	0.1	0.01	1	0.1	0.01
19. Giant rat	5	0.6	0.05	4	1.0	0.04
20. Galago	3	0.3	0.03	4	0.6	0.04
21. Steinbok	7	0.5	0.07	6	0.7	0.06
22. Hedgehog	2	0.6	0.02	4	0.9	0.04
23. Blue monkey	5	0.9	0.05	5	0.9	0.05
24. Tree hyrax	8	0.9	0.08	8	1.0	0.08
25. Hare	9	0.7	0.09	10	1.0	0.10
26. Warthog	14	2.0	0.14	14	1.0	0.14

by Waweru and Musyoki (1993) in this region. Their results indicated that elephant, buffalo and bushbuck were the most abundant and this conforms to the findings of this study.

Considering the nature of the vegetation in the salient region, it is likely that the population size and density estimates of the wildlife species sighted during this study were an underestimate. This can be supported by the fact that there were monthly variations in the counts of the wildlife species sighted during the study. The variation may have been caused by some individuals of the encountered species being missed during counting other than death and birth. Overall the wildlife species community in the salient region was characterised by low numbers. Although the extent of accuracy of these counts was not determined, the findings are, however, useful in trying to elucidate whether there was any relationship between the abundance of some wildlife species and their extent of predation by lion. From the findings of this study, it is not possible to deduce whether the observed low bongo population (a threatened species in Aberdares National Park) was due to its high level of predation by both lion and hyaena. In spite of the fact that Hillman (1983) has put forward a number of reasons which might have led to a decline of this species in the salient region (see section 3.0. of this chapter), he never seemed to pin-point at the actual cause(s) of the decline. There is therefore an urgent need to carry out a detailed study on the actual cause(s) that could be responsible for the decline of the bongo, not only in the salient region, but also in the whole of the Aberdares National Park. The findings of such a study can then be used to come up with appropriate conservation measures which will prevent further decline of the bongo population.

From the findings of this study (see chapter 4), bushbuck was the main prey of the lion followed by suni and buffalo in that order. The former in particular featured quite prominent in the lion diet and it also happened to be the most abundant in the salient region. There is therefore a possibility that its high level of predation by lion was a result of its abundance and therefore availability. It would therefore be important to follow the trend of the population size of this species in relation to its level of predation by lion. If the rate of predation is higher than the rate of recruitment, then there is a possibility that in the future its population size will decline. The same argument can apply to the suni which was the second most preyed species by lion inspite of the fact that its population size was low.

CHAPTER 4

LION DIET COMPOSITION

4.0 INTRODUCTION

Previous studies have shown that lion prefers medium sized prey species (Ewer, 1973). In some cases, larger prey species like giraffe, buffalo and eland are also fed on (Ewer, 1973). Pienaar (1969) observed that occasionally lions can even attack young elephants. Other carnivore species are also eaten occasionally although they do not comprise a significant source of food (Ewer, 1973). For instance, Pienaar (1969) recorded killing of hyaena, leopard, jackal, civet cat, ratel, caracal and cheetah by lion in Kruger National Park, South Africa. Lowther (1969) also observed lions killing hyaena, cheetah and jackal, while Edmond-Blanc (1957) describes an unsuccessful attack of a leopard by lions.

Cannibalism in lion has also been recorded. The corpse of a conspecific killed in a fight can be treated as food (Ewer, 1973; Schaller, 1969). Lions have no aversion to carrions and they can stay with a kill until they finish it even if it might not be fresh.

Lions will also occasionally feed on small sized prey species such as rodents and when rivers dry up they look out for fish that have been trapped in the shallow pools (Guggisberg, 1960). They also now and then feed on flying termites when they are abundant, grass and various fruits (Guggisberg, 1960). However, inspite of the fact that lions feed on these mentioned minor food types, their main diet is made up of medium sized ungulates (Ewer, 1973).

Carnivores exhibit a wide variety of feeding habits and only a few of them are restricted or depend on one food type (Ewer, 1973). Those prey species that are better concealed or are able to defend themselves against predation may not be as easily available to the predators as those species that are low in numbers, but are quite vulnerable (Ewer, 1973). Furthermore, even within a given prey species, not all age class categories are killed in the same proportions. For example, in Lake Manyara National Park, Tanzania, lions mainly prey on buffalo and they kill a high proportion of adult males than females and juveniles inspite of the fact that they are bigger and stronger than the latter (Makacha and Schaller, 1969). This is attributed to the solitary nature of the males which makes them prone to attack by lions. Even the aged, young, sick and injured individuals of a prey species may be taken preferentially (Ewer, 1973).

