A Comparative Morphological and Morphometric Study of the Cranial and Post-Cranial Osteology of South African Hares - Cape Hare (*Lepus capensis*) and Scrub Hare (*Lepus saxatilis*) and its Application in Archaeozoology

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DECLARATION

Student number: 3096 199 8

I declare that **A Comparative Morphological and Morphometric Study of the Cranial and Post-Cranial Osteology of South African Hares - Cape Hare (*Lepus capensis*) and Scrub Hare (*Lepus saxatilis*) and its Application in Archaeozoology**, is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the dissertation to originality checking software. The result summary is attached.

I further declare that I have not previously submitted this work, or part of it, for examination at the University of South Africa for another qualification or at any other higher education institution.

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DATE

SUMMARY

This archaeozoological study was undertaken to distinguish between the two hare species of South Africa, *Lepus capensis* (Cape hare) and *Lepus saxatilis* (scrub hare), from fragmentary archaeological faunal remains. It was previously not possible to taxonomically differentiate between these species. The research focused on Lagomorpha remains previously identified in Later Stone Age assemblages from two rock shelters, Blydefontein and Meerkat, in the Karoo. Analyses of modern skeletal material housed in museum collections demonstrated that there are indeed morphological and morphometric differences between *Lepus capensis* and *Lepus saxatilis*. The Lagomorpha material from the two archaeological assemblages were then re-examined utilising the newly established protocols. The reanalyses proved that it is now possible to distinguish between the two hare species even when in fragmentary form. It is also possible to identify *Pronolagus*. The dietary and likely cultural roles of the Lagomorpha and other small mammals in archaeological contexts are also explored.

Keywords: archaeozoology, Blydefontein, Later Stone Age, Meerkat, morphology, morphometrics, *Lepus capensis* (Cape hare), *Lepus saxatilis* (scrub hare), South Africa, taxonomy

’n Vergelykende morfologiese en morfometriese studie van die kraniale en postkraniale osteologie van Suid-Afrikaanse hase – vlakhaas (*Lepus capensis*) en kolhaas (*Lepus saxatilis*) – en die toepassing daarvan in argeosoölogie

OPSOMMING

Hierdie argeosoölogiese studie is onderneem om te onderskei tussen die twee haasspesies in Suid-Afrika, *Lepus capensis* (vlakhaas) en *Lepus saxatilis* (kolhaas), aan die hand van gefragmenteerde argeologiese fauna-oorblyfsels. Dit was nie voorheen moontlik om hierdie spesies taksonomies van mekaar te onderskei nie. Die navorsing fokus op Lagomorpha-oorblyfsels wat voorheen geïdentifiseer is in rotsskuiling-versamelings wat uit die Laat Steentydperk dateer. Die genoemde rotsskuilings is gevind by Blydefontein en Meerkat in die Karoo. Ontledings van moderne skeletmateriaal in museumversamelings het getoon dat daar wel morfologiese en morfometriese verskille tussen *Lepus capensis* en *Lepus saxatilis* is. Lagomorpha-materiaal afkomstig van die twee argeologiese versamelings is toe herondersoek aan die hand van nuut gevestigde protokolle. Die herontledings het bewys dat dit nou moontlik is om te onderskei tussen die twee haasspesies, selfs indien hulle gefragmenteerd is. Dit is ook moontlik om *Pronolagus* te identifiseer. Die rolle wat die Lagomorpha en ander klein soogdiere in argeologiese kontekste in dieet en kultuur vervul het, is ook ondersoek.

Sleutelwoorde: argeosoölogie, Blydefontein, Laat Steentydperk, Meerkat, morfologie, morfometrie, *Lepus capensis* (vlakhaas), *Lepus saxatilis* (kolhaas), Suid-Afrika, taksonomie

Ucwaningo oluqhathanisa ukwakheka kanye nesilinganiso sogebhezi lwekhanda kumbe ugebhezi lwesiqu somzimba kanye nomsebenzi walo ezilwaneni ezingonogwaja.

Uhlobo lukanogwaja olunezinyawo esezikhule ngokwanele ukuthi ungagxuma noma ugijime, kanye namehlo amakhulu anendilinga emhlophe olwaziwa ngokuthi yi*Lepus capensis* kanye nohlobo lonogwaja abatholakala eNamibia, eMozambikhi, eNingizimu Afrika, eSwazini naseLesotho olwaziwa ngokuthi yi*Lepus saxatilis* kanye nendlela okusebenza ngayo maqondana nezitho zomzimba eziba yizinsalela uma isilwane sesifile.

IQOQO LOKUBALULEKILE

Ucwaningo maqondana nezitho zomzimba ezisalayo uma isilwane sesifile lwenziwelwa ukuba kukwazeke ukuhlukanisa phakathi kwalezi zinhlobo ezimbili zonogwaja eNingizimu Afrika, okuyi*Lepus capensis* kanye ne*Lepus saxatilis* ngokubheka izingcucu zezinsalela zazo. Kwakungelula kudala ukuhlukanisa lezi zinhlobo zesilwane ngokwamaqoqo okwakheka noma okwenza kwazo. Ucwaningo lugxile kwizinsalela zohlobo lwe*Lagomorpha* olwaluvame ukubonakala ngenkathi yakudala okwakusetshenziswa kuyo amatshe ukwakha izinto (i*Stone Age*) emiphemeni emibili eyayakhiwe ngamadwala eyayihlangene eyayaziwa ngokuthi yi*Blydefontein* ne*Meerkat* esigodini esisagwadule esiseNingizimu Afrika, iKaroo. Ukuhlaziywa kwezingebhezi zemizimba yezinto ezigcinwe kwizigcinamagugu lwaveza ukuthi impela ukhona umehluko ekwakhekeni kanye nasezilinganisweni zogebhezi lwekhanda ngokomumo kumbe ugebhezi lwesiqu somzimba phakathi konogwaja abawuhlobo lwe*Lepus capensis* ne*Lepus sexatilis*. Uhlobo lwe*Lagomorpha* lwasesakhiweni semipheme ehlangene lwabe seluhlolwa kabusha kusetshenziswa izinhlobo ezintsha eziseqophelweni. Ukuhlaziywa kabusha kwaveza ubufakazi bokuthi sekuyinto engenzeka kalula ukuhlukanisa phakathi kwalezi zinhlobo ezimbili zonogwaja ngisho ngabe sezitholakala sezingcezungcezu. Kuyinto engenzeka kalula futhi ukubona uhlobo lwe*Pronolagus.* Indlela yokudla kanye nemisebenzi ehambisana nosikompilo kohlobo lwe*Lagomorpha* kanye nezinye izilwane ezincelisayo nakho kuyabhekwa.

Amagama asemqoka: archaeozoology, Blydefontein, Later Stone Age, Meerkat, morphology, morphometrics, *Lepus capensis* (Cape hare), *Lepus saxatilis* (scrub hare), South Africa, taxonomy

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The vast resources of the UNISA library certainly made this study feasible. It truly is the greatest university library in Africa, if not the world.

ABBREVIATIONS AND ACRONYMS

aDNA	ancient DNA
AZ	Archaeozoology Department
Bd	Breadth of distal end
BFacd	Greatest breadth across the *Processus articularis caudales*
BFcr	Breadth *Facies articularis cranialis*
BFcd	Breadth *Facies articularis caudalis*
BFtr	Greatest breadth across the *Processus transversi*
BG	Breadth of the glenoid cavity
Bp	Breadth of the proximal end
BPC	Breadth across the coronoid process
BTr	Breadth of the region of the Trochanter tertius
cf.	*confer* (compare with)
CB	Caput bulge
CL	Length of caput
CONL	Condyle lateral
CONM	Condyle medial
DC	Depth of the condyles (talus)
DC	Depth of the caput femoris
DDL	Depth of the distal lateral facet
Dd	Depth distal end
DHA	Diagonal Height from distal point to thoracic angle
DmTc	Depth from the minor trochanter too the caput
DNMNH	Ditsong National Museum of Natural History
Dp	Depth of the proximal end
DPA	Depth across the *Processus anconaeus*
EC	Eastern Cape Province
ESA	Earlier Stone Age
FS	Free State Province
GB	Greatest breadth
GBA	Greatest breadth across the acetabula
GBTc	Greatest breadth across the *Tuber coxarum*
GBTi	Greatest breadth across the *Tubera ischiadica*
GL	Greatest length
GLC	Greatest length of the caput
GLF	Greatest Length from *Facies articularis cranialis* to *Facies articularis caudalis*
GLP	Greatest length of the *Processus articularis*
GP	Gauteng Province
H	Height
HFcr	Height of the *Facies terminalis cranialis*
HS	Height along the spine

ICZN	International Code of Binomial Nomenclature
KZN	KwaZulu-Natal Province
LAd	Length of the *Arcus dorsalis*
LAdt	Length of the *Arcus dorsalis* on the tuber
LAIIL	Length of rim of acetabulum from ischium to ilium
LAPa	Greatest length of the arch including the *Processus articularis*
LAR	Length of the acetabulum
LCDe	Greatest length in the region of the corpus including the dens
Ld	Length dorsal
LFo	Inner length of the foramen obturatum
LG	Length of the glenoid cavity
LP	Limpopo Province
Max.	Maximum
Min.	Minimum
MP	Mpumalanga Province
MNI	Minimum Number of Individuals
MSA	Middle Stone Age
mtDNA	Mitochondrial DNA
MYA	Million Years Ago
NC	Northern Cape Province
NISP	Number of Identifiable Specimens
NMB	National Museum Bloemfontein
NMBF	National Museum Bloemfontein Florisbad
NW	North West Province
PAST	PAleontological STatistics
PL	Physiological length
QSP	Quantifiable Specimens Present
SB	Smallest breadth of the shaft of the ilium
SBI	Smallest breath across the bodies of the ischia
SBV	Smallest breadth of the vertebra
SD	Standard Deviation (in calculations)
SD	Smallest breadth of diaphysis (in measurements)
SDO	Smallest depth of the olecranon
SH	Smallest height of the shaft of the ilium
SLC	Smallest length of the *Collum scapulae*
TM	Transvaal Museum
VOC	*Vereenigde Oost-Indische Compagnie* (Dutch)
WCP	Western Cape Province
WD	Widest depth of the diaphysis

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CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

In South Africa, the order Lagomorpha comprises three genera: *Lepus* spp. (hares) consisting of two species namely *Lepus capensis* (Cape hare) and *Lepus saxatilis* (scrub hare); *Pronolagus* (rabbits) with three species: *Pronolagus rupestris* (Smith's red rock rabbit), *Pronolagus crassicaudatus* (Natal red rock rabbit), and *Pronolagus randensis* (Jameson's red rock rabbit); and *Bunolagus*[1] consisting of one species *Bunolagus monticularis* (riverine rabbit). Since the taxonomy of the order is problematic, various studies in both morphology and genetics have been undertaken in order to clarify the genera and their respective species. In 1981, Robinson undertook a complete revision of the South African Leporidae and, by including modern techniques such as karyology, sperm morphology and morphometrics, he concluded that there were only the three genera – those listed above. Later studies of chromosome counts confirmed his findings (see Robinson & Skinner 1983; Robinson & Dippenaar 1987).

1.1.1 Geographical distribution

The genus *Lepus* spp. contains a speculated 32 species worldwide, six of which occur in Africa, and two in South Africa (Happold 2013: 698). *L. capensis* has a wide-spread distribution, ranging from Africa, the Middle East and eastward into Asia. Many forms of this species have been described and have even received species rank in the past (Happold 2013: 699). Hoffmann and Smith (2005) list 38 synonyms, of which they consider seven to be sub-species. The remainder are believed to be synonyms of *L. capensis. L. saxatilis* has a wide distribution range on the African continent. According to mtDNA the species comprises three lineages (Kryger et al. 2004). One, long isolated, is confined to the southern and western parts of South Africa. The second occurs in central and south-eastern South Africa, and the third in the northern regions of South Africa (Happold 2013: 703).

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[1] Despite the colloquial name of 'rabbit' it resembles hares although cryptogenetic evidence indicates that it is a unique species (Skinner & Chimimba 2005: 75)

[2] For a full taxonomic list of new world *Lepus* spp. please refer to Flux (1983), Hoffmann & Smith (2005) and Happold

1.1.2 Research focus

This dissertation focuses on and presents a comparative morphological and morphometric study of the cranial and postcranial osteology of the two hare species *Lepus capensis* (Cape hare) and *Lepus saxatilis* (scrub hare). Each of the skeletal elements, except for the teeth, phalanges and carpals/tarsals, is compared and the differences noted in detail. The remains of the species that make up the order Lagomorpha are represented in the faunal lists of the majority of southern African archaeological localities. The protocols created in this study were tested on previously identified Later Stone Age faunal material originating from the two sites of Blydefontein and Meerkat, both located in the Karoo, South Africa. The faunal assemblages from both sites were reanalysed by the author and the material identified to species level where possible. The resulting re-identification using the established protocols yielded positive results. The outcome of the study, namely to identify hares to species level, has important implications for southern African archaeozoological research as discussed in Chapter 5.

1.1.3 The role of osteology and morphology

Comparative osteology is a morphological technique derived from the comparative anatomy traditions of veterinary sciences dating from the 19th and early 20th centuries, and that underpins the modern-day research field of archaeozoology (Nickel et al. 1992). Archaeozoologists have adapted these comparative techniques to assist in the identification of faunal material from archaeological sites and to solve archaeological research questions. Comparative morphological techniques provide researchers with the means to distinguish between closely related species. These can moreover, allow access to information from osteological materials which were previously presumed undiagnostic (Plug & Peters 1991; Macdonald 1992; Peters & Brink 1992; Brink 1993, 1994, 2005; Watson & Plug 1995; Peters et al. 1997). At present, there is no osteological key for the hares or rabbits of southern Africa. This hinders the ability to securely identify these species in archaeological faunal remains. The absence of species identification protocols also negatively impacts on palaeontology as the field relies heavily on the skeletal morphological studies of recent animals in order to identify fossils.

Leporid tooth morphological studies have been conducted on the incisors of the Leporidae (see Robinson 1986; Suchentrunk & Flux 1996), the evolution of the P3 of Leporidae (see

Hibbard 1963; Dalquest et al. 1989), and there are studies on the genetic relationships and differences between species (Kryger 2002; Kryger et al. 2004; Robinson & Matthee 2005; ben Slimen et al. 2006; ben Slimen et al. 2008; Suchentrunk et al. 2009), but very few studies have been conducted on Lagomorpha osteology. Only selective cranial and post-cranial studies could be sourced from Russia (Averianov 1995), America (Gazin 1934; Bleefeld & Bock 2002; Wible 2007), Australia (Glenny 1951), India (Rose et al. 2008) and one between two genera (*Lepus* and *Oryctolagus*) in Western Europe (Callou 1997). In the light of these comparative osteomorphological studies on hares and rabbits, the proposed research was considered to be eminently feasible. Modern skeletal material in the mammal collections of the Ditsong National Museum of Natural History in Pretoria and the National Museum in Bloemfontein was utilised in this study. A preliminary survey indicated that sufficient comparative skeletal material was available to make this study feasible and that the material was accessible.

One southern African morphometric study comparing *Lepus* spp. and *Bunolagus* sp. was conducted on external features of live animals such as the head, tooth row, ear and hind foot length (see Robinson & Dippenaar 1987). In the aforementioned study, a decrease in size in *L. saxatilis* was found, with the specimens from the south-west (Western Cape Province) being much larger than in the northern provinces and KwaZulu-Natal (KZN). Since most of the skeletal studies of *Lepus* spp. have been conducted in the Americas and in Europe, it is not yet known whether species of the same genus from southern Africa share osteomorphological characteristics with those populations, and whether geographical disparity (biogeography) might have influenced development. The main contribution of osteomorphology and morphometrics in this study will present a means to address these inadequacies. The current study will also have some impact on the science of palaeontology, as limited research has been conducted on fossil Lagomorphs and their evolution (Winkler & Avery 2010). The knowledge gained from the remains of these small mammals will facilitate investigations on past environments and also past subsistence practices.

The study further aims to establish skeletal differences between the two species of *Lepus* spp., and possible variation between the sexes (based on size), since their habits and behaviours differ and because the females in both species tend to be larger than the males (Skinner & Chimimba 2005: 67, 69). According to Happold (2013: 705), the female *L. saxatilis* is on average larger than the males in most measurements but not significantly so.

The same publication makes no mention of a sexual size difference in *L. capensis*. Robinson and Dippenaar (1987: 381) reported that they found no significant size differences in *L. saxatilis*, with the exception of the height of the mandible. This stands in contrast to a study conducted in the Kruger National Park that found the body length and eviscerated carcasses of gravid and non-gravid female scrub hares to be significantly greater than the males (Penzhorn et al. 1993: 76). Female-biased sexual size dimorphism occurs in at least one Lagomorpha species – *Sylvilagus* – the American cottontail rabbit (Davis & Roth 2008). The authors attribute the selection for smaller males to female dispersion, large male home ranges, reduced aggression, and a promiscuous mating system. It has to be noted that Robinson and Davis made use of standard zoological body measurements and added skull measurements. These primary external zoological studies are useful when discussing overall body size dimorphism. However, they do not describe the shape and therefore the differences between males and females. These measurements do not cover specific differences that occur in regions of the body that are normally associated with sexual differences i.e. head and pelvis (Schutz et al. 2009: 339).

Pelvic sexual differences are attributed to three biomechanical factors that affect the form of the pelvis: i) the stresses placed on the pelvis due to the weight of the body, ii) the size of the offspring that affects the form of the pelvis as it has to open wide enough to allow birth, and iii) the effects of the locomotory habits that result from the orientation of the limbs and the muscle attachments (Schutz et al. 2009: 340). In a study on grey foxes (*Urocyon* spp), Schutz et al. (2009: 351) found that the allometry of the body, amongst other factors, depends on regional origin. The results suggest that sexual dimorphism is present throughout the body and can not be compared to general body size (Schutz et al. 2009: 351).

A controlled study on domestic mice (*Mus* spp.) (Schutz et al. 2009: 839) established marked differences in the pelvis of birthing and non-birthing females. These findings have been supported by the works of Bowman & Miller (1999; 2001) – in relation to rats – and Pelletier et al. (2017) – in relation to Antillean fruit-eating bats. Results show that the processes of pregnancy, birthing and lactation greatly influence the skeletal architecture of not only the pelvis, but also the other bones in the skeleton, and that they can produce significant increases in female skeletal size and weight. Specifically, the pelves of non-birthing females resemble those of males more closely, while those of birthing females differ vastly from those of their male counterparts. Museum specimens are sometimes catalogued as being male or female, and as these animals were mostly wild-caught, no information on their reproductive history is known. In light of this, and the regional variations in general body size, I am reluctant to provide criteria in this study to differentiate between males and females specifically as far as the pelvis is concerned. The measurements of the pubis and its symphysis, as suggested in West (1990: 107), were not included in the measurements, as these areas in most of the museum specimens were incomplete.

1.1.4 The archaeological record

In the archaeological record, hare and rabbit remains dating from the Earlier Stone Age to the historical period have been identified (Plug & Badenhorst 2001: 220-228; Brain 2004: 36, 44, 50, 57, 63, 71, 221; also see Appendix D). Fossil evidence for the southern African *Lepus* spp. exists with certainty from 1.8–1.1 million years ago (mya) at Wonderwerk Cave (Brink et al. 2016) and the middle Pleistocene at the sites of Florisbad (Brink 1987); Duinefontein 2 (Klein et al. 1999); Elandsfontein (Klein 1974) and Cave of Hearths (Cooke 1963). Lagomorphs as a group have, however, received very little attention from faunal analysts, resulting in most remains being identified only to the order or family, but seldom to species level (Winkler & Avery 2010: 305 also see Appendix D). Since much of the earliest fossil materials have yet to be formally described, the possibility that Africa has the earliest *Lepus* spp. remains in the world (2.5mya) cannot be confirmed at this time (Winkler & Avery 2010: 314). From the relatively low number of Lagomorpha specimens present in both the palaeontological and archaeological record it seems that these resources may (i) have been underutilised (Winkler & Avery 2010: 315), (ii) are not always preserved or possibly (iii) not correctly collected (sieving and sorting) or identified.

Currently, in archaeozoological studies, skeletal materials from smaller mammals (not micro-mammals, i.e. mice and rats) are often identified to a higher taxonomic group and, if possible, to genus, but seldom to species level. This creates a gap in our understanding of the faunal record of archaeological sites resulting in a lack of data on foraging, trapping and food preferences. The importance of determining subsistence patterns in the archaeological record has been illustrated by Fa et al. (2013), who proposed that the utilisation of rabbits was an essential survival strategy for anatomically modern humans during the last 50 000 years in Iberia.

Wadley (2010) asks if it matters whether or not snares and traps were used in the South African Middle Stone Age (MSA). She highlights precisely the point that circumstantial evidence can infer that which is not preserved in the archaeological record. The setting of snares and traps indicates particular thought processes and knowledge of the environment and animal behaviour. Her analysis pointed to varying strategies between the MSA Howiesons Poort (65 800–59 500 BP (Jacobs et al. 2008)) (boasting many smaller game animals) and the Post-Howiesons Poort (59 500–52 000 BP (Jacobs et al. 2008)) boasting many larger game animals). This finding possibly relates to environmental factors or group demographics. Archaeozoological research can assist in pinpointing areas of rapid human population growth and technological advancement (Stiner et al. 1999: 193). However, these inferences can only be made if faunal remains are identified to species level as accurately as possible.

