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Analysis of the faunal remains of Kemp's Caves and an investigation into possible computerized classification of bones.

by

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I hereby declare that the dissertation

Analysis of the faunal remains of Kemp's Caves

and an investigation into possible computerized classification of bones.

which I

Elaine Swanepoel

am submitting to the

University of Pretoria

Department of Anatomy

for the degree

MSc with specialization in Anatomy

is my own work and has not been submitted by me to

any other university for degree purposes.

Elaine Swanepoel

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II FOREWORD

"Pieces of ancient bone lack the aesthetic appeal of artefacts or the grandeur of ancient buildings, yet they have a complex fascination that arises in part from their zoological origin, as evidence of long-dead animals, and in part from what we can infer from them about past human activities, and about the involvement of people in those animals' lives"

TERRY O' CONNOR, 2000

In his book, The Archaeology of Animal Bones, O' Connor mentions a hobby very few people appreciate......collecting bones. My fascination with bones has lead to a small personal collection which will probably grow until it is not so small anymore!! Standard practice for my husband on a game farm is to stop whenever a white, sunburnt skeleton catches my expert eye. Many a times I have stood over a boiling Jik and OMO filled gallon drum, stirring the newest members to my collection.

Fascination however, only gets you halfway through, and even my undying love of bones could not keep me motivated at all times. It is only after completing this study I realized how much I still do not know, and that I might spend a lifetime learning and not possess half the knowledge of the great archaeozoologists.

However, I am still going to try.

THE BONE COLLECTOR

III ACKNOWLEDGEMENTS

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I am grateful for friends and family for their prayers and encouragement: My parents for their guidance and support, financially and emotionally, during my studies and their undying faith in my abilities; For Marlene and Coen for the time consuming task of correcting my English grammar. My love and appreciation goes to my husband for the thousands of measurement values that he took down patiently as I spoke. Last, but not least, I thank God, for He made this all possible.

IV ABSTRACT AND KEYWORDS

ABSTRACT

Kemp's Caves are situated 2 km west of Krugersdorp in the Ngonyama Game Reserve. An abundance of fossilized as well as modern specimens have been excavated from this site since 1992. The Electron Spin Resonance dates for this site range from 140 000 to 11 000 BP [1]. The faunal analysis of animal remains recovered at fossil sites assists in the dating of the site, and may also give insight into the diet and behaviour of the related hominids which previously occupied the area [2,3,4]. Therefore, all excavated faunal specimens of Kemp's caves were analysed by comparing them to modern skeletal material at the National Flagship Institution. The analysis did not reject the ESR dates and showed that there were no drastic climatic changes in this area during the past 100 000 years. Approximately 3% of the faunal material could be identified to species level, while 11.5 % were assigned to different faunal classes. Five individual specimens belonging to the extinct species *Equus capensis* (Cape horse) included three molars and two humeral fragments. Bovidae size classes II and III were the most represented category, which may indicate that either leopards or hyaenas were responsible for the accumulation of the faunal remains. Contradicting this assumption, is the fact that 11% of the faunal material excavated have been burnt to some extent, which may indicate human activity.

Faunal analysis comprises of the correct identification of animal bone fragments. Conventionally, this is done by morphologically comparing the specimen to its modern counterpart. Identifiable fragments, if possible, are classified to species level while the rest are assigned to different size classes [3,4]. This is a time consuming task and not many experts are available. The secondary aim of this study was thus to investigate the possibility of identifying animal bones through computerized methods. Osteometric data of the hind limb long bones of 30 Southern African Bovid species was obtained, using as many as possible modern specimens of adults from several South African museums. Forty-five measurements were taken on the femur, tibia and metatarsal. These 18 000 measurements were used in an attempt to develop a computerized database programme to aid in the identification of bones. Ten specimens from the Kemp's Caves collection of conventionally identified bones as well as ten modern specimens were measured to test the accuracy of the developed computer programme.

Statistically, the three long bones showed significant differences between the species in the Bov II, III and IV size classes. Bov I species, however, showed significant differences in the metatarsal measurements only. Three robusticity indices were calculated, but showed overlap in all species except the African buffalo. Only 20% of the Kemp's Caves specimens were positively identified by the programme (displayed the identified species as having the highest percentage probability). The rest showed varied percentages of possibilities. The modern specimens had a 40% accuracy rate. However, many species within the database, especially in the Bov I size class, were only represented by a few modern skeletons. This may have contributed to the Bov I class not showing significant differences. Results of this preliminary study were promising, but larger samples and further statistical evaluation may enhance the accuracy of the programme.

KEYWORDS

Archaeozoology, Kemp's Caves, Faunal analysis, Osteometric morphology, Computerized identification, Animal bones, Bovidae

OPSOMMING EN KERNWOORDE

OPSOMMING

Kemp's Caves is 2km vanaf Krugersdorp in die Ngonyama Natuurreservaat geleë. Sedert 1992 het opgrawings van hierdie terrein 'n rykdom gefossileerde en moderne elemente opgelewer. Resultate van die Elektron Spin Resonansie (ESR) het datums van 140 000 tot 11 000 BP opgelewer [1]. Die analise van fauna wat herwin word by fossielterreine ondersteun die datering van 'n terrein. Dit is ook 'n aanwysing tot die dieët en gedrag van die verwante hominiede wat moontlik die area voorheen beset het [2,3,4]. Vir hierdie rede is die fauna van *Kemp's Caves* geanaliseer deur hulle met die moderne versameling by die NFI *(National Flagship Institution)* te vergelyk. Die analise het geen getuienis gelewer om die ESR datums te verwerp nie en het ook getoon dat daar in hierdie area geen drastiese klimaatsveranderinge gedurende die laaste 100 000 jaar was nie. Ongeveer 3% van die fauna versameling kon geïdentifiseer word, terwyl 11.5% tot die verskillende fauna klasse toegedeel is. Vyf individuele been-elemente wat tot die uitgestorwe spesie *Equus capensis* behoort het, het drie molare en twee humerus fragmente ingesluit. Hoefdier klasse II en III was die mees verteenwoordigde katogorie wat mag aandui dat luiperds of hiënas verantwoordelik was vir dié versameling van fauna. Die feit dat 11% van die elemente tot 'n sekere mate gebrand was, mag bogenoemde bewering weerspreek aangesien gebrande beenmateriaal menslike aktiwiteit aandui.

Fauna-analise is die korrekte identifisering van dierbeenfragmente. Konvensioneel word die fragmente morfologies vergelyk met hulle moderne ewebeeld. Identifiseerbare fragmente word, indien moontlik, geklassifiseer tot 'n spesie, terwyl die res aangedui word as 'n spesifieke grootte klas [3,4]. Hierdie is 'n tydrowende proses en daar is min deskundiges op die gebied. Daarom was die tweede doel van die studie om die moontlikheid van gerekenariseerde identifisering van dierbene te ondersoek. Osteometriese data van die agterbeen langbene van 30 Suider-Afrikaanse hoefdier spesies was verkry deur die meting van soveel moontlik volwasse moderne versamelings van verskeie Suid-Afrikaanse museums. Vyf-en-veertig afmetings van die femur, tibia en metatarsaal is geneem. Hierdie 18 000 afmetings is gebruik in 'n poging om 'n rekenaar databasis te ontwikkel wat hulp sal verleen tydens dierbeen identifikasie. Tien *Kemp's Caves* fragmente wat op die konvensionele metode geïdentifiseer is, sowel as tien moderne bene was gemeet om die akkuraatheid van die ontwikkelde rekenaarprogram te toets.

Die drie langbene het statisties betekenisvolle verskille tussen hoefdier II, III en IV klasse gewys. Hoefdier klas I het egter slegs betekenisvolle verskille in die metatarsaal afmetings gewys. Drie robustisiteitsindekse was bereken en het oorvleueling in alle spesies gewys behalwe vir die Buffel. Net 20% van die *Kemp's Caves* elemente was positief geïdentifiseer deur die program (vertoon die spesie as die hoogste persentasie moontlikheid). Die res van die toetselemente het 'n verskeidenheid persentasie moontlikhede gewys. Die moderne elemente het 'n 40% akkuraatheidskoers gewys. Baie spesies in die databasis, veral die hoefdier I klas, was egter slegs deur 'n paar moderne skelette verteenwoordig. Hierdie feit mag daartoe bygedra het dat hoefdier klas I nie veel betekenisvolle verskille getoon het nie. Die resultate van die studie was belowend maar groter versamelings en verdere statistiese evaluasie mag die akkuraatheid van die program verbeter.

KERNWOORDE

Argeodierkunde, *Kemp's Caves*, Fauna analise, Osteometriese morfologie, Gerekenariseerde identifikasie, Dierbene, Hoefdiere

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1 INTRODUCTION

It is said that the history of mankind is like a novel with most of its pages torn or lost. The few pages of information we have, are based upon fossil evidence leading to scientific facts as well as educated guesses.

Fossilized bones have been excavated worldwide from sites, caves and shelters where ecological factors permitted such preservation. South African caves in particular have yielded essential specimens, helping to reconstruct the past. A few examples include the famous Sterkfontein caves [5,6,7], Kromdraai [8,9], Swartkrans [10,11], Makapansgat [12,13] and Florisbad [14,15]. These sites date back several million years, shedding light on early man and its descendants. There are, however, little information on the origin of Anatomically Modern Humans. Only a few sites present chronologies dating back to upper Pleistocene, the era believed to be fundamental in the evolution of anatomical modern *Homo sapiens*. Sites and caves falling within this expected time period include Rose Cottage cave [16,17,18,19], Sehonghong [20, 21], Border Cave [22,23], Klasies River Mouth [24,25] and Kemp's Caves [1,26].

Kemp's Caves are situated in the Krugersdorp area in the Ngonyama Game Reserve. It was accidentally discovered in 1991 and has yielded a large quantity of fossilized and modern faunal material during ongoing excavations. Electron spin resonance (ESR) dating revealed dates as young as Holocene (6.1 ± 0.4 ka) to Upper Pleistocene (140 ± 8 ka)[1]. Southern African caves, however, do not contain volcanic material which accommodate the accurate geological dating of sites [27]. This presents difficulty in acquiring absolute dates. Therefore, to confirm the ESR dates, other methods of dating are required. One of these methods is comparative faunal analysis, which provides relative dates. Identification of an extinct faunal species is of especially great importance, for it may enhance the accuracy of the cave date, and give an indication of how the climate and environment may have changed during this crucial era in human evolution [3,4].

Faunal identification does not only give insight into the cave's elapsed time, but also supplies data on the taphonomy of the cave. Taphonomy is the study of how bones came to be buried at a specific location [27]. Animals collect bones for various purposes, but the majority of assemblages are collected by predators for sustenance [2]. Identification of the predator (man or animal) responsible for the accumulation of the cave's assemblage reflects the diet and behaviour of that species. Modification, such as gnawing and cut marks, of the faunal specimens also gives an indication as to which species were responsible for the collection of bones [3,28]. The different species identified in the faunal assemblage may also reflect the climatological conditions and the ecology present during the different periods of influx into the cave by knowing the general diets of these animals [29,30,31].

Faunal analysis is a crucial tool in the investigation into the complexity of caves. How, and under which circumstances they developed, as well as the mysteries they contain yield important information of the cave's inhabitants. Kemp's Caves in particular may yield invaluable information pertaining to our existence, as this site falls within the critical period for the origin of Anatomically Modern Humans.

Faunal analysis is, however, a time consuming and tedious task. A single specimen is identified to part and side of the skeleton and if possible to the species it belongs to. This is done by an expert comparing morphological characteristics of the excavated piece to its modern counterpart [3,4]. However, osteological measurements often constitute the only method of accurate identification. This, for example, is the case when sheep and goat specimens are analysed within the same faunal assemblage [32]. Since identification of skeletal specimens is thus possible by using metrical data, it may be possible to use a database of measurements to identify faunal specimens of an excavation site. Therefore, an investigation into possible computerized identification utilizing absolute osteometric values may yield a method which can be useful when a preliminary faunal list of a site is needed. This method may not be as accurate as the eye of an expert, but will certainly give a good idea of the faunal species present in an excavation.

The two aims of this study were to firstly analyse the faunal remains of Kemp's Caves with regard to the ESR dating, climatic changes in the area and the taphonomy of the cave. Secondly, it was to investigate the possibility of computerized identification of bones. These aims could only be achieved by conducting the study in three different stages:

Stage I: *The analysis of the faunal remains of Kemp's Caves.*

This stage of the study entailed the morphological identification and analysis of the macrofaunal remains of Kemp's Caves. The interpretation of this data included climatological, ecological and taphonomic aspects, as well as possible confirmation of the ESR dates. This may give an idea of the conditions and environment during the evolution of Anatomically Modern Humans.

Stage 2: *The collection of skeletal measurements and the development of a computerized programme for possible identification of bones.*

During this stage of the study it was attempted to ascertain whether bones could be identified exclusively according to measurement values. Because this is a new method, only the hind limb long bones of Southern African bovids were measured as a pilot study. Measurements to significantly differentiate between hind limb long bones of Southern African Bovidae were determined. Modern specimens of several South African museum collections were then measured and values were entered into a database. This data was used in the development of a computer programme for osteometric identification using the abovementioned measurements. Statistical analysis was done on all osteometric data obtained.

Stage 3: *Testing the computerized identification of bones.*

The computerized programme developed in Stage 2 was tested for accuracy and reliability on a few of the bones of Kemp's Caves by comparing the computerized results with the results obtained by the conventional methods in Stage 1. As only a few measurements were available for the Kemp's Caves specimens, it was decided to use modern specimens of known identification (of which all measurements could be taken) to also be compared to the computerized results.

2 LITERATURE

1. INTRODUCTION TO KEMP'S CAVES

Kemp's Caves are situated approximately 2 km west of Krugersdorp (26°04'51" S, 27°42'20" E) in the Ngonyama Game Reserve (see Figure 2.1). The caves were accidentally discovered through a series of events during 1991. A game ranger of the reserve stumbled upon a modern human skeleton in an area situated across the lion camp. As part of the police investigation to identify the remains, the expertise of Dr VD Kemp (coroner of the University of the Witwatersrand) was required. Dr Kemp visited the site and immediately realized the abundance of fossil material present in the area. This was reported to Prof M Henneberg at the University of the Witwatersrand, who started excavations in 1992. After Prof Henneberg left the country in 1996 research at the caves has been continued by the Department of Anatomy of the University of Pretoria [1].

The dolomitic ridge revealed a series of complex open caves, which was named after Dr Kemp. The caves are typical of the dolomitic caves formed in this area and run approximately from NW to SE [33]. Analysis by Keyser indicates a young cave age, due to the caves' position above water level [26]. This is based on the geological theory that the higher the cave (closer to the water table) the younger it is. It is thus assumed that the Kemp's caves are relatively young due to the fact that the Rietfontein stream is almost at the same level as entrance of the cave.

The caves contain fossiliferous breccia in various stages of calcification and decalcification in its walls, roof and floor [1]. Breccia often falls from the roof to the floor creating difficulty to analyze the date of the specimens according to layers in which it was first deposited.

Figure 2.1 is a simplified illustration of some of the important cave sites of South Africa and includes some older fossil sites as well. It clearly shows the close proximity of Kemp's Caves to the "Cradle of Mankind" sites in the Gauteng province.

FIGURE 2.1: Cave and excavation sites in South Africa

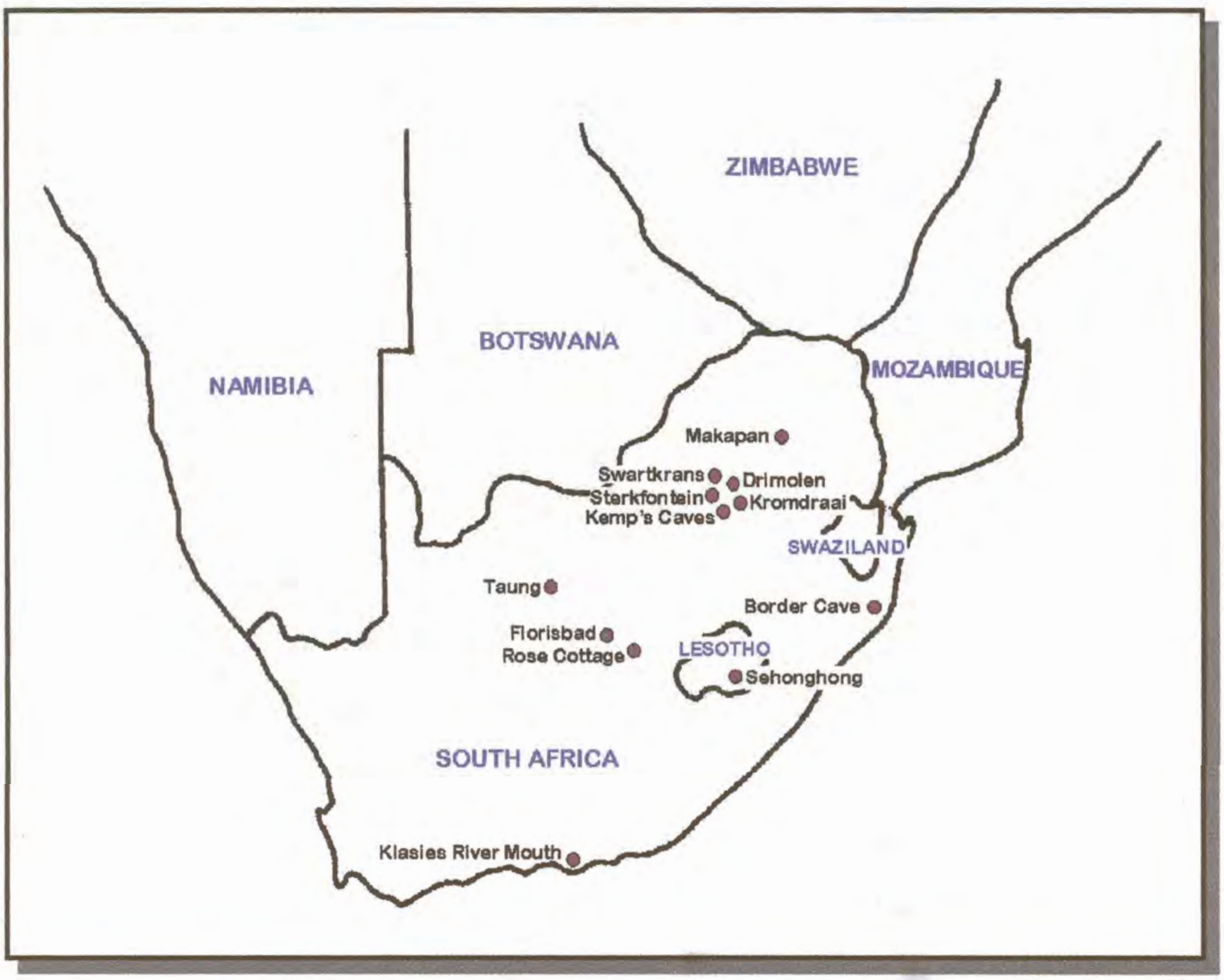
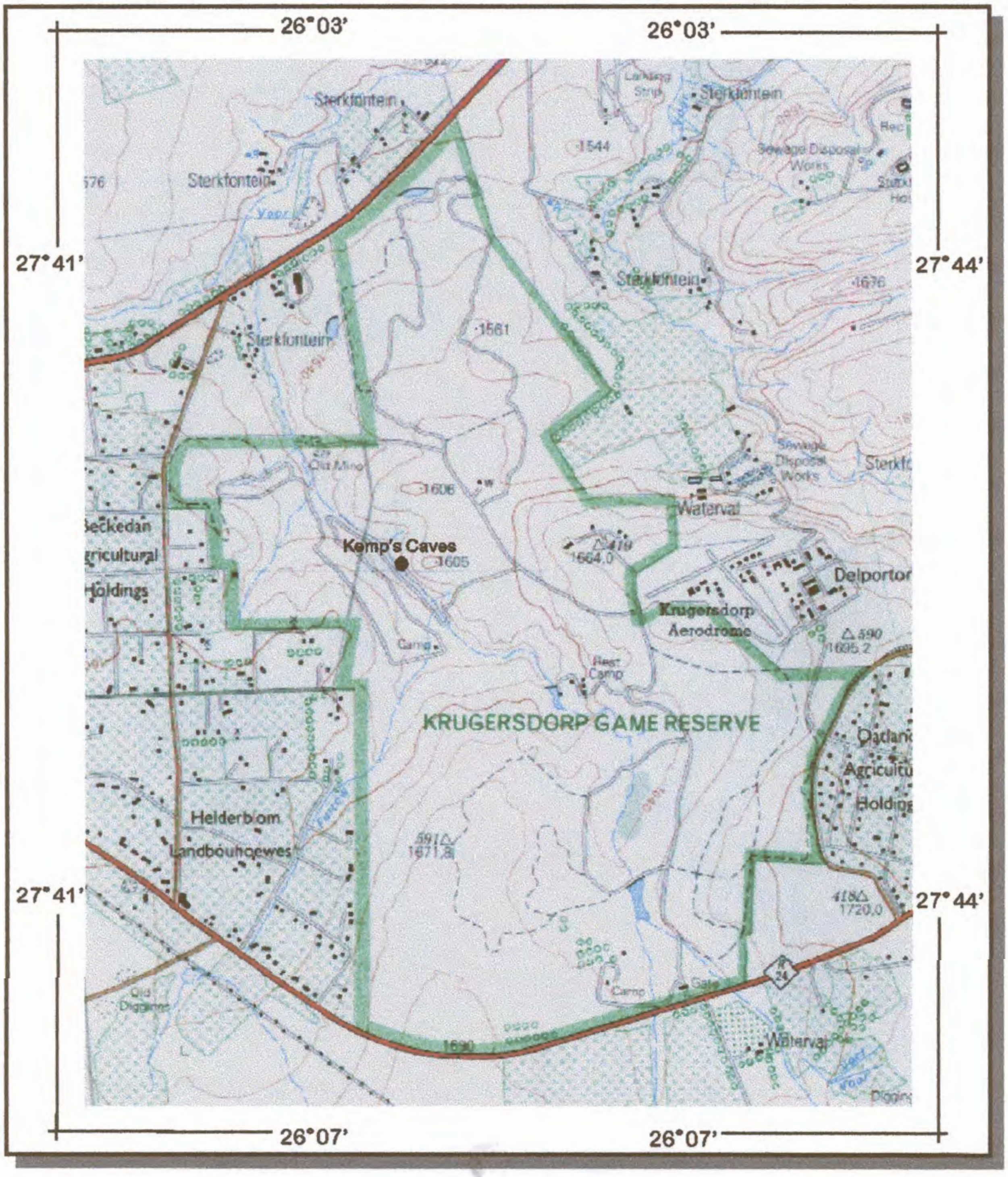


Figure 2.2 shows the Ngonyama Game Reserve (former Krugersdorp Game Reserve) 2 km west of Krugersdorp, with the location of Kemp's Caves.

FIGURE 2.2: Ngonyama Game Reserve (Copyright State 1997)



Kemp's Caves is comprised of three separate caves:

❖ Upper Kemp's Cave (UKC)

UKC was initially identified as a rock shelter [1]. It is mostly filled with collapsed rock and extends at least 7m into the ridge [33].

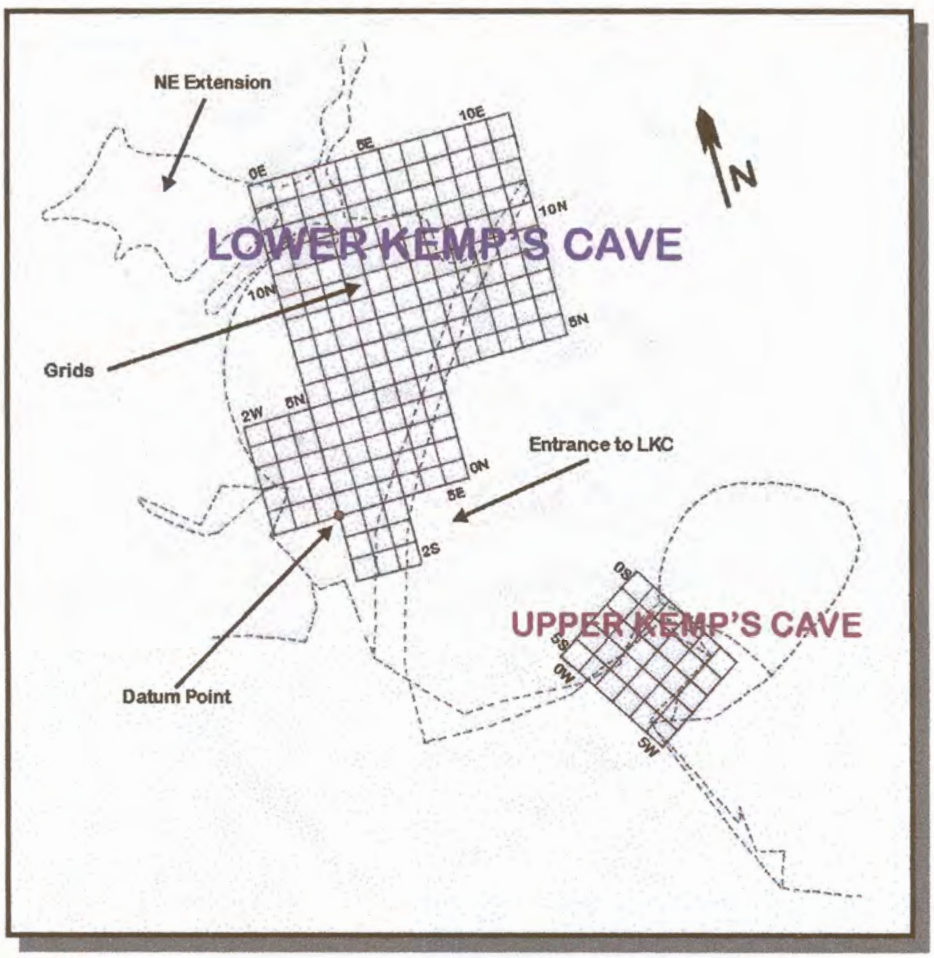
❖ Little Western Cave (LWC)

LWC is situated to the south of the entrance of UKC. It is approximately 2m long, 1m high and 1m wide [33].

❖ Lower Kemp's Cave (LKC)

This is the largest cave, situated 20m south west of UKC [1]. It is approximately 15m long and 10m wide. The height differs at separate locations in the cave and ranges between 0.1 - 5m [33]. Material retrieved from LKC was used for this study.

FIGURE 2.3: Upper and Lower Kemp's Caves



Initially a grid system was built using a datum point (designated as "0") established near the middle of the entrance of LKC. In this system, for example, a square lying 6m to the North and 2m to the East from this datum point is labeled 6N2E [33].

Problems such as the irregularity of the cave and the theft of the wires contributed to the fact that there is no permanent grid at LKC [26]. The assemblage was excavated using archaeological methods, and all material was screened through rough and fine mesh. Breccia blocks were assigned to provenance and prepared in the laboratory by using mechanical and chemical preparation techniques [1]. Only parts of LKC have been excavated, thus there are still abundant breccia to be recovered.

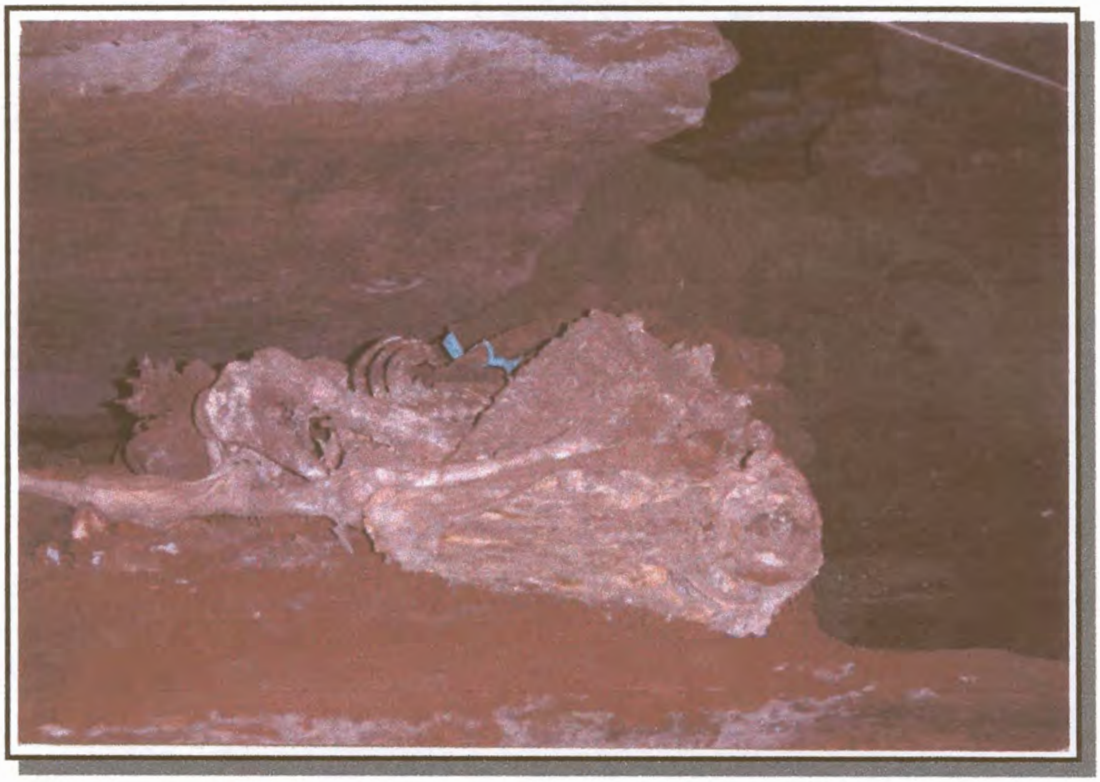
Figures 2.4, 2.5 and 2.6 are photographic representations of the entrances of UKC, LWC and LKC respectively. Figure 2.7 shows a juvenile Eland skeleton located deep within LKC, a more recent attribution to the cave's contents.

FIGURE 2.4: Entrance to Upper Kemp's Cave (Copyright University of Pretoria)

FIGURE 2.5: Entrance to Little Western Cave (Copyright University of Pretoria)

FIGURE 2.6: Entrance to Lower Kemp's Cave (Copyright University of Pretoria)

FIGURE 2.7: Juvenile Eland skeleton in Lower Kemp's Cave (Copyright University of Pretoria)



The modern human skull discovered at the site exhibits physical features resembling the San people. It is that of a young adult male aged 22-27 years. The fractured skull has porcupine gnaw marks on the frontal, zygomatic, temporal and maxillary bones. A clay bowl, corresponding to pottery usually attributed to the Sotho-Tswana people, was found in close proximity to the skull [1,26].

Artifacts such as animal bones, pottery, charcoal, glass, metal wire, as well as a Late Stone Age chert scraper (52mm X 26mm), were unearthed at the entrance of the cave. There were also a few fragments of the skull found at the cave, near these artifacts. Reconstruction of some of the glass fragments yielded a 'marble stopper' type bottle, commonly used earlier this century. Other human remains excavated at the site include carpals, tarsals and phalanges of both hands and feet, ribs and several teeth of a young adult of uncertain sex. These modern human remains were excavated by the University of the Witwatersrand and is still part of their collection. A rusted nail, broken earthenware pot and a complete Middle Stone Age spear point was also found in the vicinity of these human skeletal remains. A lower third molar belonging to an adult aged 25-35 years originated from a small ash-filled crevice in the rock in LKC. The molar was worn to the second degree, and quite large in size [26].

Presently the Department of Anatomy at the University of Pretoria is excavating in Lower Kemp's Cave which exhibits the most fossil material. Although no ancient hominid bones have as yet been discovered, Kemp's Caves fall within the expected time period for the origin of anatomical modern humans and may still yield specimens which could shed light on the evolution of anatomical modern humans [1].

Little is known about this era in human evolution. A large number of fossiliferous caves and shelters have been identified and investigated in Southern Africa, but only a few have chronologies dating back to Upper Pleistocene [34]. Aspects such as Upper Pleistocene environmental changes [35], MSA assemblages and interpretation of human behaviour [36], as well as origin, locality and demographic shifts [37] are still being debated because of the insufficient representation of this era in the fossil record.

Klein describes palaeoanthropology as a historical science, which interprets and reconstructs the life of extinct humans from their preserved skeletal anatomy. It then also assumes their behavior and the processes that shaped them but, in comparison with other evolutionary disciplines, the data is always meager [38]. Therefore, compared to the evolution of animals, the history of man is still poorly represented in the fossil record but every discovery sheds new light on old theories.

A number of contradicting theories regarding the geographical origin of modern humans exists. One theory is "multiregional evolution" which states that modern humans evolved semi-independently in Europe, Asia and Africa [39]. Another theory is known as the "Out of Africa" hypothesis that argues that modern humans evolved in Africa, migrated to Eurasia later and replaced the people living there [40]. Walter et al [41] argued that not only did early modern humans originate in Africa but evidence at the Red Sea coast suggests that the first modern humans occupied mostly coastal areas. Kemp's caves contain fossils from the time period in which anatomical modern humans evolved. If hominid remains are found at Kemp's Caves it may yield important information in this respect, being an inland site with dates of this era. The lack of significant human and natural disturbance of the fossil bearing deposits may, on the other hand, also be important to substantiate the theory of Walter et al [41].

2. ECOLOGY OF KEMP'S CAVES

Ecology is described as the scientific study of living things in relation to each other and to their environment [42]. The close interrelationship between fauna, flora, climate and geology, therefore assists the scientist in the understanding of the environment and time in which cave deposits occurred.

McKee [43] remarks that any environmental changes, apparently associated with hominid evolution, are revealed in part by the animals that changed, or did not change, within the same local context. Faunal analysis can therefore, either corroborate or challenge ecological hypothesis. This provides an important context for the appearance of the genus *Homo* and associated artefacts within a biotic community. Climatological [29,30,31] and geological [61] studies will therefore shed some light on the origin of anatomical modern humans. Thackeray [30], however, reminds that although fossil remains may facilitate environmental reconstruction, the fossil record represents only a portion of the animals that lived at the time of the deposition.

Consequently, the ecological significance of the fauna is subject to varied interpretations. It is therefore essential to corroborate evidence of all faunal elements from a site [43].

The regional ecology is thus of great importance to have a clear understanding of the faunal assemblage, taphonomy and the processes that have been busy changing and creating Kemp's Caves and the immediate area surrounding the cave. Geology, the climate, as well as the fauna and flora (veld types - past and present) give the essential background required for analysis.

2.1 Geology

Approximately 3500 - 2500 million years ago, the oldest rock formations in South Africa developed. They belong to the Archaean time period (Table 2.1). These formations constitute the basement or floor on which the younger sediments were deposited. Large masses of granite, called greenstone belts, intruded into older belts of volcanic and sedimentary rocks. These formations form an ancient greenstone terrain which underlies a large part of the country.

The granite-greenstone basement, together with it's younger cover rocks, form the Kaapvaal Craton. This ancient core of continental crust has remained relatively undisturbed since Archaean times [44].

TABLE 2.1: Geological time scale adapted from Viljoen & Reimold [44].

EON	ERA	PERIOD	EPOCH	MYA
PHANEROZOIC	CENOZOIC	QUATERNARY	HOLOCENE	Recent
			PLEISTOCENE	1.6
		TERTIARY	PLIOCENE	5
			MIOCENE	23
			OLIGOCENE	35
			EOCENE	56
			PALAEOCENE	65
	MESOZOIC	CRETACEOUS		145
		JURASSIC		208
		TRIASSIC		245
	PALAEOZOIC	PERMIAN		290
		CARBONIFEROUS		365
		DEVONIAN		405
		SILURION		440
		ORDIVICIAN		520
		CAMBRIAN		570
PRECAMBRIAN	PROTEROZOIC	LATE		900
		MIDDLE		1600
		EARLY		2500
	ARCHAEAN	LATE		3000
		MIDDLE		3400
		EARLY		

Between 2600 and 2250 million years ago, during the Proterozoic (Table 2.1), a large part of the Kaapvaal Craton was submerged by an inland sea. Older formations like the Ventersdorp lavas (huge volumes of lava flowed with interlayered sediments) were covered by a widespread sequence of sediments, known as the Transvaal Supergroup. Kemp's Caves fall within this geological group. These rocks were deposited in a large sedimentary basin [44]. This probably happened during the first major marine transgression over the continental mass in the Late Archaean [45]. It extends roughly between Mafikeng in the west, Nelspruit in the east, Pietersburg in the north and Vredefort in the South [44].

The lowest rocks of the Transvaal Supergroup consist mainly of quartzite. In many places it contains a narrow, dark-coloured quartz-pebble conglomerate known as the Black Reef. It is this conglomerate that carries gold [44].

Carbonate sediments, Malmani dolomite, accumulated in a shallow sea after deposition of the Black Reef. These distinctive carbonate rocks (dolomite and limestone) contain stromatolites, which were formed by ancient organisms similar to present-day algal colonies. The Malmani dolomites contain numerous caves. The caves have formed recently in geological time as a result of dissolution of the carbonate by penetrating groundwater. Dissolution occurred particularly along fractures in the rock. Sterkfontein, Swartkrans and Kromdraai are well-known caves found within these sediments. Although these dolomite cave formations have made these areas of South Africa the famous "Cradle of Mankind", it also poses a problem in certain parts of the country where the surface collapses as a result of dissolution, causing sinkholes [44]. Lead, zinc, vanadium and fluorite mineralization occur within the Malmani dolomite, making it economically favourable for mining [45].

2.2 Climate

The climate of any place on earth is controlled by three important factors [46]

❶ Latitude.

❷ Position relative to the distribution of land and sea.

❸ Height above sea level.

Other factors such as general circulation of the atmosphere, ocean currents, the nature of underlying soil, vegetation cover and orientation relative to hills or mountains influence the climate and each other [46].

Kemp's Caves fall within the Northeastern corner of the Highveld climatic region. It is in close proximity to the Northern Transvaal region. The average precipitation of this region currently varies from 900mm on its eastern border to 650mm in the west. The rainfall is almost exclusively due to showers and thunderstorms which is characterized by short periods of considerable rainfall. These storms are often violent with strong, gusty south-westerly winds. The winter months are normally dry and about 85% of the annual rainfall occurs in the summer months from October to March. Rain is sometimes accompanied by hail [46].

The average daily temperatures range from 27°C in January to 17°C in July. In extreme cases it may rise to 38°C and sink to -10°C respectively. For an average of 120 days during may to September, frost is likely to occur. On average winds are light except when accompanied by thunderstorms. The sunshine duration in summer is about 60% and in winter 80% of the possible. Average sunshine hours per day are between 8 and 9 hours [46].

2.3 Flora

Vegetation is made up of individual plants, few or many, according to their habitat, which belongs to a number of different species. A balance is maintained at a level of development determined by the locality or environment of living together, competing with and assisting each other. A unit of vegetation whose range of variation is small enough to permit the whole of it to have the same farming possibilities is defined as a *veld type*. Acocks developed the classification of 70 veld types, plus 75 variations for South Africa [47].

A survey conducted in 1950 classified the area around Kemp's Caves as being part of sour grassveld vegetation. Vegetation changes according to the way it is treated, and Acocks is of opinion that little or no vegetation in South Africa is in its original condition. Several theories on the vegetation during past and future eras, place Kemp's Caves on the border of different vegetation patterns. Around A.D. 1400 Kemp's Caves were probably situated on the border between bushveld and sour grassveld. Future probability (approximately 2050), positions Kemp's Caves on the junction of three veld types namely bushveld, sour grassveld and mixed grassveld. If vegetation in South Africa is under constant scientific management Kemp's Caves should be pure sour grassveld [47]. Sourveld is defined as being veld where the forage plants become unacceptable and less nutritious on reaching maturity, thus allowing the veld to be utilized for only a portion of each year [48].

Kemp's Caves fall specifically into Acocks veld type 61, called bankenveld. Bankenveld is classified as a false grassveld type [47]. Low and Rebelo edited a revised vegetation description of South Africa in 1996. According to the new edition, Kemp's cave fall within the Grassland Biome, which is dominated by a single layer of grasses, specifically veld type 34, Rocky Highveld Grassland. Bankenveld and Rocky Highveld Grassland is synonymous [49]. It is possible that this veld type was an open savanna of *Acacia caffra* (Common hook-thorn). In certain parts along its northern margin it is still open savanna, and sour bushveld regularly occurs on the rocky outcrops and hills.

Three variations of Bankenveld are recognized [47]:

➊ Western variation (sandy plains)

➋ Central variation (Witwatersrand area, high lying, largely rocky country)

➌ Eastern variation (sandy plains, but wetter than Western variation)

Kemp's Caves fall within the central variation. The rocks are mainly quartzite, shale, dolomite, chert and granite. The soils are poor and acid, and either stony or sandy. The winters are severely frosty. With regular burning the veld is particularly sour and virtually ungrazable in winter. On the rocky hills and ridges the vegetation is bushveld dominated by *Protea caffra* (Common sugarbush), *Acacia caffra* (Common hook-thorn), *Celtis africana* (White Stinkwood) and a large number of south bushveld shrubs. *Xerophyta retnervis* is a typical plant of the hills but in the sheltered valleys and sinkholes there are temperate transitional forests. Species such as *Kiggelaria africana* (Wild peach), *Halleria lucida* (Tree fuchsia) and *Leucosidea sericea* (Old wood) can be found in these forest areas [47].

Principal grass genera include *Schizachyrium* (Autumn grass), *Eragrostis* (Love grass), *Digitaria* (Finger grass), *Panicum* (Buffalo grass) and *Setaria* (Bristle grass). This veld type has a wealth of forbs and bushy plants and is closely related to the more mountainous parts of Lowveld Sour Bushveld, but it is drier and less hot [47].

Table 2.2 shows a detailed list of the characteristic species of this veld type. Kemp's Caves are situated next to the small Rietfontein river, in a rocky mountainous, forest area at an altitude of approximately 1550m.

TABLE 2.2: Kemp's Cave area plant species as listed by Bredenkamp & van Rooyen [49]

NATIONAL NO.	SPECIES	
	A. GRASSES	
	Trachypogon spicatus	Giant speargrass
	Diheteropogon amplectens	Broadleaf bluestem
	Schizachyrium sanguineum	Red autumngrass
	Andropogon schirensis	Stab grass
	Loudentia simplex	Common russet grass
	Tristachya leucothrix	Hairy trident grass
	Panicum natalense	Natal panicum
	Bewsia biflora	False love grass
	Digitaria tricholaenoides	Purple finger grass
	Digitaria monodactyla	One-finger grass
	Sporobolus pectinates	Fringed dropseed
	Harpochloa falx	Caterpillar grass
	Ctenium concinnum	Sickle grass
	Rendila altera	Toothbrush grass
	Alloteropsis semialata	Black-seed grass
	Monocymbium ceresiiforme	Boat grass
	B. DICOTYLEDONOUS FORBS	
	Sphenostylis angustifola	Wild sweetpea
	Acrotome hispida	Rough-hair sage
	Senecio venosus	Broom ragwort
	Senecio coronatus	Ragwort / Canary weed
	Justicia anagalloides	
	Pentanisia angustifola	
	Pearsonia cajanifola	
	Indigofera comosa	
	Xerophyta retinervis	
	Alcalypha angustata	
	Vernonia oligocephala	
	Cheilanthes hirta	Parsley fern

TABLE 2.2: Continue

	C. NON-GRASSY FORBS	
	Scilla nervosa	Wild squill
	Rhus rehmanniana	Bluntleaf current
	Rhus discolor	Gwarrie
	Vernonia natalensis	
	Berkeya setifera	Disseldoring
	Helichrysum oreophilum	Sewejaartjie
	D. WOODY VEGETATION	
162	*Acacia caffra*	Common Hook thorn
387	*Rhus leptodictya*	Mountain karee
392	*Rhus pyroides*	Common Wild current
396.1	*Rhus zeyheri*	Blue taaibos
657	*Ehretia rigida*	Puzzle bush
399	*Maytenus heterophylla*	Common spike-thorn
594	*Euclea crispa*	Blue guarri
253	*Zanthoxylum capense*	Small knobwood
471	*Dombeya rotundifolia*	Wild pear
87	*Protea caffra*	Highveld protea
39	*Celtis africana*	White stinkwood
447	*Ziziphus mucronata*	Buffalo-thorn
703	*Tapiphyllum parvifolium*	Small velvet leaf
702	*Vangueria infausta*	Wild medlar
710	*Canthium gilfillani*	Rock alder
537	*Combretum molle*	Velvet bushwillow
617	*Olea europaea*	Wild olive
463	*Grewia occidentalis*	Cross-berry

This Bankenveld veld type is transitional between typical grassland and bushveld. The distribution of woody elements is mostly influenced by the frosts during winter. Bankenveld was interpreted by Acocks as a fire-maintained grassland, therefore developing into savanna if fire was excluded [49].

2.4 Fauna

The habitat of an animal is closely associated with the flora which occupies the area. The frequency of a specific species is therefore dictated by its feeding type which in turn is based on the flora available.

The Ngonyama Game Reserve has been surrounding the Kemp's Cave area since 1963. Certain species have been introduced to the area which may not have been naturally present before the recent habitat changes. A typical example is *Antidorcas marsupialis* (Springbok). This fact may complicate conclusions made from faunal material during climatological change and interpretation.

Earlier upper Pleistocene faunal remains which accompany MSA artifacts in Southern Africa are all reported to be overwhelmingly modern. Extinct species include three extinct genera, namely the giant Buffalo, *Pelorovis*, the giant Hartebeest *Megalotragus*, and the giant warthog *Stylochoerus*. Extinct species in surviving genera include *Equus capensis* (Giant cape horse/zebra), *Antidorcas australis* and *Antidorcas bondi* (springboks), *Hipparion* (three-toed horse), *Sivatherium* (short-necked giraffes), *Megantereon* (sabre-tooth cats) and *Theropithecus* (giant baboon) [37].

A species list combining information on animals which may have been present in the area in the past (du Plessis [50]), animals which normally occur naturally in this type of habitat (Smithers [51]), as well as the actual species found on the reserve are represented in Table 2.3. Only larger mammal species are shown. Most of the species in the list that occupied the Kemp's Caves area are still present in the Ngonyama Game Reserve.

TABLE 2.3: Species list of past and present larger mammals within the Kemp's Caves area

PRIMATES	
Homo sapiens	Human
Papio cynocephalus ursinus	Chacma baboon
Cercopithecus aethiops	Vervet monkey
CARNIVORA	
Proteles cristatus	Aardwolf
Hyaena brunnea	Brown Hyaena
Crocuta crocuta	Spotted Hyaena
Panthera pardus	Leopard
Panthera leo	Lion
Felis caracal	Caracal
Felis lybica	African wildcat
Felis serval	Serval
Vulpes chama	Cape fox
Canis mesomelas	Black-backed jackal
Aonyx capensis	Cape clawless otter
Melivora capensis	Honey badger
Poecilogale albinucha	Striped weasel
Ictonyx striatus	Striped polecat
Civetictis civetta	African civet
Genetta	Genet
Suricata suricatta	Suricate
Herpestinae	Mongoose
PERISSODACTYLA	
Equus burcelli ♦	Burchell's zebra
ARTIODACTYLA	
Phacochoerus aethiopicus ♦	Warthog
Potamochoerus porcus	Bushpig
Hippopotamus amphibus ♦	Hippopotamus
Giraffa camelopardalus ♦	Giraffe
Sylvicapra grimmia ♦	Grey Duiker
Raphicerus campestris ♦	Steenbok
Ourebia ourebia ♦	Oribi
Oreotragus oreatragus ♦	Klipspringer
Tragelaphus scriptus	Bushbuck

TABLE 2.3: Continue

Pelea capreolus ◆	Grey Rhebuck
Redunca fulvorufula ◆	Mountain Reedbuck
Redunca arundinum ◆	Reedbuck
Aepycyros melampus ◆	Impala
Antidorcas marsupialis ◆	Springbok
Hippotragus equines ◆	Roan
Damaliscus dorcas phillipsii ◆	Blesbok
Alcelaphus buselaphus	Red Hartebeest
Hippotragus niger	Sable
Connochaetes gnou ◆	Black Wildebeeast
Tragelaphus strepsiceros ◆	Kudu
Connochaetes taurinus ◆	Blue Wildebeest
Syncerus caffer	African buffalo
Taurotragus oryx	Eland
RODENTIA	
Xerus inourus	Ground squirrel
Paraxerus cepapi	Tree squirrel
Cryptomys hottetotus	Common molerat
Hystrix africeaustralis	Porcupine
Pedetes capensis	Springhare
LAGOMORHPA	
Lepus saxatalis	Scrub Hare
HYRACOIDEA	
Procavia capensis	Rock dassie
TUBULINDENTATA	
Orycteropus afer	Aardvark
PHOLIDOTA	
Manis temminickii	Pangolin

◆ Animals that occurred here in the past [50]

3. SITE DATING

Six heavily fossilized teeth prepared from breccia blocks from three different localities in LKC, as well as a seventh from *in situ* deposits were selected in 1996 for ESR (Electron Spin Resonance) dating [1]. Sample preparations and measurements followed conventional ESR laboratory procedures [52]. Fragments of enamel were mechanically removed from different locations on the teeth. The preparation of several sub-samples tested the uniformity as well as the possibility of contamination of the specimens. The result was dates ranging from 11 ± 0,6 ka to 140 ± 8 ka classifying it as Upper Pleistocene. The youngest date is Holocene in age and dates to about 6,1 ± 0,4 ka [1].

The ESR dates of the site should be confirmed with other methods of dating. It may be difficult considering the problems associated with the dating of Southern African sites, as the development and formation of these caves do not easily accommodate geological dating for absolute results [27].

Scientists use two kinds of dating methods:

❶ Chronometric / Absolute dating

→ gives a date of actual number of years [27].

❷ Relative dating

→ gives an idea whether something is older or younger than the other [27].

Faunal dating is a method of relative dating, thus giving no definite date in years. The rock matrix from which the bone was excavated can, however, be chronometrically dated if necessary. Faunal analysis can therefore be very informative when an extinct species is discovered. Knowing the approximate era in which this animal roamed the earth, gives an idea of the date of that particular section of the site [27]. Therefore comparative faunal analysis might aid in confirming the dating of Kemp's Caves.

4. OTHER SOUTHERN AFRICAN CAVES AND SITES WITH SIMILAR DATES

Other sites in Southern Africa such as Rose Cottage Cave, Melikane and Sehonghong fall in the same time period as Kemp's Caves [34].

4.1 Rose Cottage Cave

Rose Cottage Cave is situated on the Platberg, a few kilometers away from Ladybrand in the eastern Free State (29°13' S, 27°28' E). Cave dates range from 5970 ± 70 to 28 000 ± 80 BP. The cave is about 20m long and 10m wide and is protected by a great boulder that encloses the front of the cave, leaving a skylight. The aims of the excavations are the dating of the cultural sequence and reconstructing environments through time. A grid of $38m^2$ was excavated and later reduced to $26m^2$. Charcoal from the cave's occupants has been particularly useful in providing evidence of vegetation and climatic change in the eastern Free State during the Pleistocene and Holocene. A high species diversity of micro and macro mammals has been identified from this site [16]. Rose Cottage Cave also has a long detailed sequence from early Middle Stone Age through to the Later Stone Age [19].

4.2 Sehonghong

Sehonghong rock shelter is situated in the Thaba Tseka district of eastern Lesotho (29°46' S, 28°47' E). It lies on a west-flowing tributary of the Orange River. Recently, new radiocarbon dates were established as being between1400 BP and 70 000 BP. Its long sequence of Middle and Later Stone Age deposits makes it an important site for understanding the prehistory of Lesotho. It also has potential for key issues in Southern Africa as a whole, for instance the transition from the MSA to

LSA, as well as the hunter-gatherer adaptations [53]. Sehonghong is known from historical sources to have been occupied by hunter-gatherers until AD 1872 [54]. Excavations started in 1971 under the direction of Carter, who demonstrated that the deposit is made up of a series of major occupation horizons. Non-occupation periods have led to the confirmation of extreme cold periods during some parts of the Pleistocene [55].

4.3 Border Cave

Border Cave is close to the international border between South Africa and Swaziland. It is situated on the western escarpment of the Lebombo mountains in the north of Kwazulu-Natal, approximately 2km from the Ngwavuma river gorge [22]. The dates of Border Cave have been fairly well researched, and range between 49 000 BP and130 000 BP [23]. The cave is about 50m wide and 30m deep. At an elevation of 600m just below the escarpment the height ranges between two and seven meters. The bedrock consists of rhyolites and basalts, which relate to the Stormberg series in the Karoo. The cave is accessible only from a narrow ledge, which may have been ideal for defense and security [22]. Fifteen sedimentary units have been described [23]. The first hominid remains found by Horten in 1940, included a skull as well as tibial and femoral fragments. After this several other hominid remains were found by Cooke, Jones and Malan [22]. An infant skeleton was recovered from a shallow grave. Beaumont recovered an Iron-Age burial and a mandible during the seventies. Middle Stone Age stone tools of the Levallois type, made from local trachytic lavas and quartzite, are associated with these remains [22].

4.4 Klasies River Mouth

Klasies River Mouth is situated near the town of Humansdorp on the southern coast of South Africa in the Cape Province (34°06' S, 24°24' E) [56]. The Klasies River descends in a series of falls and is never dry. The area has a combination between Mediterranean and Subtropical climates [25]. More or less five caves with several chambers were first excavated on a large scale by Singer and Wymer from 1967 to 1968. Smaller excavations, particularly at the main site, was conducted by Deacon during 1984 with the main goal being dating. The main deposits contain artifacts and associated faunal remains that are clearly beyond the 40 000 - 30 000 year range of conventional radio-carbon dating [56].

There are still problems associated with the dating, but global sequences of late Pleistocene sea level and climate changes firmly place the MSA layers between 60 000 BP and 128 000 BP. The main site has provided fragmentary human skull bones that appear to be anatomically modern [25]. Twenty-four MSA dated and two LSA dated fragmentary human specimens were recovered [56].

The artifacts from the main site closely resemble MSA artifacts from other sub-Saharan sites. Bone implements are mostly absent and stone tools dominate.

The faunal remains include mammals, birds, occasional fish and numerous shellfish. Fifteen different bovid species were identified at the main site.
The mortality profiles of the bovids are dominated by very young and post-prime individuals which suggest that these species were hunted. Human hunters obviously found it easier and less dangerous to hunt very young and very old individuals [56].

5. FAUNAL ANALYSIS

Voigt [28] defines faunal remains as the physical remnants of animals which died on a particular spot. She also describes the initial purpose of faunal analysis as merely producing a "laundry list" of identified species from faunal remains. Quantative data can also disclose the antiquity of the animal and what relation it might have had to man [57]. Swartkrans, Sterkfontein, Kromdraai and Makapansgat are well known sites where many archaezoologists have done research on the faunal assemblages of ancient times.

5.1 History

The first major contribution of archaeofaunal remains by means of a faunal analysis was in providing proof of the antiquity of man [57]. Lartet and Christie [28] undertook probably the first faunal analysis during their investigation of Palaeolithic cave sites in France in the 1860's. Bones were recovered side by side with stone implements and were used for interpretation of the diet of the occupants [28]. The first proper archaeozoological interpretation is linked to two Swiss workers named Rutimeyer and Duerst. In 1862 Rutimeyer described the mammal bones from neolithic lakeside dwellings in Switzerland. He was presumably the first to distinguish between wild and domestic animals. Thus domestication studies were underway [57].

Bate was the first to use quantative data to deduce climatic changes during the Upper Pleistocene. In 1930 she plotted frequencies of two species in different strata of the Mount Carmel caves, each of a different habitat, thus interpreting the Pleistocene environment [57].

The study of animal bone in South Africa grew out of research on the early hominid accumulations by Dart in the 1950's. During the 1960's Brain began to do research on the mechanisms at work in bone accumulations in general. The results of his faunal analysis was published in 1981. This publication was the corner stone of faunal analysis in Southern Africa. Since then, Brain has done extensive research on caves such as Swartkrans, Sterkfontein and Kromdraai. Today, publications such as "The hunter or the hunted?" [2] and "Swartkrans: A cave's chronicle of early man" [58] are used as benchmarks for methods in faunal analysis. To our knowledge, the only publication predating this, is work done on the Gamtoos valley by Hendey and Singer in 1965 [28].

5.2 General approach

Traditionally many faunal studies focused on zoogeographical relationships, environmental evolution, and the impact of humans on the landscape from the perspective of animals [58,59]. Recently topics such as nutrition, resource use, economics and other aspects of human behaviour have also been studied [58,59,60].

There have been numerous investigations and analyses on faunal remains in archaeology and palaeoanthropology for the purposes of:

- Taphonomic studies [2,58,61,]
- Domestication investigations [62,63]
- Study of human communities, including culture, diet and behavior [59,60,64]
- Species identification for special purposes, including behaviour, extinct species morphology and morphological differences between and within species [64,65,66,67]
- Climatological indications and interpretations [17,29,30,31]
- Dating [21,29,31]

Brain characterizes the faunal analysis of an African cave as a detective story where the clues are the bones, and the aim of the investigation is to establish causes of death. However, in this investigation the evidence is ancient and no witnesses survived to relate their stories [2].

Analysis of macrofaunal remains is a time consuming and tedious process if accurate results are required. Experts in this field have used reliable conventional methods for decades. These methods rely heavily on the expertise of the analyst.

Reitz and Wing [68] describes an archaeozoological study as consisting of three parts: identification, analysis and interpretation. Clason's definitions on primary and secondary data distinguished between identification and analysis [69]. The identification stage is part of collecting the primary data, which includes element representation and taxonomic identification [2,65,66,67,70]. All these facts can be replicated by subsequent analysts if necessary [68].

During faunal analysis information on the following aspects are captured, if possible:

❶ Identification and classification

Each specimen is analyzed separately by comparing the fragment with modern animal material. This is done by identifying the part of the skeleton and then classifying the fragment to the possible species by means of visual morphological characteristic comparison [4,57].

❷ Measurements

Measurements of complete bones are done and the fragments are weighed [4, 28].

❸ Age determination

This is done using several methods depending on which part of the skeleton the fragment originates from. Tooth eruption and tooth wear, as well as epiphyseal fusion, are the methods most frequently used to determine age [4, 28].

❹ Condition

The condition of the bones, whether fossilized, modern, burnt, broken, containing tooth or claw marks, reveal much about the possible history of the animal [4,28,57].

❺ Modification

Human modification is when bones were sharpened or modified for use in hunting, food preparation, making of clothes, ornaments and accessories [4,28].

Secondary data are derived from primary data by means of several quantification techniques. Secondary data is therefore the basis of analysis. Age classes, sex ratios, butchering patterns and relative frequencies of taxa, are only a few elements of this process [68].

The Southern African experts are extremely few in relation to the abundance of faunal material that has to be analyzed. The time factor presents a problem to the archaeologist and anthropologist waiting in line for a faunal analysis of their site, which may result in unwanted research interruption and suspension.

6. Taphonomy

Lyman defines taphonomy as the study of the transition, in all details, of organics from the biosphere into the lithosphere or geological record. In short it is the science of the laws of embedding or burial [71].

6.1 History

Even before taphonomy had been given a place in scientific studies, many researchers were concerned with the forces and agents responsible for marks on bones recovered from various prehistoric contexts. In 1823, Buckland, for example, observed a hyaena at Oxford University and was amazed by the mode of destruction of bones. Tournal (1833) took Buckland's observations on hyaenas a bit further by not just looking at the gnaw marks on prey-bones, but also at the locations of the bones as well as the association with the remains and traces of their predators [71].

In 1940 a Russian palaeontologist, I A Efremov, created the term *taphonomy* by combining the Greek words *taphos* (burial) and *nomos* (laws). However, quite a few terms have been used in publications describing taphonomy [71]:

- Weigelt's publication on taphonomy in 1927 is seen as the first major work on vertebrate taphonomy. He suggested the term *biostratinomy* meaning the study of the environmental factors that affect organic remains between a organism's death and the final burial of the remains.
- Richter described *aktuo-palatologie* as the science of the origin and present-day mode of formation of future fossils.
- In 1963 Muller used the term *fossildiagenese*, which translates to fossilization events that take place after the final burial of organic remains.

6.2 General approach

Since the first descriptions of bone assemblages, taphonomy became important not only to palaeontologists but also to archaeologists and archaeozoologists. The book published by CK Brain, "The Hunters or the Hunted?", in 1981 specifically incorporated taphonomy of South African caves [2].

The primary accumulating agent of the cave is deducted from the faunal analysis. It can therefore indicate, for example, the type of animal (human or non-human) or environmental agent that was responsible for the accumulation of the deposits, and the reason for the specific location. Taphonomy is thus part of the faunal analysis and reflects the holistic approach of archaeologists trying to understand and explain the totality of history [71].

As bone passes from being part of a living animal, to part of a diet of either man or animal, to human or animal refuse, to part of a sediment, to part of an archaeological sample, a lot of information about the living animal is lost. Hence, much information about human activities is also lost [4].

In 1967 Clark and Kietzke identified seven formal categories of processes which have an impact on bone assemblages during the taphonomic trajectory. Each of the processes may distort or reduce information on the assemblage. These seven processes are [4]:

➊ Biotic processes

Natural environment and human culture that influence the presence and numbers of animals at a specific site.

➋ Thanatic processes

Processes that bring about death and deposition of animals.

➌ Perthotaxic processes

Processes which result in the movement and destruction of bone before they are finally formed into a deposit.

➍ Taphic processes

The impact of physical and chemical agents which act upon bones after burial.

➎ Anataxic processes

The recycling processes by which buried bones are re-exposed to fluvial action, weathering, trampling etc.

⑤ Sullegic processes

Archaeological activities that result in selective recovery or non-recovery of bones.

⑥ Trephic processes

The research decisions related to sorting, recording and publication.

Davis [57] describes by way of a practical example how intricate taphonomy may be. The Masaai are primarily dependant upon cows for their milk and may sometimes use the blood too. Examination of the faunal debris may, however, not reveal any trace of cattle remains (the mainstay of their economy), for cattle may only rarely have been slaughtered [57].

The processes of taphonomy remind us to consider how little we understand animal taphonomy and how well we interpret the samples in a faunal analysis [4].

7. OSTEOMETRY

Metrical data gives an indication of the size and shape of a bone. Measurements are normally taken with a calliper, measuring tape and osteometric box. Whatever the equipment, the data should be comparable to other studies to be significant. Von den Driesch published a widely used set of measurements in 1976 [72]. This included illustrations and definitions of measurements for several mammalian and avian taxa.

Osteometrical data has a wide variety of applications:

① Separation of skeletally similar species

- Payne [4] as well as Badenhorst and Plug [32] have used measurements to distinguish between sheep and goat species.

➘ Peters and Plug [73] studied the osteomorphological differences of *Antidorcas marsupialis* and *Antidorcas bondi*.

➘ Peters [74] compared the osteometry of *Syncerus caffer* and *Bos taurus*.

➘ Perry and Brink [75] did comparative postcranial osteometry of *Antidorcas marsupialis* and *Pelea capreolus*.

❷ Domestication

➘ Domestication has induced morphological change, specifically size reduction [4].

➘ Higham [76] specifically showed size reduction from wild to domesticated animals.

➘ Davis [77] compared Late Pleistocene and Holocene animals and also found a reduction in size, and suggested that it was due to climatic change.

❸ Examination of size variation through time and space

➘ On making use of metrical data of a large geographical area, studies have already demonstrated size variation through time in specific species [4].

➘Audoin-Rouzeau [78] did extensive research on particularly the differences in bone measurements of cattle and sheep from prehistoric to medieval sites.

❹ Phylogeny and affinities

➘ The phylogeny and close relationship between two different species may be enhanced by the differences as well as similarities of their measurement values. An example is the distinction between wolf and domestic dog which has been researched extensively. In some parts of the world there are, for example, no wild canids which suggests that domestic dogs had spread in association with people [4].

- Watson and Plug [79] also studied *Oreotragus major wells* and *Oreotragus oreatragus*.

Metrical data can be both more sensitive and more objective than human judgement when attributing a taxon. However, some skeletal traits will be better presented by measurements, and others equally well, or even better by morphological description. For instance, a measurement of a skeletal part can just as easily be visually assessed.

7.1 Manipulation of metric data

If osteometric information is used to distinguish between or classify species, measurement values may be referred to by manually searching for the appropriate information. Science has benefitted from technology as it has developed over time, and accelerated the search for viable information when needed.

Data captured by scientists are normally organized in such a way that they have additional value beyond the value of the facts alone. This concept is defined as information [80].

Computerized technology makes use of information systems, characterized as a set of interrelated components that collect, manipulate, and disseminate data and information. It provides a feedback mechanism to meet an objective. This feedback may lead to an awareness and understanding of a set of information and how that information can be made useful to support a specific task [80]. Performing this procedure manually may demand unlimited time. A computer programme may achieve several objectives in an instant with the same procedure. It can manipulate and disseminate osteometric values to do a specific task, for example, use the database to calculate the percentage probability of a species by evaluating a set of data.

The analysis of metrical data [81,82,83] and morphological characteristics [84,85,86] of bones through complex mathematical techniques is commonly used in the analysis of human remains, but have seldom been used on faunal remains.

3 MATERIALS AND METHODS

The analysis of the faunal remains of Kemp's Caves, as well as the development and testing of the program, is a descriptive cross sectional study. The study comprised of three stages, and will be described in this way.

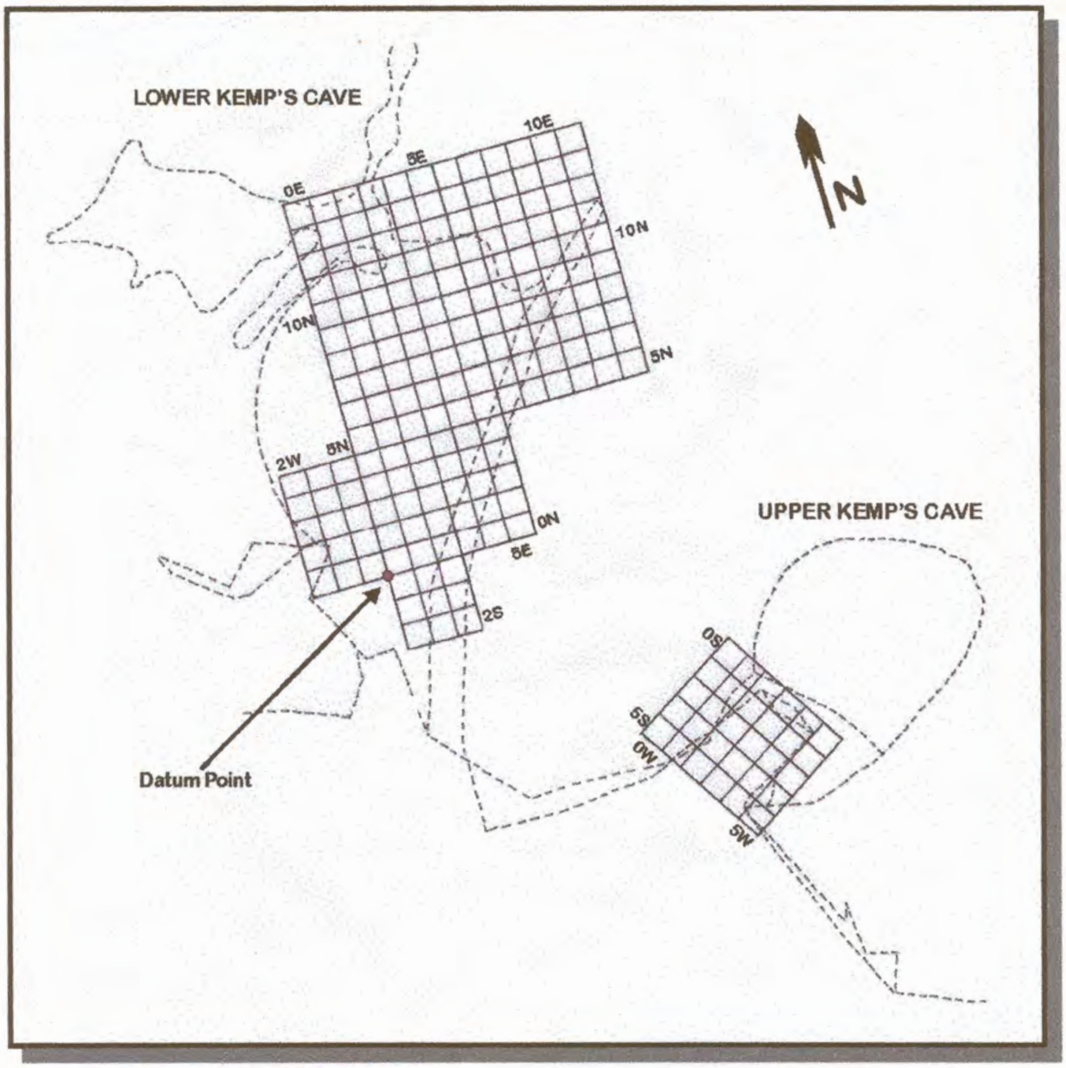
I. STAGE I - FAUNAL ANALYSIS

The purpose of stage 1 was to compose a species list indicating the species (modern or extinct) which occupied Kemp's Caves and its surrounding areas. This was done by classifying and identifying all faunal material of LKC, excavated up to date, using conventional methods. Faunal elements provide a variety of information about the history of a site. If an extinct species is identified among the remains, it is of particular value. The era in which this animal existed may give insight into the date estimates of the rock matrix that the skeletal part was recovered from. This might serve as confirmation of the dating of the entire, or part of, the excavation site.

All microfauna and archaeological artifacts were removed prior to analysis. The bones were obtained from the Department of Anatomy, University of Pretoria. Analysis took place at the Northern Flagship Institution (NFI), the former Transvaal Museum, under guidance of the staff of the Archaeozoology Department. Bones excavated in 1993, 1994, 1997, 1998 and 1999 were utilized for this study. Although the author did excavate for short periods of time at the site, staff and students of the Universities of the Witwatersrand and Pretoria removed most of the bones.

Skeletal parts lodged within decalcified breccia were prepared and both cranial and post-cranial elements were extracted. The sample included modern and fossilized material. Figure 3.1 shows the grid system in LKC.

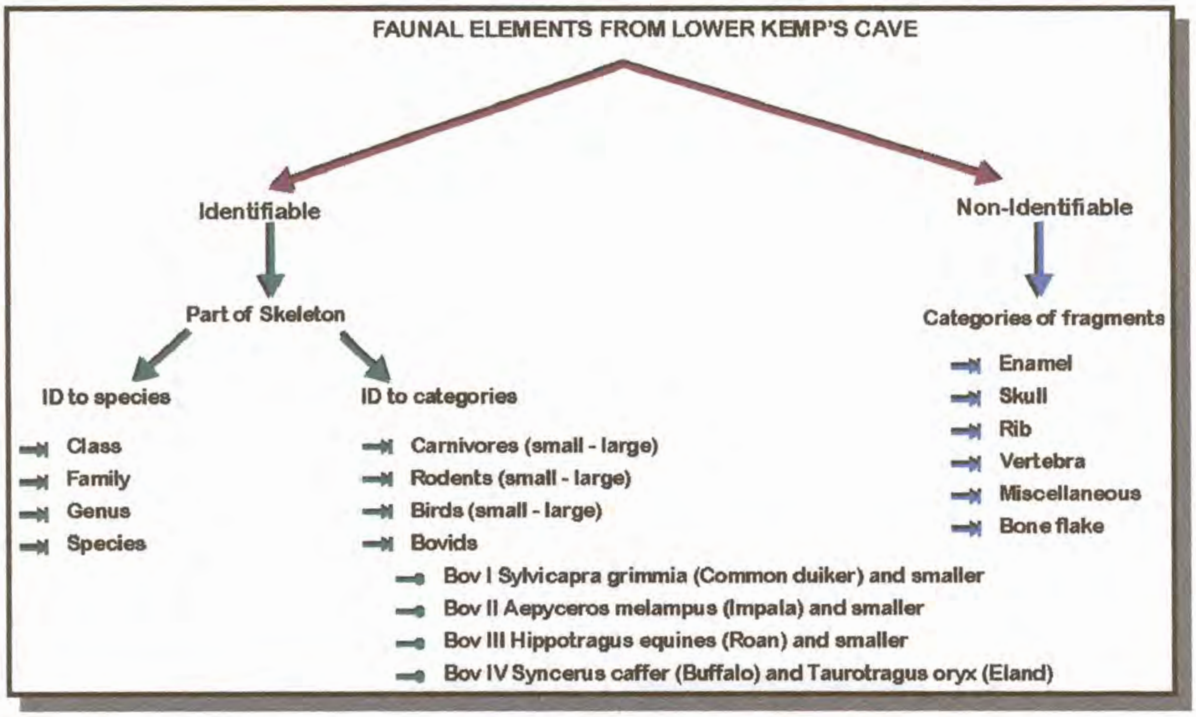
FIGURE 3.1: Site map of Kemp's Caves



Due to the difficulty of acquiring a successful grid system, the transfer of bones from Wits to UP, as well as the fact that the steel wire borders of the grids were stolen, several bones have no grid assigned to them. Although it was attempted to place specimens within a certain area in the cave where possible, attempts were not always successful.

More than eight thousand faunal elements were analyzed and compared with modern skeletal material from the Transvaal Museum. Approximately 900 pieces were identifiable while the rest were unidentifiable. These two groups were dealt with separately. Figure 3.2 is a basic scheme providing the method used to analyze the faunal material of Lower Kemp's Cave.

FIGURE 3.2: Flow diagram of faunal analysis



1.1 Identifiable bones

Identifiable bones were analyzed according to specific criteria. To identify a specific skeletal fragment, the type of bone, that is whether it is a long, short, sesamoid, accessory or irregular bone is the first step to identification. With this information the part of the skeleton from which this bone originated is then established. Next the class, family and genus are ascertained by comparing the fragment with modern skeletal material. If possible, the species is stipulated as well. Fragments not identifiable to species level were put in groups. These groups included carnivores, rodents and birds. Size indications within the classes ranged from small to large. Bovidae size were based on the classification by Brain [87]: Bov I includes the Common Duiker *(Sylvicapra grimmia)* and species smaller than that. Bov II comprise of species larger than Bov I and smaller than Impala *(Aepyceros melampus)*, and Bov III larger than Bov II and smaller than Roan *(Hippotragus equines)*. Bov IV consists of Buffalo *(Syncerus caffer)* and Eland *(Taurotragus oryx.)*

1.1.1 Observations of identifiable bones

To accurately process all the information possible from these fragments, a number of observations were noted on each specimen. This includes the establishment of the approximate age at which the individual died. This was done by different means, depending on which skeletal part of the skeleton survived.

The two methods used to determine age at death of faunal specimens are epiphyseal fusion, as well as dental eruption and tooth wear. Several different classes of tooth eruption and wear have been described for specific domestic [88,89] and wild animals [90]. Table 3.1 represents a summary, described by Plug, indicating the average age of an unknown mammalian individual according to its tooth morphology in the case of cranial fragments [91].

TABLE 3.1: Tooth eruption times and tooth wear [91]

Age class	Relative Age	Description
Class I	Foetal	Deciduous teeth not erupted
Class II	Neonate	Deciduous teeth not in wear
Class III	Juvenile	M1 in wear, M2 erupting
Class IV	Sub-adult	Loss of deciduous incisors and premolars, M3 erupting
Class V	Adult	Full permanent dentition present and in wear
Class VI	Mature	Central islands disappearing on M1 and M2
Class VII	Aged	Central islands disappearing on all teeth, M1 and M2 worn to gumline

Age determination on post-cranial fragments, for example long bones, is based upon epiphyseal fusion. Three broad categories are described for an unknown mammalian individual: a) A juvenile individual will be represented by long bones characterized by separate epi- and diaphyses, because the bones have not yet fully fused. b) A sub-adult individual will be characterized by long bones which are not yet fully fused. In this case an epiphyseal line will still be visible. c) In an adult the long bones will be completely fused [3,4].

The age of the individual may provide information about the taphonomy of the cave. Taphonomy, the study of how bones came to be buried and preserved, also includes observations about the condition of the bone. Descriptions of conditions or modifications such as gnaw marks may lead to identification of the chief accumulating agent, which in turn shed light on the taphonomy. Other conditions, such as specimens being modern or fossilized, burnt or weathered were also noted.

1.1.2 Measurement of identifiable bones

Measurements are fundamental tools of information which enhance the analysis of the skeletal material collected at the site. Measurements indicate the size of the fragments, which are used in several studies such as percentage survival rate of skeletal parts, taphonomy of the cave as well as identifying the chief accumulating agent. The equipment used included an electronic sliding caliper, spreading caliper, metal measuring tape, osteometric board and an electronic scale provided by the National Flagship Institution, University of Pretoria and Witwatersrand Technikon.

Measurements used were defined by Von den Driesch [72] and Peters [92]. These measurements were mostly done only when the bone was complete. An incomplete identifiable bone specimen was normally measured only in length, as specific structures needed for measurements were fragmented. More detail on bone measurements are described in Stage 2. All identifiable specimens were weighed. The specimen was then sealed for future study.

1.2 Non-identifiable bones

Specimens that were impossible to identify because of its small size or for any other reason, were catalogued as unidentifiable bones. These were placed in the following categories for statistical use [28]:

➊ Enamel fragments

All tooth and enamel fragments that could not be more specifically identified .

➋ Skull fragments

All fragments of the skull too small for identification.

➌ Vertebra fragments

This included all vertebrae.

➍ Rib fragments

All rib specimens, complete or not.

➎ Miscellaneous

All fragments too small to even determine from which area of the skeleton it originated. Thus it was fragmented beyond any recognition.

➏ Bone flakes

This included mostly long bone fragments that could not be identified as belonging to a specific major limb and which did not retain any articular surfaces.

All non-identifiable material were counted, weighed, documented in tables and sealed. All the faunal remains were already numbered according to the year it was excavated. Colour coding was used to accommodate easy future reference.

Prior to analysis a preliminary species list was compiled using Smithers [51] and du Plessis [50], as well as a faunal list which was acquired from the Ngonyama Game Reserve (Table 2.2). These were used to ascertain which species occurred in this area in the past, and which species are currently found in this area. The faunal list from the Game reserve was also used for interpretation of more recent, modern remains which could have been introduced by the reserve.

2. STAGE 2 - OSTEOMETRY

Stage 2 comprised of the determination of measurements which might enable morphological skeletal identification by means statistical analysis with the use of a computer programme. It involved the measuring of modern material, data capturing of the measurement values on a data base and the development of a computer program to classify and identify faunal remains using the measurements.

2.1 Measurements

As this is only a test to assess whether a data base programme will be able to identify and classify skeletal material, only the long bones of the hind limbs of all Southern African Bovid species were utilized to test the viability of classification of bones using osteometric values through computerized programmes. The 34 Southern African species available in South African museums, which represent the respective Bovid size classes I -IV and their average weight defined by Brain [87], are listed in Tables 3.2, 3.3, 3.4 and 3.5.

The modern collections used for this part of the study were kindly made available by the NFI (the former Transvaal Museum Pretoria), National Museum

(Bloemfontein) and the South African Museum (Cape Town). These three museums have the largest mammalian skeletal collections in South Africa. The bones were of known animals. Although all attempts were made to collect as many specimens for measurement purposes as possible, four species were unfortunately not represented in these Southern African modern collections and no measurements could be recorded for Dik-Dik (*Madoqua kirkii*), Sharp's Grysbok (*Raphicerus sharpei*), Puku (*Kobus vardonii*) and Lichtensteins Hartebeest (*Sigmoceros lichtensteinii*). Not all species are adequately represented in the modern skeletal collection, thus although sample sizes of thirty were preferred, some species are represented by less than this amount. Measurements defined by Von den Driesch [72] , Peters [92] and Walker [93] were used. New measurements were also developed during the course of the study where necessary.

TABLE 3.2: Bovid size class I [91]

INDIVIDUAL		WEIGHT
Dik-Dik	*Madoqua kirkii*	4.5 - 5.0 kg
Suni	*Neutragus mosvhatis*	4.5 - 7.0 kg
Blue Duiker	*Philantomba monticola*	6.0 - 7.0 kg
Cape Grysbuck	*Raphicerus melanotis*	7.0 - 9.0 kg
Sharp's Grysbuck	*Raphicerus sharpei*	7.0 - 9.0 kg
Red Duiker	*Cephalophus natalensis*	9.0 - 14.0 kg
Klipspringer	*Oreotragus oreotragus*	10.0 - 16.0 kg
Steenbok	*Raphicems campaestris*	11.0 - 15.0 kg
Grey / Common Duiker	*Sylvicapra grimmia*	11.0 - 21.0 kg
Oribi	*Ourebia ourebi*	14.0 - 19.0 kg

TABLE 3.3: Bovid size class II [91]

INDIVIDUAL		WEIGHT
Springbuck	*Antidorcas marsupialis*	18.0 - 52.0 kg
Mountain Reedbuck	*Redunca fulvorufula*	23.0 - 27.0 kg
Grey Rhebuck	*Pelea caprelus*	23.0 - 27.0 kg
Bushbuck	*Tragelaphus scriptus*	23.0 - 83.0 kg
Blesbok	*Damaliscus dorcas philipsii*	32.0 - 81.0 kg
Impala	*Aepyceros melampus*	36.0 - 69.0 kg
Reedbuck	*Redunca arundinum*	34.0 - 104.0 kg
Puku	*Kobus vardonii*	56.0 - 84.0 kg
Sheep	*Ovis*	30.0 - 70.0 kg
Goat	Capra	25.0 - 60.0 kg

TABLE 3.4: Bovid size class III [91]

INDIVIDUAL		WEIGHT
Lechwe	*Kobus leche*	77.0 - 130.0 kg
Nyala	*Tragelaphus angasii*	91.0 - 114.0 kg
Sitatunga	*Tragelaphus spekei*	91.0 - 114.0 kg
Tsessebe	*Damaliscus lunatus*	117.0 - 158.0 kg
Red Hartebeest	*Alcelaphus buselaphus*	106.0 - 172.0 kg
Lichtenstein's Hartebeest	*Alcelaphus lichtensteinii*	146.0 - 205.0 kg
Kudu	*Tragelaphus strepsiceros*	150.0 - 296.0 kg
Black Wildebeest	*Connochaetes gnou*	158.0 - 182.0 kg
Waterbuck	*Kobus ellipsiprymnus*	158.0 - 272.0 kg
Gemsbok	*Oryx gazella*	182.0 - 238.0 kg
Sable	*Hippotragus niger*	205.0 - 264.0 kg
Blue Wildebeest	*Connochaetes taurinus*	205.0 - 274.0 kg
Roan	*Hippotragus equines*	223.0 - 299.0 kg
Domestic cattle	*Bos taurus*	160.0 - 190.0 kg

TABLE 3.5: Bovid size class IV [91]

INDIVIDUAL		WEIGHT
Eland	*Taurotragus oryx*	367.0 - 837.0 kg
Buffalo	*Syncerus caffer*	396.0 - 945.0 kg

The sex and origin of the individual were documented in cases where it was catalogued as such, although male and female data was pooled. 14 individual measurements were taken on each femur, 15 on the tibia and 16 on each metatarsal of the 30 bovid species. The left side was used in each case unless only the right side was available, in which case it was documented as being the right side.

The four basic types of measurements are as follows:

❶ **Breadth measurements:**

- Measurements from the most medial to the most lateral aspects.
- These are indicated in blue on all figures.

❷ **Depth measurements:**

- Measurements from the most anterior to the most posterior aspects.
- These are indicated in purple in all figures.

❸ **Length measurements:**

- Measurements from the most proximal to the most distal aspects.
- These are indicated in green in all figures.

❹ **Circumference measurements:**

- Measurements of the smallest circumference of the shaft.
- These are indicated in orange in all figures.

Measurements were done by the author only and repeated on different occasions. Aforementioned mechanisms were utilized to minimize investigator error.

An electronic calliper was mostly used. Although the electronic calliper provided readings up to three decimals (in mm), measurements used in statistical analyses were rounded off to the nearest two decimals. Other measuring equipment used included a spreading calliper, osteometric box and metal measuring tape. A metal measuring tape was chosen to eliminate stretching and therefore inaccurate measuring.

Tables 3.6 - 3.8 stipulate the measurements used in the study. It also gives the abbreviations that will be used when referring to a specific measurement for the remainder of the text. The measuring equipment used, as well as the source of the measurement are also tabulated. A colour coded key to the descriptions of the specific measurements can be seen in each table. Each measurement was given a new abbreviation for easier reference and comprised of the following:

Abbreviation for either femur, tibia or metatarsal
↑
F(GBP)
↓
Abbreviation for measurement taken

Figures 3.3a - 3.5b diagrammatically indicate the specific individual measurements done on the femur. Figures 3.6a -3.8 show measurements on the tibia and Figures 3.9a - 3.11a the metatarsal measurements. Information on how the measurements were taken are described in detail and accompany each figure. The original abbreviation of the measurements are listed with the figures for reference. The bones are illustrated from anterior, superior and inferior views to accommodate all measurement descriptions. Every view has a different figure number, but if it is used twice to accommodate all the measurements, an "a" or "b" indicate which measurements will be shown on the specific figure.