Palatability of a prey also plays a great role in its choice by a predator. Therefore, if in a given habitat there are two prey species which are not equally abundant, then the predator will preferentially take the one which is more palatable although its numbers might be lower than those of the less palatable prey (Ewer, 1973). Apart from palatability, another factor which can influence prey choice is experience. Therefore a predator requires different killing techniques depending on the prey it is hunting. A predator becomes an adept killer of a prey species it has experience in killing and therefore may tend to prefer this type of a prey (Ewer, 1973).

To understand the feeding habits of a carnivore, it is important to establish its potential diet in different habitat types within its home range and from one season to the other. There are two commonly used methods of studying the food habits of carnivores. These are, direct observations of kills being made by a given free ranging carnivore and indirect method where remains of food items often eaten by a carnivore are determined by observing the stomach content, intestinal contents and faeces or scat. The former method is mostly applied where both the prey and the predator (carnivore) live in relatively open areas where hunting for prey is easy. The short-coming of this method is that small food items that are eaten by the carnivore can easily be missed during observations.

When studying a carnivore diet by observing faeces, stomach and intestinal contents, a problem arises as to what sort of data is to be collected. Here, two methods of data collection are commonly used (Ewer, 1973). The first one is where food items are recorded merely by their percentage occurrence out of every one hundred stomach or scats observed. The problem with this kind of data is that it does not give a direct measure of which type of prey item is important as a source of food. For example, 90% of scats each containing beetles may mean less in terms of diet of an animal than say 50% of them each containing a rabbit.

With the second method, one attempts to measure the percentage of the total food volume constituted by each category of food remains. For a freshly killed stomach, this may give a clear picture of the relative importance of food items in the diet of a carnivore, but where food digestion has already taken place the stomach remains would give a good picture of the diet and which prey items(s) is/are more important than others.

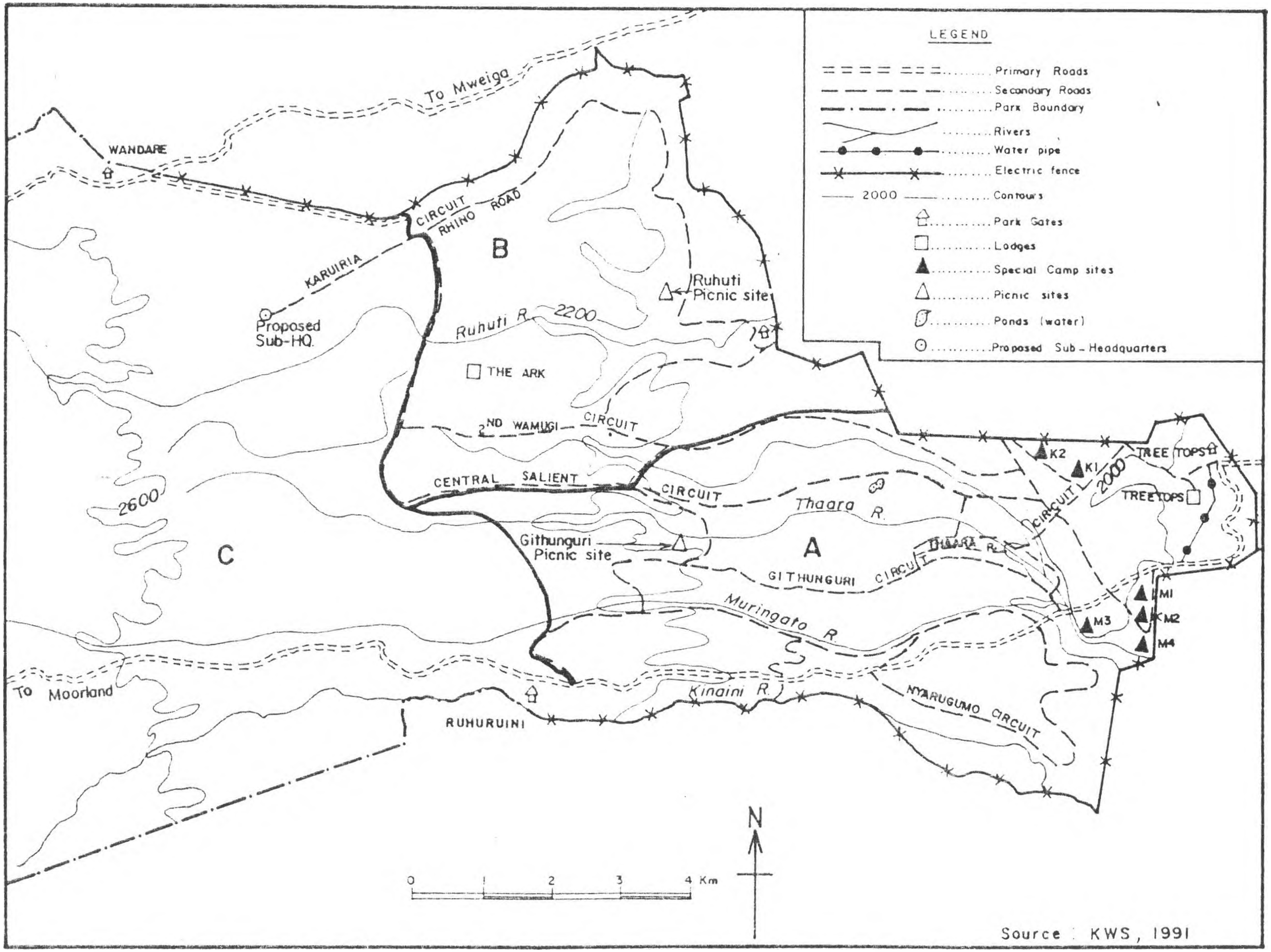
Scats analysis are widely used to determine food habits of carnivores, for example by identifying and quantifying undigested parts of a prey like hair and bones in faeces (e.g. Theodore *et al.*, 1978; Gamberg and Atkinson, 1988; Zubiri and Gotteli, 1987; Wambuguh, 1990). However, the relative frequencies of prey items found and positively identified in the scats may not represent the actual proportion of prey items fed on. Therefore determining the diet of carnivores is difficult due to the fact that there is selective consumption of prey parts like the skeleton and hair and these are also differentially digested (Pintman, 1984). A number of authors like Scott (1941), Lockline (1959), Frank (1979) and Liberg (1982) attempted to correct these errors by establishing correction factors which relate faecal composition to prey consumed for specific predators and prey species.