The aforementioned scholarly works in comparative skeletal morphological and morphometric techniques of the Leporidae have produced a valuable body of knowledge that has aided both the sciences of archaeology and palaeontology. My research aims to address limitations in osteology keys that were identified by researchers from these disciplines. Olsen (1960:4) maintains that "[A] field manual of this sort, in order to be of real service, must be well illustrated and nearly self-explanatory so that the archaeologist can identify incomplete specimens with a minimum of additional research into other literature or reference collections."

1.2 The need for osteological and morphometric keys

The justification for carrying out this research is to establish an osteological key for the two *Lepus* spp. that will translate into better and more accurate identification of their remains from archaeological sites. This, in turn, results in broader and more complete site interpretation, since more accurate species identification will reveal information on subsistence patterns, hunting methods (that display different prey evasion tactics) and environmental changes (the two species occupy different habitats) that are not physically reflected in the soil or breccias (fossil-bearing deposits). The data will provide a better and more complete reconstruction of historical, archaeological and palaeontological environments. Along similar lines, the domestication path of the donkey, as discovered through the use of both morphological and morphometric evidence, serves as an excellent example (Rossel et al. 2008). This domestication path has now been traced in more detail through the use of genetics (Kimura et al. 2013).

Creating morphometric keys in order to identify faunal remains to species level is another fundamental need in archaeozoology in South Africa. Similar keys should be established for the remaining Leporid species. Their usefulness in the archaeological record is best illustrated by the Oudepost I site. The introduction of European rabbits (*Oryctolagus cuniculus*) by Dutch settlers at the Cape poses a challenge to archaeozoologists. Cruz-Uribe and Schrire (1991: 95) in their report on Oudepost I (ACE1669–1732) on the Cape West Coast, point out that "[A]mong the most common animals at Oudepost are the Leporids, which are also among the most problematic in terms of identification". The larger Leporid bones on the site could be identified based on size as derived from the Cape hare but smaller bones could belong to either the local *Pronolagus* spp. or the European rabbit (*Oryctolagus cuniculus*). This raises the question to what extent the European settlers brought in and bred the European rabbit for meat and to what extent they hunted native rabbits and hares. At Oudepost I no conclusions could be reached as no comparative skeletal morphological and morphometric studies have been undertaken. The identification of the Cape hare, based purely on its size (Cruz-Uribe & Schrire 1991: 95), is also debatable as no morphometric data exist to support any such identification.

Based on the information provided above, the aims of this study are to:

- Discover and describe the discernible skeletal morphological and morphometric differences between the two *Lepus* spp. that occur in southern Africa.
- Create osteological and morphometric keys in order to identify faunal remains to species level.
- Apply the results of the study to the Lagomorpha material identified at Blydefontein and Meerkat; two rock shelters in the eastern Karoo with Later Stone Age (LSA) occupations dating to the late Pleistocene and Holocene (Bousman 2005).

1.3 Summary of Chapter 1

Comparative osteology has been the basis of archaeozoology from the start of the discipline. Many comparative studies between species have been conducted laying a foundation for the feasibility of the current study. There is fossil evidence for Lagomorphs in southern Africa that may date back to 18mya. It has been speculated that Africa might possess the earliest *Lepus* spp. remains in the world. With the protocols that I have now established to differentiate between *L. capensis* and *L. saxatilis*, it should be possible to more accurately identify their remains in not only the archaeological but also the palaeontological record.

In the next chapter, the complicated taxonomic history of the Lagomorpha group is discussed. The research previously conducted on the South African Lagomorphs will be presented. As Lagomorphs are present in almost all southern African archaeological faunal assemblages the reasons for their presence, or lack thereof, are explored.

1.4 Dissertation overview

In Chapter 1 a general introduction to the field of research is provided. Chapter 2 sets out to contextualise the research in terms of taxonomy, genetics and phylogenics, as well as archaeological and archaeozoological applications and indications. Chapter 3 outlines the research methodology and provides information on osteomorphology in archaeology, specimen selection, skeletal differences, measurement points, statistical methods and photographic techniques. Chapter 4 provides the results and analyses of the various skeletal elements and demonstrates how they differ between *L. capensis* and *L. saxatilis*. Chapter 5 provides detailed outlines for the archaeological applications of the data obtained. Chapter 6 presents a discussion and conclusion on the research conducted.

CHAPTER 2

BACKGROUND

2.1 Introduction

Lagomorphs are found all over the world and range in size from less than 100g to in excess of 5kg. Recent genetic studies into the relationships between the various Lagomorpha forms have revealed major gaps in the phylogenetic charts (Chapman & Flux 1990: 3). In Africa, and specifically South Africa, the whole Lagomorpha group has been given little attention (Kryger 2002; Kryger et al. 2004; Maduray et al. 2007; Suchentrunk et al. 2009; Winkler & Avery 2010: 305). In the previous chapter the current lack of knowledge on the taxonomic status of Lagomorphs in South Africa was discussed and it was highlighted that a great need exists for the clarification of the order's taxonomic status. The establishment of past and present biogeographical ranges for these animals will shed light on past ecologies and landscape (Flux & Angermann 1990: 64; Winkler & Avery 2010: 305, 315). In addition, Flux and Angermann's (1990) article called for a careful revision of the world's largest museum collections that house African hare material and pointing out that the biggest challenge to this revision will be the proficiency of individual researcher's in skeletal morphology and morphometrics.

This study deals primarily with the hare species of the Old World, and in particular southern Africa, and thus the focus of the background and taxonomic discussions will be on this region only[2].

This chapter gives a brief explanation of taxonomy and provides clarification on how animals are classified and grouped. In this chapter I will also discuss the value of genetic research, even though it is not a readily available tool to archaeologists and poses limitations within species identification. A literature review is also provided on the morphological, morphometric and genetic studies that have been conducted on South African *Lepus* spp. A brief history of the order Lagomorpha is given and, in conclusion, the possible reasons for finding Lagomorpha remains in the archaeological faunal record are discussed.

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[2] For a full taxonomic list of new world *Lepus* spp. please refer to Flux (1983), Hoffmann & Smith (2005) and Happold (2013).

2.2 Taxonomy

Identification is the process whereby a specimen or artefact is assigned to a previously established classificatory system (Driver 2011: 20), Classification is "a hierarchy of relationships based on observation" (Williams & Ebach 2009: 250). Grouping or classifying is standard in both archaeology and zoology. In taxonomy, animals are grouped based on shared or differing characteristics (Mayr 1969: 55; Driver 2011: 20), thereby providing a classification system and a hierarchical order into which animals may be placed. In the sciences of zoology and archaeozoology, animals are first referred to by order, family, genus or species, and secondly by colloquial names.

This method is used to structure and bring order to artefacts and the animal kingdom in terms of origins, sequences, typology, and relevance. Archaeozoologists identify specimens by attempting to place them in taxonomic and anatomical classification categories (Driver 2011: 26). Taxonomists endeavour to establish classifications to reflect natural groups by either breaking up larger groups into smaller ones, or placing smaller groups into more inclusive ones (Wiley et al. 1991: 91). This is accomplished by taking, amongst other factors, the evolutionary history and adaptation to the organism's environment into consideration. This method is problematic for archaeozoologists as certain species identified by zoological taxonomists are not easily distinguishable osteologically.

German morphologists use the term *Bauplan* (design plan) for the basic design of the body and, in this case, the skeleton (Mayr 2002: 121). Skeletal elements show the evolutionary history as well as adaptations to function and environment (Reitz & Wing 2008: 38-39). From a single bone or bone fragment (depending on what is available), these evolutionary and adaptive characteristics can be used to extrapolate to which animal group the bone in question belongs. Some species are easier to identify on account of their uniqueness or the availability of skeletal keys (Driver 2011: 24). In similar species, the osteological differences might be obvious when dealing with complete material, but the archaeozoologist has frequently only fragmented material to work with, which makes identification to species level even more challenging.

Linnaeus was the first person to devise a coherent naming system for both fauna and flora, while notable scientists such as Darwin endeavoured to order the animal kingdom. Phenetic classification is a hierarchy of similarities among living things, whereas phylogenetic classification represents a branching hierarchy of evolution that demonstrates shared ancestry (Ridley 1986: 3-4). Taxonomic identification is structured using a top-down approach, thus starting with the gross or main features and placing these at a high taxonomic level, then following a process of elimination until a species identification can be made (Brink 2005: 24), e.g. Mammal > Lagomorpha (hare/rabbit) > *Lepus* spp. (hare) > scrub hare (*Lepus saxatilis*).

2.3 Schools of Taxonomy

There are four main contemporary schools of taxonomy. All four schools claim that their particular system of classification maximises the storage and retrieval of information (Scott-Ram 1990: 3, 5).

2.3.1 Evolutionary systematics

This approach is based on the premise that groups of species already exist in nature (Mayr 1969: 76). This school argues that groups should be made up of similar products of evolution and is therefore based on phylogeny (Scott-Ram 1990: 4). When a group evolved too quickly, the school prefers phenetic classification (Ridley 1986: 6). Homologies (ancestral characters) are distinguished from analogies (convergent characteristics), but the problem still remains that common ancestry can only be inferred and not observed (Ridley 1986: 12; Wiley et al. 1991: 18).

2.3.2 Phenetics

This school advocates the grouping of organisms based upon the degree of observable similarity (Mayr 1969: 69; Ridley 1986: 7; Scott-Ram 1990: 3-4). It gives equal consideration to all characters and therefore leaves no room for adaptation, convergence or evolution (Mayr 1969: 69; Wiley et al. 1991: 18). This hierarchic output of multivariate statistics would replace the unstable subjective classification system. However, problems may arise because several multivariate cluster statistics exist and the resulting classification will depend on the statistical cluster used. To complicate matters even further, there is no one optimal statistical cluster and there are no real hierarchies in nature (Ridley 1986: 13).

2.3.3 Phylogenetic systematics

This approach, developed by Hening in the 1940s and 1950s and more commonly known as cladistics, focuses on relationships by classifying organisms on the basis of recent common ancestry and shared derived characteristics (Mayr 1969: 70; Scott-Ram 1990: 4; Williams & Ebach 2009: 264). The techniques of identifying ancestral and derived characteristics are used to discover the branching points and hierarchy of organisms, but of these, only derived characters are used in classification (Mayr 1969: 70; Ridley 1986: 16; Wiley et al. 1991: 19)

2.3.4 Transformed cladistics

This view abandoned the evolutionary aspect of cladistics and began looking at recurrent patterns and processes in nature as used by pre-Darwinian classification (Scott-Ram 1990: 4). Patterns relate to the distribution of forms in nature, while processes produce patterns (Ridley 1986: 14).

Cladism is one of the main schools of taxonomy wherein species are grouped by their shared derived characters, such characteristics are derived from a recently shared common ancestor (Ridley 1986: 59; Wiley et al. 1991: 18).

The prevailing problem is that each organism has an enormous number of characters that can be described in many different ways (Ridley 1986: 2). A character can be described as evolutionary stable (does not change), evolutionary labile (changes often) and evolutionary ancestral or derived (meaning that it is an earlier or later version of the same character) (Ridley 1986: 2-3). Characters can be selected either subjectively or objectively; subjectively meaning unguided by any principle and objectively meaning dictated by theoretical principles. Modern classification recognises only two objective ways to select characters to be studied, namely through phenetic and phylogenetic classification (Ridley 1986: 3).

In this research project, a derived method of outgroup comparison was used to examine skeletal elements of the two closely related species of *Lepu*s for characteristics that are unique to each species. These characteristics and the methods used for determination are discussed in detail in Chapters 3 and 4.

2.4 Genetics: DNA, mtDNA, and aDNA

Ecological genetics investigate the origin and maintenance of genetic variations within and between populations. This is undertaken in an effort to determine the mechanisms of adaptation and speciation (Lowe et al. 2004: Preface). It is still in relatively early stages of development and a single research project might typically stretch longer than the career of the researcher. Researchers studying genetics (Graur et al. 1996; Kryger 2002; Robinson & Matthee 2005; Ben Slimen et al. 2006) have undertaken studies on Lagomorpha DNA, protein sequences and Mitochondrial DNA (mtDNA) that track their possible evolutionary path and phylogenetic relationships within the order, family or genus.

A crucial point to consider is that DNA is not the blueprint of an animal or species. The blueprint is derived from the interaction of the genetics of an individual organism and the environment. The genetic drift that results from population migrations and/or environmental disasters may also influence the make-up of genetics (Matisoo-Smith & Horsburgh 2012: 13-14). mtDNA is particularly suited to DNA studies as it is passed on only through the maternal line, it accumulates mutations easily and therefore indicates variations within species (Matisoo-Smith & Horsburgh 2012: 15; Campana et al. 2013: 25). Y chromosomes are only found in the cell nuclei and can limit ancient DNA (aDNA) studies, as they can only be used when the nuclear DNA of a male specimen is well preserved. Y chromosomes have few variations and the information that they can provide on phylogenetic information is limited (Campana et al. 2013: 25).

Not all mutations are functional, some are silent mutations that remain unexpressed and do not affect the organism in any way. Mutations occur randomly and are not acquired through an organism’s particular needs. If a mutation happens to affect reproductive success, it may become a feature in future offspring. Mutations occur in a clock-like fashion and can be used to track changes in an organism through time. When this frequency of mutation is compared in two or more DNA sequences the two individuals with the most similar strands can be reliably assumed to share a more recent common ancestor. These similarities and differences in the DNA are used to reconstruct the phylogeny of an organism (Matisoo-Smith & Horsburgh 2012: 32).

2.4.1 The scope and limitations genetic research

Despite the valuable contributions DNA studies can make within archaeozoology, the technology remains expensive and beyond the normal faunal identification budget in Africa (Gifford-Gonzalez 2013: 6). aDNA analysis usually requires radiocarbon dates for all specimens that yield viable aDNA samples, adding further cost implications (Campana et al. 2013: 32). The extraction of viable ancient genetic material also depends on the preservation of the faunal specimens, and conditions in Africa are not wholly conducive. The success rate for the amplification of aDNA from moderate temperatures was found to be 23-67% and 2-4% in hot arid climates (Edwards et al. 2004). Although overall success rates have been low for aDNA extraction in Africa as a whole (Bollongino & Vigne 2008), new approaches are constantly being developed and may enhance the chances of successful extraction and amplification (Mohandesan et al. 2017).

Temperature, the chemical composition of the soil and the bone, groundwater pH and moisture levels all play a role in the decay or preservation of DNA in faunal material. It is also a process that is not yet completely understood (Allentoft et al. 2012: 4725; Pruvost et al. 2007: 739). Excavating faunal material changes the macro-environment, and this, coupled with post-excavation environments, can have dramatic consequences on the preservation of DNA (Pruvost et al. 2007: 740). In addition, there is variance in DNA preservation from sample-to-sample, a factor that is not always due to the archaeological age of the specimen. Allentoft et al. (2012: 4725) noted that a 45.2% difference in preservation can be caused by a combination of storage conditions and the archaeological age of the specimen.

These processes do not start in the laboratory but at the point of collection in the field. For this reason, most faunal collections housed in holding institutions will be unsuitable (Campana et al. 2013: 32). Yet, even if aDNA material is successfully extracted and analysed, comparative genetic markers/maps in the GenBank[3] have to be unquestionable (Yang et al. 2005: 574, 576, 577). Problems such as genetic drift, variations in groups and interbreeding also make an accurate comparison between aDNA and material stored in GenBank (and similar databases) very difficult.

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[3] GenBank is the NIH genetic sequence database, an annotated collection of all publicly available DNA sequences and can be accessed at https://www.ncbi.nlm.nih.gov/genbank/

2.4.2 Scope and limitations: A case study

Yang et al. (2005) used aDNA and the standard species size differentiation between *Lepus* spp. and *Sylvilagus* sp. (cottontail rabbit) to analyse archaeological rabbit remains from sites in the American southwest. Due to the fragmentary nature of the faunal material, coupled with the lack of genus/species-specific morphological features, most Lagomorpha remains are identified based on size. Fortunately, in this specific instance, it generally holds true that *Lepus* spp. skeletal material is larger than that of *Sylvilagus* sp. However, in extremely fragmented material, this size distinction is very difficult to detect, often resulting in their (mis)identification as rabbit. Thus stated, size alone is a very subjective criterion for identification (Yang et al. 2005: 567-568).

Within Yang et al.'s (2005) study, only 20 bones were found suitable for the extraction of aDNA. The aDNA results showed that the size separation was useful in 88% of the *Lepus* spp. and 75% in the *Sylvilagus* sp. remains. The intermediate size that could belong to either species only showed a 25% match rate, and as a result, smaller *Lepus* spp. specimens could potentially be misidentified (Yang et al. 2005: 573). Identification of the *Sylvilagus* sp. material proved to be more challenging than the *Lepus* spp. due to the different reference DNA in the GenBank. Concurrent, cross-comparison was not possible on account of the lack of reliable morphological data (Yang et al. 2005: 574). These results did yield one unexpected species, *Lepus americanus* (snowshoe hare), whose current distribution range is nearly 40km from the archaeological site, suggesting that the site falls within an ecological zone not currently inhabited by the species. This find holds interesting implications for ecological research, hunting practices and possible inter-group bartering (Yang et al. 2005: 567). In conclusion, Yang et al.'s (2005) paper clearly show that DNA analyses are useful but also limited. It should be kept in mind that even a small faunal sample could consist of 500 individual bones of which only six might be suitable for aDNA extraction (see Campana et al. 2013: 3278 for criteria), which still leaves 494 bones that require analysis according to more conventional practices.

2.4.3 Application within archaeological research

DNA analyses can confirm or discredit identifications that have been made (Yang et al. 2005; Driver 2011: 38), it is not possible to determine whether the bones form part of one animal or multiple individuals (Campana et al. 2013: 31). DNA can therefore confirm the presence of a species on site but can offer very little evidence of population density that morphological analysis of faunal material can provide. To obtain population-level aDNA, a large sample size is required and this is often difficult to obtain from a single archaeological site (Campana et al. 2013: 30). Whereas species can be separated in zoology by using external biological features, for instance fur colour, ear length, and internal biological features such as DNA, these distinctions are not visible in the osteology (Ben Slimen et al. 2006; Driver 2011: 23). With these factors considered, DNA should be employed as an additional tool to investigate faunal remains, but should not be used as a replacement for morphological and morphometric studies. Rather, these two fields of study should work in tandem to advance both research fields.

2.5 Background to Lagomorphs

On account of similarities in the development of their large ever-growing incisors, and the morphology of their brains and reproductive systems, the Lagomorphs were initially classified as a suborder of rodents. In Gidley's (1912) article, the Lagomorpha are positioned in an independent order, since acquired characteristics were identified that equate Lagomorphs with higher ungulates rather than with the more primitive rodents. Gidley (1912) lists several morphological features that distinguish the Lagomorphs from the rodents. These include dental and skeletal features such as (i) the occurrence of four top incisors in Lagomorphs compared to the two top incisors in rodents, (ii) the lack of rotation in the elbow joint of Lagomorphs compared to the free rotation of rodents, and (iii) the articulation of the fibula to the calcaneus in Lagomorphs compared to the non-articulation in rodents (Gidley 1912: 286).

The order Lagomorpha consists of two families: the Ochotonidae and the Leporidae. The Ochotonidae comprises a single genus *Ochotona* the pikas of North America and Eurasia. The Leporidae encompasses the rabbits, jackrabbits, and hares. The rabbits consist of ten genera, and although they have species in the genus that are colloquially referred to as hares, these are in fact rabbits. The genus *Lepus* is widespread in both the Old and New Worlds. The only true hares in the genus *Lepus* are jackrabbits and hares that comprise 29 species. This genus is taxonomically complex in view of the large number of species, although the validity of many of these are under debate (Flux & Angermann 1990: 61-62, 71).

The Ochotonidae are small animals that sometimes weigh less than 100g. Their hind and front limbs are of equal length, their ears are round and the skulls exhibit short snouts with a total number of 26 teeth. The Leporidae are much larger, with individuals that can reach a weight exceeding 5kg. Their hind limbs are longer than the front limbs, the ears are elongated and the skulls are characterised by long snouts and prominent supraorbital bones. The Leporidae also have large eyes specifically adapted to their nocturnal habits (Angermann et al. 1990: 7; Chapman & Flux 1990: 1-2).

The Lagomorpha group (Table 2.1) in southern Africa consists of two hares (*Lepus saxatilis* and *Lepus capensis*) and four rabbit species (*Pronolagus rupestris, Pronolagus crassicaudatus*, *Pronolagus randensis*, and *Bunolagus monticularis*)

Table 2.1: A classification of the order adapted from Meester et al. (1986: 298-307)

Order Lagomorpha		
Family Leporidae		
Genus *Lepus*	**Genus** *Pronolagus*	**Genus** *Bunolagus*
Species *capensis* (Cape hare) *saxatilis* (scrub hare)	**Species** *rupestris* (Smith's red rock rabbit) *crassicaudatus* (Natal red rock rabbit) *randensis* (Jameson's red rock rabbit)	**Species** *monticularis* (riverine rabbit)

2.6 Phylogenetic and taxonomic studies in Lagomorphs

Lagomorphs represent one of the least diversified orders in mammals (Hoffmann & Smith 2005). They are noted for their conservative morphological evolution over the last 50 million years (Fostowicz-Frelik & Meng 2013: 1). Ge et al. (2013) found that around 34 genera of Ochotonids (pikas) and 45 genera of Leporids were present in the group's evolutionary history. Of these, only one relic Ochotonid genus and 11 Leporid genera remain. The Lagomorpha phylogenetic information is thus fragmented and their morphological evolution decreased due to extensive extinctions (Ge et al. 2015: 279).