TABLE 3.6: Femur measurements

No	Abbr.	Description	Instrument	Fig
1	F(GL)◆	Greatest length.	Osteometric box	3.3a
2	F(GLH)◆	Greatest length from femur head.	Osteometric box	3.3a
3	F(SBD)◆	Smallest breadth of diaphyses.	Electronic calliper	3.3b
4	F(SCD)◆	Smallest circumference of diaphyses	Measuring tape	3.3b
5	F(GBP)◆●	Greatest breadth proximal end.	Electronic calliper	3.4
6	F(GDH)◆	Greatest depth femur head.	Electronic calliper	3.4
7	F(GBH)▮	Greatest breadth femur head.	Electronic calliper	3.4
8	F(GBD)◆●	Greatest breadth distal end.	Electronic calliper	3.5a
9	F(GLDD)✦	Greatest lateral depth distal end.	Electronic calliper	3.5a
10	F(GMDD)✦	Greatest medial depth distal end.	Electronic calliper	3.5a
11	F(GBCF)▮	Greatest breadth condylar fossa.	Electronic calliper	3.5b
12	F(SBCF)▮	Smallest breadth condylar fossa.	Electronic calliper	3.5b
13	F(GBT)✦	Greatest breadth trochlea.	Electronic calliper	3.5b
14	F(GL-GLH)▮	Greatest length-Greatest length from femur head.	Calculation	

◆ Measurements defined by Von den Driesch [72]

✦ Measurements defined by Peters [92]

● Measurements defined by Walker [93]

▮ *Measurements developed* by the author

TABLE 3.7: Tibia measurements

No	Abbr.	Description	Instrument	Fig
1	T(GL)◆●	Greatest length.	Osteometric box	3.6a
2	T(GML)▮	Greatest medial length.	Osteometric box	3.6a
3	T(GLL)◆	Greatest lateral length.	Osteometric box	3.6a
4	T(SBD)◆	Smallest breadth of diaphyses.	Electronic calliper	3.6b
5	T(SCD)◆	Smallest circumference of diaphyses	Measuring tape	3.6b
6	T(GBP)◆●	Greatest breadth proximal end.	Electronic calliper	3.7a
7	T(GDP)✚	Greatest depth proximal end.	Osteometric box	3.7a
8	T(GDLC)▮	Greatest depth lateral condyle.	Electronic calliper	3.7b
9	T(GDMC)▮	Greatest depth medial condyle.	Electronic calliper	3.7b
10	T(GDT)▮	Greatest depth tibial tuberosity.	Spreading calliper	3.7b
11	T(GDTN)▮	Greatest depth tibial tuberosity from notch.	Electronic calliper	3.7b
12	T(SBIE)▮	Smallest breadth intercondylar eminence.	Electronic calliper	3.7a
13	T(GBD)◆●	Greatest breadth distal end.	Electronic calliper	3.8
14	T(GDD)◆✚	Greatest depth distal end.	Electronic calliper	3.8
15	T(SDD)●	Smallest depth distal end.	Electronic calliper	3.8

◆ Measurements defined by Von den Driesch [72]

✚ Measurements defined by Peters [92]

● Measurements defined by Walker [93]

▮ Measurements developed by the author

TABLE 3.8: Metatarsal measurements

No	Abbr	Description	Instrument	Fig
1	M(GL)◆	Greatest length.	Osteometric box	3.9a
2	M(GML)▮	Greatest medial length.	Osteometric box	3.9a
3	M(GLL)◆	Greatest lateral length.	Osteometric box	3.9a
4	M(SBD)◆	Smallest breadth of diaphyses.	Electronic calliper	3.9b
5	M(SCD)◆	Smallest circumference of diaphyses	Measuring tape	3.9b
6	M(GBP)◆●	Greatest breadth proximal end.	Electronic calliper	3.10b
7	M(GDP)◆	Greatest depth proximal end.	Electronic calliper	3.10b
8	M(GLMA)▮	Greatest length medial articulation facet prox. end.	Electronic calliper	3.10a
9	M(GBMA)▮	Greatest breadth medial articulation facet prox. end.	Electronic calliper	3.10a
10	M(GLLA)▮	Greatest length lateral articulation facet prox. end.	Electronic calliper	3.10a
11	M(GBLA)▮	Greatest breadth lateral articulation facet prox. end.	Electronic calliper	3.10a
12	M(GBD)◆	Greatest breadth distal end.	Electronic calliper	3.11b
13	M(GDD)◆✚	Greatest depth distal end.	Electronic calliper	3.11b
14	M(GBMC)●	Greatest breadth medial condyle.	Electronic calliper	3.11a
15	M(GBLC)●	Greatest breadth lateral condyle.	Electronic calliper	3.11a
16	M(GBDE)▮	Greatest breadth distal eminences.	Electronic calliper	3.11a

◆ Measurements defined by Von den Driesch [72]

✚ Measurements defined by Peters [92]

● Measurements defined by Walker [93]

▮ Measurements developed by the author

2.1.1 Measurements on the femur

A) ANTERIOR VIEW OF THE FEMUR - FIGURE 3.3a

F(GL) = Greatest length.

➘ Original abbreviation: "GL" (Von den Driesch, 1976) [72]

The greatest distance from the proximal extremity to the distal extremity was measured. Important to note is that both femoral condyles should be in the same vertical plane. Thus both condyles should be in contact with the vertical part of the osteometric box, with the posterior aspect closest to the floor of the box. The femur should therefore be placed at an angle to the horizontal line of the box.

F(GLH) = Greatest length from femur head.

➘ Original abbreviation: "GLC" (Von den Driesch, 1976) [72]

The greatest distance from the head of the femur to the distal extremity was measured. The femur must be placed in the same position as with the F(GL) measurement. Thus both condyles should be in contact with the vertical part of the osteometric board. The F(GLH) was on average less than the F(GL).

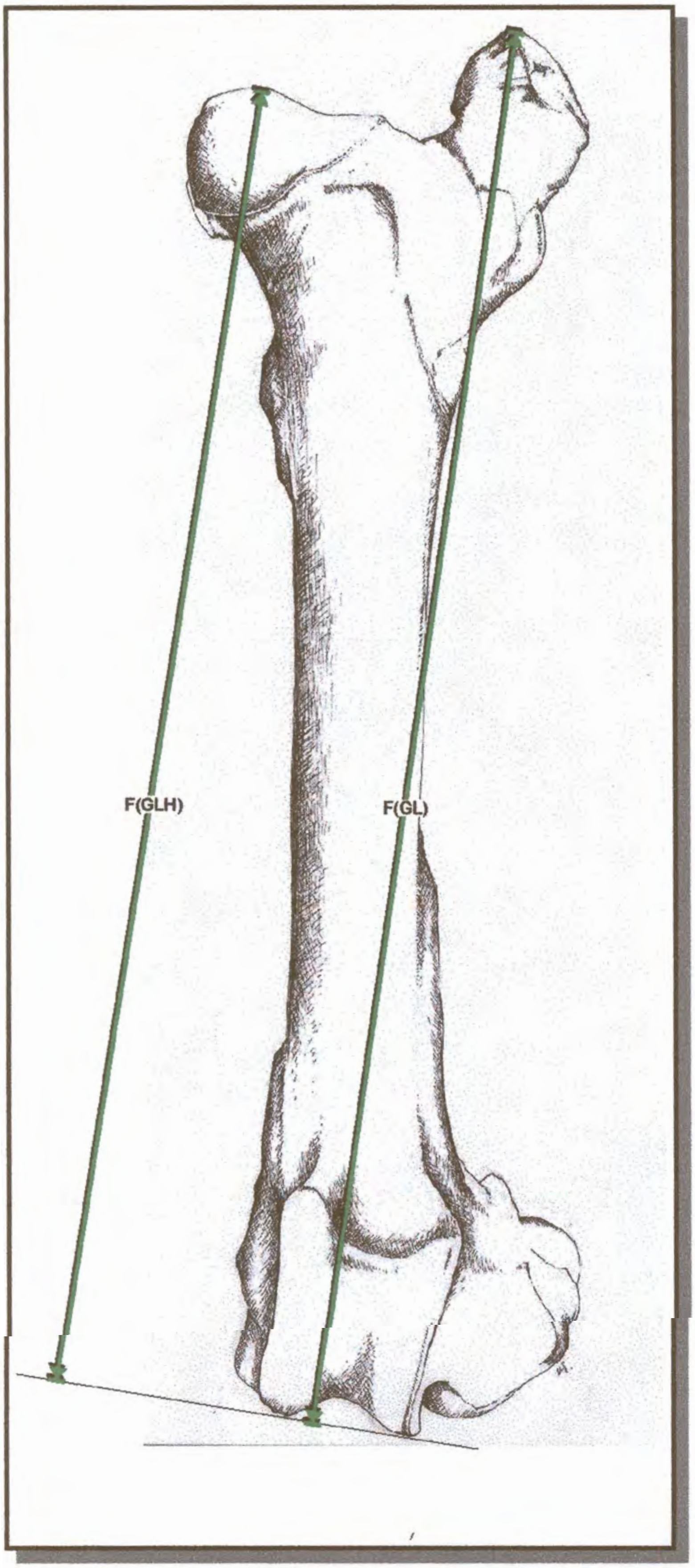


FIGURE 3.3a: Femur:
Anterior view
F(GL)
F(GLH)

A) ANTERIOR VIEW OF THE FEMUR - FIGURE 3.3b

F(SBD) = Smallest breadth of diaphyses.

➘ Original abbreviation: "SD" (Von den Driesch, 1976) [72]

The smallest breadth on the shaft of the femur was taken. The femur should be placed in the same position as for F(GL). The jaws of the calliper should be placed to the lateral and medial aspects of the shaft, and moved proximally and distally to ascertain the smallest measurement. This measurement was on average taken approximately in the middle of the femur shaft.

F(SCD) = Smallest circumference of diaphyses.

➘ Original abbreviation: "CD" (Von den Driesch, 1976) [72]

The smallest circumference of the shaft of the femur was taken with a metal measuring tape. The measuring tape must be moved proximally and distally to establish the smallest reading.

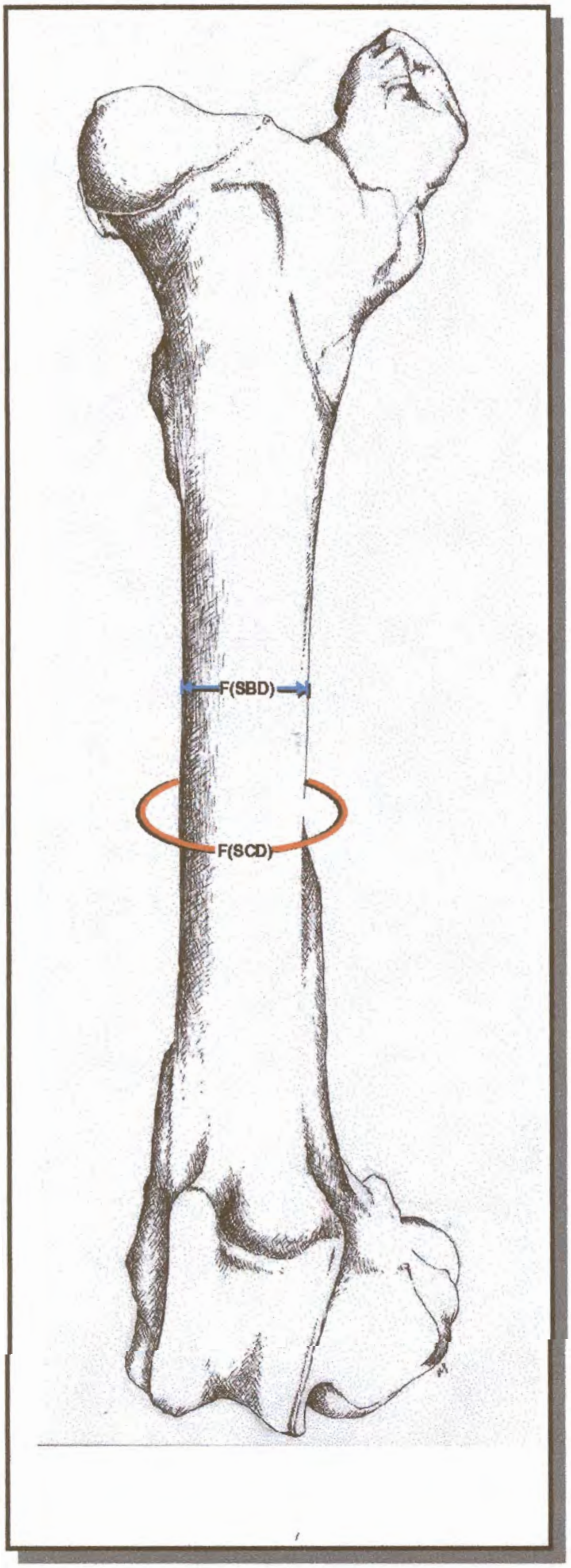


FIGURE 3.3b: Femur :
Anterior view
F(SBD)
F(SCD)

B) SUPERIOR VIEW OF THE FEMUR - FIGURE 3.4.

F(GBP) = Greatest breadth proximal end.

➘ Original abbreviation: "Bp" (Von den Driesch, 1976) [72]

"A" (Walker, 1985) [93]

The greatest breadth of the proximal end of the femur extends from the most lateral point of the greater trochanter to the most medial point of the head of the femur. This measurement was taken with a sliding calliper.

F(GBH) = Greatest breadth femur head.

➘ Developed by author

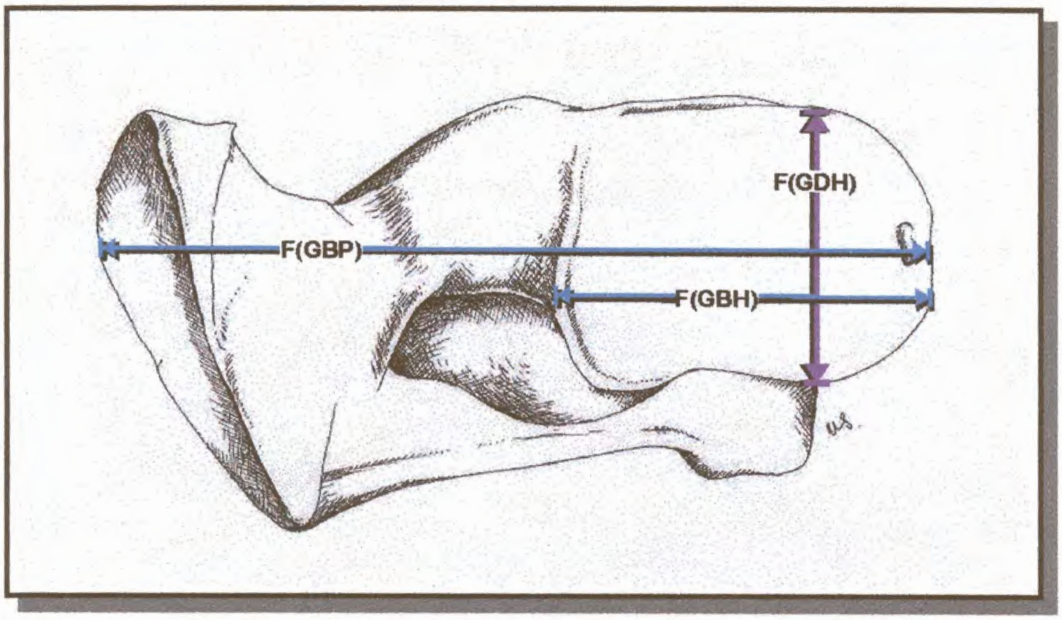
This measurement was taken with a sliding calliper and measured the breadth of the femur head. This is a fairly easy measurement as the borders of the head are usually distinct.

F(GDH) = Greatest depth femur head.

➘ Original abbreviation: "DC" (Von den Driesch, 1976) [72]

The greatest depth of the femur head is measured from anterior to posterior with a sliding calliper. The measurement should be taken perpendicular to F(GBH). The femur should be held with the superior aspect facing the measurer, as this ensures accuracy.

FIGURE 3.4: Femur: Superior view F(GBP) ; F(GBH) ; F(GDH)



C) INFERIOR VIEW OF THE FEMUR - FIGURE 3.5a.

F(GBD) = Greatest breadth distal end.

➘ Original abbreviation: "Bd" (Von den Driesch, 1976) [72]

"A" (Walker, 1985) [93]

The greatest breadth from the most lateral point to the most medial point on the distal end of the femur is measured with a sliding calliper. In some cases, for example Bov IV size specimens, an osteometric board may be used due to the size of the bone.

F(GLDD) = Greatest lateral depth distal end.

➘ Original abbreviation: "Dld" (Peters, 1985) [92]

The greatest lateral depth of the distal end of the femur is more easily measured from the lateral view. This measurement is taken with a sliding calliper from the most anterior point to the most posterior point of the lateral femoral condyle.

F(GMDD) = Greatest medial depth distal end.

➘ Original abbreviation: "Dmd" (Peters, 1985) [92]

The greatest medial depth of the distal end of the femur is also taken with a sliding calliper. This measurement is taken from the most anterior to the most posterior point of the medial femoral condyle and is more accurate if taken from a medial view of the femur.

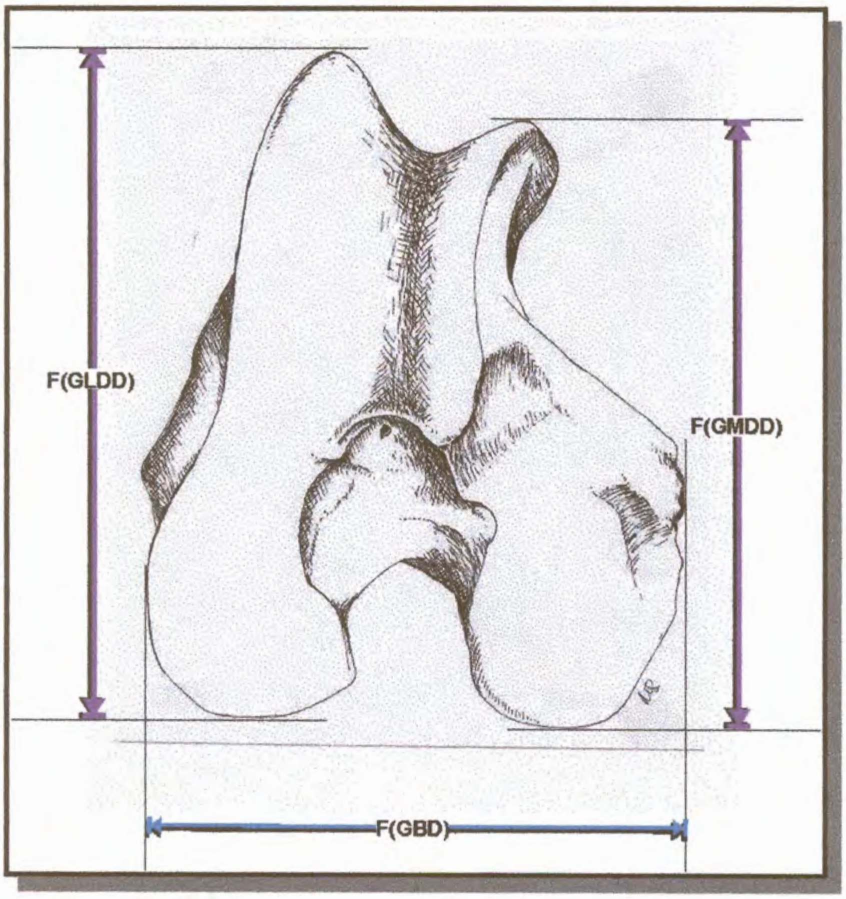


FIGURE 3.5a:
Femur:
Inferior view
F(GBD)
F(GLDD)
F(GMDD)

C) INFERIOR VIEW OF THE FEMUR - FIGURE 3.5b.

F(GBT) = Greatest breadth trochlea.

➘ Original abbreviation: "BT" (Peters, 1985) [92]

The greatest breadth of the trochlea of the femur should be measured at the same angle as the trochlea itself. The measurement must therefore be taken in line with the trochlea from the most medial to the most lateral point. A sliding calliper is used to take the measurement.

F(GBCF) = Greatest breadth condylar fossa.

➘ Developed by author

The greatest breadth of the condylar fossa of the femur is a fairly difficult measurement as the landmarks differ in every individual. In some cases it was covered with osteophytes and the actual measurement was sometimes difficult to ascertain. The sharp outer jaws of the calliper were used to measure the greatest distance in between the two femoral condyles.

F(SBCF) = Smallest breadth condylar fossa.

➘ Developed by author

The smallest breadth of the condylar fossa was also measured with the outer sharp jaws of the calliper. The smallest distance between the femoral condyles was measured. Occasionally the F(GBCF) and F(SBCF) were equal in value.

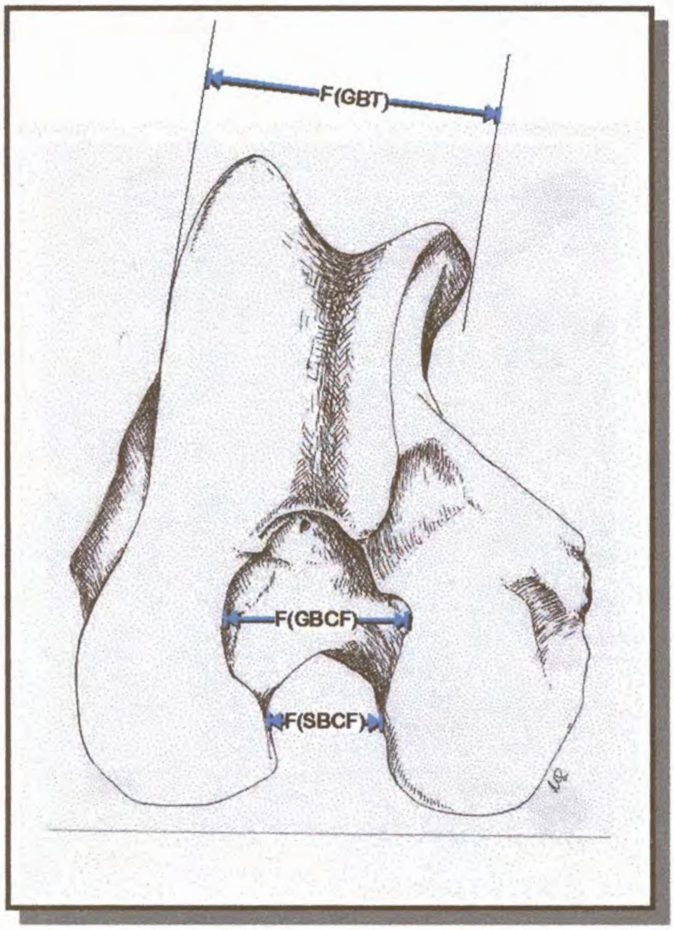


FIGURE 3.5b: Femur:
Inferior view
F(GBT)
F(GBCF)
F(SBCF)

2.1.2 Measurements on the tibia

A) ANTERIOR VIEW OF THE TIBIA - FIGURE 3.6a

T(GL) = Greatest length.

➘ Original abbreviation: "GL" (Von den Driesch, 1976) [72]

"C" (Walker, 1985) [93]

The greatest distance from the proximal extremity to the distal extremity was measured. Important to note is that the tibia should be placed at the same angle as the osteometric box. Thus it should be positioned with its long axis perpendicular to that of the horizontal part of the osteometric box.

T(GLL) = Greatest lateral length.

➘ Original abbreviation: "Ll" (Von den Driesch, 1976) [72]

The greatest distance from the most superior point of the lateral tibial condyle to the most inferior point on the distal extremity was measured. The tibia must be placed in the same position as with the T(GL) measurement.

T(GML) = Greatest medial length.

➘ Developed by the author

The greatest distance from the most superior point of the medial tibial condyle to the most inferior point on the distal extremity was measured. Again the tibia must remain in the same position as with the T(GL) measurement.

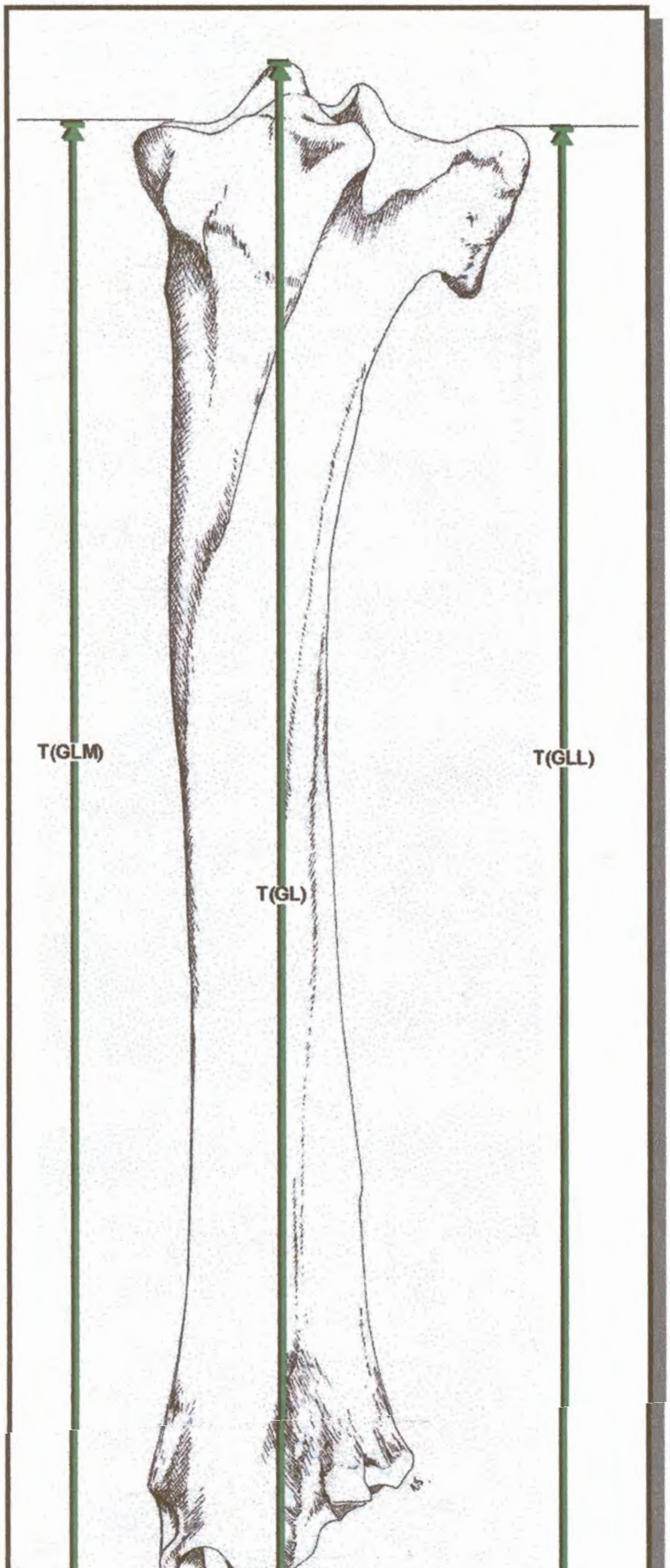


FIGURE 3.6a: Tibia:
Anterior view
T(GL)
T(GLL)
T(GLM)

A) ANTERIOR VIEW OF THE TIBIA - FIGURE 3.6b

T(SBD) = Smallest breadth of diaphyses.

➘ Original abbreviation: "SD" (Von den Driesch, 1976) [72]

The smallest diameter was taken on the breadth of the tibial shaft. The tibia should be placed in the same position as for T(GL). The jaws of the calliper should be placed on the lateral and medial apects of the shaft, and moved proximally and distally to ascertain the smallest measurement. This measurement was on average taken on the distal third of the tibial shaft.

T(SCD) = Smallest circumference of diaphyses.

➘ Original abbreviation: "CD" (Von den Driesch, 1976) [72]

The smallest circumference of the shaft of the tibia was taken with a metal measuring tape. The measuring tape must be moved proximally and distally to establish the smallest reading.

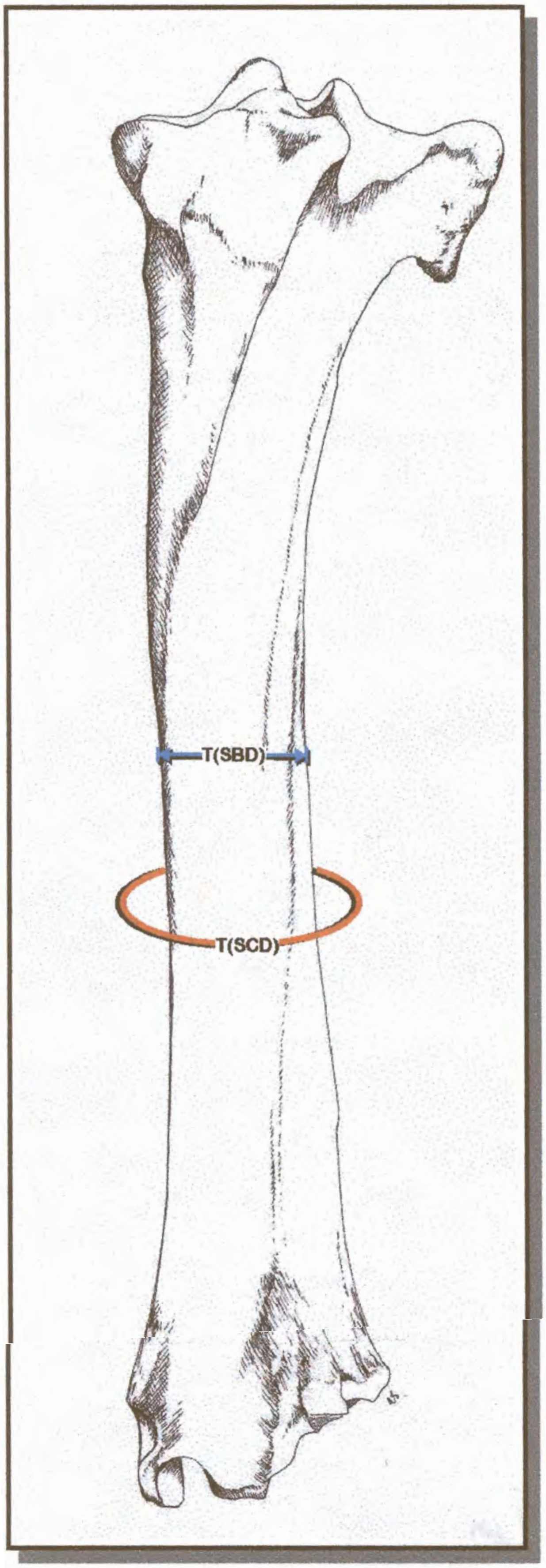


FIGURE 3.6b: Tibia:
Anterior view
T(SBD)
T(SCD)

B) SUPERIOR VIEW OF THE TIBIA - FIGURE 3.7a

T(GBP) = Greatest breadth proximal end.

Original abbreviation: "Bp" (Von den Driesch, 1976) [72]

"A" (Walker, 1985) [93]

The greatest breadth of the proximal end of the tibia was measured from the most medial to the most lateral aspects of this end. The measurement is done using a sliding calliper.

T(GDP) = Greatest depth proximal end.

Original abbreviation: "Dp" (Peters, 1985) [92]

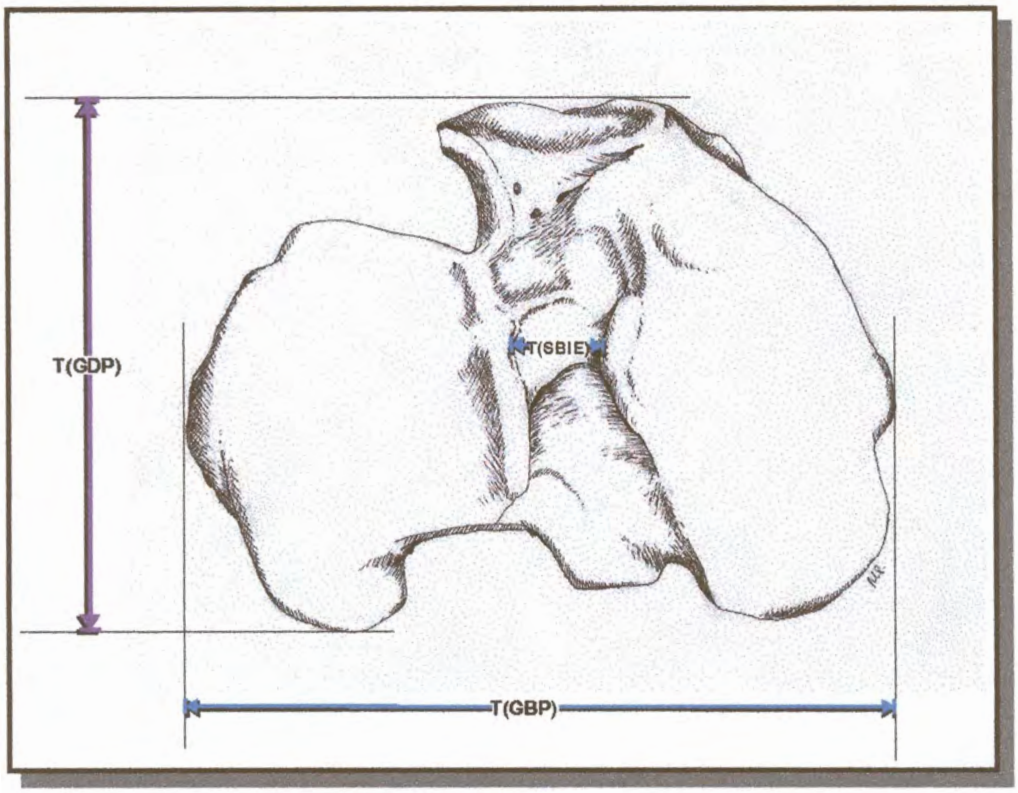
The greatest depth of the proximal end was measured in an osteometric box. This was done to ensure the accuracy of the measurement. The superior aspect of the tibia was placed so that it was in contact with the osteometric box. It was held at a right angle to the floor of the box. The greatest distance between the most anterior and posterior aspects of the proximal end was measured.

T(SBIE) = Smallest breadth intercondylar eminence.

Developed by author

The smallest distance between the medial and lateral intercondyler eminences was measured with a sliding calliper.

FIGURE 3.7a: Tibia: Superior view T(GDP) ; T(GBP) ; T(SBIE)



B) SUPERIOR VIEW OF THE TIBIA - FIGURE 3.7b

T(GDLC) = Greatest depth lateral condyle.

➘ Developed by author

The greatest depth of the lateral condyle was measured. The greatest distance from the most anterior to the most posterior point on the lateral condyle of the tibia was measured with a sliding calliper. The borders of the lateral condyle are clearly defined.

T(GDMC) = Greatest depth medial condyle.

➘ Developed by the author

The greatest depth of the medial condyle was measured. The greatest distance from the most anterior to the most posterior point on the medial condyle of the tibia was measured with a sliding calliper. This measurement was sometimes difficult, since the anterior border of the condyle is not always clear. If it was unclear, the anterior border of the smooth articulation surface was taken as the most anterior point.

B) SUPERIOR VIEW OF THE TIBIA - FIGURE 3.7b Continue

T(GDT) = Greatest depth tibial tuberosity.

➘ Developed by the author

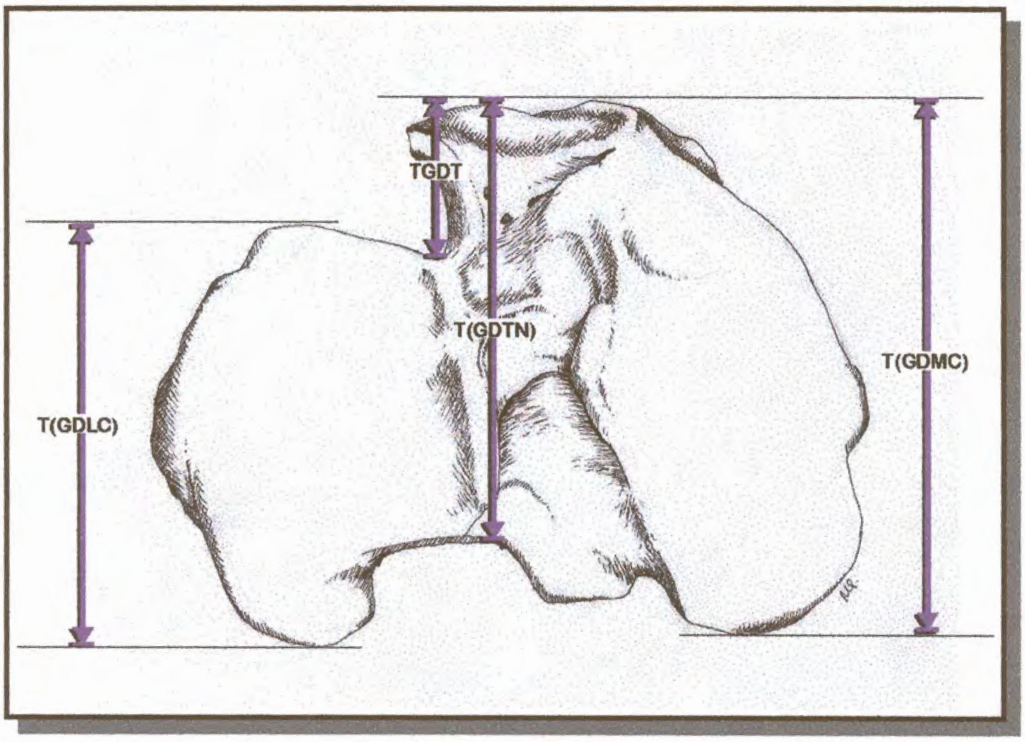
The greatest depth of the tibial tuberosity was measured with the outer sharp jaws of the sliding calliper. This measurement was not always accurate, since there are no clearly defined points where the jaws of the calliper should be placed to enable measuring.

T(GDTN) = Greatest depth tibial tuberosity from notch.

➘ Developed by the author

This measurement was done using a spreading calliper. The two jaws of the calliper were placed in contact with the tibial tuberosity anteriorly and tibial notch posteriorly respectively, to measure the greatest distance between the two points.

FIGURE 3.7b: Tibia: Superior view T(GDLC) ; T(GDMC) ; T(GDT) ; T(GDTN)



C) INFERIOR VIEW OF THE TIBIA - FIGURE 3.8

T(GBD) = Greatest breadth distal end.

➘ Original abbreviation: "Bd" (Von den Driesch, 1976) [72]

"A" (Walker, 1985) [93]

The greatest breadth of the distal end of the tibia was measured with a sliding calliper from the most medial point to the most lateral point.

T(GDD) = Greatest depth distal end.

➘ Original abbreviation: "Dd" (Von den Driesch, 1976) [72]

"Dd" (Peters, 1985) [92]

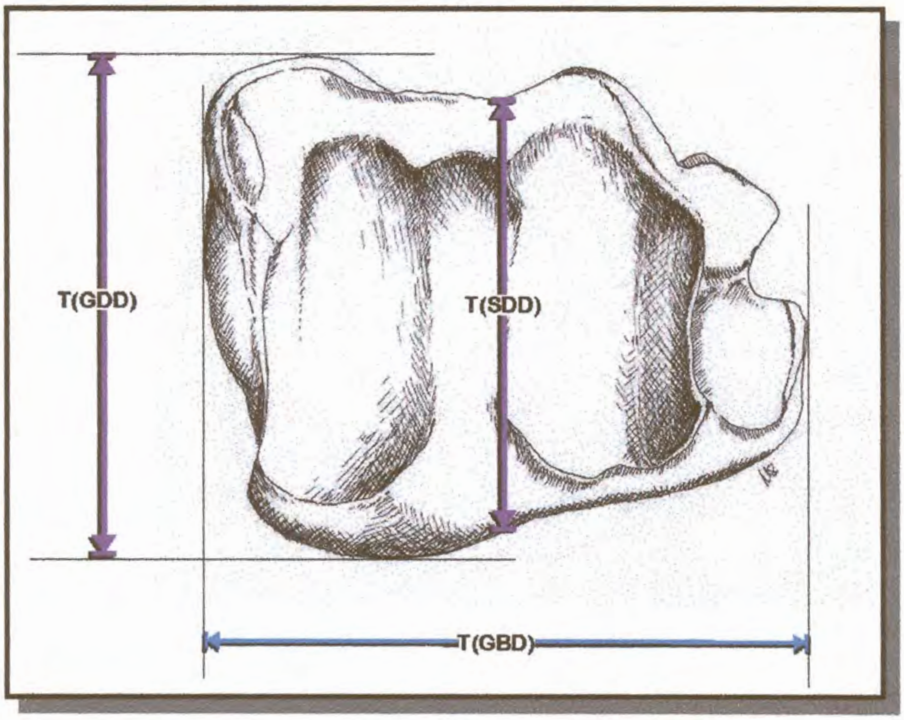
The greatest distance from the most anterior to the most posterior point of the distal end was measured with a sliding calliper.

T(SDD) = Smallest depth distal end.

➘ Original abbreviation: "B" (Walker, 1985) [93]

The smallest depth of the distal end of the tibia was measured with a sliding calliper. The measurement was mostly taken approximately between the two articulating facets for the tarsal bones.

FIGURE 3.8: Tibia: Inferior view T(GDD) ; T(GBD) ; T(SDD)



2.1.3 Measurements on the metatarsal

A) ANTERIOR VIEW OF THE METATARSAL - FIGURE 3.9a

M(GL) = Greatest length.

➘ Original abbreviation: "GL" (Von den Driesch, 1976) [72]

The greatest distance from the most superior point on the proximal extremity to the most inferior point on the distal extremity was measured. It is important to note that the metatarsal should be placed at the same plane as the osteometric box. The shaft should be positioned perpendicular to the horizontal part of the osteometric box.

M(GLL) = Greatest lateral length.

➘ Original abbreviation: "GLl" (Von den Driesch, 1976) [72]

The greatest distance from the most superior point on the proximal end to the most inferior point of the lateral condyle of the metatarsal was measured. The metatarsal must be placed in the same position as with the M(GL) measurement. This measurement was done by means of an osteometric box.

M(GML) = Greatest medial length.

➘ Developed by the author

The greatest distance from the most superior point of the proximal end to the inferior point of the medial condyle of the metatarsal was measured. The metatarsal must remain in the same position as with the M(GL) measurement.

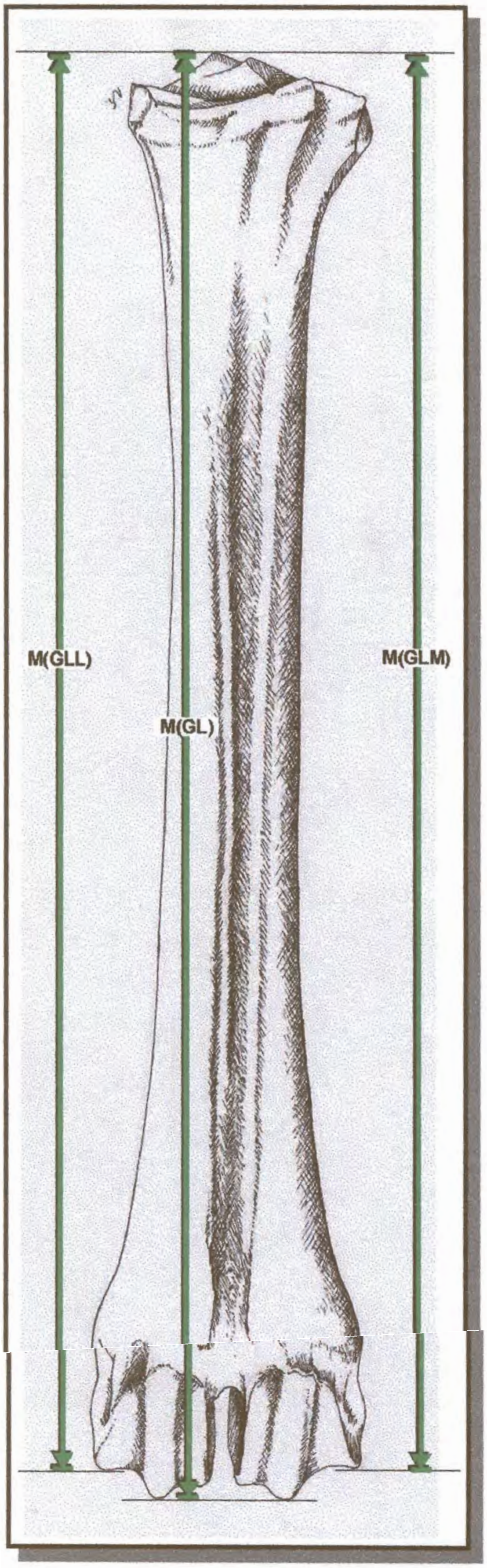


FIGURE 3.9a: Metatarsal:
Anterior view
M(GL)
M(GLM)
M(GLL)

A) ANTERIOR VIEW OF THE METATARSAL - FIGURE 3.9b

M(SBD) = Smallest breadth of diaphyses.

➘ Original abbreviation: "SD" (Von den Driesch, 1976) [72]

The smallest diameter taken on the breadth of the metatarsal shaft. The metatarsal should be placed in the same position as for M(GL). The jaws of the calliper should be placed to the lateral and medial aspects of the shaft, and moved proximally and distally to ascertain the smallest measurement. This measurement was taken on average near the middle of the shaft.

M(SCD) = Smallest circumference of diaphyses.

➘ Original abbreviation: "CD" (Von den Driesch, 1976) [72]

The smallest circumference of the shaft of the metatarsal was taken with a metal measuring tape. The measuring tape must be moved proximally and distally to establish the smallest reading. Usually this measurement was taken on the distal third of the shaft.

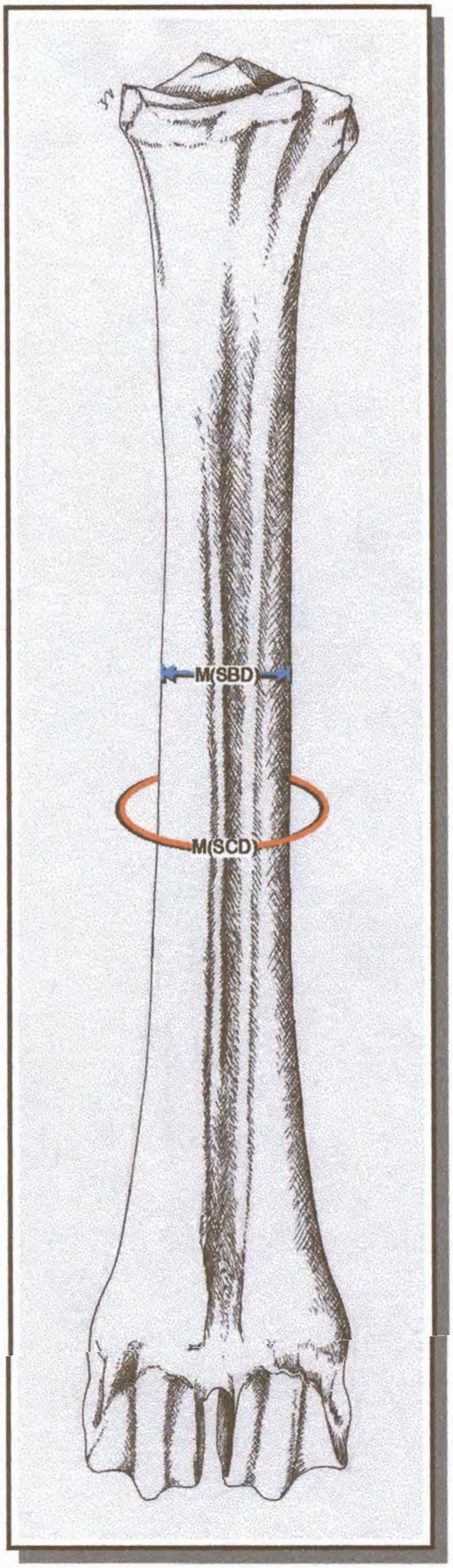


FIGURE 3.9b: Metatarsal:
Anterior view
M(SCD)
M(SBD)

B) SUPERIOR VIEW OF THE METATARSAL - FIGURE 3.10a

All of the measurements described below were uncomplicated since the borders of the articulating facets were well defined on most specimens.

M(GLLA) = Greatest length lateral articulating facet on proximal end.

➘ Developed by the author

The greatest length of the lateral articulation facet was measured with a sliding calliper.

M(GBLA) = Greatest breadth lateral articulating facet on proximal end.

➘ Developed by the author

The greatest breadth of the lateral articulating facet was measured. It is important to note that this measurement should be at a right angle to M(GLLA).

M(GLMA) = Greatest length medial articulating facet on proximal end.

➘ Developed by the author

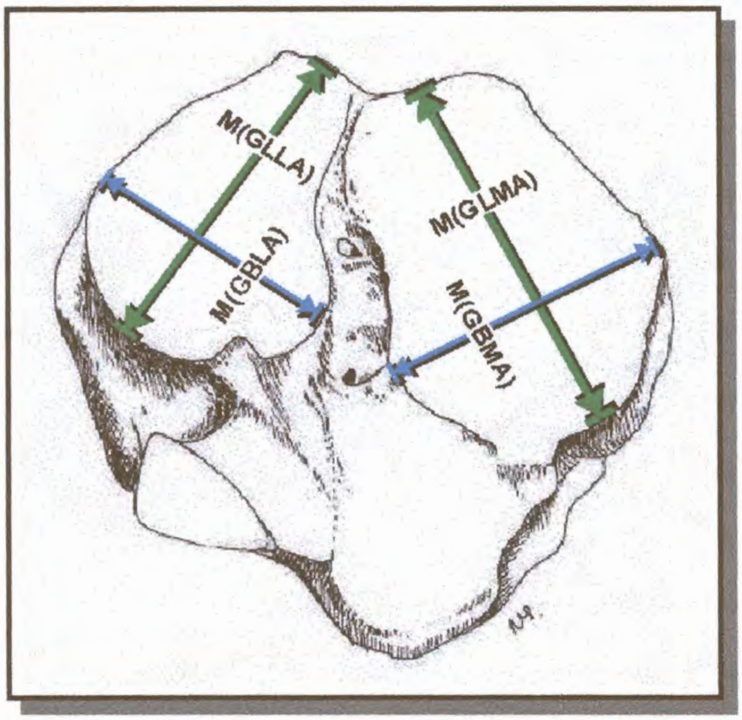
The greatest length of the medial articulating facet was measured.

M(GBMA) = Greatest breadth medial articulating facet on proximal end.

➘ Developed by the author

The greatest breadth of the medial articulating facet was measured. Again it is important to note that this measurement should be at a right angle to measurement M(GLMA).

FIGURE 3.10a: Metatarsal: Superior view M(GLLA) ; M(GBLA) ; M(GLMA) ; M(GBMA)



B) SUPERIOR VIEW OF THE METATARSAL - FIGURE 3.10b

M(GBP) = Greatest breadth proximal end.

➘ Original abbreviation: "Bp" (Von den Driesch, 1976) [72]

"C" (Walker, 1985) [93]

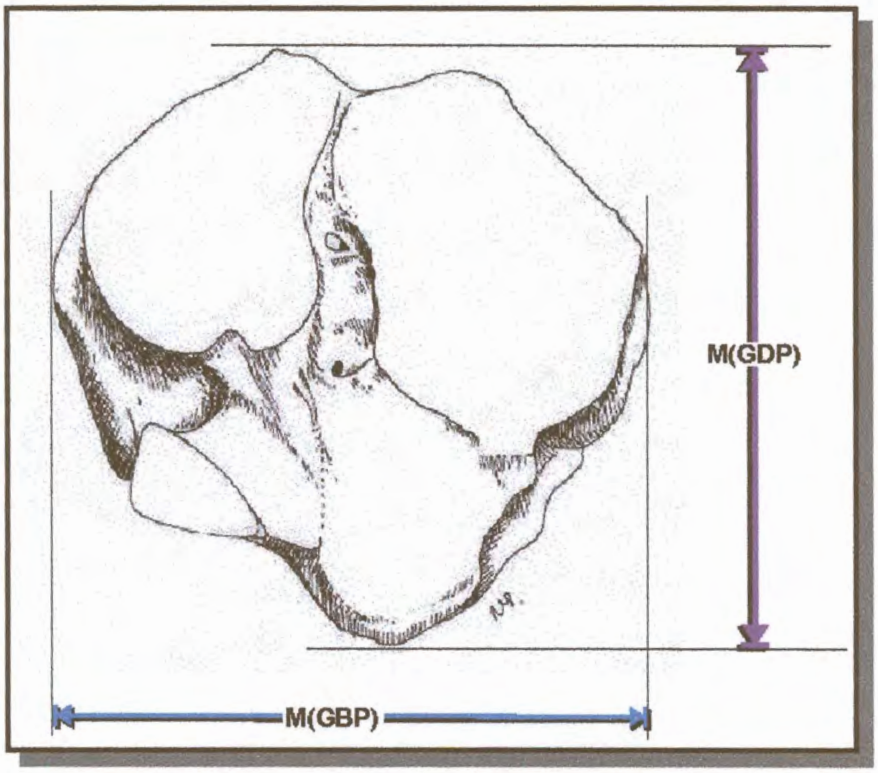
The greatest breadth is measured from the most lateral to the most medial points of the proximal end of the metatarsal with a sliding calliper.

M(GDP) = Greatest depth proximal end.

➘ Original abbreviation: "Dp" (Von den Driesch, 1976) [72]

The greatest depth was measured from the most anterior to the most posterior point on the proximal end of the metatarsal with a sliding calliper.

FIGURE 3.10b: Metatarsal: Superior view M(GDP) ; M(GBP)



C) INFERIOR VIEW OF THE METATARSAL - FIGURE 3.11a

M(GBDE) = Greatest breadth distal eminences.

➘ Developed by the author

The greatest breadth between the outsides of the medial and lateral distal eminences was measured with the outer sharp jaws of a sliding calliper to ensure an accurate measurement. Ii is important to note is that this measurement was taken on the most inferior point of the distal end.

M(GBLC) = Greatest breadth lateral condyle.

➘ Original abbreviation: "B" (Walker, 1985) [93]

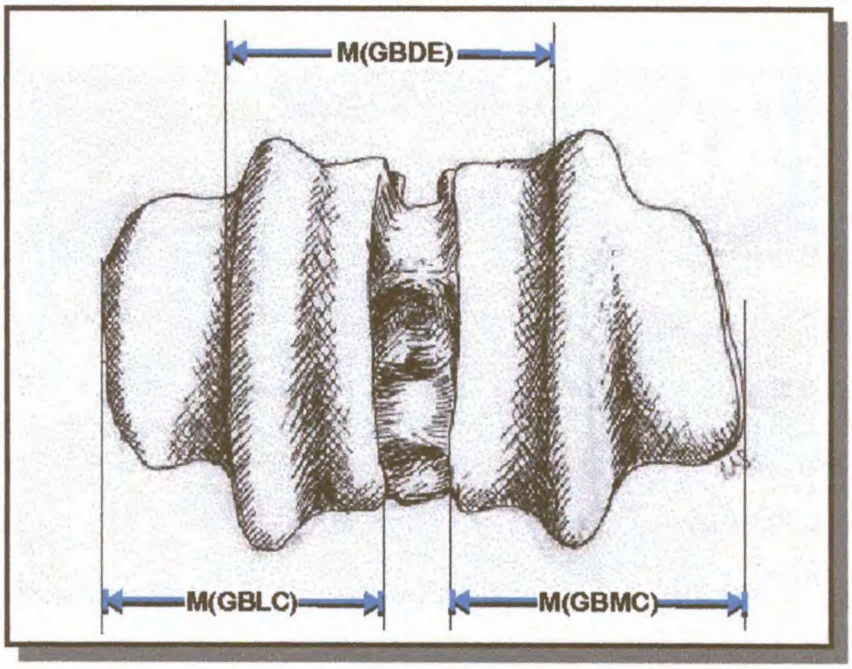
The greatest distance between the most lateral and the most medial point of the lateral condyle of the metatarsal was measured. The measurement was taken from anterior with a sliding calliper.

M(GBMC) = Greatest breadth medial condyle.

➘ Original abbreviation: "D" (Walker, 1985) [93]

The greatest distance between the most lateral and the most medial point of the medial condyle of the metatarsal was measured. The measurement was taken from anterior with a sliding calliper.

FIGURE 3.11a: Metatarsal: Inferior view M(GBDE) ; M(GBLC) ; M(GBMC)



C) INFERIOR VIEW OF THE METATARSAL - FIGURE 3.11b

M(GBD) = Greatest breadth distal end.

➘ Original abbreviation: "Bd" (Von den Driesch, 1976) [72]

The greatest distance from the most medial to the most lateral points on the distal end of the metatarsal was measured with a sliding calliper. It is important to note that the jaws of the calliper should be in line with the distal eminences of the metatarsal.

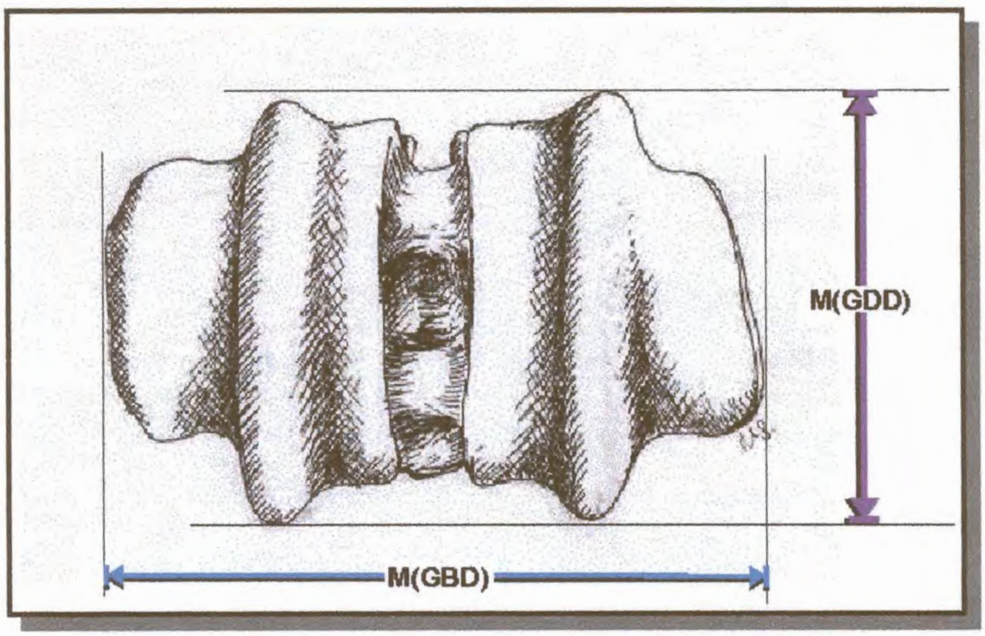
M(GDD) = Greatest depth distal end.

➘ Original abbreviation: "Dd" (Von den Driesch, 1976) [72]

"Dd" (Peters, 1985) [92]

The greatest distance from the most anterior to the most posterior points on the distal end of the metatarsal was measured with a sliding calliper. The jaws of the calliper should be at a right angle to the distal eminences of the metatarsal.

FIGURE 3.11b: Metatarsal: Inferior view M(GBD) ; M(GDD)



2.2 Data collection and statistical analysis

Measurements were entered into a database and a variety of calculations were done. These included minimum and maximum values, standard deviations as well as medians and means.

Males and females were not separated in the calculations performed on the data, since the sample sizes of most of these species were inadequate. Another reason for the combination was that a large amount of the specimens measured at the different museums were not identified as being either male or female. Further studies on more extensive collections may create large enough sample sizes to separate the specimens according to sex. The sex of each specimen was, however, noted where available.

Research has shown that differences in skeletal morphology exist between animals that are born in the wild and those born in captivity. Again, this information was lacking in most of the specimens measured. Zoo and wild born specimens were not statistically differentiated, but was, however, noted as being one or the other where data was available.

An index is a percentage value that describes measurements in relation to each other. By using indices, size factors are nullified, while shape becomes more important. The indices in this study are mainly used to determine the specimen's circumference in relation to its length. Therefore they give an indication of the robusticity of the bone.

The statistical program Sigmastat was used to establish whether a significant difference between the means of the individual Bovid class measurements exists.

Students t-tests were done to establish whether a significant difference occurs between the individual measurements within the bovid size classes. Every bovid species within a size class was statistically tested against the average of all the other species within the same bovid size class. It was therefore established whether one species in a size class differs to such an extent that it would be positively identified if compared to the species within the same bovid size class.

The data was entered into Lotus Smartsuite. Medians were then determined and used to accomplish a "model" to identify a specimen. The sample sizes were not always a good representation of the morphology of a specific species, thus there were sometimes extreme measurements to either side of the values taken. Extreme values may be the result of external conditions and adaptations which may have caused exceptional growth or restraint thereof. Therefore it was decided to use the median instead of the mean, to avoid influence of extreme values until larger sample sizes are available.

The indices that were calculated in this study are stipulated in Table 3.9.

TABLE 3.9: Indices used in Stage 2

Index Abbreviation	Description
F(SCD) / F(GL) x100	Smallest circumference of femur / Greatest length of femur X100
T(SCD) / T(GL) x100	Smallest circumference of tibia / Greatest length of tibia X100
M(SCD) / M(GL) x100	Smallest circumference of metatarsal / Greatest length of metatarsal X100

2.3 Development of computer programme

The aim of the computer programme was to use the measurements of the modern specimens in a data base to manipulate the data in such a way that it might be able to identify a specimen as belonging to a certain species.

The development of the program was done during the study by the author and a computer programmer. Specifications of the programme were developed during the course of the study. The programme needed to illustrate a labeled identification percentage probability-graph when measurements are entered one by one. This ensures that a probability could be calculated with any number of measurements. This is especially important with the abundance of fragmented specimens from South African sites. The programme also has to be able to calculate various percentage probabilities. The identification percentage probability (IPP) is a calculation of the number of measurements (median values of specific species) that fall within the range of the entered measurement values, expressed as a percentage value. The range is a fluctuation of 10% either side of the median. The programme then calculates this percentage for all the species in the database. The fractional percentage probability (FPP) calculates the percentage chance the specimen measured has of being one of the species that had positive identification percentage probabilities (IPP). A species, for example, may have a 88% IPP but a 45% FPP depending on how many species met the requirements of the entered measurement values.

All measurements were entered into a D-Base database supported by Lotus Smartsuite. Lotus Smartsuite offers an integrated combination of utilities and it is relatively easy to use to build comparisons of structures and trends as well as profiles. Lotus Smartsuite incorporates a database but also yields a strong statistical and graphical interface. Separate fields were created to accommodate the entering of data.

The identification chart utilizes the measurements of the actual samples and collates it in a database to calculate the median or model thereof. By using linear regression analysis to set off actual sizes against these medians, the programme arrives at a possible identification of the specific species. The median was used to arrive at a specific species resembling the closest average without compromising the model with extreme values.

When the measurements of an unknown specimen are presented to the programme, the computer will compare the entered information to that contained within the database. An "IF" statement within the programme tests the actual measurement given to the model and allocates a "1" (true) or a "0" (false) in each measurement category. The sum total of the statements is then calculated and expressed as a percentage-of-compliance-to-the-model in terms of a hundred percent. It therefore gives an indication of which portion of the hundred percent the specific species presents and then provides the species "model" most accurately resembling those measurements. Only species with a total greater than zero is displayed graphically with the highest scoring species as the most likely identification.

Because of the limitation of data due to sample size constraints, a fuzzy-logic element or discernable flux was built into the programme. This allows for a 10% fluctuation off the median either way in returning species profiles. As more measurements are accumulated in the database, this fluctuation will decrease and a more refined model can be construed to increase accuracy. An accurate indication of not only the identification of the species, but also other species with similarities can be seen with the existing data.

The percentages of species possibilities are displayed graphically upon identification. The identification graph also stipulates which Bovid size class the identified species falls within. Thus if a number of possible species are identified on the graph and a definite result cannot be deduced from the percentage values, the bovid size class can be used, as in conventional methods, to classify the bone.

It is not necessary for all measurements to be entered into the separate measurements fields, but the number of measurements does have an influence on the accuracy of the identification. Thus obviously the more measurements entered the better the results.

The programme is divided into three separate databases for each long bone. It is therefore essential to already know from which long bone the specimen originated.

This is only a test programme, to ascertain whether bone measurements may yield accurate diagnoses of faunal remains. The database is also designed to protect sensitive or source information not intended for public scrutiny and change.

Future expansion of the database include adding additional information regarding each species. This information includes area of distribution, feeding type, habitat, average weight as well as a photographic illustration of the specific species. The area of distribution may differentiate between skeletally similar species, like Blesbok and Bontebok, on the basis of their natural occurrence. One species was used to demonstrate how additional information may be added in future to assist identification.

3. STAGE 3 - TESTING

Stage 3 comprised of a test of accuracy and reliability of the developed programme in Stage 2. Bones of Kemp's Caves, analyzed by conventional methods, were analyzed by the computerized classification system. This faunal sample included only one femur, three tibiae and six metatarsal specimens which could be utilized for testing. These specimens were the only material which were identified to species level belonging to the three lower limb long bones used in this study. Table 3.10 gives a summary of the specimens, their LKC number, the provenance and the identification based on the conventional method of faunal analysis.

Each fragmented specimen was measured using the measurements defined in Stage 2. These values were entered into the database to be identified by the computerized classification programme according to osteometric characteristics. No specimen was complete, thus all material lacked certain values.

TABLE 3.10: Kemp's Caves specimens used to test computerized classification

DESCRIPTION	LKC NO.	PROV.	SPECIES
Proximal articulation + shaft of right metatarsal	LKC/92/34	2E/8N	Blesbok
Proximal articulation + shaft of left metatarsal	LKC/93/35	5E/9,10N	Blesbok
Proximal articulation + shaft of left metatarsal	LKC/93/40	5E/9,10N	Blesbok
Proximal articulation + shaft of left metatarsal	LKC/94/328	5,6E/10N	Blesbok
Proximal articulation + shaft of left metatarsal	LKC/93/126	5E/9N	Impala
Left metatarsal	LKC/93/302	5,6E/9,10N	Reedbuck
Distal articulation + shaft of left tibia	LKC/93/70	5E/9,10N	Blesbok
Distal articulation of right tibia	LKC/93/23	5E/9N	Impala
Distal articulation + shaft of tibia	LKC/92/38	2E/6N	Springbok
Midshaft of left femur	LKC/94/27	6E/10N	Red Hartebeest

Ten modern museum specimens, which were not measured for the database for reasons of unavailabilty at the time, were also measured and the values were entered into the computer programme. The reason for the extra specimens was that these bones were of known animals, thus, identification was not based on conventional faunal identification methods which could be faulty. The second reason was to increase the number of specimens to better test the computer programme.

Table 3.11 gives a summary of the modern specimens and the allocated National Flagship Museum number. Each specimen was measured according to measurement descriptions in Stage 2. All the modern specimens were complete and all measurements were entered into the computer programme for identification.

TABLE 3.11: Modern specimens used to test computerized classification

DESCRIPTION	MUSEUM NUMBER	SPECIES
Femur	AZ 1069	Klipspringer
Femur	AZ 526	Grey Rhebuck
Femur	AZ 645	Red Hartebeest
Tibia	AZ 782	Steenbok
Tibia	AZ 1032	Springbok
Tibia	AZ 145	Black Wildebeest
Metatarsal	AZ 1572	Cape Grysbok
Metatarsal	AZ 931	Bontebok
Metatarsal	AZ 127	Sable
Metatarsal	AZ 1457	Eland

4 RESULTS

This study, as explained previously, consisted of three stages. Stages 1 and 2 are independent of each other, while Stage 3 incorporated results from Stages 1 and 2.

I. STAGE I - FAUNAL ANALYSIS

Stage 1 comprised of the analysis of the faunal remains of Lower Kemp's Caves situated in the Ngonyama Game Reserve near Krugersdorp.

I.I Introduction

The faunal sample excavated from Lower Kemp's Cave between 1992 and 1999 constituted more than 8000 individual elements. Most of these elements were individually catalogued and numbered prior to analysis. Elements lacking this data were allocated numbers during the identification process. Details such as date and provenance were also recorded.

All faunal material and artifacts were sorted. The stone artifacts, microfauna and archaeological specimens were removed and no identification was attempted in this study. Future analysis of Kemp's Caves may incorporate these elements.

The faunal sample was subdivided into two categories namely identifiable and non-identifiable bone pieces. These elements were dealt with separately. Approximately 11.5% of the sample was identifiable. Only 3% of these were identified to a specific species, while the rest was arranged into separate size classes. A total of 88% of the elements could not be assigned to any taxa with confidence. Table 4.1 is a summary of the faunal sample size.

TABLE 4.1: Summary of LKC Faunal sample size (n).

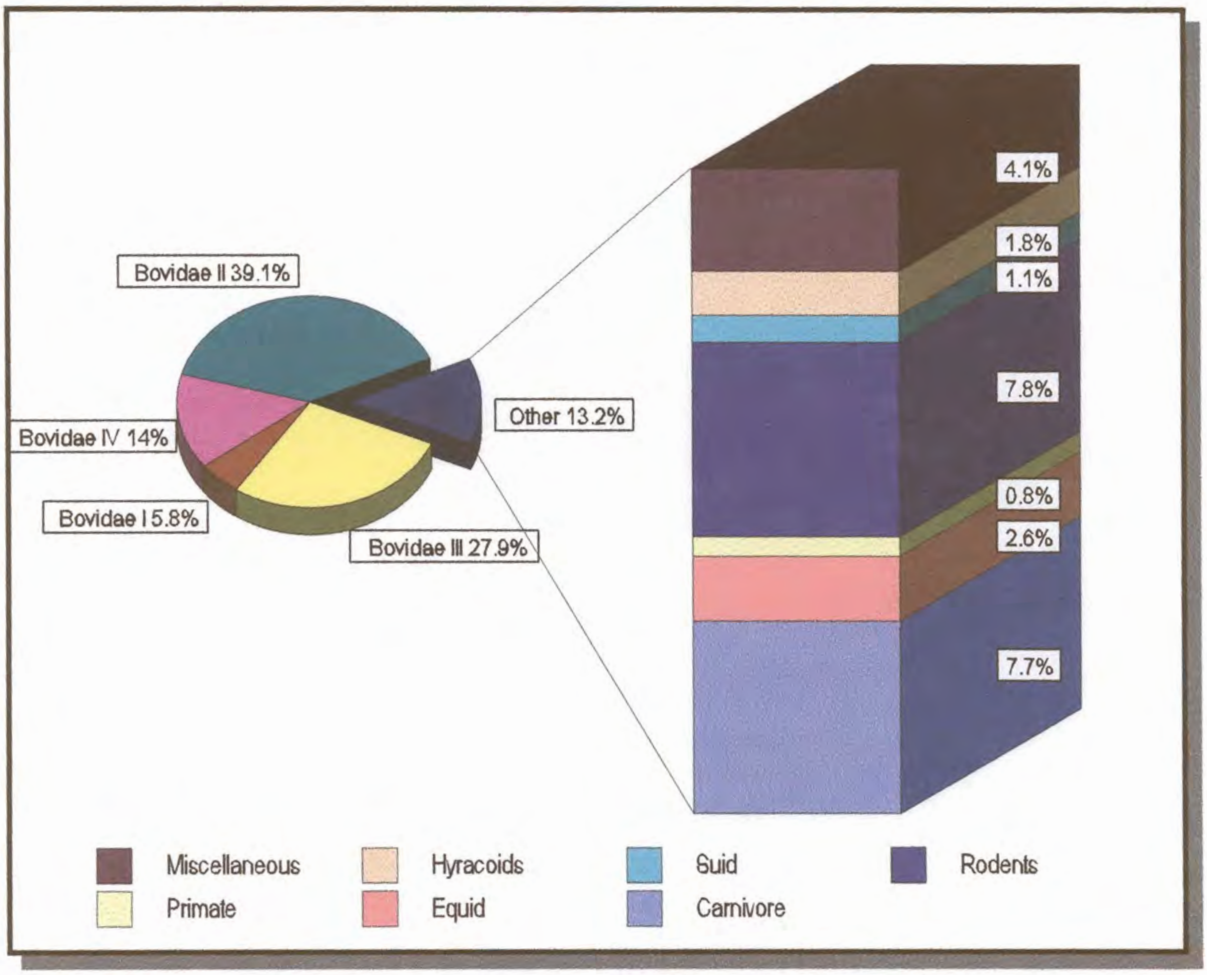
SKELETAL PART	GRID SYSTEM	NE EXTENSION	TOTAL
Bovid remains	439	207	696
Other remains	133	81	214
Total identifiable	**622**	**288**	**910**
Enamel fragments	380	335	715
Skull fragments	423	61	484
Vertebra fragments	73	44	117
Rib fragments	89	19	108
Miscellaneous	1 666	1 878	3 544
Bone flakes	1 526	658	2 184
Total unidentifiable	**4 157**	**2 995**	**7 152**
Total sample	**4 779**	**3 283**	**8 062**
Mass identifiable	8 378.0g	2 346.0g	10 724.0g
Mass unidentifiable	8 221.3g	5 361.1g	13 582.4g
Total mass	**16 599.3g**	**7 707.1g**	**24 306.4g**

1.2 Identifiable bones

Identifiable bones were assigned to skeletal part and where possible to genus and species. Figure 4.1 illustrates graphically the different Mammalian taxa identified in the sample as percentages of the total specimen count. Bovidae specimens accounted for most of the specimens with a percentage of 86.8%, while the other taxa included Primates (0.8%), Hyracoids (1.8%), Equids (2.6%), Suids (1.1%), Carnivores (7.7%) and Rodents (7.8%). Miscellaneous fauna like reptiles and birds contributed approximately 4.1% to the faunal assemblage.

Although most of the Aves class were represented by eggshell fragments, probably of the *Struthio* genus, there were a few osteological specimens of various bird class sizes. The reptilian population was represented only by shell fragments of the *Chelonian* genus.

FIGURE 4.1: Mammalian taxa representation (%).



The material recovered from LKC is listed and described below. Each specimen is defined with detail according to specific skeletal part, LKC number and provenance. Three major classes, Mammalia, Aves and Reptilia, are represented in the sample.

A) CLASS MAMMALIA

Mammalia indeterminate

➘ Five cranial and 7 postcranial specimens from a minimum of four individuals.

Material: Maxillary fragment: LKC/94/139 (5E 10N), Mandibular fragments: LKC/94/394 (5E6E 9N10N) + LKC/97/21.1 (NE Ex) + LKC/99/22E (NE Ex-AC), Os petrosum: LKC/92/154 (0E 5N) Glenoid cavity right scapula: LKC/93/61 (5E 9N10N), Distal left humerus: LKC/94/398 (5E6E 9N10N) + LKC97/4.1 (NE Ex), Femur head: LKC/98/16A (NE Ex-V), Femur shaft fragment: LKC/97/7.3 (NE EX) + LKC/99/30L (NE Ex-AE), Sesamoid: LKC/93/250 (2E 9N)

Order PRIMATES

Family HOMINIDAE

Homo sapiens (Human)

➘ Two cranial specimens representing a minimum of one individual.

Material: Left upper M2: LKC/92/69 (2E 5N), Upper P2: LKC/93/144 (5E 9N).

Family CERCOPITHECIDAE

Papio cynocephalus ursinus (Chacma baboon: Kerr, 1792)

➘ Five cranial specimens from a minimum of one aged and two adult individuals.

Material: Right upper I2: LKC/98/12M (NE Ex-U), Left lower canine: LKC/92/25 (0E 6N), Left upper M2: LKC/92/64 (2E 6N) +

LKC/97/47 (NE Ex), Right lower M3 fragment: LKC/98/12M (NE Ex-R).

Order CARNIVORA

Carnivore indeterminate

➘ Fourteen cranial and 6 postcranial specimens from a minimum of 1 small, 1 large and 2 medium sized individuals.

Material: Left mandibular fragment: LKC/97/56E (NE Ex), Left lower I2: LKC/92/59 (1E 6N), I3: LKC/94/399 (5E6E 9N10N), Left lower I3: LKC/92/61 (1E 6N), Canine: LKC92/26 (0E 6N) + LKC/92/43 (2E 6N) + LKC/93/157 (6E 10N) + LKC/94/1 (2E 3N4N) + LKC/97/5.1 (NE Ex), Premolar: LKC/93/228 (8E 7N) + LKC/94/210 (2W 2S), Lower P1: LKC/99/3D (NE Ex-W), Right upper P3: LKC/97/26 (NE Ex), Molar: LKC/94/62 (7E 9N). Right calcaneus: LKC/98/12I (NE Ex-U), Phalanx: LKC/93/26 (5E 9N), Proximal phalanx: LKC/93/220B (5E6E 9N10N) + LKC/98/12D (NE Ex-T), Intermediate phalanx: LKC/92/118 (0E 6N), Distal phalanx: LKC/98/19.3 (NE Ex).

Family FELIDAE

Felid indeterminate

➘ One postcranial specimen from one individual.

Material: Left 4th metatarsal: LKC/97/49A (NE Ex).

Subfamily Felinae

Panthera pardus (Leopard: Linnaeus, 1758)

➘ One cranial specimen from one individual.

Material: Maxillary fragment including Right P2: LKC/93/142 (5E 9N).

cf. *Panthera pardus* (Leopard: Linnaeus, 1758)

➘ One cranial specimen from one individual.

Material: Left lower I3: LKC/92/61 (1E 6N).

Felis serval (Serval: Schreber, 1776)

➘ One cranial specimen from one individual.

Material: Mandible fragment including right P1 and P2: LKC/97/91.2 (NE Ex).

Family HYAENIDAE

Subfamily Hyaeninae

Hyaenid indeterminate

➘ Two cranial specimens from a minimum of one individual.

Material: Right upper I3: LKC/97/6.2 (NE Ex), Molar fragment: LKC/94/228 (7E 5N).

Hyaena brunnea (Brown Hyaena: Thunberg, 1820)

➘ Five cranial specimens from a minimum of one individual.

Material: Right lower canine: LKC/93/156B (6E 10N), Right lower P2: LKC/94/86 (6E 10N), Right lower P3: LKC/97A (6E 10N), Right lower M1: LKC/156A (6E 10N), Right upper M3: LKC/92/47 (2E 6N).

cf. *Hyaena brunnea* (Brown Hyaena: Thunberg, 1820)

➘ Two cranial specimens from a minimum of one individual.

Material: Left lower I2: LKC/92/59 (1E 6N), Canine: LKC/94/126A (11E 5N).

Crocuta crocuta (Spotted hyaena: Erxleben, 1777)

➘ Three cranial specimens from a minimum of one juvenile and one adult individual.

Material: Mandibular fragment including P1, P2 and M1: LKC 93/156 (6E 10N), Maxillary fragment including right M1: LKC/98 5G (NE Ex-T), Left lower P1: LKC/98/3J (NE Ex-S).

Family CANIDAE

Canid indeterminate

➘ One cranial and one postcranial specimen of a minimum of one individual.

Material: Right upper canine: LKC/99/40 (NE Ex-AF).

Right ulnar fragment: LKC/92/327 (2E 9N).

Subfamily Caninae

Canis mesomelas (Black-backed jackal: Shreber, 1778)

➘ Fifteen cranial and four postcranial specimens from a minimum of two individuals.

Material: Left mandibular fragment: LKC/97/74 (NE Ex), Right lower I3: LKC/94/142 (5E 10N), Left upper canine: LKC/99/9B (NE Ex-AB), Right upper canine: LKC/99/30C (NE Ex-AE), Left lower canine: LKC/92/27 (0E 6N), Premolar fragment: LKC/94/358 (6E7E 11N12N), Right upper P1: LKC/97/30.1 (NE Ex), Right upper P2: LKC/98/3G (NE Ex-S), Left lower P2: LKC/99/14K (NE Ex-AC), Left lower P4: LKC/97/66C (NE Ex), Right upper M1: LKC/93/116 (5E 9N), Left upper M1: LKC/94/369 (6E 9N10N), Right lower M1: LKC/94/290 (5E6E 9N10N) +

LKC/99/38D (NE Ex-AF), Right upper M2: LKC/94/393 (5E6E 9N10N).

Distal articulation of right humerus: LKC/94/410 (6E7E 9N10N), Distal left humerus: LKC/93/161 (6E 10N), Acetabulum: LKC/94/116 (6E 10N), Left astralagus: LKC/93/192B (2E 4N5N).

cf. *Canis mesomelas* (Black-backed jackal: Shreber, 1778)

➘ Four cranial and one postcranial specimen from a minimum of one individual.

Material: Mandibular fragment including left P1: LKC/99/1 (NE Ex-V), Canine crown: LKC/93/152 (6E 10N), Left premolar fragment: LKC/94/386 (6E 9N10N), Left lower M2: LKC/99/30G (NE Ex-AE).

Metapodial fragment: LKC/94/67 (7E 9N).

Vulpes chama (Cape fox: Smith, 1833)

➘ One cranial and one postcranial specimen from a minimum of one individual.

Material: Right mandibular fragment: LKC/93/247 (2E 9N).

Proximal phalanx: LKC/94/174F (6E 9N10N).

Family VIVERRIDAE

Subfamily Viverrinae

Genetta genetta (Small spotted genet: Linnaeus,1758)

➘ One postcranial specimen from one individual.

Material: Distal articulation & shaft left humerus: LKC/98/12H (NE Ex-U)

Subfamily Herpestinae

Mongoose indeterminate

➘ One postcranial specimen of one individual.

Material: Metapodial: LKC/97/72.1 (NE Ex).

Order HYRACOIDEA

Family PROCAVIIDAE

Procavia capensis (Rock dassie: Pallas, 1766)

➘ Twelve cranial and 2 postcranial specimens from a minimum of three individuals.

Material: Maxillary fragment including molar: LKC/94/209 (2W 2S), Right maxillary fragment including molar: LKC/92/124 (0E 6N, Left maxillary fragment including molars: LKC/92/234 (2E 9N), Mandibular fragment including molars: LKC/92/235 (2E 9N) + LKC/92/151 (2E 9N) + LKC/97/77 (NE Ex), Right mandible including molars: LKC/98/3D (NE Ex-S), Left mandible including molars: LKC/94/150 (6E 10N), Right upper I3: LKC/97/55 (NE Ex), Right upper M3: LKC/97/52F (NE Ex) + LKC/99/22D (NE Ex-AC) + LKC/99/22N (NE Ex-AC).

Distal articulation & shaft right humerus: LKC/99/22J (NE Ex-AC), Distal articulation & shaft left humerus: LKC/99/9E (NE Ex-AB).

cf. *Procavia capensis* (Rock dassie: Pallas, 1766)

➘ One cranial and one postcranial specimen from a minimum of one individual.

Material: Left maxillary fragment including molars: LKC/94/274 (5E6E 9N10N).

Left femur: LKC/92/401 (2E 7N).

Order PERISSODACTYLA

Family EQUIDAE

Equid indeterminate

➘ Five cranial specimens from a minimum of two individuals.

Material: Molar fragment: LKC/93/274 (5E 9N) + LKC/94/366 (6E7E 11N12N) + LKC/99/38I (NE Ex-AF), Right upper premolar: LKC/93/298 (5E 8N) + LKC/93/298A (5E 8N).

Equus burcelli (Burchell's zebra: Gray,1824)

➘ Eight cranial and 3 postcranial specimens from a minimum of two individuals.

Material: Left lower P2: LKC/94/205 (2W 2S), Left upper molar: LKC/94/177 (8E9E 7N9N) + LKC/99/38Q (NE Ex-AF), Left upper M1: LKC/94/43 (3E 5N), Right lower M1: LKC/99/9F (NE Ex-AB), Left lower M1: LKC/94/420 (No grid), Left upper M2: LKC/94/127 (5E 10N) + LKC/99/30A (NE Ex-AE).

Left astralagus: LKC/93/275 (5E 9N), Right calcaneus: LKC/93/371 (6E 9N10N), Left central tarsal: LKC/93/148A (5E 9N).

cf. *Equus burcelli* (Burchell's zebra: Gray,1824)

➘ One cranial specimen from one individual.

Material: Molar fragment: LKC/94/361 (6E7E 11N12N).

Equus capensis (Extinct Cape horse/zebra: Brain, 1909)

➘ Four cranial and two postcranial specimens from a minimum of one individual.

Material: Right upper I1: LKC/94/348 (5E 11N), Left upper P2: LKC/94/317 (5E6E 10N), Right P3: LKC/94/318 (5E6E 10N), Right lower M3: LKC/94/367 (6E7E 11N12N).

Distal articulation & shaft left humerus: LKC/93/111 (No grid), Left humeral head fragment: LKC/93/112 (No grid).

Order ARTIODACTYLA

Family SUIDAE

Phacochoerus aethiopicus (Warthog: Pallas, 1766)

➘ Nine cranial specimens from a minimum of one juvenile and one adult individual.

Material: Canine: LKC/92/233 (2E 9N), Right upper canine fragment: LKC/92/37B (2E 8N), Upper premolar: LKC/94/129 (5E 10N) + LKC/94/197 (1E 5N), Premolar: LKC/92/39 (2E 6N), Molar fragments: LKC/93/113 (5E 9N) + LKC/94/58 (7E 9N) + LKC/94/89 (6E 10N) + LKC/94/149 (6E 10N).

Potamochoerus porcus (Bushpig: Linnaeus, 1758)

➘ One cranial and one postcranial specimen from a minimum of one individual.

Material: Left lower canine: LKC/94/59 (7E 9N).

Right humerus shaft fragment: LKC/93/287 (5E 9N).

Family BOVIDAE

Subfamily Alcelaphinae

Alcelaphine indeterminate

➘ Two cranial specimens from a minimum of two individuals.

Material: Right lower I1: LKC/93/11 (5E 9N)+ LKC/93/10 (5E 9N).

Damaliscus dorcas phillipsi (Blesbok: Harper, 1939)

➘ One cranial and 10 postcranial specimens from a minimum of two individuals.

Material: Left lower M1: LKC/97/8.3 (NE Ex).

Distal right humerus: LKC/92/3 (No grid) + LKC/94/68 (7E 9N), Shaft right humerus: LKC/93/77 (5E 9N10N), Shaft left humerus: LKC/94/105 (6E 10N), Left radiocarpal: LKC/99/3A (NE Ex-W), Proximal articulation & shaft left metacarpal: LKC/94/111 (6E 10N), Distal articulation & shaft left tibia: LKC/93/70 (5E 9N10N), Left naviculocuboid: LKC/94/69 (7E 9N), Proximal articulation & shaft right metatarsal: LKC/92/34 (2E 8N), Distal articulation & shaft left metatarsal: LKC/94/328 (5E6E 10N).

cf. *Damaliscus dorcas phillipsi* (Blesbok: Harper, 1939)

➘ One cranial and four postcranial specimens from a minimum of two individuals.

Material: Right lower M3: LKC/94/101 (6E 10N).

Distal articulation & shaft left radius: LKC/93/72 (5E 9N10N), Proximal articulation & shaft left metatarsal: LKC/93/35 (5E 9N10N) + LKC/93/40 (5E 9N10N), Left intermediate phalanx:

LKC/92/158 (2E 9N).

Alcelaphus buselaphus (Red Hartebeest: Pallas, 1766)

➘ Seven postcranial specimens from a minimum of one individual.

Material: Left scapular fragment: LKC/94/112 (6E 10N), Proximal arcticulation & shaft left metacarpal: LKC/93/71 (5E 9N10N), Midshaft left femur: LKC/94/27 (6E 10N), Right proximal phalanx: LKC/97/16 (NE Ex), Left proximal phalanx: LKC/97/11 (NE Ex), Left intermediate phalanx: LKC/97/15 (NE Ex), Right intermediate phalanx: LKC/97/18 (NE Ex).

cf. *Alcelaphus buselaphus* (Red Hartebeest: Pallas, 1766)

➘ Four postcranial specimens from a minimum of one individual.

Material: Distal articulation & shaft left metacarpal: LKC/97/33 (NE Ex), Proximal phalanx: LKC/94/20 (6E 10N), Right proximal phalanx: LKC/94/195 (1E 5N), Left proximal phalanx: LKC/92/71 (0E 6N).

Connochaetes gnou (Black Wildebeest: Zimmerman, 1780)

➘ One cranial and three postcranial specimens from a minimum of one individual.

Material: Right lower M2: LKC/94/257 (5E6E 9N10N), Midshaft right radius and ulna: LKC/93/159 (6E 10N), Left astralagus: LKC/94/280 (5E6E 9N10N), Right calcaneus: LKC/94/326 (5E6E 10N).

cf. *Connochaetes gnou* (Black Wildebeest: Zimmerman, 1780)

➘ One postcranial specimen from a minimum of one individual.

Material: Right metacarpal: LKC/94/326 (5E6E 9N10N).

Connochaetes taurinus (Blue Wildebeest:Burchell, 1823)

➘ One postcranial specimen from one individual.

Material: Distal left radius: LKC/92/240 (2E 9N).

cf. *Connochaetes taurinus* (Blue Wildebeest:Burchell, 1823)

➘ One postcranial specimen from one individual.