Other workers like Meriwether and Johnson (1980), Johnson and Aldred (1982) measured digestibility of carcass bones and hair since this differs among predators and prey species. Studies aimed at establishing lion diet have in most cases relied on the direct observation method, for example Rudnai (1970, 1974). However, determination of lions diet using scats has poorly been studied. In view of this, one of the aims of this study was to determine the diet of the lion population in the salient region of Aberdares National Park using hairs. Due to the nature of the vegetation in this region, direct observations of lions making kills and feeding was impossible. Therefore, I used scats to determine their diet composition. Specifically, hairs retrieved from the scats were identified to determine the various prey species that the lions were feeding on.

4.1: STUDY SITE

The study was carried out in the salient region of the eastern part of the Aberdares National Park which covered about 100 Km^2. Before data collection started the region was sub-divided into three sections, A, B and C depending on the vegetation thickness (Fig. 4.1). Section A was the area around Treetops Lodge whose vegetation was relatively open with a lot of grass

Fig. 4.1: Aberdare Salient Region



and therefore appeared to have a savanna type of vegetation with a few scattered trees. About 40 years ago, this section had thick vegetation (local people pers. comm.), but it was evident that the vegetation had changed with time due to herbivory hence the observed openness. Section B was the area around the park which was a more recent lodge compared with tree tops. The vegetation in this section was dense compared with section A due to less interference. The thickness of the vegetation in section C was very much similar to that of section B, but mainly composed of bamboo.

4.2 METHODS

Prior to the collection of the lion scats, a reconnaisance survey was carried out in the salient region of the park by driving along the roads and trucks and occasionally entering the nearby bushes. This was done for two weeks in order to determine the availability of the scats and their general appearance. During this survey, it was observed that in most cases, the scats were always found along the roads and trucks network. After this lion were collected for twelve days in a month i.e. three days per week and a total of 584 scats were collected during the study period.

During the sampling time, a vehicle was driven along the salient region roads and trucks and all the lion scats encountered were collected and put in polythene bags. Each scat was put in a polythene bag and then labelled indicating place of collection and its condition. The scats were taken to the laboratory and sun dried. Each scat was then crushed, sieved and washed using water. Crushing and sieving of the scats was done in order to ease washing. After washing, the hairs and any other undigestible materials like bones, hooves and teeth were then put in paper bags to dry.

