CHAPTER 1

INTRODUCTION

Introduction

Impala probably evolved along the moist eastern seaboard of Africa (Skinner *et al.*, 1984) and now occur over a large area of east and southern Africa. Although smaller-bodied versions of present day impala existed in the past, their basic form has remained almost unchanged and there has never been more than one species of impala present in the fossil assemblage at any given time. Such evolutionary stability is astounding when considering that the closely related alcelaphine antelopes (blesbok *Damaliscus dorcas phillipsi*, hartebeest *Alcelaphus buselaphus* and blue wildebeest *Connochaetes taurinus*), which share a common ancestor with impala, have split into new species of diverse morphology at least 18 times during the same time period (Skinner *et al.*, 1984). Not only are impala intrepid evolutionary survivors, but they are a phenomenal ecological success story (Appendix 1). Natural selection has dressed impala for success with a number of important adaptations to solve problems they face in the natural environment (Skinner *et al.*, 1984).

These adaptations enabled impala to survive, reproduce and thrive under conditions in which other species did not fare well. They were able to disperse into disturbed habitat that more specialised antelope would avoid.

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The impala prefers fairly open wooded savannas with short grasses. Impala are mixed feeders; the bulk of the diet is generally made up of grass with forbs and leaves of woody plants. During the past three decades impala have achieved distinction as a suitable ungulate species for improving meat production, although not as a sole source. However, when meat production and trophy hunting are combined, it becomes profitable to utilise game on a commercial basis (Bothma, 1989).

Over recent years the interest in wildlife management has taken a giant leap and led to the development of increased research on game. The purpose of this dissertation was to study the causes of the different sizes of impala in three regions of the Limpopo Province.

Bothma (1989) showed that there appears to be a size difference between impala from different regions of South Africa. Adult rams of the Kruger National Park were shown to be lighter than those in the north-western Limpopo Province (Bothma, 1989).

The differences between the sizes of the impala have never actually being studied in detail. In this study a comparison is made between the measurements of impala from different regions in South Africa. The aim was to determine if there is a difference and if so, to study their differences. Parameters that were addressed include: the nutritional status and growth physiology of impala in different regions of South Africa.

CHAPTER 2

LITERATURE OVERVIEW

2.1 Nutritional status

Wildlife nutrition has a determining effect on growth and successful production of offspring in animal populations. Knowledge of wildlife nutrition is an important facet of game ranch management.

Utilisation of the grazing is of great importance. To determine which food an animal selects, helps to determine preference of the animal for a type of forage. Selection is also influenced by palatability of the plant (Bothma, 1989).

The most important function of food is the production of energy for body processes. Determination of the intake and loss of energy thus provides an important measure to determine whether the animal is well nourished. Of importance for this study is the mineral status of the impala. According to Bothma (1989), the game in the Limpopo Province suffer from copper (Cu) and zinc (Zn) deficiencies, which may affect the nutritional status of animals in the area.

Over the past two decades there have been various studies to determine the forage in-take and nutritional status of herbivores. Dunham (1982) assessed the foraging behaviour of the impala in the Senqwa Wildlife Research Area, Zimbabwe. Dunham used the method of Owen-Smith (Dunham, 1982).

Foraging impala were monitored from tree top observation platforms. The time spent feeding and moving per 50 steps taken while foraging was recorded. The diet quality was directly related to proportion of grass in the diet, being at a maximum in December and January, and at a minimum in July and August (Dunham, 1982). The mean feed intake was calculated by averaging the intake rates for grasses, forbs and woody browse. Dunham (1982) found the mean feed intake of the dry season to be 96 % of the wet season intake. Dunham (1982) noted that the impala fed on grasses in mopane woodland during the wet season. Forbs were an important component of their diet. During the dry season the impala fed mainly on woody plants, with an increasing percentage being at a maximum in August and September.

In another study done by Skinner *et al.* (1984) the feed intake of impala was determined on mixed tree savanna of the Nylsvley Nature Reserve. A single person collected data from daily observations on foot covering most of the study area on a monthly basis over a six-month summer period and a six-month winter period. October to March was considered as the summer months and April to September as the winter months.

The results from the study show that the *Acacia* savanna was significantly preferred to the *Burkea* and *Diplorhychus* savanna. Finger grass (*Digitaria eriantha*) was regarded as the most popular grass in summer with *Acacia* pods being the most important constituent of the winter diet.