Material: Right astralagus: LKC/92/14 (Deep in cave).

Subfamily Antelopinae

Antidorcas marsupialis (Springbok: Zimmerman, 1780)

➘ Six postcranial specimens from a minimum of two individuals.

Material: Distal right radius and ulna: LKC/92/4 (No grid), Left proximal phalanx: LKC/92/108 (1E 6N) + LKC/92/109 (1E 6N), Intermediate phalanx: LKC/94/137 (5E 10N), Distal articulation & shaft left tibia: LKC/92/38 (2E 6N) + LKC/99/9H (NE Ex-AA).

cf. *Antidorcas marsupialis* (Springbok: Zimmerman, 1780)

➘ Three postcranial specimens from a minimum of one individual.

Material: Left proximal phalanx: LKC/92/15 (Deep in cave), Left intermediate phalanx: LKC/99/8 (NE Ex-AA), Left distal phalanx: LKC/94/376 (6E 9N10N).

Raphicerus campestris (Steenbok: Thunberg, 1811)

➘ Two postcranial specimens from a minimum of one individual.

Material: Distal articulation & shaft metacarpal: LKC/92/107 (1E 6N), Right proximal phalanx: LKC/94/144 (5E 10N).

Subfamily Bovinae

Taurotragus oryx (Eland: Pallas, 1766)

➘ Five cranial and one postcranial specimen from a number of two individuals.

Material: Right upper M1: LKC/98/8A (NE Ex-T), Left upper M1: LKC/92/231 (2E 9N) + LKC/98/8B (NE Ex-T), Right upper M2: (92/227 (2E 9N), Right upper M3: LKC/97/39A (NE Ex).
Left astralagus: LKC/99/22 (NE Ex-AC).

cf. *Taurotragus oryx* (Eland: Pallas, 1766)

➘ One cranial and one postcranial specimen from a minimum of one individual.

Material: Left upper M2: LKC/93/54 (5E 9N10N).
Styloid process left ulna: LKC/92/321 (2E 9N).

Tragelaphus strepsiceros (Kudu: Pallas, 1766)

➘ Two cranial and one postcranial specimen from a minimum of one individual.

Material: Right I: LKC/93/8A (5E 9N), Left I: LKC/93/8B).
Left distal phalanx: LKC/94/372.

Bos taurus (Domestic cattle)

➘ Five postcranial specimens from a minimum of one individual.

Material: Distal left radius: LKC/94/308 (5E6E 9N10N), Right intermediate carpal: LKC/93/8C (5E 9N), Right 4th carpal: LKC/93/8D (5E 9N), Right ulnar carpal: LKC/93/8E (5E 9N), Right 2nd and 3rd carpal: LKC/93/123 (5E 9N).

Subfamily Hippotraginae

cf. *Hippotragus niger* (Sable: Harris, 1838)

- One postcranial specimen from one individual.

Material: Right radial carpal: LKC/93/205 (5E6E 9N10N).

Subfamily Aepycerotinae

Aepyceros melampus (Impala: Lichtenstein, 1812)

- Two postcranial specimens from a minimum of one individual.

Material: Distal right tibia: LKC/93/23 (5E 9N), Proximal articulation & shaft left metatarsal: LKC/93/126 (5E 9N).

cf. *Aepyceros melampus* (Impala: Lichtenstein, 1812)

- One cranial specimen of one individual.

Material: Right upper M3: LKC/93/301 (5E6E 9N10N).

Subfamily Peleinae

Pelea capreolus (Grey Rhebok: Forster, 1790)

- One postcranial specimen from one individual.

Material: Proximal articulation & shaft left metatarsal: LKC/98/10 (NE Ex-T).

Subfamily Reduncinae

Redunca arundinum (Reedbuck: Boddaert, 1785)

- One postcranial specimen from one individual.

Material: Left metatarsal: LKC/93/302 5E6E 9N10N).

Order LAGOMORPHA

Family LEPORIDAE

Lepus saxatilis (Scrub hare: Cuvier, 1823)

➘ Three cranial and 10 postcranial specimens from a minimum of three individuals.

Material: Left mandibular fragments including molars: LKC/92/286 (2E 4N5N) + LKC/99/5A (NE Ex-AA) + LKC/99/22C (NE Ex-AC). Right scapular fragment: LKC/92/57 (1E 6N) + LKC/92/402 (2E 7N) + LKC/94/119 (6E 10N), Proximal articulation & shaft radius: LKC/92/79 (0E 6N), Pelvic fragment: LKC/92/96 (2E 6N), Distal articulation & shaft right tibia: LKC/99/140, Right tibia and fibula fragment: LKC/94/120 (6E 10N), Right metatarsal fragment: LKC/99/9J (NE Ex-AB), Left metatarsal: LKC/92/44 (2E 6N) + LKC/92/98 (2E 6N).

cf. *Lepus saxatilis* (Scrub hare: Cuvier, 1823)

➘ One postcranial specimen from one individual.

Material: Left ulna: LKC/97/49C (NE Ex).

Pronolagus indeterminate

➘ One postcranial specimen from one individual.

Material: Right tibia and fibula: LKC/92/35 (2E 8N).

Order RODENTIA

Rodent indeterminate

➘ Ten cranial and 19 postcranial specimens from a minimum of four individuals.

Material: Maxillary fragments: LKC/93/27 (5E 9N) + LKC/94/344 (5E6E 10N), Mandibular fragments: LKC/92/28 (0E 6N) + LKC/92/236 (2E 9N) + LKC/94/31 (6E 10N), Incisor: LKC/92/24 (0E 6N) + LKC/92/45A (2E 6N) + LKC/97/87.2 (NE Ex) + LKC/22L (NE Ex-AC) + LKC/99/42 (NE Ex-AF).

Right scapular fragment: LKC/99/38T (NE Ex-AF), Left scapular fragment: LKC/99/30R (NE Ex-AE), Humeral fragments: LKC/99/30 M (NE Ex-AE) + LKC/99/34 (NE Ex-AE), Distal left humerus: LKC/92/94 (2E 6N) + LKC/97/35A (NE Ex), Phalanges: LKC/92/262 (2E 9N) + LKC/92/305C (2E 9N), Left femur: LKC/92/260 (2E 9N), Distal articulation & shaft fibula: LKC/92/116 (0E 6N), Metapodial fragment: LKC/92/117 (0E 6N) + LKC/92/261 (2E 9N) + LKC/94/383 (6E 9N10N) + LKC/97/22A (NE Ex) + LKC/14N (NE Ex-AC) + LKC/99/14W (NE Ex-AC) + LKC/99/22K (NE Ex-AC) + LKC/99/29B (NE Ex-AD) + LKC/99/30K (NE Ex-AE).

Family PEDETIDAE

Pedetes capensis (Spring hare: Forster, 1778)

➘ One cranial and one postcranial specimen from a minimum of one individual.

Material: Molar: LKC/99/30S (NE Ex-AE).

Pelvic fragment: LKC/97/36.6 (NE Ex).

Family HYSTRICIDAE

Hystrix africaeaustralis (Porcupine: Peters, 1852)

➘ Twenty-four cranial and two postcranial specimens from a minimum of one juvenile and three adult individuals.

Material: Maxillary fragment including incisor: LKC/99/29A (NE Ex-AD), Mandibular fragment including molars: LKC/92/89 (2E 6N) + LKC/93/154 (6E 10N) + LKC/94/121 (6E 10N) + LKC/99/22I (NE Ex-AC) + LKC/99/30L (NE Ex-AE) + LKC/99/30O (NE Ex-AE), Right upper I: LKC/92/36 (2E 8N) + LKC/93/53 (5E 9N10N), Left lower I: LKC/94/292 (5E6E 9N10N) , Lower I: LKC/97/36.7 (NE-Ex), Molars: LKC/92/32 (0E 6N) + LKC/92/121 (0E 6N) + LKC/93/150 (6E 10N) + LKC/94/152 (6E 10N) + LKC/94/163 (6E 9N10N) + LKC/94/208 (No grid) + LKC/94/320 (5E6E 10N) + LKC/97/5.4 (NE Ex) + LKC/97/80.2 (NE Ex) + LKC/97/85.2 (NE Ex) + LKC/98/1G (NE Ex-R) + LKC/98/5H (NE Ex-T) + LKC/99/14L (NE Ex-AC).

Shaft right humerus: LKC/98/12B (NE Ex-U), Distal articulation & shaft left humerus: LKC/99/22R (NE Ex-AC).

B) CLASS AVES

Avian indeterminate

- Five postcranial specimens from a minimum of two individuals.

Material: Longbone fragment: LKC/93/220A (5E6E 9N10N) + LKC/93/259 (2E 9N), Proximal phalanx: LKC/93/190 (2E 4N5N), Pelvic fragment: LKC/94/217A (No grid), Proximal articulation & shaft right tibia: LKC/92/75 (0E6N).

C) CLASS REPTILIA

Reptilia indeterminate

- Four carapace pieces from a minimum of one individual.

Table 4.2 provides a detailed summary of the taxa identified indicating the MNI (Minimum number of individuals) values and percentages, as well as the NISP (Number of specimens) values and percentages.

The NISP calculation counts the number of specimens attributed to each taxon. An individual animal which contributes more than one identifiable bone to the faunal sample will be counted several times. This might give an over-representation of that specific taxon [4].

An MNI value estimates the minimum number of individuals. It is based upon non- reproducible elements, thus an individual cannot be counted twice [4]. There are several other calculations for the analysis of faunal remains. Kemp's Caves are still yielding large quantities of faunal remains and further in depth analysis may be viable with a larger sample size of excavated specimens.

TABLE 4.2: Summary of species identified in LKC faunal sample.

SPECIES	GRID SYSTEM		NE EXTENSION		TOTAL	TOTAL	
	NISP	% NISP	NISP	%NISP	NISP	MNI	%MNI
Class MAMMALIA	615	99.0	288	100.0	904	98	97.03
Mammal indet.	6	0.96	6	2.08	12	4	3.96
Order Primates	4	0.64	3	1.04	7	4	3.96
Family Hominidae	2	0.32	-	-	2	1	0.99
Homo Sapiens Human	2	0.32	-	-	2	1	0.99
Family Cercopithecidae	2	0.32	3	1.04	5	3	2.97
Papio c. ursinus Chacma baboon	2	0.32	3	1.04	5	3	2.97
Order Carnivora	41	6.59	26	9.03	67	18	17.82
Carnivore indet	13	2.09	7	2.43	20	4	3.96
Family Felidae	3	0.48	2	0.69	5	3	2.97
Felid indet.	-	-	1	0.35	1	1	0.99
Subfamily Felinae	3	0.48	1	0.35	2	2	1.98
Panthera pardus Leopard	2	0.32	-	-	-	1	0.99
cf. *Panthera pardus* Leopard	1	0.16	-	-	1	-	-
Felis serval Serval	-	-	1	0.35	1	1	0.99
Family Hyaenidae	9	1.45	3	1.04	12	4	3.96
Subfamily Hyaeninae	9	1.45	3	1.04	12	4	3.96
Hyaenid indet.	1	0.16	1	0.35	2	1	0.99
Hyaena brunnea Brown hyaena	5	0.80	-	-	5	1	0.99
cf. *Hyaena brunnea* Brown hyaena	2	0.32	-	-	2	-	-
Crocuta crocuta Spotted hyaena	1	0.16	2	0.69	3	2	1.98
Family Canidae	16	2.57	12	4.17	28	5	4.95
Canid indet.	1	0.16	1	0.35	2	1	0.99
Subfamily Caninae	15	2.41	11	3.82	26	4	3.96
Canis mesomelas Black-backed jackal	12	1.93	8	2.78	20	3	2.97
cf. *Canis mesomelas* Black-backed jackal	2	0.32	2	0.69	4	-	-
Vulpes chama Cape fox	1	0.16	1	0.35	2	1	0.99
Family Viverridae	-	-	2	0.69	2	2	1.98
Subfamily Viverrinae	-	-	1	0.35	1	1	0.99
Genetta genetta Small spotted genet	-	-	1	0.35	1	1	0.99
Subfamily Herpestinae	-	-	1	0.35	1	1	0.99
Mongoose indet.	-	-	1	0.35	1	1	0.99

TABLE 4.2: Continue

Order Hyracoidea	8	1.28	8	2.78	16	3	2.97
Family Procaviidae	8	1.28	8	2.78	16	3	2.97
Procavia capensis Rock dassie	6	0.96	8	2.78	14	3	2.97
cf. *Procavia capensis* Rock dassie	2	0.32	-	-	2	-	-
Order Perissodactyla	19	3.05	4	1.39	24	5	4.95
Family Equidae	19	3.05	4	1.39	24	5	4.95
Equid indet.	4	0.64	1	0.35	5	2	1.98
Equus burcelli Burchell's zebra	8	1.28	3	1.04	12	2	1.98
cf. *Equus burcelli* Burchell's zebra	1	0.16	-	-	1	-	-
Equus capensis Cape zebra	6	0.96	-	-	6	1	0.99
Order Artiodactyla	500	80.39	207	71.88	707	51	50.50
Family Suidae	11	1.77	-	-	11	3	2.97
Phacochoerus aethiopicus Warthog	9	1.45	-	-	9	2	1.98
Potamochoerus porcus Bushpig	2	0.32	-	-	2	1	0.99
Family Bovidae	55	78.6	14	71.88	69	18	47.52
Subfamily Alcelaphinae	29	4.66	7	2.43	36	7	6.93
Alcelaphine indet.	2	0.32	-	-	2	1	0.99
Damaliscus dorcas phillipsii Blesbok	10	1.60	2	0.69	12	2	1.98
cf. *Damaliscus dorcas phillipsii* Blesbok	4	0.64	-	-	4	-	-
Alcelaphus buselaphus Red Hartbeest	3	0.48	4	1.39	7	2	1.98
cf. *Alcelaphus buselaphus* Red Hartbeest	3	0.48	1	0.35	4	-	-
Connochaetes gnou Black Wildebeest	4	0.64	-	-	4	1	0.99
cf. *Connochaetes gnou* Black Wildebeest	1	0.16	-	-	1	-	-
Connochaetes taurinus Blue Wildebeest	1	0.16	-	-	1	1	0.99
cf.*Connochaetes taurinus* Blue Wildebeest	1	0.16	-	-	1	-	-
Subfamily Antelopinae	9	1.45	2	0.69	11	3	2.97
Antidorcas marsupialis Springbok	5	0.80	1	0.35	6	2	1.98
cf. *Antidorcas marsupialis* Springbok	2	0.32	1	0.35	3	-	-
Raphicerus campestris Steenbok	2	0.32	-	-	2	1	0.99
Subfamily Bovinae	12	1.93	4	1.39	16	4	3.96
Taurotragus oryx Eland	2	0.32	4	1.39	6	2	1.98
cf. *Taurotragus oryx* Eland	2	0.32	-	-	2	-	-
Tragelaphus strepsiceros Kudu	3	0.48	-	-	3	1	0.99

TABLE 4.2: Continue

Bos taurus Domestic cattle	5	0.80	-	-	5	1	0.99
Subfamily Hippotraginae	1	0.16	-	-	1	1	0.99
cf. *Hippotragus niger* Sable	1	0.16	-	-	1	1	0.99
Subfamily Aepycerotinae	3	0.48	-	-	3	1	0.99
Aepyceros melampus Impala	2	0.32	-	-	2	1	0.99
cf. *Aepyceros melampus* Impala	1	0.16	-	-	1	-	-
Subfamily Pelinae	-	-	1	0.35	1	1	0.99
Pelea capreolus Grey Rhebuck	-	-	1	0.35	1	1	0.99
Subfamily Reduncinae	1	0.16	-	-	1	1	0.99
Redunca arundinum Reedbuck	1	0.16	-	-	1	1	0.99
Bovid size class I	35	5.62	16	5.56	51	5	4.95
Bovid size class II	249	40.0	92	31.94	341	14	13.86
Bovid size class III	149	23.95	84	29.17	233	10	9.90
Bovid size class IV	1	0.16	1	0.35	2	1	0.99
Order Lagomorpha	10	1.60	5	1.74	14	4	3.96
Family Leporidae	10	1.60	5	1.74	14	4	3.96
Lepus saxatalis Scrubhare	9	1.45	4	1.39	12	3	2.97
cf. *Lepus saxatalis* Scrubhare	-	-	1	0.35	1	-	-
Pronologus indet.	1	0.16	-	-	1	1	0.99
Order Rodentia	28	4.50	29	10.07	57	9	8.91
Rodent indet.	15	2.41	14	4.86	29	4	3.96
Family Pedetidae	-	-	2	0.69	2	1	0.99
Pedetes capensis Springhare	-	-	2	0.69	2	1	0.99
Family Hystricidae	13	2.09	13	4.51	26	4	3.96
Hystrix africeaustralis Porcupine	13	2.09	13	4.51	26	4	3.96
Class AVES	5	0.80	-	-	5	2	1.98
Avian indet.							
Class REPTILIA	1	0.16	-	-	1	1	0.99
Chelonia indet.	1	0.16	-	-	1	1	0.99
TOTAL	622	100%	288	100%	910	101	100%

Agents responsible for the accumulation of faunal samples are determined by a combination of information derived from the analysis of the accumulation. These aspects include the size of the prey species, animals represented and their age classes, skeletal part survival and carnivore damage to the bone specimens.

Soon after death, the body of an animal becomes disarticulated and is subjected to the characteristic mechanical and chemical brake down of a natural environment. The survival of these skeletal parts is due to two reasons. The first is that some parts of the skeleton have greater durability than others. The durability may depend on the age of the animal, whether a portion of the bone may still be cartilaginous, as well as the histological structure of the skeletal part. The humerus head, for example, has a thin wall of compact bone, whereas its shaft has a thicker more durable wall [2]. The second reason is that different carnivores utilise different parts of the skeleton. The carcass of leopard prey characteristically include the skull and long bones. The skeletal elements of hyaena prey would be almost completely consumed because of the hyaena's outstanding bone crushing capabilities [2].

Table 4.3 is a summary of the skeletal parts represented in the LKC faunal sample. The most represented skeletal part in all the faunal groups was teeth. This is probably due to the high durability of teeth. The various long bones of the fore- and hind-limb was well represented in the bovid, carnivore and rodent groups. The skeletal representation of the primate, equid, suid and hyracoid groups were dominated by tooth specimens.

TABLE 4.3: Skeletal part representation of LKC faunal sample (n).

Skeletal Part	Bovid	Carnivore	Primate	Equid	Suid	Rodent	Hyracoid	Total
Horncore	2	-	-	-	-	-	-	2
Skull Mandible	36	11	-	-	-	13	10	70
Teeth	282	42	7	19	9	24	4	387
Scapula	8	-	-	-	-	5	-	13
Humerus	22	3	-	2	1	6	2	34
Radius	34	-	-	-	-	1	-	35
Ulna	22	1	-	-	-	1	-	24
Pelvis	8	1	-	-	-	2	-	11
Femur	13	2	-	-	-	1	1	17
Tibia, fibula	37	-	-	-	-	4	-	41
Metacarpal	24	-	-	-	-	-	-	24
Metatarsal	32	1	-	-	-	3	-	36
Metapodial	59	2	-	-	-	9	-	70
Carpus	17	-	-	-	-	-	-	17
Tarsus	26	3	-	3	-	-	-	32
Sesamoid	6	-	-	-	-	-	-	6
Proximal phalanx	35	4	-	-	-	2	-	41
Middle phalanx	23	1	-	-	-	-	-	24
Distal phalanx	11	1	-	-	-	-	-	12
Hyoid	1	-	-	-	-	-	-	1
Total	698	72	7	24	10	71	17	896

Bovid analysis are extremely important in the interpretation of predator/prey evidence in accumulations [2]. Leopard and cheetah, for example, characteristically leave the skull and distal limb long bones behind, while hyaena is capable of the crushing and digestion of most skeletal parts.

Figures 4.2, 4.3, 4.4 and 4.5 give a graphic representation of skeletal part survival of the different bovid classes.

FIGURE 4.2: Bovid size class I Percentage skeletal part survival (%)

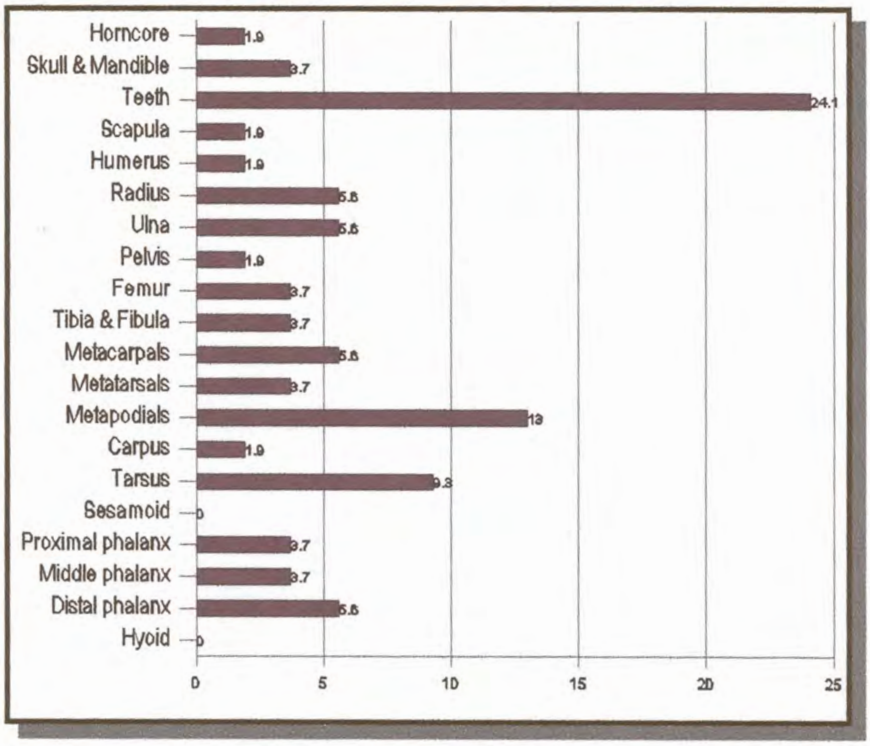


FIGURE 4.3: Bovid size class II Percentage skeletal part survival (%)

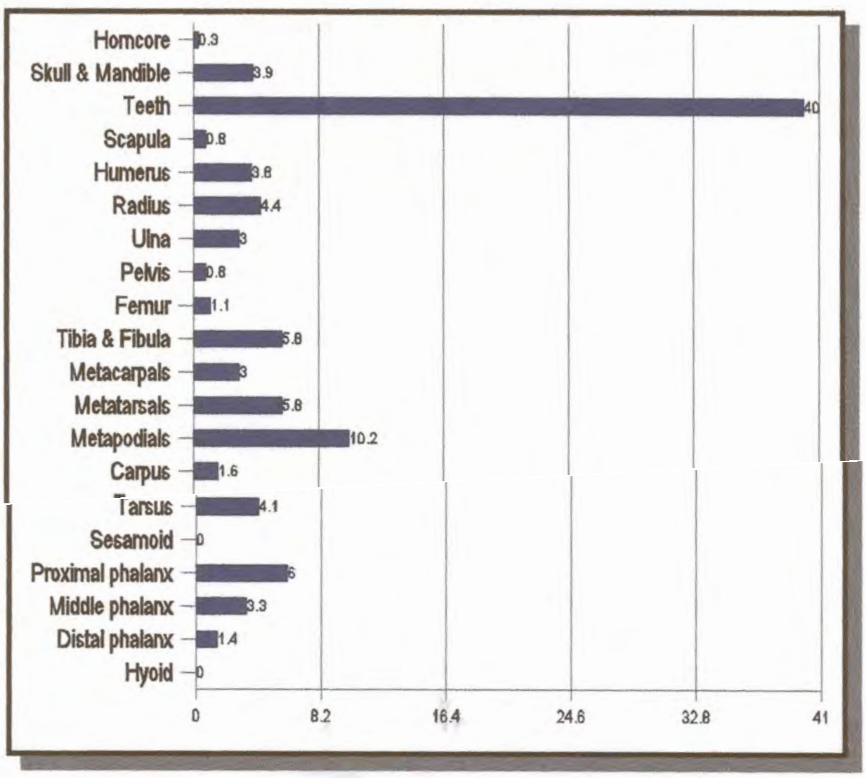


FIGURE 4.4: Bovid size class III Percentage skeletal part survival (%)

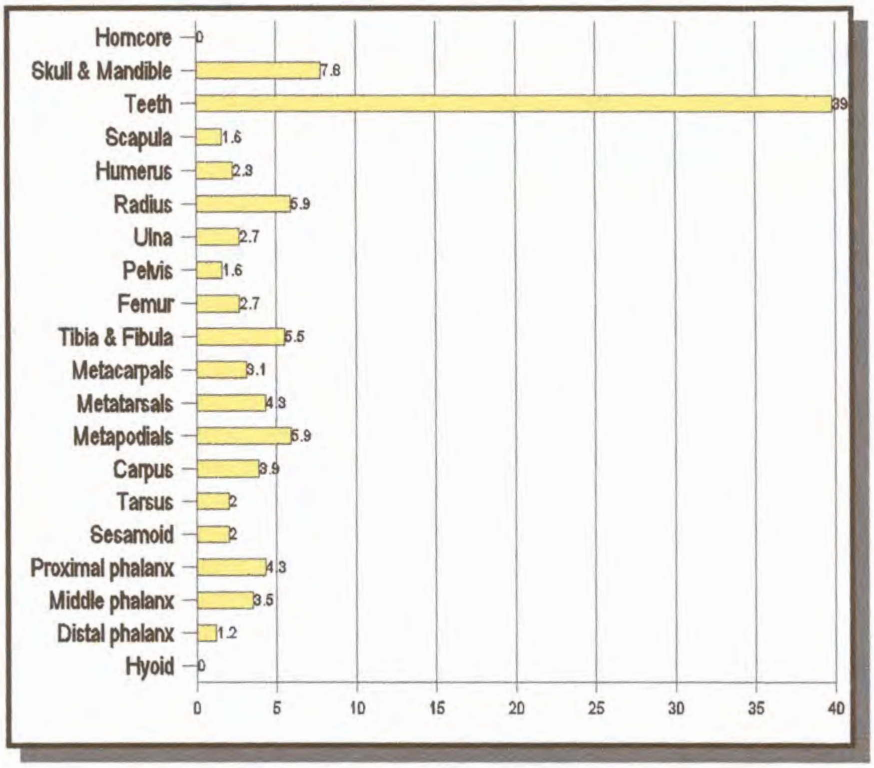
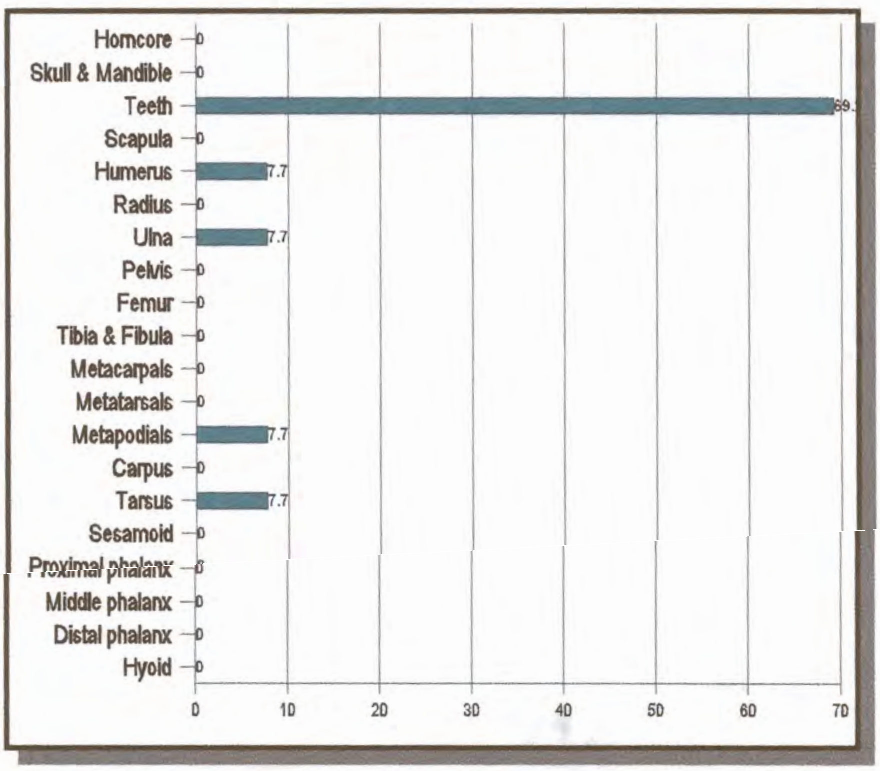


FIGURE 4.5: Bovid size class IV Percentage skeletal part survival (%)



As expected, all the bovid size classes were well represented by tooth fragments, due to its durability. Bov I, Bov II and Bov III showed high percentages of long bone survival. The metapodial specimens dominated the Bov I and Bov II classes, while all long bones were equally represented in the Bov III size class. This representation of the Bov I, II and III size classes may suggest leopard predation. The Bov IV class showed little skeletal representation which may be due to the fact that this size class were not preyed upon.

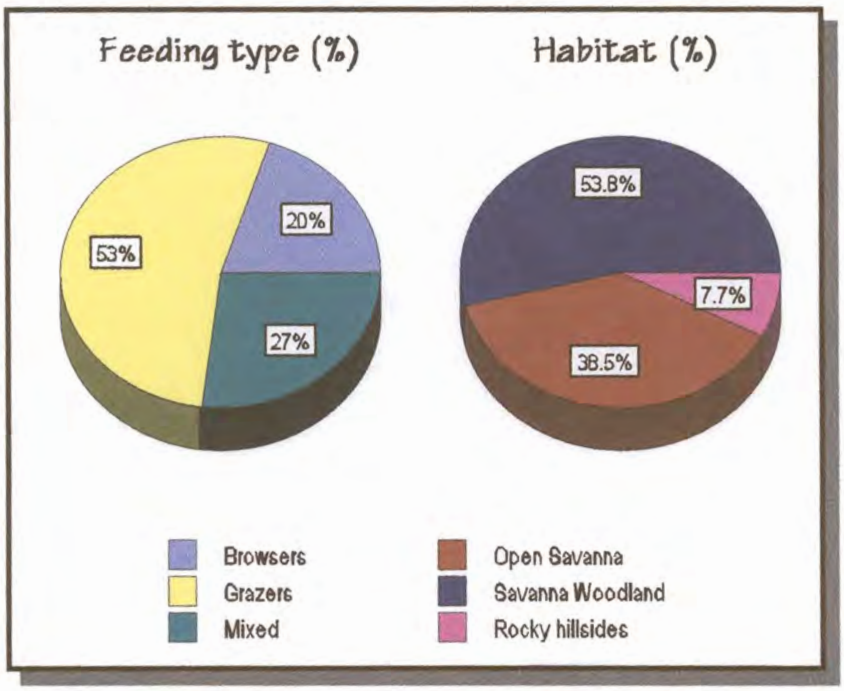
Characteristic features on the bone pieces indicated that the majority of the animals represented in the faunal sample were adult individuals. Very few separate epiphyses were identified and most of the dental specimens were permanent teeth within various stages of wear.

The habitat of any animal needs to meet the requirements of its feeding type. Both these aspects are needed for the survival of the species. The instant external factors, such as the environment and human encroachment, alter the habitat. The species representation of the area will be adjusted accordingly [51].

All extant bovid species fall in three habitat categories. They are 1) Open savanna, 2) Savanna woodlands with water and 3) Rocky hillsides [51]. Their food preference (feeding type) also classify bovids as of three groups namely grazers, browsers and mixed feeders [51].Their habitat and food requirements are inseparable. An open savanna will, for example, attract grazers, while browsers will occupy woodlands and rock hillsides. The habitat and food requirements of the species identified in the faunal sample may give an indication whether the climate and environment of Kemp's Caves have changed during its existence.

Figure 4.6 illustrates the ratio of the bovids represented in LKC according to their natural habitat, as well as the feeding type of the different species. From Figure 4.6 it can be seen that most of the bovids (53%), were grazers, while only 20% were browsers. The habitat of the different bovid species identified, showed that only a small percentage (7.7%) preferred rocky hillsides while the majority of species preferred either open savanna or savanna woodland. The feeding types clearly corresponds with the habitat preferences. The present habitat correlates with that of the species identified which may suggest no drastic change of environment.

FIGURE 4.6: Bovid habitat and feeding type representation (%).



1.3 Non-Identifiable bones

Non-identifiable bone pieces could not be identified to any species or class and were assigned to 5 different categories. These categories include enamel, skull, vertebra, rib, miscellaneous and bone flake fragments. The fragment's condition was noted and the pieces were weighed and documented. Table 4.4 is a summary of the number and weight of the non-identifiable bones recovered in every provenance.

TABLE 4.4: Non Identifiable bones recovered in LKC.

Provenance	Enamel	Skull	Vertebra	Rib	Misc	Bone flake	Total
0E 5N	5	2	-	2	4	45	58
Mass (g)	4.6	1.9	-	0.5	7.1	114.6	128.7
0E 6N	14	1	3	3	5	64	90
Mass (g)	11.3	1.5	6.0	2.7	17.0	216.7	255.2
1E 5N	-	-	-	-	-	2	2
Mass (g)	-	-	-	-	-	10.5	10.5
1E 6N	11	3	2	2	8	55	81
Mass (g)	16.2	3.1	4.4	2.9	13.2	130.6	170.4
2E 3N	-	-	-	2	15	9	26
Mass (g)	-	-	-	1.4	7.5	45.2	54.1
2E 6N	2	2	1	7	3	31	46
Mass (g)	0.7	1.3	72.9	8.8	0.8	96.7	181.2
2E 8N	-	-	-	-	-	3	3
Mass (g)	-	-	-	-	-	66.6	66.6
2E 9N	52	19	13	18	128	181	411
Mass (g)	25.5	20.2	78.2	16.1	103.4	104.1	347.5
3E 4N	-	-	-	-	-	4	4
Mass (g)	-	-	-	-	-	43.2	43.2
3E 5N	5	1	2	3	18	25	54
Mass (g)	3.1	1.3	2.1	3.4	10.5	199.7	220.1
3E 10N	3	-	-	-	-	30	33
Mass (g)	1.5	-	-	-	-	63.5	65.0
5E 8N	3	-	1	-	16	14	34
Mass (g)	2.1	-	70.2	-	34.4	96.1	202.8
5E 9N	16	5	5	4	22	35	87
Mass (g)	24.2	5.0	6.8	2.7	28.6	93.2	160.5
5E 10N	8	-	-	5	20	80	113
Mass (g)	6.2	-	-	5.1	10.2	322.5	344.0
5E 11N	8	-	-	-	27	39	74
Mass (g)	52	-	-	-	143.4	301.3	496.7
6E 10N	12	119	3	3	149	83	369
Mass (g)	8.5	76.1	1.8	17.1	83.1	288.8	475.4
7E 5N	-	-	2	-	41	16	59
Mass (g)	-	-	1.1	-	32.6	139.7	173.4

TABLE 4.4: Continue

7E 9N	15	10	1	-	35	37	98
Mass (g)	11.4	7.8	0.8	-	15.1	92.8	127.9
7E 14N	-	-	-	-	1	2	3
Mass (g)	-	-	-	-	1.3	77.1	78.4
8E 7N	3	3	1	-	15	19	41
Mass (g)	0.7	1.0	1.2	-	9.2	15.3	27.4
11E 5N	3	-	-	-	14	3	20
Mass (g)	6.5	-	-	-	12.0	58.1	76.6
1E 5N / 4E 5N	-	-	-	-	3	24	27
Mass (g)	-	-	-	-	6.8	25.8	32.6
2E 2N / 2E 3N	2	-	-	1	1	10	14
Mass (g)	0.7	-	-	16.9	3.7	18.7	40.0
2E 3N / 2E 4N	7	-	1	4	35	84	131
Mass (g)	26.3	-	1.2	2.6	39.0	255.5	324.6
2E 4N / 2E 5N	18	6	6	5	79	167	281
Mass (g)	12.8	10.1	11.4	9.7	96.5	168.6	309.1
3-6E5N / 3-6E6N	1	-	-	-	11	1	13
Mass (g)	0.5	-	-	-	83.5	85.1	163.1
5E 9N / 5E 10N	1	1	2	-	19	5	28
Mass (g)	0.5	4.4	21.3	-	108.6	109.6	244.4
5E 6E / 9N 10N	47	226	16	5	214	92	600
Mass (g)	27.5	173.4	35.9	7.7	193.8	409.5	847.8
5E 10N / 6E 10N	4	1	1	-	3	-	9
Mass (g)	1.4	0.1	6.3	-	3.7	-	11.5
6E 9N / 6E 10N	46	15	3	11	292	81	448
Mass (g)	30.9	25.3	5.6	16.5	214.3	207.0	499.6
6E 7E / 9N 10N	13	-	5	-	70	30	118
Mass (g)	12.9	-	1.4	-	59.8	62.0	136.1
6E 7E / 10N 11N	-	-	-	-	-	1	1
Mass (g)	-	-	-	-	-	35.4	35.4
6E 7E / 11N 12N	38	-	1	2	204	72	317
Mass (g)	18.0	-	0.4	1.8	425.9	415.0	861.1
8E 7N / 9E 7N	-	-	-	-	5	-	5
Mass (g)	-	-	-	-	3.1	-	3.1
8E 9E / 7N 9N	5	-	1	7	3	17	33

TABLE 4.4: Continue

Mass (g)	4.8	-	6.1	17.4	11.7	32.9	72.9
NE Ex	198	33	5	8	1114	315	1673
Mass (g)	163.1	91.4	8.9	10.2	528.1	1117.0	1918.7
NE Ex / R	5	1	-	-	12	12	30
Mass (g)	3.7	2.6	-	-	10.8	66.7	83.8
NE Ex / S	7	1	5	1	85	39	138
Mass (g)	12.5	3.3	11.8	1.5	66.1	197.6	292.8
NE Ex / T	9	-	3	-	23	35	70
Mass (g)	11.5	-	11.3	-	93.0	277.3	393.1
NE Ex / U	9	2	2	2	72	17	104
Mass (g)	14.3	5.3	2.0	6.1	111.8	113.9	253.4
NE Ex / V	5	-	1	-	31	14	51
Mass (g)	2.0	-	3.8	-	28.2	24.3	58.3
NE Ex / W	2	-	-	-	8	7	17
Mass (g)	1.9	-	-	-	8.3	20.7	30.9
NE Ex / AA	24	-	2	1	82	13	122
Mass (g)	29.3	-	1.1	6.7	61.2	73.5	171.8
NE Ex / AB	9	2	3	-	112	19	145
Mass (g)	11.4	4.1	9.4	-	141.5	82.0	248.4
NE Ex / AC	27	10	19	3	207	101	367
Mass (g)	52.6	20.6	32.2	4.3	351.9	631.7	1093.3
NE Ex / AD	3	-	-	-	-	1	4
Mass (g)	12.3	-	-	-	-	1.2	13.5
NE Ex / AE	31	7	2	3	104	39	186
Mass (g)	13.1	6.8	0.4	3.8	198.0	224.0	446.1
NE Ex / AF	6	5	2	1	84	46	144
Mass (g)	17.1	6.8	7.3	0.4	96.9	228.5	357.0
No Grid	38	9	3	7	154	210	421
Mass (g)	26.1	4.2	4.3	7.0	155.4	861.1	1058.1
Total	715	484	117	108	3544	2184	7152
Total Mass (g)	677.1	475.7	427.6	172.8	3623.9	8206.3	13582.4

Figure 4.7 illustrates the grid areas where the non-identifiable material were recovered from LKC. The green area represents the NE extension of the cave which is mostly composed of specimens transported by water from nearby locations.

FIGURE 4.7: Site map of Kemp's caves indicating excavated areas.

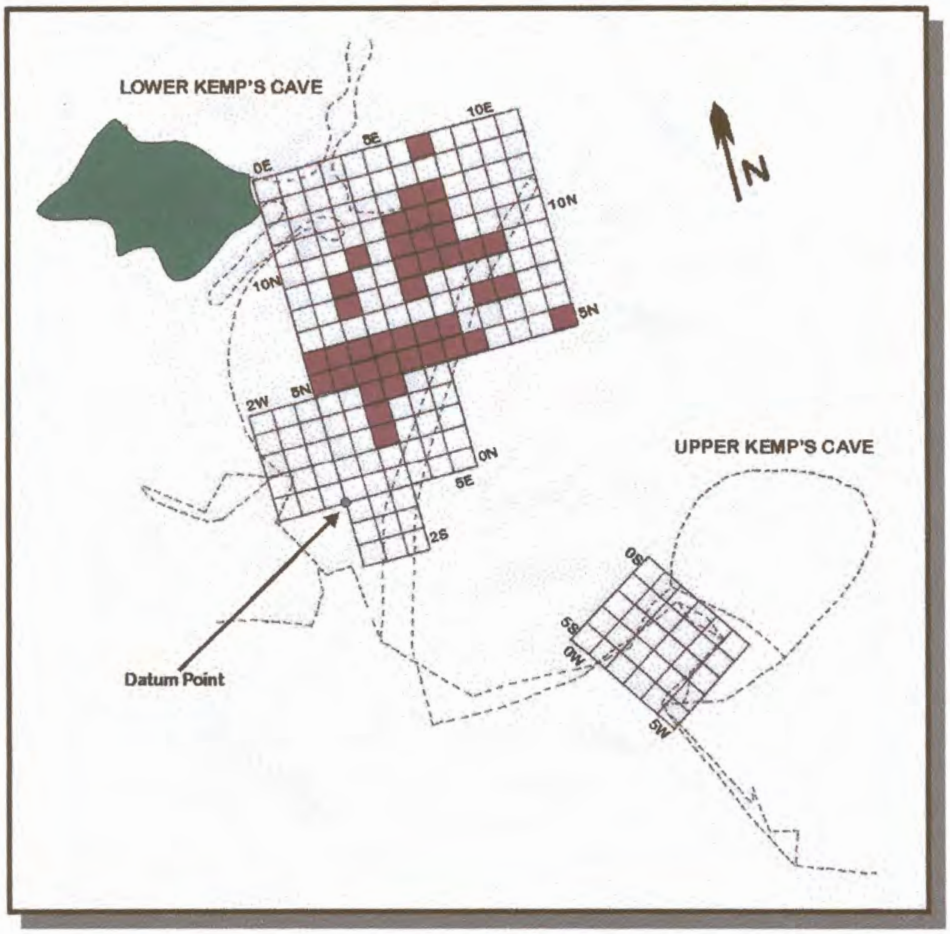
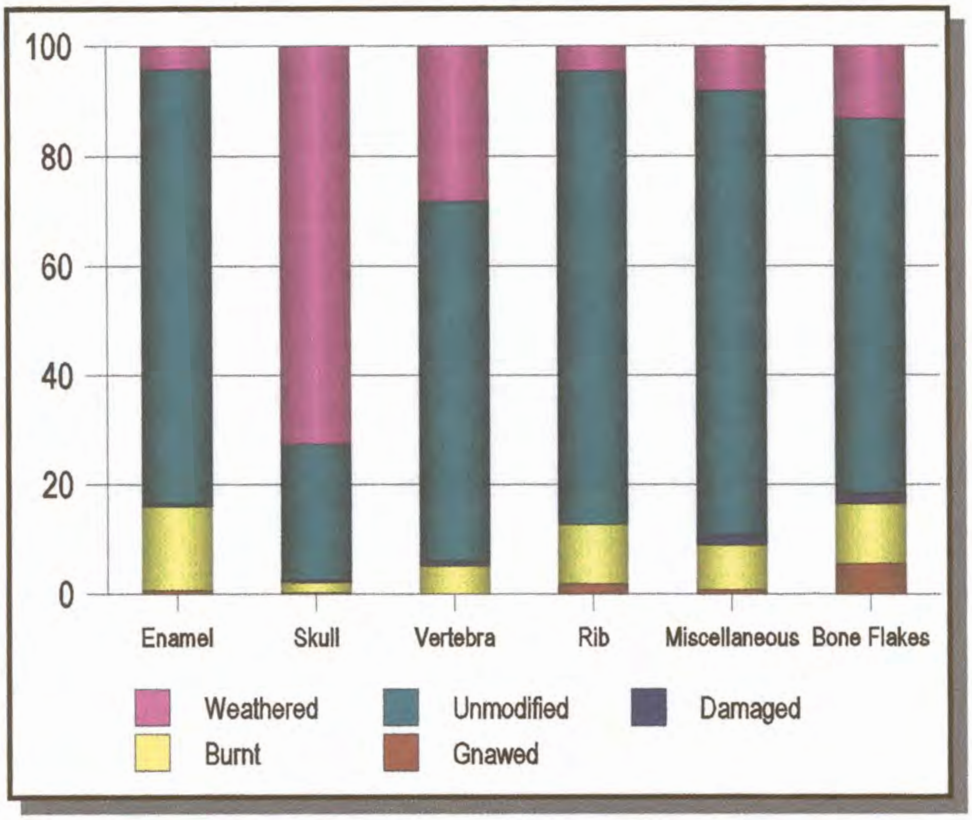


Figure 4.8 illustrates the ratios between the different conditions (damaged, burnt, gnawed, weathered or unmodified) of skeletal parts that were manifested on each non- identifiable fragment. A large amount of skull fragments were weathered. These weathered fragments were mostly from a single grid reference (6E 10N) and may represent only one individual. Most of the fragments, however, were unmodified. Only a small percentage of the fragments was recorded as being gnawed, which included mostly bone flakes. Gnaw marks which could be identified were chiefly the

result of *Hystrix africaeaustralis* (Porcupine) activity, although teeth marks of carnivores were also present. Almost no fragments were damaged. A total of 11% of the fragments were burnt which could indicate human activity. Burnt bone pieces were largely represented by enamel fragments.

FIGURE 4.8: Condition of non-identifiable bone fragments (%).



The provenances, 6E 9N10N and 6E7E 11N12N, contributed most of the bones that exhibited features that might have been related to archaeological damage during excavation or human activity. Most damage marks were not recently made, thus this might also indicate earlier human activity in the history of Kemp's Caves. Two closely related squares, 5E6E 9N10N and 6E 9N10N, accounted for 25% of the total pieces that showed evidence of burning. The NE Extension of the cave accounted for most of the gnawed bones. 5E 11N, 6E 9N10N and 6E7E 11N12N, were the dominant area for weathered specimens.

2. STAGE 2 - OSTEOMETRY

Stage two comprised of the determination and acquisition of the correct measurements of Southern African bovid species which could differentiate between the different species. The femur, tibia and metatarsal were measured. These raw measurements were then used in a data base to develop a computer programme which may assist in osteometric classification of bones.

2.1 Measurements

A total of 45 individual measurements were taken on the long bones of 30 Southern African bovid species. Two types of statistical analysis were performed to ascertain whether significant differences exist between the different species to justify and substantiate the developed computer program. The two statistical designs used were independent t-tests for each size class and measurement value, as well as regression analysis for measurement value analysis. Approximately 18 000 measurement values were recorded and statistically tested.

2.1.1 Inter-Bovid size class comparison

Brain [81] developed a class system to identify Southern African bovid species according to their size. Whenever there is not enough characteristic evidence present on a bovid skeletal specimen to confidently identify the fragment to a specific species, it is noted as belonging to one of the four bovid size classes. This is a relative elementary exercise for a trained eye. Therefore no attempt was made to compare the species of the different size classes with each other. Thus a species from Bovid class IV, for example Eland, was not statistically compared to a species belonging to size class I, for example Klipspringer, because of its obvious nature.

There are obvious size differences between the different bovid size classes, but not within them. Independent t-tests were, therefore, done to compare each species in a Bovid size class to all the other species within the same class. The t- and p- values of one of the species within a bovid size class were compared with the average of the t- and p-values of rest of the species in that group. In the case of Bovid size class IV, only one set of tests were done, as there are only two species within this size class. A separate t-test was done for each measurement taken on the femur, tibia and metatarsal. These t-test results display whether a species' bone measurements differ significantly from that of the other species (within the same bovid size class) combined, to be used in the database for identification purposes. A p-value of ≥ 0.05 was used as indication of significant difference.

Table 4.5 constitutes the key to the abbreviations used for the different species in the tables that follows. Raw measurement values of the three long bones, including their medians, means and standard deviations, can be seen in Appendices A to C. The sample sizes of each species can also be found in these appendices.

TABLE 4.5: Key to abbreviations to species (alphabetical).

Abbreviation	Species	Abbreviation	Species	Abbreviation	Species
BDU	Blue Duiker	BLA	Black Wildebeest	BLE	Blesbuck
BON	Bontebok	B	Buffalo	BUS	Bushbuck
BWI	Blue Wildebeest	CAP	Cape Grysbok	E	Eland
GDU	Grey Duiker	GEM	Gemsbok	GRH	Grey Rhebuck
IMP	Impala	KLI	Klipsringer	KUD	Kudu
LEC	Red Lechwe	MOU	Mountain Reedbuck	NYA	Nyala
ORI	Oribi	RDU	Red Duiker	REE	Reedbuck
RHA	Red Hartebeest	ROA	Roan	SAB	Sable
SIT	Sitatunga	SPR	Springbok	STE	Steenbok
SUN	Suni	TSE	Tsessebe	WAT	Waterbuck

Tables 4.6 to 4.8 provide the t- and p-values of all the bovid species from the different independent t-tests of the femur, tibia and metatarsal respectively. These values represent the average of the specific species in comparison to the average of all the species within the same Bovid size class. In order to better assess how many of the t-tests yielded statistically significant differences, graphic representation of the results were made. Figure 4.9 to 4.11 illustrate the significant values extracted from the results of the t-test of the femur, tibia and metatarsal respectively. Colour coding represents the different size classes. Different symbols specify the different portions of the bone, these being the shaft, proximal or distal measurements.

The Bovid I size class shows no significant differences between the individual measurements on the femur or the tibia. Only a few proximal extremity and shaft measurements, as well as most of the distal extremity measurements of the metatarsal were significantly different between the various species. These results show that there is a greater inter-species difference in the metatarsal than the other two long bones in this Bovid class. Almost all species in the Bovid I group was represented by only a few specimens in the different South African Museums. This may also attribute to the fact that there is little significant differences between species with the femur and tibia measurements.

The metatarsal measurements of Bovid class II displayed more significant differences than those of the femur and tibia, although several of them are significantly different. No pattern can be seen to identify whether one portion of the bone is more meaningful than another for distinguishing between the species. All three elements will therefore play a role in the identification of a Bovid class II species, but the metatarsal may be more accurate. The measurements, F(SBD), T(SBD), T(GDTN) and M(GLL) showed no significant differences in any one of the species. These measurements may therefore not have a positive contribution to osteometric identification.

Bovid III class showed significant differences in most of the measurements. *Damaliscus lunatus* (Tsessebe), however showed almost no significant differences within the Bovid III group. The only measurement expressed as being significantly different to the rest of the species within this group was the T(SDD). This measurement determines the smallest distance from the anterior to posterior points of the distal extremity of the tibia. Only one set of hind limb long bones was available in South Africa, thus no mean, median or standard deviation could be calculated for this species. This may contribute to the fact that there is almost no significant differences between the Tsessebe and the rest of the Bovid III class. A greater sample size of this species might provide positive results. The measurements, F(GBCF) and M(GML) showed little significant difference in the Bovid size class III and may therefore not contribute much to the osteometrical identification process.

Bovid IV shows distinctions in a wide variety of measurements in all three long bones. These tests actually showed the difference between the Eland (*Taurotragus oryx*) and the Buffalo (*Syncerus caffer*). In Figures 4.9 to 4.11 it can clearly be seen which measurements may not be as important in the osteometric analysis.

Species in the Bov I group therefore seem not to differ sufficiently to support osteometric identification and classification on either the femur or tibia, while species in the Bov II, Bov III and Bov IV classes differ substantially in all three bones. The measurement F(GBCF) and F(SBCF) show little significance in all four groups which may suggest that these measurements may not be useful in osteometric analysis.

TABLE 4.6: Bovid size class I - IV: Femur measurement t-test values.

Bovid species		F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GL-GLH)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)
SUN	t	-.25	-.25	-.22	-.23	-.22	-.23	-.22	-.23	-.23	-.23	-.23	-.22	-.22	-.22
	p	.802	.803	.824	.819	.826	.819	.824	.822	.820	.819	.818	.825	.825	.824
BDU	t	-.42	-.42	-.36	-.37	-.36	-.37	-.36	-.36	-.37	-.37	-.37	-.36	-.36	-.36
	p	.675	.678	.719	.710	.721	.711	.719	.717	.713	.711	.709	.722	.722	.718
CAP	t	-.85	-.84	-.86	-.87	-.87	-.87	-.86	-.87	-.87	-.87	-.87	-.86	-.86	-.87
	p	.399	.402	.390	.389	.386	.389	.390	.389	.389	.387	.385	.390	.390	.389
RDU	t	-.53	-.53	-.52	-.52	-.52	-.52	-.52	-.52	-.52	-.52	-.52	-.52	-.52	-.52
	p	.598	.598	.606	.608	.607	.603	.606	.605	.603	.605	.605	.606	.606	.604
KLI	t	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96
	p	.436	.436	.437	.437	.437	.437	.437	.437	.437	.437	.437	.437	.437	.437
STE	t	.81	.81	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83
	p	.420	.421	.408	.411	.406	.408	.409	.409	.408	.409	.408	.407	.408	.408
GDU	t	-.64	-.64	-.68	-.67	-.68	-.67	-.68	-.67	-.67	-.67	-.66	-.68	-.68	-.68
	p	.527	.523	.500	.505	.500	.505	.500	.502	.506	.507	.511	.497	.498	.501
ORI	t	-.32	-.33	-.35	-.34	-.35	-.34	-.35	-.35	-.34	-.34	-.34	-.35	-.35	-.35
	p	.748	.744	.727	.732	.728	.733	.726	.729	.731	.731	.733	.725	.725	.728
SPR	t	-6.25	-5.75	-.92	-5.45	-6.81	-6.23	-3.63	-.96	-5.69	-6.39	-5.91	-1.77	-4.95	-3.01
	p	.000	.000	.357	.000	.000	.000	.000	.000	.000	.000	.000	.080	.000	.004
MOU	t	-2.71	-2.22	-.72	-3.23	-3.77	-12.2	-2.69	-8.41	-6.97	-11.8	-13.0	-.45	-.65	-4.92
	p	.008	.029	.472	.002	.000	.000	.008	.000	.000	.000	.000	.651	.516	.000
GRH	t	-3.44	-3.33	-.53	-3.11	-7.15	-12.1	-2.45	-8.07	-13.9	-9.71	-16.5	-.84	.56	-4.41
	p	.001	.001	.596	.002	.000	.000	.016	.001	.000	.000	.000	.402	.574	.000
BUS	t	.45	.52	-.16	1.02	-.30	-5.08	-.47	-2.25	-1.49	-3.41	-2.29	-.37	1.59	-2.40
	p	.652	.602	.876	.309	.762	.005	.639	.027	.138	.016	.024	.714	.115	.018
BLE	t	.60	-.73	-.11	4.73	2.70	8.08	1.51	4.44	4.57	4.36	8.59	.31	1.26	4.11
	p	.548	.468	.916	.000	.008	.000	.135	.000	.000	.000	.000	.757	.210	.000
BON	t	4.10	3.69	-.20	4.39	2.66	5.66	3.90	8.17	6.59	9.59	8.88	.24	1.35	9.78
	p	.000	.000	.844	.000	.009	.000	.000	.000	.000	.000	.000	.808	.182	.000
IMP	t	4.26	3.42	-.40	1.29	4.06	3.00	-.05	2.16	3.09	2.36	1.10	-.85	-.75	.90
	p	.000	.001	.688	.202	.000	.004	.963	.035	.003	.021	.275	.399	.457	.370
REE	t	4.42	5.54	1.05	-.18	.78	3.05	1.33	1.12	1.47	1.53	.82	1.38	3.97	-1.04
	p	.000	.000	.343	.865	.468	.016	.242	.265	.146	1.29	.416	.226	.000	.299

TABLE 4.6: Continue

LEC	t	-3.08	-1.91	-3.41	-3.12	-2.57	-3.83	-8.73	-3.15	-5.92	-8.17	-3.78	-5.93	-1.78	-3.20
	p	.009	.073	.001	.003	.012	.000	.000	.002	.000	.000	.000	.000	.079	.002
NYA	t	-2.56	-1.83	-4.11	-3.64	-7.99	-5.97	-9.68	-5.60	-12.8	-9.96	-13.3	-3.76	-3.49	-4.03
	p	.012	.071	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000	.003	.000
SIT	t	2.57	1.04	-2.19	-1.96	-2.90	-2.13	-1.63	-1.63	-1.98	-1.75	-2.67	-.39	1.47	-3.14
	p	.013	.304	.031	.054	.005	.037	.107	.106	.051	.085	.009	.698	.146	.002
TSE	t	-.59	-.41	-.42	-.92	-.91	-.71	-.55	-.91	-.97	-.48	-.47	-.72	-1.04	-1.24
	p	.554	.682	.678	.361	.364	.477	.581	.363	.337	.630	.642	.476	.301	.219
RHA	t	-3.07	-1.97	-4.17	-5.41	-4.26	-2.66	-3.05	-3.49	-5.69	-2.81	-3.41	-.25	-2.28	-5.35
	p	.004	.059	.000	.000	.000	.013	.004	.001	.000	.007	.001	.806	.026	.000
KUD	t	5.63	6.48	3.35	3.70	-1.72	1.53	4.63	3.44	4.73	4.43	2.47	5.22	5.76	1.46
	p	.000	.000	.001	.000	.090	.131	.000	.001	.000	.000	.016	.000	.000	.49
BLA	t	-8.16	-9.92	-1.46	-2.01	3.30	-.11	-3.79	-1.84	-.90	-2.42	.28	-.90	-2.12	.76
	p	.000	.000	.148	.048	.002	.914	.000	.069	.370	.018	.777	.369	.040	.449
WAT	t	3.22	6.23	8.81	9.55	3.05	6.36	5.42	9.45	9.18	5.03	5.01	.88	.16	7.42
	p	.002	.000	.000	.000	.013	.000	.000	.000	.000	.000	.000	.383	.875	.000
GEM	t	2.16	1.13	2.26	1.35	2.32	3.94	4.10	1.60	1.63	3.10	3.54	.49	.23	1.86
	p	.049	.276	.041	.181	.023	.003	.003	.113	.142	.008	.003	.628	.817	.066
SAB	t	4.54	4.04	2.52	2.39	.58	3.30	3.69	1.90	5.89	3.91	4.27	1.46	2.28	2.62
	p	.000	.000	.016	.023	.579	.005	.003	.079	.000	.001	.000	.149	.025	.011
BWI	t	2.62	1.22	3.15	7.38	2.17	3.07	4.97	3.11	6.06	5.63	7.32	.38	.44	3.18
	p	.024	.263	.002	.000	.033	.003	.001	.003	.000	.000	.000	.703	.658	.010
ROA	t	2.15	1.60	1.28	1.39	2.71	2.11	1.26	1.41	1.56	1.75	1.84	-.38	-.32	1.50
	p	.034	.113	.204	.169	.008	.038	.212	.163	.123	.084	.070	.705	.752	.137
E/B	t	.62	.33	-4.19	-2.63	1.00	-4.57	-4.66	-4.28	-4.07	-2.94	-2.29	1.43	.55	-2.39
	p	.545	.747	.000	.016	.329	.000	.000	.000	.001	.008	.034	.170	.600	.027

TABLE 4.7: Bovid size class I - IV: Tibia measurement t-test values.

Bovid species		T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
SUN	t	-.20	-.20	-.20	-.16	-.17	-.23	-.23	-.23	-.23	-.28	-.27	-.16	-.16	-.16	-.16
	p	.839	.840	.840	.874	.867	.820	.820	.822	.822	.784	.786	.876	.872	.873	.874
BDU	t	-.38	-.38	-.38	-.26	-.28	-.37	-.37	-.37	-.36	-.45	-.44	-.25	-.26	-.26	-.26
	p	.706	.707	.708	.797	.783	.713	.710	.715	.717	.655	.661	.801	.795	.795	.799
CAP	t	1.02	1.02	1.02	1.00	1.00	.73	.73	.73	.73	.25	.25	1.00	1.00	1.00	1.00
	p	.321	.320	.320	.328	.329	.466	.467	.465	.467	.807	.807	.328	.330	.329	.329
RDU	t	-.43	-.43	-.44	-.36	-.36	-.52	-.52	-.52	-.52	-.64	-.64	-.36	-.36	-.36	-.36
	p	.666	.666	.664	.717	.716	.606	.602	.602	.604	.522	.524	.718	.717	.717	.718
KLI	t	-.20	-.19	-.19	-.19	-.19	.96	.96	.96	.96	.93	.93	-.19	-.19	-.19	-.19
	p	.846	.847	.847	.850	.851	.076	.437	.437	.437	.452	.452	.850	.851	.851	.851
STE	t	-.55	-.55	-.55	-.57	-.58	-.82	-.81	-.81	-.81	.35	.35	-.57	-.57	-.57	-.57
	p	.584	.583	.584	.569	.567	.416	.419	.420	.418	.728	.728	.570	.571	.569	.569
GDU	t	-.41	-.41	-.42	-.47	-.46	-.67	-.67	-.68	-.67	-.83	-.84	-.48	-.47	-.47	-.47
	p	.682	.680	.678	.638	.648	.505	.506	.500	.503	.407	.403	.635	.642	.640	.638
ORI	t	-.18	-.18	-.18	-.24	-.23	-.35	-.34	-.35	-.35	-.43	-.43	-.25	-.24	-.24	-.25
	p	.855	.854	.854	.808	.816	.730	.732	.729	.728	.670	.666	.806	.811	.809	.807
SPR	t	-1.92	-4.14	-4.08	-.80	-3.33	-6.51	-3.27	-1.41	-6.29	-3.80	-1.20	-1.90	-2.65	-9.17	-9.21
	p	.058	.000	.000	.426	.001	.000	.001	.162	.000	.000	.234	.060	.009	.000	.000
MOU	t	-1.50	-2.87	-2.77	-.53	-3.58	-8.72	-9.40	-2.84	-15.4	-3.25	-.49	-1.12	-2.98	-7.96	-5.29
	p	.138	.005	.007	.596	.001	.000	.000	.006	.000	.002	.624	.263	.004	.000	.000
GRH	t	-1.45	-2.65	-2.67	-.48	-2.40	-11.1	-2.70	-2.05	-2.79	-1.44	.05	-1.48	-2.90	-12.1	-5.31
	p	.150	.009	.009	.631	.018	.000	.008	.043	.006	.153	.963	.143	.005	.000	.001
BUS	t	-1.29	-2.59	-2.61	-.20	-.50	-1.76	-1.31	-1.23	-8.49	-1.54	-1.01	-.30	-1.43	-1.90	1.43
	p	.199	.011	.011	.838	.619	.081	.192	.222	.000	.126	.314	.763	.155	.101	.199
BLE	t	.03	-1.41	-1.84	-.28	1.85	5.46	.41	-1.01	3.73	1.30	-.73	1.48	2.70	7.07	4.34
	p	.979	.165	.071	.780	.074	.000	.687	.315	.001	.198	.468	.142	.008	.000	.000
BON	t	2.38	3.70	3.68	-.45	4.61	6.54	1.26	.81	6.27	1.84	-1.39	-1.96	3.70	8.26	4.46
	p	.019	.000	.000	.650	.000	.000	.212	.417	.000	.069	.167	.052	.000	.000	.000
IMP	t	2.12	5.22	5.34	-.18	3.11	2.37	4.84	3.24	2.74	4.95	.98	.92	1.89	.53	2.06
	p	.037	.000	.000	.857	.002	.021	.000	.002	.009	.000	.328	.359	.062	.601	.046
REE	t	-.21	5.37	11.53	1.04	-.40	3.39	4.31	1.98	5.12	.58	1.68	2.24	-.06	2.67	3.30
	p	.841	.000	.000	.348	.707	.001	.000	.103	.000	.589	.154	.075	.954	.009	.001

TABLE 4.7: Continue

LEC	t	-2.73	-1.99	-2.32	-7.94	-2.88	-8.28	-2.49	-2.12	-2.98	-2.44	-2.13	-1.79	-10.9	-8.66	-1.92
	p	.013	.061	.032	.000	.005	.000	.015	.038	.004	.017	.071	.077	.000	.000	.059
NYA	t	-2.41	-2.17	-2.19	-3.20	-8.16	-4.53	-3.41	-5.28	-3.54	-3.45	-.32	-4.48	-10.4	-9.82	-1.95
	p	.018	.033	.031	.002	.000	.000	.001	.000	.001	.001	.747	.001	.000	.000	.055
SIT	t	1.50	1.66	1.69	-2.76	-2.16	-2.10	-.83	-1.84	-1.49	-.85	1.50	.42	-13.2	-1.37	-1.26
	p	.138	.100	.094	.007	.034	.039	.409	.070	.141	.397	.138	.678	.000	.176	.211
TSE	t	-.14	-.09	-.10	-.68	-.48	-.80	-.78	-.31	-1.15	-.75	-.67	-.85	-.59	-.75	-5.80
	p	.889	.928	.924	.497	.632	.426	.437	.758	.254	.453	.503	.399	.556	.457	.000
RHA	t	-.64	-.59	-.57	-2.96	-2.79	-4.61	-3.32	-1.66	-2.97	-4.55	-1.81	-3.43	-2.50	-1.63	-3.12
	p	.528	.563	.572	.007	.008	.000	.002	.109	.005	.000	.084	.001	.016	.118	.003
KUD	t	5.33	5.46	5.15	3.25	3.46	4.79	5.27	1.89	.38	5.74	6.92	6.78	3.97	5.81	5.27
	p	.000	.000	.000	.002	.001	.000	.000	.063	.708	.000	.000	.000	.000	.000	.000
BLA	t	-7.54	-7.82	-5.25	-2.89	-4.06	-1.01	-4.19	-1.90	.85	-2.18	-4.62	-3.59	-2.57	-3.59	-3.44
	p	.000	.000	.000	.005	.000	.314	.000	.062	.397	.033	.000	.001	.02	.001	.001
WAT	t	2.49	2.53	2.19	5.37	6.74	2.39	9.70	4.59	2.35	3.42	7.50	1.95	7.07	2.19	2.56
	p	.015	.013	.031	.000	.000	.019	.000	.000	.022	.001	.000	.054	.000	.032	.013
GEM	t	-.40	-.65	-.83	1.90	2.08	1.77	.08	.46	-.74	-.89	-2.03	.28	2.98	1.39	.84
	p	.692	.521	.413	.087	.067	.081	.937	.646	.459	.378	.046	.781	.016	.192	.403
SAB	t	1.06	.97	.78	4.48	4.98	4.36	3.05	3.84	2.78	1.82	-.06	1.10	3.08	5.12	1.40
	p	.297	.339	.440	.000	.000	.000	.007	.001	.007	.088	.956	.275	.010	.000	.165
BWI	t	1.27	1.12	1.18	8.53	2.77	5.40	3.13	1.71	2.38	1.20	.21	-.31	4.31	2.80	1.28
	p	.209	.267	.240	.000	.007	.000	.013	.091	.020	.235	.831	.763	.001	.023	.205
ROA	t	2.13	1.93	1.84	2.69	2.14	1.96	1.34	1.37	1.23	1.27	-.62	1.80	2.02	8.02	.79
	p	.037	.057	.069	.009	.036	.054	.186	.175	.221	.208	.538	.075	.047	.000	.431
E/B	t	1.74	2.25	2.58	-2.83	-3.08	-2.95	-2.70	-1.88	-4.17	-1.11	-1.09	-1.73	-4.60	-3.45	-4.66
	p	.096	.035	.018	.010	.006	.008	.014	.073	.003	.279	.311	.097	.000	.002	.000

TABLE 4.8: Bovid size class I - IV Metatarsal measurement t-test values.

Bovid species		M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
SUN	t	-.19	-.19	-.19	-2.56	-3.29	-3.38	-2.47	-.16	-.16	-.16	-.16	-3.82	-3.41	-3.61	-3.39	-.16
	p	.851	.852	.852	.012	.001	.001	.016	.874	.875	.875	.875	.000	.001	.001	.001	.875
BDU	t	-97	.97	-97	-7.04	-9.03	-24.8	-19.8	1.00	1.00	1.00	1.00	-9.03	-8.26	-9.39	-8.82	-.26
	p	.385	.385	.385	.000	.000	.000	.000	.375	.374	.375	.374	.000	.000	.000	.000	.799
CAP	t	-.63	-.63	-.63	-1.46	-.55	-2.02	-3.88	-.61	-.61	-.61	-.61	-.49	-.59	-.26	-1.78	-.61
	p	.533	.532	.531	.148	.584	.047	.000	.544	.546	.542	.546	.623	.560	.795	.079	.546
RDU	t	-.43	-.43	-.43	-.86	-.90	-.94	-4.59	-.36	-.36	-.36	-.36	-.217	-7.56	-2.12	-1.01	1.00
	p	.667	.667	.668	.393	.371	.355	.000	.718	.717	.718	.718	.033	.000	.037	.314	.344
KLI	t	-.21	-.21	-.21	1.17	1.79	.99	.45	-.19	-.19	-.19	-.19	1.73	2.07	1.10	1.73	-.19
	p	.837	.836	.836	.244	.076	.325	.655	.850	.850	.851	.850	.087	.041	.277	.087	.851
STE	t	-.56	-.56	-.56	-1.68	-.68	-1.77	.00	-.57	-.57	-.57	-.57	2.56	2.08	2.56	2.41	-.57
	p	.579	.580	.580	.098	.495	.081	.998	.569	.569	.569	.568	.012	.041	.012	.018	.571
GDU	t	-.38	-.38	-.38	5.73	4.12	12.83	12.67	-.47	-.48	-.47	-.47	4.85	6.43	5.09	5.56	-.48
	p	.707	.707	.707	.000	.000	.000	.000	.639	.636	.640	.637	.000	.000	.000	.000	.634
ORI	t	-.19	-.20	-.19	3.10	3.00	3.32	12.92	-.24	-.25	-.25	-.25	3.57	3.65	3.29	2.61	-.24
	p	.847	.845	.846	.003	.004	.001	.000	.808	.806	.806	.805	.001	.000	.001	.001	.807
SPR	t	2.49	3.05	-.30	-5.37	-7.19	-4.54	-1.97	-3.82	-4.43	-5.94	-7.24	-6.62	-2.44	-7.23	-7.07	-5.65
	p	.014	.003	.763	.000	.000	.000	.052	.000	.000	.000	.000	.000	.017	.000	.000	.000
MOU	t	-3.39	-13.7	-.60	-2.18	-8.36	-4.05	-15.8	-12.4	-7.24	-7.67	-3.89	-8.79	-4.31	-7.55	-10.5	-5.03
	p	.001	.000	.551	.032	.000	.000	.000	.000	.000	.000	.003	.000	.000	.000	.000	.000
GRH	t	-2.30	-3.69	-.44	-4.79	-9.43	-4.16	-20.8	-20.1	-9.90	-3.7	-6.31	-14.2	-3.76	-12.2	-15.7	-15.9
	p	.024	.000	.661	.000	.000	.000	.000	.000	.000	.000	.001	.000	.000	.000	.000	.000
BUS	t	-3.69	-5.82	-.56	.54	-1.53	-6.20	-3.67	-3.3	-5.29	-1.33	-4.48	-8.11	-5.29	-8.09	-9.14	-3.88
	p	.000	.000	.580	.590	.129	.001	.000	.001	.007	.187	.010	.001	.000	.001	.000	.000
BLE	t	-.22	-1.27	.98	3.60	1.90	4.12	3.05	5.57	5.03	5.79	3.51	6.11	1.27	6.15	5.29	8.33
	p	.826	.207	.346	.002	.070	.000	.004	.000	.000	.000	.002	.000	.212	.000	.000	.000
BON	t	1.05	.44	-.62	3.40	6.52	7.49	6.64	8.62	11.93	5.57	10.17	11.68	4.94	11.33	11.71	8.54
	p	.297	.664	.536	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
IMP	t	6.49	8.18	-.19	2.09	4.24	1.89	3.44	.51	-5.04	2.79	-3.39	-.84	5.89	-.44	-.62	-1.50
	p	.000	.000	.850	.039	.000	.067	.001	.612	.000	.007	.001	.404	.000	.662	.535	.142
REE	t	-.64	1.28	-.14	2.42	2.19	1.87	1.57	1.54	2.10	2.44	3.34	1.76	1.70	2.39	2.21	2.35
	p	.548	.204	.887	.017	.031	.064	.119	.127	.089	.017	.001	.131	.092	.052	.071	.056

TABLE 4.8: Continue

LEC	t	-5.60	-1.63	-5.63	-6.56	-5.32	-4.86	-11.7	-3.06	-7.95	-4.07	-1.80	-2.26	-7.78	-1.37	-1.34	-2.04
	p	.000	.177	.000	.000	.001	.000	.000	.003	.000	.000	.077	.027	.000	.175	.186	.045
NYA	t	-1.90	-1.16	-1.76	-7.79	-4.64	-4.32	-4.23	-8.59	-10.9	-4.36	-12.8	-8.43	-10.3	-19.0	-7.97	-18.1
	p	.061	.251	.082	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SIT	t	-.16	.02	-.09	-3.90	-7.65	-1.30	-1.78	-1.62	-1.73	-1.82	-1.97	-1.66	-1.84	-1.93	-1.63	-2.15
	p	.873	.981	.925	.000	.000	.196	.080	.109	.087	.073	.053	.101	.070	.057	.106	.035
TSE	t	.46	.40	.47	-.72	-.82	-.33	-.07	-.5	-.26	-.40	-.90	-.08	.04	-.36	-.43	.25
	p	.645	.691	.639	.475	.412	.739	.945	.617	.797	.389	.370	.936	.972	.719	.671	.806
RHA	t	1.71	.77	1.76	-3.98	-3.90	-3.63	-2.79	-2.28	-2.06	-.91	-.73	-.68	-1.34	-1.03	-1.21	1.07
	p	.092	.445	.084	.000	.001	.001	.007	.029	.051	.370	.466	.499	.188	.308	.234	.289
KUD	t	5.42	4.22	5.42	3.16	2.44	2.34	3.34	2.27	1.81	2.82	2.43	-.12	2.35	-.06	.13	-1.62
	p	.000	.000	.000	.002	.017	.022	.001	.026	.074	.006	.018	.906	.022	.956	.896	.119
BLA	t	.06	.40	.05	-.41	-.42	.72	1.51	.00	-.19	.83	.29	-.96	-.05	-1.18	-1.41	-.78
	p	.949	.694	.960	.681	.673	.471	.136	.998	.851	.410	.774	.343	.960	.242	.163	.436
WAT	t	-3.51	-.88	-3.81	6.20	10.30	6.01	2.10	4.31	3.50	-.01	1.97	8.09	6.39	4.02	8.33	6.66
	p	.001	.381	.000	.000	.000	.000	.039	.000	.003	.991	.052	.000	.000	.000	.000	.000
GEM	t	-.66	-.39	-.69	1.71	1.22	1.58	-.10	.40	1.61	1.20	1.01	1.77	.69	1.49	1.69	2.14
	p	.509	.700	.494	.105	.255	.119	.923	.694	.112	.232	.314	.082	.495	.142	.096	.036
SAB	t	-3.40	-.75	-3.60	3.49	3.32	1.29	.20	1.22	3.38	2.39	1.25	2.01	2.33	1.77	1.93	5.44
	p	.001	.457	.001	.001	.002	.204	.846	.226	.002	.039	.215	.048	.027	.081	.057	.000
BWI	t	-.01	.10	-.02	.12	3.31	1.93	1.64	1.20	2.13	4.32	2.43	2.00	3.50	1.93	2.05	2.15
	p	.991	.924	.986	.907	.021	.057	.106	.235	.036	.001	.028	.049	.003	.058	.044	.035
ROA	t	.70	.59	.66	2.04	1.61	1.22	.70	1.38	2.21	1.67	.11	2.54	1.74	2.37	2.55	2.31
	p	.483	.557	.513	.045	.111	.225	.484	.171	.030	.099	.909	.013	.086	.020	.013	.024
E/B	t	10.51	13.33	13.45	-3.72	-4.69	-4.85	-1.34	-4.16	-2.18	-2.35	-1.50	-7.30	-4.26	-6.89	-6.81	-7.80
	p	.000	.000	.000	.001	.000	.000	.195	.001	.043	.030	.150	.000	.000	.000	.000	.000

FIGURE 4.9: Bovid size class I - IV: Femur measurement significance.
(All the dots, squares and asterisks indicate significant differences)

Bovid species	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GL-GLH)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)
SUN														
BDU														
CAP														
RDU														
KLI														
STE														
GDU														
ORI														
SPR	■	■		■	■	✱	✱	✱	●	●	●	●	●	●
MOU	■	■		■	■	✱	✱	✱	●	●				●
GRH	■	■		■	■	✱	✱	✱	●	●	●			●
BUS						✱		✱		●	●			●
BLE				■	■	✱		✱	●	●	●			●
BON	■	■		■	■	✱	✱	✱	●	●	●			●
IMP	■	■			■	✱		✱	●	●				
REE	■	■				✱							●	
LEC	■	■	■	■	■	✱	✱	✱	●	●	●	●	●	●
NYA	■	■	■	■	■	✱	✱	✱	●	●	●	●	●	●
SIT	■		■	■	■	✱			●	●	●			●
TSE														
RHA	■	■	■	■	■	✱	✱	✱	●	●	●		●	●
KUD	■	■	■	■	■		✱	✱	●	●	●	●	●	
BLA	■	■		■	■		✱	✱		●			●	
WAT	■	■	■	■	■	✱	✱	✱	●	●	●			●
GEM	■		■		■	✱	✱			●	●			●
SAB	■	■	■	■		✱	✱	✱	●	●	●		●	●
BWI	■		■	■	■	✱	✱	✱	●	●	●			●
ROA	■				■	✱				●	●			
E/B			■	■		✱	✱	✱	●	●	●			●

Symbols indicating significance:
- ■ = Shaft measurements of femur
- ✱ = Proximal extremity measurements of femur
- ● = Distal extremity measurements of femur

Bovid size class indications:
- Blue = Bovid size class II
- Pink = Bovid size class III
- Green = Bovid size class IV

FIGURE 4.10: Bovid size class I - IV: Tibia measurement significance.
(All the dots, squares and asterisks indicate significant differences)

Bovid species	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
SUN															
BDU															
CAP															
RDU															
KLI															
STE															
GDU															
ORI															
SPR	■	■	■		■	✱	✱		✱	✱		✱	●	●	●
MOU		■	■		■	✱	✱	✱	✱	✱			●	●	●
GRH		■	■		■	✱	✱	✱	✱				●	●	●
BUS		■	■			✱			✱					●	
BLE			■		■	✱			✱				●	●	●
BON	■	■	■		■	✱			✱	✱		✱	●	●	●
IMP	■	■	■		■	✱	✱	✱	✱	✱			●		●
REE		■	■			✱	✱		✱			✱		●	●
LEC	■	■	■	■	■	✱	✱	✱	✱	✱	✱	✱	●	●	●
NYA	■	■	■	■	■	✱	✱	✱	✱	✱		✱	●	●	●
SIT		■	■	■	■	✱		✱					●		
TSE															●
RHA				■	■	✱	✱		✱	✱	✱	✱	●		●
KUD	■	■	■	■	■	✱	✱	✱		✱	✱	✱	●	●	●
BLA	■	■	■	■	■		✱	✱		✱	✱	✱	●	●	●
WAT	■	■	■	■	■	✱	✱	✱	✱	✱	✱	✱	●		●
GEM				■	■	✱					✱		●		
SAB				■	■	✱	✱	✱	✱	✱			●	●	
BWI				■	■	✱	✱	✱	✱				●	●	
ROA	■	■	■	■		✱					✱	✱			●
E/B	■	■	■	■	■	✱	✱	✱	✱			✱	●	●	●

Symbols indicating significance:

- ■ = Shaft measurements of femur
- ✱ = Proximal extremity measurements of femur
- ● = Distal extremity measurements of femur

Bovid size class indications:

- Blue = Bovid size class II
- Pink = Bovid size class III
- Green = Bovid size class IV

FIGURE 4.11: Bovid size class I - IV: Metatarsal measurement significance.
(All the dots, squares and asterisks indicate significant differences)

Bovid species	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
SUN				■	■	✱	✱					●	●	●	●	
BDU				■	■	✱	✱					●	●	●	●	
CAP						✱	✱								●	
RDU							✱					●	●	●		
KLI					■							●	●		●	
STE				■		✱						●	●	●	●	
GDU				■	■	✱	✱					●	●	●	●	
ORI				■	■	✱	✱					●	●	●	●	
SPR	■	■		■	■	✱	✱	✱	✱	✱	✱	●	●	●	●	●
MOU	■	■		■	■	✱	✱	✱	✱	✱	✱	●	●	●	●	●
GRH	■	■		■	■	✱	✱	✱	✱	✱	✱	●	●	●	●	●
BUS	■	■				✱	✱	✱	✱		✱	●	●	●	●	●
BLE				■	■	✱	✱	✱	✱	✱	✱	●		●	●	●
BON				■	■	✱	✱	✱	✱	✱	✱	●	●	●	●	●
IMP	■	■		■	■	✱	✱		✱	✱	✱		●			
REE				■	■	✱			✱	✱	✱		●	●	●	●
LEC	■		■	■	■	✱	✱	✱	✱	✱	✱	●	●			●
NYA	■		■	■	■	✱	✱	✱	✱	✱	✱	●	●	●	●	●
SIT				■	■		✱		✱	✱	✱		●	●		●
TSE																
RHA	■		■	■	■	✱	✱	✱	✱							
KUD	■	■	■	■	■	✱	✱	✱	✱	✱	✱		●			
BLA																
WAT	■		■	■	■	✱	✱	✱	✱		✱	●	●	●	●	●
GEM												●			●	●
SAB	■		■	■	■				✱	✱		●	●	●	●	●
BWI					■	✱			✱	✱	✱	●	●	●	●	●
ROA				■	■				✱	✱		●	●	●	●	●
E/B	■	■	■	■	■	✱		✱	✱	✱		●	●	●	●	●

Symbols indicating significance:
- ■ = Shaft measurements of femur
- ✱ = Proximal extremity measurements of femur
- ● = Distal extremity measurements of femur

Bovid size class indications:
- Yellow = Bovid size class I
- Blue = Bovid size class II
- Pink = Bovid size class III
- Green = Bovid size class IV

2.1.2 Regression analysis

Regression analysis was done separately on each size class to ascertain which measurements were predictors in the model. A step-wise analysis was done by entering the different measurement values of either the femur, tibia or metatarsal of all the species in a certain Bovid group into the statistical programme, Sigmastat. The programme then determined which measurements were predictors. It therefore calculates which measurements significantly differs between the species of a specific Bovid group.

In Table 4.9 the predictors in each size category are shown for each bone.

The Bovid I group test excluded almost all femur and tibia measurements except F(GL-GLH), T(GL), T(GDP) and T(GDT) and indicated that the metatarsal was most vital when differentiating species within this size group. This correlates with the results of the individual t-tests, which showed that only the metatarsal measurements of the species within the Bovid I group show significant differences.

Most of the femur, tibia and metatarsal measurements of both Bovid groups II and III appeared to be predictors, which also correlates with the t-test analysis. No specific bone, or part of bone seems to be more important osteometricaly than the other.

The regression analysis of the species in the Bovid IV group which indicates the osteometric differences between Eland and Buffalo, showed various measurements as predictors, but specifically excluded the distal tibial measurements. These results suggest that there might be no difference in the measurements, taken in this study, on the distal tibia of these two species. These measurements may therefore not be useful in an osteometric analysis.

TABLE 4.9: Bovid size class I - IV: Measurement predictors.

SIZE	FEMUR MEASUREMENTS			TIBIA MEASUREMENTS			METATARSAL MEASUREMENTS		
	Shaft	Proximal	Distal	Shaft	Proximal	Distal	Shaft	Proximal	Distal
I	F(GL-GLH)			T(GL)	T(GDP) T(GDT)		M(GL) M(SBD) M(SCD)	M(GBP) M(GDP)	M(GBD) M(GDD) M(GBMC) M(GBLC) M(GBDE)
II	F(GLH) F(SBD) F(SCD) F(GL-GLH)	F(GBP) F(GDH) F(GBH)	F(GBD) F(GLDD) F(GMDD) F(GBCF) F(SBCF) F(GBT)	T(GL) T(GML) T(GLL) T(SBD) T(SCD)	T(GBP) T(GDP) T(GDLC) T(GDMC) T(GDT) T(GDTN) T(SBIE)	T(GBD) T(GDD) T(SDD)	M(GL) M(GML) M(GLL) M(SBD) M(SCD)	M(GBP) M(GDP) M(GLMA) M(GBMA) M(GLLA) M(GBLA)	M(GBD) M(GDD) M(GBMC) M(GBLC) M(GBDE)
III	F(GLH) F(SBD) F(SCD) F(GL-GLH)	F(GBP) F(GDH) F(GBH)	F(GBD) F(GLDD) F(GMDD) F(GBCF) F(SBCF) F(GBT)	T(GL) T(GML) T(GLL) T(SBD) T(SCD)	T(GBP) T(GDP) T(GDLC) T(GDMC) T(GDT) T(GDTN) T(SBIE)	T(GBD) T(GDD) T(SDD)	M(GL) M(GML) M(GLL) M(SBD) M(SCD)	M(GBP) M(GDP) M(GLMA) M(GBMA) M(GLLA) M(GBLA)	M(GBD) M(GDD) M(GBMC) M(GBLC) M(GBDE)
IV	F(SBD) F(GL-GLH)	F(GBH)	F(GBCF) F(SBCF) F(GBT)	T(GL)	T(GDP) T(GDLC) T(GDTN) T(SBIE)		M(GLL) M(SBD)	M(GDP) M(GBMA)	M(GDD) M(GBDE)

2.1.3 Index calculation and analysis

Three indices were calculated to ascertain the degree of robusticity of the three hind limb long bones. In each instance the index was calculated as follows for the femur, tibia and metatarsal respectively:

Smallest circumference of shaft (SCD) / Greatest length (GL) X 100

Figures 4.12 to 4.14 give an indication of the minimum and maximum values of the indices of each bone for every bovid species measured. Figure 4.12 shows the overlapping of the femur index values for the different Bovid groups. The Bovid I group shows overlapping of all species. This correlates with the t-tests that showed no significant differences between the individual measurements used to calculate this index. The species in the Bovid II class also show large areas of overlap. The Mountain Reedbuck (*Redunca fulvorufula*) and Bontebok (*Damaliscus dorcas dorcas*) species respectively have the lowest and highest index values. At the Bovid III group level there is a visible difference between the values. The robusticity index of the Sitatunga (*Tragelaphus spekei*) shows no overlap with the species within this Bovid III group. If the Bovid class of a specimen measured is known, the femur index of the Sitatunga might be usable in identification. The sample size of Sitatunga, was however, very small and a larger sample might adjust these result. Bov IV shows no overlapping, thus indicating that there will be a clear distinction between the Eland (*Taurotragus oryx*) and Buffalo (*Syncerus caffer*) species on the femur index values. Therefore it would be possible to identify these two species purely on their robusticity indices.