From each scat sample, ten hairs were randomly picked, mounted on a glass slide using DPX as a mounting media and observed under a binocular microscope. Under the microscope, the following characteristics of the hairs were observed and noted; hair texture, medulla outline, pattern and thickness among other observations. These hair characteristics were then compared with those of previously prepared hair microtographs reference collection of animals (see chapter 2) in order to determine the prey species fed on by the lions. Any undigestible material from the scats like teeth , bones and hooves were also used as additional material in determining the lions' diet. Since no relationship exists between hair quantity recovered from a scat and the quantity of prey flesh consumed by the lions, only a presence/absence of prey species types was considered. This was then expressed as a percentage of prey occurrence in the lions diet (Kruuk, 1972; Beader, 1977; Wambuguh, 1990).

4.3 RESULTS

Table 4.1 shows the percentage frequency of occurrence of prey species in the lion diet in areas A, B and C of the salient region. In all the three areas, bushbuck was the main prey species and made the bulk of the lion diet. Overall it constituted about 45.9% of the lion diet in the whole of the salient region (Table 4.1). The second important prey species for the lion was the suni (Table 4.2) and overall it constituted about 18.8% of the total lion diet (Table 4.2). To a certain extent, buffalo was the third important prey species (Table 4.1) and constituted about 6.9% of the lion diet (Table 4.2). The other prey species that were consumed by the lion appeared not to be very significant as a source of food for the lion and their percentage frequency of occurrrence in the diet was quite minimal (See Table 4.1 and 4.2).

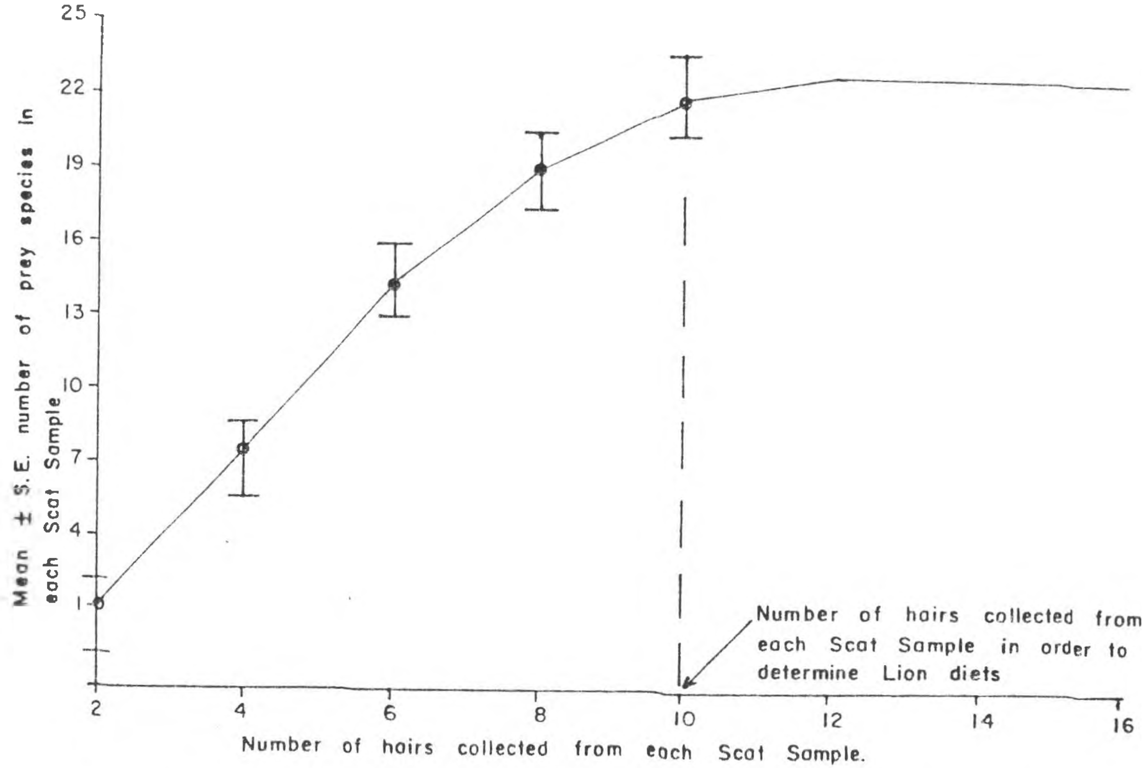


Fig. 4·2 : **Mean number ± S·E· of prey species / number of hairs curve.**

TABLE 4.1: PERCENTAGE FREQUENCY OF OCCURRENCE OF PREY SPECIES IN THE LION DIET IN THE SALIENT REGION.