Unlike the Ochotonidae, the Leporidae are capable of consuming C_4 plants – a factor that is said to have played an important role in their morphological evolution (Ge et al. 2015: 278). On account of the widespread nature of the extant Leporid species, they show very little adaptation in their feeding, behaviour or locomotion (Angermann 1983: 17). Flux (1983) commented on the taxonomic problems encountered when dealing with hares. In addition, Griffith (1827 quoted in Flux 1983: 7) argues that:

> …it is difficult to distinguish whether their relative specific characters are those of affinity or analogy. This difficulty is increased when it is considered that they are widely spread over the earth's surface in the new world as well as in the old and that a diffused allocation is a great promoter of those differences which are decidedly attributable to variety.

Differences in size and coat colour can be attributed to climatic and habitational differentiation, with single characteristics eventually becoming over-emphasised due to the scarcity of distinguishing features (within that specific climate and habitat). The insufficient number of specimens and their dubious age classifications, either observed in the wild or examined in museum collections, have further hampered the validity of results. In addition, characteristics that have traditionally assisted in differentiating between individuals have seldom been helpful in inter-species distinction.

The fossil record shows that the stem Lagomorpha originated in Asia (Ge et al. 2013: 13). These records indicate that the Ochotonids consisted of 32 genera comprising approximately 180 species and that the fossil Leporids had 45 genera with possibly 190 species. Although the validity of several of these species is controversial, the data do provide crucial information regarding the evolutionary history of these animals (Alroy 2002; Ge et al. 2013: 3). During the early Miocene (17.8mya), the Ochotonids expanded into eastern Africa, with fossil evidence for *Kenyalagomys* found at Rusinga Island, Kenya (Kryger 2002: 4; Wessels et al. 2003; Winkler & Avery 2010: 307). In southern Africa Arrisdrift, Elisabethfeld, Langental, and Grillental in Namibia have yielded remains of Ochotonids (Winkler & Avery 2010: 308).

The divergence of the African Leporids dates to the late Miocene (6.57–6.54mya) at Lothagam in Kenya and the Middle Awash in Ethiopia (5.8–5.2mya) (Winkler & Avery 2010: 307). Global cooling and aridification during the late Miocene, with the resulting change to C_4 vegetation, suited the digestion of the Leporids, particularly that of *Lepus* spp., resulting in expanding habitat ranges and diversification. Lagomorpha remains have been identified in the faunal record from the Miocene (18mya) up to the present (Plug &

Badenhorst 2001: 220-227; Winkler & Avery 2010: 308-309; Ge et al. 2013: 3; also see Appendix D). The extant Leporids, and specifically the genus *Lepus*, expanded and diverged from North America into Africa around 5.32mya (Ge et al. 2013: 5)

The taxonomic status of the genus *Lepus* was discussed at length at a symposium held during the 1982 Third International Theriological Congress. The papers presented were subsequently published in *Acta Zoologica Fennica* (1983 Volume 174). No less than six papers dealt with the taxonomic difficulties of the southern African species of this genus. The most important concerns remain the relationship between *Lepus capensis* and *Lepus europaeus* as well as the relationship between *Lepus saxatilis*, *Lepus victoriae*, *Lepus whytei* and *Lepus crawshayi*. Meester et al. (1986: 299) regard *saxatilis* and *capensis* as the only two species of *Lepus* represented in southern Africa.

Genetic studies indicate that there are phylogenetically two species of hare in South Africa that each have sibling species (Kryger 2002: 155; Kryger et al. 2004). This research was supported by Suchentrunk et al. (2009) in an article that answered the proposed splitting of *L. capensis* into *L. capensis* and *L. centralis* based on their morphology (Palacios et al. 2008). Since DNA and morphology do not always converge, Caumul and Polly (2005) argue that mammals whose last common ancestry can be measured in hundreds of thousands, or even millions of years, will provide the best phylogenetic results. This time span roughly equates to 1–10% divergence in the mtDNA sequence of the mammals. Ge et al. (2015: 278) concur as they found no statistically significant phylogenetic signals in the skull shapes of the Lagomorphs that they examined. They attribute this to the divergence of the Lagomorpha ancestry at 52mya, which provides a relatively long evolutionary history for the group. This means that even though sibling species have been identified through the use of mtDNA, these siblings will probably not be visible in morphological investigations.

2.7 *Lepus saxatilis* and *Lepus capensis*

2.7.1 *Lepus saxatilis*

Lepus saxatilis occurs exclusively in Africa and ranges from Senegal eastwards and down to the Cape. It is a relatively large animal with a body weight of 2–4kg (Skinner & Chimimba 2005: 69). The coat colour varies between a brown-grey for the lowland, and a darker grizzled grey for animals in high altitude regions (Flux & Angermann 1990: 85; Skinner &

Chimimba 2005:69). The females are larger and heavier than the males but not significantly so (Skinner & Chimimba 2005: 69). According to both Flux and Angermann (1990: 85) and Skinner and Chimimba (2005: 69), these animals show a decrease in size from the central south Cape (with an overall body length of 600mm) to the north-east (with a total length of 500mm). *L. saxatilis* prefers scrubland and savanna woodland with grass cover, and are common in agriculturally developed areas, concentrating in the vicinity of growing crops (Skinner & Chimimba 2005: 70). The species is nocturnal and emerges for feeding at sundown to consume leaves, stems and rhizomes of dry green grass, but prefers succulent green grass. When flushed, they run in an irregular course with their ears back (Skinner & Chimimba 2005: 70). They do not make use of holes dug by other animals to hide in as *L. capensis* does (Apps 2000: 117).

Figure 2.1: Scrub hare (*Lepus saxatilis*). Photo credit – William Frost – used with permission

2.7.2 *Lepus capensis*

Lepus capensis has a very wide distribution range — from southern Africa to East China. Due to their wide distribution, many forms and inter-population variations have been described and the taxonomic limits of this species are therefore uncertain (Happold 2013: 699). There are great variations in size, with animals ranging from 1–3.5kg in body weight, and with females larger than the males (Skinner & Chimimba 2005: 67). Variations in coat colour within the species can range from exceptionally pale to black in appearance (Flux & Angermann 1990: 73; Skinner & Chimimba 2005:67).

In southern Africa they are found from the Cunene River (Namibia) in a band reaching southwards towards the Cape coast. In Botswana this species is present in grasslands surrounding the Makgadikgadi Pan. In Zimbabwe their range is limited to particular areas in the southeast, and in Mozambique to the south of the Zambezi River. In South Africa *L. capensis* ranges from the far north of the Limpopo Province, the western North West Province, across the Free State Province, the north-western parts of the Eastern Cape Province and widely throughout the Western and Northern Cape Provinces (Skinner & Chimimba 2005: 68). *L. capensis* prefers open arid habitats where they can browse or graze on palatable bushes and grasses. This habitat preference is the main difference with *L. saxatilis*, with the latter preferring scrub land. Like *L. saxatilis*, they too frequent degraded ground around kraals and human habitats where the grass is kept short by grazing livestock (Skinner & Chimimba 2005: 68). Although predominantly nocturnal, they have been known to forage during the day when the weather is overcast. They tend to be less active during cold weather and remain undercover during rain. This species is apparently not dependent on water sources as they obtain their daily intake of liquids from dew and the plants they consume. *L. capensis* lies up in forms (body indent in the ground) under small bushes or in grass clumps during the day. When roused, they will run off in a zigzag pattern with their ears erect and can make extremely tight turns at high speeds. Under stress, they will make use of antbear (*Orycteropus afer*) or springhare (*Pedetes capensis*) holes to hide (Skinner & Chimimba 2005: 68).

Figure 2.2: Cape hare (*Lepus capensis*) Photo credit – Gerald and Buff Corsi © California Academy of Sciences

2.7.3 Differentiating between *L. saxatilis* and *L. capensis*

In addition to her DNA samples, Kryger (2002: 125-127, 132) applied some of the morphological features previously thought diagnostic to the species. These features include ear length, incisor breadth and the incisor groove (Robinson 1986; Suchentrunk & Flux 1996) as well as the presence/absence of a white spot on the forehead. Prior to her study, most taxonomic hypotheses concerning hares were made using external and cranial morphological characteristics (Kryger 2002: 127), but as Kryger (2002: 145) found, it was not possible to consistently apply the abovementioned external morphological characteristics to distinguish between *L. saxatilis* and *L. capensis*. However, the results did corroborate the findings of Robinson (1986) in that the incisor enamel fold consistently, but not exclusively, occurs within specimens of *L. saxatilis*. Kryger's (2002: 152) research findings also supported a general body size decrease in *L. saxatilis* from the southwest to the northeast in South Africa (Robinson & Dippenaar 1983; Skinner & Chimimba 2005: 69).

Based on the levels of genetic differentiation and phylogenetic relationships, Kryger (2002: 155) identified four discrete lineages amongst the South African hares. These genetic results suggest that the South African hares are taxonomically divided into two main species groups (the following terminology used is Kryger's) namely *Lepus saxatilis sensu lato* and *Lepus capensis sensu lato*. She identified two sibling species belonging to each main species. For *Lepus saxatilis sensu lato* the two sub-species are *Lepus saxatilis sensu stricto*, which is restricted to the southwestern corner of the Western Cape Province, and *Lepus victoriae* (?) (question mark by Kryger), which occurs throughout the central and northern regions extending into Namibia, Botswana, and Zimbabwe. For *Lepus capensis sensu lato*, the two sub-species are *Lepus capensis sensu stricto*, which is restricted to the south-central areas of South Africa, and an unnamed sibling[4], which is distributed throughout the northern parts of South Africa reaching into Namibia.

Maduray et al. (2007) used traditional as well as geometric morphometric techniques to analyse the cranium and mandibles of some of the hares collected for Kryger's 2002 study. The research was undertaken to determine whether the identified genetic sub-species could be observed in the skeletal material. The researchers did find some resemblance between the results obtained from morphometrics and those gathered through genetic research.

Palacios et al. (2008) conducted a morphological study on the hares from the Cape Province region in order to characterise the species *L. capensis*.[5] Their findings facilitated a provisional split of the Cape hare into two species; *L. capensis*, distributed near Cape Town between Lambert's Bay and Cape Agulhas, and *L. centralis*, encountered in the Central and Western Cape Province. The researchers used cranial and dental features as well as variations in coat colours in their analysis. Neither the study by Maduray et al. (2007) nor that of Kryger (2002) is mentioned or listed in the references of Palacios et al. (2008).

In partial response to Palacios et al. (2008), Suchentrunk et al. (2009) studied molecular characteristics from different regions in South Africa, and in particular the two regions identified by Palacios et al. (2008). This was undertaken to determine whether the two species suggested by Palacios et al. (2008) can be distinguished genetically. Suchentrunk et al. (2009) suggested that the coat colouring and dental groove used by Palacios et al. (2008) were not as distinctive as the latter made out. Suchentrunk et al. (2009) further argue that the molecular data show no clear evidence for a second distinct species.

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[4] This sibling has not yet been identified or placed within any of the existing suspected species

[5] Note that Palacios et al. (2008) do not distinguish between the current three Cape provinces; i.e. East, West and North, and treat the whole region as the Cape Province. See Palacios et al (2008: Figure 7, page 368).

Zachos et al. (2013) expressed concern over the inflation of taxonomy through the elevation of subspecies to species level as well as the identification of new species without sufficient morphological and/or genetic evidence. They requested that morphological data for the splitting/or elevation of species be based on more than mere qualitative character-derived differences (Zachos et al. 2013: 5).

2.8 Archaeological and archaeozoological application and indications

Archaeozoological research can assist in pinpointing areas of rapid human population growth and technological advancement (Stiner et al. 1999: 193). In addition, the data can be used to explore the utilization of local environments for the required subsistence resources (Pavao & Stahl 1999: 63; Yang et al. 2005: 576). Yang et al. (2005: 576) demonstrated that the study of rabbit remains could point to varying habitat adaptations and population ecology of the species. They speculated that these were brought about by human hunting and farming practices. The same holds true for other animal species (Yeshurun et al. 2009; Mallye 2011; Dias et al. 2016).

2.9 Material grouping, description, and identification

In archaeozoology faunal material is grouped using two biological schemes, namely the International Code of Binomial Nomenclature (ICZN), and the standardised anatomical description such as those used in Dobney and Rielly (1988). In a re-publication of his 1992 paper, to which comments have been added, Driver (2011) queried whether faunal remains indeed fit into the mould of artefact typologies. The article points out three distinct differences between faunal materials and traditional artefact typologies. Firstly, artefact groups are exclusive and are defined by non-random associations of attributes. Animals, on the other hand, are assumed to have phylogenetic relationships that are reflected in their Binomial Nomenclature classification. Secondly, the most basic form of an artefact, namely the type, does not exist as a population and cannot reproduce. The most basic form of zoological classification is the species, which does belong to a population, can reproduce, and is defined by this behaviour. Thirdly, artefact typologies are created to assist in answering research questions whereas zoological classification is descriptive and can appear in research that does not deal with phylogenetic issues (Driver 2011: 20-21).

Most archaeozoological identifications are still made on the basis of non-destructive methods of morphological and morphometric differentiation (Lupo 2011: 32; Campana et al. 2013: 31), and very rarely do archaeozoologists publish the size criteria or keys used to separate two genera (Yang et al. 2005: 573). Lyman (2011: 33-34) urges archaeozoologists to learn from and adopt the protocols used by palaeontologists for taxonomic identification. He points out that in the write-up of descriptive or systematic palaeontology, the morphometric criteria used in the identification of each specimen are provided. Moreover, each identification is fully described in the text and accompanied by an illustration. However, this is not feasible in archaeozoology. It is recommended that with key and anomalous species this protocol should be followed.

2.10 Possible explanations behind abundant and/or absent remains

Following the reference list in Plug and Badenhorst (2001), all listed articles and reports were examined for mention of any member of the Lagomorpha family. In addition, publications since 2001 were located and duly examined. All data gathered were entered into a spreadsheet (Appendix D) following the time periods used by Plug and Badenhorst (2001). It was decided to keep this time period index for consistency. Appendix D indicates the Number of Identifiable Specimens (NISP) and/or Minimum Number of Individuals (MNI) and/or in a few cases, the Quantifiable Specimens Present (QSP) counts from the relevant published faunal lists from archaeological sites.

2.10.1 The use or lack of local opportunistic procurement

Daly (1969: 149) discusses the so-called *schlepp effect*. This entails that the further from the point of consumption an animal is killed, the fewer bones will be '*schlepped*' back to the home or camp. Small taxa such as hares are relatively easily procured through net hunting, with traps, snares, bow and arrow, the aid of dogs or with a stick used as a club or missile (Campbell 1815: 367; Fitzsimons 1920: 191; Shaw 1959: 97-98, 356; Hammond-Tooke 1962: 25; Lee 1985: 208; Shaw & van Warmelo 1981: 321-322, 343). Coupled with their live weight of less than 5kg, they would incur very little *schlepp* and can be carried home intact (Grivetti 1976: 289; Lee 1985: 219).

It is also possible that hares represented too high an energy investment for such a low energy yield (low meat returns), especially when compared to the abundance of high energy-yielding (high meat returns) prey. South Africa has abundant prey animals in comparison with Europe and America, with Africa hosting almost a quarter of the world's mammal species. Of these, artiodactyls (even-toed ungulates) comprise one of the largest groups (Bigalke 1968: 265). Hyrax (*Procavia capensis*), that is present at most sites and at some in abundance, was possibly easier to hunt than hares. The variety and abundance of antelope species would also yield a higher meat return on energy investment.

The smaller number of hares that are generally recovered from archaeological sites could possibly indicate incidental kills, kills by practising young hunters, and/or garden hunting of pests in the Iron Age (IA) (Madeira 1909: 192-193). As a fur animal they could have been sourced for their skins or to be used as decorative elements on clothing (Beach 1984: 31; Lee 1985: 101, 117). The tail of the Cape hare was, for example, used as a headdress decoration (Quin 1959: 127). Hares are also used in zootherapy[6] (Quin 1959: 127; Gelfand et al. 1985: 310; de Weerd 2010: 123,153, 165, 173, 205, 242, 361, 380, 381, 397, 400, 476). Higher NISP numbers for Lagomorphs found during analyses may therefore indicate targeted hunting (See Appendix D for numbers of Lagomorpha remains identified in South African archaeological sites).

2.10.2 Environmental and density-mediated destruction

The survival of bone in the archaeological record is dependent on physical properties, such as porosity, morphology, size, and density. The environment where these sites are located, as well as the acidity of the soil and the water, will all have an effect on the survival of bone material. All bone is affected by pre- and post-depositional attritions that involve all processes that might influence the preservation of skeletal material. Pre-depositional processes include butchering techniques and meat processing (such as boiling), as well as anthropogenic and carnivore damage. Post-depositional processes are chemical or mechanical actions that occur after the material is deposited into the sediment. Once deposited, bone material can either be fragmented or totally destroyed (Marean 1991: 677).

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[6] Zootherapy refers to animal-based medicine, an aspect of archaeozoological research that has, until recently, been largely overlooked or to some extent not viewed through the correct theoretical lense (Miller & Sykes 2016).

Sites and their level of preservation differ even were localities are just a few hundred meters apart. The presence of a preservative agent, such as ash, could determine if the bone material is preserved or not.

Differences in structural density are to be expected when the basic principles of functional anatomy and adaptation are taken into account (Wall 1983; Stein 1989; Kreutzer 1992). Hares and rabbits avoid predation in very different physical ways, which have an impact on bone density. Hares employ high-speed running and jumping, while rabbits engage in cryptic behaviour, hopping in various directions and making use of constructed burrows to hide (Pavao & Stahl 1999: 62). The skeletal parts utilised in sustained speed and distance running will by implication be denser and can thus withstand higher pressure and use. These denser skeletal parts make it more likely that they will survive in the archaeological record. Density-mediated attrition is believed to play a vital role in the survival of skeletal elements through time (Lyman 1984; Klein 1989; Cruz-Uribe & Klein 1998; Schmitt & Lupo 1995). If this is true, then less dense bones will fragment easily with the result that less dense fragments will be absent or rare in an assembly as more dense fragments will remain intact or be prone to breaking into identifiable pieces (Lyman et al. 1992: 569). Following this line of argument, less dense bone fragments will be absent or rare in an assemblage (Marean 1991: 678). Density-mediated attrition is therefore vital for the survival of skeletal elements through time (Lyman 1984; Klein 1989; Cruz-Uribe & Klein 1998; Schmitt & Lupo 1995).

Pavao and Stahl (1999), in a study of the structural density of Leporid bones, found that certain elements are denser than others in keeping with their fleeing behaviour. The high-density skeletal elements are located in the hind limbs and the least dense in the forelimbs and ribs (Pavao & Stahl 1999: 60). The midportion of the calcaneus proved to be the densest, the distal femur much denser than the proximal, the proximal tibia marginally denser than the distal end, and the proximal humerus denser than the distal. Both the radius and ulna are relatively less dense compared to the other long bones. The radius proximal and distal ends are equal in density, whereas the proximal ulna is vastly more dense than the distal end (Pavao & Stahl 1999: 62). Should these densities hold true, it will be very useful to investigate the relative abundance of faunal remains and not just rely on the NISP values to determine fauna preference and use.

Lyman et al. (1992) investigated the effect that structural density had on the skeletal part representation of marmot (*Marmota flaviventris* and *Marmota monax*) bones at the archaeological sites of White Mountains, California and Salishan Mesa, Washington, in America. At White Mountain, they found that density had minimal effect on preservation. In this case the identification of element or taxon was influenced by the fragmentation rate of the material (Lyman et al. 1992: 569). At Salishan Mesa, the skeletal part frequencies correlated with density values (Lyman et al. 1992: 571). Based on these results, the researchers call for holistic site interpretations and not just a quick-fix explanation of bone density (Lyman et al. 1992: 572; Darwent et al. 2013).

According to Lyman (1984: 281), there are "minor differences in bone density between species of the same genus and slightly greater differences in bone density between genera of the same family.” Whether this holds true for similar genera from different continents has yet to be established.

2.10.3 Sieving techniques, sieve size, and lack of fieldwork experience

Screen size used during excavation is a widely debated issue in archaeozoology, with many studies having been conducted to determine whether losses in material/artefacts and thus data, actually result. Control studies have been conducted in laboratories (Shaffer 1992a; Shaffer & Sanchez 1994; Nagaoka 2005), and on archaeological material (Thomas 1969; Gordon 1993; Hutten 2005; Nagaoka 2005). These studies conclude that if 5mm sieves are used, a significant portion of the faunal data will be lost. An exception is in the case of Vale and Gargett (2002), who found that the use of a finer mesh size did not yield more significant data. If there are biases in the recovery methods on account of the mesh size, and problematic excavation, sieving, and sorting techniques, these could have a dire impact on data recovered (Densmore 2009: 41). Lyman (2012b: 1860) concludes that the sieve mesh size selected should depend on the particular deposit being sampled and the research question being asked. There are differential recoveries of material between wet and dry sieving.