The same tendency is seen in Figure 4.13 which shows the tibia indices. The close overlap of the tibial robusticity values between Bov I and Bov II, may render these values unusable for identification purposes. Bov III shows overlapping values within the group, but may be used to distinguish a specimen from Bov I and Bov II, with the exception of Nyala (*Tragelaphus angasii*) and Lechwe (*Kobus leche*). Again the Sitatunga shows no overlap within its Bovid group, thus the tibial indices may also assist in identifying tibial remains of this species. Bov IV shows little overlap, again being useful with identification.

Figure 4.14 shows overlapping of the metatarsal robusticity indices between all Bovid size groups, including the Eland species of Bovid IV. The Waterbuck (*Kobus ellipsiprymnus*) shows no overlap within the Bovid III group it belongs to. If the Bovid group of the specimen measured is known, it would be possible to identify a Waterbuck according to its meatarsal robusticity value. The Springbok (*Antidorcas marsupialis*) and Buffalo (*Syncerus caffer*), however, show no overlap with any of the other species. The Springbok have the lowest robusticity value, which indicates a thin, long metatarsal. The Buffalo has the highest value indicating a thick, short metatarsal. Thus, the metatarsals of these two species can be identified simply according to their metatarsal index values.

The Buffalo (*Syncerus caffer*) species interestingly enough, show almost no overlap with any other species. This indicates that the buffalo hind limb long bones are extremely robust, therefore short and thick. All three index values can therefore be used in osteometrical identification because of its distinguishable robustcity indices. All separate index values are available from the author.

FIGURE 4.12: Bovid size class I - IV: Minimum and maximum index values for the femur.

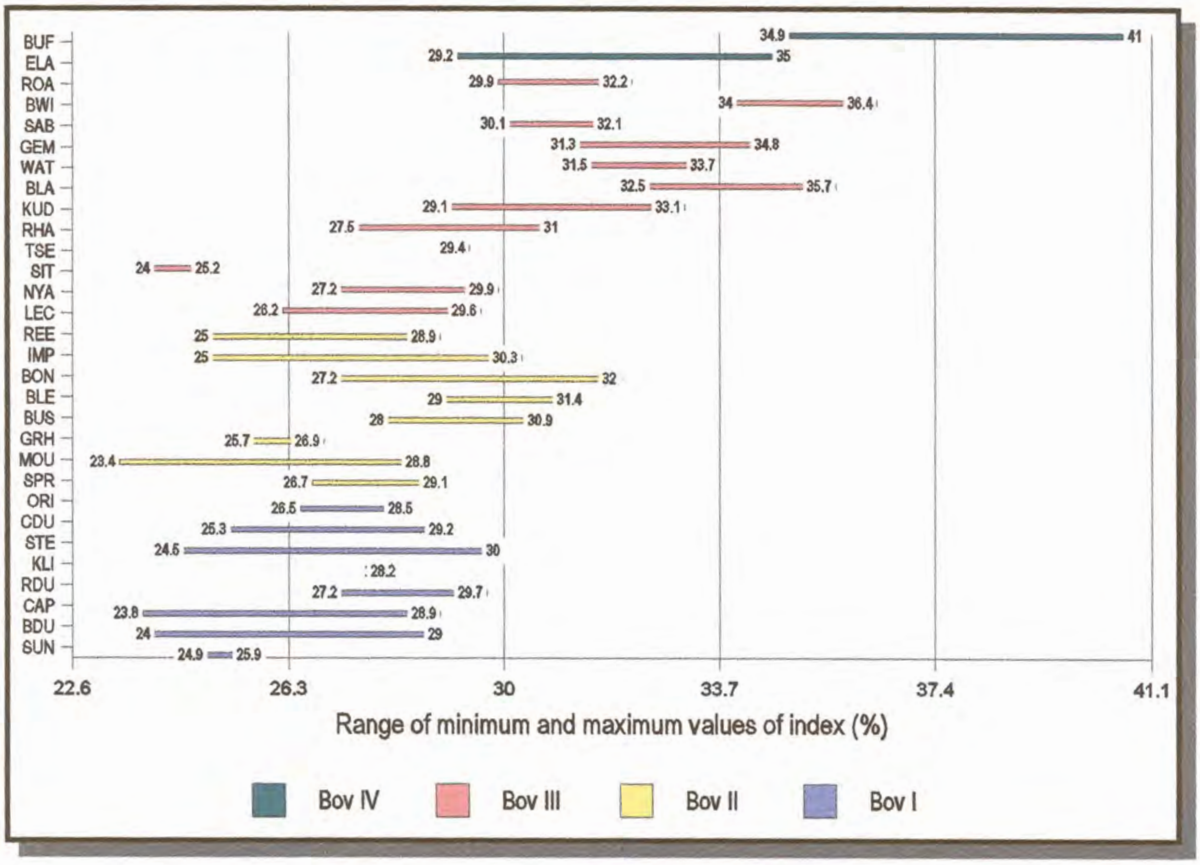


FIGURE 4.13: Bovid size class I - IV: Minimum and maximum index values for the tibia.

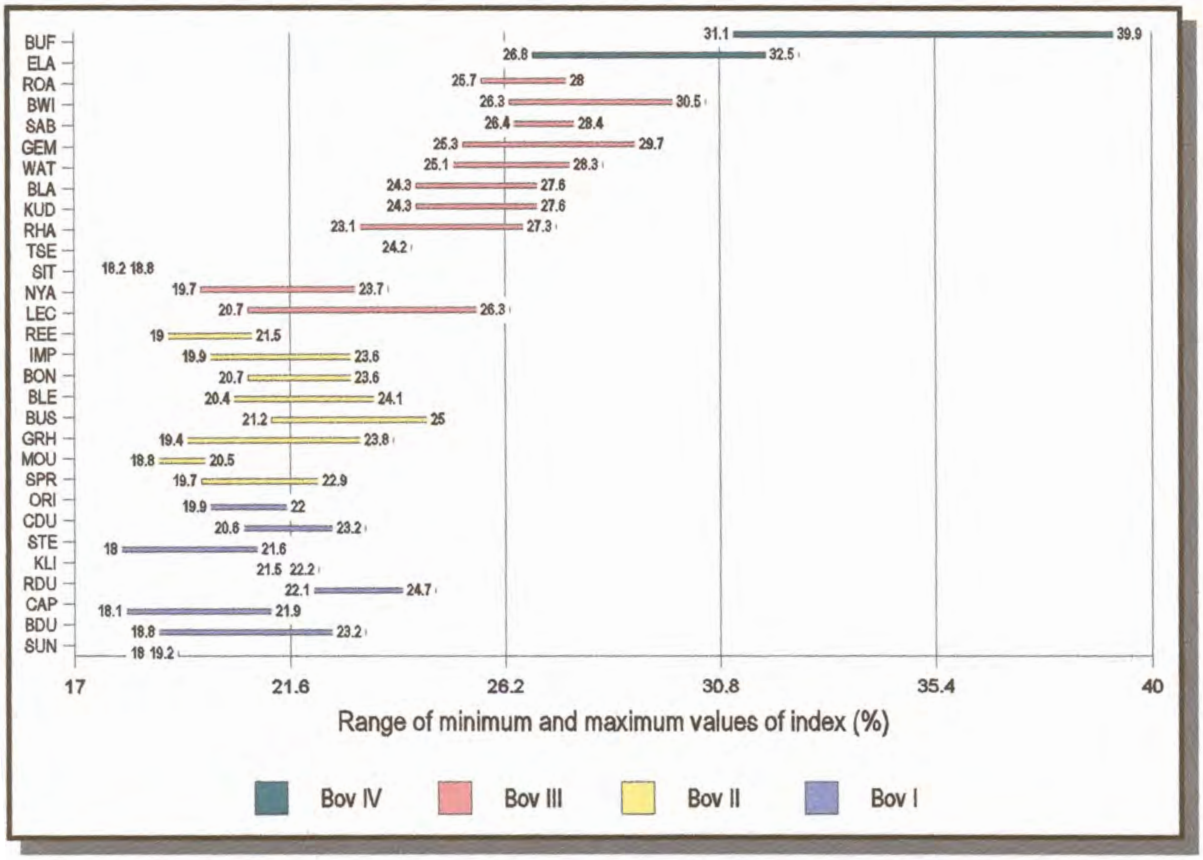
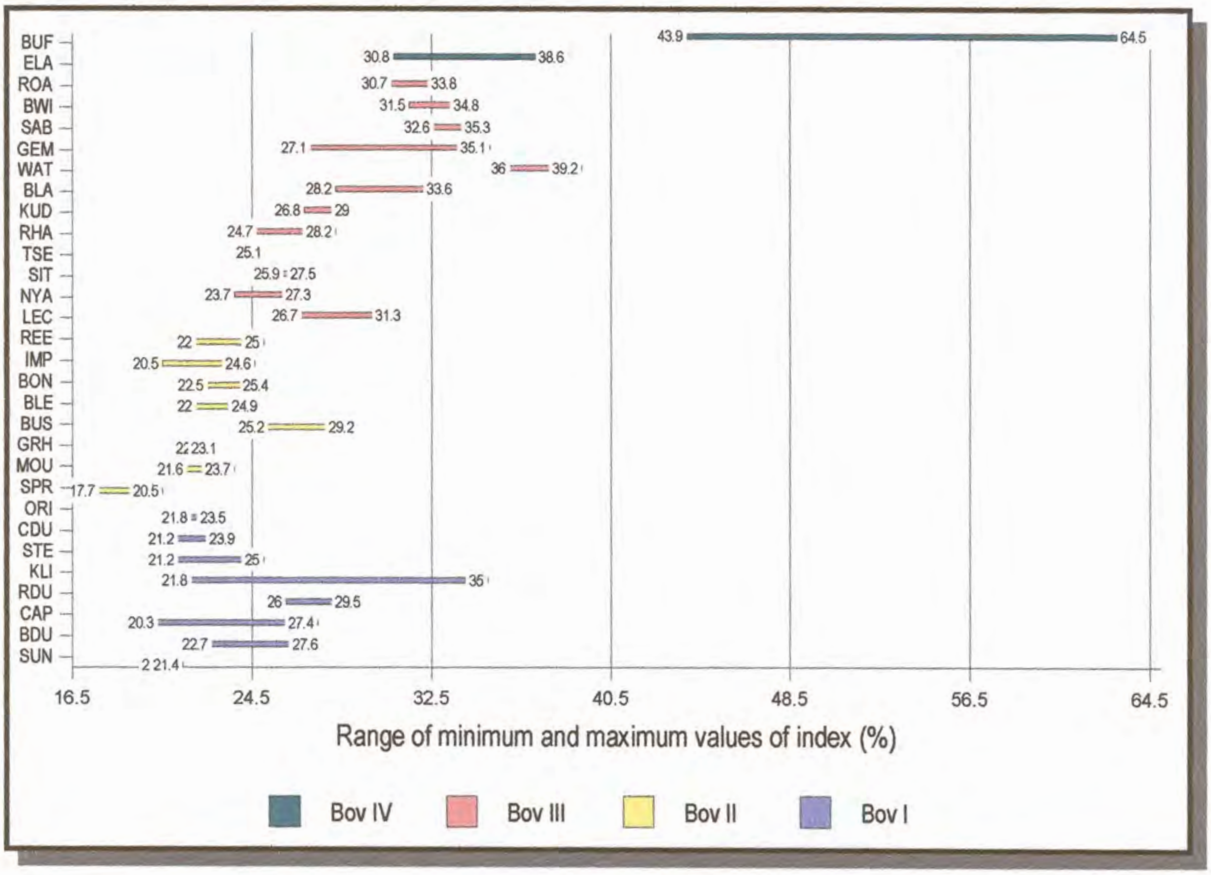


FIGURE 4.14: Bovid size class I - IV: Minimum and maximum index values for the metatarsal.



2.2 Development of programme

The programme was developed using the 97 version of Lotus Smartsuite. A copy of the Osteo-ID programme is available form the department of Anatomy, University of Pretoria or the author. Three different database identification files for the femur, tibia and metatarsal are on the Osteo - ID CD. The following steps should be taken to utilize the programme:

Step 1: If Lotus Smartsuite is not accessible, then obtain and install.

Step 2: When Lotus is up and running, insert Osteo-ID CD in CD-Rom Drive.

Step 3: From the CD, open either femur, tibia or metatarsal file (as required).

Step 4: Click on navigation icon (button) located on the upper left hand side of the screen.

Navigation icon ➜ 

Step 5: Select "Identification"

Step 6: Enter values measured on the bone that needs to be identified.

If unsure about measurement descriptions and methods, use Materials and Methods chapter as reference. With the further development of the programme these measurements will be available on the computer programme for reference.

Identification will automatically be displayed on the SPECIMEN - ID CHART the moment a value is entered. Every time a new value is entered, the graph will change according to identification. Although the graph will react even on one value entered, the identification will obviously be more accurate with additional values.

The database is protected with a password, to ensure the integrity of data and that no values are accidentally altered.

Three values are calculated by the programme. These are:

The *Identification percentage probability* (IPP) =

$$\frac{\text{Total amount of measurements falling within a species median X100}}{\text{Total measurements of respectively femur(14), tibia(15) or metatarsal(16)}}$$

This is a calculation of the number of measurements (median values of specific species) which fall within the range of the entered measurement values, expressed as a percentage. It is very important to note that this percentage is *weighted*, as it will return a percentage indicative of the number of measurements entered by the user against the total number of measurements available in the database on respectively the femur (14 measurements), the tibia (15 measurements) and the metatarsal (16 measurements).

The *Fractional percentage probability* (FPP) =

$$\frac{\text{Individual IPP value X100}}{\text{Sum of IPP values of all species identified with IPP value}}$$

This is the percentage chance the specimen measured has of being one of the species that had a positive IPP. The FPP is therefore a fractional expression of the IPP, as a percentage. The highest FPP value is then the most probable species.

The *Element percentage probability* (EPP) =

$$\frac{\text{Total number of measurements falling within range of species median X100}}{\text{Total number of measurements entered}}$$

This is a calculation of the number of measurements that shows correlation with the database measurements expressed as a percentage of the measurements that had been entered by the user. This percentage is not *weighted* and may be misleading on the basis of the overall accuracy of the database. The reason is that it may disregard some measurements unique to this species, but are similar in other. The following example explains all three values:

Example: The user enters 5 measurements of the 15 tibial measurements available for identification on the programme. Only 3 of these measurements fall within the median of Springbok, and 2 within the median values of Impala. The three calculated values returned by the programme will be:

Springbok:	Impala:
IPP: 3 / 15 X 100 = 20%	**IPP:** 2 / 15 X 100 = 13.3%
EPP: 3 / 5 X 100 = 60%	**EPP:** 2 / 5 X 100 = 40%
FPP: 20 / (20 + 13.3) X 100 = 60%	**FPP:** 13.3 / (20 + 13.3) = 40%

If the number of measurements entered are equal to that of the number of measurements available on the specific bone, the IPP and EPP will have the same value.

The Identification chart graphically shows the FPP value, but both the IPP and EPP values can be accessed. Although it is essential to enter as many of the measurements available on the specific bone, it is not mandatory. The Identification graph will react on one entry only. In such instance the user must realize that the computer will only return species which shows correlation with that one element, which will necessitate further study.

Figure 4.15 shows the Identification chart of the programme as seen on the computer screen.

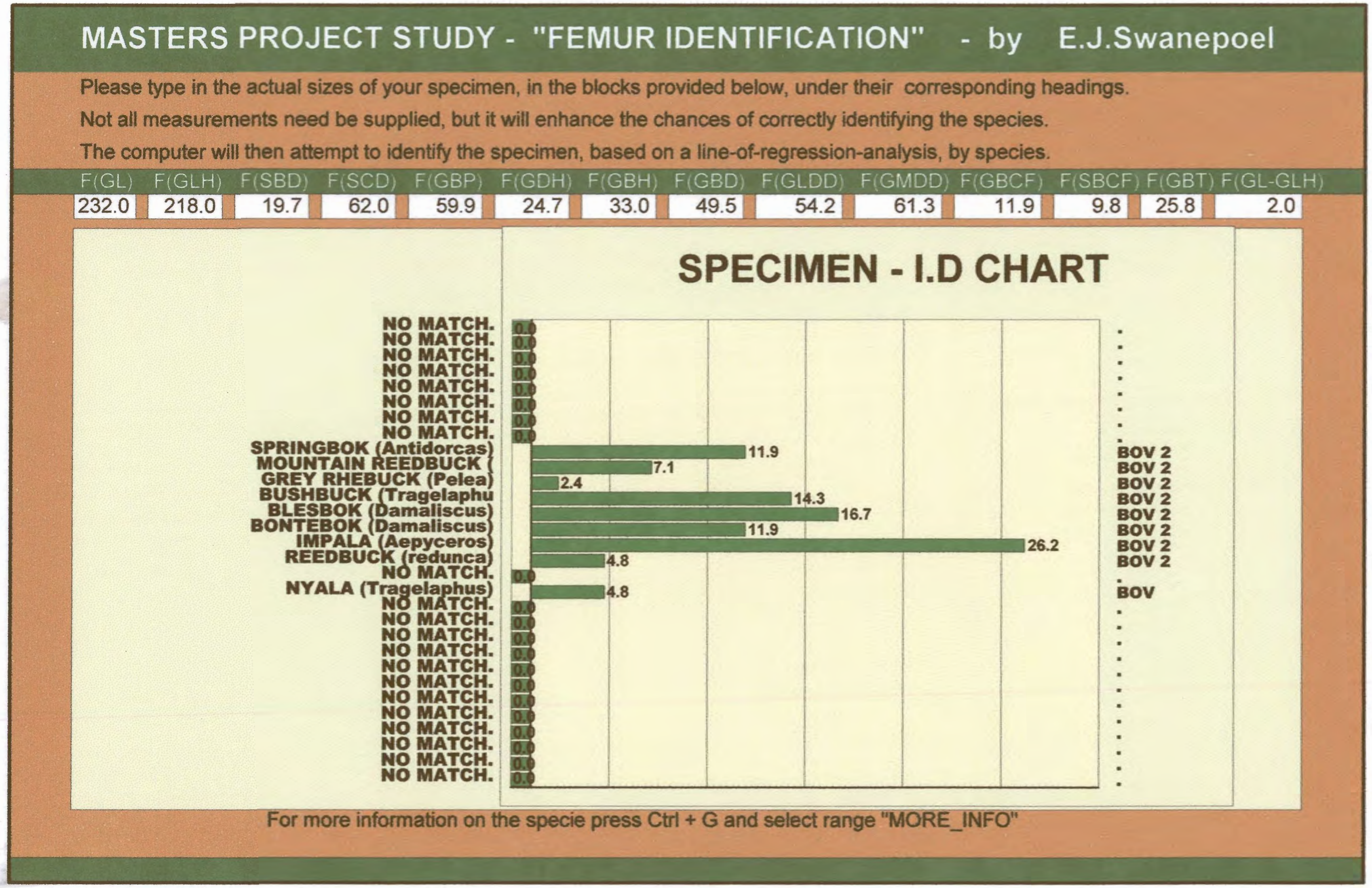


FIGURE 4.15: Identification chart as seen in the computer programme.

The identification chart also supplies the Bovid size class, if the FPP values are too close in value and are therefore of little use. As in conventional faunal analysis, the Bovid size class can at least be captured if no species can be assigned to the specimen.

The navigation icon can also be used to acquire additional detail of a specific species by selecting the "MORE INFO" option. This information may be used to further identify a species. Although only four examples (Cape Grysbok, Springbok, Red Hartebeest, Buffalo) is available at present, it indicates how the programme may be further developed. "MORE INFO" data includes the following:

❶ Minimum and maximum live weight of males and females.

❷ Distribution description.

❸ Description of species

❹ Habitat & Diet

❺ Smithers' mammal number [51]

The distribution map, for example, can be used to distinguish between similar size species, with different distributions in the Southern African region. This may assist in further identification. Blesbok and Bontebok, for example, are skeletally very similar, but have diverse natural distributions in the Southern African region. The habitat and diet of these species are of importance in the process of faunal analysis.

The navigational icon can further be used to view the EPP, IPP and FPP values of the species identified in the graph. This can be accessed by selecting the "ADDITIONAL VALUES" option.

Figure 4.16 shows the additional information that can be accessed by selecting the "MORE INFO" option at the navigation button or Ctrl + G.

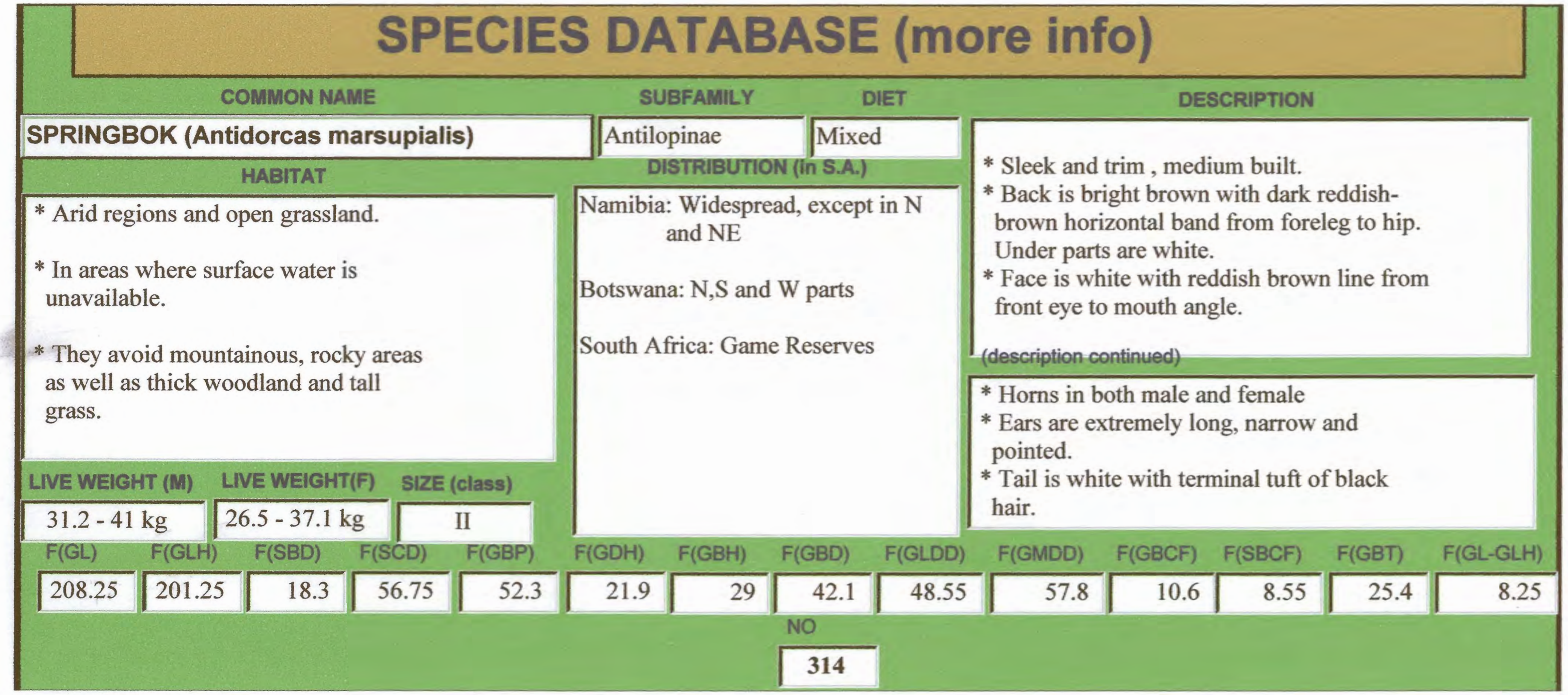


FIGURE 4.16: Additional information as seen in the computer programme.

3. STAGE 3 - TESTING

Stage 3 comprised of a test of accuracy and reliability of the programme developed in this study. The test included specimens from the Kemp's Cave collection which were identified as either femur, tibia or metatarsal of a specific species. Only ten specimens fulfilled these criteria. One of these specimens (LKC/93/23) were a non-fused epiphyses, which indicated that it belonged to a sub-adult or juvenile. All modern collection measurements taken for this study were that of adult individuals. Although the results obtained from testing this juvenile specimen with the developed programme may therefore be negative, it's identification graphs are also included here. The ten identified specimens of the Kemp's Cave collection were identified by an independent expert to verify accuracy.

Ten modern specimens from the National Flagship Institution, with known identifications, were also used for the testing stage. The reasons for including the extra specimens were that 1) the sample size (femur, tibia and metatarsal specimens of bovids) from Kemp's Caves was too small and 2) the accuracy of the identification of the fragmented specimens of Kemp's Cave could be doubted. Specimens that could not be utilised for various reasons in the original data collection, were measured. These included a femur, tibia and metatarsal from each of Bovid size class I, II and III, as well as a metatarsal from Bov IV.

3.1 Kemp's Caves specimens

Figures 4.17 to 4.26 show the results of the different specimens from the Kemp's Cave collection. These specimens were in various stages of fragmentation, thus only certain measurements could be taken from each. The original identification was done, by the author, by comparing the specimen to the modern collection of the

National Flagship Institution collection.

The results of the test include the specimen number, the measurements taken (Tables 4.10 - 4.19), the specimen - ID chart (with FPP values) as well as the IPP values for each of the species calculated by the developed programme.

The IPP value is a calculation which indicates how many of the entered measurements , fall within the range of the database medians, expressed as a percentage.

The Identification Percentage Probability (IPP) values shown with the ID results of the Kemp's Caves specimens, are mostly very low values. The reason being that these fragmented specimens could only supply a few measurements. These values give a good indication of the fact that identification with only a few measurements may be less accurate. The Fractional Percentage Probability (FPP) values are also shown on the ID chart. These values give an indication of the probability of the specimen measured as being one of all the species that showed positive IPP values.

LKC/94/27 (Fig 4.17) Conventionally identified as Red Hartebeest:

Although Red Hartebeest had a 14.3% probability, the ID chart showed a higher probability for it to be either Lechwe or Sitatunga. Lechwe, however, does not naturally occur in this area. The Sitatunga sample size was also very small and the results of this ID might change with a larger sample. The IPP values were relatively low, but correlated with the fact that only two measurements were available for identification testing.

LKC/92/38 (Fig 4.18) Conventionally identified as Springbok:

The ID chart showed a 20% probability for both Springbok and Oribi, but the highest probability with 60% is Grey Rhebuck. Oribi and Springbok showed a low 7% IPP value, whereas Grey Rhebuck showed higher (20%) IPP value. These results may however, change drastically if proximal measurements values are entered.

LKC/93/23 (Fig 4.19) Conventionally identified as Impala:

The only three species that showed a probability is Oribi (40%), Mountain Reedbuck (20%) and Grey Rhebuck (40%). The IPP values of all three species were, however, relatively low, as only three measurements were entered. This specimen, however, was an unfused distal extremity. No juveniles or sub-adults were measured and utilised in the database which might explain the absence of the probability of Impala on the ID chart.

LKC/93/70 (Fig 4.20) Conventionally identified as Blesbok:

A combination of four species showed the highest probability percentage at 16% which included Blesbok. The IPP values ranged form 20% - 27% which is relatively high if one takes into account that only a third of the measurements were entered. One of the measurements available was the T(SCD), smallest circumference of the tibial shaft. As can be seen in Figure 4.13, the robusticity values of all four species overlaps completely which correlates with the identification results.

LKC/93/302 (Fig 4.21) Conventionally identified as Reedbuck:

All measurements could be taken on this specimen as it was a complete metatarsal. Although sixteen species showed varied percentage probabilities, Reedbuck had the third highest FPP (12.7%) and a 63% IPP. Bontebok had the highest probability with a 17.7% FPP and a 88% IPP value.

LKC/93/126 (Fig 4.22) Conventionally identified as Impala:

Grey Rhebuck showed the highest (42.9%) percentage probability, while Oribi, Mountain Reedbuck and Bushbuck were also identified as possible species. Impala did not have a positive IPP and therefore did not show on the ID chart. All species showed relative low IPP values (6% to 19%), which correlates with the fact that only three measurements could be entered.

LKC/94/328 (fig 4.23) Conventionally identified as Blesbok:

Springbok and Reedbuck had the highest (22.7%) FPP values. Although Blesbok had a positive IPP value, its fractional probability was only 4.5%. Again it can be seen in Figure 4.14 that all the identified species show overlap in the metatarsal robusticty value (which includes the M(SCD). This may explain the large amount species that was identified in this specific test.

LKC/93/40 (Fig 4.24) Conventionally identified as Blesbok:

All five species that showed percentage probabilities, had a 20% FPP value. The only measurement available was the M(SCD). The IPP values of all four species was extremely low (6%). This is obviously due to the fact that only the smallest circumference measurement of this bone was available. In Figure 4.14 these species show great overlap in the robusticity values and thus these results correlates with the metatarsal robusticity index. Bontebok, however, does not naturally occur in the Kemp's cave area, which might be useful information in further identification.

LKC/93/35 (Fig 4.25) Conventionally identified as Blesbok:

Although Blesbok showed a high (15.7%) FPP vlaue, Reedbuck was identified as being the most (21.8%) probable species. Eight different species showed positive IPP values, which ranged between 6% and 44%. Blesbok showed an IPP value of 31%, which is relatively high when less than half the measurements were available for identification.

LKC/92/34 (Fig 4.26) Conventionally identified as Blesbok:

Blesbok, Springbok, Bushbuck, Reedbuck and Nyala each had a 14.3% fractional probability value, while Impala had the highest FPP value at 28.6%. Only two measurements were available (M(SBD) and M(GBP) which might explain that Blesbok did not have a higher FPP value.

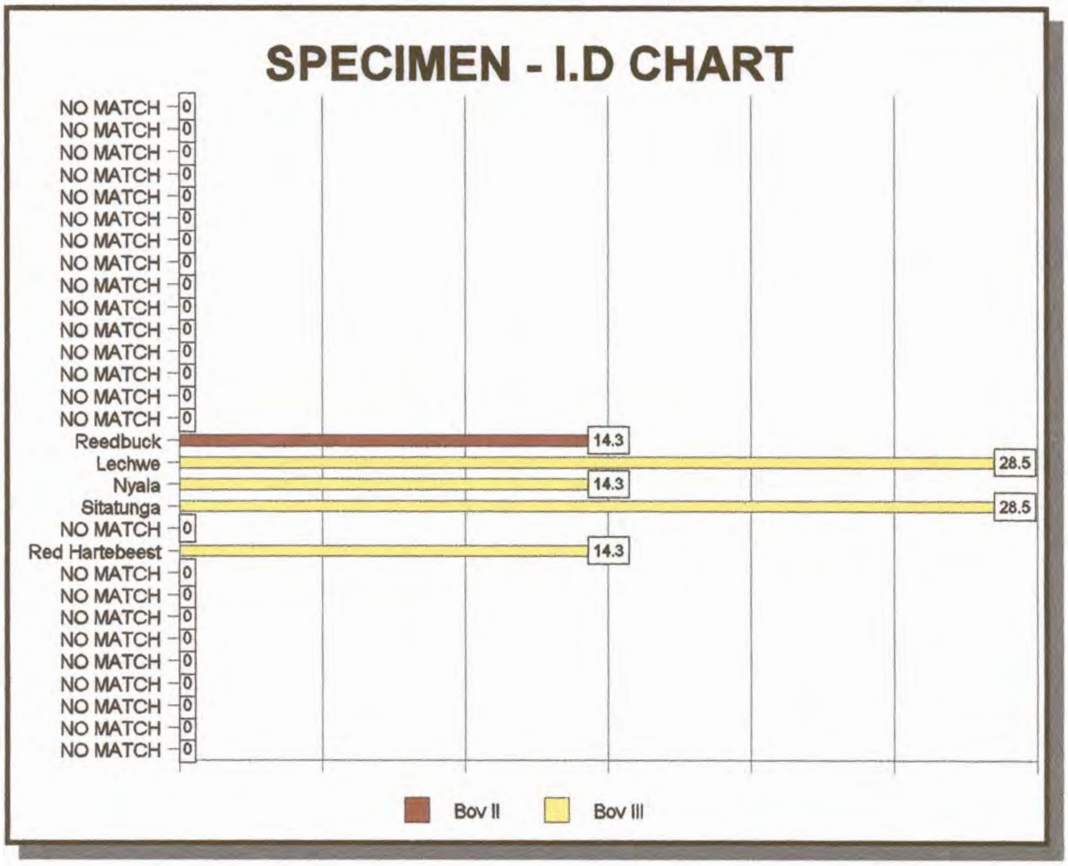
Only 20% of the identification tests was correctly identified (having the highest FPP value) as being the species which was conventionally identified during faunal analysis. In 90% of the tests the species had a positive IPP value and featured on the identification graph. Reasons for the low success rate might be 1) the small number of measurements available because of fragmentation 2) possible inaccurate conventional identification and 3) the inaccuracy of the computer programme, resulting from the small number of specimens in the database used for the development of the programme.

KEMP'S CAVE SPECIMEN (LKC/94/27) Red Hartebeest femur

TABLE 4.10: Measurements of specimen LKC/94/27.

F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)
-	-	24.2	76.0	-	-	-	-	-	-	-	-	-

FIGURE 4.17: Identification chart of LKC/94/27 - FPP (%).



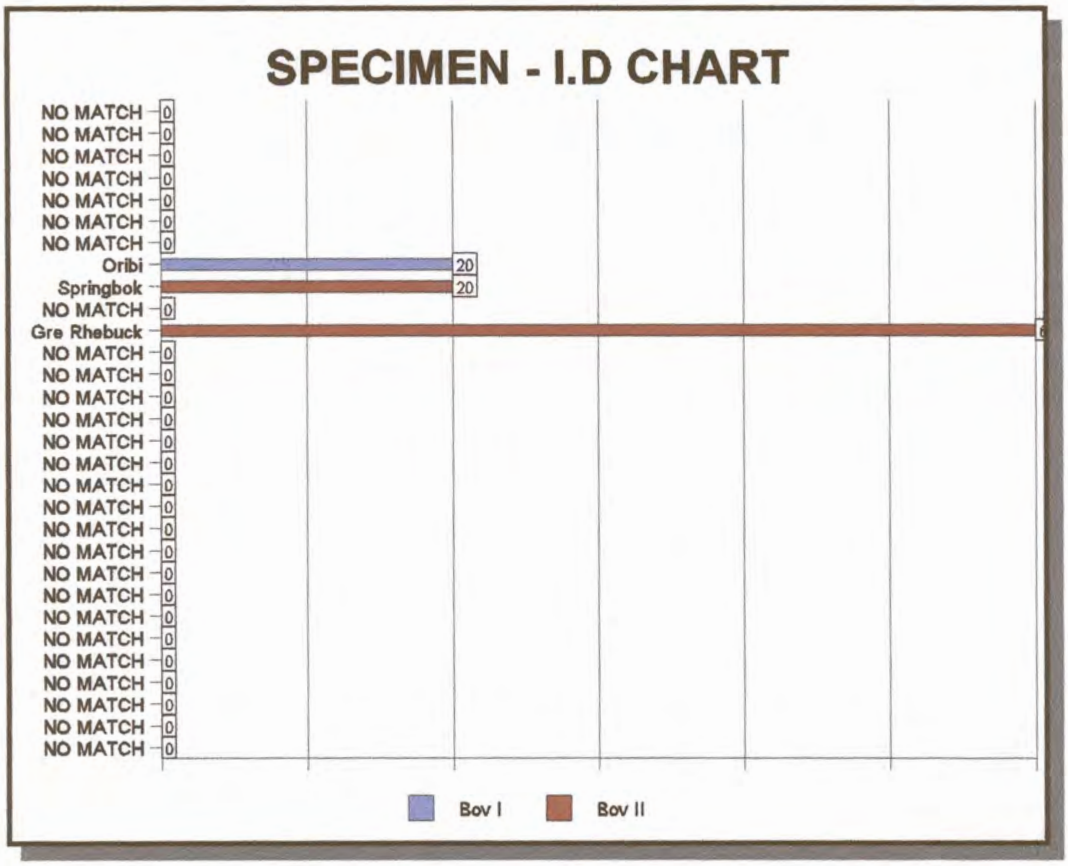
SPECIES	IPP	SPECIES	IPP
Reedbuck	8%	Sitatunga	15%
Lechwe	15%	Red Hartebeest	8%
Nyala	8%		

KEMP'S CAVE SPECIMEN (LKC/92/38) Springbok tibia

TABLE 4.11: Measurements of specimen LKC/92/38.

T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
-	-	-	15.6	47.0	-	-	-	-	-	-	-	24.6	20.5	13.8

FIGURE 4.18: Identification chart of LKC/92/38 - FPP (%).



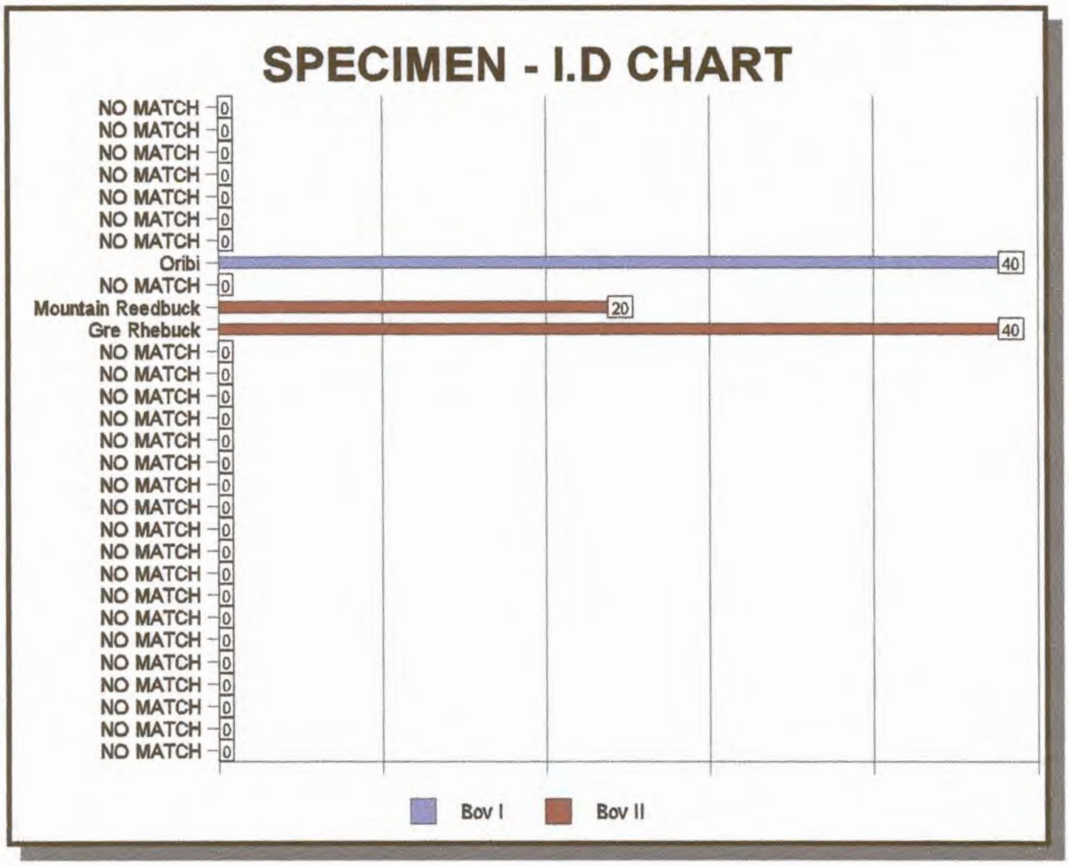
SPECIES	IPP	SPECIES	IPP
Oribi	7%	Grey Rhebuck	20%
Springbok	7%		

KEMP'S CAVE SPECIMEN (LKC/93/23) Impala tibia

TABLE 4.12: Measurements of specimen LKC/93/23.

T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
-	-	-	-	-	-	-	-	-	-	-	-	26.4	19.9	13.5

FIGURE 4.19: Identification chart of LKC/93/23 - FPP (%).



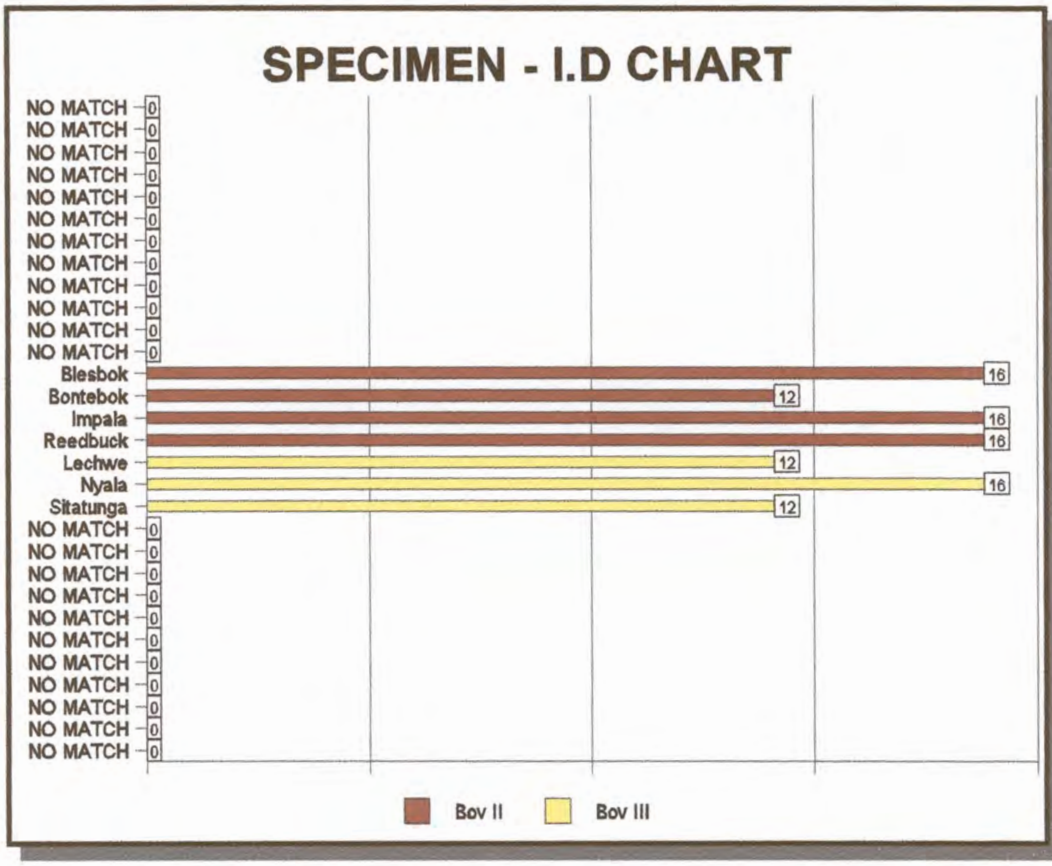
SPECIES	IPP	SPECIES	IPP
Oribi	13%	Grey Rhebuck	13%
Mounatin Reedbuck	6%		

KEMP'S CAVE SPECIMEN (LKC/93/70) Blesbok tibia

TABLE 4.13: Measurements of specimen LKC/93/70.

T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
-	-	-	22.5	66.0	-	-	-	-	-	-	-	34.5	27.8	20.4

FIGURE 4.20: Identification chart of LKC/93/70 - FPP (%).



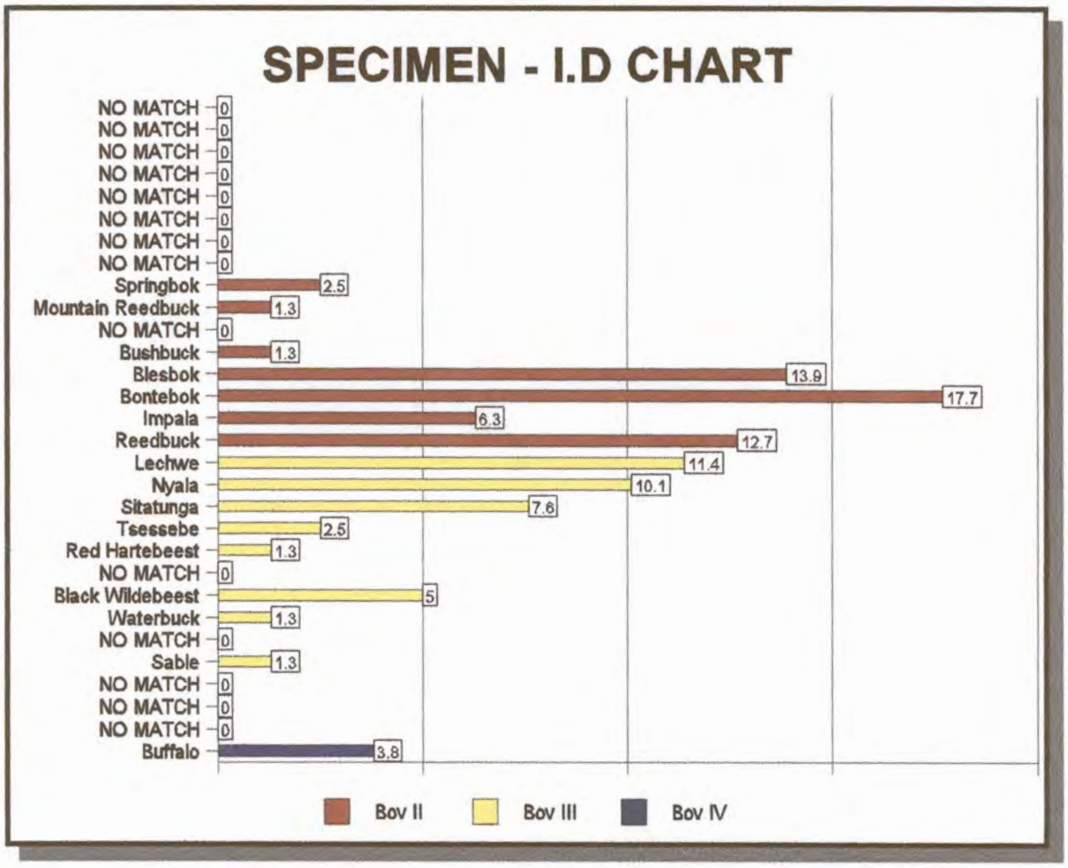
SPECIES	IPP	SPECIES	IPP
Blesbok	27%	Lechwe	20%
Bontebok	20%	Nyala	27%
Impala	27%	Sitatunga	20%
Reedbuck	27%		

KEMP'S CAVE SPECIMEN (LKC/93/302) Reedbuck metatarsal

TABLE 4.14: Measurements of specimen LKC/93/302.

M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
225.0	220.0	222.0	15.0	57.0	29.5	32.3	23.4	13.5	21.2	12.1	32.1	21.9	15.0	14.9	14.8

FIGURE 4.21: Identification chart of LKC/93/302 - FPP (%).



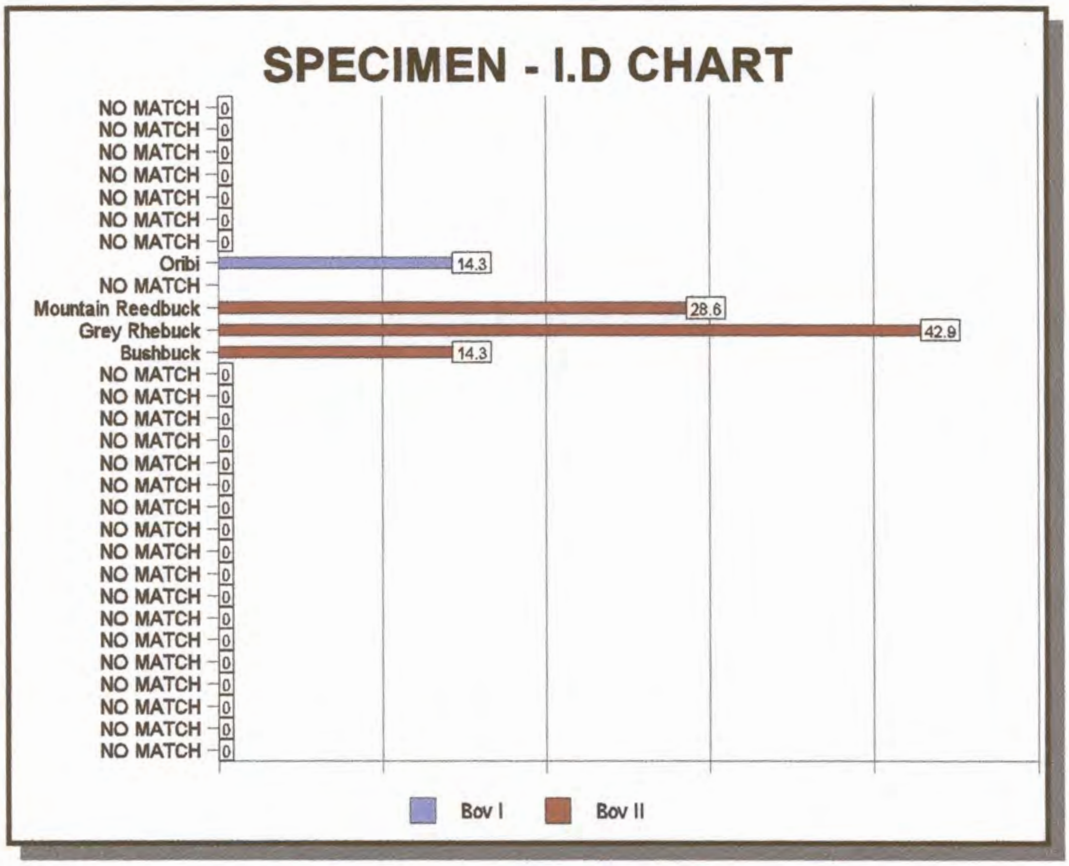
SPECIES	IPP	SPECIES	IPP	SPECIES	IPP
Sprinbok	6%	Reedbuck	63%	Red Hartebeest	6%
Mounatin Reedbuck	6%	Lechwe	56%	Black Wildebeest	25%
Bontebok	88%	Nyala	50%	Waterbuck	6%
Blesbok	69%	Sitatunga	44%	Sable	6%
Impala	25%	Tsessebe	13%	Buffalo	19%

KEMP'S CAVE SPECIMEN (LKC/93/126) Impala metatarsal

TABLE 4.15: Measurements of specimen LKC/93/126.

M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
-	-	-	11.9	-	21.0	23.0	-	-	-	-	-	-	-	-	-

FIGURE 4.22: Identification chart of LKC/93/126 - FPP (%).



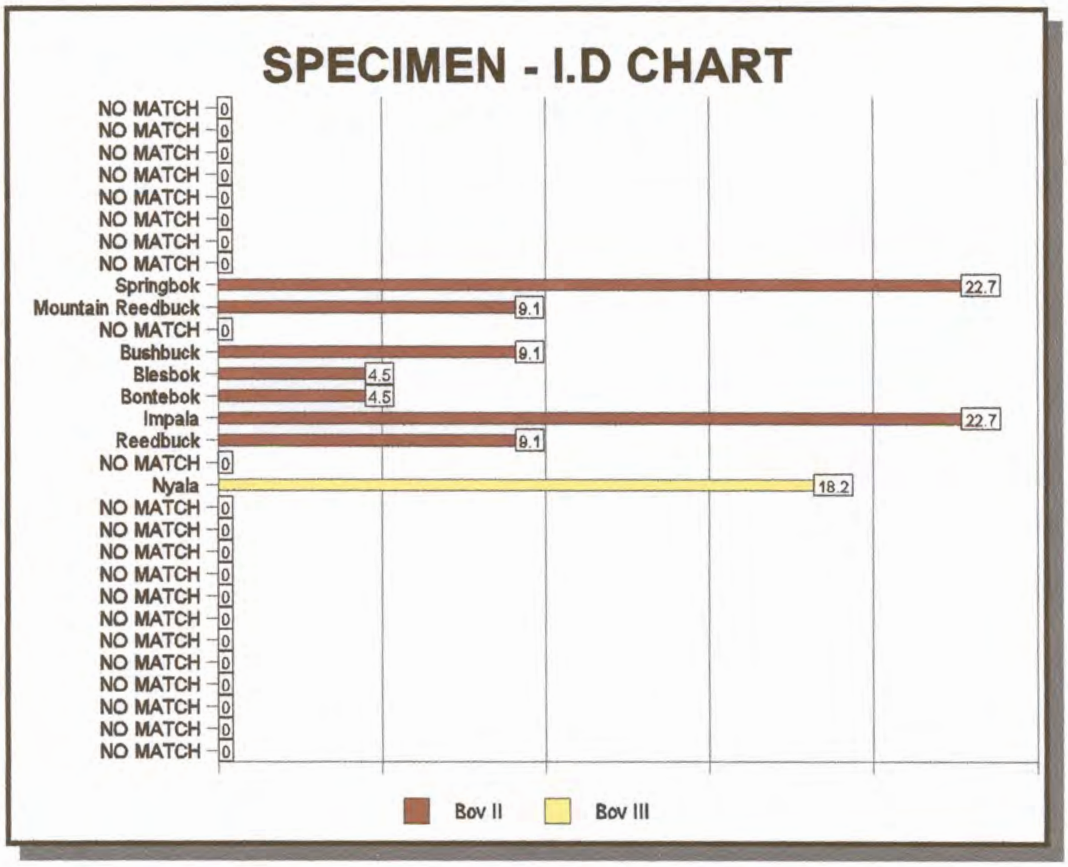
SPECIES	IPP	SPECIES	IPP
Oribi	6%	Grey Rhebuck	19%
Mountain Reedbuck	13%	Bushbuck	6%

KEMP'S CAVE SPECIMEN (LKC/94/328) Blesbok metatarsal

TABLE 4.16: Measurements of specimen LKC/94/328.

M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
-	-	-	15.0	49.5	-	-	-	-	-	-	26.9	18.9	12.7	12.2	12.9

FIGURE 4.23: Identification chart of LKC/94/328 - FPP (%).



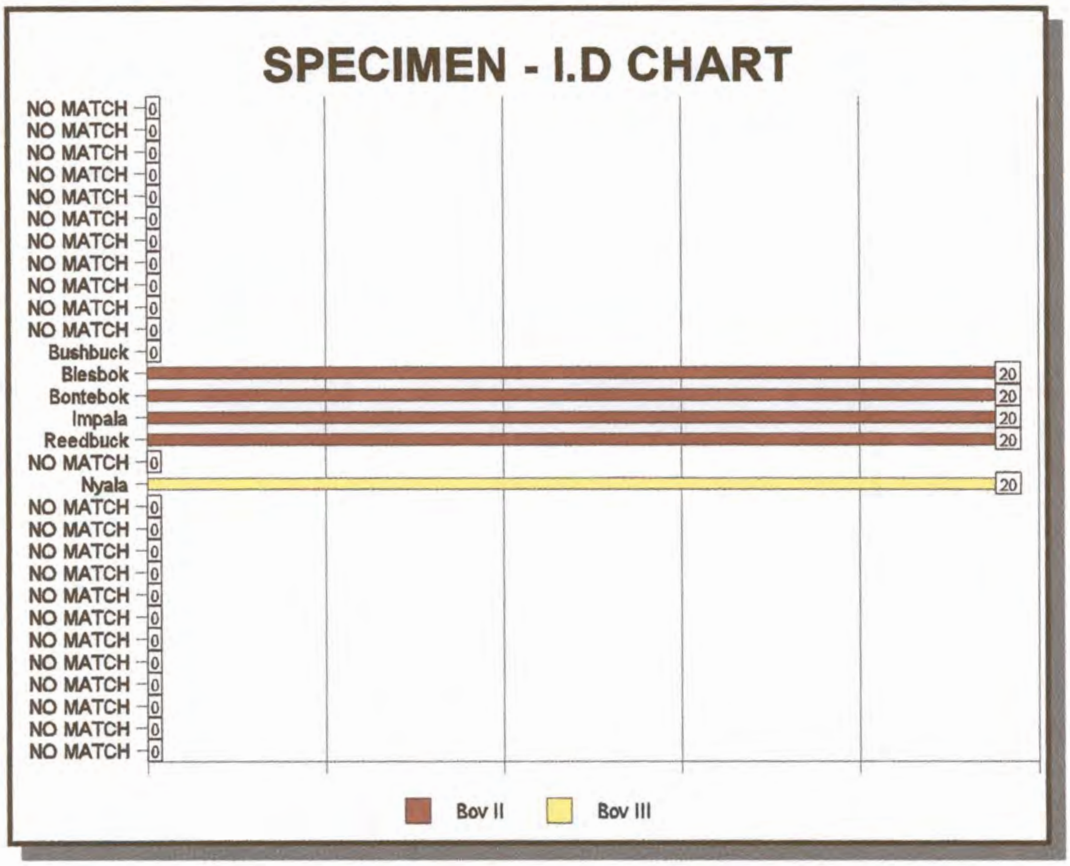
SPECIES	IPP	SPECIES	IPP
Springbok	31%	Bontebok	6%
Mountain Reedbuck	13%	Impala	31%
Bushbuck	13%	Reedbuck	13%
Blesbok	6%	Nyala	25%

KEMP'S CAVE SPECIMEN (LKC/93/40) Blesbok metatarsal

TABLE 4.17: Measurements of specimen LKC/93/40.

M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
-	-	-	-	57.0	-	-	-	-	-	-	-	-	-	-	-

FIGURE 4.24: Identification chart of LKC/93/40 - FPP (%).



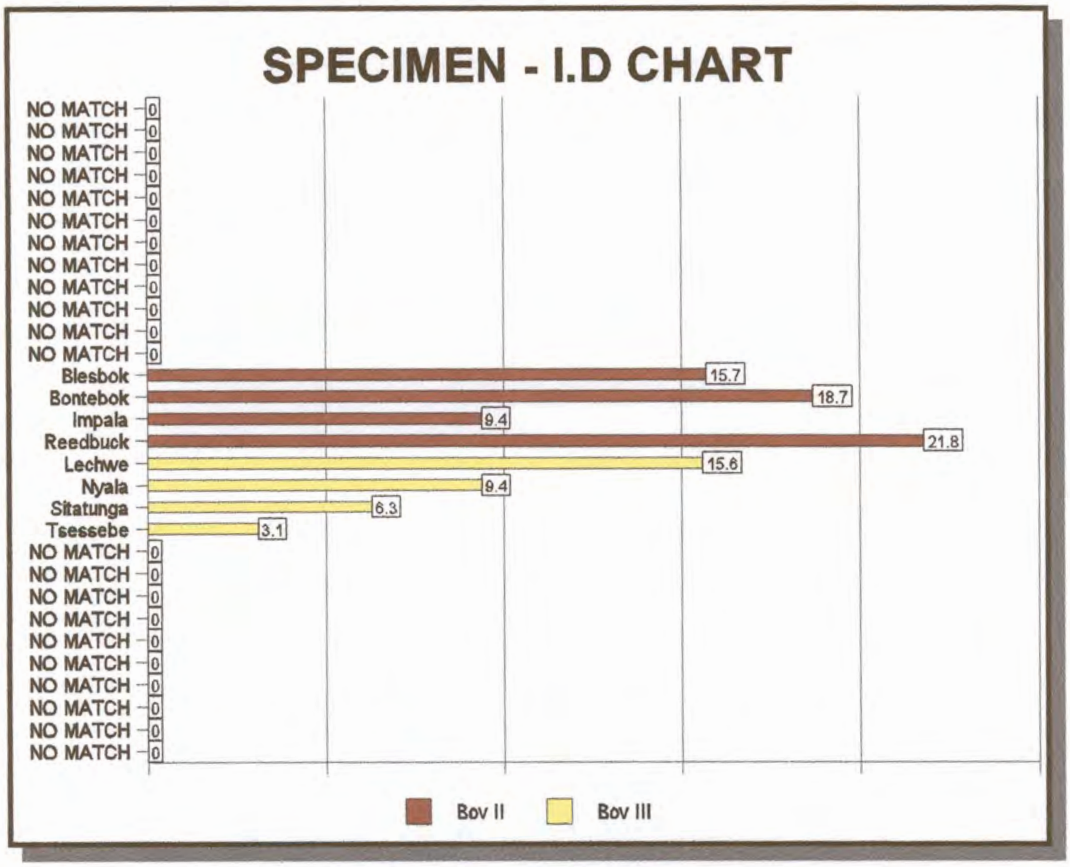
SPECIES	IPP	SPECIES	IPP
Blesbok	6%	Reedbuck	6%
Bontebok	6%	Nyala	6%
Impala	6%		

KEMP'S CAVE SPECIMEN (LKC/93/35) Blesbok metatarsal

TABLE 4.18: Measurements of specimen LKC/93/35.

M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
-	-	-	17.3	-	26.6	31.6	21.8	11.9	18.3	12.2	-	-	-	-	-

FIGURE 4.25: Identification chart of LKC/93/35 - FPP (%).



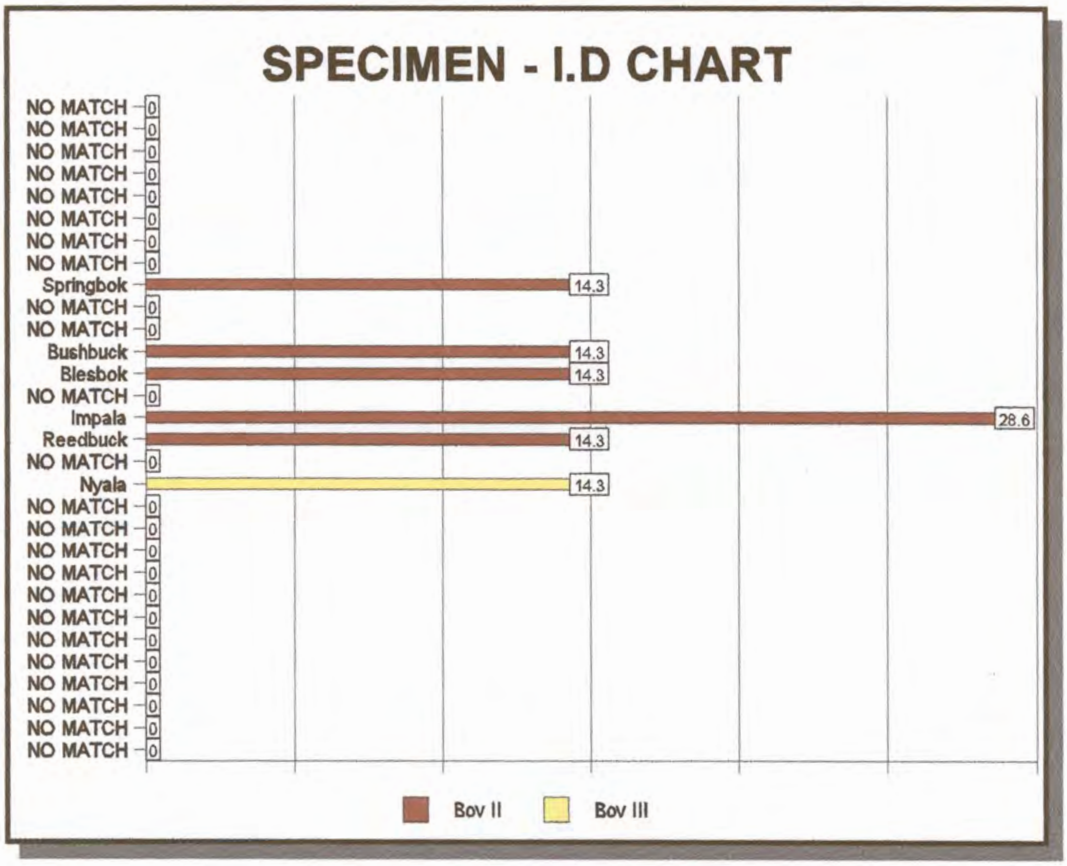
SPECIES	IPP	SPECIES	IPP
Blesbok	31%	Lechwe	30%
Bontebok	38%	Nyala	19%
Impala	19%	Sitatunga	12%
Reedbuck	44%	Tsessebe	6%

KEMP'S CAVE SPECIMEN (LKC/92/34) Blesbok metatarsal

TABLE 4.19: Measurements of specimen LKC/92/34.

M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
-	-	-	16.7	-	25.6	-	-	-	-	-	-	-	-	-	-

FIGURE 4.26: Identification chart of LKC/92/34 - FPP (%).



SPECIES	IPP	SPECIES	IPP
Springbok	6%	Impala	13%
Bushbuck	6%	Reedbuck	6%
Blesbok	6%	Nyala	6%

3.2 Modern collection specimens

Figures 4.27a to 4.36a show the results of the modern specimens measured. The result of the test include the specimen number (AZ Museum number), the measurements taken (Tables 4.20 - 4.29) , the specimen - ID chart (with FPP values) as well as the IPP values for each of the species calculated by the developed programme.

These specimens are of known origin and include bones which were not utilized in the developed database. All specimens are part of the skeletal collection of the National Flagship Institution's archaeozoological department.

All the specimens were complete bones thus all measurements could be entered. This gives the Identification Percentage Probability (IPP) significant value, and will therefore be discussed at each test.

Figures 4.27b to 4.36b accompany each identification chart of the modern collection test specimens. As the programme might be used by archaeozoologists who mostly analyse fragmented specimens (mostly either, shaft, proximal or distal fragments of long bones), each test identification was repeated three times. Only shaft , proximal or distal measurements was entered respectively. Results of these tests can be seen in Figures 4.27b to 4.36b which compare the FPP values of the different species identified when only certain measurements were entered.

AZ 1069 (Fig 4.27a and b) Klipspringer:

Although Klipspringer had a relative high IPP value (54%), it was Cape Grysbok and Red Duiker which had the highest (25.6%) fractional probabilities. The FPP value of Klipspringer increased from 16.3% (all measurements entered) to 20% when only the shaft measurements were used for identification, but was never identified as having the highest FPP value (see Figure 4.27b).

AZ 526 (Fig 4.28a and b) Grey Rhebuck:

Grey Rhebuck had the highest FPP (37.9%) and this value increased further to 80% when only the shaft measurements was utilised for identification. The five other species identified showed varied fractional probabilities from 3.4% to 24.1%. Common Duiker, Springbok, Oribi and Impala did not feature on the identification chart during the proximal extremity measurement identification (see Figure 4.28b).

AZ 645 (Fig 4.29a and b) Red Hartebeest:

A total of nine species were identified and was assigned a positive IPP value and showed varied percentages (2% to 22%) fractional probabilities. Although Tssesebe had the highest FPP value (22%), the Red Hartebeest had the second highest FPP value (20%) as well as a very high (77%) IPP value. It must be taken into account that there were only one Tsessebe specimen available for the database measurements. A larger sample size might have had different results, which may have identified Red Hartebeest as the most probable species. As can be seen in Figure 4.29b, Blesbok and Bontebok were only identified as being probable species with the distal extremity measurements. Tsessebe and Red Hartebeest showed equal (33.3%) FPP values in the proximal extremity input. The different measurement inputs did therefore not change the most probable species but did enhance the chances of it being correctly identified as Red Hartebeest.

AZ 782 (Fig 4.30a and b) Steenbok:

This result positively identified the specimen as Steenbok being the most probable species with a 29.8% fractional probability and a very high (93%) IPP value. Four other species showed positive IPP values with fractional probability values of between 2.1% and 25.5%. The distal extremity measurement input showed that the FPP of Red Duiker increased substantially to a value equal to that of Steenbok (33.3%) with the same measurements entered (see Figure 4.30b).

AZ 1032 (Fig 4.31a and b) Springbok:

This specimen was identified as being either Mountain Reedbuck or Grey Rhebuck with equal FPP values (27.3%). Springbok had a FPP value of only 12.1%, but a 27% IPP value. Thus, although it was not identified as the most probable species, the measurements entered still corresponded with a 27% value with that of Springbuck. In Figure 4.31b it can clearly be seen that the reason why Reedbuck and Grey Rhebuck were identified as the most probable species, was because the shaft measurement entered matched almost perfectly with that of these two species.

AZ 145 (Fig 4.32a and b) Black Wildebeest:

This specimen was also positively identified as Black Wildebeest. Although the FPP vlaue was relatively low (21.1%), the IPP was 73%. The reason for the FPP value being low was that 12 other species also showed resemblance to some of the measurements. The FPP values ranged between 1.7% to 18.3%. If, however, only the distal extremity measurements would have been available, it would have identified Tsessebe and Red Hartebeest as being the most probable species (Figure 4.32b).

AZ 1572 (Fig 4.33a and b) Cape Grysbok:

Red Duiker was identified as being the most probable species with a very high FPP value (64.3%). Suni and Steenbok both had a FPP value of 7.1% and a IPP of 6%. Cape Grysbok was identified with a IPP of 19% and a fractional probability of 21.4%. If, however, only proximal measurements were entered into the system the most probable species would have Cape Grysbok (40%) and the FPP value of Red Duiker would have decreased to 20% (Figure 4.33b). Both Suni and Steenbok only showed correlation with the shaft measurements entered.

AZ 931 (Fig 4.34a and b) Bontebok:

More than ten species were identified with fractional probabilities ranging form 1.6% to 15.9%. The large number of species identified as having corresponding measurements medians with that of the specimen entered, resulted in relatively low FPP values. Nyala and Blesbok had the highest (15.9%) FPP values. Although Bontebok had only a 12.7% chance of being the probable species, results showed that 50% of the measurements corresponded with the measurement entered. In Figure 4.34b it can be seen that Reedbuck would have been identified as the most probable species if only the distal extremity measurements would have been available. The proximal measurement values of Blesbok, as well as the distal measurements of Nyala showed to be the most significant measurements which identified them as the most probable species.

AZ 127 (Fig 4.35a and b) Sable:

Although Sable was identified as the second most probable species with a 11.8% FPP value, it was Black Wildebeest with a 14.1% FPP value that was identified as the most probable species. Nine of the 17 species identified showed correlation with only the shaft measurements with a FPP probability of 3.5%. Sable was, however, identified as being the most probable species when only the proximal measurements were entered. Red Hartebeest, however, would have been the most probabale species if the only measurements that were entered were that of the distal extremity (Figure 4.35b).

AZ 1457 (Fig 3.36) Eland:

Only three species were illustrated on the identification chart. These included Kudu and Eland with a 25% fractional probability and Buffalo with a 50% FPP value. In Figure 4.36b it can clearly be seen that the proximal and distal extremity measurements of the Buffalo showed a 100% correlation with that of the measurements entered. The shaft measurements, however, resembled that of the Eland and Kudu better (37.5%).

30% of the tests on the modern specimen collection showed the correct species as having the highest probability. There was, however, no identification chart that did not include the correct species and all showed these species as having the second or third highest FPP value.

By entering different sets of values which included elements of respectively the shaft, proximal extremity and distal extremity did in some cases change the results drastically in some cases and the correct species were identified as either sharing the highest FPP value or having the highest.

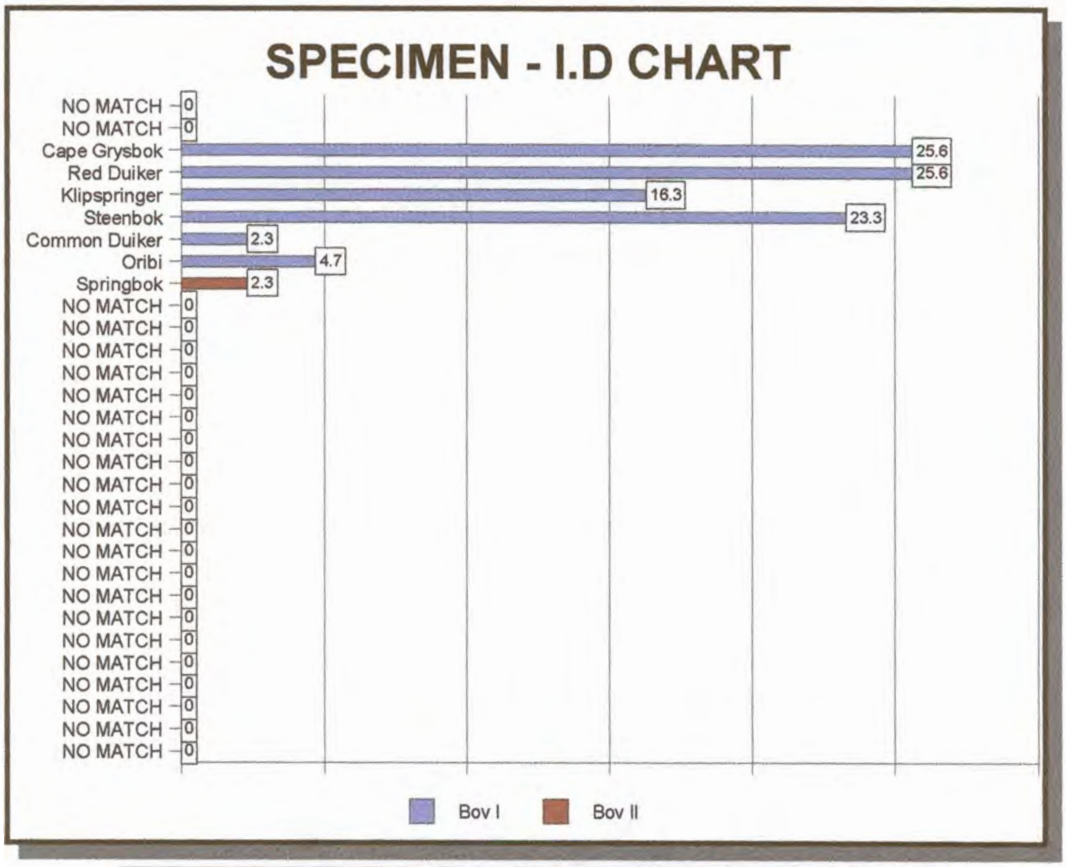
Table 4.30 gives a summary of the results when different measurements were entered into the computer programme with the modern collection test results. As can be seen, the proximal extremities of all three bones showed a higher (60%) identification accuracy. Six of the ten specimens that were not identified as the most probable species when all measurements were entered, were correctly identified when only measurements of certain portions of the bone were utilized. Only one specimen (AZ 526) was constantly identified as the most probable species, no matter which separate elements were entered.

MODERN SPECIMEN (AZ 1069) Klipspringer femur

TABLE 4.20: Measurements of specimen AZ 1069.

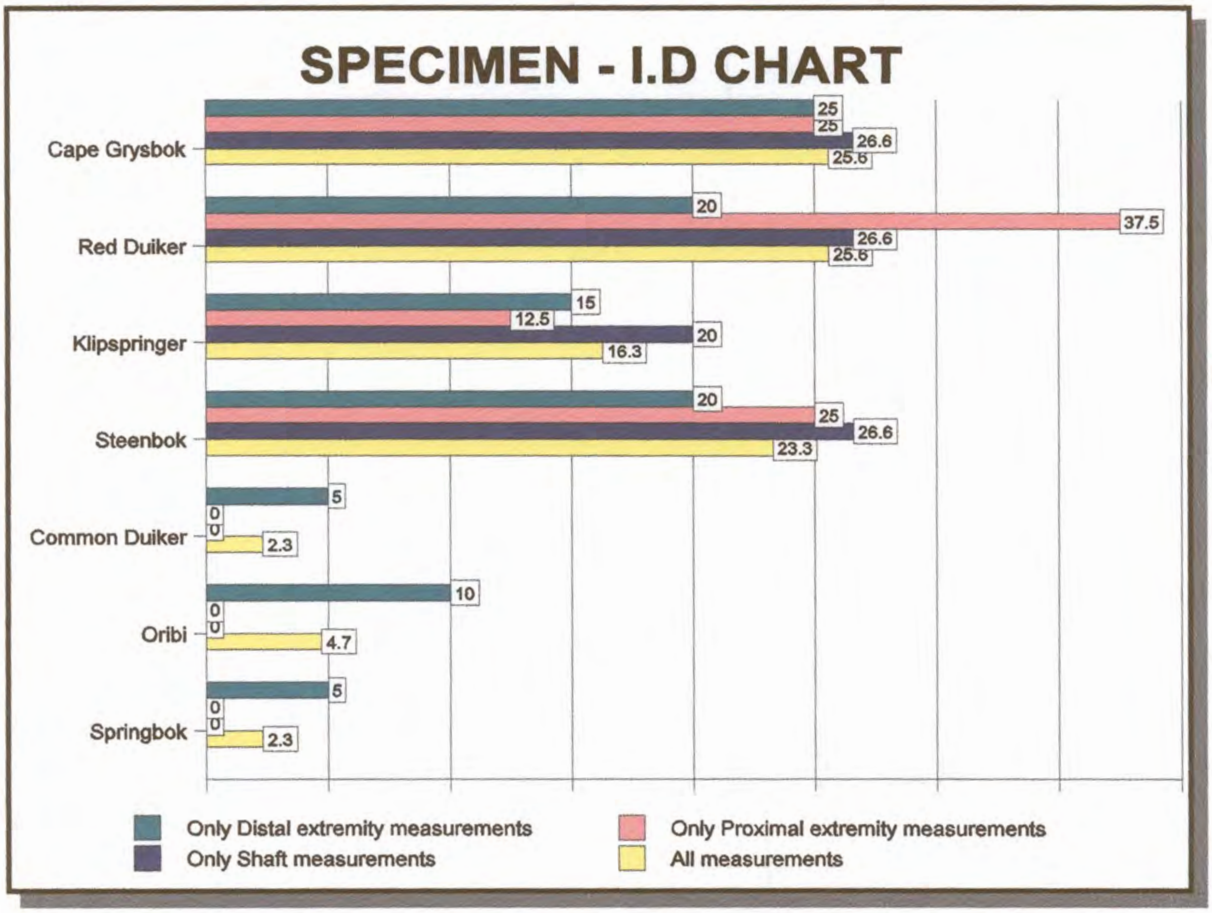
F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)
151.5	149.0	12.1	40.0	33.0	16.1	18.5	30.0	33.0	35.5	9.3	8.3	14.2

FIGURE 4.27a: Identification chart of AZ 1069 - FPP (%).



SPECIES	IPP	SPECIES	IPP
Cape Grysbok	85%	Common Duiker	8%
Red Duiker	85%	Oribi	15%
Klipspringer	54%	Springbok	8%
Steenbok	77%		

FIGURE 4.27b: Differences in measurement input of AZ 1069 - FPP (%).

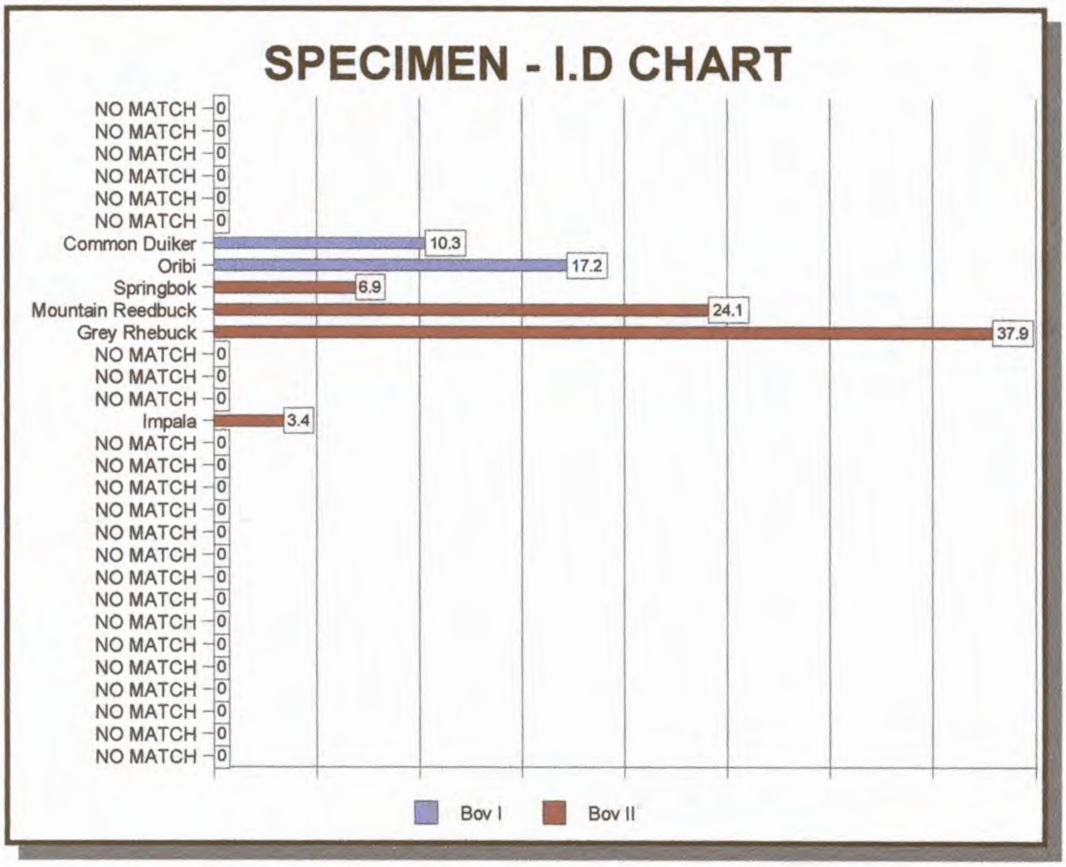


MODERN SPECIMEN (AZ 526) *Grey Rhebuck femur*

TABLE 4.21: Measurements of specimen AZ 526.

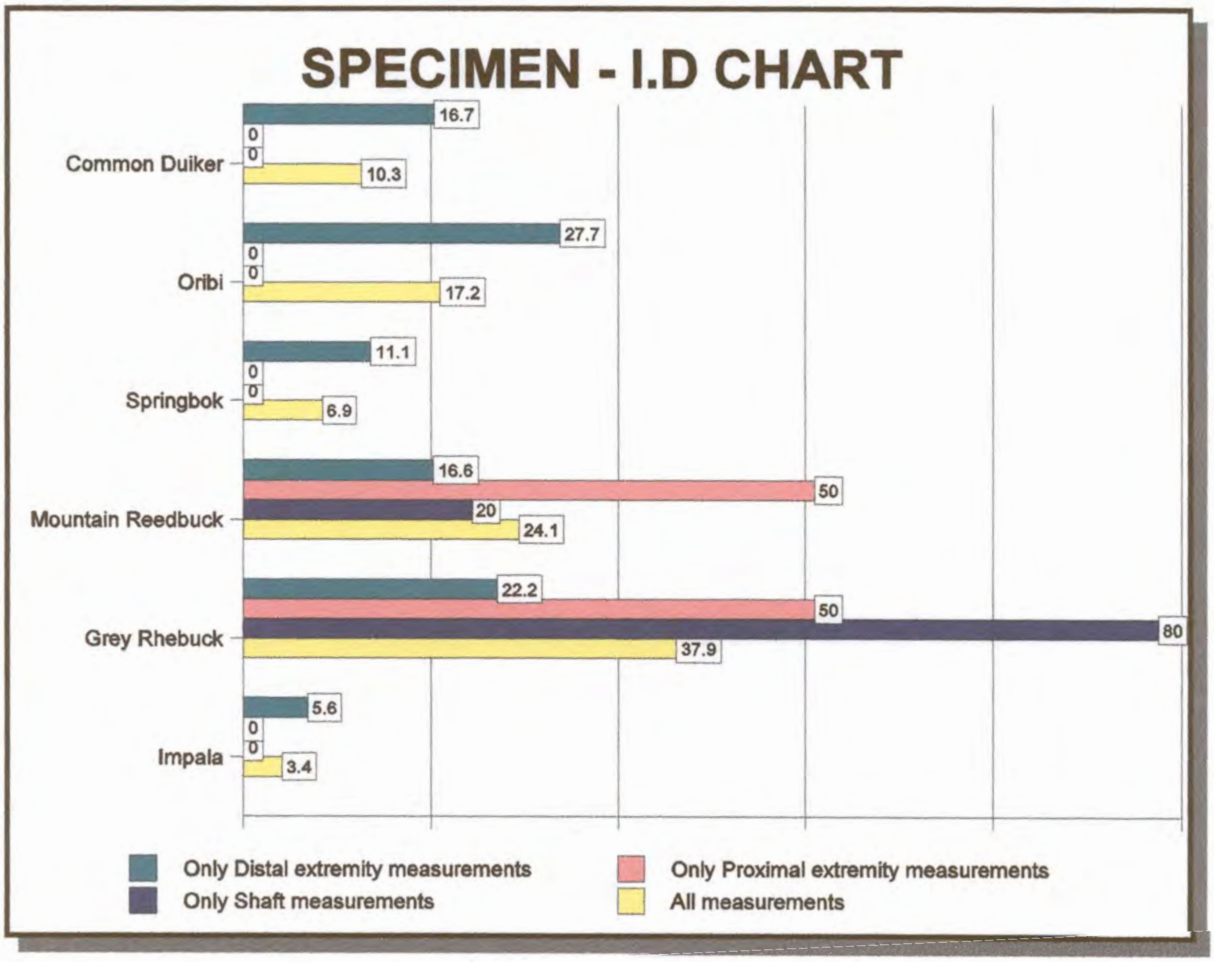
F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)
190.0	185.0	16.3	52.0	46.3	20.2	27.0	37.6	42.8	47.4	11.0	8.2	20.5

FIGURE 4.28a: Identification chart of AZ 526 - FPP (%).



SPECIES	IPP	SPECIES	IPP
Common Duiker	23%	Mountain Reedbuck	54%
Oribi	38%	Grey Reedbuck	85%
Springbok	15%	Impala	8%

FIGURE 4.28b: Differences in measurement input of AZ 526 - FPP (%)

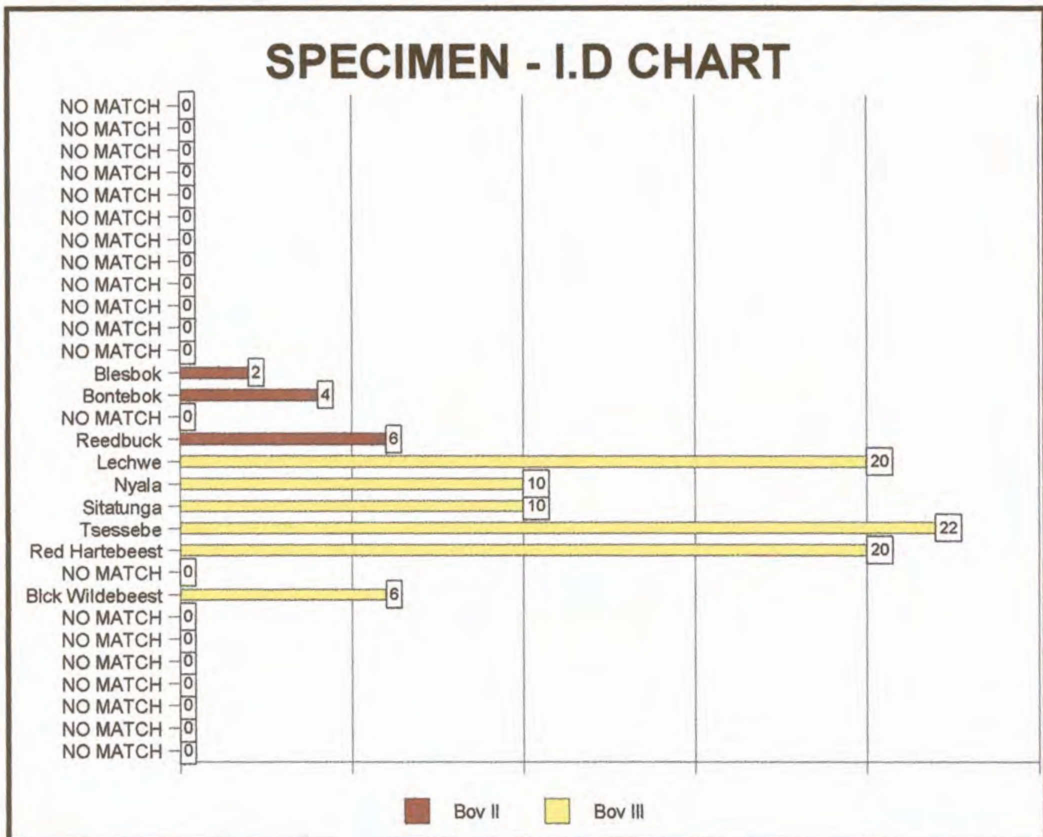


MODERN SPECIMEN (AZ 645) Red Hartebeest femur

TABLE 4.22: Measurements of specimen AZ 645.