PREY SPECIES	AREA OF SALIENT REGION		
	A	B	C
BUSHBUCK	45.3	44.5	47.8
SUNI	13.8	28.5	14.0
BUFFALO	8.5	3.4	8.8
WARTHOG	5.0	1.0	0.6
WATERBUCK	5.4	1.1	0.6
BUSHPIG	4.8	1.4	1.4
HARE	3.6	2.7	4.4
GIANT RAT	0.5	1.3	1.4
TREE HYRAX	2.1	0.5	1.2
DUICKER	1.0	1.1	0.4
COLOBUS MONKEY	1.1	1.8	5.2
BABOON	0.2	-	-
LION	2.3	0.8	1.2
FOREST HOG	1.7	2.1	1.2
BLUE MONKEY	0.2	0.3	1.0
GALAGO	0.3	1.1	-
BONGO	0.7	1.8	2.4
STEINBOK	0.9	3.0	-
HEDGEHOG	0.2	-	-
CLAWLESS OTTER	0.3	-	-
MOUNTAIN REEDBUCK	-	-	2.0
HYAENA	0.1	-	-
UNKNOWN	1.8	3.3	6.4

TABLE 4.2: MEAN (±SE) PERCENTAGE FREQUENCY OF OCCURRENCE PREY *SPECIES IN THE LION DIET IN THE SALIENT REGION.*

PREY SPECIES	MEAN (±S.E) PERCENTAGE FREQUENCY OF OCCURRANCE OF PREY SPECIES	PERCENTAGE FREQUENCY OF OCCURRANCE OF PREY SPECIES (after angular transformc
BUSHBUCK	45.9 ± 1.0	42.65
SUNI	18.8 ± 4.9	25.70
BUFFALO	6.9 ± 1.8	15.23
WARTHOG	2.2 ± 1.4	8.53
WATERBUCK	2.4 ± 1.5	8.91
BUSHPIG	2.6 ± 1.2	9.28
HARE	3.6 ± 0.5	10.94
GIANT RAT	1.1 ± 0.3	6.02
TREE HYRAX	1.3 ± 0.5	6.55
DUICKER	0.8 ± 0.2	5.13
COLOBUS MONKEY	2.7 ± 1.3	9.46
LION	1.5 ± 0.4	7.03
FOREST HOG	1.7 ± 0.3	7.49
BLUE MONKEY	0.5 ± 0.3	4.05
GALAGO	0.7 ± 0.4	4.80
BONGO	1.7 ± 0.5	7.49
STEINBOK	2.0 ± 1.0	8.13
UNKNOWN	3.8 ± 1.4	11.24

Table 4.3 shows the percentage frequency of occurrence of prey species in the lion diet in areas A, B and C during the wet and dry seasons. Statistical analysis showed that there was no significant difference between the percentage frequency of occurrence of prey species in the lion diet in each of the areas during the dry and wet seasons (for area A, Mann-Whitney 2-tailed test, $U = 269$, d.f = 22, 18, $p > 0.05$; for area B, Mann-Whitney 2-tailed test, $U = 182$, d.f. = 18, 18, $p > 0.05$ and for area C, Mann-Whitney 2-tailed test, $U = 131.5$, d.f. = 16, 14, $p > 0.05$). Therefore, the lion diet in each region was the same irrespective of the season. Statistical analysis also showed that there was no significant difference between the percentage frequency of occurrence of prey species in the lion diet in areas A, B & C (ANOVA, $F = 0.005$, d.f. = 2, 46, $p > 0.05$). This indicated that the lion diet composition was the same in each of the three areas.

4.4 DISCUSSION

This study has given an indication of the nature of the diet of lions in the salient region. Bushbuck, suni and to a certain extent buffalo constituted the main bulk of the lion diet with other species not being significant as a source of food. Bushbuck which constituted the bulk of the diet was also the most abundant in the salient region. This may to a certain extent explain why it featured prominently in the lion diet compared with the other prey species which were less abundant. The deduction is that bushbuck was probably preyed on more than any other species due to its abundance. The suni was less abundant in the region yet it was the second most important prey species for the lion. It is likely that it was preferred by the lions in relation to other species inspite of its low numbers. Both buffalo and elephant were abundant yet the former was less preyed on by lion. The latter was not found to be eaten by lion. These two species are big sized animals and therefore the lions could not easily prey on

TABLE 4.3: PERCENTAGE FREQUENCY OF OCCURRENCE OF PREY SPECIES IN THE LION DIET IN THE SALIENT REGION DURING THE DRY AND WET SEASONS.