Shaffer and Sanchez (1994) proved that animals with a body mass of 4.5kg and smaller skeletal elements have a greater potential to be lost when using coarse sieves of 5mm and larger. They recovered only vertebrae, carpals, patella, and phalanges with the use of a 5mm screen. On the contrary, it is important to note that with the use of a 2mm mesh they recovered metapodials and tarsals of the jackrabbit (*Lepus californicus*) (Shaffer & Sanchez 1994: 528). These experiments were conducted with complete skeletal elements placed in the sieves, and with no additional material normally associated with the archaeological record, such as stones, soil, and plant material. It has to be kept in mind that archaeological faunal material is more likely to be fragmented. If the fragmented faunal material is combined with the normal archaeological detritus, the loss of potentially identifiable faunal material will be even greater through large sieve mesh (Shaffer 1992a: 130).

Sieves are inanimate objects and thus the recovery of material relies on the skills of the individuals who are sifting and sorting. This is another hotly debated issue about which little has been written. "Field staff are the principle limiting factor in an assemblage's capacity to support research because they pick out what they are told or shown to pick out, and discard the unusual stuff" (G. Campbell Pers. Comm. 2015). "My advice to archaeologist doing sieving in the field, and when they don't have experienced osteologists with them at the site, is to sort out what is not bone and to leave all the rest for sorting in the lab" (L Jonsson Pers. Comm. 2015).

The archaeological record is finite and non-renewable. If the excavation and recovery methods are not planned for maximum retrieval, valuable and potentially crucial information for the interpretation of the site and the environment will be left in the spoil heaps. Understanding the role of mesh size used and the potential bias it creates in the faunal record is crucial. As a result of inadequate recovery procedures, serious errors in the interpretation of food procurement and subsistence strategies have occurred and will continue to do so (Gordon 1993). The majority of South African faunal reports sampled for their fauna data that specifically pertain to Lagomorphs (see Appendix D), do not mention the sieve mesh size (see Klein 1978; Mazel 1990; Schrire et al. 1993; Plug 1997; Badenhorst 2003; Sadr 2007; Wadley 2008; Nelson 2009). A limited number of articles do indicate mesh size (see Orton et al. 2005: 27; Bradfield et al. 2009: 176; Jerardino et al. 2009: 75; Antonites 2013: 99), with one in particular mentioning that all the material was sieved through a 5mm and a 1mm mesh size (Esterhuysen 2010: 68). Antonites (2013: 99) mentions that 5mm sieves were used for his excavations at Mutamba, Limpopo Province, and that ten-litre bucket flotation samples were taken from each excavation block. Flotation is a seldom-used method of retrieval on South African archaeological sites and its effects on faunal retrieval are not included in this discussion. Gordon (1993: 458) comes to the conclusion that oversight to report the sieve mesh size that was used during excavation complicates the interpretation and comparison of faunal data between sites. Out of 96 published articles on southern African archaeological sites that include faunal reports, only 13 mention the sieve sizes that were used during excavation. As noted above, this oversight will make inter-site faunal data comparison difficult.

2.10.4 Skill and technique of the faunal analyst

Archaeozoological work is largely based on pattern recognition (Wolverton 2012: 392). Detailed documentation of descriptive attributes is extremely important as two researchers can examine the same specimen and propose different results (O'Connor 1996; Gobalet 2001; Bochenski 2008). A basic familiarity with skeletal anatomy is required to make intra- and inter-taxonomic identifications. This involves consulting published guides/keys and accessing skeletal collections with known taxonomic identities that are usually housed in museums and at some universities. Most archaeozoologists prefer the latter method, as it is still the most reliable means of species identification. The analyst needs to know which features are taxonomically diagnostic and should be able to identify qualitative or morphological traits that are present or absent. Quantitative traits can include counts of anatomical structures and metric annotations of features or bone size.

Most papers mention, and/or are written by, the person(s) who identified the remains, but seldom document their qualifications, experience with fragmented fauna, the methods they employed, or the comparative skeletal collection utilised (Gobalet 2001: 377). The following example is used to demonstrate the varying levels of expertise: "Identifiable bone was studied by Job Kibii (University of the Witwatersrand). Kibii mostly identified faunal classes rather than species (van Doornum 2007: 32)." The above article provides no explanation as to why the material was only identified to class level. A comparative collection, with more than one specimen per species, is essential for reliable identification, especially between two closely related species (Bochenski 2008: 1247). "Experience may be the best teacher in terms of the taxonomic level to which the identification of a particular specimen can confidently be taken, this is particularly so with fragments of skeletal elements" (Lyman 2002: 16).

These authors have called for data quality as well as quality assurances in archaeozoology. They urge analysts to not only publish their findings, but also the methods and criteria used in identification. Unfortunately, it seems that journal editors are reluctant to include large tables or extensive descriptions due to space limitations. As a result, Cruz-Uribe noted during a panel session at the Society for American Archaeologists (SAA) 60th Annual Meeting that published faunal identifications have to be taken, at some level, on faith (Butler & Lyman 1996: 22).

2.11 Summary of Chapter 2

While Lagomorphs occur all over the world they are as a whole understudied and underdescribed. As a result, their evolutionary history remains unclear. External morphological and morphometric, as well as genetic studies of the South African hares, have been undertaken in an effort to clarify their taxonomy. These are of limited use in archaeology thus the reliance on skeletal morphology and morphometrics.

Hare remains are found in almost all archaeological faunal assemblages, yet the amount of material recovered and/or identified differs markedly from site to site. This phenomenon can be attributed to single or combined factors in the field and laboratory.

In the next chapter the methodology followed to establish the protocols for inter-species identification is discussed.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This study explores and describes the differences between the skeletal elements of the two *Lepus* species of southern Africa. The research is both qualitative and quantitative, since morphological and morphometric data were gathered to establish any visual and measurable differences between the two taxa. The production of skeletal keys is extremely labour intensive, since the skeleton of every species contains hundreds of bones. As a result, they are relatively rare in vertebrate archaeozoology.

This chapter begins with a brief overview of the history of morphological and morphometric studies. The criteria used to select the specimens for the current study are discussed. The establishment of protocols for each species is described and the statistics used to explore the data are reviewed. The nomenclature for each bone and the points where each morphometric measurement was taken are illustrated with photographs.

3.2 Morphological and morphometric studies

As explained in Chapter 2, comparative osteology underpins the science of archaeozoology (Nickel et al. 1992), as archaeozoologists use these techniques to assist in the identification of often fragmented remains. The process of identification needs to be independently reproducible and the criteria used for identification clearly defined. It is by this process of comparison of the skeletal elements of modern animals, of known origin and species, that diagnostic characteristics become known. The specimens used must preferably be wild healthy male and female adults. Animals that exhibit pathology are unsuitable and will not be used.

In terms of using zoological collections as reference material, uncertainties exist regarding the effects that captivity has on the skeletal morphology of animals. As many skeletons housed in museum collections are obtained from zoos, this is a very pertinent question (Bello-Hellegouarch et al. 2013: 306). Very few studies on this subject have been conducted, with most focusing primarily on crania (O’Regan & Kitchener 2005: 227). Zoo animals that are housed under conditions that simulate their natural environment may not differ at all (Peters & Brink, 1992: 166; I. Plug Pers. Comm 2016). Studies have demonstrated that there are no significant morphological differences between captive and wild specimens and that captive specimens can be used, with caution, in skeletal morphological studies (O'Regan & Kitchener 2005; Morimoto et al. 2011; Bello-Hellegouarch et al. 2013; Lewton 2017). However, caution is needed, as it is not a given that all captive and captive-bred animals are unaffected just because the studied examples were not. It is an area of research that needs urgent attention (O'Regan & Kitchener 2005: 227). Morphological and morphometric studies depend on the availability of sufficiently large collections of modern reference material, as ample reference material is required to distinguish natural individual variation from characteristics that are diagnostic for the taxon (Boessneck et al. 1964; Peters et al. 1997). Due to the scarcity of post-cranial material available for study purposes, five *L. capensis* specimens that originated from the Bloemfontein Zoological Gardens were included in this study (See Appendix A).

3.3 Osteomorphology in archaeozoology

Taxonomy and how animals are placed within the evolutionary tree were discussed in Chapter 2. Certain skeletal characteristics relating to both form and function make individual skeletal elements identifiable to the trained archaeozoologists. Essential to this identification process is the concept of pattern recognition, since archaeozoological analysis is largely based on pattern recognition (Wolverton 2012: 392). Detailed documentation of descriptive attributes is extremely important as two researchers can examine the same specimen and propose different results (O'Connor 1996; Gobalet 2001; Bochenski 2008). However, it has to be kept in mind that these guides can never serve as substitutes for a complete comparative skeletal collection and should only be used in conjunction with, and not as a replacement of, a comparative skeletal collection (Lyman 2010; Wolverton 2012: 387). Internet keys with rotating photographs and 3D imaging are still very new and, while representing an important development for research, their validity and success remain to some extent untested (Betts et al. 2011; Maschner et al. 2011).

Geometric morphometrics provide a visual representation of shape and shape variation by using a system of coordinates (Cartesian landmarks and semi-landmarks), and represent a powerful tool for distinguishing between species. Although it is widely used in morphological studies of complete skeletal material, its effectiveness when dealing with fragmented faunal material is still being developed. Cornette et al. (2015), Dollion et al. (2015), Hanot and Guintard (2017) and Boroni et al. (2017) used geometric morphometrics to assist in the identification of fragmented archaeological and palaeontological faunal material. Their results were positive and demonstrated the potential of this method to aid future species identifications. The main objective of my study is to identify landmarks and metrics in the post-cranial elements of the two hare species that could assist in species identification when dealing with fragmented archaeological faunal material. The decision was thus taken to apply traditional morphological and morphometric techniques. There is no doubt that the future application of geometric morphometrics to fragmented material will yield interesting results.

When a skeletal key is established it is essential that several specimens are analysed to ensure that the identified feature is actually related to the species and not to the individual being examined. Just as the bodies of *Homo sapiens sapiens* vary in height, form (from petite to robust) and between the sexes, so do animal bodies within the same species. Males are normally larger than females, although there are exceptions; i.e. the spotted hyena (*Crocuta crocuta*). Some males have horns which are absent in females, e.g. klipspringer (*Oreotragus oreotragus*). Regional differences in Leporid size do occur (see measurement tables in Skinner & Chimimba 2005).

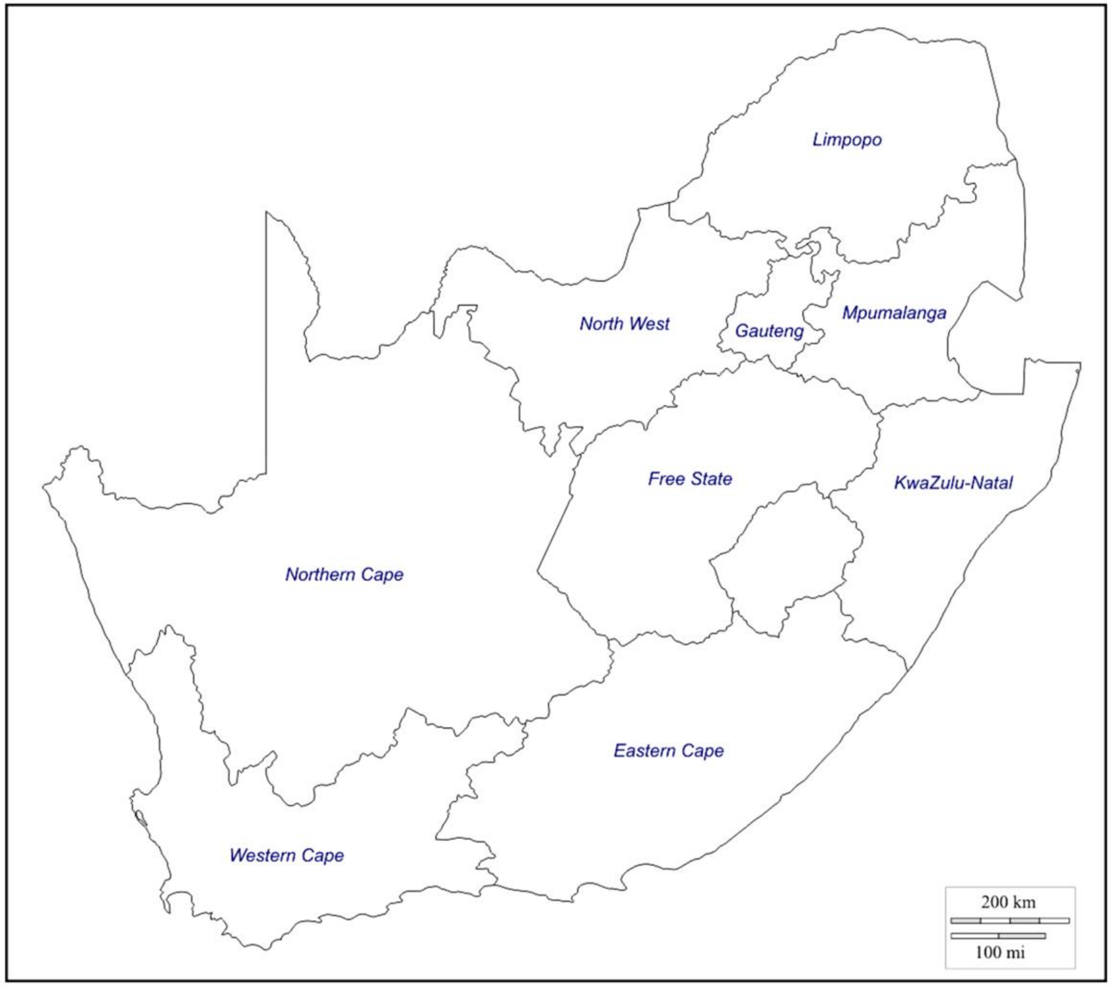
3.4 Specimen selection

The specimens used have been sourced from the collections of the Ditsong National Museum of Natural History and the National Museum in Bloemfontein. These specimens are of known taxonomic identity, since the results need to be reproducible. Appendix A includes the following information regarding the examined specimens: collection numbers, sex, the locality where the animals were obtained (Figure 3.1), as well as the skeletal elements present. It was the practice of early mammalogists to only keep the skulls and mandibles since these were thought to be the only skeletal elements that could be used for species identification. It is for this reason that only a limited number of complete (i.e. skull, mandible, and skeleton) specimens could be accessed in museum collections. The Ditsong National Museum of Natural History holds the majority of complete specimens in their Archaeozoological (AZ) and Mammal (TM) collections, namely 33 *L. capensis* and 38 *L.*

saxatilis from various localities. The National Museum in Bloemfontein (NMB) has one complete specimen of each species in their collection, both originating from the Eastern Cape region, while the Florisbad Quaternary Research Station (NMBF) holds well over 100 skulls with or without mandibles, and with or without humeri in their collection. The records of the South African Museum in Cape Town (Iziko Museums) show four *L. capensis* and three *L. saxatilis*. In light of the sufficient number of specimens housed at the Ditsong National Museum of Natural History and the National Museum in Bloemfontein, and in particular the inaccessibility of the Iziko collections on account of renovations at the time, the Iziko specimens were not included in this study.

The most complete specimens with intact skulls, mandibles and skeletons, were used in their entirety to obtain not only a full morphological but also a morphometric dataset for each specimen. It has to be noted that these specimens were not always complete, with either a side (left or right), or a complete element being absent. This is especially true for the small skeletal elements in the fore and hind limbs; i.e. carpals/tarsals, calcaneus, astragali, metacarpals/tarsals, and phalanxes. During skinning and preparation to produce skins for study, these bones were usually left in the front and back paws to maintain the shape of the appendage. Besides, the extraction of these bones was not possible as their removal would have resulted in damage to or destruction of the skin (T Kearney Pers. Comm. 2016). In addition, complete skulls with mandibles with no associated post-crania were examined to meet the research quotas. Appendix A provides a complete record of each specimen and the skeletal elements that were examined and measured.

Normally only adult animals are used for morphological and morphometric studies. In view of the limited number of post-cranial specimens available the decision was taken to include older sub-adults. The age was established by observing the fusion line of the epiphysis element. If the fusion line was still visible but closed and in the process of disappearing, the individual was included in the study.



Limpopo Province
None

Mpumalanga Province
2 - *L. capensis*
3 - *L. saxatilis*

KwaZulu-Natal Province
None - *L. capensis*
7 - *L. saxatilis*

Eastern Cape Province
1 - *L. capensis*
7 - *L. saxatilis*

Western Cape Province
None - *L. capensis*
1 - *L. saxatilis*

Northern Cape Province
14 - *L. capensis*
9 - *L. saxatilis*

North West Province
4 - *L. capensis*
1 - *L. saxatilis*

Free State Province
14 - *L. capensis*
7 - *L. saxatilis*

Gauteng Province
1 - *L. capensis*
6 - *L. saxatilis*

Figure 3.1: Map showing locations of specimens used and sample sizes

For this study the following numbers of individuals were examined (Figure 3.1):

> *L. capensis*: 40 specimens were examined, of which 20 were female and 14 were male, while six were unspecified.
>
> *L. saxatilis*: 42 specimens were examined, of which 21 were female and 20 were male, while one was unspecified.

For specimens where external measurements and weight were recorded after capture, the information can be found in Appendix A.

3.5 Establishing skeletal differences

The differences and similarities for each individual skeletal element of *L. capensis* and *L. saxatilis* were established by using five individuals of each. This was done by the examination of each element of the two species placed alongside one another. The binomial nomenclature order in Schaller (2007: 10-79) was followed and used in the descriptions in Chapter 4. As some sections of bones are more accurately described in two seminal archaeozoological texts, namely von den Driesch (1976) and Dobney and Rielly (1988), these were used and the source clearly indicated. Each element was systematically examined and each similarity and difference was noted in separate documents for each species. Once the base descriptions were established for every individual element of each species, these were tested on all subsequent specimens. Differences observed were noted along with the corresponding accession number as well as possible explanations, i.e. individual, age-related or sexual dimorphism. By following the above methodology the validity and reliability of the characteristics that were recognised could be verified. As explained above, this method ensures that differences in morphology are in fact species diagnostic and not related to the individual examined. Specimens that were found to be outliers, and that were probably misidentified both by sex and/or species based on the established descriptions, were noted and also brought to the attention of the curator.

Morphometrics/dimensions are components of morphology (Reitz & Wing 2008: 64-65) and are seen as primary data (Reitz & Wing 2008: 158, 179). These could support observed morphology but may reveal morphology that is not visible to the eye, e.g. changes in body size over geographical areas or time (Reitz & Wing 2008: 182-190). All measurements were taken with digital calipers with 0.05mm accuracy. The proposed skeletal measurements in von den Driesch (1976) were used and, where necessary, new measurement points were established based on the observed morphology (see section 3.6).

Viscardi et al. (2010) give a comprehensive overview of possible disparate results that can arise when using measurements obtained from different researchers and by using different measuring instruments. All measurements for this study were taken and recorded by the author and the measuring instruments remained unchanged.

Since studies have already been conducted on the teeth of the *Lepus* species (see Chapter 2), no further analyses were undertaken of the dentition, though skulls and jaws were examined.

3.6 Measurement points

In this section, only the new measurement points that have been established will be illustrated.

3.6.1 Skull

Three measurement points were added (Figure 3.3):

20 – *Bullae* – one edge of calliper resting on the skull and other next to the process.

21 – *Bullae* straight across – edge of the caliper in the foramen next to the occipital and the other on the suture under the ear canal.

22 – *Bullae* diagonally across – edge of the caliper on the foramen next to the occipital over the broadest part with the other edge resting on the skull.

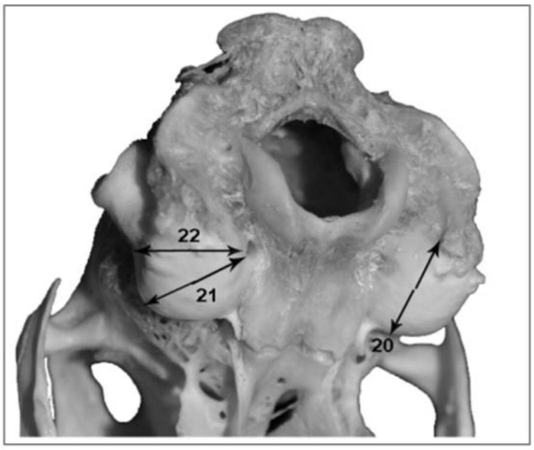


Figure 3.3: Skull with measurements 20, 21 and 22 illustrated

3.6.2 Mandible

Two measurement points were added (Figure 3.4):

6 – Height of the mandible in front of P3, measured on the buccal side.

7 – Height of the mandible behind M3 measured on the buccal side.

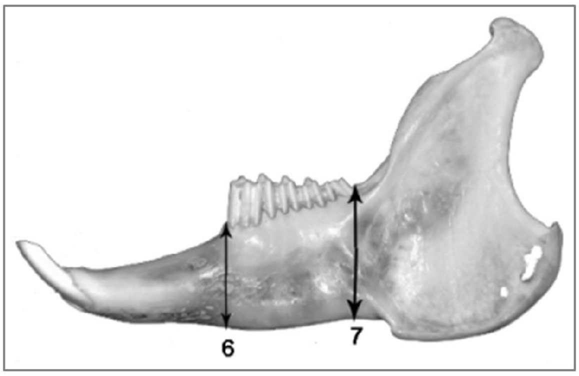


Figure 3.4: Mandible with measurements 6 and 7 illustrated

3.6.3 Atlas

Two measurement points were added (Figure 3.5):

LAd – Length of *Arcus dorsalis*.