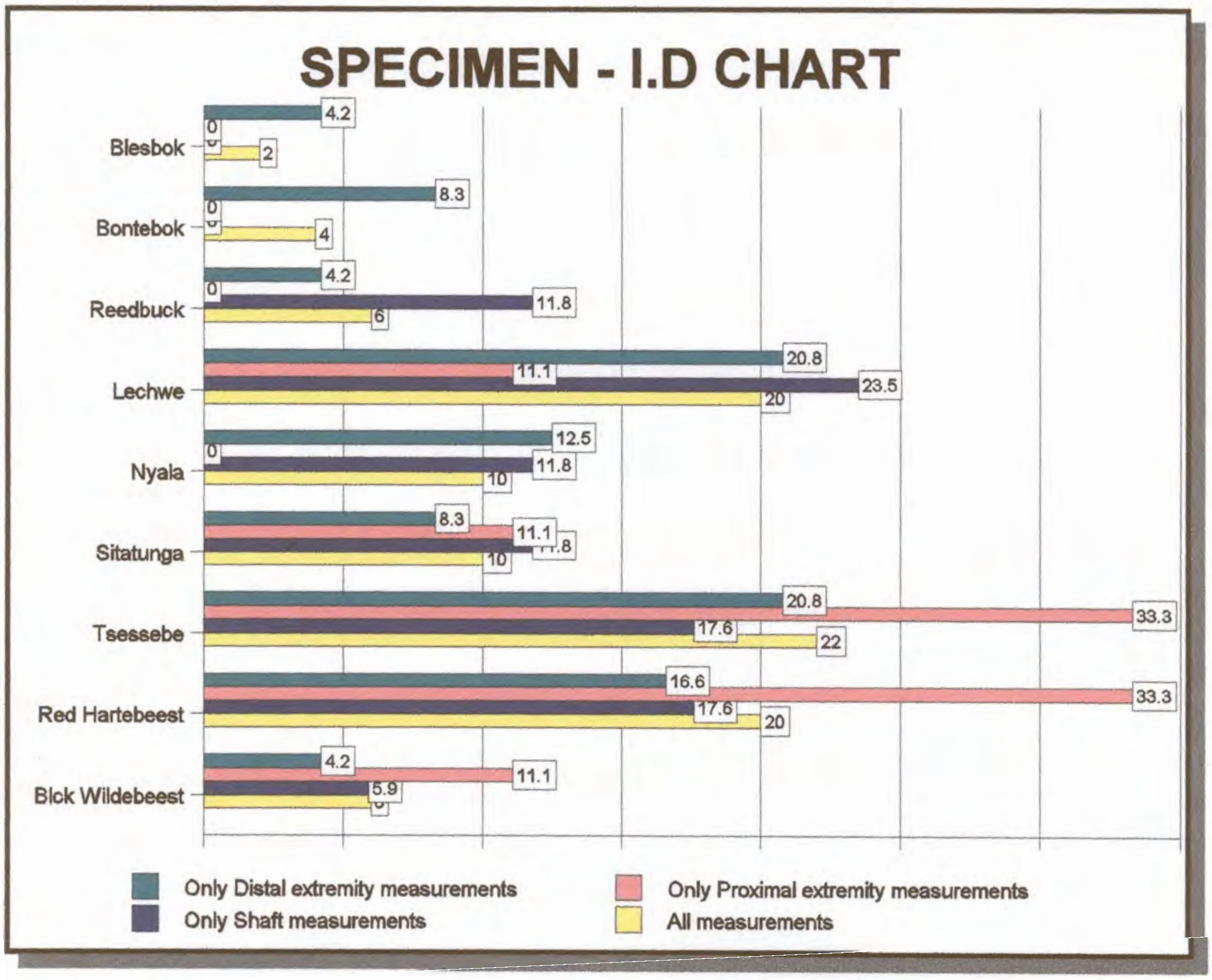
F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)
281.5	268.0	23.5	80.0	77.6	33.5	42.9	62.6	71.2	83.8	13.8	11.8	32.2

FIGURE 4.29a: Identification chart of AZ 645 - FPP (%).



SPECIES	IPP	SPECIES	IPP
Blesbok	8%	Sitatunga	38%
Bontebok	15%	Tsessebe	85%
Reedbuck	23%	Red Hartebeest	77%
Lechwe	77%	Black Wildebeest	23%
Nyala	38%		

FIGURE 4.29b: Differences in measurement input of AZ 645 - FPP (%).

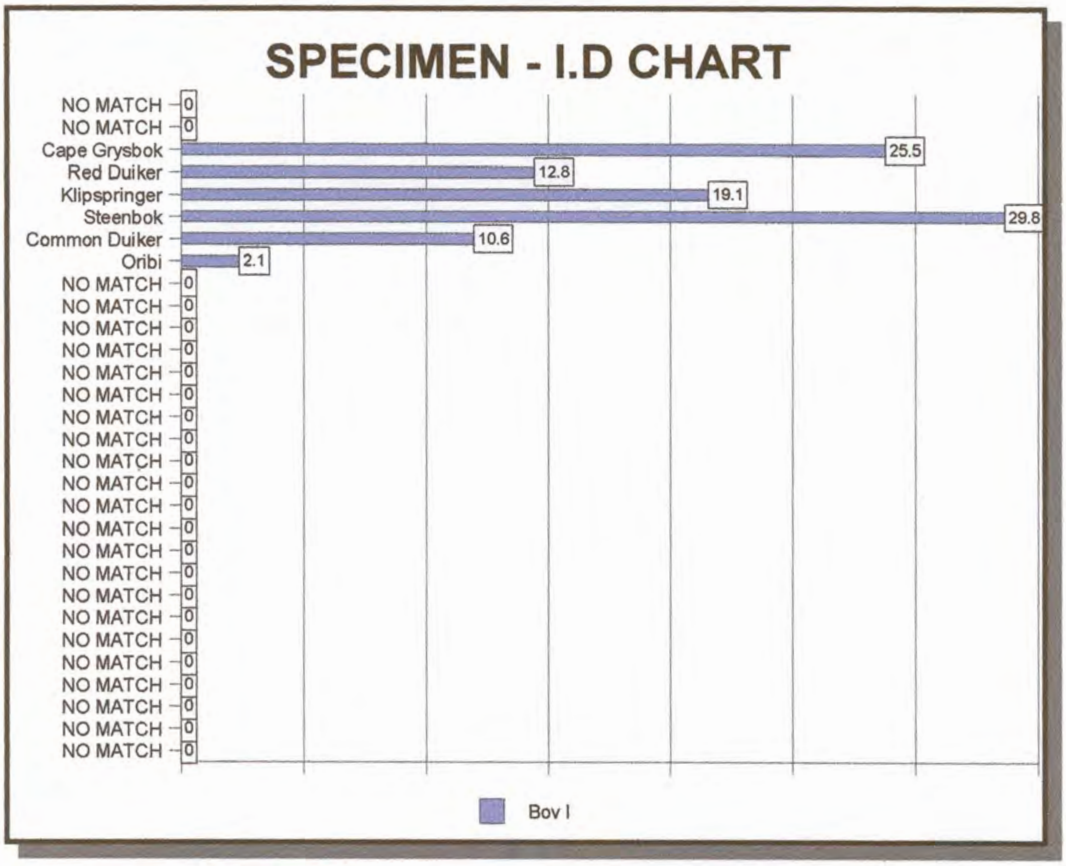


MODERN SPECIMEN (AZ 782) Steenbok tibia

TABLE 4.23: Measurements of specimen AZ 782.

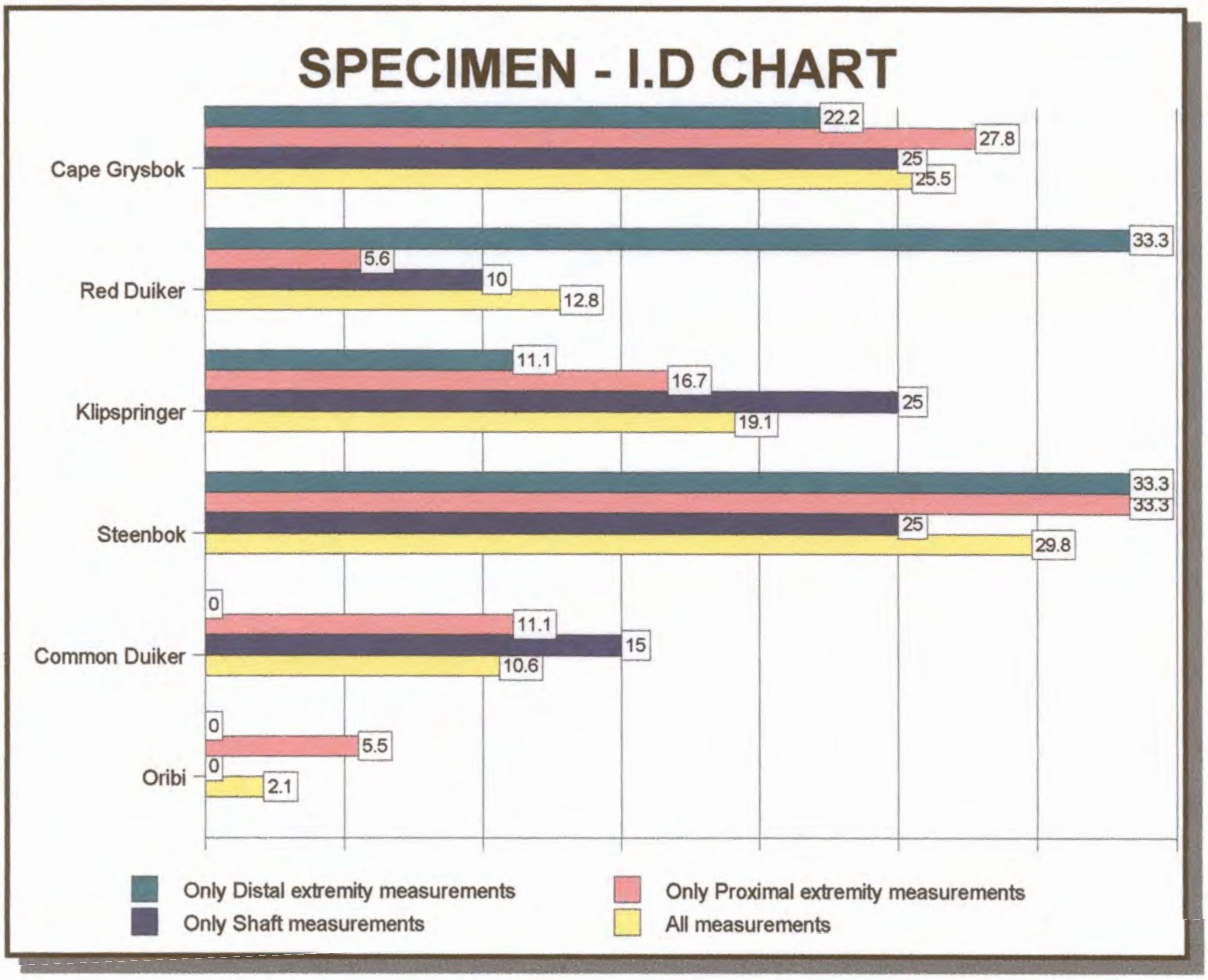
T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
183.0	180.5	180.0	12.2	37.0	30.8	35.0	22.7	19.2	34.5	10.5	6.6	19.1	14.9	10.4

FIGURE 4.30a: Identification chart of AZ 782 - FPP (%).



SPECIES	IPP	SPECIES	IPP
Cape Grysbok	80%	Steenbok	93%
Red Duiker	40%	Common Duiker	33%
Klipspringer	60%	Oribi	7%

FIGURE 4.30b: Differences in measurement input of AZ 782 - FPP (%).

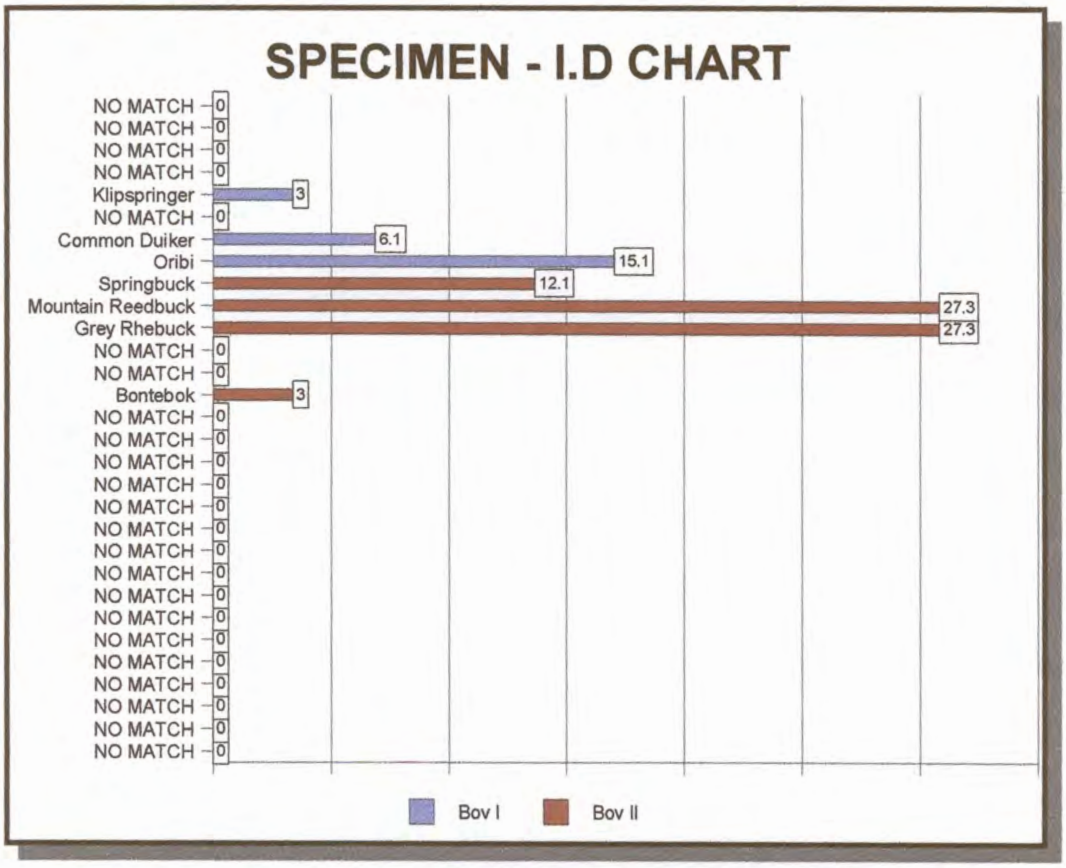


MODERN SPECIMEN (AZ 1032) Springbuck tibia

TABLE 4.24: Measurements of specimen AZ 1032.

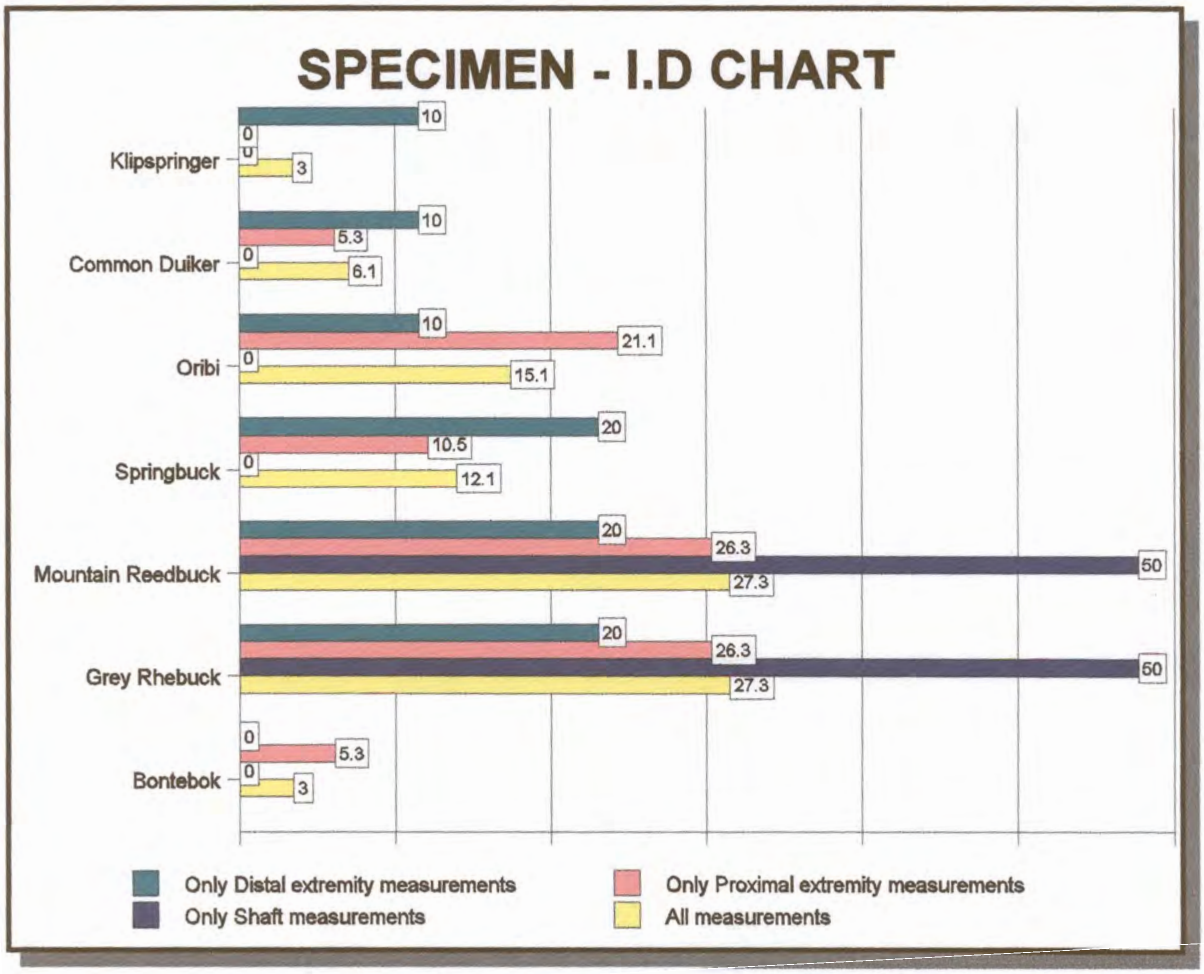
T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
232.0	227.0	224.5	16.9	51.0	42.8	43.5	29.3	22.4	40.5	11.7	8.9	28.1	21.6	13.0

FIGURE 4.31a: Identification chart of AZ 1032 - FPP (%).



SPECIES	IPP	SPECIES	IPP
Klipsrpinger	7%	Mountain Reedbuck	60%
Common Duiker	13%	Grey Rhebuck	6%
Oribi	33%	Bontebok	7%
Springbok	27%		

FIGURE 4.31b: Differences in measurement input of AZ 1032 - FPP (%).

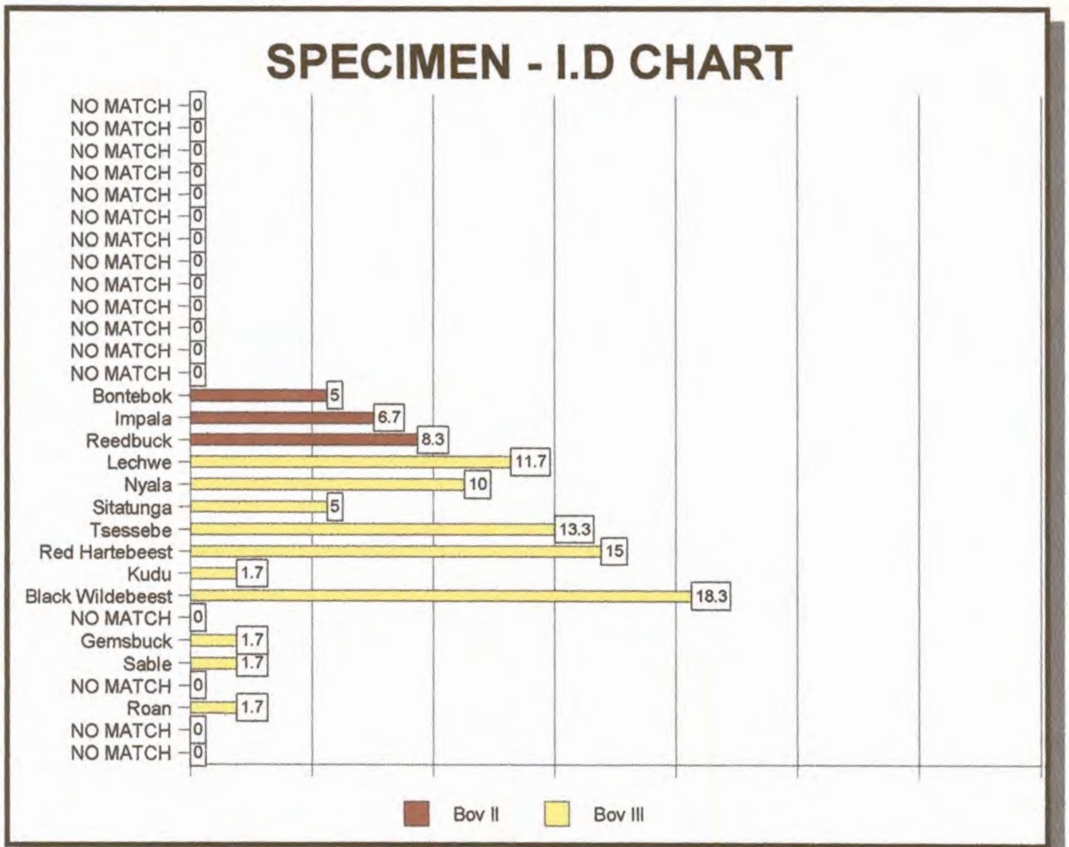


MODERN SPECIMEN (AZ 145) Black Wildebeest tibia

TABLE 4.25: Measurements of specimen AZ 145.

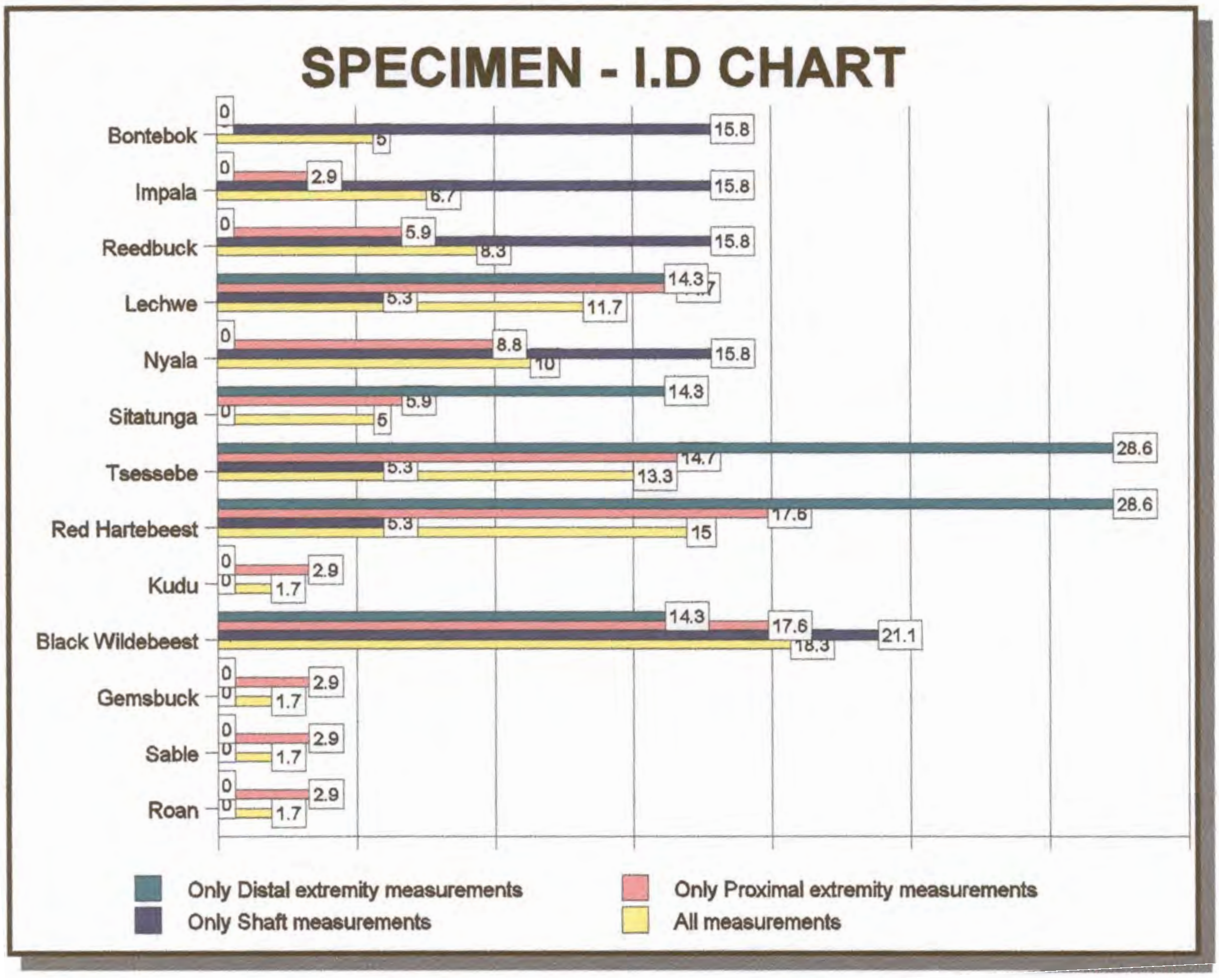
T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
312.0	302.5	298.5	26.9	76.0	72.3	67.5	39.9	42.6	57.5	18.0	12.4	42.4	32.3	22.7

FIGURE 4.32a: Identification chart of AZ 145 - FPP (%).



SPECIES	IPP	SPECIES	IPP	SPECIES	IPP
Bontebok	20%	Sitatunga	20%	Black Wildebeest	73%
Impala	27%	Tsessebe	53%	Gemsbuck	7%
Reedbuck	33%	Red Hartebeest	60%	Sable	7%
Lechwe	47%	Kudu	7%	Roan	7%
Nyala	40%				

FIGURE 4.32b: Differences in measurement input of AZ 145 - FPP (%).

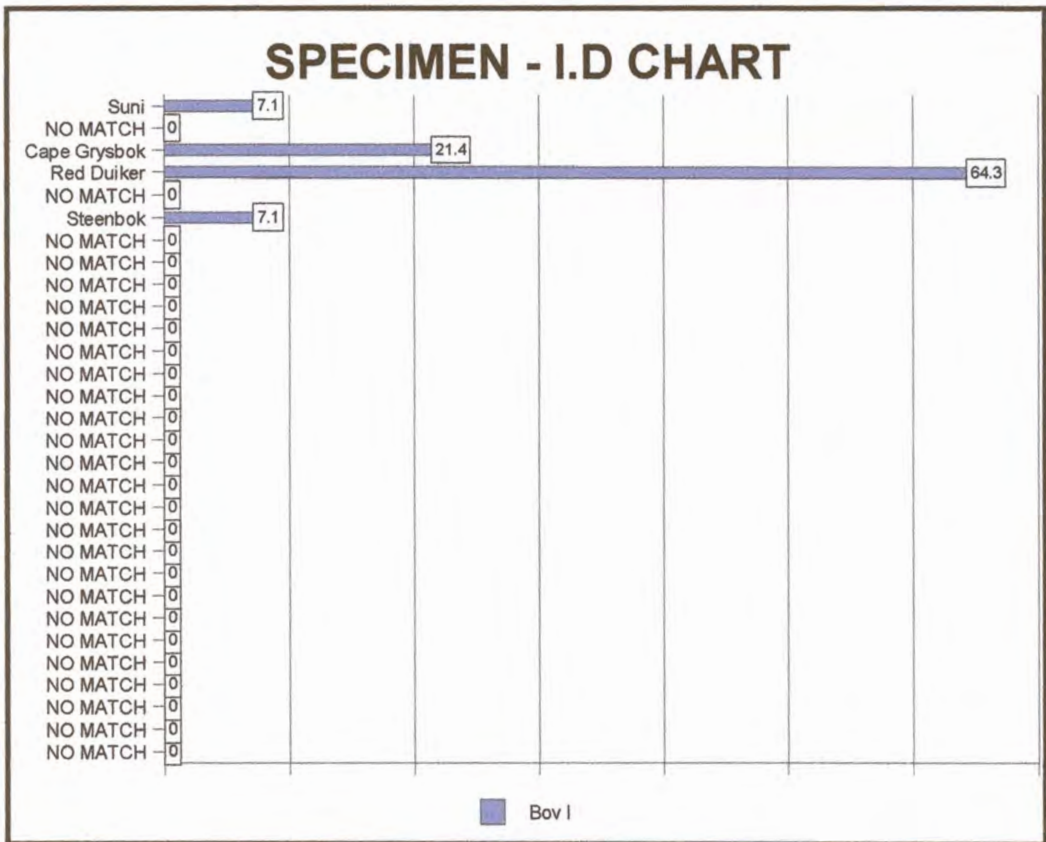


MODERN SPECIMEN (AZ 1572) *Cape Grysbok metatarsal*

TABLE 4.26: Measurements of specimen AZ 1572.

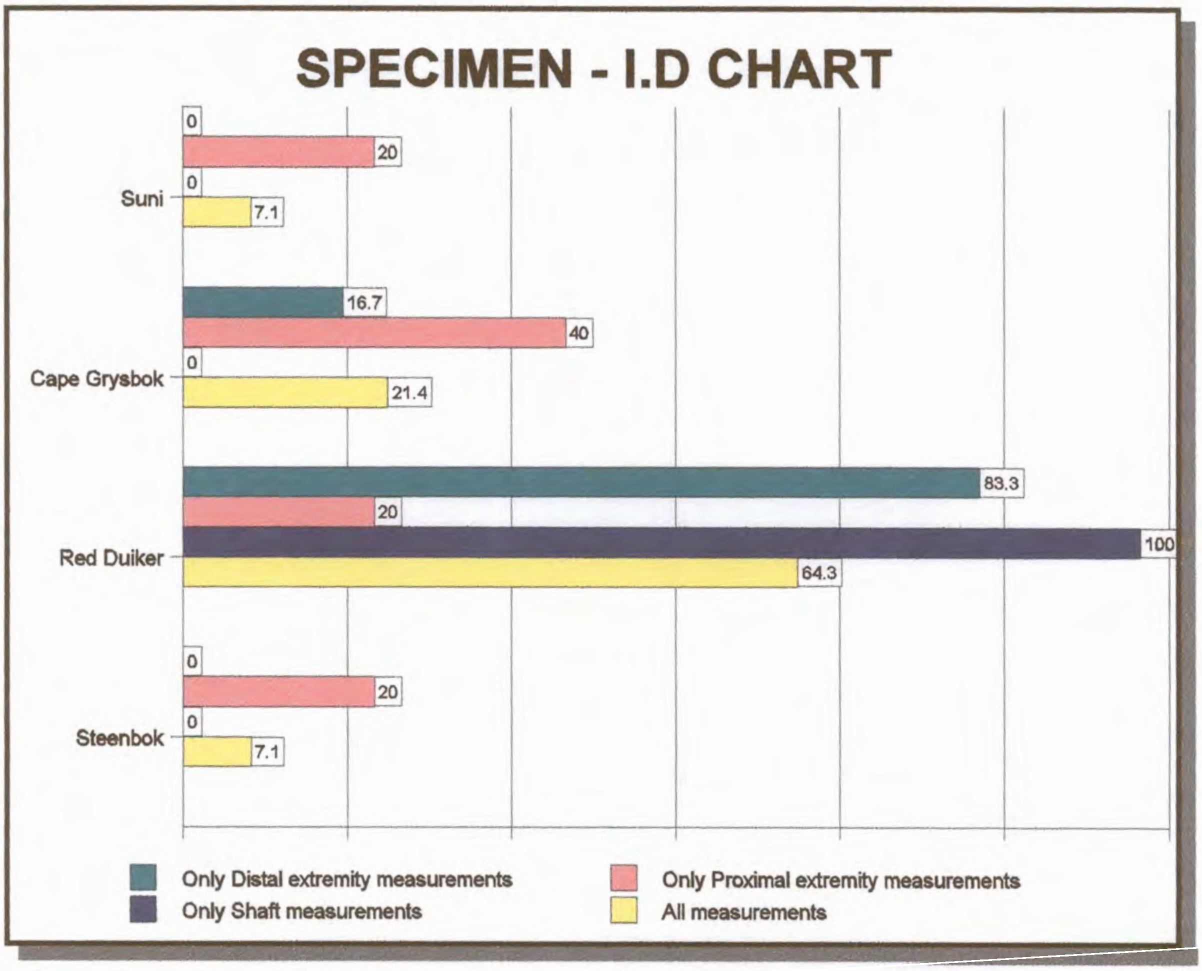
M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
121.0	118.5	119.9	8.2	28.0	14.6	14.5	10.9	4.6	7.5	6.2	15.7	11.4	7.4	6.9	7.5

FIGURE 4.33a: Identification chart of AZ 1572 - FPP (%).



SPECIES	IPP	SPECIES	IPP
Suni	6%	Red Duiker	56%
Cape Grysbok	19%	Steenbok	6%

FIGURE 4.33b: Differences in measurement input of AZ 1572 - FPP (%).

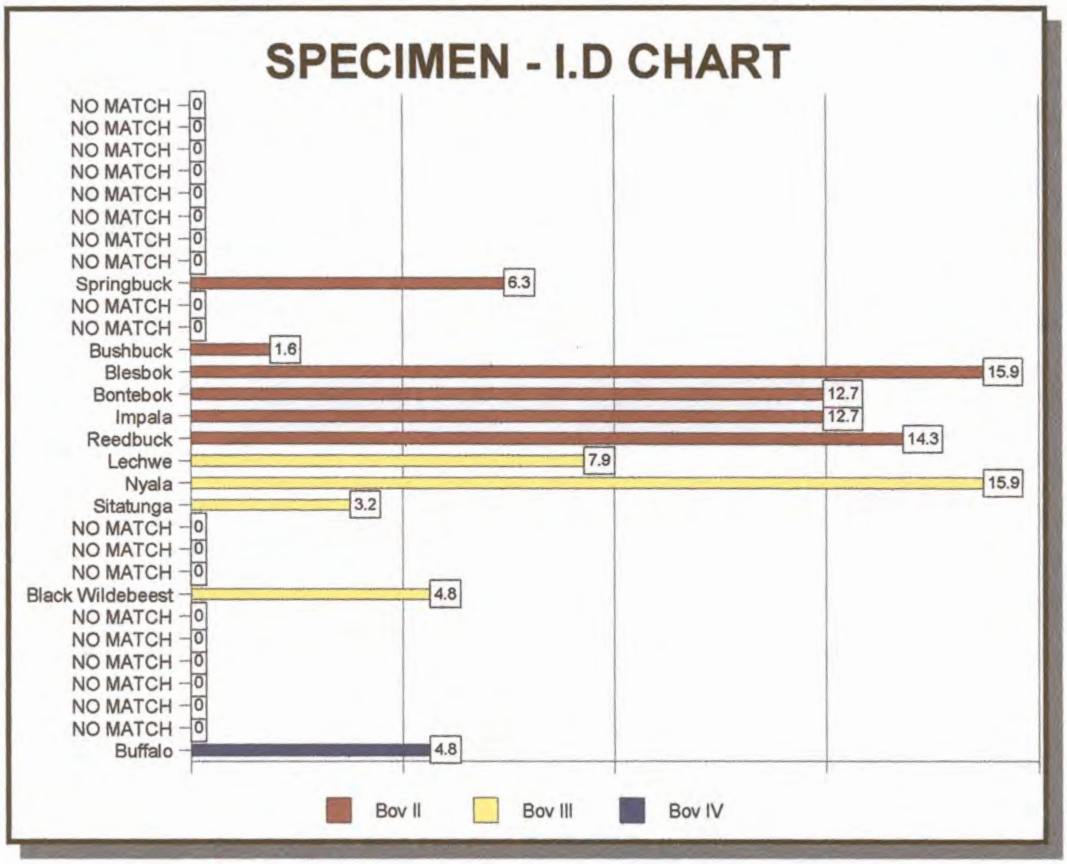


MODERN SPECIMEN (AZ 931) Bontebok metatarsal

TABLE 4.27: Measurements of specimen AZ 931.

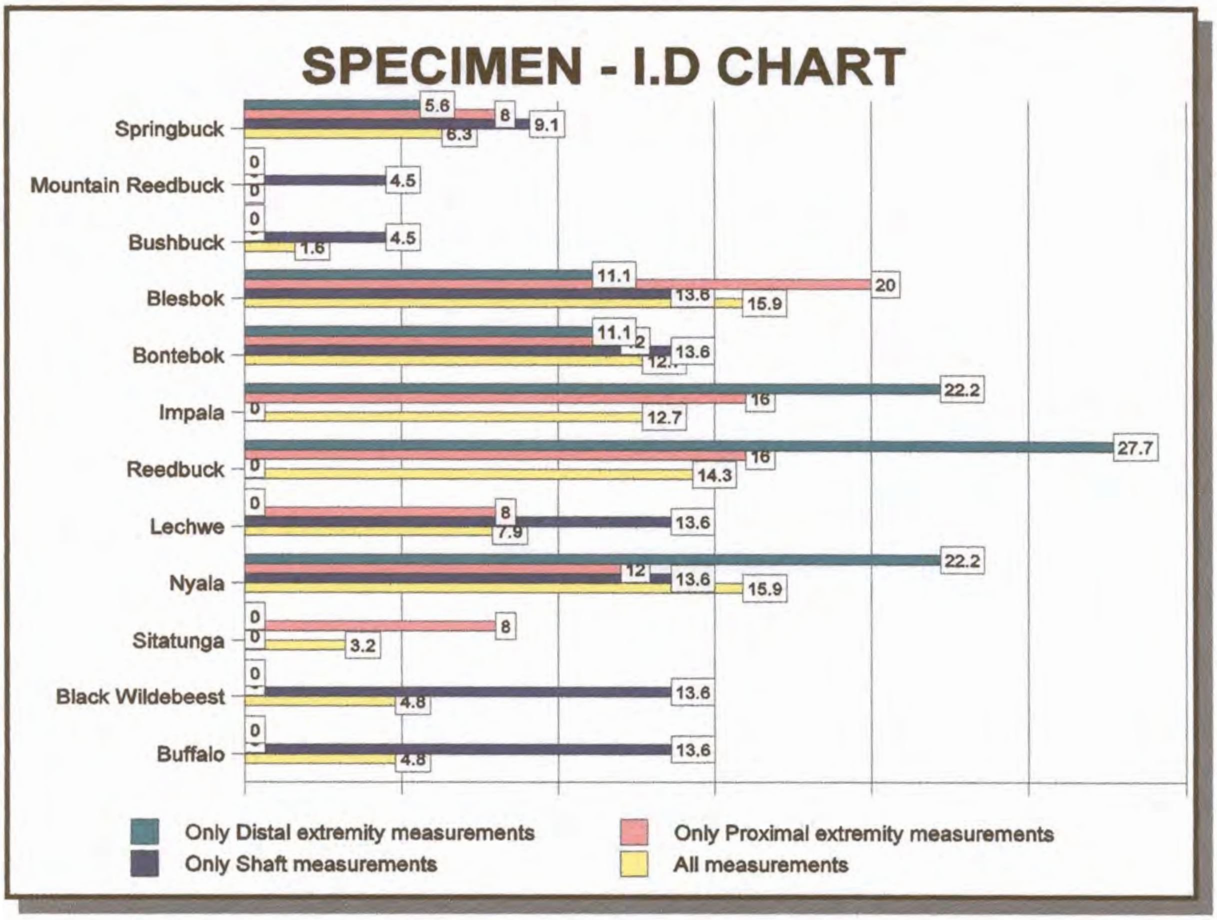
M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
217.0	213.0	214.0	14.3	48.0	27.2	28.9	19.7	12.0	18.0	10.6	28.4	20.7	12.7	12.7	14.3

FIGURE 4.34a: Identification chart of AZ 931 - FPP (%).



SPECIES	IPP	SPECIES	IPP	SPECIES	IPP
Springbok	31%	Impala	50%	Sitatunga	13%
Bushbuck	6%	Reedbuck	56%	Black Wildebeest	19%
Blesbok	63%	Lechwe	31%	Buffalo	19%
Bontebok	50%	Nyala	63%		

FIGURE 4.34b: Differences in measurement input of AZ 931 - FPP (%).

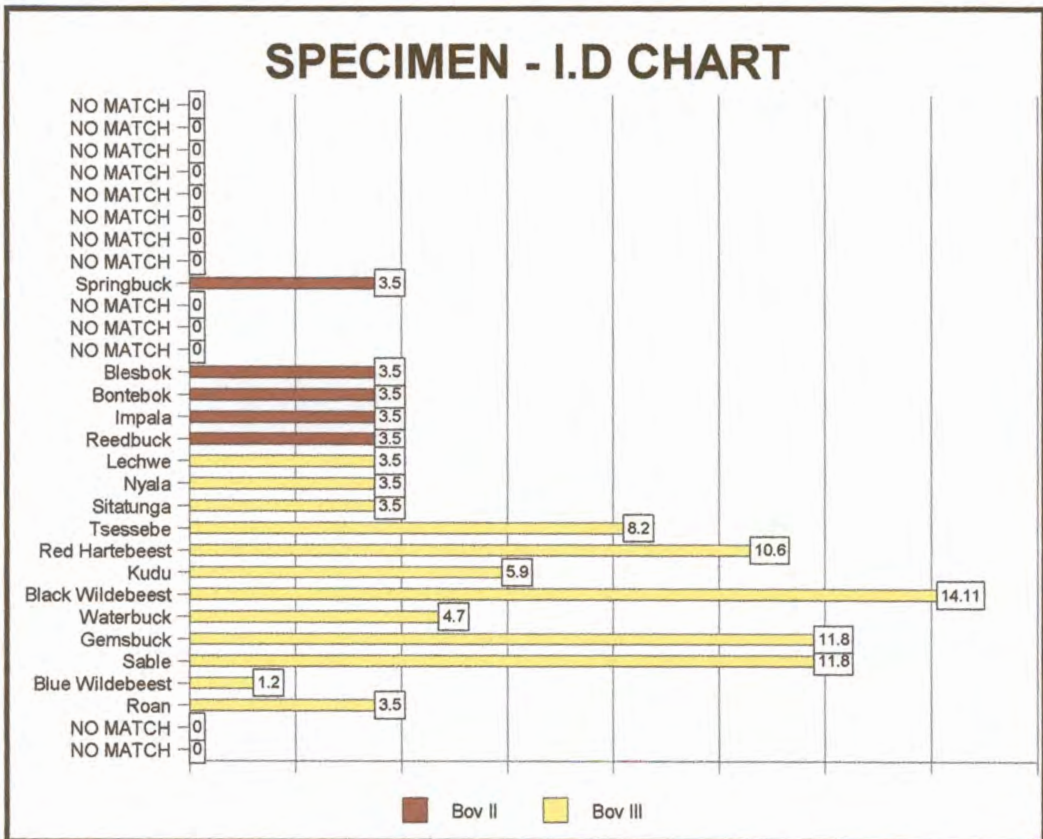


MODERN SPECIMEN (AZ 127) Sable metatarsal

TABLE 4.28: Measurements of specimen AZ 127.

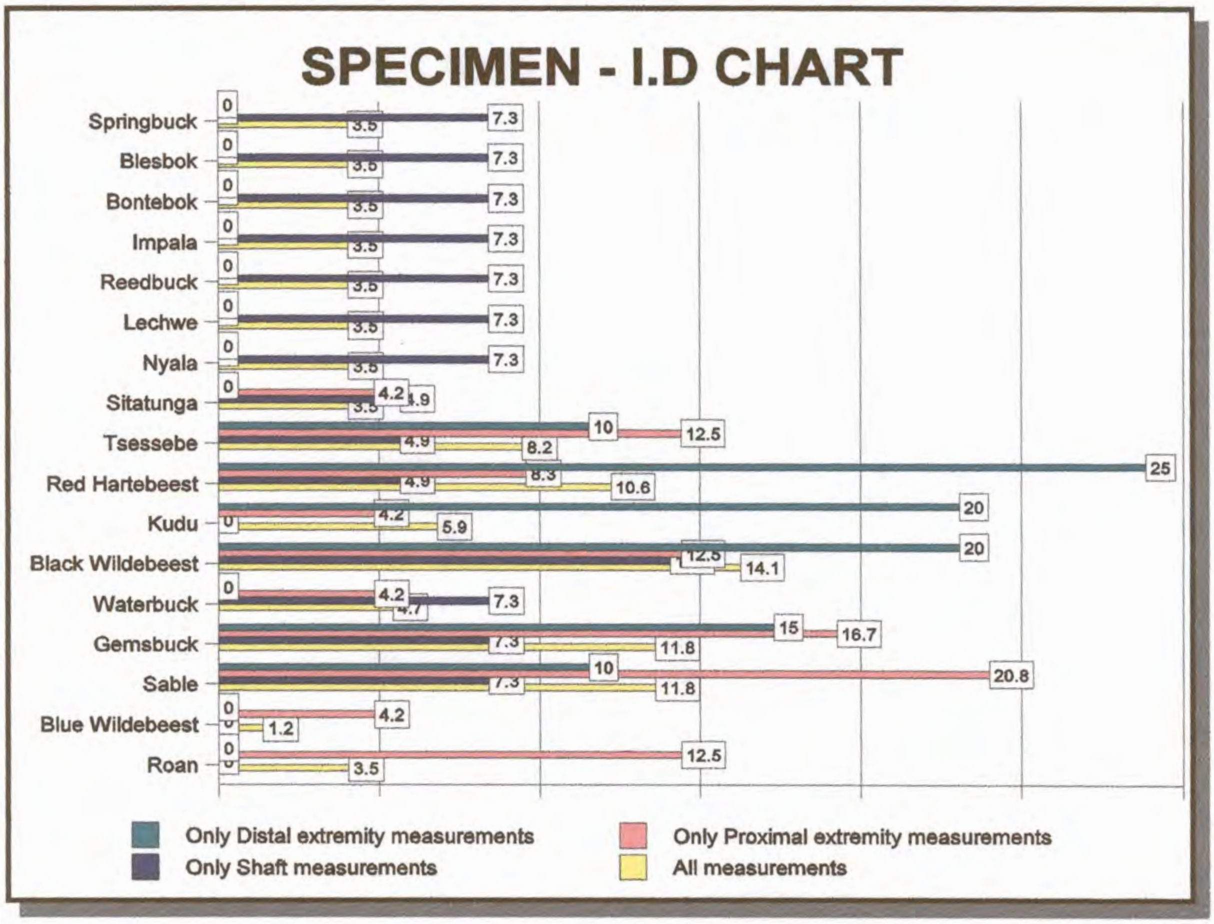
M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
234.0	228.0	230.0	21.1	73.0	37.8	38.2	26.7	15.9	21.7	15.2	42.2	27.5	19.9	19.0	19.0

FIGURE 4.35a: Identification chart of AZ 127 - FPP (%).



SP ECIES	IPP	SPECIES	IPP	SPECIES	IP P
Springbok	19%	Nyala	19%	Waterbuck	25%
Blesbok	19%	Sitatunga	19%	Gemsbuck	63%
Bontebok	19%	Tsessebe	44%	Sable	63%
Impala	19%	Red Hartebeest	56%	Blue Wildebeest	6%
Reedbuck	19%	Kudu	31%	Roan	19%
Lechwe	19%	Black Wildebeest	75%		

FIGURE 4.35b: Differences in measurement input of AZ 127 - FPP (%).

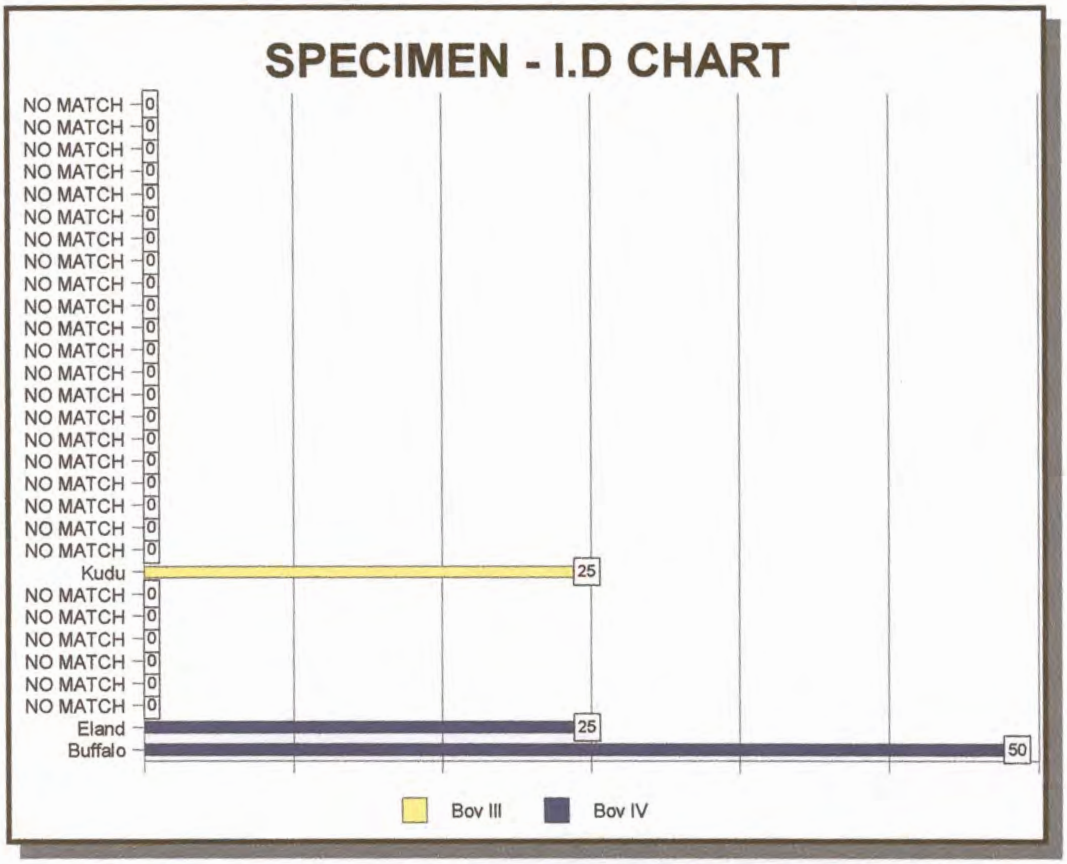


MODERN SPECIMEN (AZ 1457) Eland metatarsal

TABLE 4.29: Measurements of specimen AZ 1457.

M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GMBC)	M(GBLC)	M(GBDE)
316.0	310.0	312.0	37.0	123.0	57.5	58.5	40.9	24.0	40.0	24.0	60.4	40.4	28.6	27.8	28.6

FIGURE 4.36a Identification chart of AZ 1457 - FPP (%).



SPECIES	IPP	SPECIES	IPP
Kudu	19%	Buffalo	38%
Eland	19%		

FIGURE 4.36b Differences in measurement input of AZ 1457 - FPP (%).

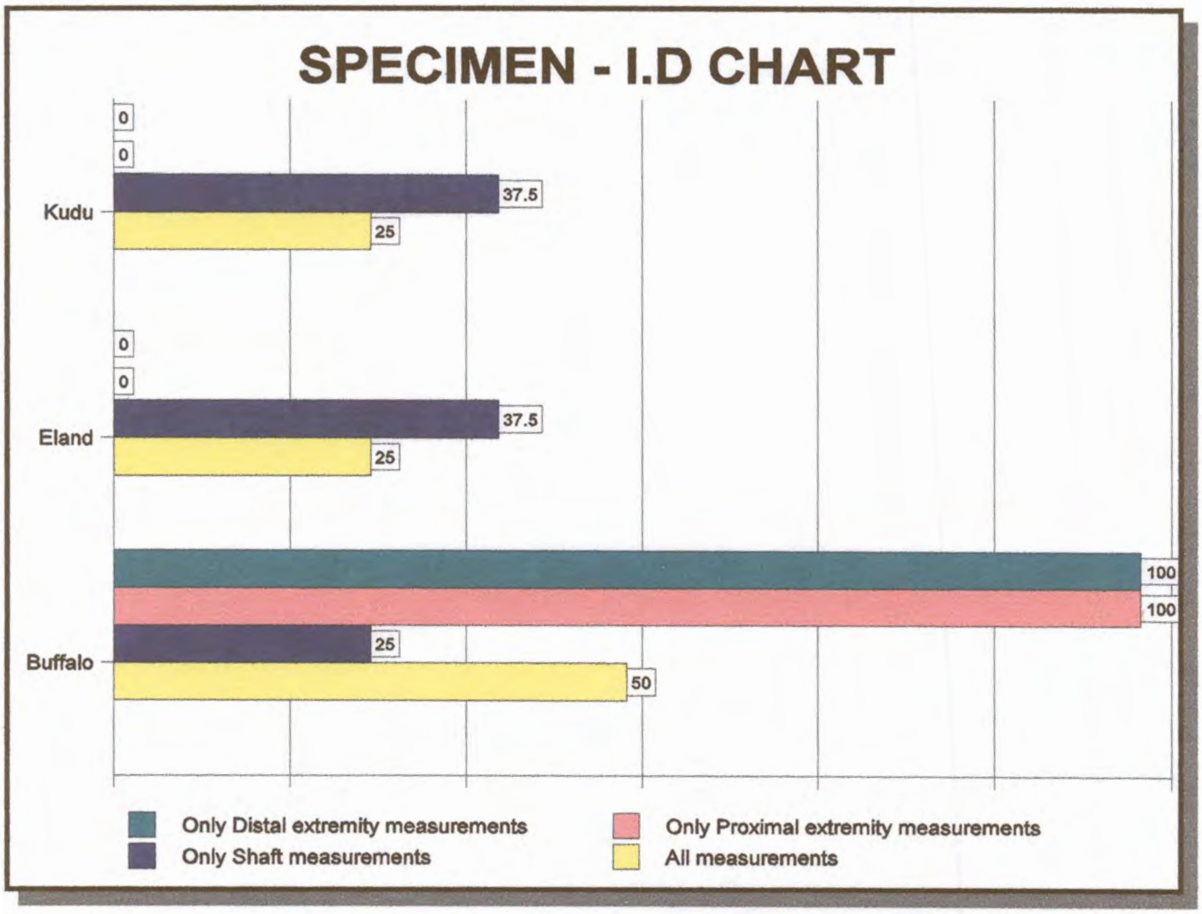


TABLE 4.30: Summary of the different measurement input results.

Specimen	All	Shaft	Proximal	Distal
FEMUR				
AZ 1069 (Klipspringer)				
AZ 526 (Grey Rhebuck)	●	●	●	●
AZ 645 (Red Hartebeest)			●	
Total for femur tests *	33%	33%	66%	33%
TIBIA				
AZ 782 (Steenbok)	●		●	●
AZ 1032 (Springbuck)				●
AZ 145 (Black Wildebeest)	●	●	●	
Total for tibia tests *	66%	33%	66%	66%
METATARSAL				
AZ 1572 (Cape Grysbok)			●	
AZ 931 (Bontebok)		●		
AZ 127 (Sable)			●	
AZ 1457 (Eland)		●		
Total for metatarsal tests *	0%	50%	50%	0%
GRAND TOTAL (%) **	**30%**	**40%**	**60%**	**30%**

● Identified as being the most probable species, thus having the highest FPP value
* The percentage of specimens of the femur, tibia or metatarsal specimens that was correctly identified as being the most probable species
** The total percentage of specimens that was correctly identified when respectively all, the shaft, the proximal extremity or the distal extremity measurements were entered into the computer programme

5 DISCUSSION

1. STAGE 1 - FAUNAL ANALYSIS

Stage 1 of this study entailed the analysis of the faunal remains excavated at Kemp's Caves, South Africa. It involved mainly the sorting and identification of fragmented bone pieces. The results were used to confirm the ESR dates of the site, especially with the use of identified extinct animal remains. Five specimens were identified as being representative of *Equus capensis* (Cape horse / zebra). At present, this is the only extinct species that was recovered at Kemp's Caves.

The results of the faunal analysis were also utilized to give insight into environmental changes such as climate and habitat, which may have occurred in the Kemp's Caves area during its existence. The last aim of this stage was to suggest a primary accumulating agent for the caves for better understanding of the caves' taphonomy.

1.1 Faunal assemblage

More than 8000 specimens were sorted and identified to species level where possible. Twelve percent of the elements could be identified to larger mammalian and other categories, while only three percent could be identified to different taxa and species (see Table 4.1). Plug is of opinion that the small amount of identified specimens typically found from sites in South Africa is due to the fact that these excavation sites produce specimens which are fragmented to a large extent [94].

Like most other cave sites, the faunal remains of Kemp's Caves is composed mostly of bovid specimens. More than 85% of the specimens belonged to 13 different bovid species. Bovid size class II and III represented 68% of the bovid sample, suggesting activity of medium to large sized predators.

Only one domestic species, *Bos taurus* (domestic cattle), was identified. The five specimens were modern and not fossilized, suggesting a recent origin. The cave is situated in an environment which had been a game reserve for the past 40 years, which suggests that no domestic cattle have been found here since 1963. This may imply that the specimens were brought in from the outside, probably part of a human meal, when considering that only five specimens were identified. It could also have been scavenged and brought in from a neighbouring farm of an animal that died of natural causes. Another explanation could be that it was washed from a site outside the game reserve into the tunnel of the North-eastern extension. It could also have been washed into the North-eastern tunnel prior to 1963. Brain states that it is not unusual for separate specimens of a skeleton or even a bone to be transported by water before it is deposited as part of the faunal assemblage. It is, however, necessary to keep in mind which parts of the skeleton can be carried away by an aqueous current to establish whether a certain specimen could have been washed in or not [2]. The specimens consisted of four carpals (complete) and the distal articulation of a radius. Studies have shown that structures such as complete skulls, ribs, vertebrae and phalanges were transported by the current, but that teeth, metapodials and tibiae became imbedded within the riverbed [2]. It is however, still unclear whether water could have been responsible for the transportation.

Several carnivore specimens ranging from large species, like leopard, to smaller species, like mongooses, were represented in the sample. Carnivores often prey on other carnivores, thus the fact that carnivore specimens were represented in the assemblage might indicate accumulation by scavenging and hunting of non-human predators. The skeletal representation of the carnivores may, however, also be the result of natural deaths.

Only a few avian and reptilian specimens were represented by either ostrich egg shell or fragmented carapaces. No fish remains except a few crab pinchers were found. This indicates that avian and reptilian fauna might not have been a major part in the diet of either man or animal at Kemp's Caves.

The faunal assemblage of sites with similar dates show several similarities with that of Kemp's Caves (see Table 4.2 for species identified at Kemp's Caves).

Rose Cottage Cave showed many similar macro-mammalian species which included most bovids which were also identified at Kemp's Caves. *Antidorcas marsupialis* (Springbok) were well represented with a high NISP value of 106. The extinct species *Equus capensis* was also identified and was represented by six separate specimens [34].

The faunal sample of Sehonghong is dominated by fish, thus no clear comparison could be made with this site in Lesotho.

Klasies River Mouth yielded similar bovid and carnivorous species, but also had a large quantity of fish and molluscs. Klasies River Mouth further yielded several hominid specimens, which included a fragmentary skull, that appears to be anatomically modern, as well as twenty four MSA dated specimens [56]. *Pelorovis antiquus* (Giant buffalo), which became extinct between 12 000 and 10 000 BP, was the only extinct species identified [95].

Klasies River Mouth and Border Cave are both coastal sites and yielded several hominid specimens regarded as anatomically modern humans. Kemp's Caves fall within this important era of the evolution of anatomical modern humans, but had yielded no hominid specimens which could be associated with the older deposits in the cave. This fact may support the theory that anatomical modern humans had a coastal evolutionary history [41]. However, there has only been a small amount of fossils excavated at the Kemp's Caves site, and it may still yield hominid specimens. This may then contradict this theory, as Kemp's Caves is an inland site.

1.2 Equus capensis

Equus capensis was the first species of fossil horse to be described in South Africa. Broom identified several equid specimens that led him to suggest for some time that an extinct equid may have existed in the Cape Province, but it was only in 1909 that he was able to describe the dentition of this animal [96]. The first fossil (left mandibular ramus) was found in a slab of limestone on a beach at Ysterplaatz in Table Bay [2]. Twenty species of *Equus* were described in South Africa between 1909 and 1950. Five of these were that of several other zebra species, and the rest are considered to all be *E. capensis*. These specimens allowed Broom to describe the species in greater detail.

Although no formal classification is given, Broom describes *E. capensis* as a horse species with a skull considerably larger (10-15%) than *E. caballus*. It had the same pattern of the lower molars of modern horses, but lacked any traces of the protostylid [97]. The animal appeared to be more powerfully built than *E. caballus*, but did not stand very high [2].

Mixed criticism about Broom's identification included that of Wells [98], who considered Broom's type *E. capensis* as indeterminable and suggested that the correct name for the extinct Cape horse should be *E. helmei dreyer*. Churcher, however, supported Broom's identification and applied the type *E. capensis* to the Sterkfontein valley material [2].

Klein suggested that *E. capensis* disappeared from the Southern Cape with other forms such as the giant buffalo *(Pelorovis antiquus)* and giant hartebeest (*Megalotragus*) around 12 000 - 10 000 years BP. These dates coincide with the environmental changes of the terminal Pleistocene. He also suggests that both the environment as well as man's more effective hunting methods could have been responsible for these extinctions [99]. The extinct equids had a larger body-size than the extant equids. This indicates a similarly low metabolic rate and implies that extinct equids like *E. capensis* had the ability to cope with more low quality food. This in turn defines the feeding niche of *E. capensis* as having a larger amount of course grass as part of its diet than extant equids [100]. It is therefore suggested that the giant grazers such as *Megalotragus priscus*, *Pelorovis antiquus* and *Equus capensis* acted as "lawn mowers". This feeding niche stimulated the production of new growth of the grassland herb layer [101].

Remains of *E. capensis* have been found all over South Africa, and have been the object of rock paintings and engravings of artists that may have seen the horse alive. These artistic records show various differences. Several records show this species with stripes, like a zebra, while other paintings lacks a striped appearance which resembles a horse [2]. Brain [2] illustrated *Equus capensis* as having stripes (Figure 5.1) whereas Maglio and Cooke [97] showed a non-striped species (Figure 5.2).

FIGURE 5.1: *Equus capensis* as illustrated in "The Hunters or the Hunted" [2].

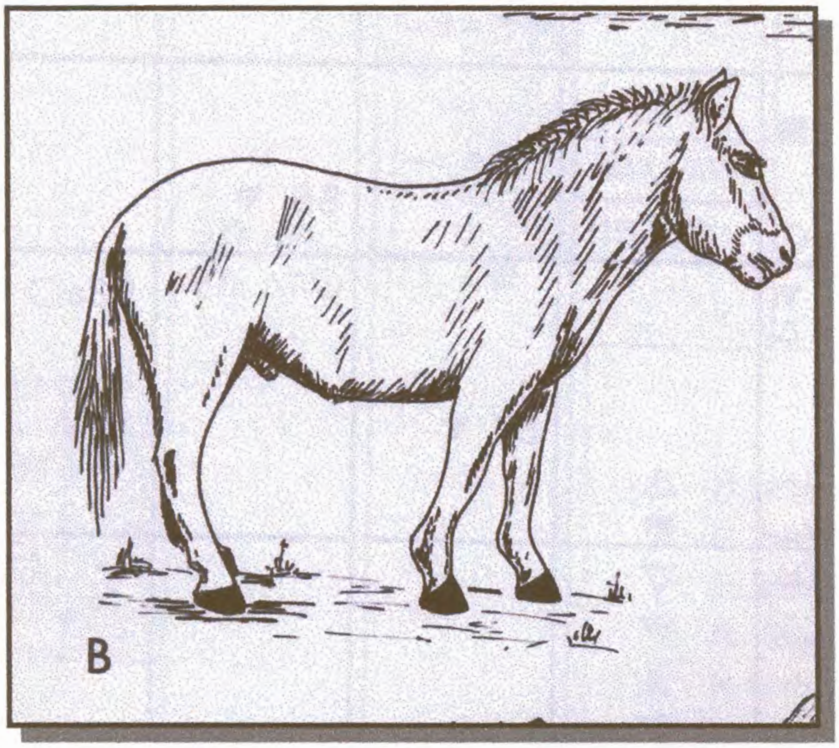
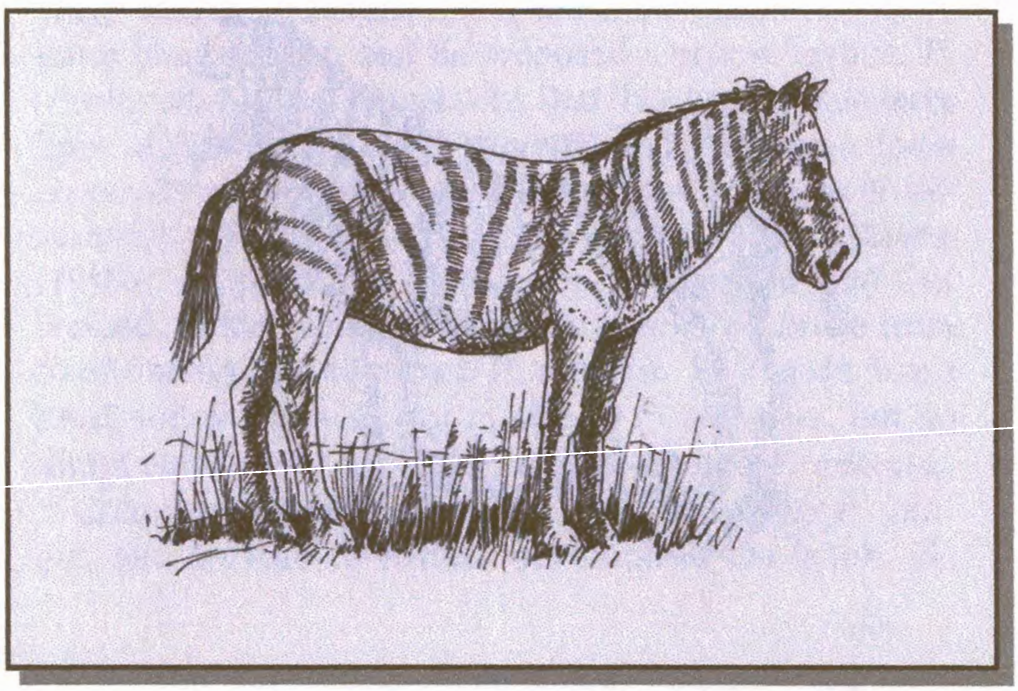


FIGURE 5.2: *Equus capensis* as illustrated in "Evolution of African mammals" [97].



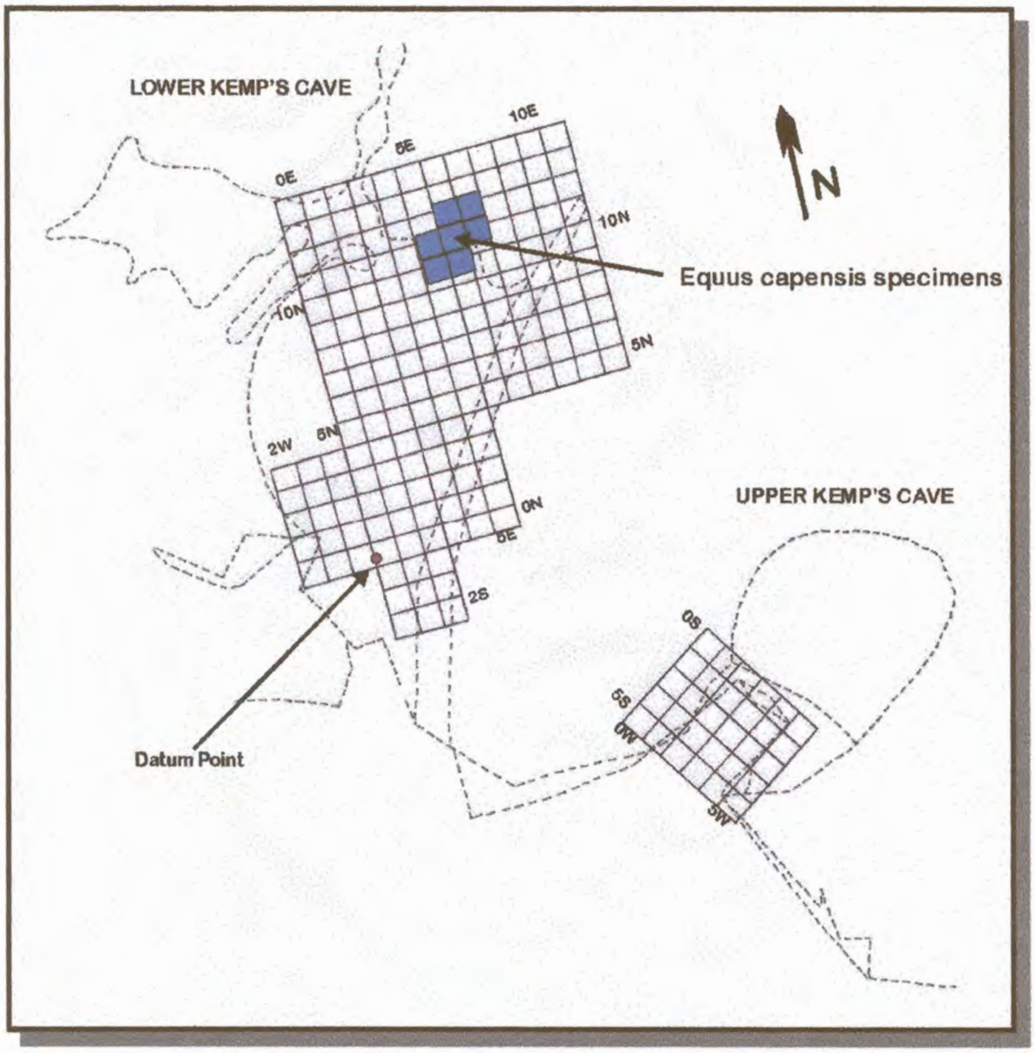
1.3 Dating

Dating of Southern African caves is very difficult due to the fact that no volcanic material are available for absolute dates [27]. Therefore it is essential that other methods of dating are done. Electron Spin Resonance has provided dates for many sites, but is nevertheless dependent on the uptake of uranium. Faunal analysis have thus been the primary means of dating for South African fossil sites [102]. The Taung *Australopithecus* was, for example, assigned to the Pliocene on the basis of the analysed fauna associated with the specimen [103]. The oldest associations are those of Sterkfontein and Makapansgat, but the most recent work has been done by Cooke [95]. Faunal analysis can be used for date confirmation if an extinct species is identified in the faunal remains. Knowledge of the approximate era the extinct animal roamed the earth, may be indicative as to the date of that particular section of the site from which the extinct animal remains originated.

Kemp's Caves produced ESR dates of 11 000 BP to 140 000 BP. All faunal specimens identified in the Kemp's Caves faunal assemblage was of modern species, except one extinct equid. *E. capensis* (Cape zebra / horse) was identified. This animal became extinct approximately 10 000 BP. This species confirms the dates of the Electron Spin Resonance results. Three of the five *E. capensis* specimens were excavated from provenances 5E6E 10N, 5E 11N and 6E7E 11N12N. Unfortunately, no provenance was associated with the other two specimens which were fragments of a left humerus. Therefore, they could not be of use to assist with confirmation of the ESR dates of Kemp's Caves. Wells describes the earlier sites as having a larger amount of extinct species that the later sites such as Florisbad which had a progressively decreasing number of extinct species [104].

Figure 5.3 illustrates the area from which *E. capensis* specimens were excavated, suggesting that this part of the cave has a date of at least 10 000 to 12 000 BP.

FIGURE 5.3: Provenance of the excavated *Equus capensis* specimens.



Other species which became extinct during the last 100 000 years are the giant buffalo (*Pelorovis*), giant hartebeest (*Megalotragus*), giant warthog (*Stylochoerus*), extinct springbuck (*Antidorcas*), three-toed horse (*Hipparion*), short-necked giraffes (*Sivatherium*), sabre-tooth cats (*Megantereon*) and giant baboon (*Theropithicus*) [37]. None of these species were identified, thus the earlier date (140 000 BP) could not be confirmed. Klein does, however, suggest that *E. capensis* may have already existed 1.8 Myr ago [105].

North American vertebrate palaeontologists established the term "Land Mammal Ages" to represent a fauna whose members existed during the same restricted geochronologic interval. Cooke states that our knowledge of the Pleistocene in Africa is not yet adequate to designate Land-Mammal "Ages" and therefore in 1965 proposed the term "Faunal span". This concept describes the duration of existence of a particular faunal assemblage. One of these proposed faunal spans is called the *Florisbad-Vlakkraal Faunal Span*. This span is characterized by an assemblage of living species enriched by surviving extinct forms. Extinct species are not found with the Later Stone Age cultures which began about 12 000 BP and are thus referred to as recent [106]. The identification of *Equus capensis* might then suggest that Kemp's Caves fall partly into the *Florisbad-Vlakkraal Faunal Span*. Hendey describes this similar time-span as the *Florisian Mammal Age*. It is characterized by fauna which was essentially similar to that of the Holocene although many of the mammals excavated showed that the extinct species were larger than their modern counterpart. These species included *E. capensis* [103].

There are, however, very modern specimens identified. With further excavations and possible identification of more extinct species the chronology of Kemp's Caves might become more clear. No faunal specimens were found to contradict the current ESR dates.

1.4 Ecology and environment

Kemp's Caves fall within veldtype 61, Bankenveld. Bankenveld is classified as a grassveld and have soils which are poor and acid. The largest percentage (53%) of species identified in the faunal sample is grazers and 27% is mixed feeders. Both these feeding types has grasses as part of their diet. Only 20% is browsers, which utilize woody vegetation (Figure 4.6). Thus the diet of the species identified correlates with this grassveld veldtype.

Bankenveld is classified as a sourveld which is characterized by plants that become less nutritious and palatable when reaching maturity, thus the plants can only be utilized for parts of the year while the plants are still young. Although some of the grasses which are characteristic of this veld type had a low palatability value, all species identified did have at least one grass or tree species which featured in their preferred diet (Table 5.1). Grass species such as *Panicum maximum* (Buffalo grass), *Cynodon dactylon* (Couch grass) and *Themda triandra* (Red Grass), which were mentioned as some of the main dietary grasses for grazers are however, not characteristic of Bankenveld. The fact that the diets of all species identified did have representation of plants presently occurring in this area, might indicate that the flora did not change much during the formation of the cave deposits. Although animals easily adapt to their environment, certain species do prefer specific plants. Table 5.1 shows which of the species identified utilizes a specific plant species which are characteristic to Bankenveld. This table was compiled from information of Van Oudtshoorn [48] and Smithers [51]. It also gives an indication of its palatability value [48].

Cooke states that during the Pleistocene there was a rise of modern species and a decline in the archaic forms. It is therefore demonstrated by the excavated fossil herbivores that the broad ecological conditions did not vary much and that the different regions during Pleistocene times maintained the same distinctive characteristics today [107]. Brink, however suggests that the feeding niche of species like *Antidorcas bondi* who relied on the "lawn mowing" type of grazing done by *Equus capensis* and *Pelorovis antiquus* suggests that the ecology of southern Africa might have been different from present due to the facilitated interaction of grazers. This also suggests that the grasslands of Southern Africa were more productive during the Late Pleistocene than at present [108]. The species that were identified in the faunal sample of Kemp's Caves in the present study were all animals that occurred here in the past or still occurs in the area. This fact may also suggest that the environment and climate have not changed much in the last 100 000 years. Kemp's Caves may still yield a large amount of fossilized material, including hominid remains, which may result in a different interpretation of the historical ecology of the area.

TABLE 5.1: Plant species utilized by identified animal species of Kemp's Caves.

PLANT SPECIES		PALATABILITY	ANIMAL SPECIES
	GRASSES		
Trachypogon spicatus	Giant speargrass	Average → Low	Reedbuck
Schizachyrium sanguineum	Red autumngrass	Low → Average	Sable
Panicum natalense	Natal panicum	Low → Average	Blue Wildebeest,Springbuck
Digitaria tricholaenoides	Purple finger grass	High	Blue Wildebeest
Digitaria monodactyla	One-finger grass	Low → Average	Blue Wildebeest
Sporobolus pectinates	Fringed dropseed	Low	Black Wildebeest, Springbuck Red Hartebeest
Ctenium concinnum	Sickle grass	Low	Blesbuck
	FORBS		
Variation of palatable forbs		N / A	Steenbok, Grey Rhebuck
	WOODY VEGETATION		
Maytenus heterophylla	Common spike-thorn	Average	Impala
Dombeya rotundifolia	Wild pear	Average	Sable
Ziziphus mucronata	Buffalo-thorn	Average	Impala, Sable, Springbuck
Combretum molle	Velvet bushwillow	Average	Impala
Grewia occidentalis	Cross-berry	Average	Impala, Eland, Springbuck

1.5 Taphonomy and Bone accumulations

Caves are commonly used as retreats and breeding sites by several animal species, as well as by humans. Bony food remains accumulate at these sites and may fossilize in certain circumstances. These bone accumulations are useful in identifying the inhabitants of the cave and have therefore been thoroughly researched during the last century [2,3,58].

The three most common agents responsible for bone accumulations are porcupines, humans and carnivores [2,28,109]. Kemp's Caves exhibit a variety of evidence which may conclude that both humans and animals were responsible for the accumulations at this site. Findings of Kemp's Caves that relate to conclusions made in various studies of the different chief accumulating agents, are listed below to give an indication of the varied interpretations:

1.5.1 Porcupine as accumulating agent

The rodent, *Hystrix africauastralis* (Porcupine), is confirmed to be an important bone collector although this species is in fact vegetarian. Brain suggests that porcupines carry more bones to caves than any other accumulating agent [2]. During 1956 a well-known porcupine, by the name of Aristotle, was studied by the zoology department of Rhodes University to establish behaviourial patterns. Observations showed that the porcupine appeared to have no interest in meaty, fresh bones. Dry bones, however were instantly taken to its lair and gnawed. Like other rodents, the porcupine has open-rooted incisors that constantly grow and therefore require regular attrition to keep them at a functional length [2].

Hendey and Singer found that porcupine bone assemblages characteristically display high frequencies of gnawed bone and low percentages of non-identifiable fragments [110]. Carnivores and humans tend to shatter and fragment bones for nutritional value, while porcupines only utilize it as a tool. Porcupine assemblages consequently exhibit mostly non-fragmented bones which are extensively gnawed [28].

Kemp's Caves have a high percentage (88%, see Table 4.1) of non-identifiable, severely fragmented bones, of which only nine percent (see Figure 4.8) were gnawed by various species. Approximately 20 identifiable bones were documented as being modified by porcupines and a few porcupine quills were found in the faunal assemblage. Porcupines may have been responsible for a small percentage of the skeletal remains, but are definitely not considered to be a chief accumulating agent of Kemp's Caves.

1.5.2 Hyaena as accumulating agent

Hyaenas have enormous jaws which explains why they are extremely efficient at crushing bones and therefore leave only tooth row sections and the very robust parts of long bone ends in larger mammals [2,51].

The adaptation of the upper and lower third premolars in conjunction with their powerful jaw muscles establishes effective bone crushing. The anterior and posterior cusps have been reduced while the central cusps enlarged to be converted into conical hammers. The scarcity of gnawed fragments and the high incidence of severely fragmented bones in the present study thus indicate hyaena involvement [3]. Gnawed bones contributed less than nine percent of the bones in Kemp's Caves.

The faunal sample of the Kemp's caves bovids showed varied evidence of long bone fragments of larger mammals. There is, however, a significant amount of long bones where only the proximal or distal extremity survived.

Hyenas are implicated when large amounts of coprolites are present [2,3]. Coprolites can be defined as fossilized droppings. Hyaena droppings resemble those of a large dog in shape and size. It consists of mainly mineral matter derived from bones with sometimes a few hairs. The faecal masses are green but turn white upon drying in air. The coprolites of Kemp's Caves where not tested, but resemble all above descriptions. There were a large amount of coprolites in the sample of Kemp's Caves, which may signify hyaena activity at some point.

Stone artifacts are often found at sites where humans have been involved in the accumulation of an assemblage. The scarcity of stone artifacts at Kemp's Caves suggest hyaena activity [3]. This is attributed to the fact that hyenas and humans do not frequently inhabit the same living space [57]. At a site in Zimbabwe, it was found that coprolites originated in layers where human artifacts and cultural material were low. This may suggest that hyaenas occupied these sites when human residents were elsewhere [2]. Although all archaeological artifacts were removed from the sample, stone artifacts were not found in the Kemp's Caves' excavations.

☞ **Brown hyaena**

The brown hyaena (*Hyaena brunnea*) is typically smaller than the spotted hyaena and is characterized by a sloping back and banding of the front legs. Brown hyaena, similar to spotted hyaena, uses both burrows and caves as breeding and feeding lairs [2].

Research has shown that the brown hyaena tend to collect more bones to dens than Spotted hyaena [3,28]. They prey on springbok-reedbuck size antelope (Bov II), although larger antelope like Blue Wildebeest, zebra and kudu are sometimes hunted. Approximately 39.1% of the Kemp's Cave collection consist of

Bov II size ungulates (see Figure 4.1).

Female brown hyaena bring their young to the den, whereas spotted hyaena takes their young to the field from a very early age [3]. Hence the skeletal representation of the brown hyaena itself will include specimens of all age classes, and the spotted hyaena lairs would mostly be represented by adults only [2,3]. Kemp's Caves yielded several adult specimens of both spotted and brown hyaena as well as one juvenile spotted hyaena specimen (see Table 4.2). The skeletal representation of the hyaena specimens of Kemp's Caves gives therefore no clear evidence whether brown or spotted hyaena, if any, could have been accumulating bones at Kemp's Caves.

Brown hyaena accumulations have been proved to feature a large amount of other carnivores, with Black-backed jackal (*Canis mesomelas*) and bat-eared foxes (*Otocyon megalotis*) being the most numerous [2,3]. The reason is that the female brown hyaena deliberately hunts smaller carnivores as food for their cubs in the breeding dens [2]. The Kemp's Caves assemblage contained approximately 20 separate black-backed jackal skeletons of a minimum of two individuals (see Table 4.2)

The fact that Black-backed jackal specimens were relatively well represented in the assemblage might suggest that the brown hyaena may have played a role as accumulating agent.

☞ **Spotted hyaena**

William Buckland first suggested that *Crocuta crocuta* (Spotted hyaena) may have been responsible for bone accumulations after a cave in Yorkshire revealed an abundance of spotted hyaena remains as well as the skeletal fragments of prey [2]. He concluded that hyaenas are bone collectors and also prey upon each other. This study resulted in the birth of a concept known as the "bone-accumulating, cannibalistic hyaena" [2]. Robert Knox, who extensively traveled South Africa, challenged the accumulating theory of Buckland. He debated that hyaenas bring their young to the field from an early age and was of opinion that there would be no reason to carry a portion of the prey back to their lairs [2]. While Dart was attempting to explain the accumulation at Makapansgat, he undertook a study of modern hyaena lairs. After completion of this study he forcefully rejected the bone collecting theory. Despite this rejection, evidence has shown hyaenas as definite bone collectors [2].

Sutcliffe suggested that there are two kinds of spotted hyaena lairs [103]. The first is characterized by the fragmented gnawed remains of the crocuta species itself. These fragments were represented by different ages and individuals. The second type of lair has less skeletal remains of the species itself and is characterized by an abundance of prey skeletal material. He explained the two lairs as the one being the living quarters and the other the eating quarters [111]. Research by Matthews described that in deep soil habitats, hyaenas prefer burrows, but in rocky or mountainous areas they make use of recesses or caves [112].

Although spotted hyaenas are scavengers, it has been confirmed that they are also avid and effective hunters [2,51]. Hyaenas have been found to successfully hunt prey as large as adult waterbuck, eland and buffalo but mostly prey on wildebeest-zebra size (Bov III) [2,3,28]. If larger predators such as lions were prominent in the area, there would be enough food to scavenge, whereas hunting would take preference if such large predators did not occupy these areas. If it can be established whether the hyaena diet consisted of scavenged or hunted meals it can consequently suggest whether larger predators were inhabitants of the area [2]. It is uncertain whether prey was hunted or scavenged at Kemp's Caves, thus no deductions can be made about the occupancy of larger predators.

Kemp's caves definitely qualify as a breeding lair for any predator, and although deep soiled areas are found in the area, the cave is situated in a rocky habitat. This may suggest that spotted hyaena might have used the cave as a retreat. The faunal analysis of Kemp's caves included 27.9% Bov III size class bovids as well as 2.6% Equids (see Figure 4.1). These are prey and scavenger size animals for the spotted hyaena. Although some evidence may suggest hyaena to have been an accumulating agent at Kemp's Caves, it may have been for short periods when humans or leopards did not occupy the caves.

1.5.3 Leopard as accumulating agent

The species *Panthera pardus* is successful predators due to the fact that they are extremely adaptable, hence they are normally the last of the large predators to disappear under pressure form human encroachment [2]. Brain describes leopards as being secretive in which case a cave plays an important role in their behavioural patterns for retreat, breeding and feeding [2].

Mount Suswa, a dormant volcano near Nairobi, presented the best evidence for leopards' use of caves. Predatory animals normally prefer to take their food to certain definite places. In the case of Mount Suswa, the leopard preferred a very dark recess where no light could penetrate [2].