PREY SPECIES	AREA OF SALIENT REGION					
	AD	AW	BD	BW	CD	CW
BUSHBUCK	36.8	51.7	34.7	55.7	42.1	51.3
SUNI	12.4	15.1	41.3	14.7	4.7	19.7
BUFFALO	7.7	9.0	2.6	4.3	11.6	7.1
WARTHOG	5.6	4.5	0.7	1.3	1.6	-
WATERBUCK	3.9	2.6	1.2	0.9	1.6	-
BUSHPIG	5.4	4.5	1.1	1.7	1.1	1.6
HARE	4.1	3.2	2.3	3.1	5.3	3.9
GIANT RAT	0.3	0.7	0.8	1.8	1.6	1.3
TREE HYRAX	3.5	1.1	0.4	0.5	1.6	1.0
DUICKER	1.3	0.8	1.1	1.1	1.1	-
COLOBUS MONKEY	1.1	1.1	1.6	2.2	9.5	2.6
BABOON	0.2	0.2	-	-	-	-
LION	4.2	0.9	1.5	0.3	2.6	0.3
FOREST HOG	2.3	1.2	2.3	2.0	2.1	0.6
BLUE MONKEY	0.2	0.2	0.4	0.3	1.6	0.6
GALAGO	0.3	0.4	0.7	1.6	-	-
BONGO	0.8	0.6	1.8	2.1	3.6	1.6
STEINBOK	1.1	0.8	2.6	3.4	-	-
HEDGEHOG	0.5	-	-	-	-	-
CLAWLESS OTTER	0.8	-	-	-	-	-
MOUNTAIN REEDBUCK	-	-	-	-	-	3.2
HYAENA	0.2	-	-	-	-	-
UNKNOWN	2.2	1.4	2.9	3.0	8.3	5.2

LEGEND

AD – Area A Dry season
AW – Area A Wet season
BD – Area B Dry season
BW – Area B Wet season
CD – Area C Dry season

them. The idea is supported by other studies that have been carried out to determine the diet of lions. For example Mitchell *et al* (1965); Hirst (1969); Makacha and Schaller (1969); Kruuk and Turner (1967), Pienaar (1969); Saba (1974) and Rudnai (1970, 1974). These studies have also shown that lions prefer certain prey species than others and in most cases they feed on medium sized herbivores. For example, Rudnai (1970, 74) found out that in Nairobi National Park, Kenya, lions preferred wildebeest, kongoni, zebra and warthog, and these herbivores provided 80% of the total lion diet. In particular, kongoni, zebra and wildebeest were the main prey species of the lion and were taken in large proportions. Other prey species were taken in low proportions. In another study, Schaller (1972) working in Serengeti National Park, Tanzania observed that lions in this area normally fed on medium sized herbivores, mainly wildebeest, zebra, buffalo and topi. These prey species were the main source of food for the lions and were the most preferred in relation to the other available prey species. Saba (1974) reported that in the Masai Mara Game Reserve, Kenya, lions mostly preyed on buffalo, wildebeest and zebra. The former two were the most preferred and contributed the highest proportion of the lion diet. Buffalo were locally available species and constituted the lions' main food source. Other species like giraffe, hartebeest and warthog were fed on by lions but in low proportions compared with the main prey species and therefore did not contribute significantly to the lions' diet. Table 4 gives a summary of some studies carried out on lions in different conservation areas of Africa.

The findings of this study are in agreement with the results obtained in other studies that lions in the salient region of Aberdares National Park showed preference of certain prey species and these were taken in large proportions in relation to other species. The preferred prey species therefore provided the bulk of the lions' diet.

The type of prey species in a given area determines the diet of predators that are found in it (Schaller, 1972; Kruuk, 1972; Eaton, 1974; Bearder, 1977). This was found to be the case in this study on lion diet. From the results obtained, the diet composition of the lions in the salient region of Aberdares National Park was different from lion populations that have been studied elsewhere in Africa. The three most important prey species as a source of food for these lions were different from those of lions in other areas of Africa. For instance, Rudnai (1970, 1974) reported that wildebeest, zebra, kongoni and warthog were the main prey species of the lion population in Nairobi National Park, Kenya. Schaller (1972) found out that in Serengeti National Park, Tanzania, lions mainly fed on wildebeest, zebra, buffalo and topi In yet another study, in Masai Mara Game Reserve, Kenya, Saba (1974) reported that lions in this area mainly preyed on buffalo, wildebeeste and zebra. However the findings of this study in Aberdares National Park are in agreement with other studies on lions which have shown that lions' diet is broad (i.e. they can feed on a variety of prey species that are found in their habitat).