LAdt – Length of *Arcus dorsalis* on tuber.

One measurement point was changed – Length of the *Arcus dorsalis* (LAd) was measured to the right/lateral side of the tuber. This measurement is usually only taken in carnivores. Seeing that the atlas so closely resembles that of carnivores, the decision was taken to include the measurement. A difference was observed between the two species – not on the tuber but on the length of the arch itself. The length of the *Arcus dorsalis* tuber (LAdt) was added and measured on the tuber.

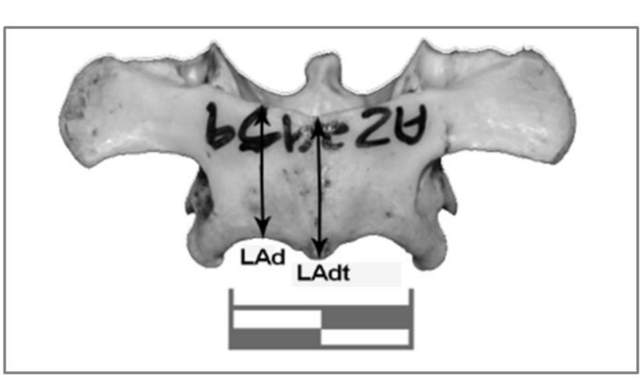


Figure 3.5: Atlas with measurements LAd and LAdt illustrated

3.6.4 Humerus

Two measurement points were added (Figure 3.6):

CL – Length of caput – Caliper edge resting on major trochanter.

DmTc – Depth of minor trochanter.

CL was introduced as a protrusion on the minor tuber side of the proximal articulation was observed. There are distinct differences in the depths of the major and minor trochanters and the DmTc was added in addition to the Dp measurement (von den Driesch 1976: 77).

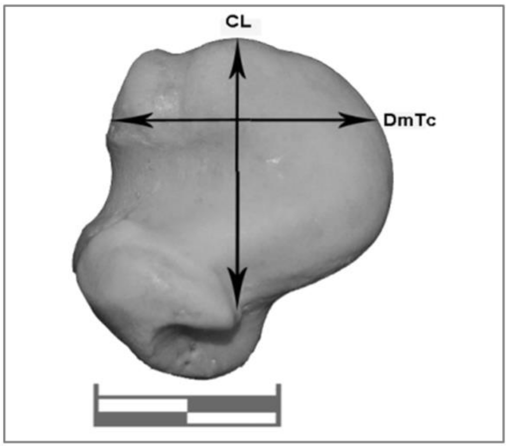


Figure 3.6: Humerus with measurement CL and DmTc illustrated

3.6.5 Radius

One measuring point was added and one was moved (Figure 3.7)

SD –Smallest depth of the diaphysis.

WD – Widest depth of the diaphysis.

The SD measurement as indicated by von den Driesch (1976: 79) was moved to just below the proximal articulation, as in Lagomorpha this is the smallest part of the radius shaft. The original measurement point was kept and renamed WD – Widest Depth, as the morphology showed a distinct widening of the shaft at this point in both species.

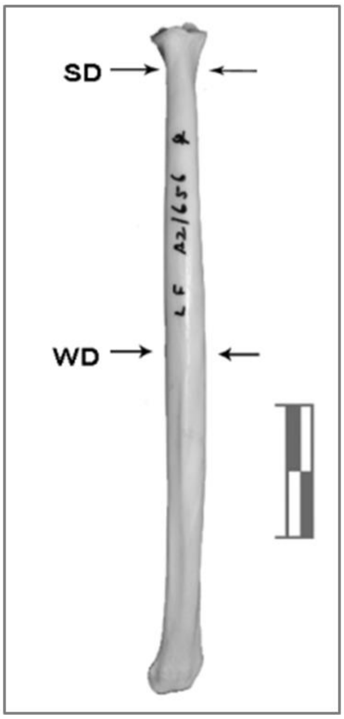


Figure 3.7: Radius with measurements SD and WD illustrated

3.6.6 Ulna

The orientation of two measuring points was adjusted (Figure 3.8):

DPA – Depth across the *Processus anconaeus*.

SDO – Smallest depth of the olecranon

The orientation of these two measurements was moved. In von den Driesch (1976: 79) both these measurements are diagonally angled across the proximal part of the ulna. In Lagomorpha the shortest distance from the *Processes anconaeus* to the caudal border, as required for the DPA, is straight across. The Lagomorpha has a distinctive indent in the olecranon making the smallest depth of the olecranon, as required for the SDO, straight across

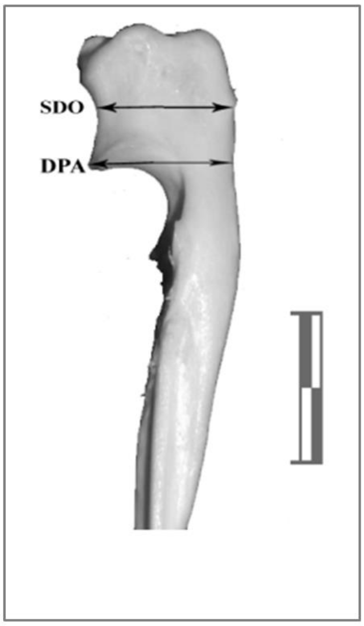


Figure 3.8: Ulna with measurement DPA and SDO illustrated

3.6.7 Pelvis

One measurement point was added (Figure 3.9):

LAii – Length of the acetabulum rim from ischium to ilium.

This measurement was added to measure the observed difference in the length of the acetabulum from ischium to ilium.

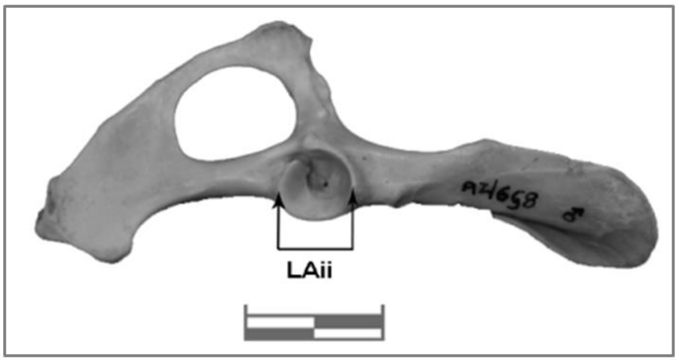


Figure 3.9: Pelvis with measurement LAii illustrated

3.6.8 Femur

Three measurement points were added (Figures 3.10; 3.11 & 3.12):

CB – Caput bulge – From the P*ars caudalis* straight across the caput.

The caput has a distinctive observed orientation difference between the two species which was not captured by the DC measurement in von den Driesch (1976: 85).

Figure 3.10: Femur with measurement CB illustrated

CONL and **CONM** – the measurement of the medial and lateral condyles from the tip of the trochlea to the tip of the condyle.

The differing morphology between the two species as well as the difference in locomotory habits prompted the inclusion of these measurements.

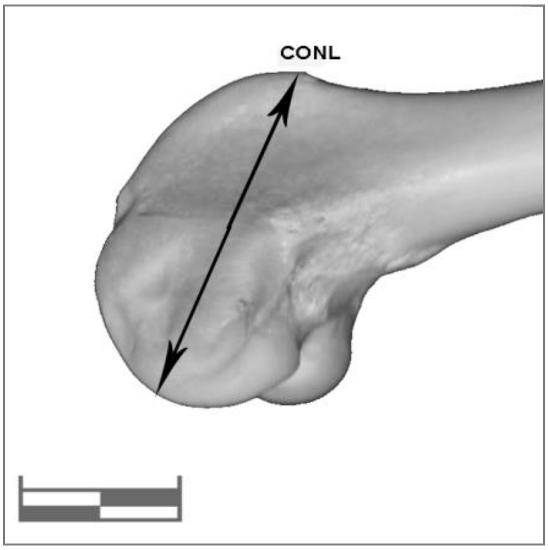


Figure 3.11: Femur distal with measurement CONL illustrated

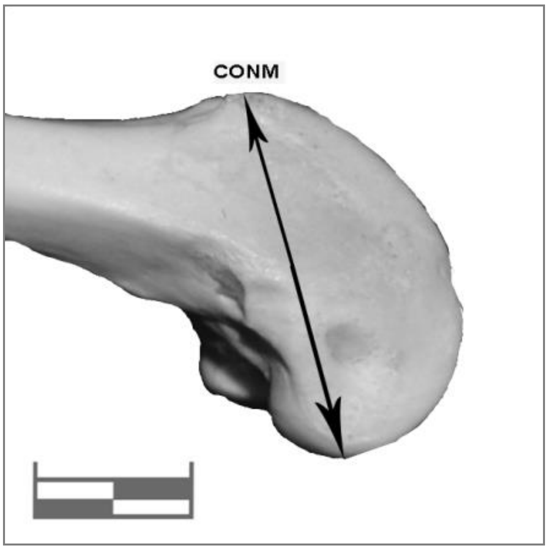


Figure 3.12: Femur distal with measurement CONM illustrated

3.6.9 Tibia

Two measurement points were added (Figures 3.13 & 3.14):

Dp – Depth of the proximal articulation measured from the front of the condyles to the crest.

DDL – Depth of the distal lateral facet measured with one caliper edge resting on the straight dorsal edge and the other touching the tip of the plantar edge.

Lagomorpha has distinctive proximal tibial tubers, which contrast between the two species. The Dp measurement was added to capture these observed differences.

DDL was added as the observed morphology called for the distal medial facet to be measured.

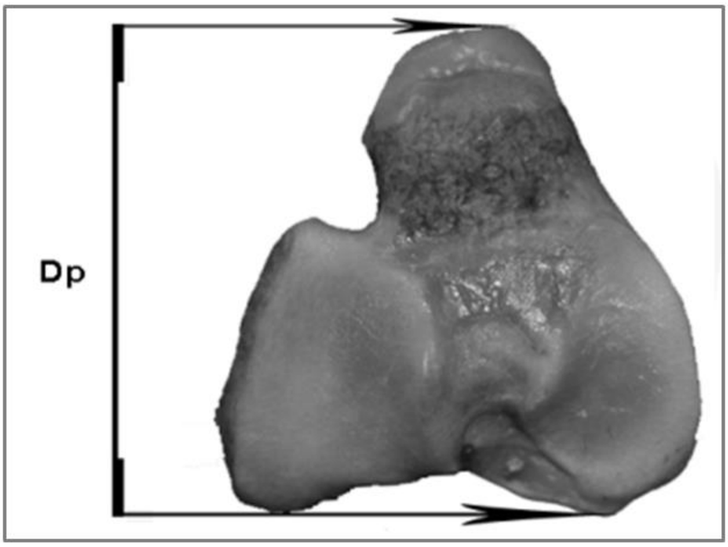


Figure 3.13: Tibia proximal with measurement Dp illustrated

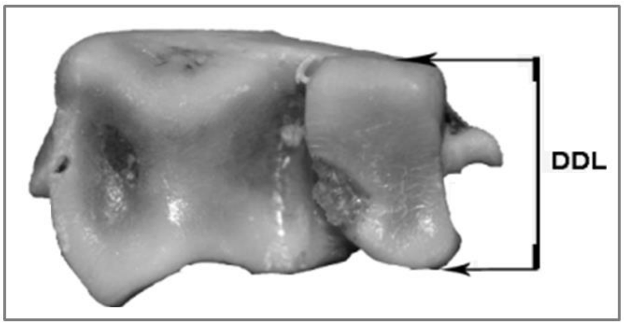


Figure 3.14: Tibia distal with measurement DDL illustrated

3.6.10 Talus

One measuring point was added (Figure 3.15):

DC – Depth of the condyles taken across the condyles viewing distally. The caliper points are placed on the condyle ridges.

It was added on account of differences in the hind leg movement between two species.

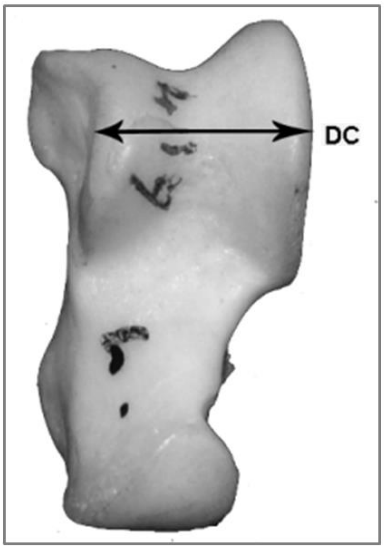


Figure 3.15: Talus with measurement DC illustrated

3.7 Statistical methods

Data management, statistical testing and graphics were produced using Excel and PAST (PAleontological STatistics) (Hammer et al. 2001). Bivariate plots and line graphs were used to compare and test the data obtained. Correlations between measurement points on skeletal elements indicate variations within and also between the two species.

Each measurement, as positioned in von den Driesch (1976) for the Lagomorphs in particular or skeletal elements in general, was taken and recorded in Excel. The additional measurement points that were added, as indicated above, were similarly recorded. These measurements were taken from the left and right elements. Mainly left elements measurements were used during calculations, and where that element was not complete, the right elements measurements were substituted. Appendix C provides the raw data as measured for each specimen, while Appendix B contains the reworked data that were used for statistical analyses. In Appendix B, each element is listed in the following order: *L.*

capensis and *L. saxatilis* as a whole, followed by the female and male skeletal elements for each species.

The following calculations were made using the recorded measurement data (Table 3.2):

Table 3.2: Define the calculations that were used for the statistical analyses of the data (see Appendix B)

Mean	of all the data points measured
Standard deviation	of all the data points measured
Confidence coefficient	1.96 was used to calculate the 95% confidence levels
Average margin of error	confidence coefficient x standard deviations ÷ sample size ^0.5
Average upper bound	mean + margin of error
Average lower bound	mean - the margin of error
Data margin of error	confidence coefficient x standard deviations
Data upper bound	the mean + margin of error
Data lower bound	mean - margin of error
Minimum	of all the measurements taken
Maximum	of all the measurements taken
Range	minimum - maximum

The upper and lower bound with the average numbers were used to obtain the 95% confidence indexes. The reliability of the measurements for the identification of species was tested through 95% confidence levels and expressed as box plots. All measurement points were plotted against each other in bivariate scatter plots.

The measurements were statistically tested to attain p-values, which in turn indicate the significance of the differences in the measurements and the observed morphology. Using Excel and PAST, the measurements were analysed through two-tailed t-tests and Mann-Whitney U-tests, the latter being applied where there were fewer than ten measurements per species. The p-values for each measurement are provided in a table before the discussion of each element in Chapter 4 (Tables 4.3 - 4.19). $P<0.001$ is considered statistically highly significant with a one in a thousand chance of being incorrect. $P<0.05$ is considered statistically significant with a one in twenty chance of being incorrect.

3.8 Photographs

A high-resolution digital camera was used to photograph the skeletal material. Each element of each species was photographed in their dorsal, volar/plantar, lateral, medial, proximal and distal aspects, with the inclusion of a photo scale. The photographs were manipulated in Photoshop. Manipulations included zooming, sizing scales, deleting the background, converting the colour image to greyscale and adding text. Skeletal elements were not manipulated in any other way, or to enhance or diminish features. The decision was taken to use only those photographs that clearly highlighted the differences in morphology, or where the articulation of two elements was needed to enhance the understanding of the morphology, i.e. the talus and calcaneus.

3.9 Summary of Chapter 3

Methodologies used in the establishment of protocols need to be reproducible and detail on procedures followed have to be provided. I explained the rationale for selecting faunal specimens for this study. Details were given on how the protocols that will be discussed in Chapter 4 have been established. The statistical methods used to explore the raw morphometric data are provided along with the methods applied in their manipulation of visual records.

In Chapter 4, the differences observed in each element between the two species are discussed in detail and illustrated, where possible, with photographs.

CHAPTER 4

RESULTS AND ANALYSES

4.1 Introduction

This chapter discusses the differences observed on each skeletal element between *L. capensis* and *L. saxatilis*. The numbers and nomenclature used for the morphology are, as stated in Chapter 3.5, those used by Schaller (2007). Where the veterinary nomenclature is not specific enough to indicate the exact morphological area under discussion, the terminology and numbering of von den Driesch (1976) were used (e.g. zygomatic arch). Each element is discussed individually with photos that illustrate both species with the numbered morphological section under discussion. The 95% confidence levels of the measurements and the scatter plots with the ellipses are included to indicate observed differences in the osteometrics. Only those box plots and scatter plots that reflected differences between the two species were included.

Since not all specimens were complete, or some parts could not be measured due to breakage or articulation, the *n* fluctuates between the various measurements within each element. The scatter plots consistently demonstrate that *L. saxatilis* is bigger in all dimensions, although there is overlap on all the measurements of the larger *L. capensis* and the smaller *L. saxatilis*. This overlap is evident in the 95% confidence levels. The chapter was specifically designed with the directive given by Olsen (1960) in Chapter 1 section 1.1.4 in mind.

4.2 Skeletal elements, measurements, and 95% confidence measurements

4.2.1 Element name - Skull

Number of individuals examined: *L. capensis* – 27; *L. saxatilis* – 29

A total of 231 individual scatter plots for the skull were drawn up and 22 box plots for each measurement’s 95% confidence levels.

Photos of the skull are set at a 2cm scale unless otherwise indicated.

Table 4.3: Skull measurement's p-values. Measurements 1 – 19's p-values are all statistically highly significant. Measurement 22 is statistically significant. Measurements 20 and 21 are not statistically significant.

Element/ Measurement	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Skull												
1	31	89.29	4.30	79.60	97.05		31	94.43	6.25	81.13	104.37	p<0.001
2	30	79.74	3.80	73.82	89.22		30	87.15	5.58	75.55	97.36	p<0.001
3	31	69.65	3.50	63.49	77.70		30	76.00	5.20	63.99	84.81	p<0.001
4	31	41.00	5.50	14.37	47.96		31	46.49	3.26	40.38	52.49	p<0.001
5	29	36.58	2.38	32.46	41.56		31	40.69	3.45	34.43	46.26	p<0.001
6	30	19.52	1.76	15.88	24.23		31	20.72	1.73	16.62	24.38	p<0.001
7	31	35.78	9.18	29.71	83.05		31	39.28	2.87	33.53	43.62	p<0.001
8	30	31.94	3.66	24.65	38.90		31	34.27	5.08	26.40	47.28	p<0.001
9	31	15.55	0.95	13.95	17.40		31	17.14	1.20	14.47	18.99	p<0.001
10	30	23.56	1.49	21.38	26.68		31	29.15	2.17	21.28	31.14	p<0.001
11	31	5.88	0.68	4.38	7.44		31	6.77	0.71	5.11	8.10	p<0.001
12	30	14.32	0.69	12.51	15.10		30	15.24	0.98	13.20	17.28	p<0.001
13	27	33.92	1.89	30.81	39.38		29	36.03	2.56	30.65	40.22	p<0.001
14	31	28.94	0.97	27.46	31.45		30	30.51	1.58	27.60	33.81	p<0.001
15	31	23.20	1.43	20.29	26.15		31	25.43	2.19	21.59	30.85	p<0.001
16	28	37.00	2.41	33.61	42.83		29	41.75	2.49	35.09	45.05	p<0.001
17	29	39.97	1.69	37.37	44.42		28	43.16	2.31	38.38	47.46	p<0.001
18	31	19.08	1.47	15.90	21.95		31	21.30	2.04	17.24	25.21	p<0.001
19	31	11.40	0.83	10.20	13.09		31	12.46	0.90	10.50	13.90	p<0.001
20	30	11.60	0.84	9.61	13.29		31	11.39	0.72	9.67	12.58	p>0.05
21	30	8.15	0.57	7.27	9.31		31	8.15	0.68	6.96	9.46	p>0.05
22	30	10.18	0.76	8.44	11.52		31	9.77	0.57	8.70	11.13	p<0.05

P 10[7]

- ❖ The roof of the cranium — *Calvaria* (19) is slightly more bulbous in shape in *L. capensis* and more elongated in *L. saxatilis*. In *L. capensis* at — *Vertex* (20) — there is an upturn forming a prominent raised area whereas the corresponding area in *L. saxatilis* is located further down the caudal side of the skull. This also ensures that when the complete skull is placed on its cranial side, the *L. capensis* nasal region is almost flat with the table surface, while the *L. saxatilis* nasal region is raised (Figures 4.20 & 4.21; Figures 4.24 & 4.25).

- ❖ The corresponding measurement in von den Driesch (1976) is #7: frontal length. The 95% confidence (Figure 4.16) for this measurement is interesting as it shows that the bulging makes this area bigger in *L. capensis* and causes the measurements of *L. saxatilis* to fall in the middle of the *L. capensis* measurement. The corresponding p-value for this measurement is highly significant (Table 4.3).