After making a kill the carcass is dragged up to 2km after which they either hide the prey by covering it with vegetation or lodging it in a tree [113]. Hyaenas tend to be the main culprit in taking prey from leopards. It is thus of great importance to immediately take the prey to an unaccessible spot [2]. Additional evidence from a farm in Namibia showed leopards dragging their prey up a rocky slope into a cave. Hyaenas are absent from this area, thus no competition denotes only a quiet spot for storage [2]. This fact may implicate that either no or few hyaenas are present at times when the leopard only stores prey in the cave and had no reason to hide prey from competition. It may therefore be suggested that a leopard would generally drag it's prey to a distinctive secretive and protected area to be fed upon. Leopards also tend to return to the carcass after the initial feeding [113].

Leopard takes a wider array of prey than does any other large carnivore [113]. This species does, however, mostly prey on Bov II and Bov III size ungulates [51]. Prey are normally eaten from the buttocks and then the shoulder area. The long bones of large leopard prey are not broken and crushed as in hyaena and lion kills [113]. If undisturbed, leopards tend to eat the body, neck and upper parts of the limbs. The head and lower leg segments are rejected [2].

Several breeding lairs have been described as caves leading into one or more tunnel structures [2]. The North-eastern tunnel in Kemp's Caves has been described by the game rangers as being the living quarters of the resident leopard.

Bov II (39.1%) and III (27.9%) dominated the bovid specimens (see Figure 4.1) in the Kemp's caves assemblage. It is also shown in Figure 4.2 to 4.4 that the head (skull and teeth) and lower leg bones, such as the metapodials, carpals, tarsals and phalanges, had the highest frequencies.

It is evident from studies that leopard skeletal remains would also be part of the faunal assemblage in caves inhabited by this species, although it is not a definite indication of their occupation. Leopards living in a cave may be represented by the remains of either mature or young leopard individuals, that succumbed to anything from illness to accidental death and injury during hunting [2]. Two leopard cranial specimens and one leopard-sized 4th metatarsal were identified in the Kemp's Caves assemblage. Further excavations may yield more of these skeletal elements.

During excavations from 1992, a leopard have definitely resided at this site. With above mentioned evidence from the assemblage it is presumed that leopard was largely responsible for the bone accumulations at Kemp's Caves.

1.5.4 Humans as accumulating agent

Approximately 11% of the bones recovered from Kemp's Caves were severely burnt. The fact that veld fires only scorch the bone and does not enter the bone cavity may suggest human activity, because of their habit of cooking meat. The burnt specimens can, however, be modern, which might indicate that humans occupied Kemp's Caves only recently.

Klein suggests that carnivore and human accumulations can be separated by analyzing the carnivore : ungulate ratio. This is because carnivores more frequently feed upon other carnivores than man does. Thus the higher the ratio between carnivore and ungulate the better the chances that carnivores were responsible for the accumulation [114]. Kemp's Caves show relatively few carnivore specimens which indicates a low carnivore (7.7%) : ungulate (86.8%) ratio (see Figure 4.1). This may also signify human involvement.

Hyaenas do not generally form an association with humans, but it is possible that the carcasses have been scavenged from a settlement [2]. It can therefore be suggested that the evidence which points towards the absence of hyaenas during most of the caves' history, might implicate human presence. However, no stone tools have been found, therefore Kemp's Caves have no concrete evidence to implicate human involvement.

Avery describes the Elandsfontein kill/butchery site (C10) as having a low density of artifacts, with or without a high number of formal tools. It is also recognized by sparse scatter of bones and limited evidence of carnivore activity [115]. Kemp's caves has a low density of artifacts and almost no tools, but there are a number of facts that suggest carnivore activity. This may also be an indication of the absence of human activity.

1.5.5. *Conclusion*

Brain states that the process of bone accumulation depends greatly on the form of the cave itself, but that any cave that have been open for thousands of years is likely to have had bones brought in by a variety of ways [109]. Considering all the facts and evidence it is therefore suggested that all three agents (hyaena, leopard and human) were responsible for the accumulation of the faunal remains at either the same time, or different periods in the cave's history. Humans may, however, only have occupied Kemp's Caves during recent years.

The Sehonghong faunal assemblage is dominated by fish which suggest that either human or animal could have been involved in the accumulation of this site's excavated faunal specimens.

Regarding the taphonomy of the Klasies River Mouth site, Binford suggested that there was no concrete evidence for hyaena activity and leopard involvement is undetermined [24]. Klasies River Mouth also proved to have been inhabited by porcupines, but they did not substantially modify the character of the faunal assemblage [24]. These results on bone accumulation coincide with the preliminary results of Kemp's Caves.

Although there were other accumulating agents at work at Border Cave, it is clear that humans played a major role in this assemblage. The cave is only accessible from a narrow ledge which may have been for defence and security for these hominids.

1.6 Difficulties experienced in Stage I

Several problems were encountered during the faunal analysis of Kemps' Caves. The consistency and accuracy of bone removal and excavation methods may have been compromised with the staff and students of two different Universities contributing to the faunal sample. Methods of screening and sorting may have been different and some important fragments may have been sorted as unimportant and discarded. Thus the archaeological activities resulted into the selective recovery or non-recovery of bones. Information regarding specimens, such as provenance, were sometimes inaccurate or missing. Some of the fragments excavated may also have been lost with the moving of specimens from the one university to the other.

Bone preservation can be influenced by several agents such as environmental factors and human activity factors. Processes that involve the movement and destruction of bone before they are finally formed into a deposit, may also give a distorted view of what really expired during the caves' history and development.

This faunal sample is only a fraction of the fossils that may still be excavated at Kemp's Caves. The deductions based on this sample may not be as accurate as the whole representative sample that maystill be excavated.

The faunal sample of Kemp's Caves was relatively small in relation to sites such as Sterkfontein and Makapansgat. With only a limited amount of specimens being identifiable as well as the fact that a large number of specimens were without a provenance, it was difficult to ascertain differences in older and younger deposits.

Excavations are still ongoing at Kemp's Caves and the Northern extension specifically has not been ESR dated. Almost half of the specimens analyzed came from this extension which may contain more modern material. An abundance of fossilized breccia in the roof, floor and walls also still need to be removed and dated.

The area surrounding the Kemp's Caves site has been part of the Ngonyama Game Reserve for the past 40 years. Species that do not occur here naturally may have been introduced by the Game Reserve. An example is *Antidorcas marsupialis* (Springbok). The distribution of this species does not normally include the Kemp's Caves area. All Springbok specimens were fairly modern and may indeed have been the result of the introduction of this species to the Game Reserve.

2. STAGE 2 - OSTEOMETRY

Stage 2 entailed the acquiring of measurements for possible osteometric identification of bones. This included the collecting of data as well as the development of a computer programme using these measurements for identification purposes. The measurement data were statistically analyzed to ascertain whether osteometric identification of bones may be viable.

2.1 Measurements

Approximately 18 000 measurements were taken of 30 Southern African bovid species. Forty-five measurements represented the three hind limb long bones which included the femur, tibia and metatarsal. The data was obtained from the skeletal collections of the National Flagship Institution (Pretoria), National Museum

(Bloemfontein) and the South African Museum (Cape Town). Although most measurements were pre-defined, a few were developed by the author. Almost all the pre-defined measurements were easily measured, while some of the new measurements were more difficult to acquire on all species. These measurements include the T(GDTN), F(SBCF) and F(GBCF) and will be discussed below.

Student's t-tests were done to establish whether a specific species would differ from the species within the same Bovid size class. This was done for every measurement on all three long bones. The result was values representing the average of the specific species, in comparison to the average of all the species within the same Bovid size class. Tsessebe showed no significant differences with any of the measurements, but this may be due to the fact that there was only one specimen available for measurement.

2.1.1 Femur

The femur measurements showed a high percentage of values which significantly differed within the size classes (see Figure 4.9). No femoral measurements showed significant differences within the Bovid I size class. This may be the result of the relatively small sample sizes of the different Bov I species. Due to the limited number of measurements available for the statistical testing, the mean may be less accurate for the specific measurement. Additional skeletal collections of other institutions worldwide, may yield a larger sample size and may clarify this issue.

The Bov II, III and IV size classes showed little significant differences in the Femur (Smallest Breadth Condylar Fossa) and Femur (Greatest Breadth Condylar Fossa) measurements. These measurements indicated the size of the condylar fossa of the femur. It was, however, difficult to obtain these dimensions and they did not show any particular pattern during data collection. It could not be established where the greatest or smallest measurements of the condylar fossa would be on each individual specimen. Every individual specimen within the same species showed a variance. Although these measurements were used in this study, it might be of less significant value in osteometric differentiation in future studies.

The Bov II class showed no significant differences in the Femur (Smallest Breadth Diaphyses) measurement. Thus the smallest breadth of the diaphyses of these species did not differ significantly to distinguish between them. The F(SBD) was, however, significantly different within the Bov III and IV size classes.

2.1.2 Tibia

None of the tibial measurements of the Bov I size class showed significant differences (see Figure 4.10). This correlates with the femoral measurements and may be due to the same reasons as discussed above. The smallest breadth of the tibial shaft also showed no significant differences between the species of the Bov II size class, while this measurement was notably significant with the Bov III and IV size classes. The Tibia (Greatest Depth Tibial tuberosity from Notch) measurement was developed during the course of this study to ascertain the depth of the tibial tuberosity which might have shown significant differences by reflecting the strength of the muscle attaching to this tuberosity. The T(GDTN) measurement appeared to have no significant differences within the species of Bovid size class I, II and IV. The T(GDTN) was, however, a predicting measurement in the regression analysis and did proved to be of significant value in the Bov III size class. Further analysis of this measurement may shed more light on its effectiveness in osteometric identification. Gemsbuck, Sable and Blue Wildebeest showed no differences in any of the length measurements of the tibia, which might have implications in the computer programme when only these measurements are available on a specimen of either of these species.

2.1.3 Metatarsal

The measurements of the metatarsal showed significant differences in almost all Bovid size classes (see Figure 4.11). Bov I size class showed significant differences in only some of the metatarsal measurements. No significant differences can be seen in any of the greatest lengths, the superior articulating facets or the Metatarsal (Greatest Breadth Distal Extremity). A larger sample size may adjust these results, but presently the metatarsal is the only bone in this study which may be indicative of the different species in Bov I. The Metatarsal (Smallest Breadth Diaphyses) showed significant differences within the Bov II class, in comparison with the femur and tibia diaphyses which showed no significant differences in their breadth measurements. Thus the metatarsal is the only hind limb long bone that will differ sufficiently to distinguish between the Bov II species with regards to the diaphyseal breadth. Further research may shed light on this interesting result. The Metatarsal (Greatest Medial Length) showed very little difference between the species in the Bov III group. Black Wildebeest and Gemsbuck particularly showed little significant differences in the metatarsal measurements. Further studies may shed light on this aspect. Again, the fact that there was only one Tsessebe specimen available for measuring may account for the fact that there were no significant different metatarsal values observed for this species.

2.1.4 Regression analysis

A regression analysis was done to establish measurements with a high probability of being good predictors of the three hind limb long bones (see Table 4.9). As deducted from the t-tests, it can be seen that there are only one femoral and three tibial measurements which are predictors for the Bov I size class. This size class is best identified by measurements of the metatarsal. Bov II, III and IV size classes showed that almost every measurement taken on the femur, tibia and metatarsal could be used for osteometric identification. Most of the measurements developed by the author showed a high probability to be predictive in osteometric identification.

2.1.5 Index calculation and analysis

Three indices were calculated for respectively the femur, tibia and metatarsal. In Figures 4.12 to 4.14, it can be seen that there is a large area of overlap between most of the species on all three bones. The indices are indicative of the robusticity of the specific bone. There are, however, a few species which could be identified purely on their index values if the Bovid size class were known. In Bov III the metatarsal index will clearly identify Waterbuck as it had the highest robusticity value. Sitatunga had the smallest robusticity values of the femur and tibia, with very little overlap (especially on the tibia), if at all. These two indices are therefore very important indicators for this species. The Buffalo showed the most robust bones of all the species. In all three indices it showed almost no overlap, not even with the Eland. These robusticity values can therefore be an important element in the identification of Buffalo remains.

With further studies and a larger specimen database specific values might prove to be important in identifying the different Bovid size classes.

2.2 Development of programme

The programme was developed for the '97 version of Lotus Smartsuite. Three probability values were calculated by the programme on information supplied by the supporting database of measurements. Measurements on 30 bovid species yielded a vast amount of information which were used to metrically distinguish between bovid species. These calculations included the Identification Percentage Probability (IPP), Fractional Percentage Probability (FPP) and Element Percentage Probability (EPP). The programme reacts when only one measurement is entered, but is accuracy increases as more measurements are entered. The EPP may give a misleading probability value when only a few measurements are entered by the user, while the IPP is a weighted value which take into account how many measurements have been entered.

A "MORE INFO" option is available which may assist with further identification of a specimen. The distribution map, for example, can be used to distinguish between similar size species, with different distributions in the Southern African region. Blesbok and Bontebok, for example, are skeletally very similar, but have diverse natural distributions in the Southern African region. The habitat and diet of these species are of importance in the process of faunal analysis.

It was decided to use the median value, rather than the mean, in the computerized database to counteract the extreme measurement values that some of the individual specimens exhibited. A larger sample size of measurement values will better represent the average measurement and the mean value may therefore be more accurate in future studies.

Presently Lotus Smartsuite is still necessary to run this programme. Further development may yield an independent computer programme for the identification of bones.

Even though this is a pilot programme in conceptual phase, there are infinitely more possibilities and applications through programmatic refinements and restructuring such as the use of only the measurements which showed significant differences. However, a larger specimen database is necessary for more accurate osteometric identification. Complex mathematical techniques to analyse metrical data is commonly used with human material, but seldom with faunal remains [81,82,83].

2.3 Difficulties experienced in Stage 2

All measurements frequently used in faunal analysis [72,92,93], (defined by several authors) as well as measurements considered to demonstrate species differences, were obtained from the femur, tibia and metatarsal. This was only a pilot study and it was therefore decided that approximately 15 measurements on a single skeletal element will be sufficient to test the viability of osteometric identification of bones. The femur, tibia and metatarsal were respectively represented by 14, 15 and 16 separate measurements. There may, however, be additional measurements which were not collected in this study which can be vital for inter species differentiation. Further investigation may yield extra measurements which may prove to be more significant. Measurements used in this study may also prove to be insignificant in species differentiation.

Although 34 Southern African bovid species were identified for this study, there were four species which were not represented by any of the skeletal collections. These species included Dik-Dik (*Madoqua kirkii*), Sharp's Grysbuck (*Raphicerus sharpei*), Puku (*Kobus vardonii*) and Lichtensteins Hartebeest

(*Sigmoceros lichtensteinii*). Skeletal fragments that belong to any of these species will therefore not be represented in the measurement database.

The small sample size of certain species did not clearly represent the morphological characteristics of that species. Extreme cases included Tsessebe (one specimen), Suni and Sitatunga (two specimens each) as well as Roan and Klipspringer (three specimens each). The small sample sizes also necessitated that the male and female specimens had to be pooled for statistical analysis. This might have affected the testing of the programme in Stage 3.

Reproducibility of the measurements, for example the T(GDT), may hinder accuracy. The T(GDT) gives an indication of the size of the tibial tuberosity. Sometimes it may be difficult to allocate certain points where the measurement needs to be taken from. These measurements did prove to be significantly different, and was listed as predictors of the tibial measurements, but may depend on the experience of the analyst. Additional statistical analysis may give a better indication as to which measurements are true predictors. With this information the user would know which measurements will be of greater value for accuracy.

Lotus Smartsuite may prove to have limited use in further studies. Further development may provide an independent computer programme, which will be written specifically according to specifications obtained from this study. Presently it is essential that the user have access to Lotus Smartsuite to utilize the Osteo-ID CD.

3. STAGE 3 - TESTING

Stage 3 comprised of the testing of the computer programme developed in Stage 2. Ten Kemp's Caves specimens, which were conventionally analyzed by comparing the fragment to its modern skeletal part, as well as ten modern skeletal elements not used in the database, were utilized to test the accuracy and viability of the developed programme.

3.1 Results

Only 20% of the Kemp's Cave specimens were correctly identified (see Figures 4.17 to 4.26). Nine of the ten had the conventionally identified species on the chart (in other words indicating it as a possibility) while one specimen, LKC/93/23 (Impala tibia), did not show it at all. This specimen was, however, an unfused distal extremity of the tibia which indicated that it belonged to a juvenile or sub-adult individual. No juvenile or sub-adult individuals were measured for the development of the programme, which explains the absence of the species on the identification chart.

The Kemp's Caves specimens were identified by the author by means of conventional analysis and by an independent expert, but the identifications may still have been inaccurate. The small sample sizes of some of the database species may also have influenced the results. Because only a few measurements were available on these fragmented specimens, it may also indicate that some measurements may not be sufficient for osteometric identification. The IPP and EPP values differed significantly with these test specimens because of the small quantity of measurement available on each fragment.

The modern collection specimens (3 femur, 3 tibia and 4 metatarsal) were that of known species and were complete. All measurements could be obtained from these bones, thus the EPP and IPP values were equivalent. Only 30% of the specimens showed the correct species as having the highest FPP value when all measurements were entered (see Figures 4.27a to 4.36a). All the other identification charts included the correct species, but it had the second or third highest FPP value. The IPP values of all these species, however, were always high, thus indicating a good identification, although it did not have the highest FPP. This could be due to the fact that in a lot of cases a large number of species had measurements which fell within the median value, which in turn affected the FPP values. The results changed, however, when only certain measurements were entered into the developed programme (see Figures 4.27b to 4.36b). The results increased to a 60% accuracy rate when only proximal measurements were entered and a 40% rate when only the shaft measurements were entered (see Table 4.20). This suggests that the proximal measurements of all three long bones may prove to be more important in osteometric identification of animal bones. Further research may shed light on this result. Although the metatarsal measurements showed significant differences in all the Bov size classes, the accuracy rate dropped to 0% (all measurements entered, and only distal measurements entered) with the metatarsal test specimens. This 0% indicated that it was not identified as the most probable species, but it was, nevertheless, listed as one of the species on the identification chart. It did, however, increase to a 50% accuracy rate with only shaft or proximal measurements.

Even though these results seem unsatisfactory, it should be kept in mind that this was only a pilot study. A variety of external factors may have influenced the data collection and programme development. This include the small sample sizes of the database specimens. The database sample size also decreased due to the fact that the male and female specimens had to be combined. This fact may therefore give a false reflection, if the majority of a sample was either sex. In order for a positive identification to be obtained, the entered value should fall within a range which is presently a fluctuation of 10% either side of the median. If the database sample size increases, the current range of 10% may be dropped to 5% or less, which may result in higher FPP values, because fewer species will fall within the median range.

It is therefore the opinion of the author that with further research into the correct measurement collection, and a larger database, computerized osteometric identification of bones will definitely prove to be of value for faunal analysis.

3.2 Difficulties experienced in Stage 3

The few measurements available from the test material of the Kemp's Caves and modern collection specimens could have given a distorted or misleading accuracy rate. More specimens in further research may adjust the accuracy rate. Another excavation site with a larger sample of test specimens could also prove to be more informative.

Although indices were calculated for the three long bones, it was not incorporated in the database, and did therefore not have an influence on the identifications of the species. Although there were overlap of most species, there were certain species which could have been positively influenced by the index value. Further development of the programme should include index values.

6 CONCLUSION

I. STAGE I - FAUNAL ANALYSIS

→ The 34 macro-mammalian species that were identified in the faunal sample, show correlations with that of other sites with similar dates such as Rose Cottage Cave, Klasies River Mouth and Border Cave. Although Kemp's Caves have not yet produced any hominid remains (except modern human material), it may still yield important specimens which might shed light on the evolution of Anatomically Modern Humans.

→ One extinct species, *Equus capensis*, was identified. This species became extinct between 10 000 BP and 12 000 BP, which corresponds with the youngest ESR date of Kemp's Caves.

→ The faunal analysis did not contradict the earlier ESR dates, but ongoing excavations and analysis might assist in further date confirmations.

→ All species identified (except *E. capensis*) either occurred here in the past or still occurs in the Kemp's Caves area. This suggests that the environment did not change drastically over the last 100 000 years.

→ The faunal analysis suggests that porcupine, hyaena, leopard and man may have been responsible for the bone assemblage and accumulations at different stages of the cave's development. The most likely was a combination between hyaena and leopard.

2. STAGE 2 - MEASUREMENTS

→ A total of 18 000 measurements were taken from 30 South African bovid species represented by the modern skeletal collections of three South African museums. A total of 14, 15 and 16 measurements were respectively taken on the femur, tibia and metatarsal.

→ Most measurements taken on the three long bones showed varied significant differences within the Bov II, III and IV size classes. Bov I, however, only showed significant differences in the metatarsal measurement values. Index values showed to be significant in identification for specific species within a Bovid size class.

→ The developed programme calculated three different percentage probabilities to assist in the osteometric identification of bones.

3. STAGE 3 - TESTING

→ An accuracy rate of 20% was obtained for Kemp's Caves specimens. These specimens were, however, exceedingly fragmented and only a few measurements were available on each specimen.

→ An accuracy rate of 30% was the result of the modern collection test specimens. This rate, however, increased to 60% with only proximal measurements entered and to 40% with only shaft measurement entered.

→ The use of the computer programme was, however, only a pilot study and further research on a larger sample for the database, more significant measurements, better statistical analysis and further refinements and restructuring of the programme may yield better results.

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A

APPENDIX A - FEMUR

Appendix A contains the raw measurements taken on the femur of 30 Southern African Bovid specimens from the Transvaal, National and South African Museums. It also includes the mean, median, standard deviation and minimum and maximum values for each measurement.

Each individual specimen is abbreviated as follows:

Specimen number → **Sun 1P** ← Abbreviation for Museum

Abbreviation for Bovid species

ABBREVIATION FOR MUSEUM:

P → Transvaal Museum specimen - Pretoria (Archaeozoological collection)
K → South African Museum specimen - Cape Town (Mammal collection)
B → National Museum specimen - Bloemfontein (Florisbad collection)

TABLE 4.5: Key to abbreviations to bovid species (alphabetical).

Abbreviation	Species	Abbreviation	Species	Abbreviation	Species
BDu	Blue Duiker	Bla	Black Wildebeest	Ble	Blesbok
Bon	Bontebok	Buf	Buffalo	Bus	Bushbuck
BWi	Blue Wildebeest	Cap	Cape Grysbok	Ela	Eland
GDu	Grey Duiker	Gem	Gemsbok	GRh	Grey Rhebuck
Imp	Impala	Kli	Klipsringer	Kud	Kudu
Lec	Red Lechwe	Mou	Mountain Reedbuck	Nya	Nyala
Ori	Oribi	Rdu	Red Duiker	Ree	Reedbuck
RHa	Red Hartebeest	Roa	Roan	Sab	Sable
Sit	Sitatunga	Spr	Springbok	Ste	Steenbok
Sun	Suni	Tse	Tsessebe	Wat	Waterbuck

OTHER ABBREVIATIONS USED IN APPENDIX:

STD DEV →	Standard Deviation
MIN →	Minimum value
MAX →	Maximum value
MUS NO. →	Museum number of specimen
M/F →	Male or female
W/Z →	Wild or zoo born
NA →	Specific bone not available for measuring
NAM →	Specific part of bone not available for measuring

TABLE 3.6: Femur measurements

No	Abbr.	Description	Instrument	Fig
1	F(GL)◆	Greatest length.	Osteometric box	3.3a
2	F(GLH)◆	Greatest length from femur head.	Osteometric box	3.3a
3	F(SBD)◆	Smallest breadth of diaphyses.	Electronic calliper	3.3b
4	F(SCD)◆	Smallest circumference of diaphyses	Measuring tape	3.3b
5	F(GBP)◆●	Greatest breadth proximal end.	Electronic calliper	3.4
6	F(GDH)◆	Greatest depth femur head.	Electronic calliper	3.4
7	F(GBH)▮	Greatest breadth femur head.	Electronic calliper	3.4
8	F(GBD)◆●	Greatest breadth distal end.	Electronic calliper	3.5a
9	F(GLDD)◇	Greatest lateral depth distal end.	Electronic calliper	3.5a
10	F(GMDD)	Greatest medial depth distal end.	Electronic calliper	3.5a
11	F(GBCF)▮	Greatest breadth condylar fossa.	Electronic calliper	3.5b
12	F(SBCF)▮	Smallest breadth condylar fossa.	Electronic calliper	3.5b
13	F(GBT)	Greatest breadth trochlea.	Electronic calliper	3.5b
14	F(GL-GLH)▮	Greatest length-Greatest length from femur head.	Calculation	

◆ Measurements defined by Von den Driesch [72]

◇ Measurements defined by Peters [92]

● Measurements defined by Walker [93]

▮ Measurements developed by the author

SUNI (Neotragus mocathus) n=2																	
INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Sun 1P	1254	F	W	110.0	107.0	8.3	28.5	22.8	10.3	13.3	19.0	22.8	24.1	5.3	4.3	10.6	3.0
Sun 2P	819	F	W	118.5	116.0	8.9	29.5	23.2	11.5	14.0	21.1	24.8	26.1	6.6	4.7	11.6	2.5
MEDIAN				114.3	111.5	8.6	29.0	23.0	10.9	13.7	20.1	23.8	25.1	6.0	4.5	11.1	2.8
MEAN				114.3	111.5	8.6	29.0	23.0	10.9	13.7	20.1	23.8	25.1	6.0	4.5	11.1	2.8
STD DEV				6.0	6.4	0.4	0.7	0.3	0.8	0.5	105	104	104	0.9	0.3	0.7	0.4
MIN				110.0	107.0	8.3	28.5	22.8	10.3	13.3	19.0	22.8	24.1	5.3	4.3	10.6	2.5
MAX				118.5	116.0	8.9	29.5	23.2	11.5	14.0	21.1	24.8	26.1	6.6	4.7	11.6	3.0

BLUE DUIKER (*Philantomba monticola*) n=5

INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
BDu 1P	2226	F	W	101.0	100.5	7.6	26.5	20.6	10.3	12.5	18.7	20.4	21.6	5.7	5.6	9.3	0.5
BDu 2P	2515	?	?	102.5	101.5	7.9	28.0	20.7	10.5	13.7	18.4	22.7	24.3	6.1	4.5	9.5	1.0
BDu 3P	548	M	?	104.0	102.5	7.4	25.0	20.4	9.7	12.6	18.3	21.3	22.3	5.4	5.0	9.5	1.5
BDu 4P	1090	?	?	112.0	111.0	7.8	27.5	23.2	11.2	13.9	20.5	24.3	25.6	6.8	5.3	10.3	1.0
BDu 5P	2551	F	Z	100.0	98.5	8.1	29.0	22.3	10.7	13.0	19.0	20.7	21.9	5.1	4.8	10.1	1.5
MEDIAN				102.5	101.5	7.8	27.5	20.7	10.5	13.0	18.7	21.3	22.3	5.7	5.0	9.5	1.0
MEAN				103.9	102.8	7.8	27.2	21.4	10.5	13.1	19.0	21.9	23.1	5.8	5.0	9.7	1.1
STD DEV				4.8	4.8	0.3	1.5	1.2	0.5	0.6	0.9	1.6	1.7	0.7	0.4	0.4	0.4
MIN				100.0	98.5	7.4	25.0	20.4	9.7	12.5	18.3	20.4	21.6	5.1	4.5	9.3	0.5
MAX				112.0	111.0	8.1	29.0	23.2	11.2	13.9	20.5	24.3	25.6	6.8	5.6	10.3	1.5

CAPE GRYSBOK (Raphicerus melanotis) n=23																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Cap 1K	35854	F	?	149.0	147.0	12.1	39.0	31.6	14.7	18.9	28.2	31.0	33.1	8.6	7.9	14.5	2.0
Cap 2K	36818	F	W	153.0	150.0	12.2	39.5	33.0	15.8	19.2	28.3	31.2	34.8	8.9	7.0	15.3	3.0
Cap 3K	36012	F	W	146.5	143.0	11.9	38.5	30.6	14.0	18.7	27.7	32.0	33.9	8.2	7.0	14.5	3.5
Cap 4K	36246	F	Z	144.0	142.0	11.1	37.0	32.1	15.1	19.3	29.1	32.2	33.9	8.8	7.0	14.1	2.0
Cap 5K	36205	F	W	156.5	154.0	11.7	38.5	33.7	15.3	20.2	29.2	32.2	33.9	8.7	7.1	14.1	2.5
Cap 6K	37189	M	?	144.5	142.0	12.5	40.5	31.9	15.1	19.4	28.8	32.2	33.5	8.9	6.9	15.8	2.5
Cap 7K	36328	M	?	149.0	147.5	13.2	43.0	34.2	15.5	20.0	29.3	32.6	34.7	9.5	6.4	14.9	1.5
Cap 8K	39667	?	W	146.5	144.0	12.4	40.5	33.2	15.5	19.6	28.3	32.2	33.5	9.9	8.0	14.9	2.5
Cap 9K	38778	F	W	159.0	157.0	13.1	45.0	35.9	16.0	20.9	31.2	35.2	36.5	8.1	7.6	16.6	2.0
Cap 10K	38719	M	W	161.0	159.0	13.1	40.0	32.7	15.5	19.5	29.6	33.4	35.2	9.7	8.2	14.8	2.0
Cap 11K	40380	M	W	153.5	151.5	11.1	38.0	33.1	16.1	20.4	30.8	33.4	35.8	9.0	7.1	15.4	2.0
Cap 12K	40386	M	W	155.0	154.0	13.3	41.5	33.9	15.9	20.0	30.4	34.1	36.4	9.5	8.5	14.5	1.0
Cap 13K	40525	F	W	157.0	155.0	12.9	41.5	33.4	16.1	20.5	29.1	34.0	35.8	8.2	7.3	15.3	2.0
Cap 14K	36247	M	W	153.5	151.0	11.4	36.5	31.9	15.1	19.7	28.8	31.9	33.6	9.5	7.2	14.5	2.5
Cap 15K	39202	F	W	140.0	137.5	10.9	35.0	32.8	15.3	20.0	27.3	31.7	33.5	8.6	6.8	13.9	2.5
Cap 16K	39082	F	W	153.0	150.0	11.6	37.5	32.6	15.0	19.2	28.4	30.7	33.2	9.4	7.3	14.2	3.0
Cap 17K	39821	F	W	149.5	147.0	12.0	41.0	32.1	15.8	19.1	28.1	32.7	33.6	8.0	6.7	15.1	2.5
Cap 18K	40503	M	W	162.5	160.0	12.1	42.0	35.0	16.5	21.0	31.3	34.7	37.3	9.2	6.3	14.8	2.5
Cap 19K	36700	M	W	157.0	154.0	12.3	40.0	35.1	16.4	19.5	30.8	33.5	36.4	8.7	7.7	16.3	3.0
Cap 20K	36204	M	W	154.5	151.0	12.7	40.0	33.8	15.7	19.5	29.2	32.3	35.0	9.4	6.9	16.1	3.5
Cap 21K	36804	F	Z	161.5	158.0	13.5	42.5	34.2	16.5	20.7	30.6	34.2	35.8	8.0	7.4	16.6	3.5
Cap 22K	35109	F	W	151.0	147.5	12.6	39.5	32.7	15.0	18.4	27.6	32.0	33.9	7.1	6.7	15.1	3.5
Cap 23K	36056	F	W	143.5	141.0	12.3	38.5	30.9	14.6	17.1	27.5	30.9	32.8	7.9	6.7	15.3	2.5
MEDIAN				153.0	150.0	12.3	40.0	33.0	15.5	19.5	29.1	32.2	33.9	8.8	6.7	14.9	2.5
MEAN				152.2	149.7	12.3	39.8	33.1	15.5	19.6	29.1	32.6	34.6	8.8	7.2	15.1	2.5
STD DEV				6.2	6.2	0.7	2.3	1.3	0.6	0.9	1.2	1.2	1.3	0.7	0.6	0.8	0.7
MIN				140.0	137.5	10.9	35.0	30.6	14.0	17.1	27.3	30.7	32.8	7.1	6.3	13.9	2.5
MAX				162.5	160.0	13.5	45.0	35.9	16.5	21.0	31.3	35.2	37.3	9.9	8.5	16.6	3.5

RED DUIKER (*Cephalophus natalensis*) n=10

INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
RDu 1P	1538	F	W	136.5	135.0	11.4	40.0	30.0	14.1	19.3	25.6	31.4	34.8	6.0	5.5	14.0	1.5
RDu 2P	1044	F	W	143.0	138.0	11.9	41.5	31.3	14.8	20.7	28.0	33.7	36.1	8.7	6.7	12.9	5.0
RDu 3P	1043	F	W	145.0	141.0	11.8	42.0	30.9	14.9	18.8	26.4	32.1	35.7	6.9	6.1	13.5	4.0
RDu 4P	1495	M	Z	143.0	138.5	11.0	40.0	31.6	15.5	18.9	29.4	34.5	35.7	11.2	8.6	13.8	4.5
RDu 5P	827	F	W	141.5	138.0	11.1	38.5	30.5	14.4	18.5	26.9	32.4	34.9	8.2	6.9	13.8	3.5
RDu 6P	824	F	?	145.0	140.0	12.8	43.0	31.4	15.3	17.6	27.5	33.9	37.1	8.8	6.8	13.1	5.0
RDu 7P	828	F	W	140.0	134.5	11.1	38.5	29.2	14.4	17.2	28.0	32.5	36.0	7.5	6.9	14.0	5.5
RDu 8P	1197	M	?	146.0	142.0	12.1	42.0	31.8	14.7	19.4	27.9	33.2	36.4	8.9	6.6	14.1	4.0
RDu 9P	1258	M	W	142.0	137.0	11.4	39.0	31.0	14.9	17.6	27.8	31.7	35.9	8.0	6.7	13.0	5.0
RDu 10P	1967	M	W	143.5	138.0	11.7	41.0	31.2	14.6	19.5	27.9	34.1	35.9	6.8	5.7	15.1	5.5
MEDIAN				143.0	138.0	11.6	40.5	31.1	14.8	18.9	27.9	32.9	35.9	8.1	6.7	13.8	4.8
MEAN				142.6	138.2	11.6	40.6	30.9	14.8	18.8	27.5	33.0	35.9	8.1	6.7	13.7	4.4
STD DEV				2.8	2.4	0.6	1.6	0.8	0.4	1.1	1.0	1.1	0.7	1.5	0.8	0.7	1.2
MIN				136.5	134.5	11.0	38.5	29.2	14.1	17.2	25.6	31.4	34.8	6.0	5.5	12.9	4.0
MAX				146.0	142.0	12.8	43.0	31.8	15.5	20.7	29.4	34.5	37.1	11.2	8.6	15.1	5.5

KLIPSPRINGER (*Oreotragus oreotragus*) n=2																	
INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Kli 1K	39085	F	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kli 2K	40383	M	W	149.5	147.5	12.2	42.0	33.9	16.6	19.5	29.8	34.5	36.2	8.4	6.8	13.3	2.0
Kli 3B	820	?	Z	156.0	149.5	13.2	44.0	35.0	17.5	20.6	30.5	36.5	38.0	7.5	5.8	16.5	6.5
MEDIAN				152.8	148.5	12.7	43.0	34.5	17.1	20.1	30.2	35.5	37.1	8.0	6.3	14.9	4.3
MEAN				152.8	148.5	12.7	43.0	34.5	17.1	20.1	30.2	35.5	37.1	8.0	6.3	14.9	4.3
STD DEV				4.6	1.4	0.7	1.4	0.8	0.6	0.8	0.5	1.4	1.3	0.6	0.7	2.3	3.2
MIN				149.5	147.5	12.2	42.0	33.9	16.6	19.5	29.8	34.5	36.2	7.5	5.8	13.3	0.0
MAX				156.0	149.5	13.2	44.0	35.0	17.5	20.6	30.5	36.5	38.0	8.4	6.8	16.5	6.5

STEENBOK (Raphicerus campaestris) n=20																	
INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Ste 1K	35281	F	W	164.5	161.5	14.2	40.5	33.6	16.2	20.3	29.7	34.7	35.4	9.1	7.2	15.6	3.0
Ste 2K	37057	M	W	148.0	141.5	11.7	37.0	33.4	14.4	19.0	30.7	32.9	36.8	9.3	6.8	15.0	6.5
Ste 3K	36327	F	?	136.5	133.5	10.3	33.5	31.8	13.5	17.6	28.1	32.2	34.9	9.9	6.7	13.8	3.0
Ste 4K	36353	F	W	130.5	127.0	11.3	36.0	29.5	14.0	17.6	26.4	31.5	33.8	9.2	7.6	14.4	3.5
Ste 5K	37082	M	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ste 6K	36286	M	W	136.5	133.5	11.7	37.5	31.9	14.8	18.1	29.0	34.2	36.8	8.1	6.7	14.8	3.0
Ste 7B	9438	M	W	144.5	140.0	12.3	38.0	34.6	14.6	18.4	29.6	32.0	36.9	6.7	5.7	14.8	4.5
Ste 8B	4289	F	W	138.5	135.0	11.9	41.5	34.7	14.1	19.1	30.2	34.2	38.2	7.7	6.2	15.7	3.5
Ste 9B	8730	M	W	140.0	135.5	10.7	35.0	31.0	13.5	17.0	26.5	32.5	34.8	7.2	5.7	13.8	4.5
Ste 10B	9761	F	W	144.5	141.0	12.8	43.0	35.0	14.8	19.0	29.5	33.0	36.2	6.7	6.4	14.4	3.5
Ste 11B	9787	M	W	120.0	117.0	11.0	35.0	28.9	13.7	16.2	25.6	29.5	33.6	6.7	5.8	13.4	3.0
Ste 12P	1760	M	Z	144.0	137.0	12.2	37.0	33.3	14.9	18.9	29.3	31.4	36.6	8.6	7.5	14.5	7.0
Ste 13P	2294	?	?	152.0	147.0	12.8	40.0	36.6	15.8	20.2	30.2	35.9	41.1	8.1	5.1	16.3	5.0
Ste 14P	1830	M	Z	133.5	129.0	11.4	37.0	32.1	13.8	17.6	27.8	31.2	35.3	6.9	6.2	14.3	4.5
Ste 15P	644	F	Z	139.5	136.0	11.2	36.5	29.8	13.8	17.9	29.0	31.7	35.8	9.1	7.4	15.1	3.5
Ste 16P	1119	M	?	139.0	132.5	12.2	40.0	33.5	14.0	19.1	28.9	34.4	39.3	8.3	6.4	15.7	6.5
Ste 17P	1491	F	W	143.5	135.5	11.5	37.0	35.0	14.7	19.7	29.9	34.2	37.9	8.2	6.3	14.9	8.0
Ste 18P	611	F	Z	137.0	132.5	11.3	39.0	31.9	13.9	17.6	28.4	32.2	35.3	8.3	6.2	13.4	4.5
Ste 19P	690	F	Z	145.0	139.5	12.1	37.5	34.3	15.4	19.6	31.0	35.4	39.6	8.2	6.4	16.7	5.5
Ste 20P	494	M	Z	140.5	136.0	11.5	37.0	35.4	15.7	20.1	30.1	35.8	39.6	9.4	5.9	16.0	4.5
Ste 21P	2591	M	W	146.5	140.0	11.9	39.0	35.7	15.8	20.0	30.8	34.6	39.0	9.2	7.1	14.6	6.5
MEDIAN				140.3	135.8	11.7	37.3	33.5	14.5	19.0	29.4	33.0	36.7	8.3	6.4	14.8	4.5
MEAN				141.2	136.5	11.8	37.9	33.1	14.6	18.7	29.0	33.2	36.8	8.2	6.5	14.9	4.7
STD DEV				8.8	8.6	0.9	2.3	2.2	0.8	1.2	1.5	1.7	2.1	1.0	0.7	0.9	1.5
MIN				120.0	117.0	10.3	33.5	28.9	13.5	16.2	25.6	29.5	33.6	6.7	5.1	13.4	4.5
MAX				164.5	161.5	14.2	43.0	36.6	16.2	20.3	31.0	35.9	41.1	9.9	7.6	16.7	8.0

COMMON DUIKER (Sylvicapra grimmia) n=16

INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
CDu 1P	2459	M	W	163.0	160.0	13.5	45.0	40.5	17.8	22.9	34.3	41.7	45.3	8.9	7.4	17.4	3.0
CDu 2P	2256	F	Z	164.0	159.0	12.9	41.5	35.3	16.3	22.2	33.3	38.2	43.8	7.5	6.3	17.6	5.0
CDu 3P	1149	M	W	156.0	150.0	12.5	41.5	36.5	15.4	20.4	31.8	37.6	42.6	8.2	6.6	16.0	6.0
CDu 4P	1154	F	Z	164.5	157.0	14.8	48.0	40.2	17.2	23.5	33.9	40.2	44.6	8.0	7.4	18.0	7.5
CDu 5P	1620	M	W	160.5	155.5	13.1	41.0	36.5	16.8	22.4	34.4	39.8	45.1	9.7	7.4	16.9	5.0
CDu 6P	2592	M	W	168.5	162.0	15.3	48.0	38.3	17.2	21.9	34.7	40.1	45.0	8.8	7.0	18.3	6.5
CDu 7P	523	F	Z	163.5	155.0	14.4	47.0	37.4	16.4	22.5	33.9	37.5	42.7	7.7	7.3	16.8	8.5
CDu 8P	2255	M	Z	160.0	153.5	12.8	42.5	38.4	16.6	22.9	34.8	42.7	48.3	9.2	8.2	17.0	6.5
CDu 9P	558	F	Z	166.5	158.0	13.8	45.0	38.1	16.8	20.6	32.1	38.3	44.5	8.9	5.6	17.2	8.5
CDu 10P	551	F	Z	158.0	152.5	13.2	42.0	36.0	16.6	21.4	33.3	38.4	41.5	7.9	6.9	15.6	5.5
CDu 11P	552	F	Z	162.0	156.5	13.1	43.0	36.2	16.9	22.7	33.8	38.0	42.7	8.2	6.6	16.3	5.5
CDu 12P	368	M	?	170.0	162.0	14.8	45.0	38.9	17.7	22.8	35.0	39.8	44.6	8.2	7.1	18.4	8.0
CDu 13P	649	M	?	157.5	150.5	13.6	44.0	37.6	17.0	23.6	35.4	39.0	44.1	10.5	8.7	17.3	7.0
CDu 14P	1855	F	Z	160.5	157.5	13.8	46.0	38.1	17.4	21.9	36.0	40.2	45.5	9.1	8.6	16.9	3.0
CDu 15P	1490	?	W	174.5	167.0	14.8	47.5	41.1	17.6	24.0	36.4	41.1	44.4	9.6	7.0	19.4	7.5
CDu 16P	1774	F	Z	168.0	165.5	13.9	45.5	40.1	19.0	23.7	36.7	42.5	47.5	9.6	9.9	19.2	2.5
MEDIAN				163.3	157.3	13.7	45.0	38.1	17.0	22.6	34.4	39.8	44.6	8.9	7.2	17.3	6.3
MEAN				163.6	157.6	13.8	44.5	38.1	17.0	22.5	34.4	39.7	44.5	8.8	7.4	17.4	6.0
STD DEV				5.0	4.9	0.8	2.4	1.7	0.8	1.0	1.4	1.7	1.7	0.8	1.0	1.1	1.9
MIN				156.0	150.0	12.5	41.0	35.3	15.4	20.4	31.8	37.5	41.5	7.5	5.6	15.6	2.5
MAX				174.5	167.0	15.3	48.0	41.1	19.0	24.0	36.7	42.7	48.3	10.5	9.9	19.4	8.0

ORIBI (*Ourebia orebi*) n=5																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Ori 1B	9752	F	W	168.0	158.5	14.1	44.5	40.3	17.0	24.9	35.5	39.4	45.0	7.4	5.8	19.7	9.5
Ori 2B	9321	F	W	173.0	165.5	15.2	48.0	41.8	17.0	23.1	36.1	40.3	44.9	9.5	7.7	17.6	7.5
Ori 3B	9319	M	W	171.0	164.0	14.1	47.0	42.4	16.9	23.6	35.8	40.6	44.3	8.6	8.3	19.4	7.0
Ori 4P	2229	F	W	168.0	162.5	14.4	47.0	40.9	17.5	24.9	35.4	39.9	45.4	9.6	8.7	18.8	5.5
Ori 5P	2228	M	W	161.5	153.0	14.7	46.0	40.6	17.0	23.4	33.9	39.4	43.8	9.0	8.4	18.3	8.5
MEDIAN				168.0	162.5	14.4	47.0	40.9	17.0	23.6	35.5	39.9	44.9	9.0	8.3	18.8	7.5
MEAN				168.3	160.7	14.5	46.5	41.2	17.1	24.0	35.3	39.9	44.7	8.8	7.8	18.8	7.6
STD DEV				4.4	5.0	0.5	1.3	0.9	0.2	0.9	0.9	0.5	0.6	0.9	1.2	0.8	1.5
MIN				161.5	153.0	14.1	44.5	40.3	16.9	23.1	33.9	39.4	43.8	7.4	5.8	17.6	5.5
MAX				173.0	165.5	15.2	48.0	42.4	17.5	24.9	36.1	40.6	45.4	9.6	8.7	19.7	9.5

SPRINGBOK (Antidorcas marsupialis) n=20

INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)
Spr 1B	7425	F	W	199.5	187.5	18.7	56.0	51.6
Spr 2B	7423	M	W	219.5	208.5	20.4	62.5	53.2
Spr 3B	9609	F	W	198.0	191.0	17.2	54.0	50.2
Spr 4B	7418	M	W	215.5	206.5	18.8	57.5	53.2
Spr 5B	7435	F	W	209.5	204.0	18.7	57.5	54.7
Spr 6B	7434	M	W	221.5	215.5	19.3	62.5	56.0
Spr 7B	6019	M	W	169.5	162.0	10.3	49.0	43.9
Spr 8B	7421	F	W	205.0	196.5	18.2	55.0	51.3
Spr 9B	7424	M	W	213.5	204.0	18.6	59.5	52.4
Spr 10B	7422	M	W	211.0	202.5	18.8	59.5	52.8
Spr 11B	7420	F	W	197.5	186.5	17.9	56.0	51.6
Spr 12B	7433	M	W	219.0	205.5	20.3	60.5	55.7
Spr 13B	7426	F	W	193.5	187.5	17.4	54.0	47.9
Spr 14B	7419	M	W	207.0	200.0	17.6	56.5	56.1
Spr 15B	7431	F	W	212.0	205.0	17.1	57.0	52.2
Spr 16B	7432	M	W	223.5	215.0	21.2	65.0	55.0
Spr 17B	7436	M	W	214.5	206.5	18.4	58.5	55.7
Spr 18B	9885	M	Z	179.5	171.0	15.6	49.0	43.7
Spr 19B	9324	F	Z	182.5	176.5	17.7	53.0	44.6
Spr 20B	9798	F	Z	192.0	184.0	17.6	55.0	50.0
MEDIAN				208.3	201.3	18.3	56.8	52.3
MEAN				204.2	195.8	18.0	56.9	51.6
STD DEV				14.9	14.6	2.2	4.1	3.9
MIN				169.5	162.0	10.3	49.0	43.7
MAX				223.5	215.5	21.2	65.0	56.1

INDIVIDUAL	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Spr 1B	20.9	28.9	41.9	49.4	58.0	10.6	9.3	23.8	12.0
Spr 2B	22.7	30.4	43.9	47.7	57.9	12.3	8.6	26.2	11.0
Spr 3B	21.0	28.7	41.4	49.0	57.7	13.2	9.0	25.8	7.0
Spr 4B	22.1	28.9	43.5	48.5	59.3	10.1	9.2	25.1	9.0
Spr 5B	22.5	28.9	42.3	47.7	57.1	11.0	8.0	25.8	5.5
Spr 6B	23.9	31.5	45.1	51.7	61.6	13.5	8.5	27.5	6.0
Spr 7B	19.3	25.7	36.5	40.8	47.0	8.1	7.0	21.2	7.5
Spr 8B	21.7	29.1	40.5	48.8	56.5	10.2	8.1	25.6	8.5
Spr 9B	22.8	30.4	44.8	50.7	61.0	9.9	9.0	26.9	9.5
Spr 10B	22.6	30.5	43.1	48.6	58.6	10.7	8.4	24.3	8.5
Spr 11B	20.7	28.1	39.8	46.6	55.0	10.2	7.5	23.5	11.0
Spr 12B	23.3	31.3	44.9	49.4	58.8	10.6	9.1	26.5	13.5
Spr 13B	21.3	28.5	41.6	46.1	55.7	11.8	10.3	25.2	6.0
Spr 14B	21.2	30.0	43.8	49.3	58.4	11.7	9.9	26.3	7.0
Spr 15B	22.4	30.3	41.9	48.5	57.2	13.1	10.3	24.8	7.0
Spr 16B	23.0	31.3	46.9	51.2	61.1	12.4	8.2	29.0	8.5
Spr 17B	23.4	30.8	44.2	51.1	61.3	9.6	8.2	27.1	8.0
Spr 18B	18.7	25.6	36.3	41.8	49.7	9.3	8.0	21.4	8.5
Spr 19B	18.2	25.7	37.7	42.3	49.8	8.9	7.2	23.0	6.0
Spr 20B	18.9	27.3	39.1	42.6	50.9	10.0	9.0	23.9	8.0
MEDIAN	21.9	29.0	42.1	48.6	57.8	10.6	8.6	25.4	8.3
MEAN	21.5	29.1	42.0	47.6	56.6	10.9	8.6	25.1	8.4
STD DEV	1.7	1.9	2.9	3.3	4.2	1.5	0.9	2.0	2.1
MIN	18.2	25.6	36.3	40.8	47.0	8.1	7.0	21.2	6.0
MAX	23.9	31.5	46.9	51.7	61.6	13.5	10.3	29.0	8.5

MOUNTAIN REEDBUCK (*Redunca fulvorula*) n=7																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Mou 1K	37186	M	W	196.5	190.5	14.9	48.0	43.4	19.7	26.3	38.6	43.1	48.0	12.9	10.7	19.7	6.0
Mou 2K	40655	F	W	214.5	205.0	17.5	57.5	45.0	21.3	28.1	42.5	47.0	52.7	12.7	9.6	21.4	9.5
Mou 3K	40644	M	W	213.5	204.5	16.7	56.5	45.4	20.8	26.5	41.2	45.5	52.1	11.2	8.9	21.7	9.0
Mou 4B	9843	M	?	205.0	197.0	16.7	55.5	48.3	20.3	28.3	40.6	43.7	48.8	11.1	9.1	19.9	8.0
Mou 5B	9350	?	?	208.5	204.0	18.6	60.0	46.8	21.6	29.0	44.3	46.7	51.4	11.8	9.1	21.3	4.5
Mou 6P	1285	M	Z	207.5	203.0	15.0	48.5	46.0	20.4	26.4	40.9	44.8	49.7	10.9	8.6	19.1	4.5
Mou 7P	2946	M	?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mou 8P	780	F	Z	196.5	189.5	14.9	49.0	41.5	18.9	24.6	39.2	43.8	48.0	12.2	9.3	18.2	7.0
MEDIAN				207.5	203.0	16.7	55.5	45.4	20.4	26.5	40.9	44.8	49.7	11.8	9.1	19.9	7.0
MEAN				206.0	199.1	16.3	53.6	45.2	20.4	27.0	41.0	44.9	50.1	11.8	9.3	20.2	6.9
STD DEV				7.3	6.8	1.5	4.9	2.2	0.9	1.5	1.9	1.5	2.0	0.8	0.7	1.3	2.0
MIN				196.5	189.5	14.9	48.0	43.4	18.9	24.6	38.6	43.1	48.0	10.9	8.6	18.2	4.5
MAX				214.5	205.0	18.6	60.0	48.3	21.6	29.0	44.3	47.0	52.7	12.9	10.7	21.7	8.0

GREY RHEBUCK (*Pelea capreolus*) n=4																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
GRh 1K	39319	M	W	191.0	182.0	16.4	49.0	42.1	18.3	24.2	38.3	44.5	47.8	10.4	10.5	18.1	9.0
GRh 2K	40069	M	W	186.0	179.0	16.3	49.0	45.7	19.2	25.4	38.8	43.1	47.6	10.1	9.6	18.2	7.0
GRh 3K	40630	F	W	199.5	192.0	16.0	51.5	45.3	20.1	25.4	39.9	45.8	48.7	10.1	10.5	19.2	7.5
GRh 4K	37054	F	W	201.0	194.0	16.8	54.0	45.5	20.5	27.9	38.7	46.5	49.9	11.5	8.9	19.3	7.0
MEDIAN				195.3	187.0	16.4	50.3	45.4	19.7	25.4	38.8	45.2	48.3	10.3	10.1	18.7	7.3
MEAN				194.4	186.8	16.4	50.9	44.7	19.5	25.7	38.9	45.0	48.5	10.5	9.9	18.7	7.6
STD DEV				7.1	7.4	0.3	2.4	1.7	1.0	1.6	0.7	1.5	1.0	0.7	0.8	0.6	0.9
MIN				186.0	179.0	16.0	49.0	42.1	18.3	24.2	38.3	43.1	47.6	10.1	8.9	18.1	7.0
MAX				201.0	194.0	16.8	54.0	45.7	20.5	27.9	39.9	46.5	49.9	11.5	10.5	19.3	9.0

BUSHBUCK (Tragelaphus scriptus) n=4																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Bus 1K	36693	M	W	233.0	219.5	21.0	72.0	49.3	23.5	31.9	45.6	51.4	57.4	12.5	10.4	23.0	13.5
Bus 2K	36692	F	W	212.5	202.5	19.0	59.5	44.8	22.1	22.9	38.9	47.9	50.5	12.2	9.4	20.5	10.0
Bus 3B	12100	F	W	228.5	217.0	19.8	64.5	49.6	23.7	28.2	44.8	48.8	52.7	12.0	11.5	23.5	11.5
Bus 4P	2095	M	?	235.5	225.5	21.2	70.0	52.4	24.3	29.7	43.6	51.9	56.9	10.3	10.3	21.3	10.0
MEDIAN				230.8	218.3	20.4	67.3	49.5	23.6	29.0	44.2	50.1	54.8	12.1	10.4	22.2	10.8
MEAN				227.4	216.1	20.3	66.5	49.0	23.4	28.2	43.2	50.0	54.4	11.8	10.4	22.1	11.3
STD DEV				10.3	9.8	1.0	5.6	3.1	0.9	3.8	3.0	2.0	3.3	1.0	0.9	1.4	1.7
MIN				212.5	202.5	19.0	59.5	44.8	22.1	22.9	38.9	47.9	50.5	10.3	9.4	20.5	10.0
MAX				235.5	225.5	21.2	72.0	52.4	24.3	31.9	45.6	51.9	57.4	12.5	11.5	23.5	13.5

BLESBOK (*Damaliscus dorcas philipsii*) n=12																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Ble 1K	38680	?	W	232.0	213.5	22.3	70.0	64.1	26.9	34.7	50.5	57.9	71.9	14.9	11.5	29.8	18.5
Ble 2K	37055	F	W	211.5	198.5	19.7	62.0	60.1	25.6	32.2	48.5	55.0	68.7	14.1	11.2	26.2	13.0
Ble 3K	36979	M	W	226.0	214.0	20.6	65.5	64.0	26.9	35.2	50.1	58.3	71.3	15.4	11.0	28.5	12.0
Ble 4K	36680	F	Z	219.5	203.0	22.1	68.0	62.1	25.5	34.1	50.7	55.0	67.0	13.7	10.7	27.7	16.5
Ble 5K	36343	M	W	223.0	206.5	20.8	65.0	64.0	27.6	33.6	48.5	54.9	68.6	15.0	11.4	27.9	16.5
Ble 6B	12038	M	W	224.0	213.0	21.1	68.5	65.0	26.2	35.9	49.9	57.1	69.3	11.8	8.1	28.5	11.0
Ble 7B	12036	M	W	228.0	213.0	21.8	71.5	65.3	26.4	35.3	49.6	56.4	68.9	11.4	9.1	28.8	15.0
Ble 8B	12035	M	W	235.5	222.5	21.8	72.0	67.5	25.8	35.7	51.6	59.7	73.5	11.6	8.4	30.6	13.0
Ble 9B	12039	M	W	227.0	211.0	22.0	68.0	66.4	25.0	34.1	47.0	55.5	67.4	11.2	9.2	29.0	16.0
Ble 10B	12037	M	W	222.0	205.5	21.1	66.0	62.3	25.5	34.2	50.5	56.5	69.5	15.4	10.5	29.6	16.5
Ble 11B	9944	F	W	221.0	209.5	20.7	67.0	65.5	25.6	34.2	46.7	56.0	69.8	11.6	9.3	29.6	11.5
Ble 12B	7446	F	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ble 13B	7438	M	W	228.0	213.5	21.3	66.5	65.9	25.4	35.4	51.6	59.7	70.9	11.7	8.9	28.8	14.5
MEDIAN				225.0	212.0	21.2	67.5	64.6	25.7	34.5	50.0	56.5	69.4	12.8	9.9	28.8	14.8
MEAN				224.8	210.3	21.3	67.5	64.4	26.0	34.6	49.6	56.8	69.7	13.2	9.9	28.8	14.5
STD DEV				6.2	6.2	0.8	2.8	2.1	0.8	1.0	1.6	1.7	1.9	1.7	1.2	1.1	2.4
MIN				211.5	198.5	19.7	62.0	60.1	25.0	32.2	46.7	54.9	67.0	11.2	8.1	26.2	11.5
MAX				235.5	222.5	22.3	72.0	67.5	27.6	35.9	51.6	59.7	73.5	15.4	11.5	30.6	16.5

BONTEBOK (Damaliscus dorcas dorcas) n=29

INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Bon 1K	35116	M	Z	244.5	229.0	22.0	67.0	62.6	27.9	35.7	52.2	59.3	69.6	13.2	10.1	30.9	15.5
Bon 2K	35056	M	W	239.0	226.0	22.4	70.0	62.7	27.2	37.7	51.4	61.9	70.8	13.2	8.7	30.0	13.0
Bon 3K	65052	F	W	235.0	220.5	20.2	66.5	61.6	25.8	35.5	49.4	60.1	69.5	13.6	9.7	29.0	14.5
Bon 4K	35048	F	W	230.5	216.0	20.7	64.5	59.9	24.9	34.7	49.6	59.0	67.7	13.5	9.3	30.2	14.5
Bon 5K	35047	F	W	238.5	225.5	21.1	68.0	62.9	26.3	34.3	48.4	60.9	70.9	13.4	9.5	30.6	13.0
Bon 6K	36017	F	W	220.0	210.0	19.5	60.0	57.9	25.4	35.4	48.3	57.4	66.7	12.6	10.1	28.6	10.0
Bon 7K	36053	?	W	226.0	210.0	20.8	65.0	60.0	25.1	34.1	48.2	56.0	65.7	12.8	9.5	30.2	16.0
Bon 8K	35928	M	W	226.5	215.0	19.5	61.5	61.1	24.7	35.5	47.4	55.8	65.9	14.2	10.3	29.3	11.5
Bon 9K	35927	M	W	235.5	222.5	21.8	69.0	65.1	26.9	37.7	50.8	58.4	68.8	12.2	8.8	32.1	13.0
Bon 10K	36151	F	W	235.5	219.5	22.3	70.5	63.0	27.6	37.9	53.3	60.7	72.0	12.9	10.3	31.2	16.0
Bon 11K	36054	F	W	221.5	211.5	19.5	60.5	61.9	25.7	36.3	48.3	57.7	66.2	11.8	9.6	30.4	10.0
Bon 12K	36202	?	W	247.5	233.0	22.4	69.0	64.5	27.1	37.5	51.3	61.3	69.8	12.8	9.2	31.0	14.5
Bon 13K	36279	F	W	214.0	205.0	18.6	59.5	55.2	24.3	32.6	46.8	57.5	67.0	15.9	10.9	28.0	9.0
Bon 14K	36295	M	W	241.5	228.5	22.5	69.5	62.6	26.5	34.6	50.5	60.9	69.9	14.5	9.9	31.5	13.0
Bon 15K	36834	F	Z	220.5	204.0	27.3	70.5	63.0	26.8	34.8	51.7	56.7	70.7	13.6	10.6	27.7	16.5
Bon 16K	36659	M	W	234.0	221.5	20.7	65.0	60.2	26.1	36.2	50.3	59.4	69.0	12.7	10.2	30.3	12.5
Bon 17K	36288	M	W	219.0	209.5	18.7	60.5	59.1	24.8	34.3	47.6	55.5	65.4	12.8	10.3	29.3	9.5
Bon 18K	36281	M	W	216.5	207.5	19.0	59.5	56.7	26.4	34.7	48.5	56.9	66.3	12.1	9.5	29.7	9.0
Bon 19K	36985	M	W	213.0	203.5	18.6	58.5	53.7	23.9	32.1	47.5	56.3	65.8	15.2	11.3	28.1	9.5
Bon 20K	38726	M	W	245.0	233.0	22.0	70.5	61.3	22.1	31.9	48.0	57.0	66.1	12.6	11.0	33.3	12.0
Bon 21K	38740	F	W	234.0	221.0	21.8	69.5	63.6	26.7	37.2	54.4	60.3	69.4	10.5	8.0	31.2	13.0
Bon 22K	38735	F	W	233.0	219.0	22.9	71.5	64.7	27.3	37.3	51.1	59.5	70.3	12.6	9.8	32.5	14.0
Bon 23K	14090	F	W	231.5	216.5	21.0	66.0	62.8	25.8	34.8	48.5	58.0	67.9	12.5	9.7	28.5	15.0
Bon 24K	40398	M	W	241.5	228.0	22.2	70.0	63.7	27.1	37.0	52.5	60.8	71.1	11.8	9.9	31.4	13.5
Bon 25K	40407	F	W	226.0	215.5	21.1	67.0	62.8	25.2	36.4	48.2	55.7	66.2	11.3	9.3	30.8	10.5
Bon 26K	39793	M	W	237.5	223.0	21.7	68.5	65.3	26.6	36.6	51.6	60.9	69.8	13.3	10.2	31.2	14.5
Bon 27K	41140	M	W	245.5	228.0	22.0	72.0	67.7	27.9	38.1	52.3	62.8	72.4	12.7	9.4	30.6	17.5
Bon 28K	40746	M	W	241.0	228.0	22.4	71.0	63.6	26.8	37.8	52.9	61.2	70.6	11.4	10.0	32.2	13.0
Bon 29K	40835	M	W	233.5	218.0	21.0	68.5	62.3	26.2	36.8	50.6	58.4	67.3	12.6	8.2	30.6	15.5
MEDIAN				234.0	219.5	21.1	68.0	62.6	26.3	35.7	50.3	59.0	69.0	12.8	9.8	30.6	13.0
MEAN				232.0	218.9	21.2	66.5	61.8	26.0	35.7	50.1	58.8	68.6	12.9	9.8	30.4	13.1
STD DEV				9.9	8.7	1.8	4.2	3.0	1.3	1.7	2.1	2.1	2.1	1.1	0.8	1.4	2.4
MIN				213.0	203.5	18.6	58.5	53.7	22.1	31.9	46.8	55.5	65.4	10.5	8.0	27.7	10.5
MAX				247.5	233.0	27.3	72.0	67.7	27.9	38.1	54.4	62.8	72.4	15.9	11.3	33.3	17.5

IMPALA (*Aepyceros melampus*) n=17

INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Imp 1P	1198	F	Z	232.0	218.0	19.7	62.0	59.9	24.7	33.0	49.5	54.2	61.3	11.9	9.8	25.8	14.0
Imp 2P	1273	F	Z	228.0	217.0	17.6	57.0	56.5	22.9	31.4	47.0	52.1	61.2	11.4	8.8	25.7	11.0
Imp 3P	646	M	Z	242.0	222.0	21.3	72.0	65.7	25.7	34.2	50.5	59.3	66.9	11.4	7.0	28.9	20.0
Imp 4P	1590	F	Z	233.0	221.0	21.1	67.0	61.9	24.3	33.5	47.0	56.3	63.7	12.0	9.5	25.0	12.0
Imp 5P	688	F	Z	219.0	205.5	17.5	56.0	56.4	23.8	33.5	46.7	55.1	61.3	12.1	10.4	25.6	13.5
Imp 6P	525	F	Z	216.5	205.5	18.2	59.5	54.0	21.7	29.9	45.1	52.2	59.0	11.4	9.3	24.0	11.0
Imp 7P	2218	M	W	239.0	225.0	21.9	72.5	64.2	25.1	33.6	53.7	58.7	68.0	11.2	9.4	31.8	14.0
Imp 8P	1450	M	Z	239.0	222.0	21.1	68.5	64.6	25.0	35.7	48.4	57.6	66.1	14.4	9.6	27.7	17.0
Imp 9P	643	F	Z	227.0	213.0	18.8	61.5	54.6	22.9	31.4	47.2	52.6	62.3	13.1	10.6	28.1	14.0
Imp 10P	2296	F	Z	234.5	219.5	19.9	64.0	58.5	24.1	32.5	46.4	55.2	64.7	11.9	8.9	26.7	15.0
Imp 11P	816	M	W	227.0	213.0	18.5	60.0	58.2	23.0	32.3	47.9	54.7	61.7	11.6	9.7	27.5	14.0
Imp 12P	1055	M	Z	246.0	231.0	21.4	68.0	65.6	25.1	36.9	51.3	56.6	63.6	10.7	10.0	28.7	15.0
Imp 13P	2419	F	Z	233.5	221.0	19.4	63.5	58.7	23.8	34.0	47.5	53.3	61.6	11.8	9.4	26.2	12.5
Imp 14P	532	F	Z	234.0	217.0	20.9	65.5	62.2	25.0	34.1	50.2	54.9	63.4	11.2	10.4	27.5	17.0
Imp 15P	2469	M	Z	249.0	237.0	22.1	72.0	64.5	25.8	35.7	51.1	57.0	65.3	11.5	9.0	28.4	12.0
Imp 16P	2376	F	Z	236.0	222.0	20.8	66.0	60.9	25.0	33.5	48.9	55.0	63.8	11.2	8.7	27.9	14.0
Imp 17P	751	F	Z	238.0	223.0	19.9	66.0	63.4	25.8	36.3	50.2	57.2	65.3	10.4	9.4	27.1	15.0
MEDIAN				234.0	221.0	19.9	65.5	60.9	24.7	33.5	48.4	55.1	63.6	11.5	9.4	27.5	14.0
MEAN				233.7	219.6	20.2	64.8	60.6	24.3	33.6	48.7	55.4	63.5	11.7	9.4	27.2	14.2
STD DEV				8.6	7.9	1.5	5.0	3.8	1.2	1.8	2.2	2.2	2.4	0.9	0.8	1.8	2.3
MIN				216.5	205.5	17.5	56.0	54.0	21.7	29.9	45.1	52.1	59.0	10.4	7.0	24.0	12.0
MAX				249.0	237.0	22.1	72.5	65.7	25.8	36.9	53.7	59.3	68.0	14.4	10.6	31.8	17.0

REEDBUCK (redunca arundinum) n=6																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Ree 1K	40529	?	W	264.0	249.5	21.4	66.0	62.7	28.1	36.5	53.2	58.8	70.0	17.4	11.5	28.4	14.5
Ree 2K	38808	M	W	265.0	249.5	23.1	72.0	61.1	24.1	36.5	53.3	58.8	66.0	16.6	11.4	29.8	15.5
Ree 3B	8706	M	W	257.0	247.5	22.6	71.5	64.0	27.9	38.4	55.4	61.2	70.1	15.8	10.9	29.2	9.5
Ree 4P	1068	M	Z	253.0	242.0	19.9	73.0	59.1	24.5	36.4	52.6	58.5	66.7	13.5	10.6	26.4	11.0
Ree 5P	105	F	?	237.5	231.0	19.7	63.0	58.2	23.9	35.0	49.7	55.8	62.3	12.1	9.8	25.5	6.5
Ree 6P	110	M	?	239.0	228.0	21.4	68.0	56.4	22.5	33.0	49.9	54.4	62.0	12.6	11.0	26.7	11.0
MEDIAN				255.0	244.8	21.4	69.8	60.1	24.3	36.5	52.9	58.7	66.4	14.7	11.0	27.6	11.0
MEAN				252.6	241.3	21.4	68.9	60.3	25.2	36.0	52.4	57.9	66.2	14.7	10.9	27.7	11.3
STD DEV				12.0	9.6	1.4	3.9	2.9	2.3	1.8	2.2	2.4	3.5	2.2	0.6	1.7	3.3
MIN				237.5	228.0	19.7	63.0	56.4	22.5	33.0	49.7	54.4	62.0	12.1	9.8	25.5	6.5
MAX				265.0	249.5	23.1	73.0	64.0	28.1	38.4	55.4	61.2	70.1	17.4	11.5	29.8	15.5

RED LECHWE (Kobus leche) n=5

INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Lec 1B	8714	F	Z	271.0	261.0	22.2	72.0	63.9	26.6	37.7	54.1	62.0	71.7	14.1	11.9	29.5	10.0
Lec 2P	539	F	Z	283.5	267.0	22.3	78.5	67.3	29.0	40.3	60.3	63.9	77.9	13.8	11.2	32.8	16.5
Lec 3P	2945	F	?	291.0	279.0	25.9	86.0	73.7	29.4	41.4	63.9	67.4	80.4	14.7	12.9	37.3	12.0
Lec 4P	498	F	Z	271.0	258.5	20.7	71.0	63.7	27.9	37.0	57.5	60.0	72.6	12.2	10.8	31.8	12.5
Lec 5P	593	M	Z	292.0	274.0	22.5	78.0	70.0	29.6	43.5	61.2	64.9	77.0	13.8	10.8	32.8	18.0
MEDIAN				283.5	267.0	22.3	78.0	67.3	29.0	40.3	60.3	63.9	77.0	13.8	11.2	32.8	12.5
MEAN				281.7	267.9	22.7	77.1	67.7	28.5	40.0	59.4	63.6	75.9	13.7	11.5	32.8	13.8
STD DEV				10.3	8.6	1.9	6.0	4.2	1.2	2.7	3.7	2.8	3.7	0.9	0.9	2.8	3.3
MIN				271.0	258.5	20.7	71.0	63.7	26.6	37.0	54.1	60.0	71.7	12.2	10.8	29.5	10.0
MAX				292.0	279.0	25.9	86.0	73.7	29.6	43.5	63.9	67.4	80.4	14.7	12.9	37.3	18.0

NYALA (Tragelaphus angasii) n=6

INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Nya 1K	36902	M	?	290.5	276.0	25.6	87.0	68.8	28.6	39.7	56.1	64.1	75.1	13.2	12.3	35.9	14.5
Nya 2K	38811	F	?	265.0	251.5	21.1	72.0	62.0	28.7	35.2	52.4	61.3	70.6	14.7	12.8	31.7	13.5
Nya 3K	36903	F	?	248.0	237.5	20.0	70.0	56.3	25.8	33.3	51.1	59.8	67.1	12.5	12.1	28.4	10.5
Nya 4P	2974	F	?	251.0	239.5	20.5	71.5	59.5	27.2	34.6	51.6	58.1	68.2	13.4	12.1	29.8	11.5
Nya 5P	107	M	W	297.0	289.0	27.4	88.0	68.9	29.3	40.9	56.7	65.3	74.7	12.2	11.8	37.2	8.0
Nya 6P	106	F	W	244.0	230.0	19.8	70.5	58.0	25.8	34.3	50.2	57.1	67.6	12.0	10.7	29.5	14.0
MEDIAN				258.0	245.5	20.8	71.8	60.8	27.9	34.9	52.0	60.6	69.4	12.9	12.1	30.8	12.5
MEAN				265.9	253.9	22.4	76.5	62.3	27.6	36.3	53.0	61.0	70.6	13.0	12.0	32.1	12.0
STD DEV				22.8	23.6	3.3	8.6	5.4	1.5	3.2	2.7	3.3	3.6	1.0	0.7	3.6	2.5
MIN				244.0	230.0	19.8	70.0	56.3	25.8	33.3	50.2	57.1	67.1	12.0	10.7	28.4	8.0
MAX				297.0	289.0	27.4	88.0	68.9	29.3	40.9	56.7	65.3	75.1	14.7	12.8	37.2	14.0

SITATUNGA (Tragelaphus spekei) n=2

INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Sit 1P	2958	?	W	311.0	300.0	22.9	74.5	70.1	30.1	42.0	59.1	68.8	75.7	15.9	15.5	29.4	11.0
Sit 2P	405	M	W	309.0	305.0	21.7	78.0	67.3	28.9	40.0	56.2	62.2	69.7	15.8	15.6	27.6	4.0
MEDIAN				310.0	302.5	22.3	76.3	68.7	29.5	41.0	57.7	65.5	72.7	15.9	15.6	28.5	7.5
MEAN				310.0	302.5	22.3	76.3	68.7	29.5	41.0	57.7	65.5	72.7	15.9	15.6	28.5	7.5
STD DEV				1.4	3.5	0.8	2.5	2.0	0.8	1.4	2.1	4.7	4.2	0.1	0.1	1.3	4.9
MIN				309.0	300.0	21.7	74.5	67.3	28.9	40.0	56.2	62.2	69.7	15.8	15.5	27.6	4.0
MAX				311.0	305.0	22.9	78.0	70.1	30.1	42.0	59.1	68.8	75.7	15.9	15.6	29.4	11.0

TSESSEBE (Damaliscus lunatus) n=1																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Tse 1B	9922	?	?	279.0	264.0	26.4	82.0	78.4	32.2	42.4	61.4	71.6	88.0	14.7	10.9	33.3	15.0
MEDIAN				279.0	264.0	26.4	82.0	78.4	32.2	42.4	61.4	71.6	88.0	14.7	10.9	33.3	15.0
MEAN				279.0	264.0	26.4	82.0	78.4	32.2	42.4	61.4	71.6	88.0	14.7	10.9	33.3	15.0
STD DEV				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MIN				279.0	264.0	26.4	82.0	78.4	32.2	42.4	61.4	71.6	88.0	14.7	10.9	33.3	0.0
MAX				279.0	264.0	26.4	82.0	78.4	32.2	42.4	61.4	71.6	88.0	14.7	10.9	33.3	15.0

RED HARTBEEST (*Alcelaphus buselaphus*) n=9																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(CBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
RHa 1K	39820	F	W	270.5	252.5	25.1	79.0	77.5	30.9	43.3	59.9	70.8	86.0	17.3	10.8	33.6	18.0
RHa 2K	40837	M	W	302.0	288.0	26.6	84.5	85.1	32.8	45.9	62.3	71.8	87.8	17.1	11.2	38.0	14.0
RHa 3B	9930	?	?	273.5	254.5	24.9	83.0	76.0	33.9	42.3	60.3	72.8	88.6	16.8	12.3	35.4	19.0
RHa 4B	7437	F	W	281.5	263.5	24.0	77.5	81.9	33.0	46.1	63.1	72.9	87.8	17.1	14.4	34.7	18.0
RHa 5B	9763	M	Z	281.0	262.5	26.4	87.0	85.3	33.0	45.0	66.2	72.3	87.8	13.4	11.4	38.7	18.5
RHa 6B	9417	M	W	298.5	287.0	28.0	91.0	93.3	35.4	49.2	67.5	76.9	94.0	17.4	9.7	37.1	11.5
RHa 7B	12032	F	W	293.0	275.5	26.5	88.5	81.6	32.0	45.8	64.9	71.8	87.3	14.7	9.6	35.3	17.5
RHa 8B	9773	F	W	274.0	260.0	23.8	78.5	77.3	32.2	43.1	60.6	71.0	87.9	18.1	13.4	34.0	14.0
RHa 9B	8715	F	Z	281.5	261.5	24.5	81.0	80.1	32.3	43.5	63.1	73.3	88.7	16.0	12.2	36.6	20.0
MEDIAN				281.5	262.5	25.1	83.0	81.6	32.8	45.0	63.1	72.3	87.8	17.1	11.4	35.4	18.0
MEAN				283.9	267.2	25.5	83.3	82.0	32.8	44.9	63.1	72.6	88.4	16.4	11.7	35.9	16.7
STD DEV				11.3	13.2	1.4	4.8	5.4	1.3	2.1	2.7	1.8	2.2	1.5	1.6	1.8	2.9
MIN				270.5	252.5	23.8	77.5	76.0	30.9	42.3	59.9	70.8	86.0	13.4	9.6	33.6	11.5
MAX				302.0	288.0	28.0	91.0	93.3	35.4	49.2	67.5	76.9	94.0	18.1	14.4	38.7	20.0

KUDU (Tragelaphus strepsiceros) n=8																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Kud 1K	38768	M	?	352.5	329.0	33.3	112.0	101.2	43.9	57.3	82.7	89.0	108.6	22.0	18.1	46.8	23.5
Kud 2B	9923	?	?	390.0	365.5	35.9	129.0	103.4	44.0	57.7	84.6	93.6	112.7	17.7	16.2	48.1	24.5
Kud 3B	9924	?	?	357.0	337.0	32.4	113.0	98.4	41.0	55.6	80.3	85.6	103.2	19.3	13.3	44.6	20.0
Kud 4B	9933	?	W	380.5	360.0	33.5	120.0	103.1	45.0	58.1	86.3	93.5	109.8	22.7	17.7	46.6	20.5
Kud 5B	8713	?	W	360.0	346.0	32.5	108.0	92.1	41.4	53.3	80.5	87.0	102.6	21.8	17.8	43.4	14.0
Kud 6P	1592	F	W	325.0	307.0	28.0	95.0	81.5	35.4	50.7	68.1	75.2	83.7	18.7	15.3	33.6	18.0
Kud 7P	1260	F	Z	337.0	324.5	31.1	101.0	86.1	38.8	50.3	77.5	83.6	99.3	20.9	18.7	40.9	12.5
Kud 8P	1261	F	Z	338.0	331.0	29.3	98.5	89.2	40.7	57.7	79.9	88.0	101.2	21.0	18.2	39.8	7.0
MEDIAN				354.8	334.0	32.5	110.0	95.3	41.2	56.5	80.4	87.5	102.9	21.0	17.8	44.0	19.0
MEAN				355.0	337.5	32.0	109.6	94.4	41.3	55.1	80.0	86.9	102.6	20.5	16.9	43.0	17.5
STD DEV				22.1	19.2	2.5	11.4	8.3	3.1	3.2	5.6	5.9	8.9	1.8	1.8	4.8	6.0
MIN				325.0	307.0	28.0	95.0	81.5	35.4	50.3	68.1	75.2	83.7	17.7	13.3	33.6	7.0
MAX				390.0	365.5	35.9	129.0	103.4	45.0	58.1	86.3	93.6	112.7	22.7	18.7	48.1	20.5

BLACK WILDEBEEST (*Connochaetes gnou*) n=21

INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Bla 1K	38783	F	Z	254.0	228.0	26.5	88.5	85.6	33.6	49.9	67.9	72.4	93.5	15.2	10.6	40.9	26.0
Bla 2K	36239	F	W	262.5	243.5	27.0	89.5	82.0	31.6	46.6	68.4	72.4	91.7	19.7	14.1	39.3	19.0
Bla 3K	39318	F	W	269.5	246.5	28.3	92.0	86.5	31.8	45.9	69.5	70.8	90.1	9.4	8.5	40.7	23.0
Bla 4K	39233	F	Z	257.0	232.0	26.1	89.5	84.5	31.7	46.7	68.4	70.8	92.3	17.9	13.6	39.9	25.0
Bla 5K	39121	F	Z	259.0	236.5	25.5	86.0	81.9	32.0	46.1	68.1	71.3	91.5	15.9	12.2	40.8	22.5
Bla 6K	36675	M	Z	268.5	243.0	27.7	92.0	89.0	33.0	46.7	69.2	70.3	90.7	15.6	12.8	40.3	25.5
Bla 7K	36660	M	W	273.0	244.0	28.3	93.5	82.8	31.2	45.6	68.8	72.2	91.3	19.0	13.9	40.7	29.0
Bla 8K	37090	F	?	263.5	243.0	27.1	89.0	90.0	33.6	47.5	70.4	72.1	94.8	16.0	12.7	41.6	20.5
Bla 9K	36710	F	Z	256.0	230.5	27.5	91.5	88.8	31.5	47.3	67.5	70.8	90.9	16.4	9.7	40.7	25.5
Bla 10K	38249	F	Z	240.5	222.0	23.5	80.0	81.6	29.3	42.8	64.2	66.6	88.2	17.1	12.3	38.3	18.5
Bla 11B	8708	M	W	292.0	256.0	30.0	96.0	95.5	35.8	49.3	76.9	77.7	99.7	16.7	13.3	43.5	36.0
Bla 12B	8742	M	W	286.5	259.0	29.7	96.5	92.1	34.4	47.2	72.2	75.2	96.6	14.9	11.1	40.1	27.5
Bla 13B	9358	M	W	296.0	270.0	30.1	99.5	98.8	34.9	49.5	76.5	82.0	103.8	17.5	16.9	44.3	26.0
Bla 14B	6079	?	?	271.5	249.5	27.9	93.5	85.7	31.2	46.9	63.8	72.4	89.1	17.7	11.7	40.2	22.0
Bla 15B	8714	F	W	257.0	239.0	25.2	83.5	81.4	32.6	46.9	64.2	70.5	92.6	13.1	12.5	38.1	18.0
Bla 16B	9779	M	W	284.0	259.0	29.4	96.0	93.1	35.2	46.2	74.5	78.5	98.4	16.3	14.1	41.3	25.0
Bla 17B	8736	M	W	264.5	236.5	25.4	86.0	88.4	31.4	44.7	67.1	71.7	91.2	18.2	13.3	39.1	28.0
Bla 18B	7447	F	W	271.5	246.5	27.4	94.5	89.0	33.0	46.5	70.3	75.4	98.3	15.6	12.3	43.1	25.0
Bla 19B	12054	M	W	279.0	253.0	27.5	96.0	93.8	33.5	50.3	73.0	75.3	97.5	14.7	11.8	43.4	26.0
Bla 20B	12053	M	W	252.0	220.0	26.0	84.5	79.5	30.3	42.9	67.2	69.9	89.3	18.2	13.2	38.0	32.0
Bla 21B	12052	M	W	270.0	244.0	26.3	90.5	88.5	33.9	46.9	68.4	76.2	98.0	13.5	11.4	41.7	26.0
MEDIAN				268.5	243.5	27.4	91.5	88.4	32.6	46.7	68.4	72.2	92.3	16.3	12.5	40.7	25.5
MEAN				268.0	242.9	27.3	90.9	87.5	32.6	46.8	69.4	73.1	93.8	16.1	12.5	40.8	25.0
STD DEV				13.9	12.6	1.7	4.9	5.2	1.7	1.9	3.6	3.5	4.2	2.3	1.8	1.8	4.3
MIN				240.5	220.0	23.5	80.0	79.5	29.3	42.8	63.8	66.6	88.2	9.4	8.5	38.0	25.0
MAX				296.0	270.0	30.1	99.5	98.8	35.8	50.3	76.9	82.0	103.8	19.7	16.9	44.3	32.0

WATERBUCK (Kobus ellipsiprymnus) n=6																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Wat 1B	9952	?	?	345.0	318.0	31.9	110.0	98.0	38.1	54.5	82.5	87.0	107.7	15.9	11.0	47.2	27.0
Wat 2B	6017	F	W	357.0	328.0	32.4	115.5	101.1	40.3	54.9	83.7	85.4	102.1	20.8	15.9	45.4	29.0
Wat 3B	12014	M	?	349.5	320.5	33.6	110.0	101.7	40.6	57.0	80.8	84.3	103.9	13.9	13.5	44.7	29.0
Wat 4B	9960	?	?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wat 5P	1853	F	Z	325.0	297.0	32.4	109.0	96.3	39.5	55.7	84.5	83.3	102.3	16.9	13.4	47.2	28.0
Wat 6P	1873	F	Z	322.0	302.0	31.8	108.5	96.2	36.7	54.9	78.7	78.5	97.4	18.2	11.8	44.6	20.0
Wat 7P	1160	F	Z	348.0	323.0	34.1	114.0	97.7	38.3	56.7	82.2	80.7	101.0	19.1	14.7	45.8	25.0
MEDIAN				346.5	319.3	32.4	110.0	97.9	38.9	55.3	82.4	83.8	102.2	17.6	13.5	45.6	27.5
MEAN				341.1	314.8	32.7	111.2	98.5	38.9	55.6	82.1	83.2	102.4	17.5	13.4	45.8	26.3
STD DEV				14.2	12.4	0.9	2.9	2.4	1.5	1.0	2.1	3.1	3.4	2.4	1.8	1.2	3.4
MIN				322.0	297.0	31.8	108.5	96.2	36.7	54.5	78.7	78.5	97.4	13.9	11.0	44.6	20.0
MAX				357.0	328.0	34.1	115.5	101.7	40.6	57.0	84.5	87.0	107.7	20.8	15.9	47.2	29.0

GEMSBUCK (*Oryx gazelle*) n=6																	
INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Gem 1K	33520	?	?	316.5	297.0	31.0	110.0	98.9	38.5	51.3	73.5	81.1	101.9	20.0	15.1	44.8	19.5
Gem 2K	33517	?	?	295.5	269.0	29.2	92.5	87.6	36.4	46.5	64.8	76.0	92.8	15.6	10.3	38.3	26.5
Gem 3B	9376	F	W	301.5	273.0	29.2	96.0	98.3	38.9	52.7	74.0	79.2	99.0	19.1	14.9	43.0	28.5
Gem 4B	9304	F	W	320.0	287.0	28.2	100.0	102.4	40.3	53.6	77.1	81.0	102.6	15.2	14.6	46.6	33.0
Gem 5P	475	F	Z	329.0	296.0	31.5	109.0	107.0	42.4	56.7	81.3	85.2	104.0	18.1	14.0	46.7	33.0
Gem 6P	1576	?	?	313.5	285.0	28.1	100.0	98.5	36.7	52.3	74.4	79.2	102.6	14.4	11.8	46.4	28.5
MEDIAN				315.0	286.0	29.2	100.0	98.7	38.7	52.5	74.2	80.1	102.3	16.9	14.3	45.6	28.5
MEAN				312.7	284.5	29.5	101.3	98.8	38.9	52.2	74.2	80.3	100.5	17.1	13.5	44.3	28.2
STD DEV				12.3	11.6	1.4	7.0	6.4	2.3	3.3	5.4	3.0	4.1	2.3	2.0	3.3	5.0
MIN				295.5	269.0	28.1	92.5	87.6	36.4	46.5	64.8	76.0	92.8	14.4	10.3	38.3	26.5
MAX				329.0	297.0	31.5	110.0	107.0	42.4	56.7	81.3	85.2	104.0	20.0	15.1	46.7	33.0

SABLE (Hippotragus niger) n=6																	
INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Sab 1K	39526	M	?	315.5	293.0	28.5	95.0	87.1	36.1	49.3	77.3	78.1	96.1	21.9	14.0	41.5	22.5
Sab 2B	6080	?	?	322.5	299.5	29.0	97.0	97.4	36.4	48.5	74.3	78.8	101.0	18.2	16.6	45.1	23.0
Sab 3B	9920	?	?	318.0	288.5	29.5	96.5	94.0	37.2	47.5	78.7	79.1	100.4	18.8	17.0	45.9	29.5
Sab 4P	1856	F	Z	315.0	292.0	29.1	101.0	94.9	38.2	50.8	79.9	81.2	98.6	15.8	11.8	44.9	23.0
Sab 5P	1265	M	Z	318.0	301.0	28.9	100.0	99.4	38.3	53.0	80.7	82.7	102.5	17.8	16.5	48.3	17.0
Sab 6P	472	M	W	331.0	310.0	30.6	103.0	96.6	40.7	53.1	80.4	82.5	101.4	15.8	15.4	49.3	21.0
MEDIAN				318.0	296.3	29.1	98.5	95.8	37.7	50.1	79.3	80.2	100.7	18.0	16.0	45.5	22.8
MEAN				320.0	297.3	29.3	98.8	94.9	37.8	50.4	78.6	80.4	100.0	18.1	15.2	45.8	22.7
STD DEV				6.0	7.8	0.7	3.1	4.3	1.7	2.3	2.4	2.0	2.3	2.3	2.0	2.8	4.0
MIN				315.0	288.5	28.5	95.0	87.1	36.1	47.5	74.3	78.1	96.1	15.8	11.8	41.5	17.0
MAX				331.0	310.0	30.6	103.0	99.4	40.7	53.1	80.7	82.7	102.5	21.9	17.0	49.3	29.5

BLUE WILDEBEEST (*Connochaetes taurinus*) n=5

INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
BWi 1K	36064	?	W	307.5	271.0	34.7	108.0	95.0	37.5	53.1	75.8	82.4	102.5	17.5	13.1	41.9	36.5
BWi 2K	33518	?	?	313.5	286.0	33.8	107.0	108.4	39.0	56.9	78.5	85.4	106.8	18.2	12.0	43.0	27.5
BWi 3B	3737	?	?	332.0	312.0	34.4	113.0	103.8	42.1	60.1	78.5	83.5	107.8	14.6	13.5	46.0	20.0
BWi 4P	1272	M	W	321.0	290.0	30.3	117.0	108.5	38.6	56.9	81.6	86.5	107.5	15.7	13.9	45.0	31.0
BWi 5P	563	F	Z	304.0	277.0	31.3	109.0	105.5	38.8	54.7	78.6	80.1	102.9	19.0	15.9	41.6	27.0
MEDIAN				313.5	286.0	33.8	109.0	105.5	38.8	56.9	78.5	83.5	106.8	17.5	13.5	43.0	27.5
MEAN				315.6	287.2	32.9	110.8	104.2	39.2	56.3	78.6	83.6	105.5	17.0	13.7	43.5	28.4
STD DEV				11.2	15.7	2.0	4.1	5.5	1.7	2.6	2.1	2.5	2.6	1.8	1.4	1.9	6.0
MIN				304.0	271.0	30.3	107.0	95.0	37.5	53.1	75.8	80.1	102.5	14.6	12.0	41.6	20.0
MAX				332.0	312.0	34.7	117.0	108.5	42.1	60.1	81.6	86.5	107.8	19.0	15.9	46.0	36.5

ROAN (*Hippotragus equinus*) n=3

INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Roa 1B	9919	?	?	337.0	300.5	30.5	102.0	101.2	37.5	53.1	80.6	83.9	105.5	16.1	13.2	49.2	36.5
Roa 2P	2933	?	?	375.0	340.0	32.9	112.0	111.8	43.5	58.6	83.5	92.4	117.9	17.8	15.1	51.5	35.0
Roa 3P	1591	?	W	311.0	285.0	28.8	100.0	96.1	33.4	48.1	71.9	75.6	92.2	14.1	10.2	34.3	26.0
MEDIAN				337.0	300.5	30.5	102.0	101.2	37.5	53.1	80.6	83.9	105.5	16.1	13.2	49.2	35.0
MEAN				341.0	308.5	30.7	104.7	103.0	38.1	53.3	78.7	84.0	105.2	16.0	12.8	45.0	32.5
STD DEV				32.2	28.4	2.1	6.4	8.0	5.1	5.3	6.0	8.4	12.9	1.9	2.5	9.3	5.7
MIN				311.0	285.0	28.8	100.0	96.1	33.4	48.1	71.9	75.6	92.2	14.1	10.2	34.3	26.0
MAX				375.0	340.0	32.9	112.0	111.8	43.5	58.6	83.5	92.4	117.9	17.8	15.1	51.5	36.5

ELAND (Taurotragus oryx) n=15

INDIVIDUAL	MUS NO.	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBOF)	F(SBOF)	F(GBT)	F(GL-GLH)
Ela 1K	35061	M	W	460.0	411.0	43.8	158.0	142.3	54.3	68.1	116.5	111.4	138.1	31.9	19.6	63.6	49.0
Ela 2K	36696	F	Z	357.5	328.0	33.8	114.0	104.2	43.5	56.3	89.9	89.8	110.0	23.8	15.8	48.8	29.5
Ela 3K	36749	M	Z	417.5	371.5	38.6	142.0	123.8	47.2	54.8	103.7	102.3	123.3	26.1	18.6	53.9	46.0
Ela 4K	36674	F	Z	373.0	338.5	32.3	119.0	109.2	46.0	56.8	93.7	94.0	117.0	24.6	19.2	52.9	34.5
Ela 5K	35572	?	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ela 6K	36280	?	Z	364.5	343.5	28.6	106.5	103.8	45.4	53.2	87.7	96.3	113.8	21.1	18.4	51.3	21.0
Ela 7K	39303	F	W	407.5	374.5	36.1	128.5	129.2	52.1	62.6	96.3	104.5	128.2	23.9	18.2	57.3	33.0
Ela 8K	38248	F	Z	395.0	360.5	34.9	126.0	116.7	47.8	60.5	98.7	98.5	124.2	20.5	15.6	54.6	34.5
Ela 9K	37142	F	?	408.0	375.0	35.4	124.0	127.8	51.4	67.1	96.2	100.9	125.4	24.1	18.0	54.7	33.0
Ela 10K	39311	M	W	432.0	398.0	40.1	138.0	127.9	47.4	63.6	103.4	108.5	128.4	22.2	17.4	58.9	34.0
Ela 11B	260	?	W	446.0	398.0	43.5	146.5	142.6	55.5	69.6	111.5	107.2	132.1	19.7	16.2	58.4	48.0
Ela 12B	9756	?	Z	457.0	424.0	43.2	153.0	143.0	56.5	75.8	112.9	112.7	140.0	21.4	18.2	61.0	33.0
Ela 13B	9432	?	W	383.0	350.0	37.2	124.5	113.6	47.0	56.8	92.7	99.1	117.0	22.7	18.5	52.5	33.0
Ela 14B	4281	?	?	386.5	362.0	30.8	114.0	113.8	43.6	61.6	90.5	95.0	114.8	19.7	19.0	46.6	24.5
Ela 15B	9925	?	?	416.0	392.0	38.0	140.0	129.1	51.9	72.6	102.2	108.9	131.3	24.5	19.8	55.9	24.0
Ela 16B	9442	F	W	437.5	404.0	40.7	153.0	138.6	54.1	70.5	109.7	101.9	132.0	24.1	17.0	60.8	33.5
MEDIAN				408.0	374.5	37.2	128.5	127.8	47.8	62.6	98.7	101.9	125.4	23.8	18.2	54.7	33.0
MEAN				409.4	375.4	37.1	132.5	124.4	49.6	63.3	100.4	102.1	125.0	23.4	18.0	55.4	34.0
STD DEV				32.8	28.6	4.6	16.0	13.7	4.3	7.0	9.1	6.8	9.0	3.1	1.3	4.7	8.2
MIN				357.5	328.0	28.6	106.5	103.8	43.5	53.2	87.7	89.8	110.0	19.7	15.6	46.6	24.0
MAX				460.0	424.0	43.8	158.0	143.0	56.5	75.8	116.5	112.7	140.0	31.9	19.8	63.6	33.5

BUFFALO (Syncerus caffer) n=6																	
INDIVIDUAL	MUS NO	M/F	W/Z	F(GL)	F(GLH)	F(SBD)	F(SCD)	F(GBP)	F(GDH)	F(GBH)	F(GBD)	F(GLDD)	F(GMDD)	F(GBCF)	F(SBCF)	F(GBT)	F(GL-GLH)
Buf 1K	33386	F	W	420.5	378.0	45.5	151.0	164.0	64.7	85.8	115.9	116.6	145.6	23.3	13.7	62.0	42.5
Buf 2K	33442	?	?	433.0	400.5	50.1	167.0	176.5	66.2	85.6	129.1	122.5	153.5	21.0	14.9	71.0	32.5
Buf 3B	9774	F	W	381.0	355.0	43.6	145.0	144.1	56.0	67.5	110.3	102.5	132.5	23.3	16.4	56.6	26.0
Buf 4B	8743	F	W	373.0	354.0	47.9	153.0	156.7	57.9	76.6	115.9	110.3	140.6	20.0	19.1	59.1	19.0
Buf 5B	4283	?	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Buf 6P	524	F	Z	375.0	370.0	39.9	131.0	134.9	54.5	73.2	112.1	106.5	138.6	22.2	21.3	56.4	5.0
Buf 7P	2216	M	W	418.0	370.0	50.6	165.0	154.7	58.3	78.7	119.5	112.6	110.9	18.8	18.4	61.3	48.0
MEDIAN				399.5	370.0	46.7	152.0	155.7	58.1	77.7	115.9	111.5	139.6	21.6	17.4	60.2	29.3
MEAN				400.1	371.3	46.3	152.0	155.2	59.6	77.9	117.1	111.8	137.0	21.4	17.3	61.1	28.8
STD DEV				26.6	17.1	4.1	13.3	14.6	4.8	7.1	6.7	7.1	14.6	1.8	2.8	5.4	15.8
MIN				373.0	354.0	39.9	131.0	134.9	54.5	67.5	110.3	102.5	110.9	18.8	13.7	56.4	5.0
MAX				433.0	400.5	50.6	167.0	176.5	66.2	85.8	129.1	122.5	153.5	23.3	21.3	71.0	48.0

B

APPENDIX B - TIBIA

Appendix B contains the raw measurements taken on the tibia of 30 Southern African Bovid specimens from the Transvaal, National and South African Museums. It also includes the mean, median, standard deviation and minimum and maximum values for each measurement.