Most studies on lion diet have been based on direct observations of lions feeding in their natural habitats (e.g. Rudnai, (1970, 1974); Saba, (1974); Pienaar, (1969); Kruuk and Turner (1967); Foster and Kearney (1967). Whereas this method can to a certain extent give an idea of the diet composition of lions, there are shortcomings in that one might miss out certain prey species which could be important as a source of food for the lion population under study. To overcome this problem, it is important to combine both direct and indirect methods in order to make a comprehensive diet of lions. The indirect methods that can be used are either analysis of faeces or regurgitates. This method has been found to be very useful in determining hyaena diet by various authors, for example Kruuk (1972), Bearder (1977), Zubiri and Gottelli (1987) and Wambuguh (1990). These authors have however noted that there are certain problems associated with this method (i.e. faecal analysis) as a means of studying hyaena diet.

However, there is no available literature to show the faecal analysis method has been used to determine lion diet. Inspite of this and considering that it was not possible to make direct observations of lions making kills in the salient region due to the nature of the vegetation, this method to a certain degree gave a picture of the diet of lions in this area. The same problems associated with this method as highlighted by aforementioned authors were experienced in this study.

CHAPTER 5

5.0 GENERAL DISCUSSION

The results obtained in this study have given an idea of the prey types and therefore the diet composition of the lions in the salient region of Aberdares National Park. The findings clearly indicated that the lions had a broad diet and therefore preyed on a wide variety of animal species. Based on the counts carried out in the salient region, it follows that the prey species in a given area determines the diet of predators that are found in it. This was found to be the case for the lions in the salient region and the findings are in agreement with other studies that have established a relationship between the diet of predators and the prey types or species found within their range or habitat (e.g. Schaller, 1972; Kruuk, 1972; Eaton, 1974; Bearder, 1977; Wambuguh; 1990).

Inspite of the fact that the lions were found to feed on a wide variety of prey species, they showed prey preference and preyed heavily on bushbuck, suni and buffalo in that order. These results are in agreement with other studies (e.g. Rudnai, 1970, 1974; Pienaar, 1969; Mitchel *et al.*, 1965; Makacha and Schaller, 1969; Ewer, 1973 and Saba, 1974) which have shown the diet of lions can be broad but they do show preference of certain prey species. Like other studies carried elsewhere (e.g. Schaller, 1972; Rudnai, 1970, 1974; Saba, 1974; Pienaar, 1969; Makacha and Schaller, 1969) it was evident that the lions in the salient region preyed on medium sized prey species. However, their diet composition was different from other lion populations that have been studied elsewhere in Africa. Even their three most preferred prey species were found to be different from those lions studied elsewhere. This is in agreement with other studies (e.g Schaller, 1972;Kruuk, 1974; Eaton, 1974; Bearder, 1977) which have been shown that diet composition of predators is to a certian extent determined by the type of prey in their habitat.

Studies which have been carried out to determine the diet of lions have been based on direct observations when they were feeding in their habitats (e.g. Foster and Kearney, (1967); Pienaar (1969); Rudnai (1970, 1974); Saba (1974). This method can give an indication of lion diet composition but one of its shortcomings is that there is a possibility of certain prey species being missed altogether yet they could be important sources of food for the lion population being studied. To improve on this diet composition obtained using this method, it is important to combine both direct and indirect methods. The latter method includes analysis of scats and regurgitates. For this study, it was not possible to determine the diet composition of lions using the direct observation method due to the nature of the vegetation in the salient region. Instead, hairs of mammals obtained from lion scats were used to determine their diet composition. Although this method was not evaluated in order to determine its reliability as a means of determining lion diet composition, it at least helped to make an estimate of the diet composition of the lions in a case where direct observation method could not be used. However, the method has been found to be useful in determining hyaena diet by various authors (e.g. Kruuk (1972), Bearder (1977), Zubiri and Gottelli (1987), Wambuguh (1990). These authors however noted that this method has certain shortcomings as a means of determining the diet of hyaenas and predators in general.