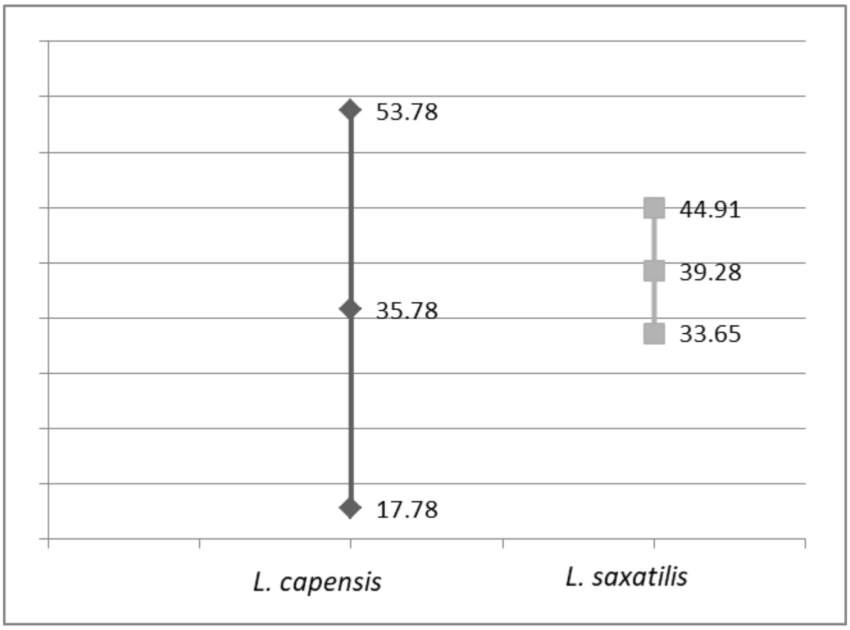


Figure 4.16: Skull measurement #7 – Frontal length: bregma to nasal. 95% confidence levels upper bound, mean and lower bound

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[7] There are 36 pages of nomenclature for the skull in Schaller (2007) and the numbering of each page starts at 1. The corresponding page numbers of the anatomy described are included to minimise confusion.

- Forehead — *Frons* (21) — is a sunken area in between the two orbits. *Fossa frontalis* (22) — in *L. capensis* there is a very prominent dip in the centre before rising again to meet the nasal bone. In *L. saxatilis* there is a prominent ridge where the two halves of the suture meet (Figures 4.20 & 4.21; Figures 4.22 & 4.23).

- Zygomatic arch — *Arcus zygomaticus* (26) — the oral zygomatic (von den Driesch 1976: 51) is narrower in *L. capensis* and does not flare as much laterally as that of *L. saxatilis*. This flare forms an almost flat articulation surface in *L. saxatilis.* In *L. capensis* the flare flows smoothly into the process whereas in *L. saxatilis* it returns to the process at an angle of almost 90º. The front part makes a slight tip and forms a shallower semi-circular notch in *L. capensis* and a deep semi-circular notch in *L. saxatilis*. The aboral zygomatic (von den Driesch 1976: 51) follows the line and width of the arch in *L. capensis* before it tapers dramatically to about half the width and ends in a sharp point. In *L. saxatilis* the arch ends in a rounded point (Figures 4.22 & 4.23).

- *Occiput* (24) — in *L. capensis* the lines leading from the occiput to the parietal sutures are strongly developed and end 4–5mm before the suture line. The lines are also strongly developed in *L. saxatilis* and join directly onto the suture (Figures 4.28 & 4.29).

- Dorsal part of the occipital — *Squama occipitalis* (22) — the sides of the occiput are angled inwards towards the *foramen magnum* in *L. capensis*. The articulation surfaces that surround the foramen are thin and elongated, extending into the shallower muscle/ligament attachment observed in (24). In *L. saxatilis* the sides are more on par with the foramen magnum. These sides form strong ridges that result in stronger and deeper sulci. The articulation surfaces that surround the foramen are broader and flatter, extending into the deep muscle/ligament attachment observed in (24). In contrast to the articulation facet around the top part of the foramen magnum in *L. saxatilis*, there is no corresponding articulation surface in *L. capensis*. A depression for muscle and ligament attachments is present in *L. capensis* but is not as deep or as prominent as those in *L. saxatilis* (Figures 4.22 & 4.23; Figures 4.28 & 4.29).

P16

- *Foramen magnum* (3) — it is broad and roundish in shape in *L. capensis*, while in *L. saxatilis* it is elongated and almost teardrop-shaped. The orientation is also different, with the foramen magnum in *L. capensis* placed more vertically at an angle of almost 90º, while in *L. saxatilis* it is more at a 75º angle (Figures 4.21 & 4.22; Figures 4.26 & 4.27).

P 24

- *Bulla tympanica* (8) — of *L. capensis* seems to be bigger than that of *L. saxatilis*. The observation is supported by two of the new measurements added (20 & 22) (Figures 4.17 & 4.18). Measurement 22 is statistically significant at $p<0.05$ (Tble 4.3).
- The *bullae* of *L. capensis* are slightly bigger but appear to be more so due to the orientation of the back of the skull (Figures 4.20 & 4.21). The effect is further enhanced by the gracile nature of the *L. capensis* skull.

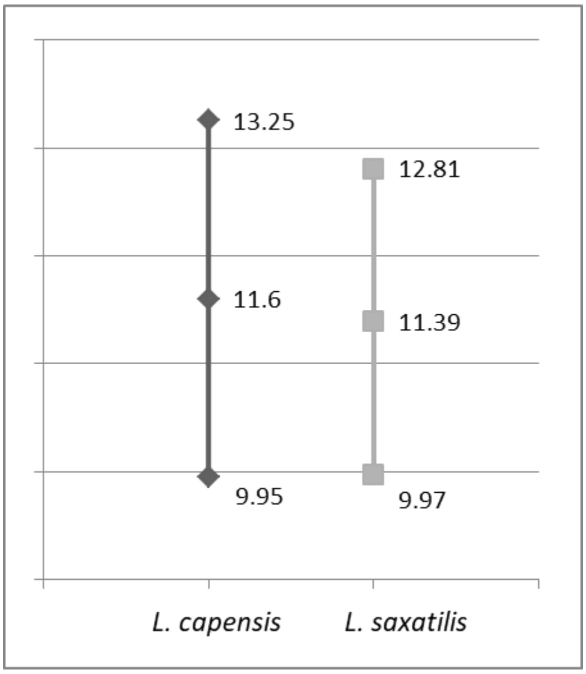


Figure 4.17: Skull measurement #20 – Bulla straight across 95% confidence levels upper bound, mean and lower bound values indicated

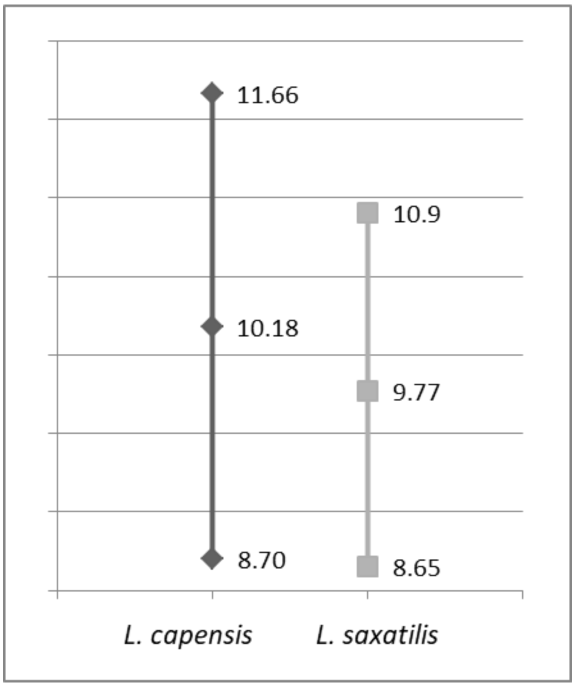


Figure 4.18: Skull measurement #22 – Diagonally across 95% confidence levels upper bound, mean and lower bound values indicated

- The measurement #4 in von den Driesch (1976) showed an interesting result in the 95% confidence level, as the *L. saxatilis* overlaps with the upper bound of the *L. capensis.* It is the only measurement for the skull that is the inverse of all the others (Figure 4.19). No noticeable differences in the nasal area were recorded in the morphology.

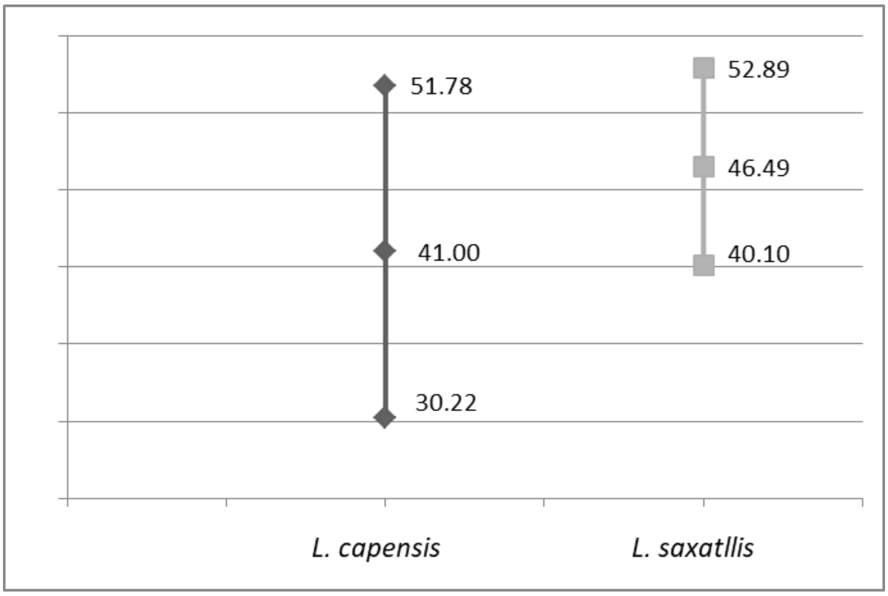


Figure 4.19: Skull measurement #4 – Dental length. 95% confidence levels upper bound, mean and lower bound values indicated

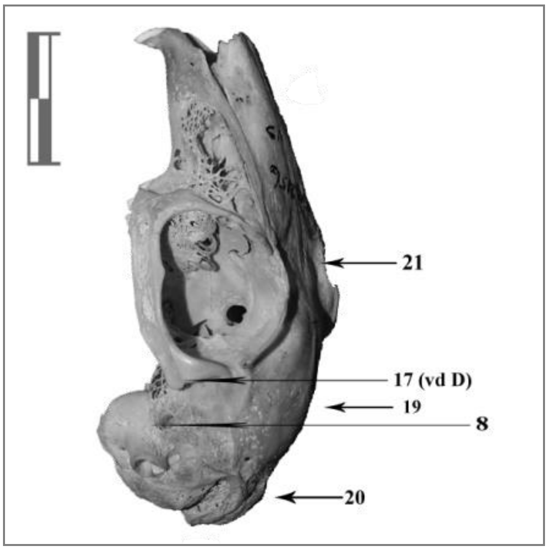


Figure 4.20: *L. capensis* – Skull lateral view. #17 originates from von den Driesch (1976), all others are numbered according to Schaller (2007)

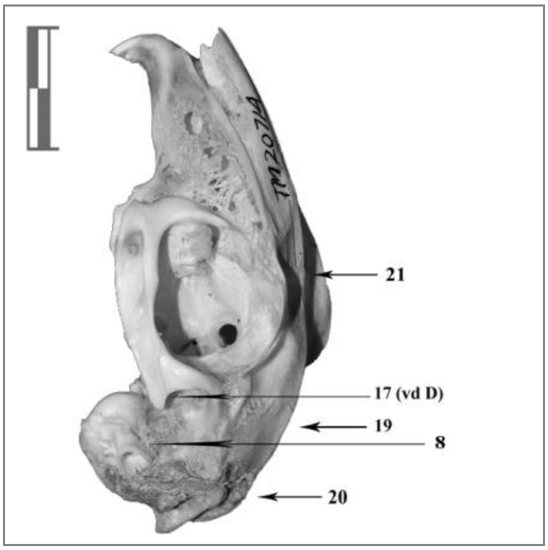


Figure 4.21: *L. saxatilis* – Skull lateral view. #17 originates from von den Driesch (1976), all others are numbered according to Schaller (2007)

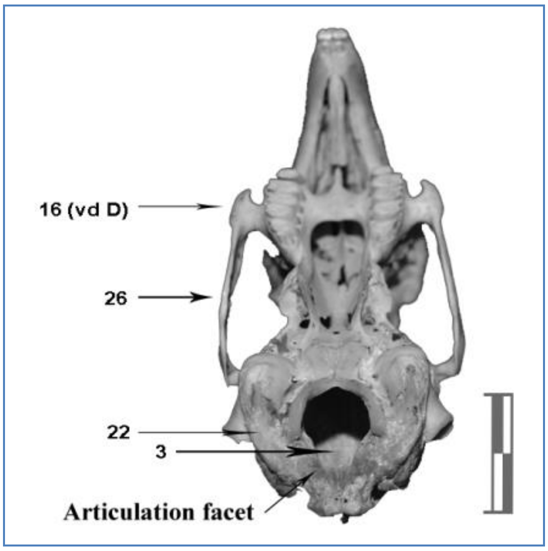


Figure 4.22: *L. capensis* – Skull basal view. #16 originates from von den Driesch (1976), all others are numbered according to Schaller (2007)

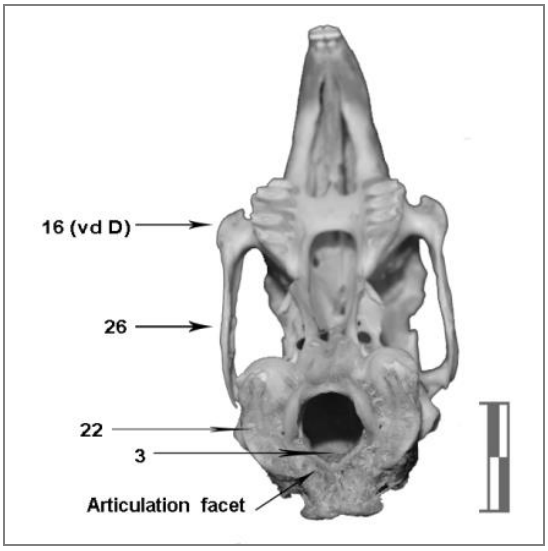


Figure 4.23: *L. saxatilis* – Skull basal view. #16 originates from von den Driesch (1976), all others are numbered according to Schaller (2007)

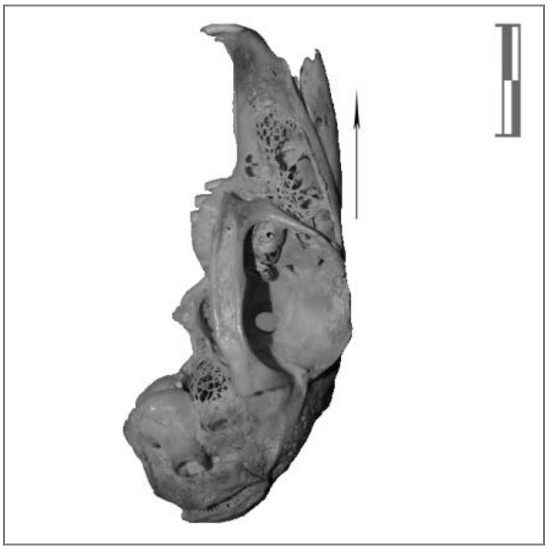


Figure 4.24: *L. capensis* – Skull dorsal edge

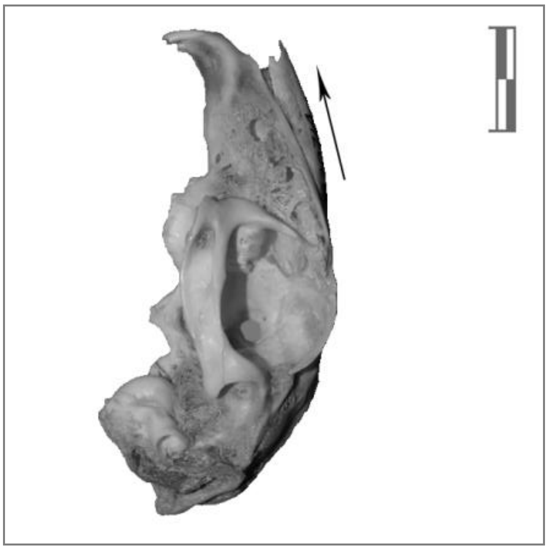


Figure 4.25: *L. saxatilis* – Skull dorsal edge

Figure 4.26: *L. capensis* – Skull *foramen magnum* orientation

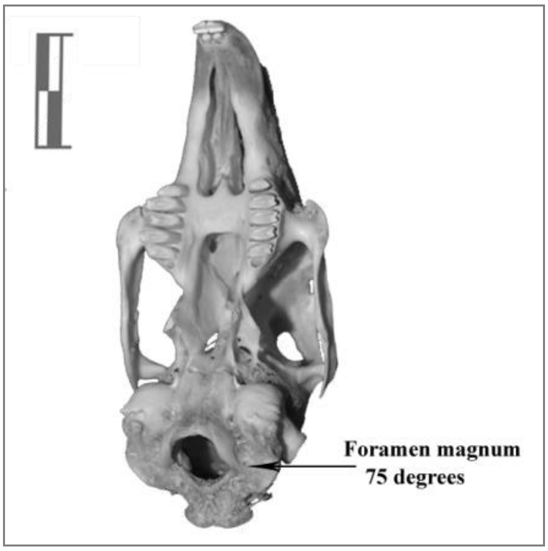


Figure 4.27: *L. saxatilis* – Skull *foramen magnum* orientation

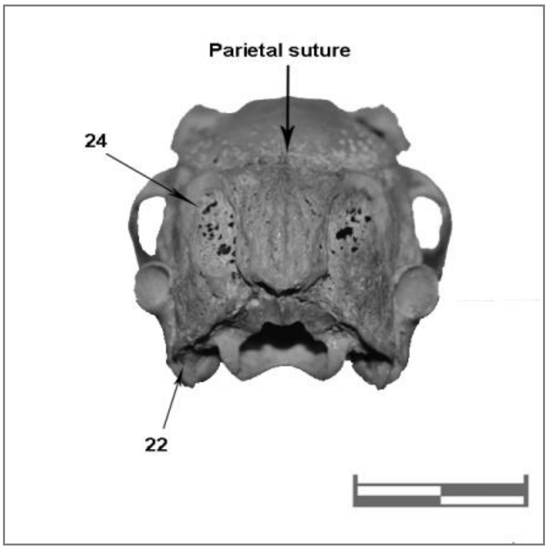


Figure 4.28: *L. capensis* – Skull occiput

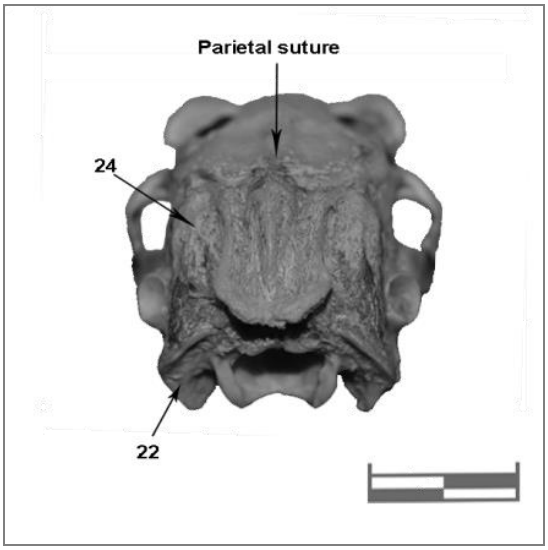


Figure 4.29: *L. saxatilis* – Skull occiput

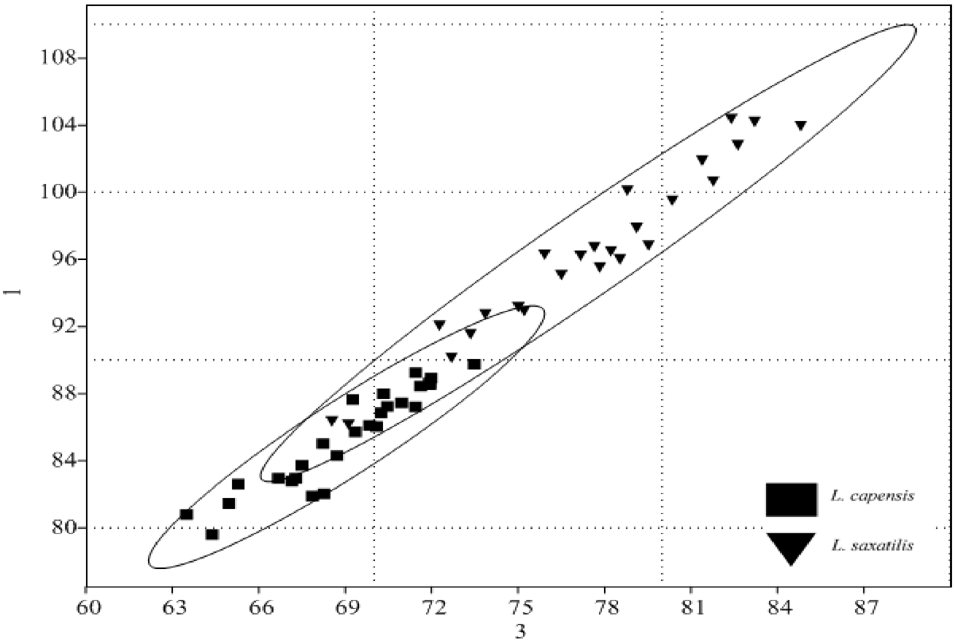


Figure 4.30: Skull measurement #1 – Total length vs #3 – Basal length — indicating a high correlation between these measurements in both species