Each individual specimen is abbreviated as follows:

Specimen number — Abbreviation for Museum

Sun 1P

Abbreviation for Bovid species

ABBREVIATION FOR MUSEUM:

P → Transvaal Museum specimen - Pretoria (Archaeozoological collection)
K → South African Museum specimen - Cape Town (Mammal collection)
B → National Museum specimen - Bloemfontein (Florisbad collection)

TABLE 4.5: Key to abbreviations to bovid species (alphabetical).

Abbreviation	Species	Abbreviation	Species	Abbreviation	Species
BDu	Blue Duiker	Bla	Black Wildebeest	Ble	Blesbok
Bon	Bontebok	Buf	Buffalo	Bus	Bushbuck
BWi	Blue Wildebeest	Cap	Cape Grysbok	Ela	Eland
GDu	Grey Duiker	Gem	Gemsbok	GRh	Grey Rhebuck
Imp	Impala	Kli	Klipsringer	Kud	Kudu
Lec	Red Lechwe	Mou	Mountain Reedbuck	Nya	Nyala
Ori	Oribi	Rdu	Red Duiker	Ree	Reedbuck
RHa	Red Hartebeest	Roa	Roan	Sab	Sable
Sit	Sitatunga	Spr	Springbok	Ste	Steenbok
Sun	Suni	Tse	Tsessebe	Wat	Waterbuck

OTHER ABBREVIATIONS USED IN APPENDIX:	
STD DEV →	Standard Deviation
MIN →	Minimum value
MAX →	Maximum value
MUS NO. →	Museum number of specimen
M/F →	Male or female
W/Z →	Wild or zoo born
NA →	Specific bone not available for measuring
NAM →	Specific part of bone not available for measuring

TABLE 3.7: Tibia measurements

No	Abbr.	Description	Instrument	Fig
1	T(GL)◆●	Greatest length.	Osteometric box	3.6a
2	T(GML)▮	Greatest medial length.	Osteometric box	3.6a
3	T(GLL)◆	Greatest lateral length.	Osteometric box	3.6a
4	T(SBD)+	Smallest breadth of diaphyses.	Electronic calliper	3.6b
5	T(SCD)◆	Smallest circumference of diaphyses	Measuring tape	3.6b
6	T(GBP)◆●	Greatest breadth proximal end.	Electronic calliper	3.7a
7	T(GDP)	Greatest depth proximal end.	Osteometric box	3.7a
8	T(GDLC)▮	Greatest depth lateral condyle.	Electronic calliper	3.7b
9	T(GDMC)	Greatest depth medial condyle.	Electronic calliper	3.7b
10	T(GDT)▮	Greatest depth tibial tuberosity.	Spreading calliper	3.7b
11	T(GDTN)▮	Greatest depth tibial tuberosity from notch.	Electronic calliper	3.7b
12	T(SBIE)▮	Smallest breadth intercondylar eminence.	Electronic calliper	3.7a
13	T(GBD)◆●	Greatest breadth distal end.	Electronic calliper	3.8
14	T(GDD)◆+	Greatest depth distal end.	Electronic calliper	3.8
15	T(SDD)+	Smallest depth distal end.	Electronic calliper	3.8

◆ Measurements defined by Von den Driesch [72]

\+ Measurements defined by Peters [92]

● Measurements defined by Walker [93]

▮ Measurements developed by the author

SUNI (*Neutragus mocathus*) n=2																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Sun 1P	1254	F	W	133.0	132.0	130.5	8.4	25.0	21.6	23.0	13.8	10.6	23.5	7.9	4.8	13.6	10.0	7.2
Sun 2P	819	F	W	143.5	142.0	141.0	9.0	27.5	23.5	25.0	15.3	10.7	26.0	8.4	5.4	14.0	11.1	7.7
MEDIAN				138.3	137.0	135.8	8.7	26.3	22.6	24.0	14.6	10.7	24.8	8.2	5.1	13.8	10.6	7.5
MEAN				138.3	137.0	135.8	8.7	26.3	22.6	24.0	14.6	10.7	24.8	8.2	5.1	13.8	10.6	7.5
STD DEV				7.4	7.1	7.4	0.4	1.8	1.3	1.4	1.1	0.1	1.8	0.4	0.4	0.3	0.8	0.4
MIN				133.0	132.0	130.5	8.4	25.0	21.6	23.0	13.8	10.6	23.5	7.9	4.8	13.6	10.0	7.2
MAX				143.5	142.0	141.0	9.0	27.5	23.5	25.0	15.3	10.7	26.0	8.4	5.4	14.0	11.1	7.7

BLUE DUIKER (*Philantomba monticola*) n=5																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
BDu 1P	2226	F	W	112.0	111.5	110.0	7.3	22.0	19.9	19.5	11.0	10.5	21.0	6.0	4.1	12.6	9.3	6.9
BDu 2P	2515	?	?	117.0	116.0	115.5	6.9	22.0	21.3	20.0	12.8	9.8	21.5	6.5	4.5	12.9	9.5	7.2
BDu 3P	548	M	?	116.0	115.0	114.0	7.5	23.0	19.8	19.5	11.9	10.2	20.5	7.6	4.4	13.0	9.2	7.1
BDu 4P	1090	?	?	124.5	123.5	122.0	8.2	25.0	22.9	21.0	12.7	11.9	21.5	7.3	5.1	14.0	10.6	7.4
BDu 5P	2551	F	Z	103.5	102.5	102.0	7.4	24.0	20.5	20.0	12.9	10.5	20.0	6.7	4.2	13.6	9.7	7.2
MEDIAN				116.0	115.0	114.0	7.4	23.0	20.5	20.0	12.7	10.5	21.0	6.7	4.4	13.0	9.5	7.2
MEAN				114.6	113.7	112.7	7.5	23.2	20.9	20.0	12.3	10.6	20.9	6.8	4.5	13.2	9.7	7.2
STD DEV				7.7	7.6	7.4	0.5	1.3	1.3	0.6	0.8	0.8	0.7	0.6	0.4	0.6	0.6	0.2
MIN				103.5	102.5	102.0	6.9	22.0	19.8	19.5	11.0	9.8	20.0	6.0	4.1	12.6	9.2	6.9
MAX				124.5	123.5	122.0	8.2	25.0	22.9	21.0	12.9	11.9	21.5	7.6	5.1	14.0	10.6	7.4

CAPE GRYSBOK (*Raphicerus melanotis*) n=22

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Cap 1K	35854	F	?	175.5	174.0	173.0	12.2	37.0	31.2	31.5	19.2	16.7	30.0	12.0	7.3	16.4	13.8	10.5
Cap 2K	36818	F	W	183.5	181.0	180.0	11.9	35.5	30.4	32.5	19.6	16.7	31.0	9.4	6.0	16.8	14.4	10.3
Cap 3K	36012	F	W	168.5	167.5	166.0	11.4	34.5	30.4	28.5	19.2	14.1	28.0	8.1	6.5	16.6	14.1	10.5
Cap 4K	36246	F	Z	173.0	171.0	170.0	11.1	35.5	30.0	29.5	19.5	16.1	28.5	9.1	6.1	17.4	14.1	10.0
Cap 5K	36205	F	W	181.0	179.0	178.0	11.1	35.5	32.1	32.0	21.0	16.7	31.0	10.9	6.5	17.2	14.6	10.2
Cap 6K	37189	M	?	171.0	178.5	177.5	11.8	36.0	31.7	31.0	20.5	16.3	29.0	8.8	6.8	17.0	14.8	11.0
Cap 7K	36328	M	?	173.5	171.5	170.5	12.1	38.0	30.4	32.5	19.7	15.5	31.0	8.4	6.3	17.1	14.6	9.9
Cap 8K	39667	?	W	177.5	175.0	174.0	12.3	36.0	32.0	33.5	22.5	15.8	31.5	10.3	7.1	17.3	13.9	10.1
Cap 9K	38778	F	W	189.0	181.0	180.0	12.6	38.0	33.3	34.0	21.6	17.1	31.5	8.0	6.0	18.6	14.9	10.8
Cap 10K	38719	M	W	191.0	189.0	188.0	11.9	36.0	32.4	34.0	21.9	17.1	32.0	9.7	6.7	18.2	14.2	10.0
Cap 11K	40380	M	W	183.5	186.0	185.0	11.4	36.0	33.4	33.0	20.7	16.0	31.0	8.9	7.2	18.5	15.2	10.4
Cap 12K	40386	M	W	181.5	180.0	178.0	12.9	39.0	33.8	32.5	23.0	17.9	31.5	9.0	7.2	17.8	14.7	10.3
Cap 13K	40525	F	W	184.0	181.0	179.0	12.1	37.0	33.2	33.0	22.5	17.1	31.5	9.8	6.5	17.9	14.4	9.6
Cap 14K	36247	M	W	182.0	180.0	178.0	10.2	33.0	31.3	31.0	19.9	15.9	29.5	9.8	6.8	16.4	14.3	10.3
Cap 15K	39202	F	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cap 16K	39082	F	W	179.0	178.0	177.0	11.0	33.5	30.0	32.5	20.4	16.9	31.5	9.9	6.8	16.9	14.0	9.9
Cap 17K	39821	F	W	173.0	172.0	170.5	12.1	36.0	29.8	30.5	20.6	16.3	30.0	9.0	6.1	17.5	14.5	10.7
Cap 18K	40503	M	W	188.5	186.5	185.0	11.5	36.5	32.7	35.5	25.0	18.7	34.0	11.4	7.2	17.8	14.7	11.3
Cap 19K	36700	M	W	183.5	181.0	179.5	11.9	36.0	32.0	33.5	21.0	15.7	32.0	9.1	7.1	17.6	15.3	10.5
Cap 20K	36204	M	W	185.0	183.0	181.5	11.8	37.0	31.0	32.5	20.8	15.1	32.0	9.0	7.1	17.8	15.9	10.6
Cap 21K	36804	F	Z	186.5	184.5	183.0	12.3	37.0	31.6	34.0	23.7	15.1	31.5	10.7	6.7	18.0	15.3	10.2
Cap 22K	35109	F	W	184.5	182.0	180.5	11.7	36.5	28.3	32.5	20.5	14.8	31.0	9.7	6.7	17.2	14.5	9.7
Cap 23K	36056	F	W	169.0	168.0	166.5	11.1	34.5	28.1	31.0	18.7	15.3	29.0	10.2	6.1	16.5	14.5	9.7
MEDIAN				181.8	180.0	178.0	11.9	36.0	31.5	32.5	20.7	16.2	31.0	9.6	6.7	17.4	14.5	10.3
MEAN				180.2	178.6	177.3	11.7	36.1	31.3	32.3	21.0	16.2	30.8	9.6	6.7	17.4	14.6	10.3
STD DEV				6.6	5.9	5.9	0.6	1.4	1.6	1.6	1.6	1.1	1.4	1.0	0.4	0.6	0.5	0.4
MIN				168.5	167.5	166.0	10.2	33.0	28.1	28.5	18.7	14.1	28.0	8.0	6.1	16.4	14.0	9.6
MAX				191.0	189.0	188.0	12.9	39.0	33.8	35.5	25.0	18.7	34.0	12.0	7.2	18.6	15.9	11.3

RED DUIKER (*Cephalophus natalensis*) n=10

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
RDu 1P	1538	F	W	147.0	144.0	143.0	11.6	35.5	28.5	29.5	15.9	15.0	27.5	6.7	5.1	18.0	14.2	10.4
RDu 2P	1044	F	W	155.0	154.0	152.0	12.2	36.5	31.0	29.5	17.9	16.3	28.5	8.9	6.1	18.6	14.4	10.5
RDu 3P	1043	F	W	154.5	153.0	151.0	12.2	37.5	31.2	29.5	17.3	15.6	29.0	8.4	5.9	18.5	14.7	11.0
RDu 4P	1495	M	Z	144.0	142.0	139.0	11.2	35.5	32.6	29.5	18.1	16.4	28.0	7.8	8.4	20.2	15.4	12.0
RDu 5P	827	F	W	155.0	153.5	150.0	12.0	35.0	30.9	29.5	17.9	15.2	28.5	9.7	7.4	18.7	13.9	10.0
RDu 6P	824	F	?	155.0	153.5	151.0	12.2	37.5	31.0	29.0	18.4	15.8	28.0	9.1	7.2	18.3	14.5	10.9
RDu 7P	828	F	W	154.0	152.5	148.5	11.1	34.0	30.6	29.0	17.3	16.0	27.5	8.7	7.0	18.3	15.1	10.9
RDu 8P	1197	M	?	158.0	156.0	154.0	12.3	38.5	31.6	31.0	19.3	15.2	30.0	8.9	6.9	18.6	15.2	10.6
RDu 9P	1258	M	W	152.0	150.0	148.5	11.2	34.0	31.2	30.0	18.0	15.4	29.0	8.1	7.6	18.0	15.7	10.8
RDu 10P	1967	M	W	155.0	153.0	151.0	11.8	36.0	31.8	31.0	18.1	15.4	30.0	9.7	6.4	18.9	14.8	10.8
MEDIAN				154.8	153.0	150.5	11.9	35.8	31.1	29.5	18.0	15.5	28.5	8.8	7.0	18.6	14.8	10.8
MEAN				153.0	151.2	148.8	11.8	36.0	31.0	29.8	17.8	15.6	28.6	8.6	6.8	18.6	14.8	10.8
STD DEV				4.2	4.6	4.5	0.5	1.5	1.1	0.7	0.9	0.5	0.9	0.9	0.9	0.6	0.6	0.5
MIN				144.0	142.0	139.0	11.1	34.0	28.5	29.0	15.9	15.0	27.5	6.7	5.1	18.0	13.9	10.0
MAX				158.0	156.0	154.0	12.3	38.5	32.6	31.0	19.3	16.4	30.0	9.7	8.4	20.2	15.7	12.0

KLIPSPRINGER (*Oreotragus oreotragus*) n=3																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Kli 1K	39085	F	W	169.5	168.5	167.0	11.5	36.5	NAM	NAM	NAM	NAM	NAM	NAM	7.0	20.0	17.0	12.7
Kli 2K	40383	M	W	171.0	170.0	168.0	11.9	38.0	32.9	32.0	19.2	17.3	28.5	9.9	6.9	19.8	15.5	10.7
Kli 3B	820	?	Z	176.0	175.5	174.5	12.7	39.0	32.7	33.0	20.3	17.6	32.5	10.2	6.3	20.8	16.1	12.0
MEDIAN				171.0	170.0	168.0	11.9	38.0	32.8	32.5	19.8	17.5	30.5	10.1	6.9	20.0	16.1	12.0
MEAN				172.2	171.3	169.8	12.0	37.8	32.8	32.5	19.8	17.5	30.5	10.1	6.7	20.2	16.2	11.8
STD DEV				3.4	3.7	4.1	0.6	1.3	0.1	0.7	0.8	0.2	2.8	0.2	0.4	0.5	0.8	1.0
MIN				169.5	168.5	167.0	11.5	36.5	32.7	32.0	19.2	17.3	28.5	9.9	6.3	19.8	15.5	10.7
MAX				176.0	175.5	174.5	12.7	39.0	32.9	33.0	20.3	17.6	32.5	10.2	7.0	20.8	17.0	12.7

STEENBOK (*Raphicerus campaestris*) n=21

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Ste 1K	35281	F	W	198.5	196.0	195.0	12.3	37.5	33.3	32.5	24.0	16.0	33.0	11.6	6.7	18.1	15.4	11.7
Ste 2K	37057	M	W	186.0	184.0	183.0	11.4	35.0	30.6	34.5	21.2	18.5	31.5	10.3	6.7	18.2	14.3	10.4
Ste 3K	36327	F	?	175.0	173.0	172.0	10.0	32.5	29.6	31.0	21.4	16.2	NAM	NAM	6.8	18.7	14.7	10.0
Ste 4K	36353	F	W	171.0	169.0	167.5	10.7	32.5	27.7	28.5	18.3	16.1	26.5	7.6	6.1	18.7	15.1	10.1
Ste 5K	37082	M	W	185.5	183.5	182.0	12.1	37.0	32.3	35.0	22.3	17.7	33.0	11.1	6.7	19.5	15.8	11.2
Ste 6K	36286	M	W	176.0	174.5	172.0	11.1	34.0	29.3	34.0	19.0	18.4	30.5	8.5	5.8	18.4	15.0	9.7
Ste 7B	9438	M	W	183.5	181.5	180.5	12.1	37.0	30.7	33.0	23.1	16.6	31.0	9.5	5.5	19.9	15.2	10.6
Ste 8B	4289	F	W	178.0	177.0	175.0	12.4	38.5	30.3	33.5	22.2	17.1	32.5	10.2	5.7	19.9	15.6	10.9
Ste 9B	8730	M	W	178.0	176.5	175.0	10.0	32.0	28.1	31.0	21.6	17.2	29.5	10.8	6.3	18.2	14.4	9.4
Ste 10B	9761	F	W	189.0	187.5	186.5	12.8	39.5	31.0	33.0	20.0	16.3	32.0	10.1	5.8	21.1	15.7	10.0
Ste 11B	9787	M	W	161.0	160.0	159.0	10.5	32.0	27.1	30.5	18.8	14.8	28.0	9.7	6.4	17.7	12.7	8.9
Ste 12P	1760	M	Z	181.0	179.0	178.0	11.8	35.5	30.5	33.0	21.6	16.2	32.0	9.8	7.9	18.5	14.1	10.7
Ste 13P	2294	?	?	189.0	187.0	186.0	12.8	39.0	32.5	34.5	22.6	17.6	32.5	10.6	6.2	20.6	15.3	10.9
Ste 14P	1830	M	Z	173.5	171.5	170.5	11.5	34.5	27.9	31.5	20.2	16.0	30.5	10.4	6.4	17.4	14.2	9.1
Ste 15P	644	F	Z	172.5	170.5	169.0	11.3	34.0	29.3	31.0	20.3	15.9	30.0	10.1	7.5	18.7	14.2	9.9
Ste 16P	1119	M	?	171.0	169.5	168.5	12.0	35.5	31.9	32.5	22.6	16.8	30.5	10.0	6.7	20.1	14.5	11.2
Ste 17P	1491	F	W	181.5	179.0	178.0	11.0	33.0	30.3	33.0	21.2	15.9	32.0	10.8	7.7	19.9	14.8	9.8
Ste 18P	611	F	Z	174.0	172.0	171.0	11.7	35.0	29.7	32.5	22.8	17.2	30.5	9.1	7.0	19.8	14.1	10.2
Ste 19P	690	F	Z	181.5	179.0	175.0	12.2	36.5	31.3	35.0	24.2	18.6	32.5	10.2	6.3	19.1	15.2	11.8
Ste 20P	494	M	Z	176.0	174.0	172.5	12.0	37.0	31.7	34.0	23.5	20.0	32.0	10.2	7.3	20.4	15.1	10.9
Ste 21P	2591	M	W	183.0	180.5	179.5	12.6	37.0	30.8	33.5	23.0	16.8	32.5	11.1	7.7	19.5	14.5	9.7
MEDIAN				178.0	177.0	175.0	11.8	35.5	30.5	33.0	21.6	16.8	31.8	10.2	6.7	19.1	14.8	10.2
MEAN				179.3	177.4	176.0	11.6	35.5	30.3	32.7	21.6	16.9	31.1	10.1	6.6	19.2	14.8	10.3
STD DEV				8.1	7.9	8.0	0.8	2.3	1.7	1.7	1.7	1.2	1.7	0.9	0.7	1.0	0.7	0.8
MIN				161.0	160.0	159.0	10.0	32.0	27.1	28.5	18.3	14.8	26.5	7.6	6.2	17.4	14.1	8.9
MAX				198.5	196.0	195.0	12.8	39.5	33.3	35.0	24.2	20.0	33.0	11.6	7.9	21.1	15.3	11.8

COMMON DUIKER (*Sylvicapra grimmia*) n=16																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
CDu 1P	2459	M	W	183.5	181.0	180.0	14.4	42.5	36.4	39.0	24.5	20.0	35.5	11.3	6.6	22.3	17.7	12.8
CDu 2P	2256	F	Z	184.5	181.5	180.5	12.1	38.5	34.8	35.5	23.5	19.4	32.5	10.2	6.9	22.2	17.4	12.1
CDu 3P	1149	M	W	184.5	182.5	181.0	12.8	38.0	35.1	34.0	20.4	18.1	31.0	11.2	6.7	21.5	16.4	11.9
CDu 4P	1154	F	Z	191.5	189.5	187.0	13.4	42.0	35.9	39.0	23.3	21.3	37.5	11.3	7.1	22.0	18.0	11.8
CDu 5P	1620	M	W	181.5	179.0	176.5	12.8	38.0	34.7	38.0	21.0	20.1	35.0	11.6	7.2	21.9	18.1	13.0
CDu 6P	2592	M	W	203.0	200.5	198.0	15.1	44.5	37.2	38.5	21.9	20.8	32.5	12.1	7.8	23.4	18.0	13.3
CDu 7P	523	F	Z	190.0	187.5	184.5	14.6	43.0	35.1	39.5	21.8	21.4	37.5	13.0	6.4	22.2	17.6	10.9
CDu 8P	2255	M	Z	185.0	182.0	180.0	12.9	39.0	36.9	37.0	21.9	19.9	35.0	11.6	8.5	21.8	16.0	10.9
CDu 9P	558	F	Z	199.0	196.5	195.0	13.8	43.0	34.8	37.0	22.6	20.6	36.0	10.0	7.0	21.9	17.4	12.1
CDu 10P	551	F	Z	192.0	190.0	188.0	12.9	40.0	34.3	37.0	23.5	19.4	35.0	10.1	6.8	20.8	16.9	12.2
CDu 11P	552	F	Z	187.5	185.0	183.0	12.6	40.0	34.1	36.5	21.6	19.8	35.0	11.2	7.4	20.4	16.8	12.2
CDu 12P	368	M	?	201.0	199.0	197.0	14.9	45.0	36.6	37.5	22.0	21.0	33.0	11.3	7.4	21.3	18.2	12.5
CDu 13P	649	M	?	183.5	180.0	178.0	13.3	39.5	35.8	36.0	21.6	19.6	33.0	9.6	8.5	21.3	16.2	12.1
CDu 14P	1855	F	Z	188.0	185.5	182.0	14.5	42.5	37.7	36.5	22.5	20.6	34.0	9.7	7.9	22.2	18.0	12.9
CDu 15P	1490	?	W	206.5	204.0	201.0	15.8	46.0	38.3	40.0	24.6	23.1	38.0	11.1	7.9	22.9	18.7	13.1
CDu 16P	1774	F	Z	203.5	200.0	198.0	14.1	43.0	39.2	40.5	23.9	22.1	37.5	11.9	8.5	21.6	18.3	13.0
MEDIAN				189.0	186.5	183.8	13.6	42.3	35.9	37.3	22.3	20.4	35.0	11.3	7.3	21.9	17.7	12.2
MEAN				191.5	189.0	186.8	13.8	41.5	36.1	37.6	22.5	20.5	34.9	11.1	7.4	21.9	17.5	12.3
STD DEV				8.4	8.4	8.2	1.1	2.6	1.5	1.8	1.2	1.2	2.1	0.9	0.7	0.7	0.8	0.7
MIN				181.5	179.0	176.5	12.1	38.0	34.1	34.0	20.4	18.1	31.0	9.6	6.4	20.4	16.0	10.9
MAX				206.5	204.0	201.0	15.8	46.0	39.2	40.5	24.6	23.1	38.0	13.0	8.5	23.4	18.7	13.3

ORIBI (*Ourebia orebi*) n=5

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GSD)	T(GDD)	T(SDD)
Ori 1B	9752	F	W	204.0	202.0	200.5	13.9	42.0	36.2	40.5	25.8	19.9	38.5	11.9	7.2	23.5	18.3	12.4
Ori 2B	9321	F	W	215.0	212.0	211.0	14.5	46.0	37.2	41.0	25.7	20.0	39.0	13.6	8.3	23.6	18.3	12.5
Ori 3B	9319	M	W	211.0	208.5	206.0	13.7	42.0	36.5	39.5	20.5	17.0	37.5	13.5	8.2	22.7	18.9	12.6
Ori 4P	2229	F	W	206.5	204.0	202.5	15.7	45.5	36.4	40.0	23.8	22.0	39.0	12.0	8.4	22.5	17.7	11.9
Ori 5P	2228	M	W	191.5	189.0	187.5	13.3	42.0	34.5	38.0	25.6	19.7	35.5	11.3	7.5	21.6	17.4	12.3
MEDIAN				206.5	204.0	202.5	13.9	42.0	36.4	40.0	25.6	19.9	38.5	12.0	8.2	22.7	18.3	12.4
MEAN				205.6	203.1	201.5	14.2	43.5	36.2	39.8	24.3	19.7	37.9	12.5	7.9	22.8	18.1	12.3
STD DEV				8.9	8.8	8.8	0.9	2.1	1.0	1.2	2.3	1.8	1.5	1.0	0.5	0.8	0.6	0.3
MIN				191.5	189.0	187.5	13.3	42.0	34.5	38.0	20.5	17.0	35.5	11.3	7.2	21.6	17.4	11.9
MAX				215.0	212.0	211.0	15.7	46.0	37.2	41.0	25.8	22.0	39.0	13.6	8.4	23.6	18.9	12.6

SPRINGBOK (*Antidorcas marsupialis*) n=20

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Spr 1B	7425	F	W	257.5	253.5	251.5	18.2	59.0	43.2	50.0	33.4	24.6	44.5	14.2	8.4	28.9	21.5	13.6
Spr 2B	7423	M	W	278.0	273.5	271.5	20.0	59.0	46.8	51.0	33.0	25.5	47.0	15.2	9.5	31.9	22.5	15.3
Spr 3B	9609	F	W	261.0	258.0	255.5	16.8	51.5	43.8	49.0	28.9	25.1	45.0	13.6	9.6	27.9	22.2	14.8
Spr 4B	7418	M	W	271.0	266.0	263.5	18.5	56.0	46.9	49.5	32.9	26.9	45.0	14.0	9.4	29.8	23.3	14.9
Spr 5B	7435	F	W	266.0	262.0	259.0	18.3	57.0	45.1	49.5	33.5	24.9	44.0	12.0	9.3	29.0	23.2	14.2
Spr 6B	7434	M	W	285.0	281.0	277.0	19.4	61.0	47.8	53.0	34.4	28.3	48.0	13.6	9.9	31.3	24.5	16.1
Spr 7B	6019	M	W	217.0	214.0	212.0	15.5	46.0	38.8	40.0	25.5	21.7	38.0	10.1	6.8	25.5	18.5	12.3
Spr 8B	7421	F	W	255.5	252.5	250.0	18.4	55.0	44.2	48.5	31.8	26.0	45.5	12.7	8.3	29.9	23.1	14.7
Spr 9B	7424	M	W	266.5	263.0	260.0	17.7	54.0	47.2	52.5	33.7	28.2	47.5	15.1	8.4	30.2	22.5	14.6
Spr 10B	7422	M	W	261.5	257.0	254.0	17.7	54.0	44.5	51.0	29.8	25.7	47.5	15.6	8.5	29.5	21.3	14.3
Spr 11B	7420	F	W	250.0	246.5	243.0	17.1	53.5	42.7	48.0	29.6	24.3	44.0	13.8	9.7	28.4	20.9	13.8
Spr 12B	7433	M	W	271.0	267.5	265.0	17.3	53.5	46.2	51.0	33.9	27.4	46.5	14.0	8.9	30.4	22.2	15.4
Spr 13B	7426	F	W	249.5	246.0	244.0	16.9	50.5	43.7	47.0	29.8	24.9	44.5	11.7	9.2	28.6	21.7	14.2
Spr 14B	7419	M	W	272.0	268.5	265.0	18.5	54.5	45.2	50.5	30.6	24.6	46.0	14.3	10.6	29.3	22.5	14.4
Spr 15B	7431	F	W	267.0	262.5	259.0	17.9	54.0	44.6	49.0	30.7	24.9	44.5	13.5	10.2	28.7	22.1	13.5
Spr 16B	7432	M	W	279.5	275.5	272.0	18.6	56.0	48.2	53.5	34.1	26.3	50.5	15.2	10.2	30.8	24.2	15.9
Spr 17B	7436	M	W	266.0	260.5	258.0	18.8	57.0	46.5	50.0	33.8	27.3	47.0	13.6	8.1	31.7	24.3	13.4
Spr 18B	9885	M	Z	225.0	221.0	218.0	14.7	46.0	37.9	40.0	25.9	22.1	38.5	10.2	8.2	24.7	20.1	12.2
Spr 19B	9324	F	Z	222.5	220.0	218.5	16.1	49.5	40.1	44.5	28.1	24.1	40.0	12.8	7.2	27.7	19.4	13.3
Spr 20B	9798	F	Z	240.0	237.0	234.5	16.6	50.0	41.3	46.5	29.4	23.9	42.5	15.1	9.5	27.0	21.0	13.2
MEDIAN				263.8	259.3	256.8	17.8	54.0	44.6	49.5	31.3	25.0	45.0	13.7	9.3	29.2	22.2	14.3
MEAN				258.1	254.3	251.6	17.7	53.9	44.2	48.7	31.1	25.3	44.8	13.5	9.0	29.1	22.1	14.2
STD DEV				19.1	18.7	18.4	1.3	4.0	2.9	3.7	2.7	1.8	3.1	1.6	1.0	1.9	1.6	1.1
MIN				217.0	214.0	212.0	14.7	46.0	37.9	40.0	25.5	21.7	38.0	10.1	6.8	24.7	18.5	12.2
MAX				285.0	281.0	277.0	20.0	61.0	48.2	53.5	34.4	28.3	50.5	15.6	10.6	31.9	24.5	16.1

MOUNTAIN REEDBUCK (*Redunca fulvorula*) n=8																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Mou 1K	37186	M	W	247.0	244.5	240.0	14.4	46.5	41.4	45.0	25.7	22.6	41.0	13.1	9.5	25.5	21.8	15.4
Mou 2K	40655	F	W	264.5	260.0	258.5	17.7	53.5	44.1	45.5	30.4	21.7	44.5	14.9	9.1	28.7	23.4	16.2
Mou 3K	40644	M	W	257.5	255.0	253.0	18.0	51.0	45.1	46.0	30.4	22.0	44.0	12.3	8.3	28.7	22.1	15.5
Mou 4B	9843	M	?	255.0	253.0	249.5	16.8	49.5	42.0	45.0	26.0	21.4	42.0	14.2	9.4	27.2	22.9	15.2
Mou 5B	9350	?	?	258.0	255.0	252.0	17.7	53.0	46.4	48.0	28.8	21.3	46.5	15.0	9.8	30.0	23.1	16.2
Mou 6P	1285	M	Z	258.0	255.0	254.0	17.7	50.0	42.0	45.0	27.8	21.8	43.0	14.2	8.8	26.9	21.9	15.1
Mou 7P	2946	M	?	251.0	248.0	246.5	17.2	51.0	42.6	45.0	27.6	23.4	44.5	14.9	8.0	27.0	21.4	15.1
Mou 8P	780	F	Z	241.0	237.5	235.5	17.0	48.5	41.3	42.0	26.2	23.2	40.5	12.0	9.0	26.2	20.7	13.6
MEDIAN				256.3	254.0	250.8	17.5	50.5	42.3	45.0	27.7	21.9	43.5	14.2	9.1	27.1	22.0	15.3
MEAN				254.0	251.0	248.6	17.1	50.4	43.1	45.2	27.9	22.2	43.3	13.8	9.0	27.5	22.2	15.3
STD DEV				7.4	7.2	7.6	1.2	2.3	1.9	1.6	1.9	0.8	2.0	1.2	0.6	1.5	0.9	0.8
MIN				241.0	237.5	235.5	14.4	46.5	41.3	42.0	25.7	21.3	40.5	12.0	8.0	25.5	20.7	13.6
MAX				264.5	260.0	258.5	18.0	53.5	46.4	48.0	30.4	23.4	46.5	15.0	9.8	30.0	23.4	16.2

GREY RHEBUCK (*Pelea capreolus*) n=4																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
GRh 1K	39319	M	W	NAM	NAM	NAM	15.4	48.0	NAM	NAM	NAM	NAM	NAM	NAM	NAM	26.7	19.8	15.3
GRh 2K	40069	M	W	229.0	227.0	223.5	14.4	45.0	40.7	44.0	26.8	22.1	43.0	14.0	8.4	25.5	20.5	14.6
GRh 3K	40630	F	W	250.0	247.0	244.0	16.0	59.5	42.2	44.5	28.7	23.0	44.0	12.9	8.2	25.4	19.2	15.4
GRh 4K	37054	F	W	252.0	249.0	246.0	16.2	49.0	40.0	46.0	24.8	23.9	46.0	17.1	8.4	27.2	20.8	15.9
MEDIAN				250.0	247.0	244.0	15.7	48.5	40.7	44.5	26.8	23.0	44.0	14.0	8.4	26.1	20.2	15.4
MEAN				243.7	241.0	237.8	15.5	50.4	41.0	44.8	26.8	23.0	44.3	14.7	8.3	26.2	20.1	15.3
STD DEV				12.7	12.2	12.5	0.8	6.3	1.1	1.0	2.0	0.9	1.5	2.2	0.1	0.9	0.7	0.5
MIN				229.0	227.0	223.5	14.4	45.0	40.0	44.0	24.8	22.1	43.0	12.9	8.2	25.4	19.2	14.6
MAX				252.0	249.0	246.0	16.2	59.5	42.2	46.0	28.7	23.9	46.0	17.1	8.4	27.2	20.8	15.9

BUSHBUCK (*Tragelaphus scriptus*) n=4																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Bus 1K	36693	M	W	254.0	248.5	244.5	19.6	57.0	45.1	51.0	30.8	24.3	46.0	13.5	9.5	27.7	25.0	17.8
Bus 2K	36692	F	W	229.5	225.0	222.5	17.8	50.0	41.6	45.5	26.5	25.1	40.0	10.9	9.0	25.8	23.3	17.6
Bus 3B	12100	F	W	260.0	256.0	254.0	19.0	55.0	47.9	48.0	30.4	25.2	43.5	11.2	10.0	29.9	24.2	16.7
Bus 4P	2095	M	?	256.0	252.0	248.0	20.9	64.0	47.2	50.0	30.4	24.7	49.0	14.0	10.5	30.4	25.2	18.2
MEDIAN				255.0	250.3	246.3	19.3	56.0	46.2	49.0	30.4	24.9	44.8	12.4	9.8	28.8	24.6	17.7
MEAN				249.9	245.4	242.3	19.3	56.5	45.5	48.6	29.5	24.8	44.6	12.4	9.8	28.5	24.4	17.6
STD DEV				13.8	13.9	13.7	1.3	5.8	2.8	2.4	2.0	0.4	3.8	1.6	0.6	2.1	0.9	0.6
MIN				229.5	225.0	222.5	17.8	50.0	41.6	45.5	26.5	24.3	40.0	10.9	9.0	25.8	23.3	16.7
MAX				260.0	256.0	254.0	20.9	64.0	47.9	51.0	30.8	25.2	49.0	14.0	10.5	30.4	25.2	18.2

BLESBOK (*Damaliscus dorcas philipsii*) n=13																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Ble 1K	38680	?	W	278.0	272.5	268.0	20.3	62.0	56.2	53.5	32.8	31.8	50.0	15.1	10.9	34.8	28.3	17.8
Ble 2K	37055	F	W	260.0	254.5	250.5	17.6	53.0	50.7	48.5	29.3	27.8	46.5	14.1	10.2	30.7	26.3	16.8
Ble 3K	36979	M	W	274.0	268.0	265.0	19.7	58.5	53.3	52.5	32.0	29.8	48.0	14.3	11.6	32.2	27.7	18.2
Ble 4K	36680	F	Z	264.0	259.0	256.0	20.4	60.0	53.3	51.5	29.2	28.6	50.5	14.6	9.3	32.2	27.8	18.9
Ble 5K	36343	M	W	271.0	265.0	262.0	19.5	59.0	53.5	51.0	30.0	28.7	49.0	15.2	11.6	32.3	27.9	19.1
Ble 6B	12038	M	W	265.5	261.0	256.0	22.1	64.0	52.2	50.5	32.6	31.7	46.0	11.3	9.8	33.9	28.1	18.0
Ble 7B	12036	M	W	271.0	266.0	261.0	20.3	61.5	53.1	52.5	30.9	29.0	51.5	14.1	9.8	34.5	28.1	19.6
Ble 8B	12035	M	W	282.0	275.5	272.0	22.4	66.0	53.6	55.0	33.3	32.6	51.0	15.1	9.3	35.3	28.5	19.1
Ble 9B	12039	M	W	271.0	267.0	263.0	20.6	60.5	51.4	50.5	30.5	27.7	48.5	12.8	9.3	32.6	26.9	16.0
Ble 10B	12037	M	W	269.5	264.0	260.0	19.4	59.0	52.2	51.5	30.7	30.1	48.5	12.4	10.6	33.5	28.6	18.6
Ble 11B	9944	F	W	274.0	269.0	265.0	20.2	60.5	52.4	52.0	30.0	29.5	48.5	13.9	9.2	31.9	28.6	19.8
Ble 12B	7446	F	W	259.5	254.0	251.0	18.9	57.0	53.5	50.0	32.3	29.5	47.5	13.2	9.7	32.5	26.7	19.1
Ble 13B	7438	M	W	279.0	275.0	270.0	20.0	59.5	55.0	53.5	32.5	31.8	49.5	12.4	9.8	33.4	27.1	19.5
MEDIAN				271.0	266.0	262.0	20.2	60.0	53.3	51.5	30.9	29.5	48.5	14.1	9.8	32.6	27.9	18.9
MEAN				270.7	265.4	261.5	20.1	60.0	53.1	51.7	31.2	29.9	48.8	13.7	10.1	33.1	27.7	18.5
STD DEV				7.0	6.9	6.7	1.2	3.2	1.4	1.7	1.4	1.6	1.7	1.2	0.8	1.3	0.8	1.1
MIN				259.5	254.0	250.5	17.6	53.0	50.7	48.5	29.2	27.7	46.0	11.3	9.2	30.7	26.3	16.0
MAX				282.0	275.5	272.0	22.4	66.0	56.2	55.0	33.3	32.6	51.5	15.2	11.6	35.3	28.6	19.8

BONTEBOK (*Damaliscus dorcas dorcas*) n=29																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Bon 1K	35116	M	Z	291.5	284.5	283.0	20.3	64.5	54.2	56.5	33.8	31.6	52.0	14.8	9.2	33.6	27.2	18.7
Bon 2K	35056	M	W	285.0	279.0	276.0	21.9	65.0	55.2	53.5	33.1	31.4	51.0	13.6	8.8	33.2	28.5	19.4
Bon 3K	65052	F	W	286.0	279.0	278.0	19.9	62.0	51.7	53.0	34.0	32.9	48.5	16.1	9.2	31.8	27.6	20.0
Bon 4K	35048	F	W	279.5	274.0	271.0	20.5	62.0	52.7	51.5	32.1	29.1	47.0	13.6	9.8	31.0	27.4	19.0
Bon 5K	35047	F	W	287.0	281.5	279.0	20.5	64.0	52.3	54.0	33.2	29.6	49.0	14.7	9.7	32.7	28.9	19.0
Bon 6K	36017	F	W	272.0	267.5	265.0	19.1	57.0	50.2	49.0	31.2	28.0	46.5	13.4	8.9	30.2	26.4	17.2
Bon 7K	36053	?	W	276.5	271.0	269.0	20.2	60.5	50.9	51.0	31.6	28.2	49.0	14.8	8.4	31.2	27.1	18.5
Bon 8K	35928	M	W	276.0	271.0	269.0	19.7	58.5	50.8	51.0	31.0	28.0	49.5	13.7	9.4	32.0	26.8	19.4
Bon 9K	35927	M	W	292.0	287.0	284.5	20.1	64.5	53.2	53.0	34.3	28.8	50.0	14.9	8.6	32.0	28.1	18.2
Bon 10K	36151	F	W	284.5	278.0	276.0	20.7	63.5	54.3	53.0	33.9	31.6	51.0	11.5	8.4	32.5	28.1	17.9
Bon 11K	36054	F	W	272.0	268.0	261.5	19.4	57.5	53.4	52.0	33.2	28.8	51.5	13.0	9.2	32.2	27.6	17.9
Bon 12K	36202	?	W	296.0	291.0	287.0	21.3	64.0	53.8	53.0	33.5	29.3	51.5	14.7	9.5	32.7	28.0	18.4
Bon 13K	36279	F	W	261.0	255.0	252.5	18.5	56.0	51.3	47.0	31.0	28.1	44.5	12.8	9.6	31.0	27.2	16.0
Bon 14K	36295	M	W	292.0	285.0	282.5	19.4	60.5	53.6	52.5	32.5	31.3	48.5	12.8	9.0	31.6	27.8	18.2
Bon 15K	36834	F	Z	268.5	267.0	259.5	20.3	63.5	55.9	52.5	32.3	29.4	49.0	13.5	10.4	31.5	26.8	17.8
Bon 16K	36659	M	W	288.0	283.5	280.0	19.8	60.5	53.4	51.5	32.6	29.9	48.0	13.9	9.3	31.7	27.2	17.6
Bon 17K	36288	M	W	268.0	263.0	261.0	18.3	56.5	50.8	49.5	29.1	28.0	47.5	13.3	10.2	32.1	27.0	16.4
Bon 18K	36281	M	W	265.0	265.5	261.5	17.6	55.0	50.9	50.0	32.8	28.6	47.0	13.4	9.2	32.1	26.9	16.5
Bon 19K	36985	M	W	264.5	259.0	256.5	18.4	55.0	50.5	46.5	29.6	28.4	45.5	11.6	10.1	31.0	26.8	17.2
Bon 20K	38726	M	W	299.0	293.5	290.0	20.7	64.0	56.9	55.0	34.6	32.2	51.0	14.8	10.0	33.8	28.7	18.7
Bon 21K	38740	F	W	286.0	281.5	279.0	21.0	63.5	56.8	53.5	35.6	34.9	49.5	13.4	5.7	31.4	27.2	17.3
Bon 22K	38735	F	W	286.0	280.5	278.5	21.6	65.5	53.0	53.0	35.5	33.0	51.0	12.7	8.8	32.8	28.5	18.2
Bon 23K	14090	F	W	280.5	275.5	272.5	20.4	62.0	51.8	51.0	31.8	29.6	46.5	11.8	9.5	31.3	26.5	16.6
Bon 24K	40398	M	W	290.0	284.0	281.0	20.8	65.0	55.6	53.5	34.5	31.9	49.5	12.7	8.4	32.0	27.4	18.2
Bon 25K	40407	F	W	279.0	274.0	272.0	19.7	61.0	50.8	51.0	31.0	29.0	47.0	13.2	8.9	30.6	27.1	17.7
Bon 26K	39793	M	W	290.5	284.0	283.0	21.2	63.5	55.3	53.5	35.6	31.5	50.0	13.1	9.3	32.5	28.1	18.4
Bon 27K	41140	M	W	295.0	288.0	285.5	20.8	66.0	55.4	55.0	35.9	32.7	49.5	14.0	9.2	33.7	28.3	18.4
Bon 28K	40746	M	W	289.5	283.0	281.5	21.4	65.0	56.8	53.0	34.0	32.8	51.5	17.1	9.1	33.0	29.1	18.8
Bon 29K	40835	M	W	285.5	280.5	277.0	20.7	62.5	53.0	53.5	33.8	32.2	49.0	11.8	8.1	32.4	29.3	18.4
MEDIAN				285.5	279.0	277.0	20.3	62.5	53.2	53.0	33.2	29.6	49.0	13.4	9.2	32.0	27.4	18.2
MEAN				282.3	277.0	274.2	20.1	61.7	53.3	52.1	33.0	30.4	49.0	13.6	9.1	32.1	27.6	18.1
STD DEV				10.3	9.6	9.9	1.0	3.4	2.1	2.2	1.8	1.9	2.0	1.3	0.9	0.9	0.8	1.0
MIN				261.0	255.0	252.5	17.6	55.0	50.2	46.5	29.1	28.0	44.5	11.5	5.7	30.2	26.4	16.0
MAX				299.0	293.5	290.0	21.9	66.0	56.9	56.5	35.9	34.9	52.0	17.1	10.4	33.8	29.3	20.0

IMPALA (*Aepyceros melampus*) n=17																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Imp 1P	1198	F	Z	277.0	273.0	270.0	20.9	62.5	52.0	56.0	34.4	29.3	53.0	18.2	10.1	33.3	26.0	16.9
Imp 2P	1273	F	Z	286.0	281.0	279.0	19.1	59.0	49.2	53.0	30.7	26.4	52.0	16.9	9.4	30.3	24.3	16.0
Imp 3P	646	M	Z	291.5	288.5	286.0	21.3	68.0	53.0	59.5	37.6	30.8	45.5	15.7	9.1	32.2	26.6	18.5
Imp 4P	1590	F	Z	287.0	282.0	280.0	21.6	61.0	49.9	55.5	64.5	32.0	53.0	14.8	9.6	33.7	25.7	17.0
Imp 5P	688	F	Z	275.5	271.5	268.5	18.4	55.5	49.0	53.5	32.6	26.5	50.5	14.5	10.8	29.9	23.3	17.0
Imp 6P	525	F	Z	274.0	270.5	268.5	18.9	54.5	45.8	51.0	31.8	26.5	48.0	14.6	9.0	28.8	22.7	15.7
Imp 7P	2218	M	W	291.5	287.5	285.0	22.3	67.0	54.3	59.0	38.5	31.5	58.0	14.7	8.9	34.3	27.3	18.3
Imp 8P	1450	M	Z	298.0	294.0	292.0	21.2	65.5	52.4	57.0	34.3	29.3	55.5	14.9	11.0	33.3	25.5	19.1
Imp 9P	643	F	Z	278.0	275.0	272.0	19.7	58.0	49.5	52.5	30.7	29.9	50.5	16.2	11.1	29.0	24.1	17.3
Imp 10P	2296	F	Z	283.0	278.5	275.5	20.5	62.5	49.9	55.0	33.7	28.9	51.0	15.0	10.1	31.0	24.3	18.9
Imp 11P	816	M	W	286.0	280.0	278.0	19.8	59.0	50.5	52.0	31.8	27.5	49.5	14.9	10.8	30.7	24.4	16.3
Imp 12P	1055	M	Z	296.0	294.5	288.5	23.1	70.0	53.7	60.0	37.0	30.0	57.0	16.7	9.3	34.3	27.4	18.0
Imp 13P	2419	F	Z	277.5	274.0	271.5	20.7	61.5	51.2	53.0	31.5	27.9	52.0	14.3	9.4	33.6	25.5	16.2
Imp 14P	532	F	Z	283.0	278.0	275.0	20.8	62.0	52.7	57.0	33.0	30.9	53.5	13.7	9.2	31.2	25.5	18.8
Imp 15P	2469	M	Z	298.0	295.0	291.5	23.4	68.0	55.1	60.0	38.7	29.4	56.5	16.6	9.8	35.0	29.3	20.5
Imp 16P	2376	F	Z	284.5	281.5	279.0	22.8	65.0	52.7	56.5	36.0	30.5	53.0	15.9	9.8	33.4	27.0	18.4
Imp 17P	751	F	Z	285.5	282.0	279.5	23.0	66.0	54.0	58.0	35.4	31.8	55.0	15.8	9.7	32.9	26.7	18.5
MEDIAN				285.5	281.0	279.0	20.9	62.5	52.0	56.0	34.3	29.4	53.0	15.0	9.7	32.9	25.5	18.0
MEAN				285.4	281.6	278.8	21.0	62.6	51.5	55.8	36.0	29.4	52.6	15.5	9.8	32.2	25.6	17.7
STD DEV				7.6	7.9	7.7	1.5	4.5	2.4	2.9	7.8	1.9	3.3	1.2	0.7	1.9	1.7	1.3
MIN				274.0	270.5	268.5	18.4	54.5	45.8	51.0	30.7	26.4	45.5	13.7	8.9	28.8	22.7	15.7
MAX				298.0	295.0	292.0	23.4	70.0	55.1	60.0	64.5	32.0	58.0	18.2	11.1	35.0	29.3	20.5

REEDBUCK (*Redunca arundinum*) n=6																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Ree 1K	40529	?	W	321.0	316.5	313.0	20.1	61.0	56.5	62.5	37.8	29.6	54.0	18.6	12.1	35.0	29.6	18.6
Ree 2K	38808	M	W	314.0	300.5	305.0	22.1	65.0	54.1	64.5	35.8	29.5	57.0	25.0	12.3	36.0	26.7	18.7
Ree 3B	8706	M	W	309.5	306.0	302.5	23.0	66.5	57.6	59.0	38.4	31.6	56.0	16.9	10.9	35.9	29.4	20.4
Ree 4P	1068	M	Z	309.5	306.0	303.5	19.9	60.0	55.5	56.5	34.3	30.0	54.5	15.4	10.8	33.6	26.6	18.2
Ree 5P	105	F	?	298.0	294.0	291.0	19.7	59.0	52.3	56.5	32.9	30.6	53.0	15.1	9.9	32.9	25.4	17.4
Ree 6P	110	M	?	306.5	302.0	301.0	22.2	62.0	52.0	57.0	30.3	28.4	53.0	19.7	9.9	32.7	24.6	18.1
MEDIAN				309.5	304.0	303.0	21.1	61.5	54.8	58.0	35.1	29.8	54.3	17.8	10.9	34.3	26.7	18.4
MEAN				309.8	304.2	302.7	21.2	62.3	54.7	59.3	34.9	30.0	54.6	18.5	11.0	34.4	27.1	18.6
STD DEV				7.7	7.5	7.1	1.4	2.9	2.3	3.4	3.1	1.1	1.6	3.7	1.0	1.5	2.1	1.0
MIN				298.0	294.0	291.0	19.7	59.0	52.0	56.5	30.3	28.4	53.0	15.1	9.9	32.7	24.6	17.4
MAX				321.0	316.5	313.0	23.0	66.5	57.6	64.5	38.4	31.6	57.0	25.0	12.3	36.0	29.6	20.4

RED LECHWE (*Kobus leche*) n=5

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Lec 1B	8714	F	Z	322.0	316.0	312.5	22.5	67.0	56.7	59.0	35.3	28.8	52.0	14.6	11.8	35.2	29.7	19.2
Lec 2P	539	F	Z	326.0	322.0	317.0	23.5	69.0	61.8	65.5	41.0	37.4	60.0	17.5	11.3	37.7	29.8	20.6
Lec 3P	2945	F	?	331.0	327.0	324.0	25.4	87.0	64.4	66.5	40.7	41.2	64.0	18.8	13.2	38.5	31.8	23.1
Lec 4P	498	F	Z	317.0	311.0	308.0	21.8	65.5	57.7	59.0	37.0	33.9	55.5	17.9	10.6	35.8	30.0	20.0
Lec 5P	593	M	Z	336.0	330.0	327.0	24.9	73.5	62.0	66.0	41.4	34.4	60.0	18.5	11.0	38.3	32.7	21.2
MEDIAN				326.0	322.0	317.0	23.5	69.0	61.8	65.5	40.7	34.4	60.0	17.9	11.3	37.7	30.0	20.6
MEAN				326.4	321.2	317.7	23.6	72.4	60.5	63.2	39.1	35.1	58.3	17.5	11.6	37.1	30.8	20.8
STD DEV				7.4	7.8	7.9	1.5	8.7	3.2	3.9	2.8	4.6	4.6	1.7	1.0	1.5	1.4	1.5
MIN				317.0	311.0	308.0	21.8	65.5	56.7	59.0	35.3	28.8	52.0	14.6	10.6	35.2	29.7	19.2
MAX				336.0	330.0	327.0	25.4	87.0	64.4	66.5	41.4	41.2	64.0	18.8	13.2	38.5	32.7	23.1

NYALA (*Tragelaphus angasii*) n=5

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Nya 1K	36902	M	?	320.0	315.0	313.0	26.8	63.0	61.5	66.0	36.2	40.8	63.0	18.6	12.3	37.7	29.8	22.9
Nya 2K	38811	F	?	300.0	292.5	291.0	24.3	70.0	55.5	57.5	30.9	32.1	52.5	16.7	12.3	35.7	27.8	19.6
Nya 3K	36903	F	?	284.5	279.0	277.0	21.6	66.0	53.5	55.5	30.8	28.8	50.0	17.8	11.6	33.9	26.5	18.8
Nya 4P	2974	F	?	285.0	280.0	278.0	22.4	67.5	55.7	55.0	30.8	30.5	50.0	18.2	11.2	34.2	26.4	18.8
Nya 5P	107	M	W	345.0	342.0	338.0	25.6	75.0	62.5	67.0	37.4	37.2	61.0	22.1	10.8	38.4	30.7	23.7
Nya 6P	106	F	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MEDIAN				300.0	292.5	291.0	24.3	67.5	55.7	57.5	30.9	32.1	52.5	18.2	11.6	35.7	27.8	19.6
MEAN				306.9	301.7	299.4	24.1	68.3	57.7	60.2	33.2	33.9	55.3	18.7	11.6	36.0	28.2	20.8
STD DEV				25.7	26.8	26.0	2.2	4.5	4.0	5.8	3.3	5.0	6.2	2.0	0.7	2.0	1.9	2.4
MIN				284.5	279.0	277.0	21.6	63.0	53.5	55.0	30.8	28.8	50.0	16.7	10.8	33.9	26.4	18.8
MAX				345.0	342.0	338.0	26.8	75.0	62.5	67.0	37.4	40.8	63.0	22.1	12.3	38.4	30.7	23.7

SITATUNGA (*Tragelaphus spekei*) n=2																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Sit 1P	2958	?	W	373.0	367.0	366.0	21.3	68.0	61.9	71.0	38.8	38.7	61.0	23.6	14.1	37.8	30.7	20.7
Sit 2P	405	M	W	373.0	368.0	367.0	22.2	70.0	59.6	63.5	35.3	34.1	62.5	22.1	13.9	37.6	34.7	20.3
MEDIAN				373.0	367.5	366.5	21.8	69.0	60.8	67.3	37.1	36.4	61.8	22.9	14.0	37.7	32.7	20.5
MEAN				373.0	367.5	366.5	21.8	69.0	60.8	67.3	37.1	36.4	61.8	22.9	14.0	37.7	32.7	20.5
STD DEV				0.0	0.7	0.7	0.6	1.4	1.6	5.3	2.5	3.3	1.1	1.1	0.1	0.1	2.8	0.3
MIN				373.0	367.0	366.0	21.3	68.0	59.6	63.5	35.3	34.1	61.0	22.1	13.9	37.6	30.7	20.3
MAX				373.0	368.0	367.0	22.2	70.0	61.9	71.0	38.8	38.7	62.5	23.6	14.1	37.8	34.7	20.7

TSESSEBE (*Damaliscus lunatus*) n=1

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Tse 1B	9922	?	?	335.0	328.0	326.0	26.9	81.0	66.8	65.5	42.3	35.7	60.5	16.8	11.4	43.3	33.8	0.1
MEDIAN				335.0	328.0	326.0	26.9	81.0	66.8	65.5	42.3	35.7	60.5	16.8	11.4	43.3	33.8	0.1
MEAN				335.0	328.0	326.0	26.9	81.0	66.8	65.5	42.3	35.7	60.5	16.8	11.4	43.3	33.8	0.1
STD DEV				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MIN				335.0	328.0	326.0	26.9	81.0	66.8	65.5	42.3	35.7	60.5	16.8	11.4	43.3	33.8	0.1
MAX				335.0	328.0	326.0	26.9	81.0	66.8	65.5	42.3	35.7	60.5	16.8	11.4	43.3	33.8	0.1

RED HARTBEEST (*Alcelaphus buselaphus*) n=9																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
RHa 1K	39820	F	W	324.0	311.0	308.5	25.1	77.0	65.2	67.0	42.3	40.1	58.5	17.9	11.7	42.5	33.5	22.5
RHa 2K	40837	M	W	354.0	347.5	344.0	29.4	82.5	68.8	69.0	41.0	42.1	63.0	18.0	11.7	45.0	37.5	25.0
RHa 3B	9930	?	?	328.5	320.0	318.0	25.6	81.0	67.7	66.5	40.1	40.9	63.5	21.9	12.3	44.0	34.9	24.8
RHa 4B	7437	F	W	334.0	326.0	323.0	26.7	78.0	67.1	68.5	41.8	39.2	62.0	17.5	13.5	43.9	34.8	21.3
RHa 5B	9763	M	Z	331.5	324.5	322.5	28.0	85.0	70.4	70.5	46.4	42.4	62.0	17.3	10.9	46.5	41.9	22.8
RHa 6B	9417	M	W	355.5	347.5	346.0	31.3	89.5	72.8	72.5	45.8	42.3	63.5	18.2	12.3	47.7	37.4	24.4
RHa 7B	12032	F	W	341.0	330.5	331.5	28.0	84.0	69.9	68.0	41.3	38.1	61.5	16.5	12.1	46.8	37.6	21.1
RHa 8B	9773	F	W	317.5	311.0	309.5	28.4	81.0	66.0	68.0	40.2	36.9	63.0	18.6	12.6	43.3	34.1	21.1
RHa 9B	8715	F	Z	339.5	332.0	331.0	26.7	78.5	69.2	67.5	43.4	40.0	60.0	16.7	12.6	43.9	34.4	20.9
MEDIAN				334.0	326.0	323.0	28.0	81.0	68.8	68.0	41.8	40.1	62.0	17.9	12.3	44.0	34.9	22.5
MEAN				336.2	327.8	326.0	27.7	81.8	68.8	68.8	42.5	40.2	61.9	18.1	12.2	44.8	36.2	22.7
STD DEV				12.8	13.4	13.4	1.9	3.9	2.4	1.9	2.3	1.9	1.7	1.6	0.7	1.8	2.6	1.7
MIN				317.5	311.0	308.5	25.1	77.0	65.2	66.5	40.1	36.9	58.5	16.5	10.9	42.5	33.5	20.9
MAX				355.5	347.5	346.0	31.3	89.5	72.8	72.5	46.4	42.4	63.5	21.9	13.5	47.7	41.9	25.0

KUDU (*Tragelaphus strepsiceros*) n=8

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Kud 1K	38768	M	?	387.0	375.0	372.5	35.5	105.0	85.9	91.5	48.9	50.1	83.0	27.3	17.9	56.8	48.6	35.6
Kud 2B	9923	?	?	423.5	415.0	412.0	37.2	111.0	86.8	95.0	55.9	49.1	90.0	28.7	18.2	58.0	47.7	33.7
Kud 3B	9924	?	?	392.0	385.0	382.5	37.0	107.0	84.3	88.5	48.0	40.7	79.5	27.2	16.8	56.3	47.7	33.2
Kud 4B	9933	?	W	426.0	415.0	411.5	38.5	108.5	88.4	92.5	52.2	45.2	86.0	27.4	18.7	59.0	48.1	33.1
Kud 5B	8713	?	W	394.0	385.0	381.5	32.4	96.0	82.9	83.5	45.7	42.8	81.0	19.4	16.1	54.1	44.6	31.3
Kud 6P	1592	F	W	339.0	333.0	328.0	28.3	82.5	74.3	70.5	39.3	37.9	61.0	24.2	15.5	47.7	37.7	23.2
Kud 7P	1260	F	Z	374.0	367.0	362.0	33.2	95.0	79.5	80.0	43.8	41.1	75.5	23.3	17.4	52.9	51.1	36.9
Kud 8P	1261	F	Z	376.0	369.0	365.0	33.3	94.5	80.9	84.5	45.5	42.9	80.5	27.5	19.0	53.7	47.9	36.1
MEDIAN				389.5	380.0	377.0	34.4	100.5	83.6	86.5	46.9	42.9	80.8	27.3	17.7	55.2	47.8	33.5
MEAN				388.9	380.5	376.9	34.4	99.9	82.9	85.8	47.4	43.7	79.6	25.6	17.5	54.8	46.7	32.9
STD DEV				28.0	26.8	27.4	3.3	9.6	4.6	8.0	5.1	4.2	8.7	3.1	1.2	3.6	4.0	4.3
MIN				339.0	333.0	328.0	28.3	82.5	74.3	70.5	39.3	37.9	61.0	19.4	15.5	47.7	37.7	23.2
MAX				426.0	415.0	412.0	38.5	111.0	88.4	95.0	55.9	50.1	90.0	28.7	19.0	59.0	51.1	36.9

BLACK WILDEBEEST (*Connochaetes gnou*) n=21

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Bla 1K	38783	F	Z	291.5	280.0	282.0	27.3	78.0	72.5	62.0	41.4	43.0	64.5	16.6	12.0	43.5	36.1	22.4
Bla 2K	36239	F	W	305.0	296.0	293.0	26.1	74.0	70.7	66.0	41.1	42.9	61.5	20.5	13.2	41.4	33.3	21.9
Bla 3K	39318	F	W	315.0	300.0	303.0	26.9	78.0	72.2	65.5	46.4	47.5	60.0	17.1	6.5	42.4	35.0	22.5
Bla 4K	39233	F	Z	298.0	290.0	286.0	26.3	75.0	70.3	64.0	40.4	42.5	61.0	18.0	12.8	41.0	33.2	22.6
Bla 5K	39121	F	Z	297.0	289.0	286.0	27.7	79.0	70.8	64.0	40.8	41.7	62.0	15.5	11.6	43.4	34.4	22.7
Bla 6K	36675	M	Z	312.0	303.0	301.0	28.3	82.0	74.1	68.5	45.1	46.0	65.0	17.5	12.0	45.2	37.2	24.0
Bla 7K	36660	M	W	319.0	311.0	312.0	28.9	82.0	68.7	69.0	42.1	46.5	65.0	18.0	8.2	42.3	35.6	25.5
Bla 8K	37090	F	?	307.5	298.0	296.0	28.3	81.5	74.2	69.5	44.5	45.8	66.5	17.3	12.0	44.7	36.8	24.2
Bla 9K	36710	F	Z	294.0	287.0	285.0	28.9	81.0	71.2	65.5	40.7	41.9	61.5	15.1	10.5	44.2	35.0	23.2
Bla 10K	38249	F	Z	282.5	274.0	272.5	25.3	73.5	67.8	62.5	36.2	39.3	59.0	14.4	12.0	41.3	33.1	20.7
Bla 11B	8708	M	W	337.0	329.0	327.0	30.4	89.0	79.2	75.0	47.8	48.2	69.5	17.0	14.3	49.9	39.6	25.6
Bla 12B	8742	M	W	319.0	310.5	309.0	31.5	86.0	76.0	71.0	46.3	46.5	65.5	18.1	12.1	47.7	35.7	25.1
Bla 13B	9358	M	W	351.0	340.5	388.0	30.7	88.5	80.7	74.5	45.9	46.1	71.0	17.6	14.9	50.8	39.0	24.1
Bla 14B	6079	?	?	315.0	307.5	306.0	29.2	81.0	69.6	63.5	40.7	41.1	59.5	13.8	11.3	44.9	33.9	21.2
Bla 15B	8714	F	W	307.5	298.0	296.0	26.6	77.0	68.3	63.0	38.3	39.2	61.0	16.6	11.3	41.3	34.6	23.0
Bla 16B	9779	M	W	323.0	317.5	316.0	31.0	88.5	77.5	74.5	47.4	48.4	70.0	17.5	13.0	48.7	37.1	23.2
Bla 17B	8736	M	W	303.0	289.0	286.5	27.6	81.0	73.7	67.5	38.9	39.6	64.0	16.9	13.8	46.0	35.9	22.9
Bla 18B	7447	F	W	312.5	304.5	303.0	29.1	81.5	76.3	68.5	44.8	44.9	64.5	17.3	12.2	46.5	34.5	21.9
Bla 19B	12054	M	W	321.0	310.0	308.5	30.2	84.5	78.5	74.0	46.1	47.0	69.0	20.7	10.8	48.8	36.2	22.7
Bla 20B	12053	M	W	295.0	286.5	284.0	26.0	76.0	71.1	63.0	37.5	38.1	61.5	15.6	13.9	43.2	35.4	20.6
Bla 21B	12052	M	W	315.5	306.0	304.0	27.9	80.0	72.9	68.5	39.5	40.7	68.0	17.9	11.7	46.0	34.1	21.9
MEDIAN				312.0	300.0	301.0	28.3	81.0	72.5	67.5	41.4	43.0	64.5	17.3	12.0	44.7	35.4	22.7
MEAN				310.5	301.3	302.1	28.3	80.8	73.2	67.6	42.5	43.7	64.3	17.1	11.9	44.9	35.5	22.9
STD DEV				15.7	15.8	23.7	1.8	4.6	3.7	4.3	3.5	3.3	3.7	1.7	1.9	3.0	1.7	1.4
MIN				282.5	274.0	272.5	25.3	73.5	67.8	62.0	36.2	38.1	59.0	13.8	6.5	41.0	33.1	20.6
MAX				351.0	340.5	388.0	31.5	89.0	80.7	75.0	47.8	48.4	71.0	20.7	14.9	50.8	39.6	25.6

WATERBUCK (*Kobus ellipsiprymnus*) n=7

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Wat 1B	9952	?	?	376.0	365.0	360.0	31.9	96.0	85.6	84.5	50.0	46.4	75.5	24.9	14.0	52.7	42.4	28.7
Wat 2B	6017	F	W	382.5	372.5	369.0	33.0	96.0	87.2	86.0	53.8	48.0	78.0	22.6	16.6	52.2	40.3	28.7
Wat 3B	12014	M	?	372.0	364.0	357.0	33.9	98.5	84.6	86.0	49.3	43.0	78.0	23.3	14.9	51.5	41.6	29.6
Wat 4B	9960	?	?	378.5	368.5	362.5	37.3	107.0	87.1	86.5	51.0	47.2	79.5	21.7	15.0	55.5	45.9	32.1
Wat 5P	1853	F	Z	351.0	345.0	338.0	33.7	99.0	89.7	86.0	56.8	52.8	74.0	22.2	13.3	54.1	44.3	30.2
Wat 6P	1873	F	Z	347.0	340.0	335.0	33.2	97.5	85.6	80.0	50.5	48.8	73.0	23.3	14.5	51.9	39.1	28.7
Wat 7P	1160	F	Z	366.0	358.0	355.0	35.2	101.5	56.7	82.0	53.2	50.7	73.0	23.8	16.1	55.0	40.6	29.5
MEDIAN				372.0	364.0	357.0	33.7	98.5	85.6	86.0	51.0	48.0	75.5	23.3	14.9	52.7	41.6	29.5
MEAN				367.6	359.0	353.8	34.0	99.4	82.4	84.4	52.1	48.1	75.9	23.1	14.9	53.3	42.0	29.6
STD DEV				13.7	12.2	12.6	1.8	3.9	11.4	2.5	2.7	3.1	2.7	1.1	1.1	1.6	2.4	1.2
MIN				347.0	340.0	335.0	31.9	96.0	56.7	80.0	49.3	43.0	73.0	21.7	13.3	51.5	39.1	28.7
MAX				382.5	372.5	369.0	37.3	107.0	89.7	86.5	56.8	52.8	79.5	24.9	16.6	55.5	45.9	32.1

GEMSBUCK (*Oryx gazelle*) n=6																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SB(E)	T(GBD)	T(GDD)	T(SDD)
Gem 1K	33520	?	?	338.0	326.5	324.5	31.5	93.0	82.4	71.5	44.4	47.9	60.0	16.4	13.0	50.8	38.6	24.7
Gem 2K	33517	?	?	342.5	336.0	333.5	28.9	86.5	70.5	71.5	45.8	45.1	65.5	18.9	11.7	46.3	38.7	25.5
Gem 3B	9376	F	W	328.0	318.0	315.5	31.1	88.0	80.3	69.5	42.0	42.0	60.5	12.3	15.0	49.5	36.6	24.3
Gem 4B	9304	F	W	337.0	328.0	325.0	31.7	94.5	84.9	74.0	47.4	45.0	69.0	16.9	14.9	55.5	42.3	28.4
Gem 5P	475	F	Z	347.0	334.0	332.0	35.2	103.0	87.9	78.5	48.5	19.9	68.0	17.1	14.5	54.0	42.3	30.6
Gem 6P	1576	?	?	334.0	326.0	322.0	31.4	89.0	79.4	70.0	41.9	46.5	59.5	16.9	12.4	51.7	37.7	27.0
MEDIAN				337.5	327.3	324.8	31.5	91.0	81.4	71.5	45.1	45.1	63.0	16.9	13.8	51.3	38.7	26.3
MEAN				337.8	328.1	325.4	31.6	92.3	80.9	72.5	45.0	41.1	63.8	16.4	13.6	51.3	29.4	26.8
STD DEV				6.6	6.4	6.6	2.0	6.0	6.0	3.3	2.7	10.6	4.3	2.2	1.4	3.3	2.4	2.4
MIN				328.0	318.0	315.5	28.9	86.5	70.5	69.5	41.9	19.9	59.5	12.3	11.7	46.3	36.6	24.3
MAX				347.0	336.0	333.5	35.2	103.0	87.9	78.5	48.5	47.9	69.0	18.9	15.0	55.5	42.3	30.6

SABLE (*Hippotragus niger*) n=6																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Sab 1K	39526	M	?	342.0	332.0	329.0	33.1	93.5	76.4	74.0	46.8	50.7	66.0	17.8	13.5	45.9	40.2	28.0
Sab 2B	6080	?	?	352.0	342.0	338.5	31.8	93.0	78.3	73.5	45.2	39.9	67.0	15.4	15.5	51.6	41.1	27.9
Sab 3B	9920	?	?	339.0	330.5	327.0	32.3	93.5	83.4	77.0	45.8	52.2	69.0	17.4	16.4	50.9	42.5	26.0
Sab 4P	1856	F	Z	335.5	327.0	325.0	31.5	93.0	83.2	77.0	48.1	53.0	69.5	17.4	11.0	50.6	41.3	27.0
Sab 5P	1265	M	Z	342.0	335.0	333.0	33.0	97.0	82.9	78.0	48.8	52.1	69.0	22.9	14.8	52.3	43.7	30.2
Sab 6P	472	M	W	357.5	345.0	343.0	34.0	97.0	83.1	81.0	48.5	49.3	74.0	23.7	14.7	53.5	44.2	28.1
MEDIAN				342.0	333.5	331.0	32.7	93.5	83.0	77.0	47.5	51.4	69.0	17.6	14.8	51.3	41.9	28.0
MEAN				344.7	335.3	332.6	32.6	94.5	81.2	76.8	47.2	49.5	69.1	19.1	14.3	50.8	42.2	27.9
STD DEV				8.4	7.0	7.0	0.9	1.9	3.1	2.8	1.5	4.9	2.8	3.4	1.9	2.6	1.6	1.4
MIN				335.5	327.0	325.0	31.5	93.0	76.4	73.5	45.2	39.9	66.0	15.4	11.0	45.9	40.2	26.0
MAX				357.5	345.0	343.0	34.0	97.0	83.4	81.0	48.8	53.0	74.0	23.7	16.4	53.5	44.2	30.2

BLUE WILDEBEEST (*Connochaetes taurinus*) n=4																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
BWi 1K	36064	?	W	346.5	336.0	336.0	34.1	94.0	80.0	73.5	46.6	44.0	66.0	17.4	13.0	49.3	38.2	26.8
BWi 2K	33518	?	?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BWi 3B	3737	?	?	388.0	377.0	376.0	36.2	102.0	83.0	79.0	50.6	47.6	75.0	17.6	13.4	52.2	41.4	26.8
BWi 4P	1272	M	W	365.0	352.0	351.0	35.8	111.0	84.5	78.0	49.2	54.8	73.0	22.1	12.7	51.7	41.7	30.2
BWi 5P	563	F	Z	338.0	328.0	327.0	35.7	103.0	81.0	78.5	47.7	53.8	71.0	21.1	13.8	53.0	41.1	29.2
MEDIAN				355.8	344.0	343.5	35.8	102.5	82.0	78.3	48.5	50.7	72.0	19.4	13.2	52.0	41.3	28.0
MEAN				359.4	348.3	347.5	35.5	102.5	82.1	77.3	48.5	50.1	71.3	19.6	13.2	51.6	40.6	28.3
STD DEV				22.2	21.6	21.4	0.9	7.0	2.0	2.5	1.7	5.1	3.9	2.4	0.5	1.6	1.6	1.7
MIN				338.0	328.0	327.0	34.1	94.0	80.0	73.5	46.6	44.0	66.0	17.4	12.7	49.3	38.2	26.8
MAX				388.0	377.0	376.0	36.2	111.0	84.5	79.0	50.6	54.8	75.0	22.1	13.8	53.0	41.7	30.2

ROAN (*Hippotragus equinus*) n=3

INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Roa 1B	9919	?	?	365.5	353.5	351.0	35.5	98.5	82.2	79.0	48.6	45.6	73.0	14.4	14.0	53.3	43.0	28.0
Roa 2P	2923	?	?	428.0	414.0	410.0	41.1	110.0	91.9	83.5	51.3	49.8	78.0	22.3	16.8	59.0	43.3	28.1
Roa 3P	1591	?	W	339.0	328.0	325.0	32.5	95.0	80.2	74.5	44.8	46.6	66.0	17.1	16.1	50.3	42.6	26.0
MEDIAN				365.5	353.5	351.0	35.5	98.5	82.2	79.0	48.6	46.6	73.0	17.1	16.1	53.3	43.0	28.0
MEAN				377.5	365.2	362.0	36.4	101.2	84.8	79.0	48.2	47.3	72.3	17.9	15.6	54.2	43.0	27.4
STD DEV				45.7	44.2	43.6	4.4	7.8	6.3	4.5	3.3	2.2	6.0	4.0	1.5	4.4	0.4	1.2
MIN				339.0	328.0	325.0	32.5	95.0	80.2	74.5	44.8	45.6	66.0	14.4	14.0	50.3	42.6	26.0
MAX				428.0	414.0	410.0	41.1	110.0	91.9	83.5	51.3	49.8	78.0	22.3	16.8	59.0	43.3	28.1

ELAND (*Taurotragus oryx*) n=16																		
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Ela 1K	35061	M	W	430.0	416.0	414.0	45.6	134.0	120.0	112.0	68.7	61.3	100.0	28.0	19.6	73.0	60.7	39.5
Ela 2K	36696	F	Z	349.0	337.5	331.5	36.8	113.5	97.9	88.5	54.4	46.2	80.0	23.5	14.2	58.7	45.4	29.5
Ela 3K	36749	M	Z	394.5	384.0	372.0	40.8	119.5	113.1	99.5	58.7	55.7	90.5	22.8	19.0	66.6	53.5	36.3
Ela 4K	36674	F	Z	375.5	363.0	358.0	37.7	111.5	102.2	90.5	54.0	49.4	83.5	24.0	17.1	63.2	50.2	30.7
Ela 5K	35572	?	W	412.0	399.5	396.0	40.3	120.0	108.6	98.5	55.3	53.4	93.5	29.2	19.8	68.2	50.1	35.9
Ela 6K	36280	?	Z	368.5	356.5	349.0	33.0	99.5	98.3	88.5	53.8	52.0	81.0	23.7	18.0	61.4	49.8	32.4
Ela 7K	39303	F	W	403.5	393.0	390.0	39.0	115.5	106.5	97.5	53.7	53.1	88.0	21.8	17.1	67.1	50.9	35.3
Ela 8K	38248	F	Z	394.0	382.5	378.0	41.6	121.0	105.4	93.5	57.8	49.8	83.0	20.9	15.5	64.5	52.4	35.9
Ela 9K	37142	F	?	398.0	386.0	382.0	38.3	111.0	106.4	95.5	55.0	54.0	85.0	24.4	16.9	66.4	52.1	36.4
Ela 10K	39311	M	W	428.0	417.0	407.0	43.4	123.0	109.6	102.0	58.3	57.6	94.0	27.0	19.6	66.0	56.5	34.6
Ela 11B	260	?	W	432.5	417.0	414.0	46.7	131.0	116.5	102.0	62.6	63.9	98.0	31.3	18.0	74.7	56.9	41.8
Ela 12B	9756	?	Z	433.5	416.5	420.0	47.9	133.5	121.0	102.5	62.2	58.1	96.0	26.1	20.8	73.3	56.0	36.3
Ela 13B	9432	?	W	382.5	373.0	369.5	35.8	102.5	100.4	87.0	54.8	49.3	82.0	21.4	16.6	63.7	50.8	34.0
Ela 14B	4281	?	?	401.0	387.0	386.0	36.9	117.5	96.8	90.5	56.8	47.7	82.0	20.5	17.2	60.3	46.4	33.7
Ela 15B	9925	?	?	414.0	398.0	396.0	42.3	121.5	107.7	96.5	58.3	51.2	88.5	22.2	19.6	67.7	53.8	35.7
Ela 16B	9442	F	W	437.5	423.5	422.0	46.3	135.0	119.2	104.0	62.7	57.4	96.0	25.9	18.2	74.0	58.4	38.4
MEDIAN				402.3	390.0	388.0	40.6	119.8	107.1	97.0	57.3	53.3	88.3	23.9	18.0	66.5	52.3	35.8
MEAN				403.4	390.6	386.6	40.8	119.3	108.1	96.8	57.9	53.8	88.8	24.5	18.0	66.8	52.7	35.4
STD DEV				25.8	24.7	26.3	4.4	10.6	8.0	6.9	4.2	5.0	6.7	3.1	1.7	4.9	4.2	3.1
MIN				349.0	337.5	331.5	33.0	99.5	96.8	87.0	53.7	46.2	80.0	20.5	14.2	58.7	45.4	29.5
MAX				437.5	423.5	422.0	47.9	135.0	121.0	112.0	68.7	63.9	100.0	31.3	20.8	74.7	60.7	41.8

BUFFALO (*Syncerus caffer*) n=7																			
INDIVIDUAL	MUS NO	M/F	W/Z	T(GL)	T(GML)	T(GLL)	T(SBD)	T(SCD)	T(GBP)	T(GDP)	T(GDLC)	T(GDMC)	T(GDT)	T(GDTN)	T(SBIE)	T(GBD)	T(GDD)	T(SDD)
Buf 1K	33386	F	W	392.5	372.5	369.0	46.4	131.0	120.5	103.5	62.6	74.0	98.5	24.1	22.6	78.8	57.4	45.1
Buf 2K	33442	?	?	425.0	407.0	397.0	53.0	159.0	133.5	120.0	71.7	78.6	101.5	33.7	19.1	85.6	67.5	52.3
Buf 3B	9774	F	W	375.5	358.0	348.0	43.0	127.0	110.8	98.0	59.4	60.2	91.5	24.3	19.2	71.3	58.0	39.5
Buf 4B	8743	F	W	370.0	352.0	343.0	46.2	136.0	115.9	111.0	60.7	63.1	90.5	20.4	17.9	76.1	61.3	41.9
Buf 5B	4283	?	W	367.5	348.0	343.0	45.0	130.5	115.6	112.5	60.3	61.0	95.5	26.0	20.2	76.7	57.0	41.8
Buf 6P	524	F	Z	373.0	355.0	346.0	39.3	116.0	108.5	90.0	54.3	60.1	82.0	24.3	16.8	71.1	52.5	36.3
Buf 7P	2216	M	W	385.5	374.0	359.0	54.0	154.0	132.3	110.0	63.9	74.1	86.0	37.6	19.6	80.7	64.1	49.7
MEDIAN				375.5	358.0	348.0	46.2	131.0	115.9	110.0	60.7	63.1	91.5	24.3	19.2	76.7	58.0	41.9
MEAN				384.1	366.6	357.9	46.7	136.2	119.6	106.4	61.8	67.3	92.2	27.2	19.3	77.2	59.7	43.8
STD DEV				20.1	20.4	19.7	5.2	15.2	9.9	10.0	5.3	7.9	6.9	6.1	1.8	5.1	5.0	5.6
MIN				367.5	348.0	343.0	39.3	116.0	108.5	90.0	54.3	60.1	82.0	20.4	16.8	71.1	52.5	36.3
MAX				425.0	407.0	397.0	54.0	159.0	133.5	120.0	71.7	78.6	101.5	37.6	22.6	85.6	67.5	52.3

C

APPENDIX C - METATARSAL

Appendix C contains the raw measurements taken on the metatarsal of 30 Southern African Bovid specimens from the Transvaal, National and South African Museums. It also includes the mean, median, standard deviation and minimum and maximum values for each measurement.