The use of scats in determining diet of predators is an old method which can prove to be better than making direct feeding observations. However, such data should be treated cautiously in most cases since there may be no relationship between the abundance of a prey species and its frequency in occurrence in predator scats (Gordon, 1978). This is due to the fact that the remains of a large prey species may occur in most scats of the predator than those of a smaller prey species even though the abundance may be similar (Gordon, 1978). Furthermore, predators are to a certain extent opportunistic feeders (McIntosh, 1963, Coman and Brunner (1972), such that uncommon or even elusive prey species may not be frequently represented in scats. Scat analysis as a means of determing prey is further limited due to the fact that at times it is not possible to clearly distinguish hair samples from closely related prey species (Gordon, 1978). Inspite of these shortcomings, the analysis of prey hairs contained in scats of predators is an important method in determining their diet composition. Therefore, in this study of lion diet in the Salient region using hairs found in their scats proved to be an important method inspite of the already mentioned shortcomings and in a situation where the dirtect observation method could not be used.

Due to the short period of the study, there is a need to carry out further studies on the diet composition of lions in the Salient region in the near future. Such a study, if prolonged and executed propoerly, can give a better understanding of the actual diet composition of the lion population in the region. This study has therefore provided baseline information of diet composition of the lion upon which future and further studies on the same can be planned and executed.

From the results of this study, it was not possible to explain the observed low population size of the bongo in the Salient region. Inspite of the fact that Hillman (1983) proposed a number of causes which could have led to the low bongo population, he never seemed to be specific in explaining the reason as to why this species is on the decline. Even from the current study, it was not possible to draw any conclusions as to the causes of the observed low bongo population. The results indicated that this species was not heavily preyed on by the lion and it was not among the most preferred prey species. Inspite of this there is an urgent need to carry out studies on the bongo not only in the salient region but also in the whole of Aberdares National Park. It is only after this that meaningful conservation measures of this threatened species can be formulated and executed.

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APPENDIX I

MAMMALS OF THE ABERDARE NATIONAL PARK

Common Name	Scientific Name
Giant white-toothed shrew	*Crocidura occidentalis*
Mole shrew	*Surdisorex spp.*
Rousette fruit bat	*Rousettus aegyptiacus*
Hollow-faced bat	*Nycteris hispida*
Banana bat or African	
Pipistrelle	*Pipistrellus nanus*
Greater galago	*Galago crassicaudatus*
Black-faced vervet	*Cercopithecus aethiops*
Blue or Syke's monkey	*Cecopithecus mitis*
Olive baboon	*Papio anubis*
Black and white colobus	*Colobus guereza*
Hunting dog	*Lycaon pictus*
Silver-backed jackal	*Canis mesomelas*
Side-striped jackal	*Canis adustus*
Zorilla	*Ictonyx striatus*
Clawless otter	*Aonyx capensis*
African civet	*Civettictis civetta*

Bush or large spotted genet	*Genetta trigina*
African palm civet	*Nandinia binotata*
Marsh mongoose	*Atilax paludinosus*
Slender or black-tipped mongoose	*Herpeste sanguineus*
White-tailed mongoose	*Ichneumia albicauda*
Spotted hyena	*Crocuta crocuta*
African wildcat	*Felis lybica*
Serval cat	*Felis serval*
Golden cat	*Felis aurata*
Lion	*Panthera leo*
Leopard	*Panthera pardus*
Ant bear	*Orycteropus ater*
Tree hyrax	*Dendrohyrax arboreus*
African elephant	*Loxodonta africana*
Black rhinocerus	*Diceros bicornis*
Giant forest hog	*Hylochoerus meinertzhageni*
Bush pig	*Potamochoerus porcus*
Blue duiker	*Cephalophus monticola*
Kilipspringer	*Oreotragus oreotragus*
Suni antelope	*Nesotragus moschatus*
Steinbok	*Raphicerus campestris*
Common waterbuck	*Kobus ellipsiprymnus*

Bohor Reedbuck	*Redunca redunca*
Chandler's mountain Reedbuck	*Redunca fulvorufula*
Impala	*Aepyceros melampus*
Bongo	*Boocerus eurycerus*
Bushbuck	*Tragelaphus scriptus*
Eland	*Tautotragus oryx*
African buffalo	*Syncerus caffer*
African hare	*Lepus capensis*
Porcupine	*Hystrix galeata*
Bush squirrel	*Paraxerus ochraceus*
African dormouse	*Graphiurus muririus*
Crested rat	*Lophyomis imhausi*
Kenya mole rat	*Tachyoryctes ibeanus*
Giant rat	*Cricetomys gambianus*

Source: Williams, J.G. (1971). A field guide to the National Parks of East Africa. Collins.