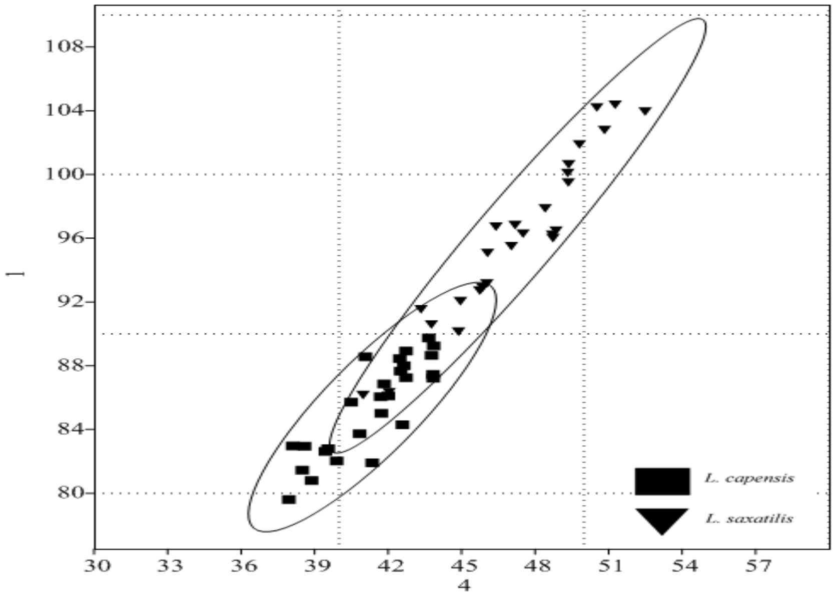


Figure 4.31: Skull measurements #1 – Total length vs #4 – Dental length — indicating a high correlation between these measurements in both species

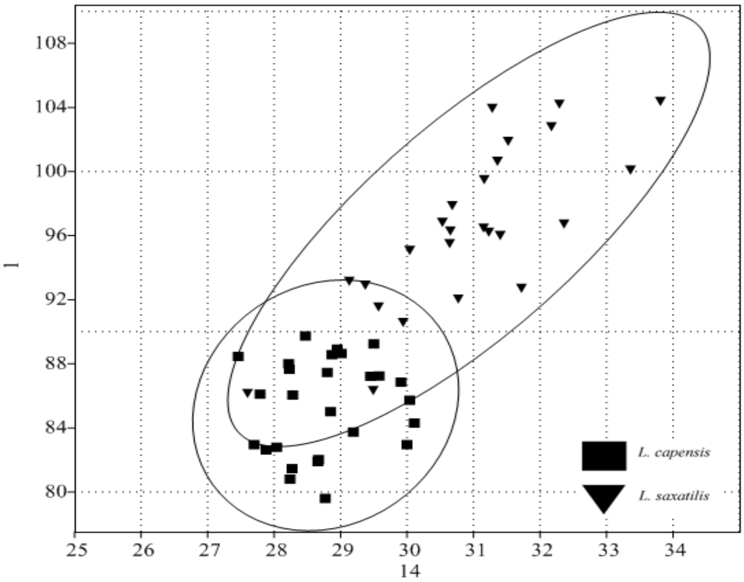


Figure 4.32: Skull measurement #1 – Total length vs #14 – Greatest breadth of the braincase — indicating a high correlation between these measurements in *L. saxatilis.* Note a tight grouping in *L. capensis*

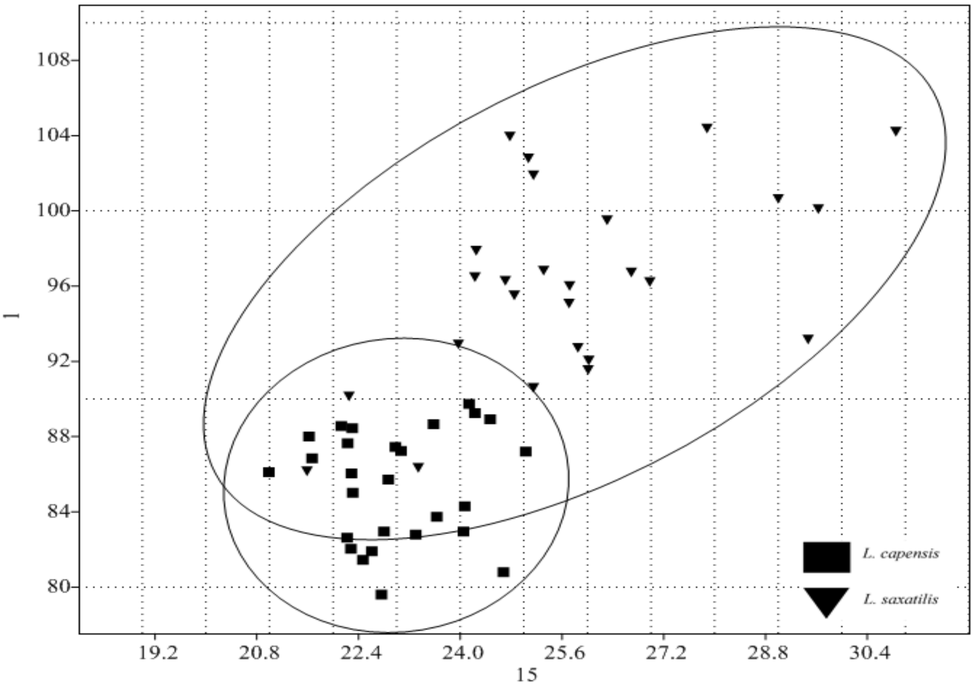


Figure 4.33: Skull measurement #1 – Total length vs #15 – Breadth of the skull — indicating a high correlation between these measurements in *L. saxatilis*. Note a tight grouping in *L. capensis*

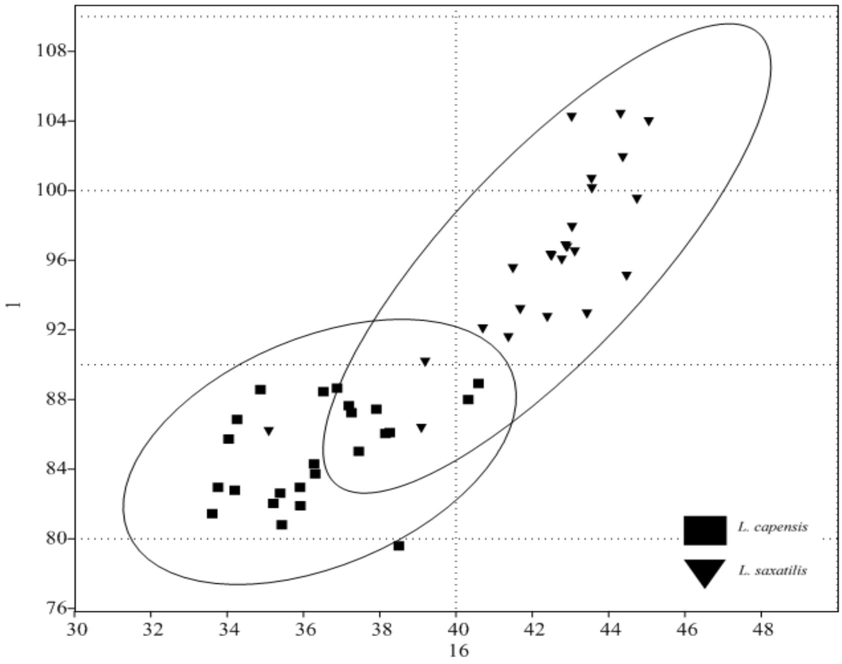


Figure 4.34: Skull measurement #1 – Total length vs #16 – Oral zygomatic breadth — indicating a high correlation between these measurements in *L. saxatilis*

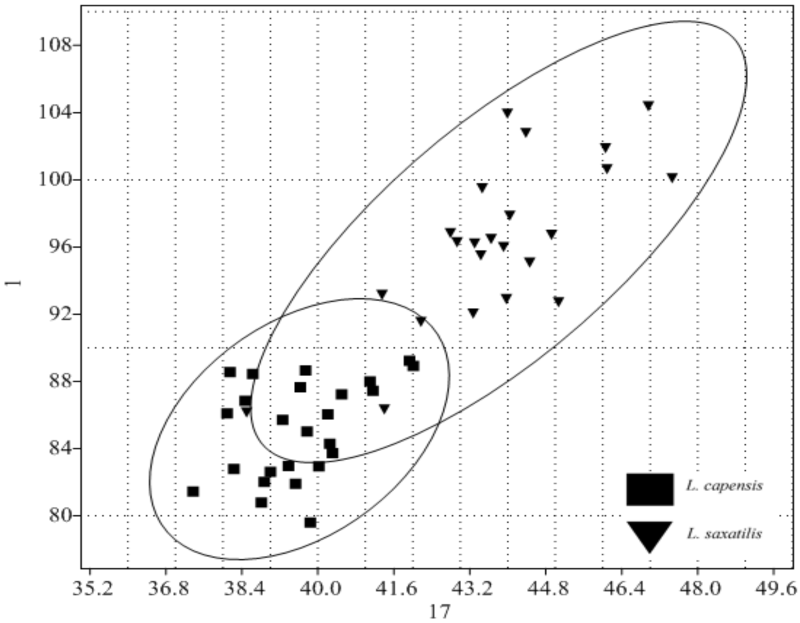


Figure 4.35: Skull measurement #1 – Total length vs #17 – Aboral zygomatic breadth indicating a high correlation between these measurements in *L. saxatilis*. Note a tight grouping in *L. capensis*

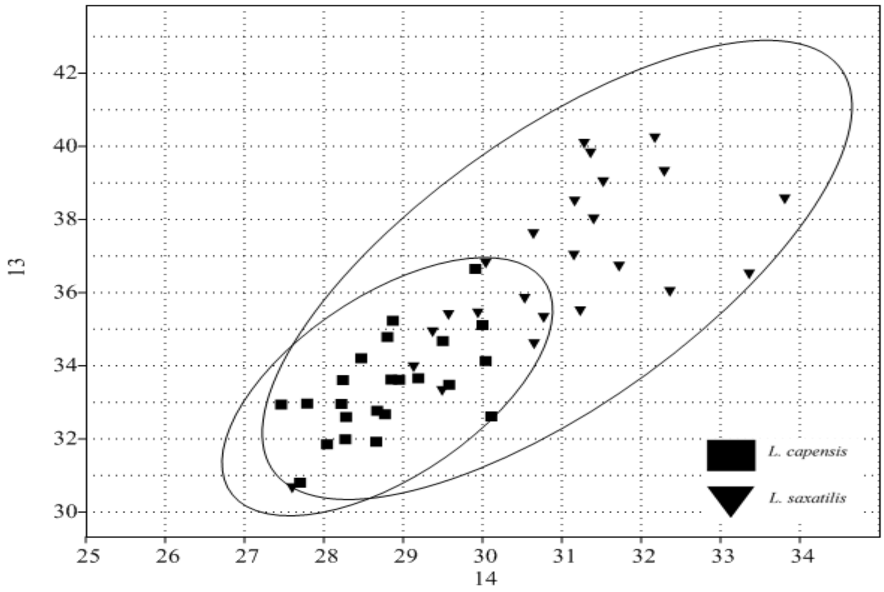


Figure 4.36: Skull measurement #13 – Greatest breadth across the ear openings vs #14 – Greatest breadth of the braincase — indicating a higher correlation between these measurements in *L. capensis*

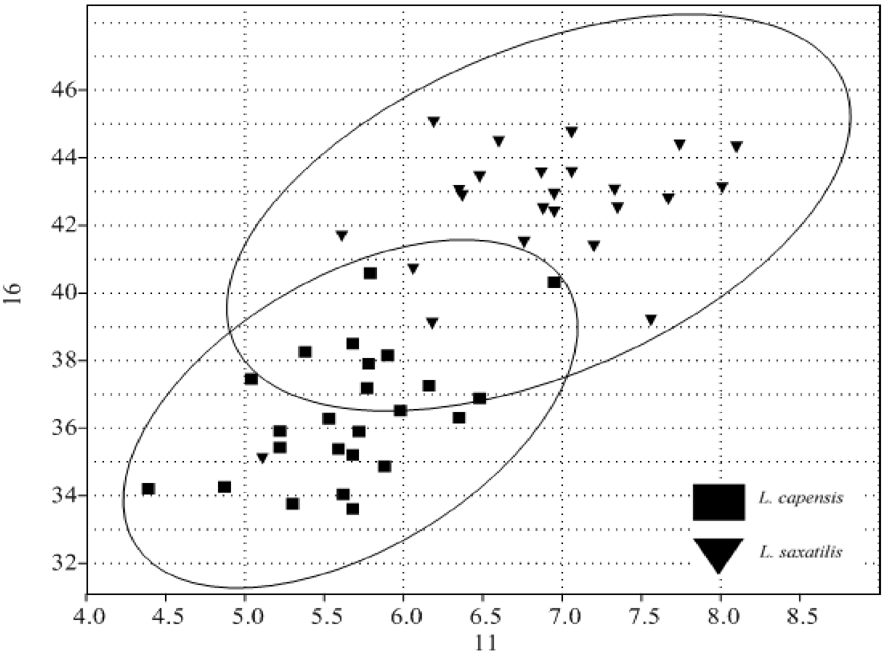


Figure 4.37: Skull measurement #16 – Oral zygomatic breadth vs #11 – Palatal length — indicating a higher correlation between these measurements in *L. capensis*

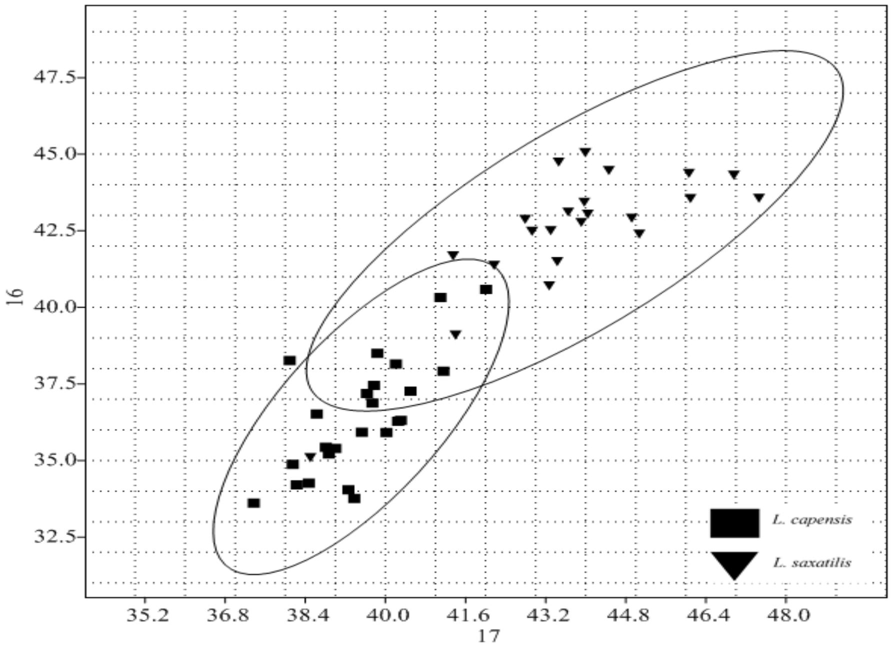


Figure 4.38: Skull measurement #16 Oral zygomatic vs #17 – Aboral zygomatic breadth — indicating a high correlation between these measurements in both species

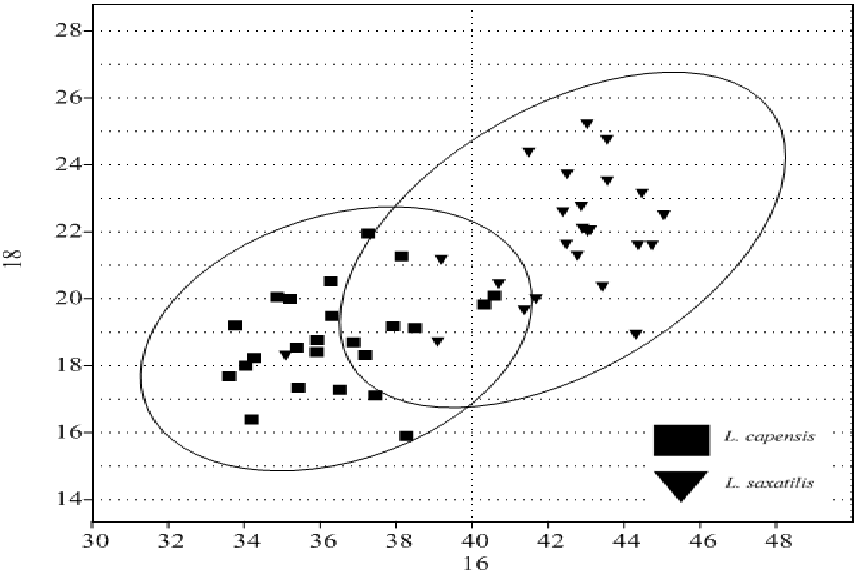


Figure 4.39: Skull measurement #18 – Greatest breadth of the nasals vs #16 – Oral zygomatic breadth — indicating a tight grouping specifically for *L. capensis*

All the measurements overlap with the lower bound of *L. saxatilis* (Figures 4.40 – 4.47).

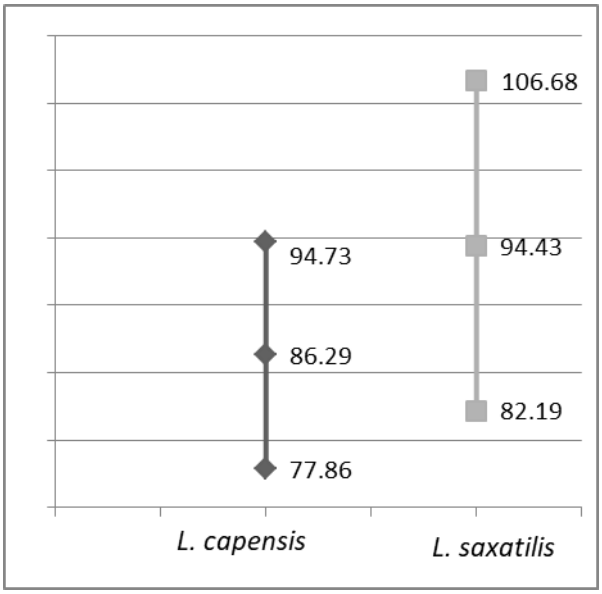


Figure 4.40: Skull measurement #1 – Total length. 95% confidence levels upper bound, mean and lower bound values indicated

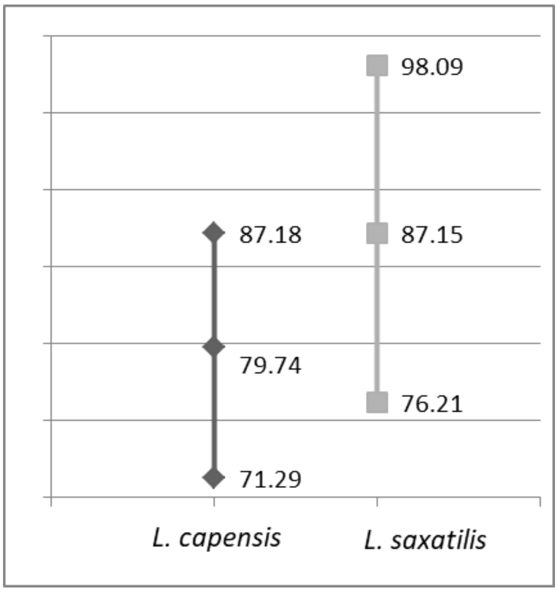


Figure 4.41: Skull measurement #2 – Condyle basal length. 95% confidence levels upper bound, mean and lower bound values indicated

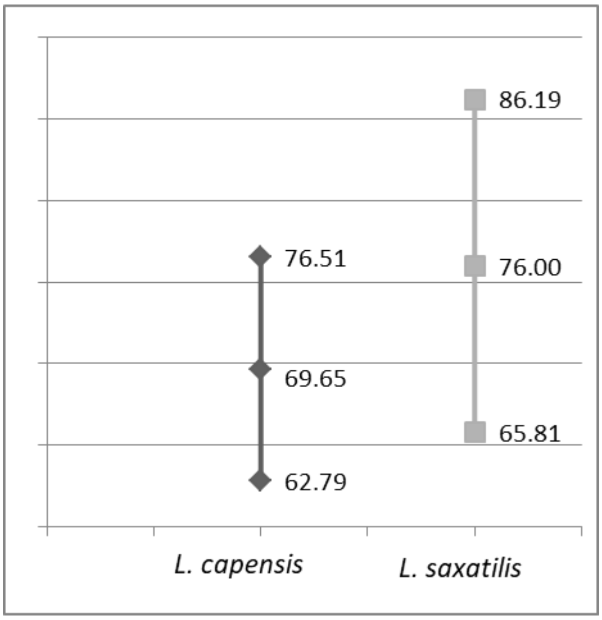


Figure 4.42: Skull measurement #3 – Basal length. 95% confidence levels upper bound, mean and lower bound values indicated