Each individual specimen is abbreviated as follows:

Specimen number
Abbreviation for Museum
Sun 1P
Abbreviation for Bovid species

ABBREVIATION FOR MUSEUM:

P → Transvaal Museum specimen - Pretoria (Archaeozoological collection)
K → South African Museum specimen - Cape Town (Mammal collection)
B → National Museum specimen - Bloemfontein (Florisbad collection)

TABLE 4.5: Key to abbreviations to bovid species (alphabetical).

Abbreviation	Species	Abbreviation	Species	Abbreviation	Species
BDu	Blue Duiker	Bla	Black Wildebeest	Ble	Blesbok
Bon	Bontebok	Buf	Buffalo	Bus	Bushbuck
BWi	Blue Wildebeest	Cap	Cape Grysbok	Ela	Eland
GDu	Grey Duiker	Gem	Gemsbok	GRh	Grey Rhebuck
Imp	Impala	Kli	Klipspringer	Kud	Kudu
Lec	Red Lechwe	Mou	Mountain Reedbuck	Nya	Nyala
Ori	Oribi	Rdu	Red Duiker	Ree	Reedbuck
RHa	Red Hartebeest	Roa	Roan	Sab	Sable
Sit	Sitatunga	Spr	Springbok	Ste	Steenbok
Sun	Suni	Tse	Tsessebe	Wat	Waterbuck

OTHER ABBREVIATIONS USED IN APPENDIX:

STD DEV →	Standard Deviation
MIN →	Minimum value
MAX →	Maximum value
MUS NO. →	Museum number of specimen
M/F →	Male or female
W/Z →	Wild or zoo born
NA →	Specific bone not available for measuring
NAM →	Specific part of bone not available for measuring

TABLE 3.8: Metatarsal measurements

No	Abbr	Description	Instrument	Fig
1	M(GL)◆	Greatest length.	Osteometric box	3.9a
2	M(GML)▮	Greatest medial length.	Osteometric box	3.9a
3	M(GLL)◆	Greatest lateral length.	Osteometric box	3.9a
4	M(SBD)◆	Smallest breadth of diaphyses.	Electronic calliper	3.9b
5	M(SCD)◆	Smallest circumference of diaphyses	Measuring tape	3.9b
6	M(GBP)◆●	Greatest breadth proximal end.	Electronic calliper	3.10b
7	M(GDP)◆	Greatest depth proximal end.	Electronic calliper	3.10b
8	M(GLMA)▮	Greatest length medial arctic. facet prox. end.	Electronic calliper	3.10a
9	M(GBMA)▮	Greatest breadth medial arctic. facet prox. end.	Electronic calliper	3.10a
10	M(GLLA)▮	Greatest length lateral arctic. facet prox. end.	Electronic calliper	3.10a
11	M(GBLA)▮	Greatest breadth lateral arctic. facet prox. end.	Electronic calliper	3.10a
12	M(GBD)◆	Greatest breadth distal end.	Electronic calliper	3.11b
13	M(GDD)◆✚	Greatest depth distal end.	Electronic calliper	3.11b
14	M(GBMC)●	Greatest breadth medial condyle.	Electronic calliper	3.11a
15	M(GBLC)●	Greatest breadth lateral condyle.	Electronic calliper	3.11a
16	M(GBDE)▮	Greatest breadth distal eminences.	Electronic calliper	3.11a

◆ Measurements defined by Von den Driesch [72]

✚ Measurements defined by Peters [92]

● Measurements defined by Walker [93]

▮ Measurements developed by the author

SUNI (*Neotragus moscathus*) n=2																			
INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Sun 1P	1254	F	W	103.0	102.0	102.5	7.0	22.0	10.8	11.4	7.5	3.5	6.9	3.6	10.8	8.0	5.0	4.9	5.0
Sun 2P	819	F	W	112.5	111.0	111.5	7.3	23.5	11.4	13.2	8.4	3.7	7.5	4.2	11.5	8.6	5.3	5.1	5.2
MEDIAN				107.8	106.5	107.0	7.2	22.8	11.1	12.3	8.0	3.6	7.2	3.9	11.2	8.3	5.2	5.0	5.1
MEAN				107.8	106.5	107.0	7.2	22.8	11.1	12.3	8.0	3.6	7.2	3.9	11.2	8.3	5.2	5.0	5.1
STD DEV				6.7	6.4	6.4	0.2	1.1	0.4	1.3	0.6	0.1	0.4	0.4	0.5	0.4	0.2	0.1	0.1
MIN				103.0	102.0	102.5	7.0	22.0	10.8	11.4	7.5	3.5	6.9	3.6	10.8	8.0	5.0	4.9	5.0
MAX				112.5	111.0	111.5	7.3	23.5	11.4	13.2	8.4	3.7	7.5	4.2	11.5	8.6	5.3	5.1	5.2

BLUE DUIKER (*Philantomba monticola*) n=5

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
BDu 1P	2226	F	W	80.0	79.0	79.5	6.3	20.0	10.1	10.5	6.7	3.3	6.2	4.0	10.2	6.9	4.7	4.6	4.7
BDu 2P	2515	?	?	88.0	87.0	87.5	5.9	20.0	10.3	11.0	7.5	3.8	6.8	4.3	10.1	7.7	4.5	4.4	4.7
BDu 3P	548	M	?	NAM	NAM	NAM	5.9	18.5	10.8	11.5	NAM	NAM	NAM	NAM	10.0	7.4	4.6	4.4	4.4
BDu 4P	1090	?	?	92.5	91.5	91.0	6.9	22.0	10.7	10.9	7.7	3.9	7.6	4.8	11.0	8.3	4.9	4.8	5.0
BDu 5P	2551	F	Z	76.0	75.5	75.0	6.4	21.0	10.2	10.5	6.9	3.6	6.5	3.4	10.7	7.1	4.3	4.2	4.5
MEDIAN				84.0	83.0	83.5	6.3	20.0	10.3	10.9	7.2	3.7	6.7	4.2	10.2	7.4	4.6	4.4	4.7
MEAN				84.1	83.3	83.3	6.3	20.3	10.4	10.9	7.2	3.7	6.8	4.1	10.4	7.5	4.6	4.5	4.7
STD DEV				7.5	7.3	7.3	0.4	1.3	0.3	0.4	0.5	0.3	0.6	0.6	0.4	0.5	0.2	0.2	0.2
MIN				76.0	75.5	75.0	5.9	18.5	10.1	10.5	6.7	3.3	6.2	3.4	10.0	6.9	4.3	4.2	4.4
MAX				92.5	91.5	91.0	6.9	22.0	10.8	11.5	7.7	3.9	7.6	4.8	11.0	8.3	4.9	4.8	5.0

CAPE GRYSBOK (*Raphicerus melanotis*) n=23

INDIVIDUAL	MUS NO	M/F	WZ	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Cap 1K	35854	F	?	124.5	122.5	121.5	9.1	30.5	15.2	15.9	10.9	5.1	7.4	4.9	16.8	12.1	8.0	7.3	8.8
Cap 2K	36818	F	W	132.0	129.5	130.5	8.5	30.0	15.1	15.0	11.4	5.1	8.9	6.7	16.3	12.1	7.6	7.0	7.7
Cap 3K	36012	F	W	132.5	130.5	131.0	8.1	30.0	14.7	15.6	10.9	5.3	7.2	6.3	16.4	12.0	7.3	7.0	7.9
Cap 4K	36246	F	Z	125.5	123.5	124.0	8.7	30.0	15.2	15.2	11.9	5.9	8.9	7.1	16.2	11.6	7.3	6.8	7.5
Cap 5K	36205	F	W	132.5	130.5	131.0	8.7	31.0	15.7	15.4	11.1	5.7	7.7	6.7	16.9	12.0	7.6	7.2	7.7
Cap 6K	37189	M	?	129.0	126.0	127.0	8.3	28.5	16.4	16.1	12.3	5.7	7.5	6.6	17.3	12.7	8.0	7.4	8.5
Cap 7K	36328	M	?	129.0	121.0	122.0	9.0	31.0	15.6	14.5	11.1	5.8	8.1	6.0	17.0	12.1	7.7	7.4	8.3
Cap 8K	39667	?	W	125.0	122.5	123.0	9.3	30.5	15.9	15.5	11.3	6.2	8.7	6.3	16.5	12.7	7.7	6.9	7.6
Cap 9K	38778	F	W	132.5	129.5	130.0	9.6	32.5	16.0	15.5	12.1	5.8	9.0	6.7	17.3	12.9	8.0	7.5	8.4
Cap 10K	38719	M	W	136.0	134.0	134.5	9.5	33.0	14.8	15.0	10.7	5.6	8.9	6.4	16.6	12.6	7.7	7.3	7.6
Cap 11K	40380	M	W	133.0	130.5	131.5	8.9	32.0	15.8	15.3	11.4	5.6	8.5	6.2	16.7	12.9	7.8	7.3	7.6
Cap 12K	40386	M	W	128.5	126.0	126.5	9.9	31.5	15.4	15.1	11.7	6.0	9.5	6.6	17.3	12.8	8.0	7.7	8.0
Cap 13K	40525	F	W	133.5	131.0	132.0	9.7	32.5	16.1	16.3	11.8	6.2	9.2	7.1	17.0	13.0	8.0	7.5	7.5
Cap 14K	36247	M	W	130.5	128.0	128.5	7.2	26.5	15.2	15.9	11.1	5.5	7.8	5.8	16.5	12.2	7.5	7.1	8.0
Cap 15K	39202	F	W	117.0	115.0	115.5	8.6	32.0	15.6	15.5	11.6	6.4	8.1	6.8	16.8	12.4	7.7	7.3	8.3
Cap 16K	39082	F	W	129.5	127.0	128.0	8.9	30.0	15.4	15.9	11.5	5.5	9.5	6.8	16.5	12.6	7.7	7.2	7.6
Cap 17K	39821	F	W	128.0	126.0	126.5	10.0	33.0	15.8	15.6	11.4	6.0	8.0	6.4	16.7	12.6	7.6	7.1	7.7
Cap 18K	40503	M	W	138.0	135.0	136.0	9.3	32.0	16.7	16.3	11.9	6.1	9.6	7.1	17.3	13.1	8.4	7.8	8.3
Cap 19K	36700	M	W	129.0	126.5	127.0	9.6	30.0	16.1	16.5	11.8	5.6	8.5	6.2	17.5	12.8	7.9	7.5	8.9
Cap 20K	36204	M	W	128.5	126.0	127.0	8.9	32.5	15.4	15.8	11.3	6.7	8.3	6.2	16.9	12.3	7.8	7.4	8.1
Cap 21K	36804	F	Z	130.0	128.0	128.5	10.1	32.5	16.0	16.8	12.0	6.0	8.6	6.5	17.3	12.8	7.9	7.6	8.1
Cap 22K	35109	F	W	129.0	126.5	127.0	9.7	31.0	14.8	15.2	11.3	5.7	8.4	6.5	16.3	12.6	7.4	7.2	7.5
Cap 23K	36056	F	W	121.5	119.0	120.0	8.9	30.0	15.2	15.0	10.8	6.3	8.3	6.1	15.9	11.8	7.5	7.0	7.7
MEDIAN				129.0	126.5	127.0	9.0	31.0	15.6	15.5	11.4	5.8	8.5	6.5	16.8	12.6	7.7	7.3	7.9
MEAN				129.3	126.7	127.3	9.1	31.0	15.6	15.6	11.4	5.8	8.5	6.4	16.8	12.5	7.7	7.3	8.0
STD DEV				4.6	4.7	4.8	0.7	1.6	0.5	0.6	0.4	0.4	0.7	0.5	0.4	0.4	0.3	0.3	0.4
MIN				117.0	115.0	115.5	7.2	26.5	14.7	14.5	10.7	5.1	7.2	4.9	15.9	11.6	7.3	7.0	7.5
MAX				138.0	135.0	136.0	10.1	33.0	16.7	16.8	12.3	6.7	9.6	7.1	17.5	13.1	8.4	7.6	8.9

RED DUIKER (*Cephalophus natalensis*) n=10

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
RDu 1P	1538	F	W	108.0	106.0	107.0	9.1	31.0	14.7	15.1	10.1	5.2	8.9	6.9	14.1	10.2	6.5	5.7	7.1
RDu 2P	1044	F	W	113.0	110.5	111.0	9.3	31.0	15.9	15.0	12.2	5.2	10.2	8.0	15.2	10.8	7.1	6.9	7.4
RDu 3P	1043	F	W	115.0	113.0	114.0	9.3	31.5	15.9	16.6	12.1	5.9	10.8	7.1	15.4	10.7	6.9	9.7	6.8
RDu 4P	1495	M	Z	105.0	103.0	104.0	8.8	31.0	18.1	16.1	12.5	6.6	10.2	6.8	16.5	11.2	7.6	7.5	7.6
RDu 5P	827	F	W	113.5	110.5	112.0	9.6	31.5	15.5	14.5	11.6	5.2	10.1	6.6	15.1	10.9	6.9	6.8	6.8
RDu 6P	824	F	?	117.5	115.0	116.0	8.5	31.0	15.4	14.9	11.9	5.2	9.8	6.0	16.0	11.3	7.3	7.2	7.2
RDu 7P	828	F	W	111.5	109.5	110.5	8.4	29.0	15.5	14.5	12.8	5.9	9.6	7.1	15.1	10.8	7.0	6.7	7.1
RDu 8P	1197	M	?	116.0	114.5	115.0	9.6	32.0	15.8	15.1	12.4	5.6	10.0	6.5	15.7	11.2	7.2	7.0	7.1
RDu 9P	1258	M	W	110.0	108.0	109.0	9.4	30.0	15.1	14.8	12.0	5.5	9.6	6.8	15.2	11.0	7.1	7.0	7.0
RDu 10P	1967	M	W	103.0	101.0	102.0	9.5	30.0	15.6	15.2	13.3	5.6	10.8	6.4	16.1	11.3	7.3	7.2	7.5
MEDIAN				112.3	110.0	110.8	9.3	31.0	15.6	15.1	12.2	5.6	10.1	6.8	15.3	11.0	7.1	7.0	7.1
MEAN				111.3	109.1	110.1	9.2	30.8	15.8	15.2	12.1	5.6	10.0	6.8	15.4	10.9	7.1	7.2	7.2
STD DEV				4.8	4.7	4.6	0.4	0.9	0.9	0.7	0.8	0.5	0.6	0.5	0.7	0.3	0.3	1.0	0.3
MIN				103.0	101.0	102.0	8.4	29.0	14.7	14.5	10.1	5.2	8.9	6.0	14.1	10.2	6.5	5.7	6.8
MAX				117.5	115.0	116.0	9.6	32.0	18.1	16.6	13.3	6.6	10.8	8.0	16.5	11.3	7.6	9.7	7.6

KLIPSPRINGER (*Oreotragus oreotragus*) n=3

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Kli 1K	39085	F	W	107.0	104.0	105.5	9.8	37.5	18.0	16.8	12.9	6.3	11.4	7.4	19.3	15.6	8.9	8.8	7.8
Kli 2K	40383	M	W	153.5	151.0	151.5	10.0	33.5	16.8	17.9	11.4	5.7	9.9	5.8	18.7	13.9	8.0	8.6	8.9
Kli 3B	820	?	Z	108.0	105.5	105.5	10.6	34.5	17.2	17.5	13.1	6.8	10.0	7.5	19.5	14.9	8.5	8.4	9.9
MEDIAN				108.0	105.5	105.5	10.0	34.5	17.2	17.5	12.9	6.3	10.0	7.4	19.3	14.9	8.5	8.6	8.9
MEAN				122.8	120.2	120.8	10.1	35.2	17.3	17.4	12.5	6.3	10.4	6.9	19.2	14.8	8.5	8.6	8.9
STD DEV				26.6	26.7	26.6	0.4	2.1	0.6	0.6	0.9	0.6	0.8	1.0	0.4	0.9	0.5	0.2	1.1
MIN				107.0	104.0	105.5	9.8	33.5	16.8	16.8	11.4	5.7	9.9	5.8	18.7	13.9	8.0	8.4	7.8
MAX				153.5	151.0	151.5	10.6	37.5	18.0	17.9	13.1	6.8	11.4	7.5	19.5	15.6	8.9	8.8	9.9

STEENBOK (*Raphicerus campaestris*) n=21

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Ste 1K	35281	F	W	136.5	134.5	135.0	8.8	30.5	16.5	16.6	11.4	5.2	9.0	7.0	17.2	12.5	7.7	7.5	8.3
Ste 2K	37057	M	W	145.0	142.5	143.0	8.8	31.0	15.2	16.1	11.5	5.2	8.4	5.4	17.0	13.0	7.6	7.5	7.2
Ste 3K	36327	F	?	135.0	132.0	133.0	9.2	30.0	15.4	15.3	11.1	4.9	9.2	5.2	17.1	12.8	7.7	7.5	7.6
Ste 4K	36353	F	W	129.0	126.0	127.0	8.3	29.0	15.2	15.8	11.7	5.3	9.0	5.4	17.0	12.6	8.0	7.5	7.1
Ste 5K	37082	M	W	142.0	139.5	140.5	9.7	32.5	16.1	17.0	11.8	5.8	10.3	5.4	18.0	12.3	8.2	8.0	8.1
Ste 6K	36286	M	W	135.0	132.0	133.5	8.4	31.0	15.4	15.7	11.8	5.3	8.9	5.9	16.6	12.4	7.4	7.2	7.4
Ste 7B	9438	M	W	141.0	138.5	139.0	9.8	31.0	16.3	17.2	13.4	6.6	10.3	7.2	18.9	13.3	8.9	8.6	8.7
Ste 8B	4289	F	W	133.5	131.5	132.0	9.1	32.0	15.1	17.6	12.5	5.6	9.4	6.3	17.5	13.1	7.9	7.7	8.0
Ste 9B	8730	M	W	137.0	135.0	135.0	8.4	29.0	14.5	16.6	11.5	5.7	8.3	6.1	17.2	12.6	7.9	7.6	8.0
Ste 10B	9761	F	W	139.0	136.5	137.0	10.0	34.0	15.8	17.1	12.3	5.9	9.0	5.8	18.6	13.3	8.5	8.2	8.7
Ste 11B	9787	M	W	127.0	124.5	125.0	7.9	27.5	14.4	16.3	11.7	5.9	9.7	5.2	16.0	12.3	7.4	7.1	7.4
Ste 12P	1760	M	Z	141.0	138.5	139.0	9.3	31.0	16.2	17.8	12.6	5.2	9.4	5.3	17.7	13.1	8.4	7.9	8.0
Ste 13P	2294	?	?	142.0	140.0	140.5	10.1	33.0	16.2	17.7	11.9	5.4	8.9	5.7	18.9	14.1	8.9	8.7	7.8
Ste 14P	1830	M	Z	131.0	139.0	139.5	8.6	29.5	14.5	16.4	11.6	5.3	8.6	5.0	16.9	12.4	7.8	7.6	7.5
Ste 15P	644	F	Z	132.0	130.0	130.5	9.1	29.5	15.9	15.8	10.9	4.9	8.6	5.1	16.9	12.8	7.8	7.4	7.5
Ste 16P	1119	M	?	133.0	130.0	131.0	9.5	32.0	16.6	17.1	12.3	5.3	9.3	6.2	17.7	13.2	8.3	7.9	8.5
Ste 17P	1491	F	W	134.0	132.5	132.5	8.4	29.5	15.1	17.3	11.9	5.2	9.2	5.2	17.6	13.4	8.5	8.0	7.8
Ste 18P	611	F	Z	132.0	129.5	130.0	8.8	30.5	15.8	16.6	11.5	4.7	9.3	4.7	17.2	12.8	7.9	7.6	7.9
Ste 19P	690	F	Z	131.0	128.0	128.5	8.8	31.5	15.4	16.0	12.0	4.7	11.0	6.6	18.4	14.1	8.5	8.3	8.9
Ste 20P	494	M	Z	132.0	130.0	131.0	9.1	33.0	16.1	17.3	12.2	5.6	10.1	5.9	18.6	14.6	8.6	8.3	8.7
Ste 21P	2591	M	W	142.0	139.0	140.0	9.6	32.0	16.2	17.9	11.5	5.2	9.7	6.7	19.3	13.7	9.0	8.7	8.7
MEDIAN				135.0	132.5	133.5	9.1	31.0	15.8	16.6	11.8	5.3	9.2	5.7	17.5	13.0	8.0	7.7	8.0
MEAN				135.7	133.8	134.4	9.0	30.9	15.6	16.7	11.9	5.4	9.3	5.8	17.6	13.1	8.1	7.8	8.0
STD DEV				5.0	5.1	5.0	0.6	1.6	0.7	0.8	0.6	0.4	0.7	0.7	0.9	0.6	0.5	0.5	0.5
MIN				127.0	124.5	125.0	7.9	27.5	14.4	15.3	10.9	4.7	8.3	4.7	17.2	12.3	7.4	7.6	7.1
MAX				145.0	142.5	143.0	10.1	34.0	16.6	17.9	13.4	6.6	11.0	7.2	19.3	14.6	9.0	8.7	8.9

COMMON DUIKER (*Sylvicapra grimmia*) n=16

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
CDu 1P	2459	M	W	155.0	154.0	154.5	11.3	35.0	18.6	20.7	13.8	6.5	12.3	8.1	18.6	13.8	8.5	8.3	8.5
CDu 2P	2256	F	Z	151.0	149.0	150.0	9.7	32.0	18.7	20.0	13.7	6.7	10.9	8.3	18.2	13.5	8.4	8.2	8.1
CDu 3P	1149	M	W	148.5	146.0	147.0	9.5	31.5	18.0	18.4	13.0	6.4	11.9	7.4	16.0	13.1	7.3	7.1	6.9
CDu 4P	1154	F	Z	158.0	155.5	156.5	10.2	34.0	18.4	20.2	14.1	5.8	10.9	7.6	18.8	14.6	8.8	8.6	8.2
CDu 5P	1620	M	W	147.5	145.5	146.0	10.6	32.5	19.2	19.4	13.1	5.8	10.9	6.4	18.7	14.4	8.6	8.2	8.6
CDu 6P	2592	M	W	163.0	161.0	162.0	11.4	36.0	19.2	21.0	15.6	6.7	13.5	8.9	19.2	13.6	8.8	8.6	8.1
CDu 7P	523	F	Z	154.5	152.5	153.0	11.5	37.0	18.9	19.8	14.2	7.1	13.4	8.5	18.3	14.3	8.4	8.2	8.0
CDu 8P	2255	M	Z	156.5	154.0	155.0	10.5	34.0	19.3	21.8	14.4	6.6	12.5	8.1	17.8	14.6	8.3	8.3	7.9
CDu 9P	558	F	Z	169.0	167.0	168.0	10.0	36.0	18.3	20.2	14.4	6.6	11.7	8.4	18.7	13.4	8.5	8.4	8.3
CDu 10P	551	F	Z	157.5	155.0	156.0	10.3	33.5	18.3	19.1	13.0	6.9	10.6	7.5	17.5	13.6	8.2	7.9	7.6
CDu 11P	552	F	Z	154.5	152.5	153.5	10.4	33.5	18.6	20.0	13.5	7.1	11.3	7.6	18.1	13.9	8.3	8.3	7.9
CDu 12P	368	M	?	161.0	159.0	160.0	11.5	36.0	19.0	19.9	14.7	7.1	13.2	8.1	18.2	14.1	8.7	8.5	7.8
CDu 13P	649	M	?	154.0	151.5	152.5	10.2	33.0	18.9	20.2	13.6	6.5	12.7	8.0	18.1	13.7	8.5	8.4	8.1
CDu 14P	1855	F	Z	157.5	155.5	156.5	11.2	35.0	18.9	21.1	15.1	7.4	11.8	7.8	18.1	13.9	8.6	8.0	7.9
CDu 15P	1490	?	W	166.0	164.0	165.0	11.4	37.5	19.2	21.0	12.4	6.7	10.9	7.6	19.4	15.0	8.7	8.7	8.9
CDu 16P	1774	F	Z	167.0	164.5	165.5	11.1	36.5	19.7	20.9	15.3	7.4	13.8	7.8	19.7	14.8	9.4	9.0	8.7
MEDIAN				157.0	154.5	155.5	10.6	34.5	18.9	20.2	14.0	6.7	11.9	7.9	18.3	13.9	8.5	8.3	8.1
MEAN				157.5	155.4	156.3	10.7	34.6	18.8	20.2	14.0	6.7	12.0	7.9	18.3	14.0	8.5	8.3	8.1
STD DEV				6.3	6.3	6.4	0.7	1.8	0.4	0.8	0.9	0.5	1.1	0.6	0.9	0.5	0.4	0.4	0.5
MIN				147.5	145.5	146.0	9.5	31.5	18.0	18.4	12.4	5.8	10.6	6.4	18.1	13.1	7.3	8.0	6.9
MAX				169.0	167.0	168.0	11.5	37.5	19.7	21.8	15.6	7.4	13.8	8.9	19.7	15.0	9.4	9.0	8.9

ORIBI (*Ourebia orebi*) n=5																				
INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Ori 1B	9752	F	W	152.0	149.0	150.0	11.2	34.0	19.3	20.3	13.5	7.0	10.2	6.9	19.1	15.1	8.8	8.2	9.2
Ori 2B	9321	F	W	160.5	158.0	159.0	10.8	37.0	18.6	20.9	14.0	7.2	10.2	7.0	20.5	15.3	9.5	8.9	9.6
Ori 3B	9319	M	W	161.5	158.5	159.5	10.6	37.5	18.9	21.6	13.6	6.8	11.0	7.3	21.4	15.8	9.8	9.1	9.8
Ori 4P	2229	F	W	162.0	158.5	159.5	11.1	38.0	19.7	20.9	14.4	6.3	11.5	6.5	20.6	15.4	9.4	8.8	9.9
Ori 5P	2228	M	W	156.0	153.5	154.5	10.8	34.0	19.1	21.1	14.6	6.0	11.5	7.4	19.8	15.5	8.9	8.7	9.2
MEDIAN				160.5	158.0	159.0	10.8	37.0	19.1	20.9	14.0	6.8	11.0	7.0	20.5	15.4	9.4	8.8	9.6
MEAN				158.4	155.5	156.5	10.9	36.1	19.1	21.0	14.0	6.7	10.9	7.0	20.3	15.4	9.3	8.7	9.5
STD DEV				4.3	4.2	4.2	0.2	1.9	0.4	0.5	0.5	0.5	0.7	0.4	0.9	0.3	0.4	0.3	0.3
MIN				152.0	149.0	150.0	10.6	34.0	18.6	20.3	13.5	6.0	10.2	6.5	19.1	15.1	8.8	8.2	9.2
MAX				162.0	158.5	159.5	11.2	38.0	19.7	21.6	14.6	7.2	11.5	7.4	21.4	15.8	9.8	9.1	9.9

SPRINGBOK (*Antidorcas marsupialis*) n=20

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Spr 1B	7425	F	W	241.0	238.0	239.0	14.3	45.0	22.4	26.9	17.7	9.0	13.4	8.0	24.2	18.9	11.0	10.7	11.4
Spr 2B	7423	M	W	250.5	247.0	248.0	15.1	50.0	25.2	29.3	19.7	9.9	15.4	9.3	26.4	20.8	12.1	11.7	12.7
Spr 3B	9609	F	W	232.5	229.5	230.5	12.9	45.0	23.5	27.5	17.5	9.5	12.6	9.0	25.7	19.2	11.7	11.2	11.1
Spr 4B	7418	M	W	244.0	241.0	242.0	14.0	48.5	24.2	27.8	18.0	9.2	14.4	9.3	25.2	19.9	11.5	11.1	12.4
Spr 5B	7435	F	W	239.5	235.5	237.0	14.2	47.0	24.4	28.2	18.5	9.1	14.8	8.6	25.7	19.6	11.5	10.9	13.1
Spr 6B	7434	M	W	253.5	250.0	251.0	13.7	48.5	25.5	28.5	20.7	10.9	15.7	9.3	27.4	20.8	12.2	11.9	13.0
Spr 7B	6019	M	W	204.5	201.0	202.0	11.2	39.5	20.5	23.4	15.7	7.6	11.9	6.8	21.6	17.0	9.8	9.3	10.6
Spr 8B	7421	F	W	238.5	235.0	236.0	13.7	49.0	23.6	27.9	18.6	9.1	13.4	8.5	25.2	19.8	11.5	11.2	12.3
Spr 9B	7424	M	W	242.5	239.5	240.5	13.9	46.0	24.7	28.1	18.5	9.7	13.9	8.5	26.1	19.9	12.0	11.5	12.5
Spr 10B	7422	M	W	237.0	233.0	234.0	13.9	44.5	24.3	27.1	18.6	8.6	14.2	8.9	25.6	19.3	11.5	10.9	12.5
Spr 11B	7420	F	W	232.0	229.0	230.0	13.2	46.5	21.6	26.5	17.4	8.2	14.7	8.3	23.5	19.6	10.9	10.4	11.2
Spr 12B	7433	M	W	251.5	248.5	249.5	13.3	44.5	24.0	29.1	19.7	9.2	15.7	9.3	25.6	20.4	11.6	11.2	12.9
Spr 13B	7426	F	W	226.0	222.5	223.5	13.3	46.0	23.3	25.7	17.8	9.3	14.4	9.3	24.8	19.1	11.2	11.0	12.0
Spr 14B	7419	M	W	244.5	241.5	242.5	13.7	45.0	23.8	27.7	18.5	9.6	12.6	9.7	25.2	20.0	11.1	10.7	12.5
Spr 15B	7431	F	W	247.0	244.0	245.0	12.5	45.5	23.8	27.1	19.3	10.1	14.5	8.2	25.2	19.9	11.5	10.9	12.1
Spr 16B	7432	M	W	254.0	251.0	252.0	13.8	49.0	25.5	30.9	19.9	9.6	14.3	9.3	28.1	20.3	13.2	12.4	13.2
Spr 17B	7436	M	W	244.5	241.0	242.0	13.8	47.0	25.3	30.0	19.9	10.1	15.1	8.5	25.7	20.7	11.5	11.2	12.6
Spr 18B	9885	M	Z	207.0	204.0	204.5	11.1	40.0	20.4	23.5	16.1	8.4	19.6	7.1	21.8	16.8	9.9	9.5	10.2
Spr 19B	9324	F	Z	207.0	204.0	205.0	12.0	42.5	21.2	25.5	16.4	8.1	12.0	6.9	23.2	17.5	10.7	10.2	11.3
Spr 20B	9798	F	Z	210.5	207.0	208.0	12.7	43.0	20.8	25.2	16.1	8.3	11.9	7.5	22.4	17.7	10.1	9.6	10.8
MEDIAN				240.3	236.8	238.0	13.7	45.8	23.8	27.6	18.5	9.2	14.4	8.6	25.2	19.7	11.5	11.0	12.4
MEAN				235.4	232.1	233.1	13.3	45.6	23.4	27.3	18.2	9.2	14.2	8.5	24.9	19.4	11.3	10.9	12.0
STD DEV				16.1	16.1	16.2	1.0	2.8	1.7	1.9	1.4	0.8	1.8	0.9	1.7	1.2	0.8	0.8	0.9
MIN				204.5	201.0	202.0	11.1	39.5	20.4	23.4	15.7	7.6	11.9	6.8	21.6	16.8	9.8	9.3	10.2
MAX				254.0	251.0	252.0	15.1	50.0	25.5	30.9	20.7	10.9	19.6	9.7	28.1	20.8	13.2	12.4	13.2

MOUNTAIN REEDBUCK (*Redunca fulvorula*) n=7																			
INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Mou 1K	37186	M	W	176.0	173.0	174.0	11.9	38.0	20.4	21.6	14.7	6.7	12.8	7.5	22.1	16.6	10.2	9.6	10.1
Mou 2K	40655	F	W	192.0	189.0	190.0	13.9	44.5	20.1	23.3	16.0	7.8	13.6	9.8	24.7	17.8	11.7	10.6	12.3
Mou 3K	40644	M	W	189.0	186.0	187.0	13.8	44.5	23.4	23.5	16.2	7.9	14.4	9.0	24.1	18.3	11.5	10.5	11.3
Mou 4B	9843	M	?	189.0	185.5	186.5	14.2	42.5	21.4	23.4	15.0	8.2	12.5	8.6	23.9	17.1	11.0	10.5	11.5
Mou 5B	9350	?	?	191.5	188.5	189.5	13.9	43.0	24.0	23.4	16.2	8.0	15.0	9.0	24.7	18.5	11.1	10.3	11.6
Mou 6P	1285	M	Z	187.0	183.5	185.0	12.8	41.0	21.9	23.0	16.0	9.2	13.5	8.6	23.7	17.5	10.7	10.0	12.4
Mou 7P	2946	M	?	185.5	182.5	183.5	14.2	44.0	22.4	22.5	16.3	7.7	14.0	9.3	23.2	16.8	10.7	10.0	12.2
Mou 8P	780	F	Z	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MEDIAN				189.0	185.5	186.5	13.9	43.0	21.9	23.3	16.0	7.9	13.6	9.0	23.9	17.5	11.0	10.3	11.6
MEAN				187.1	184.0	185.1	13.5	42.5	21.9	23.0	15.8	7.9	13.7	8.8	23.8	17.5	11.0	10.2	11.6
STD DEV				5.4	5.4	5.4	0.9	2.3	1.5	0.7	0.6	0.7	0.9	0.7	0.9	0.7	0.5	0.4	0.8
MIN				176.0	173.0	174.0	11.9		20.1	21.6	14.7	6.7	12.5	7.5	22.1	16.6	10.2	9.6	10.1
MAX				192.0	189.0	190.0	14.2	44.5	24.0	23.5	16.3	9.2	15.0	9.8	24.7	18.5	11.7	10.6	12.4

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GREY RHEBUCK (*Pelea capreolus*) n=4

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
GRh 1K	39319	M	W	183.0	179.5	180.5	11.9	41.0	20.1	22.9	15.4	8.4	12.9	8.5	22.2	16.6	9.9	9.7	10.5
GRh 2K	40069	M	W	188.0	180.0	181.0	11.1	43.5	19.6	22.5	15.4	8.3	11.2	7.6	22.0	16.7	10.3	9.5	10.7
GRh 3K	40630	F	W	191.0	188.0	189.0	12.4	43.0	21.7	22.6	15.3	8.2	12.1	8.0	22.6	17.3	10.2	9.8	10.7
GRh 4K	37054	F	W	195.0	192.0	193.0	11.8	44.0	20.9	22.6	15.3	7.9	14.5	8.7	22.9	17.3	10.6	9.8	10.7
MEDIAN				189.5	184.0	185.0	11.9	43.3	20.5	22.6	15.4	8.3	12.5	8.3	22.4	17.0	10.3	9.8	10.7
MEAN				189.3	184.9	185.9	11.8	42.9	20.6	22.7	15.4	8.2	12.7	8.2	22.4	17.0	10.3	9.7	10.7
STD DEV				5.1	6.1	6.1	0.5	1.3	0.9	0.2	0.1	0.2	1.4	0.5	0.4	0.4	0.3	0.1	0.1
MIN				183.0	179.5	180.5	11.1	41.0	19.6	22.5	15.3	7.9	11.2	7.6	22.0	16.6	9.9	9.5	10.5
MAX				195.0	192.0	193.0	12.4	44.0	21.7	22.9	15.4	8.4	14.5	8.7	22.9	17.3	10.6	9.8	10.7

BUSHBUCK (*Tragelaphus scriptus*) n=4

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Bus 1K	36693	M	W	172.0	169.0	170.5	15.1	47.0	22.9	23.5	17.2	7.7	16.5	7.7	21.9	16.3	9.8	10.1	10.2
Bus 2K	36692	F	W	157.0	155.0	156.0	13.7	42.0	21.2	21.3	14.4	6.5	13.5	7.9	19.9	14.9	9.1	9.4	9.3
Bus 3B	12100	F	W	178.5	175.5	176.0	15.3	45.0	22.7	24.3	16.2	8.7	14.1	8.3	22.4	16.1	10.6	10.3	10.6
Bus 4P	2095	M	?	179.5	177.0	172.0	15.4	52.5	23.2	25.1	16.6	7.8	16.2	9.3	23.1	16.3	10.3	10.2	11.3
MEDIAN				175.3	172.3	171.3	15.2	46.0	22.8	23.9	16.4	7.8	15.2	8.1	22.2	16.2	10.1	10.2	10.4
MEAN				171.8	169.1	168.6	14.9	46.6	22.5	23.6	16.1	7.7	15.1	8.3	21.8	15.9	10.0	10.0	10.4
STD DEV				10.4	10.0	8.7	0.8	4.4	0.9	1.6	1.2	0.9	1.5	0.7	1.4	0.7	0.7	0.4	0.8
MIN				157.0	155.0	156.0	13.7	42.0	21.2	21.3	14.4	6.5	13.5	7.7	19.9	14.9	9.1	9.4	9.3
MAX				179.5	177.0	176.0	15.4	52.5	23.2	25.1	17.2	8.7	16.5	9.3	23.1	16.3	10.6	10.3	11.3

BLESBOK (*Damaliscus dorcas philipsii*) n=12

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Ble 1K	38680	?	W	224.0	220.5	221.5	15.3	52.5	27.5	30.3	22.4	10.4	19.6	11.4	31.5	20.9	14.7	14.1	16.0
Ble 2K	37055	F	W	214.0	210.5	211.5	14.1	47.0	25.6	27.6	20.4	11.1	17.1	10.3	28.2	19.1	13.0	12.3	14.8
Ble 3K	36979	M	W	225.0	221.0	222.0	15.3	50.5	27.8	29.2	21.6	11.7	17.8	9.9	30.8	20.5	14.2	12.5	15.8
Ble 4K	36680	F	Z	215.0	212.0	212.5	15.2	51.0	26.7	28.9	20.6	10.9	19.1	10.1	29.7	20.1	13.7	13.0	14.4
Ble 5K	36343	M	W	218.0	214.0	215.0	15.0	48.5	26.3	29.4	21.1	10.8	18.4	9.9	30.2	20.3	14.0	13.4	15.5
Ble 6B	12038	M	W	218.0	214.0	215.0	16.2	53.0	27.9	30.2	21.8	11.7	18.3	10.8	31.4	20.4	14.7	14.1	15.4
Ble 7B	12036	M	W	226.0	222.5	223.5	15.5	52.5	28.4	31.8	20.5	11.3	18.6	11.4	31.1	21.8	14.4	13.9	14.5
Ble 8B	12035	M	W	230.5	226.5	227.5	17.0	57.5	29.9	30.8	21.2	12.0	19.6	11.7	32.7	21.8	15.0	14.6	15.1
Ble 9B	12039	M	W	223.0	219.0	220.5	15.4	52.0	26.8	28.5	21.2	11.1	18.9	10.5	29.8	20.3	13.6	13.3	14.5
Ble 10B	12037	M	W	221.5	217.5	219.0	15.0	54.0	25.6	30.5	21.2	11.4	19.6	10.2	30.8	21.0	13.8	13.4	15.2
Ble 11B	9944	F	W	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM
Ble 12B	7446	F	W	210.5	207.0	208.0	14.8	50.5	27.3	28.9	19.5	10.3	16.3	11.5	29.0	20.3	13.7	13.3	14.1
Ble 13B	7438	M	W	221.0	217.5	218.5	15.1	54.5	27.3	29.6	21.0	12.4	19.2	11.8	30.4	20.7	14.1	13.5	14.8
MEDIAN				221.3	217.5	218.8	15.3	52.3	27.3	29.5	21.2	11.2	18.8	10.7	30.6	20.5	14.1	13.4	15.0
MEAN				220.5	216.8	217.9	15.3	52.0	27.3	29.6	21.0	11.3	18.5	10.8	30.5	20.6	14.1	13.5	15.0
STD DEV				5.7	5.5	5.6	0.7	2.8	1.2	1.1	0.7	0.6	1.0	0.7	1.2	0.7	0.6	0.7	0.6
MIN				210.5	207.0	208.0	14.1	47.0	25.6	27.6	19.5	10.3	16.3	9.9	28.2	19.1	13.0	12.3	14.1
MAX				230.5	226.5	3222.0	17.0	57.5	29.9	31.8	22.4	12.4	19.6	11.8	32.7	21.8	15.0	14.6	16.0

BONTEBOK (*Damaliscus dorcas dorcas*) n=29

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Bon 1K	35116	M	Z	231.5	228.0	228.5	15.6	54.5	26.8	31.9	21.3	11.9	19.9	11.7	32.0	21.4	14.7	14.3	14.8
Bon 2K	35056	M	W	229.5	225.5	227.0	15.9	55.5	28.6	31.4	20.9	12.0	18.8	12.4	32.3	22.0	14.9	14.3	15.2
Bon 3K	65052	F	W	219.5	215.5	217.0	14.8	54.0	27.7	30.6	21.0	11.9	18.3	11.4	31.1	20.8	14.3	13.9	14.8
Bon 4K	35048	F	W	224.0	220.0	221.5	15.0	54.0	27.0	29.6	21.3	11.6	17.3	11.6	30.9	20.7	14.2	13.8	15.0
Bon 5K	35047	F	W	227.0	223.5	224.5	15.1	53.5	28.5	31.1	21.7	11.0	17.3	11.6	32.7	22.3	14.8	14.5	15.6
Bon 6K	36017	F	W	216.5	213.5	214.0	14.2	52.0	25.9	28.9	19.6	11.4	17.5	11.1	29.5	20.7	13.7	13.0	13.8
Bon 7K	36053	?	W	217.0	213.5	214.5	14.5	52.5	27.9	29.6	21.1	11.8	17.9	10.8	30.4	20.4	13.9	13.4	15.0
Bon 8K	35928	M	W	219.5	216.0	217.0	14.6	54.0	26.5	29.5	21.6	11.5	16.3	10.9	30.6	20.7	14.3	13.8	14.4
Bon 9K	35927	M	W	227.0	223.5	224.5	15.1	52.0	28.5	30.8	21.4	11.5	16.2	11.9	31.1	21.9	14.4	13.9	15.2
Bon 10K	36151	F	W	226.5	223.0	224.0	15.3	52.0	28.3	30.9	22.0	11.3	17.9	11.2	31.4	21.9	14.1	14.1	14.9
Bon 11K	36054	F	W	218.0	215.0	215.5	14.0	51.0	27.0	29.2	21.4	11.9	16.6	11.8	30.7	20.8	14.2	13.8	14.5
Bon 12K	36202	?	W	231.5	228.0	229.0	15.4	55.5	27.6	31.1	21.5	12.6	18.2	12.0	31.9	22.4	14.7	13.8	14.9
Bon 13K	36279	F	W	212.5	209.0	210.0	14.1	54.0	26.2	28.7	20.5	10.8	18.3	10.7	29.5	19.8	13.4	13.1	13.3
Bon 14K	36295	M	W	231.5	228.0	229.0	15.7	52.5	27.7	30.8	21.7	11.1	17.0	12.9	30.5	21.4	14.0	13.4	14.3
Bon 15K	36834	F	Z	217.0	214.5	215.0	15.3	52.5	28.1	30.3	20.3	11.0	18.0	9.9	30.9	21.3	14.7	13.7	15.0
Bon 16K	36659	M	W	230.0	227.0	228.0	15.0	55.0	26.7	30.2	21.6	12.0	18.3	11.9	31.0	20.8	14.1	13.8	14.1
Bon 17K	36288	M	W	219.0	215.0	216.0	14.3	52.0	26.8	30.0	21.9	11.9	17.9	10.4	30.6	21.3	14.0	13.2	14.9
Bon 18K	36281	M	W	216.5	213.5	214.5	14.4	52.0	26.7	28.7	21.2	11.9	17.2	11.1	30.2	20.8	14.0	13.3	14.1
Bon 19K	36985	M	W	222.0	218.5	219.5	13.3	50.0	26.4	28.3	20.3	10.8	18.5	11.8	29.5	20.8	14.1	13.3	13.1
Bon 20K	38726	M	W	239.0	235.5	236.5	14.9	55.0	28.5	31.9	22.0	11.8	19.2	11.2	31.9	22.9	14.5	14.0	15.3
Bon 21K	38740	F	W	222.0	218.0	219.5	14.8	53.5	28.6	30.2	20.4	13.1	18.2	10.8	30.9	21.0	14.2	13.7	13.9
Bon 22K	38735	F	W	225.5	223.0	224.0	15.8	57.0	27.2	30.5	22.3	13.1	17.2	12.0	31.5	21.3	14.5	14.0	14.6
Bon 23K	14090	F	W	222.5	218.5	220.0	15.6	53.5	26.8	29.3	19.3	11.5	17.6	10.8	30.1	20.2	13.8	13.3	14.1
Bon 24K	40398	M	W	230.0	227.0	228.0	15.2	53.5	28.7	31.0	21.9	12.0	18.2	11.7	32.0	20.5	14.9	14.3	15.1
Bon 25K	40407	F	W	218.0	215.0	216.0	15.1	53.0	26.6	29.3	20.9	12.3	17.0	10.7	30.1	20.7	14.1	13.5	13.8
Bon 26K	39793	M	W	231.5	228.0	229.0	16.3	56.0	28.4	31.6	21.4	12.4	17.8	11.2	31.4	21.7	14.6	14.1	14.8
Bon 27K	41140	M	W	230.5	227.0	228.0	16.3	53.5	29.6	32.1	22.1	13.7	18.9	11.2	32.4	22.4	14.8	14.6	14.8
Bon 28K	40746	M	W	232.0	228.5	229.5	15.5	55.0	29.2	31.3	21.8	12.4	18.5	12.0	32.5	21.8	14.9	14.5	14.9
Bon 29K	40835	M	W	221.5	218.0	219.0	15.2	54.5	27.4	30.9	21.8	12.4	18.7	11.9	31.5	21.8	14.5	13.9	14.7
MEDIAN				224.0	220.0	221.5	15.1	53.5	27.6	30.5	21.4	11.9	17.9	11.4	31.0	21.3	14.3	13.8	14.8
MEAN				224.4	221.0	222.0	15.0	53.6	27.6	30.3	21.2	11.9	17.9	11.4	31.1	21.3	14.3	13.8	14.6
STD DEV				6.5	6.4	6.5	0.7	1.6	1.0	1.1	0.7	0.7	0.9	0.6	0.9	0.7	0.4	0.4	0.6
MIN				212.5	209.0	210.0	13.3	50.0	25.9	28.3	19.3	10.8	16.2	9.9	29.5	19.8	13.4	13.0	13.1
MAX				239.0	235.5	236.5	16.3	57.0	29.6	32.1	22.3	13.7	19.9	12.9	32.7	22.9	14.9	14.6	15.6

IMPALA (*Aepyceros melampus*) n=17

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Imp 1P	1198	F	Z	231.5	229.0	229.5	15.2	52.0	26.7	30.8	19.6	9.8	16.7	10.0	27.9	22.2	13.0	12.4	13.1
Imp 2P	1273	F	Z	240.0	238.0	238.5	14.2	52.0	25.7	28.4	19.3	9.4	17.8	9.0	25.8	20.1	12.1	11.6	11.8
Imp 3P	646	M	Z	238.0	235.0	235.5	16.7	58.5	28.4	31.7	21.1	9.5	17.0	10.0	29.8	22.8	13.7	13.1	14.1
Imp 4P	1590	F	Z	245.5	242.0	243.0	14.3	50.5	25.2	29.7	18.5	8.2	18.3	8.8	26.2	21.5	12.1	11.8	11.9
Imp 5P	688	F	Z	233.0	230.5	231.0	13.1	48.5	24.9	27.9	19.2	7.8	15.1	8.8	25.7	21.8	11.6	11.4	10.9
Imp 6P	525	F	Z	237.0	234.0	234.5	13.8	48.5	23.1	27.0	17.3	7.9	16.4	8.2	25.0	19.5	11.4	11.0	11.8
Imp 7P	2218	M	W	248.0	245.0	246.0	16.2	57.0	27.9	30.7	21.3	10.0	19.2	9.8	29.4	23.2	13.5	12.9	14.0
Imp 8P	1450	M	Z	248.0	246.0	246.5	16.5	57.0	26.8	30.8	20.4	8.7	16.8	9.5	28.0	22.4	12.9	12.6	12.9
Imp 9P	643	F	Z	241.0	238.0	238.5	14.4	51.0	24.3	29.6	18.7	7.9	16.7	8.8	25.1	20.9	11.8	11.0	12.0
Imp 10P	2296	F	Z	238.0	235.0	235.5	15.5	53.0	25.3	28.5	19.0	9.0	17.3	8.6	27.2	21.9	12.4	12.1	13.3
Imp 11P	816	M	W	237.0	236.0	236.5	14.2	55.0	24.4	28.0	19.4	8.9	16.6	8.8	25.5	20.3	11.7	11.3	11.9
Imp 12P	1055	M	Z	251.0	248.5	249.0	16.0	57.0	29.2	30.7	20.6	10.1	18.6	8.8	29.1	22.9	13.6	12.5	13.9
Imp 13P	2419	F	Z	240.0	237.5	238.0	14.8	52.0	26.8	30.7	20.6	9.4	17.7	9.0	27.5	22.0	13.1	12.3	13.1
Imp 14P	532	F	Z	234.0	231.0	232.0	15.4	53.0	26.4	29.9	19.1	8.9	18.7	10.0	27.1	22.7	NAM	12.4	13.7
Imp 15P	2469	M	Z	246.0	244.0	244.5	15.7	57.0	30.1	30.6	20.1	9.4	17.8	9.5	29.7	22.7	13.8	13.1	14.1
Imp 16P	2376	F	Z	239.5	237.0	237.5	15.2	53.0	27.3	30.1	19.1	9.4	17.9	10.2	27.9	22.5	13.0	12.3	12.6
Imp 17P	751	F	Z	245.0	242.0	242.5	15.8	58.5	27.3	30.2	20.2	9.3	17.3	10.3	28.3	23.0	13.1	12.4	13.6
MEDIAN				240.0	237.5	238.0	15.2	53.0	26.7	30.1	19.4	9.3	17.3	9.0	27.5	22.2	13.0	12.3	13.1
MEAN				240.7	238.1	238.7	15.1	53.7	26.5	29.7	19.6	9.0	17.4	9.3	27.4	21.9	12.7	12.1	12.9
STD DEV				5.7	5.7	5.7	1.0	3.3	1.8	1.3	1.0	0.7	1.0	0.6	1.6	1.1	0.8	0.7	1.0
MIN				231.5	229.0	229.5	13.1	48.5	23.1	27.0	17.3	7.8	15.1	8.2	25.0	19.5	11.4	11.0	10.9
MAX				251.0	248.5	249.0	16.7	58.5	30.1	31.7	21.3	10.1	19.2	10.3	29.8	23.2	13.8	13.1	14.1

REEDBUCK (*Redunca arundinum*) n=5																			
INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Ree 1K	40529	?	W	239.0	235.5	235.0	16.7	56.0	27.1	30.3	21.7	11.0	19.6	10.7	28.7	20.8	13.3	12.6	14.5
Ree 2K	38808	M	W	245.0	241.0	242.0	16.0	54.0	28.6	29.3	19.9	11.0	17.3	12.3	28.6	21.4	13.3	12.4	14.3
Ree 3B	8706	M	W	236.0	231.0	233.0	16.5	59.0	30.2	32.7	22.7	13.0	21.5	12.5	32.4	23.1	15.0	14.5	15.0
Ree 4P	1068	M	Z	228.0	224.5	226.0	14.7	51.0	25.9	31.1	19.0	9.9	17.7	11.8	28.3	21.9	13.3	13.3	13.9
Ree 5P	105	F	?	229.5	225.5	227.0	15.4	55.0	27.0	28.4	21.3	11.0	18.6	12.9	28.1	21.1	13.3	12.8	12.9
Ree 6P	110	M	?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MEDIAN				236.0	231.0	233.0	16.0	55.0	27.1	30.3	21.3	11.0	18.6	12.3	28.6	21.4	13.3	12.8	14.3
MEAN				235.5	231.5	232.6	15.9	55.0	27.8	30.4	20.9	11.2	18.9	12.0	29.2	21.7	13.6	13.1	14.1
STD DEV				7.0	6.9	6.5	0.8	2.9	1.7	1.7	1.5	1.1	1.7	0.8	1.8	0.9	0.8	0.8	0.8
MIN				228.0	224.5	226.0	14.7	51.0	25.9	28.4	19.0	9.9	17.3	10.7	28.1	20.8	13.3	12.4	12.9
MAX				245.0	241.0	242.0	16.7	59.0	30.2	32.7	22.7	13.0	21.5	12.9	32.4	23.1	15.0	14.5	15.0

RED LECHWE (*Kobus leche*) n=5

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Lec 1B	8714	F	Z	226.0	221.5	223.0	17.8	61.0	29.3	29.5	20.9	12.0	18.9	11.3	32.0	22.8	19.6	19.2	15.8
Lec 2P	539	F	Z	232.0	222.0	229.0	17.8	62.0	30.1	30.4	22.9	9.7	19.4	13.5	37.0	22.8	17.3	16.2	17.9
Lec 3P	2945	F	?	225.0	223.0	224.0	19.8	70.5	30.9	31.9	24.2	10.7	21.1	12.9	37.0	24.2	16.5	17.3	18.1
Lec 4P	498	F	Z	228.0	225.0	224.5	16.5	62.0	14.5	29.8	21.5	11.2	18.8	12.1	34.2	22.0	15.8	15.1	15.8
Lec 5P	593	M	Z	238.0	233.0	234.5	18.2	68.5	30.1	31.8	23.4	11.4	20.7	11.4	36.7	24.0	17.1	16.3	17.2
MEDIAN				228.0	222.0	224.5	17.8	62.0	30.1	30.4	22.9	11.2	19.4	12.1	36.7	22.8	17.1	16.3	17.2
MEAN				229.8	227.0	227.0	18.0	64.8	27.0	30.7	22.6	11.0	19.8	12.2	35.4	23.2	17.3	16.8	17.0
STD DEV				5.3	4.8	4.8	1.2	4.4	7.0	1.1	1.4	0.9	1.1	1.0	2.2	0.9	1.4	1.5	1.1
MIN				225.0	22.5	223.0	16.5	61.0	14.5	29.5	20.9	9.7	18.8	11.3	32.0	22.0	15.8	15.1	15.8
MAX				238.0	233.0	234.5	19.8	70.5	30.9	31.9	24.2	12.0	21.1	13.5	37.0	24.2	19.6	19.2	18.1

NYALA (*Tragelaphus angasii*) n=6

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Nya 1K	36902	M	?	240.0	237.0	238.0	19.1	65.5	31.8	32.5	24.3	11.7	22.0	9.5	29.4	22.5	12.5	13.4	13.6
Nya 2K	38811	F	?	225.0	223.0	224.0	17.3	57.5	29.3	31.5	20.5	11.2	18.5	10.3	26.8	21.1	12.4	12.0	12.3
Nya 3K	36903	F	?	226.0	223.0	224.0	15.8	53.5	27.4	29.7	20.3	10.0	18.9	10.6	26.3	20.1	12.1	12.1	12.0
Nya 4P	2974	F	?	224.5	222.0	223.0	16.7	57.0	26.5	30.4	19.8	10.3	18.4	10.2	26.2	21.3	11.9	11.9	12.4
Nya 5P	107	M	W	249.0	247.0	248.0	18.6	67.0	30.8	34.7	21.6	10.6	21.9	10.7	29.5	23.4	13.6	13.6	13.6
Nya 6P	106	F	W	215.5	212.2	213.5	16.1	53.5	26.7	29.7	20.5	10.1	20.1	9.8	25.0	20.8	11.7	11.4	11.8
MEDIAN				225.5	223.0	224.0	17.0	57.3	28.4	31.0	20.5	10.5	19.5	10.3	26.6	21.2	12.3	12.1	12.4
MEAN				230.0	227.4	228.4	17.3	59.0	28.8	31.4	21.2	10.7	20.0	10.2	27.2	21.5	12.4	12.4	12.6
STD DEV				12.2	12.5	12.4	1.3	5.9	2.2	1.9	1.6	0.7	1.7	0.5	1.8	1.2	0.7	0.9	0.8
MIN				215.5	212.2	213.5	15.8	53.5	26.5	29.7	19.8	10.0	18.4	9.5	25.0	20.1	11.7	11.4	11.8
MAX				249.0	247.0	248.0	19.1	67.0	31.8	34.7	24.3	11.7	22.0	10.7	29.5	23.4	13.6	13.6	13.6

SITATUNGA (*Tragelaphus spekei*) n=2																			
INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Sit 1P	2958	?	W	243.5	240.5	242.0	20.3	67.0	31.7	32.3	22.6	11.7	21.1	10.9	34.1	22.7	15.0	14.7	15.0
Sit 2P	405	M	W	257.0	253.5	255.0	20.6	66.5	32.7	33.2	23.6	11.5	20.4	10.6	34.4	23.4	15.4	16.1	15.5
MEDIAN				250.3	247.0	248.5	20.5	66.8	32.2	32.8	23.1	11.6	20.8	10.8	34.3	23.1	15.2	15.4	15.3
MEAN				250.3	247.0	248.5	20.2	66.8	32.2	32.8	23.1	11.6	20.8	10.8	34.3	23.1	15.2	15.4	15.3
STD DEV				9.5	9.2	9.2	0.2	0.4	0.7	0.6	0.7	0.1	0.5	0.2	0.2	0.5	0.3	1.0	0.4
MIN				243.5	240.5	242.0	20.3	66.5	31.7	32.3	22.6	11.5	20.4	10.6	34.1	22.7	15.0	14.7	15.0
MAX				257.0	253.5	255.0	20.6	67.0	32.7	33.2	23.6	11.7	21.1	10.9	34.4	23.4	15.4	16.1	15.5

TSESSEBE (*Damaliscus lunatus*) n=1

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Tse 1B	9922	?	?	269.0	263.0	266.0	19.6	67.5	35.4	38.4	25.5	13.9	23.1	11.9	40.4	27.4	17.9	17.2	20.1
MEDIAN				269.0	263.0	266.0	19.6	67.5	35.4	38.4	25.5	13.9	23.1	11.9	40.4	27.4	17.9	17.2	20.1
MEAN				269.0	263.0	266.0	19.6	67.5	35.4	38.4	25.5	13.9	23.1	11.9	40.4	27.4	17.9	17.2	20.1
STD DEV				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MIN				269.0	263.0	266.0	19.6	67.5	35.4	38.4	25.5	13.9	23.1	11.9	40.4	27.4	17.9	17.2	20.1
MAX				269.0	263.0	266.0	19.6	67.5	35.4	38.4	25.5	13.9	23.1	11.9	40.4	27.4	17.9	17.2	20.1

RED HARTBEEST (*Alcelaphus buselaphus*) n=9

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
RHa 1K	39820	F	W	254.0	250.0	251.0	19.7	65.5	33.8	35.8	25.2	13.0	24.0	12.2	38.8	25.4	18.3	17.1	19.1
RHa 2K	40837	M	W	265.5	260.0	262.0	18.9	69.0	32.6	36.9	24.6	13.4	23.3	14.1	38.2	25.7	17.8	16.6	19.3
RHa 3B	9930	?	?	255.0	250.0	252.0	19.4	69.0	35.2	37.2	25.4	13.3	23.9	14.4	41.3	26.6	18.9	18.2	20.8
RHa 4B	7437	F	W	253.5	248.5	251.0	18.9	64.0	34.3	36.1	26.5	13.1	22.6	13.6	39.0	26.8	17.8	17.3	19.5
RHa 5B	9763	M	Z	265.0	260.0	261.5	19.3	72.0	36.3	38.6	29.2	14.5	24.1	12.0	41.7	27.6	19.2	18.3	19.6
RHa 6B	9417	M	W	273.0	269.0	270.0	23.1	76.0	37.0	39.3	27.0	15.9	25.5	16.2	43.3	28.5	19.8	19.2	21.0
RHa 7B	12032	F	W	265.5	260.0	262.0	20.0	74.5	34.8	35.9	26.1	14.6	24.5	15.0	41.3	26.5	18.7	18.6	20.5
RHa 8B	9773	F	W	253.5	249.0	251.0	20.4	71.5	33.2	35.7	25.1	12.6	23.7	12.6	39.7	25.6	18.0	17.4	19.5
RHa 9B	8715	F	Z	267.0	261.0	263.0	20.0	66.0	33.0	36.2	25.6	12.3	23.0	12.4	39.4	27.0	18.2	17.8	19.1
MEDIAN				265.0	260.0	261.5	19.7	69.0	34.3	36.2	25.6	13.3	23.9	13.6	39.7	26.6	18.3	17.8	19.5
MEAN				261.3	256.4	258.2	20.0	69.7	34.5	36.9	26.1	13.6	23.8	13.6	40.3	26.6	18.5	17.8	19.8
STD DEV				7.4	7.2	7.0	1.3	4.1	1.5	1.3	1.4	1.1	0.9	1.4	1.7	1.0	0.7	0.8	0.7
MIN				253.5	248.5	251.0	18.9	64.0	32.6	35.7	24.6	12.3	22.6	12.0	38.2	25.4	17.8	16.6	19.1
MAX				273.0	269.0	270.0	23.1	76.0	37.0	39.3	29.2	15.9	25.5	16.2	43.3	28.5	19.8	19.2	21.0

KUDU (*Tragelaphus strepsiceros*) n=7

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Kud 1K	38768	M	?	312.0	308.0	309.0	29.6	90.5	44.4	47.5	31.1	16.6	27.5	18.4	43.4	23.2	19.9	19.7	19.8
Kud 2B	9923	?	?	342.5	338.0	339.0	28.0	95.0	44.1	48.7	31.6	19.1	28.1	17.5	42.4	33.4	19.7	19.1	19.3
Kud 3B	9924	?	?	319.0	315.0	316.0	26.9	89.0	43.1	45.4	32.1	17.1	28.5	18.2	41.1	31.8	18.9	18.7	18.5
Kud 4B	9933	?	W	331.5	327.5	328.5	28.0	92.0	44.4	47.7	32.5	16.6	29.3	20.5	43.1	33.1	20.0	19.7	18.9
Kud 5B	8713	?	W	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM	NAM
Kud 6P	1592	F	W	254.5	248.0	250.0	21.5	71.0	36.9	35.6	24.5	12.5	22.6	11.6	37.1	27.1	16.9	16.7	16.9
Kud 7P	1260	F	Z	299.0	295.0	296.0	23.9	80.0	40.1	43.2	31.5	15.4	26.2	14.6	38.0	30.2	17.8	17.2	18.1
Kud 8P	1261	F	Z	298.0	294.5	295.0	23.9	81.5	40.0	41.8	30.4	15.5	26.1	13.8	39.2	31.4	18.8	17.8	19.1
MEDIAN				312.0	308.0	309.0	26.9	89.0	43.1	45.4	31.5	16.6	27.5	17.5	41.1	31.4	18.9	18.7	18.9
MEAN				308.1	303.7	304.8	26.0	85.6	41.9	44.3	30.5	16.1	26.9	16.4	40.6	30.0	18.9	18.4	18.7
STD DEV				28.6	29.3	29.0	2.9	8.4	2.9	4.6	2.7	2.0	2.2	3.1	2.5	3.7	1.2	1.2	0.9
MIN				254.5	248.0	250.0	21.5	71.0	36.9	35.6	24.5	12.5	22.6	11.6	37.1	23.2	16.9	16.7	16.9
MAX				342.5	338.0	339.0	29.6	95.0	44.4	48.7	32.5	19.1	29.3	20.5	43.4	33.4	20.0	19.7	19.8

BLACK WILDEBEEST (*Connochaetes gnou*) n=20

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Bla 1K	38783	F	Z	211.0	206.5	207.0	18.9	65.0	34.5	35.6	24.7	13.9	23.0	13.6	39.1	24.5	18.0	16.9	19.1
Bla 2K	36239	F	W	232.0	228.0	229.0	19.2	65.5	35.4	36.6	26.1	13.3	22.4	12.7	38.4	26.0	18.0	16.6	18.5
Bla 3K	39318	F	W	224.0	219.5	221.0	19.7	68.5	36.0	35.0	25.5	13.1	23.2	13.4	38.7	24.4	17.9	17.2	19.2
Bla 4K	39233	F	Z	207.0	203.0	204.0	19.1	69.5	35.9	38.1	27.0	12.8	23.2	12.7	39.0	25.6	18.6	16.7	19.3
Bla 5K	39121	F	Z	213.5	209.0	210.0	19.4	66.0	35.9	37.9	25.7	13.9	22.5	11.0	39.4	24.5	18.3	17.0	19.8
Bla 6K	36675	M	Z	211.5	207.5	208.5	20.4	71.0	38.2	38.7	27.7	14.7	23.9	12.0	41.3	26.6	19.3	18.1	19.9
Bla 7K	36660	M	W	225.5	221.0	222.0	20.3	68.5	37.1	35.6	28.3	15.1	26.2	14.7	38.7	24.9	17.8	17.1	19.1
Bla 8K	37090	F	?	212.0	207.0	208.0	19.6	69.0	35.2	36.2	27.0	15.1	24.6	12.9	40.5	25.8	18.8	17.1	19.8
Bla 9K	36710	F	Z	205.0	201.0	202.0	20.4	68.0	35.5	36.8	25.4	14.4	22.7	12.7	39.8	25.1	19.0	17.4	19.8
Bla 10K	38249	F	Z	202.5	198.0	199.0	17.2	64.5	34.3	36.2	25.2	13.2	22.9	12.3	37.4	23.8	17.7	16.2	18.5
Bla 11B	8708	M	W	237.5	231.5	233.0	19.9	74.0	39.1	40.5	28.1	16.1	25.6	12.9	42.1	28.1	19.9	18.6	20.7
Bla 12B	8742	M	W	228.0	223.0	225.0	21.6	76.0	38.9	40.3	27.9	14.9	25.3	16.0	41.8	27.2	19.1	18.3	20.9
Bla 13B	9358	M	W	240.5	236.0	236.5	20.7	74.5	33.2	36.0	21.5	9.1	19.4	9.5	37.6	23.2	14.6	14.2	16.0
Bla 14B	6079	?	?	227.5	222.0	224.5	19.3	66.0	34.7	36.9	27.6	13.8	23.9	13.0	39.8	24.5	18.3	17.6	18.9
Bla 15B	8714	F	W	219.0	216.0	217.0	18.3	65.5	33.7	35.9	25.2	12.3	22.4	13.7	37.8	24.2	17.7	16.5	18.1
Bla 16B	9779	M	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bla 17B	8736	M	W	221.0	216.0	217.5	18.9	68.0	36.3	38.5	25.2	13.4	23.2	12.1	40.4	26.3	18.7	18.0	20.0
Bla 18B	7447	F	W	222.0	218.0	219.0	19.2	71.5	37.3	39.6	27.0	13.4	24.4	14.6	40.3	26.0	18.4	18.1	19.2
Bla 19B	12054	M	W	227.5	222.5	223.5	21.1	74.0	37.5	38.9	26.2	14.1	24.2	14.9	41.7	26.8	18.8	18.9	20.3
Bla 20B	12053	M	W	221.0	215.5	217.0	17.5	65.0	34.3	37.0	24.9	14.2	22.8	13.1	40.3	25.2	18.2	17.3	20.7
Bla 21B	12052	M	W	227.0	221.5	223.0	19.3	68.0	35.7	37.2	23.6	12.7	23.6	13.2	39.7	27.1	18.4	17.8	19.2
MEDIAN				221.5	217.0	218.3	19.4	68.3	35.8	37.0	25.9	13.9	23.2	13.0	39.8	25.4	18.4	17.3	19.3
MEAN				220.8	216.1	217.3	19.5	68.9	35.9	37.4	26.0	13.7	23.5	13.1	39.7	25.5	18.3	17.3	19.4
STD DEV				10.5	10.2	10.4	1.1	3.5	1.7	1.6	1.7	1.4	1.5	1.4	1.4	1.3	1.0	1.0	1.1
MIN				202.5	198.0	199.0	17.2	64.5	33.2	35.0	21.5	9.1	19.4	9.5	37.4	23.2	14.6	14.2	16.0
MAX				240.5	236.0	236.5	21.6	76.0	39.1	40.5	28.3	16.1	26.2	16.0	42.1	28.1	19.9	18.9	20.9

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WATERBUCK (*Kobus ellipsiprymnus*) n=7

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Wat 1B	9952	?	?	241.5	235.0	237.5	24.2	87.5	43.8	44.7	35.7	16.7	23.4	17.9	46.6	30.8	22.3	21.0	22.1
Wat 2B	6017	F	W	245.5	239.0	241.0	25.3	88.5	42.5	43.1	34.8	15.6	26.8	17.5	47.7	30.5	23.0	21.3	22.1
Wat 3B	12014	M	?	239.0	232.0	235.0	25.3	89.0	41.7	42.2	31.3	15.1	24.4	16.8	47.9	30.7	22.7	21.2	23.1
Wat 4B	9960	?	?	242.5	235.0	237.0	25.4	91.5	44.1	44.3	35.8	17.9	26.6	17.1	50.5	31.9	25.2	22.5	22.4
Wat 5P	1853	F	Z	231.0	225.0	227.0	26.1	90.5	40.8	39.2	30.6	15.8	21.3	14.9	47.9	29.6	22.2	20.9	22.5
Wat 6P	1873	F	Z	231.0	227.5	228.5	25.6	88.5	40.0	39.3	28.8	15.2	21.9	12.7	45.2	29.0	21.2	20.5	20.5
Wat 7P	1160	F	Z	243.0	237.5	238.5	28.3	92.0	41.8	43.8	33.0	16.1	25.0	15.0	47.1	30.2	21.7	21.0	22.5
MEDIAN				241.5	235.0	237.0	25.4	89.0	41.8	43.1	33.0	15.8	24.4	16.8	47.7	30.5	22.3	21.0	22.4
MEAN				239.1	233.0	234.9	25.7	89.6	42.1	42.4	32.9	16.1	24.2	16.0	47.6	30.4	22.6	21.2	22.2
STD DEV				5.8	5.2	5.2	1.3	1.7	1.5	2.3	2.7	1.0	2.1	1.9	1.6	0.9	1.3	0.6	0.8
MIN				231.0	225.0	227.0	24.2	87.5	40.0	39.2	28.8	15.1	21.3	12.7	45.2	29.0	21.2	20.5	20.5
MAX				245.5	239.0	241.0	28.3	92.0	44.1	44.7	35.8	17.9	26.8	17.9	50.5	31.9	25.2	22.5	23.1

GEMSBUCK (*Oryx gazelle*) n=6																			
INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Gem 1K	33520	?	?	240.0	235.0	236.0	23.6	79.0	40.8	37.5	25.0	17.3	25.8	16.1	44.9	26.0	20.6	20.1	21.4
Gem 2K	33517	?	?	265.5	260.5	262.0	21.3	72.0	36.9	37.3	26.7	14.8	24.2	14.9	41.4	26.6	19.3	18.3	20.5
Gem 3B	9376	F	W	234.0	228.0	230.0	22.3	75.0	39.3	36.4	27.6	15.3	24.3	13.8	43.1	27.7	19.4	18.9	21.0
Gem 4B	9304	F	W	251.0	243.5	247.0	24.0	88.0	43.9	41.4	31.7	18.2	27.3	15.3	47.6	31.0	21.6	21.0	23.3
Gem 5P	475	F	Z	245.0	240.0	242.0	24.4	83.5	42.3	38.8	29.2	16.6	25.1	17.4	47.5	29.1	22.2	21.8	22.6
Gem 6P	1576	?	?	237.0	232.5	234.0	23.4	79.0	41.0	40.5	28.1	14.2	26.4	13.8	44.3	28.7	20.1	19.7	21.5
MEDIAN				242.5	237.5	239.0	23.5	79.0	40.9	38.2	27.9	16.0	25.5	15.1	44.6	28.2	20.4	19.9	21.5
MEAN				245.4	139.9	241.8	23.2	79.4	40.7	38.7	28.1	16.1	25.5	15.2	44.8	28.2	20.5	20.0	21.7
STD DEV				11.5	11.5	11.6	1.2	5.7	2.4	2.0	2.3	1.6	1.2	1.4	2.4	1.8	1.2	1.3	1.0
MIN				234.0	228.0	230.0	21.3	72.0	36.9	36.4	25.0	14.2	24.2	13.8	41.4	26.0	19.3	18.3	20.5
MAX				265.5	260.5	262.0	24.4	88.0	43.9	41.4	31.7	18.2	27.3	17.4	47.6	31.0	22.2	21.8	23.3

SABLE (*Hippotragus niger*) n=6

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Sab 1K	39526	M	?	239.5	232.5	234.0	24.2	78.0	38.5	38.7	28.6	16.8	25.4	14.8	42.9	27.0	20.0	18.9	21.0
Sab 2B	6080	?	?	245.5	239.0	241.0	23.4	81.0	38.3	38.5	27.5	15.6	25.3	16.2	43.8	28.7	20.3	19.9	21.0
Sab 3B	9920	?	?	237.5	230.5	233.5	22.7	80.5	39.9	38.9	27.8	15.8	25.2	14.7	46.3	28.0	21.2	20.5	22.1
Sab 4P	1856	F	Z	235.5	230.5	232.5	24.6	81.0	37.3	36.1	27.8	15.1	24.2	16.3	45.5	28.7	20.7	20.2	21.0
Sab 5P	1265	M	Z	238.0	233.0	235.5	24.1	84.0	37.1	39.6	27.6	15.2	25.5	13.0	45.6	29.1	20.6	19.9	21.5
Sab 6P	472	M	W	245.0	238.5	241.0	23.9	83.0	38.3	41.7	29.1	16.2	28.2	17.7	47.8	29.0	22.2	21.8	21.9
MEDIAN				238.8	232.8	234.8	24.0	81.0	38.3	38.8	27.8	15.7	25.4	15.5	45.6	28.7	20.7	20.1	21.3
MEAN				240.2	234.0	236.3	23.8	81.3	38.2	38.9	28.1	15.8	25.6	15.5	45.3	28.4	20.8	20.2	21.4
STD DEV				4.1	3.8	3.8	0.7	2.1	1.0	1.8	0.6	0.6	1.3	1.6	1.8	0.8	0.8	1.0	0.5
MIN				235.5	230.5	232.5	22.7	78.0	37.1	36.1	27.5	15.1	24.2	13.0	42.9	27.0	20.0	18.9	21.0
MAX				245.5	239.0	241.0	24.6	84.0	39.9	41.7	29.1	16.8	28.2	17.7	47.8	29.1	22.2	21.8	22.1

BLUE WILDEBEEST (*Connochaetes taurinus*) n=4

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
BWi 1K	36064			249.0	243.0	245.5	21.3	78.5	39.8	40.3	27.7	15.6	26.0	15.0	44.5	28.1	20.5	19.9	21.9
BWi 2K	33518			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BWi 3B	3737			269.0	263.0	265.0	18.6	89.0	49.6	44.3	30.2	16.4	26.8	15.9	47.6	29.7	21.7	21.2	22.4
BWi 4P	1272			253.0	248.0	250.0	24.7	88.0	39.4	42.3	30.6	18.4	25.3	15.1	47.1	29.1	22.2	21.5	22.7
BWi 5P	563			244.0	239.0	241.0	24.8	84.0	41.0	43.5	30.3	17.7	26.2	14.6	46.3	29.2	21.6	20.6	22.2
MEDIAN				251.0	245.5	247.8	23.0	86.0	40.4	42.9	30.3	17.1	26.1	15.1	46.7	29.2	21.7	20.9	22.3
MEAN				253.8	248.3	250.4	22.4	84.9	42.5	42.6	29.7	17.0	26.1	15.2	46.4	29.0	21.5	20.8	22.3
STD DEV				10.8	10.5	10.4	3.0	4.8	4.8	1.7	1.3	1.3	0.6	0.5	1.4	0.7	0.7	0.7	0.3
MIN				244.0	239.0	241.0	18.6	78.5	39.4	40.3	27.7	15.6	25.3	14.6	44.5	28.1	20.5	19.9	21.9
MAX				269.0	263.0	265.0	24.8	89.0	49.6	44.3	30.6	18.4	26.8	15.9	47.6	29.7	22.2	21.5	22.7

ROAN (*Hippotragus equinus*) n=3																			
INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Roa 1B	9919	?	?	250.0	243.0	245.5	25.8	84.5	39.2	39.6	28.8	17.7	27.6	16.3	48.7	29.8	22.1	21.5	22.9
Roa 2P	2923	?	?	303.0	296.0	299.0	27.8	93.0	44.9	45.1	34.8	19.5	28.9	13.9	52.4	33.3	24.5	23.6	24.7
Roa 3P	1591	?	W	248.0	242.0	244.0	24.9	81.0	39.3	37.4	27.8	15.4	23.9	12.9	45.5	28.5	21.1	20.5	21.4
MEDIAN				250.0	243.0	245.5	25.8	84.5	39.3	39.6	28.8	17.7	27.6	13.9	48.7	29.8	22.1	21.5	22.9
MEAN				267.0	260.3	262.8	26.2	86.2	41.1	40.7	30.5	17.5	26.8	14.4	48.9	30.5	22.6	21.9	23.0
STD DEV				31.2	30.9	31.3	1.5	6.2	3.3	4.0	3.8	2.1	2.6	1.7	3.5	2.5	1.7	1.6	1.7
MIN				248.0	242.0	244.0	24.9	81.0	39.2	37.4	27.8	15.4	23.9	12.9	45.5	28.5	21.1	20.5	21.4
MAX				303.0	296.0	299.0	27.8	93.0	44.9	45.1	34.8	19.5	28.9	16.3	52.4	33.3	24.5	23.6	24.7

ELAND (*Taurotragus oryx*) n=14

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Ela 1K	35061	M	W	298.0	287.0	289.5	32.9	115.0	58.4	60.7	38.6	20.2	36.9	22.0	60.9	38.8	28.0	27.0	30.8
Ela 2K	36696	F	Z	NAM	NAM	NAM	25.9	89.5	48.8	52.3	NAM	NAM	27.7	15.9	48.7	31.7	23.0	22.4	22.7
Ela 3K	36749	M	Z	278.0	272.0	274.0	30.2	99.0	54.4	54.4	37.8	20.2	31.5	22.0	54.7	35.8	25.8	25.1	26.0
Ela 4K	36674	F	Z	281.0	275.0	277.5	27.7	96.5	50.0	50.6	34.9	18.9	30.8	19.3	52.9	33.6	25.1	24.0	25.9
Ela 5K	35572	?	W	333.5	297.0	300.0	23.3	104.0	49.4	49.2	33.2	16.1	30.9	14.1	51.9	32.1	20.5	20.1	22.4
Ela 6K	36280	?	Z	280.5	275.0	277.5	20.1	94.0	41.4	46.8	27.5	11.8	24.8	12.9	46.5	29.0	19.6	18.4	19.4
Ela 7K	39303	F	W	289.5	282.5	285.0	23.6	98.0	49.0	52.0	32.4	14.2	30.3	15.4	51.9	31.5	20.9	19.8	22.7
Ela 8K	38248	F	Z	281.0	275.0	277.5	24.4	103.0	46.6	43.6	30.4	13.7	27.3	15.0	50.1	29.6	20.9	19.9	21.6
Ela 9K	37142	F	?	292.0	285.0	287.5	22.7	96.0	47.2	49.2	32.3	13.8	29.7	14.2	52.3	31.7	21.7	20.3	22.6
Ela 10K	39311	M	W	298.0	293.0	294.5	26.7	103.0	47.6	47.4	33.9	13.2	29.0	12.3	51.6	31.4	21.5	20.3	22.4
Ela 11B	260	?	W	305.0	298.0	300.0	33.2	109.0	58.1	60.8	39.0	23.5	37.5	21.6	58.9	32.4	27.2	26.0	28.6
Ela 12B	9756	?	Z	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ela 13B	9432	?	W	273.0	267.5	269.5	25.7	91.0	51.5	50.7	36.1	21.0	31.7	18.7	51.5	33.9	24.4	23.4	24.7
Ela 14B	4281	?	?	295.5	289.5	291.5	27.2	91.0	49.0	49.7	35.9	18.5	31.4	19.5	50.5	34.2	23.1	22.3	22.8
Ela 15B	9925	?	?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ela 16B	9442	F	W	304.5	299.0	301.0	34.7	110.0	55.7	58.1	38.4	22.4	37.5	20.1	60.8	37.9	27.8	27.7	29.5
MEDIAN				292.0	285.0	287.5	26.3	98.5	49.2	50.7	34.9	18.5	30.9	17.3	51.9	32.3	23.1	22.4	22.8
MEAN				293.0	284.3	286.5	27.0	99.9	50.5	51.8	34.6	17.5	31.2	17.4	53.1	33.1	23.5	22.6	24.4
STD DEV				16.0	10.7	10.7	4.3	7.8	4.7	5.1	3.5	3.9	3.8	3.5	4.3	2.8	2.9	3.0	3.3
MIN				273.0	267.5	269.5	20.1	89.5	41.4	43.6	27.5	11.8	24.8	12.3	46.5	29.0	19.6	18.4	19.4
MAX				333.5	299.0	301.0	34.7	115.0	58.4	60.8	39.0	23.5	37.5	22.0	60.9	38.8	28.0	27.7	30.8

BUFFALO (*Syncerus caffer*) n=7

INDIVIDUAL	MUS NO	M/F	W/Z	M(GL)	M(GML)	M(GLL)	M(SBD)	M(SCD)	M(GBP)	M(GDP)	M(GLMA)	M(GBMA)	M(GLLA)	M(GBLA)	M(GBD)	M(GDD)	M(GBMC)	M(GBLC)	M(GBDE)
Buf 1K	33386	F	W	222.5	213.0	216.0	35.8	113.5	60.0	52.3	39.7	19.4	38.7	18.6	71.0	40.6	32.4	32.9	37.7
Buf 2K	33442	?	?	233.0	226.0	226.5	24.6	133.0	66.5	59.2	46.3	26.3	34.6	24.7	75.5	40.9	35.5	33.6	37.1
Buf 3B	9774	F	W	208.5	201.0	203.0	34.3	113.0	57.3	50.1	39.6	22.6	30.9	19.0	66.1	35.1	30.3	28.9	33.4
Buf 4B	8743	F	W	202.0	193.0	195.5	36.9	119.0	61.7	55.7	40.9	21.5	32.9	18.5	67.8	36.8	30.8	29.8	34.6
Buf 5B	4283	?	W	200.0	191.0	193.5	38.8	119.0	59.5	54.2	41.0	24.1	35.7	20.4	88.3	37.2	30.7	30.5	33.3
Buf 6P	524	F	Z	237.0	227.5	230.5	34.0	104.0	55.3	53.7	39.3	16.3	37.2	15.8	65.7	37.5	30.1	29.5	33.6
Buf 7P	2216	M	W	212.5	206.0	207.0	46.4	137.0	62.6	57.4	39.2	19.0	34.9	20.3	71.6	40.8	33.4	32.1	35.0
MEDIAN				212.5	206.0	207.0	35.8	119.0	60.0	54.2	39.7	21.5	34.9	19.0	71.0	37.5	30.8	30.5	34.6
MEAN				216.5	208.2	210.3	35.8	119.8	60.4	54.7	40.9	21.3	35.0	19.6	72.3	38.4	31.9	31.0	35.0
STD DEV				14.7	14.7	14.5	6.5	11.6	3.7	3.1	2.5	3.4	2.6	2.7	7.9	2.3	2.0	1.8	1.8
MIN				200.0	191.0	193.5	24.6	104.0	55.3	50.1	39.2	16.3	30.9	15.8	65.7	35.1	30.1	28.9	33.3
MAX				237.0	227.5	230.5	46.4	137.0	66.5	59.2	46.3	26.3	38.7	24.7	88.3	40.9	35.5	33.6	37.7