Skinner *et al.* (1984) calculated the daily feed intake to vary between 2.1 and 2.6 % of the body weight per day for the impala. The crude protein (CP) concentration of the diet varied between 106 and 213 g/kg dry matter DM, with a digestibility of between 57 and 69 %. Daily faecal production was estimated at 7.0 – 11 g/kg DM of the body mass. The CP concentration of the faeces was 170 – 200 g/kg DM.

Berry & Louw (1982) investigated the seasonal nutritional status of blue wildebeest in the Etosha National Park. The nutritive status of wildebeest was assessed using visual condition ratings, kidney fat, bone marrow and blood plasma as indicators of nutritional stress.

The visual physical appearance is a good indicator of the nutritional status (Berry & Louw, 1982). Five mutually exclusive categories, whereby the nutritive level of the wildebeest could be subjectively measured, were used. The ratings were based on skeletal details of the animal's body. The points were awarded on the following basis:

- 5 (excellent) - hindquarters well rounded and no ribs showing; general appearance in relation to posture and coat sheen excellent.
- 4 (good) - hindquarters rounded, but ribs showing slightly
- 3 (fair) - hindquarters angular in appearance and ribs well defined.
- 2 (poor) - pelvic bones prominent and ribs protruding

1 (very poor) - skeletal details clearly visible and rump concave; general appearance, posture and coat condition deteriorated.

Using the above ratings Berry & Louw (1982) found 78 % of the wildebeest to be in good to excellent condition. Thirty one percent were in fair condition and less that 1 % were classified as being in poor condition. Tests for seasonal differences in the nutritive level of all age-sex classes showed that more wildebeest were in excellent condition during the dry, cold season than during the wet, hot season (Berry & Louw, 1982). This might have been due to the stresses imposed by sexual activity in the bulls and lactation in cows, which were maximal in the wet, hot season.

The analysis of the nine blood parameters confirmed that Etosha's wildebeest were at a normal level of nutrition. Inorganic phosphorus appeared to be marginally deficient. Liver analyses showed lower P, Cu and cobalt (Co) concentrations, but not at a degree that nutrition was a limiting factor to the population(Berry & Louw, 1982).

Fairall & Klein (1984) did a comparison between two equivalently sized African antelope, namely the blesbuck (*Damaliscus dorcas*) and the impala with respect to their protein intake and their water turnover. They found that the impala had a water turnover double that of the blesbuck. The difference was related to differences in the CP concentration in their diets. The nutritional value of the higher rainfall grasslands of South Africa where the blesbuck is adapted has a low fibre and an average CP concentration during the hot wet season and a high fibre, low protein content during the dry winters.

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The habitat of the impala provided a food source of much greater annual stability for a selective feeder that can adapt its feeding.

The necessity of drinking water for the impala would seem to be coupled to the physiological need to eliminate nitrogenous waste imposed by their high CP intake. This high protein content of its diet has led to the high levels of nitrogenous waste products that have to be excreted in the urine, thus higher water turnover and nitrogen excretion (Fairall & Klein, 1984).

Recently, Pietersen & Meissner (1993) determined the food selection and intake by male impalas in the Timbavati area, Mpumalanga. The aim was to obtain information on quality of diet selected during different seasons and to determine intake.

Pietersen & Meissner (1993) used four 18 to 30 month old hand-raised, partially tamed impala males. The animals were oesophageally fistulated to obtain samples of forage grazed. The impala were also regularly treated with helminthics. The test impala grazed in a 10 hectare fenced off paddock.

Pietersen & Meissner (1993) found that intake dropped significantly in May. The decrease in intake corresponded with a very low *in vivo* dry organic matter and a high lignin content of the forage. They suggested that a second reason for the decreased DM intake might have been because May is the peak of the rutting season.

During June and July the intake was not decreased. This was attributed to the fact that the area experienced late rainfall in May, which enabled consumption of higher digestible material and because the CP was partly supplemented through the intake of significant amounts of browse.

Pietersen & Meissner (1993) found that the intake generally increased in response to the increase in forage CP, digestibility of organic material (DOM) and cell wall constituents. The forage selected had a CP concentration of approximately 97 g/kg and a DOM of 572 g/kg. The influence of lignin content is noticeable by the variation in intake and digestibility. An increase in lignin led to a decrease in intake.

Grant *et al.* (1995), using the faecal P and N as indicators, determined the nutritive value of the veld. The research was conducted during the drought of 1992 – 1993 in the Kruger National Park. A drought is expected to result in a decline in both the quality and quantity of the fodder. This decline often leads to a loss in condition, mortalities and a failure to reproduce. It would therefore be of value to monitor the decline in forage quality to facilitate timely decisions. The sample collection was of fresh, clean faeces at monthly intervals from May 1992 to May 1993. Two grazer species buffalo (*Syncerus caffer*) and blue wildebeest, a mixed feeder, impala and two browser species, the kudu (*Tragelaphus strepsiceros*) and the giraffe (*Giraffa camelopardalis*) were included in the study.

The results obtained, showed significant differences between species, season and landscape (Grant *et al.,* 1995). For species, results corresponded with their feeding habits; the grazers differed from the mixed feeders and browsers. The season, July – September showed the lowest faecal concentrations of N and P. The highest concentrations for N were recorded in January – March and for P, October – December. For both nutrients, the lowest concentrations occurred in the dry season and the highest in the wet season.

With respect to landscapes, the P concentration was lower on granite soils than basalt soils and alluvial soil. The alluvial soils of the Limpopo / Luvuvhu floodplains recorded the highest P concentration. The highest faecal N concentrations were recorded in the *Combretum* veld. Faecal N concentrations were higher on granite than on basalt and higher during the wet season. The faecal P concentrations were also higher in the wet season than the dry season (Grant *et al.,* 1995).

Grazers showed the lowest faecal N concentration and browsers the highest. In contrast, P concentrations were highest for mixed feeders followed by grazers and browsers.

The faecal N concentrations are well correlated with the condition of the animals. From the results Grant *et al.* (1995), concluded that the buffalo as bulk grazers would suffer most in a long-term drought because of the rapid decline in food quality.

Short grass feeders such as blue wildebeest and a browser such as the kudu, which compete with other browsers, would only experience a decline in population numbers when the food becomes limiting.

Impala numbers are most probably not controlled by nutritional means because they are highly selective animals. This would allow them to obtain a diet adequate in quality and quantity (Grant *et al.*, 1995).

Dietary N concentrations may influence P excretion (Wrench *et al.*, 1997) when dietary N concentrations are low. It was found that including faecal N concentration did not improve the prediction of dietary P concentration. Tannins did not affect the predictability of P concentration.

Faecal N concentrations are needed to predict N concentrations of the browse. Tannins affect the digestibility of N, thus showing a high faecal N concentration. Browsers therefore, show a higher faecal N concentration as a result of the high level of tannins in the leaves of some of the browse that they consume (Wrench *et al.* 1997), than grazers. The faecal samples have proven to be valuable in determining nutritional status of wild herbivores.

Factors affecting the concentration of N and P in the faeces are:

a. Environmental factors

Rain reportedly has a leaching effect on faecal minerals due to the erosion of the pellets (Wrench *et al.,* 1996). Results showed that up to 20 mm of rain had no influence on N concentrations in the faeces, whereas more than 5 mm of rain decreased the P concentrations. Samples that were left open in the sun for two days or longer had significantly lower P and N concentrations. These results indicate that only fresh samples that have not been exposed for more than one day should be collected for assessment of nutrient status.

Dung beetles are very active in summer and it is often difficult to even obtain fresh samples without dung beetles. Samples that have been processed by dung beetles had a higher nitrogen concentration, while the P concentration was not affected. The increase in the N concentration could be due to the excretions from the dung beetles, flies or mites.

b. Laboratory factors

When samples are collected in the veld, it is not always possible to dry the wet samples. Fungal growth often occurs on dung samples even when fresh samples are oven dried. Samples that are air dried in a ventilated room did not differ significantly from samples dried in an oven. Samples that were dried in paper bags in the sun showed significantly lower N and P levels (Wrench *et al.,* 1996).

Wrench *et al.* (1996) found that N concentration was lower and the P concentration higher due to the fungal growth. To prevent fungal growth the samples should be well ventilated and should be placed where they can dry quickly.

The chemical composition of body tissue, particularly the liver, is a good reflection of the dietary status of domestic and wild animals (Webb *et al.* 2001). Some minerals, including selenium, copper and manganese are stored in the liver. These minerals are essential for the growth and health of the animal.

2.2 Growth Physiology

Man has used game meat obtained from the cropping of wild populations for many centuries. Since pioneering work of the Americans, Dasmann & Mossman (1960) the concept of using the African ungulate fauna for game farming, has become established. The impala is numerically the most important single species (Fairall, 1983) available for game farming in the Lowveld, the bushveld areas in the Limpopo Province, Mpumalanga and Northern KwaZulu - Natal.

Fairall (1983) recorded the body weight as an indication of the growth of the impala and presented it in the form of the theoretical Von Bertanlanffy growth curve. It illustrates the concept of exponential growth and attainment of the asymptotic weight more clearly than the raw data.

The growth rate was seen to be high and the asymptotic weight is achieved at an age of five years, but 75 % of mature mass is achieved by two years of age. Mature weight in the population was 49.2 ± 1.02 kg in males and 38.3 ± 1.79 kg in females.

Fairall (1983) analysed carcass composition of 15 impala. Fat extraction from samples of the *longissimus dorsi* muscles was done on these carcasses.

The dressing percentage was calculated as 57 %, while the relative mass of hind leg and foreleg compared to the neck and rib cage, showed that the better cuts make up a large proportion of the carcass. While impala in good condition have free intestinal fat deposits, the carcass rarely has any visible fat. Fat extraction of the *longissimus* muscle gave a mean value of 2.8 % fat in nine-month-old impala, 4 % in the two year olds and 3 % in the mature animals.

According to Anderson (1982) the male impala on the

- Nyala game ranch, situated near Emangeni, is lighter and smaller than those from the Kruger National Park, and considerably lighter than those of the Serengeti Game Park. Anderson's final conclusion was that male impala from a smaller game ranch were lighter than those from larger reserves. This has, however, never been studied.

CHAPTER 2

2.3 Parasitology

Diseases, parasites and preventative disease and parasite management are an integral part of wildlife management. The parasites and their game hosts have undergone evolution together and the association has developed to a near perfect balance.

In natural populations and in their feral state, mortality and predators eliminate overpopulation and all weak and parasite susceptible individuals until the equilibrium is re-established. Supplementary feeding and some form of parasite control are necessary. The parasites of game can be divided into the following groups: ectoparasites, which live on the surface of the host's skin, for example ticks, lice and fleas, and endoparasites that live within the host's for their continued existence, such as round worms, tape worms and liver flukes.

As a general rule it may be accepted that blue wildebeest and smaller game carry mainly the immature stage of ticks, while larger game such as kudu, giraffe and buffalo carry both the immature and adult stages of ticks in large numbers (Bothma, 1989).

Ticks have a simple life cycle which can be described briefly as follows: the adult, fully engorged female tick falls from the host and lays her eggs in a protected place. In time the eggs hatch and the small larvae, also sometimes known as *pepper ticks* (*Rhipicephalus spp.)* climb onto the grass stems to await the arrival of a suitable host. The larvae then attach onto the host and engorge themselves on blood. These larvae then dismount and turn into the adult (Bothma, 1989).

One of the most interesting adaptations that accounts for the success of the impala, and one which was unknown until recently, is the unique grooming system they employ to defend themselves against the threat of ectoparasties (Bothma, 1989).
The ecotone habitat in which impala occurs exposes them to a higher density of ticks than the grassland savanna inhabited by antelope like springbok or gazelle. Because of this, the impala is the only hoofed mammal that engages in reciprocal grooming, in addition to the self-grooming.

There are four large groups of endoparasites, which are of varying importance to game: Trematoda, tapeworms, round worms and Nematoda.

Wireworn (*Haemonchus contortus*) has been recorded in 19 species of antelope. Infestations of *Cooperia spp* in the liver on impala cause enlargement and inflammation in the bile ducts. Cases of bilharzias, conical fluke and liver fluke have been recorded too, but without apparent effect on their hosts (Maree & Casey, 1993).

2.4 Motivation

Many farms in the Limpopo Province utilise the game meat obtained from the cropping of wildlife populations as a source of income. The problem presently is attempting to determine the environmental factors affecting the size of the impala. The aim of this study is to determine these factors and assess the degree to which each environmental parameter affects the size of the impala in the Limpopo Province.