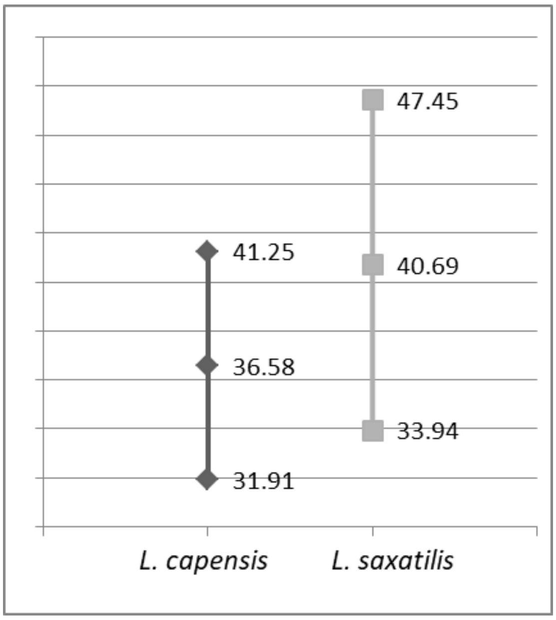


Figure 4.43: Skull measurement #5 – Greatest length nasal. 95% confidence levels upper bound, mean and lower bound values indicated

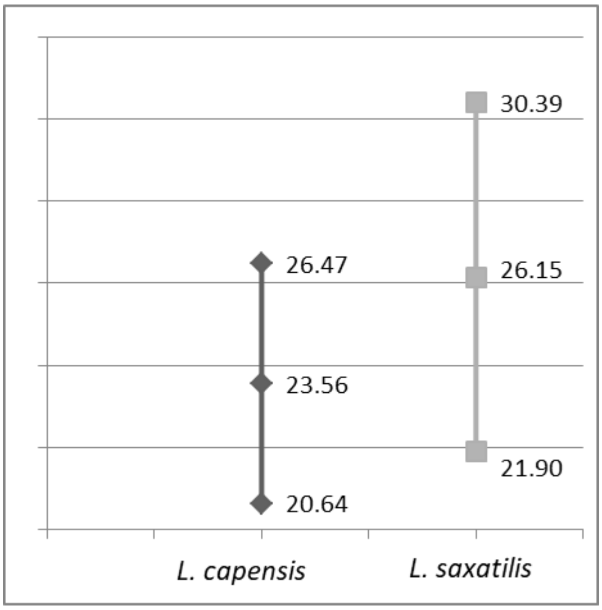


Figure 4.44: Skull measurement #10 – Length of the diastema. 95% confidence levels upper bound, mean and lower bound values indicated

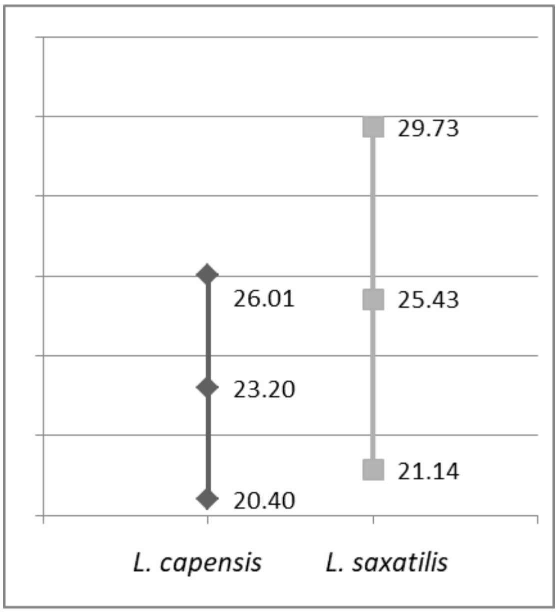


Figure 4.45: Skull measurement #15 – Breadth of the skull. 95% confidence levels upper bound, mean and lower bound values indicated

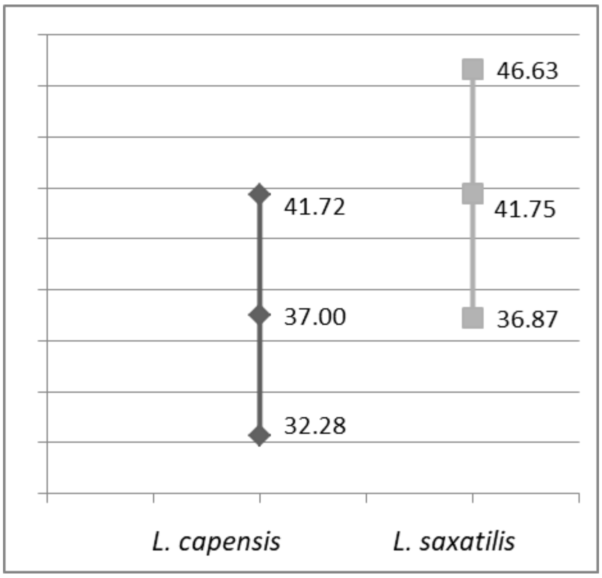


Figure 4.46: Skull measurement #16 – Oral zygomatic breadth. 95% confidence levels upper bound, mean and lower bound values indicated

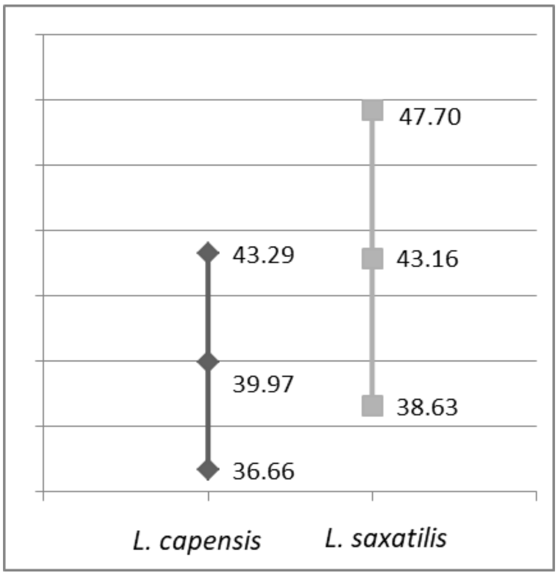


Figure 4.47: Skull measurement #17 – Aboral zygomatic breadth. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.2 Element name - Mandible

Number of individuals examined: *L. capensis* – 28; *L. saxatilis* – 28

A total of 28 individual scatter plots for the mandible were drawn up and seven box plots for each measurement's 95% confidence levels.

Photos of the mandible are set at a 2cm scale and the caput at a 1cm scale.

Table 4.4: Mandible measurements p-values. Measurements 1 – 7's p-values are all statistically highly significant

Element/ Measure-ment	***Lepus capensis***					***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**	***n***	**Mean**	**SD**	**min.**	**max.**	
Mandible											
1	23	58.23	3.06	54.95	67.59	28	64.83	4.09	54.31	71.77	p<0.001
2	28	16.54	0.96	14.60	18.45	29	18.39	1.19	15.96	20.68	p<0.001
3	28	35.08	1.58	31.87	39.64	28	39.31	2.88	32.25	43.42	p<0.001
4	28	18.41	1.23	16.81	20.85	28	20.66	1.90	16.00	24.35	p<0.001
5	28	39.37	2.41	35.17	46.79	29	45.20	2.87	37.74	50.13	p<0.001
5a	28	37.77	2.56	32.94	46.02	29	43.57	2.90	36.39	48.75	p<0.001
6	21	11.62	0.81	9.90	13.11	26	13.25	0.90	10.54	14.65	p<0.001
7	21	14.30	1.06	12.25	15.82	26	16.43	1.17	13.33	18.27	p<0.001

- *Incisura vasorum facialium* (9) — it is distinctive in both species and forms a definite division between the ventral margin and the *Ramus mandibulae* (23). This distinction is much more prominent in *L. saxatilis* (Figures 4.48 & 4.49; Figures 4.50 & 4.51).

- *Margo interalveolaris* (22) and *Margo ventralis* (8) — in *L. capensis* the two parts flow smoothly into each other. In *L. saxatilis* there appears to be a distinction between the two parts and the ventral margin is distinctly rounder. This does seem to be a variable feature, as ten of the specimens examined showed no such distinction (Figures 4.48 & 4.49; Figures 4.50 & 4.51).

- *Ramus mandibulae* (23) — in *L. capensis* is thinner and less strongly developed than in *L. saxatilis*, with the latter exhibiting big and robust muscle attachments (Figures 4.48 & 4.49; Figures 4.50 & 4.51).

- *Fovea pterygoidea* (37) — in *L. capensis* is present but, due to the smaller articulation and its placement on top of the collum, the fovea is not pronounced. It is much more pronounced in *L. saxatilis* on account of the size and angle of the articulation (Figures 4.50 & 4.51).

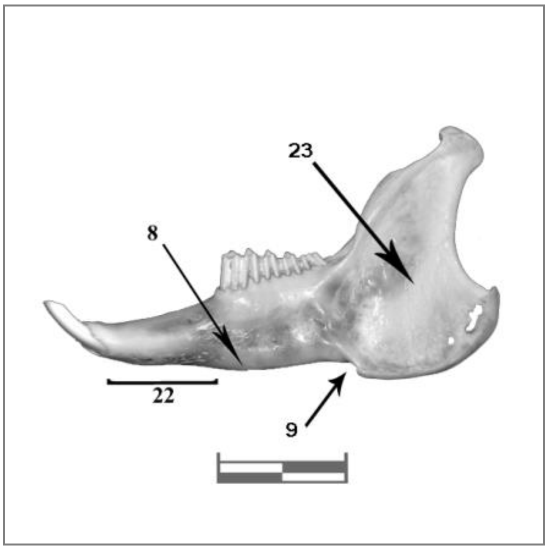


Figure 4.48: *L. capensis* – Mandible lateral aspect

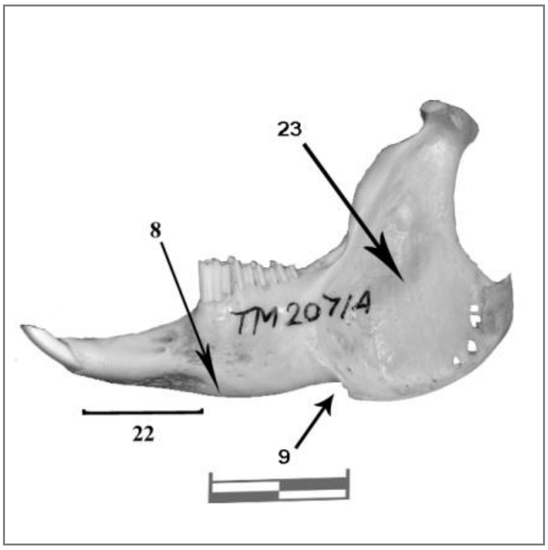


Figure 4.49: *L. saxatilis* – Mandible lateral aspect

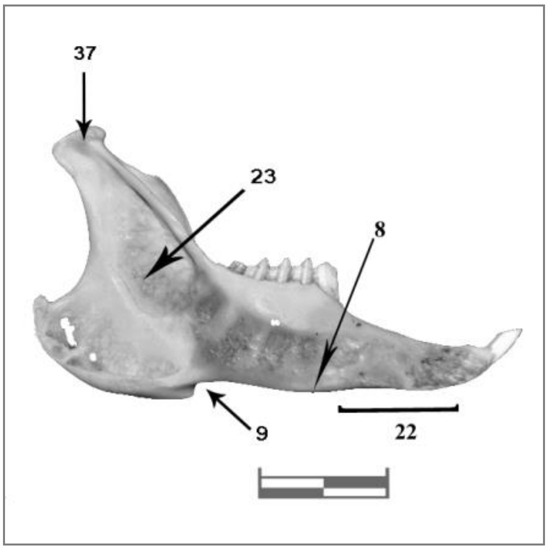


Figure 4.50: *L. capensis* – Mandible medial aspect

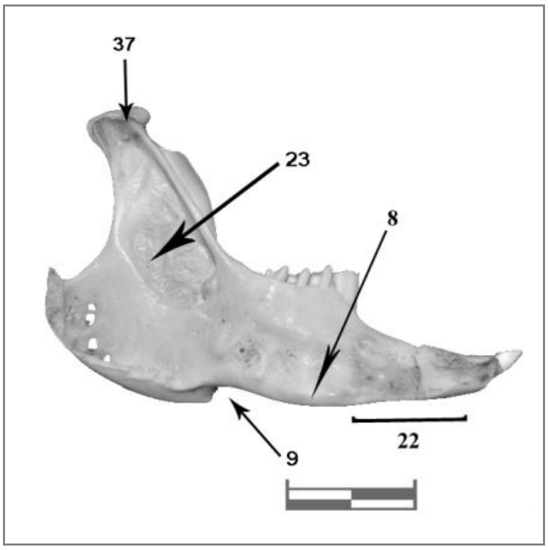


Figure 4.51: *L. saxatilis* – Mandible medial aspect

- *Caput mandibulae* (35) — in *L. capensis* is set on top of *Collum mandibulae* (36). The articulation facet is small and exhibits a flatter elongated bulb with a dorsally extending point. In *L. saxatilis* the articulation is set at an angle on (36) and slopes dorsally. The articulation is large and bulbous with a dorsally extending point and is teardrop-shaped. The articulation is set slightly to the buccal side (Figures 4.52 & 4.53).

- *Collum mandibulae* (36) — in *L. capensis* is narrow where it originates at the articulation facet and gradually broadens out as it descends towards the tooth row. In *L. saxatilis* it is broad and stays the same width from the articulation to the tooth row (Figures 4.52 & 4.53).

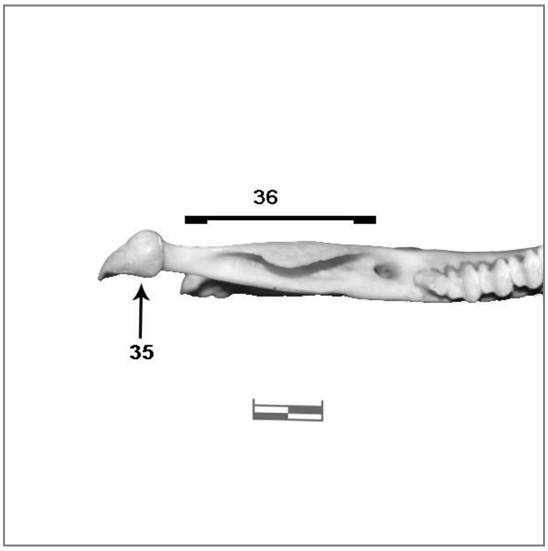


Figure 4.52: *L. capensis* – Mandible caput and collum

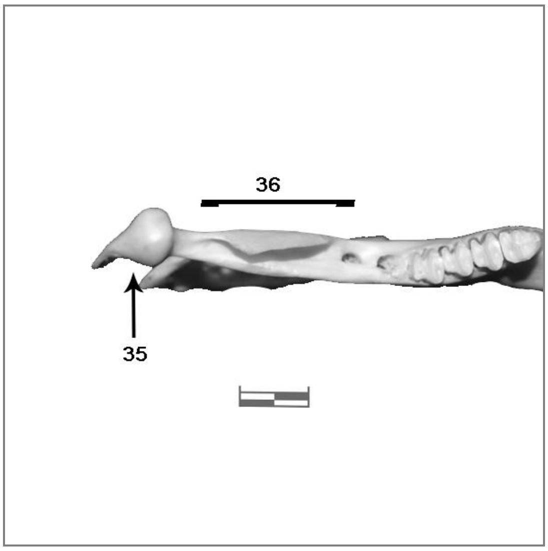


Figure 4.53: *L. saxatilis* – Mandible caput and collum

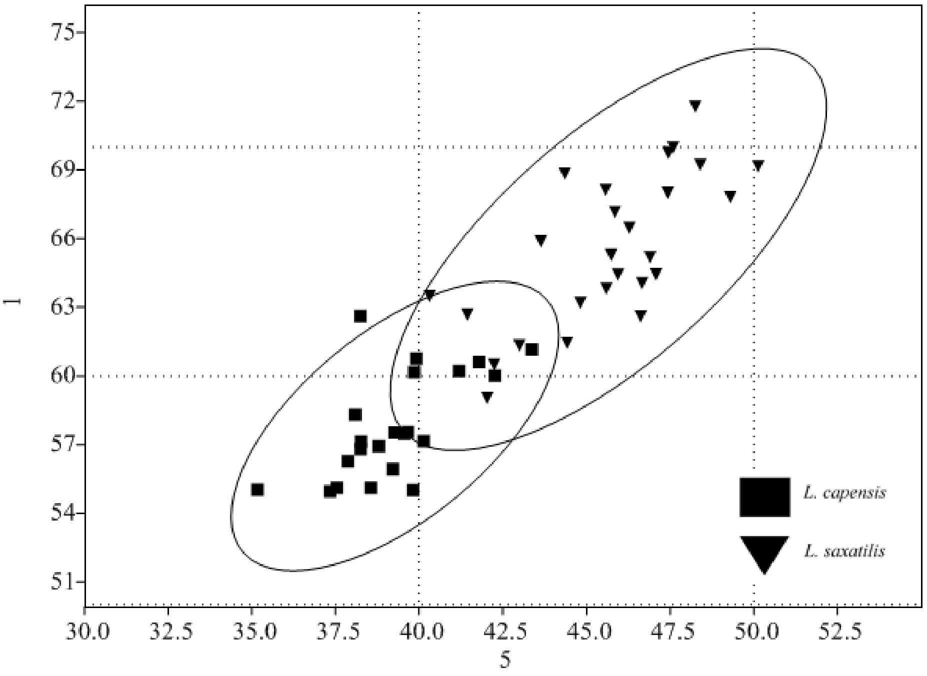


Figure 4.54: Mandible measurement #1 – Length from angle vs #5 – Height of the vertical ramus — indicating a correlation in both species

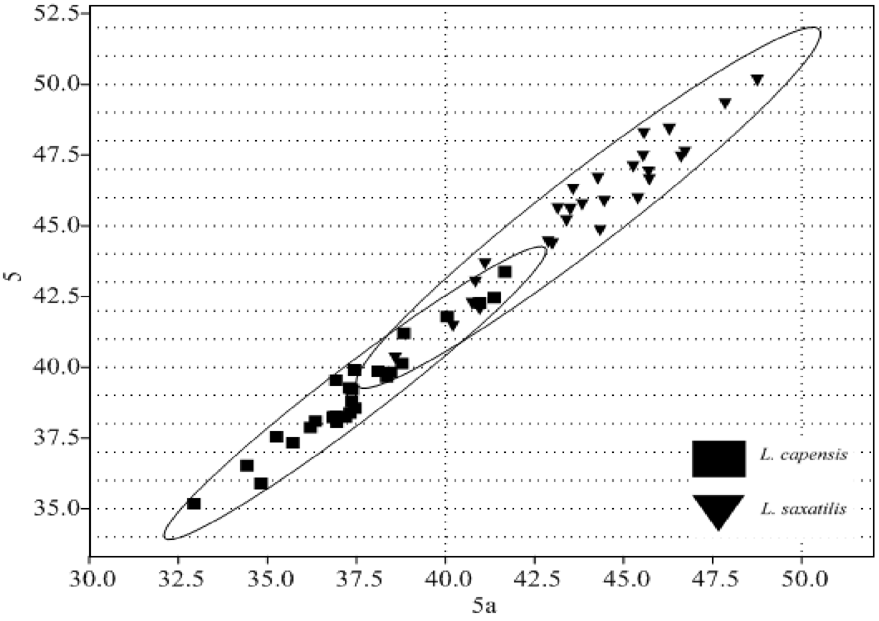


Figure 4.55: Mandible measurement #5 – Height of the vertical ramus vs #5a – Height of the vertical ramus in projection — indicating a high correlation in both species

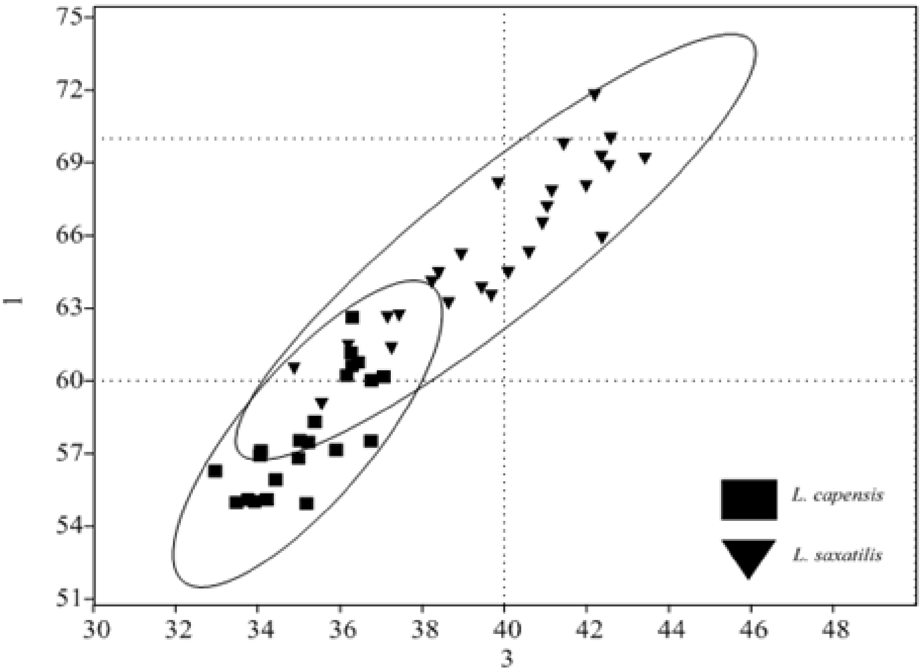


Figure 4.56: Mandible measurement #1 – Length from angle vs #3 – Length of the aboral border of the alveolus of M3 – indicating a high correlation in both species

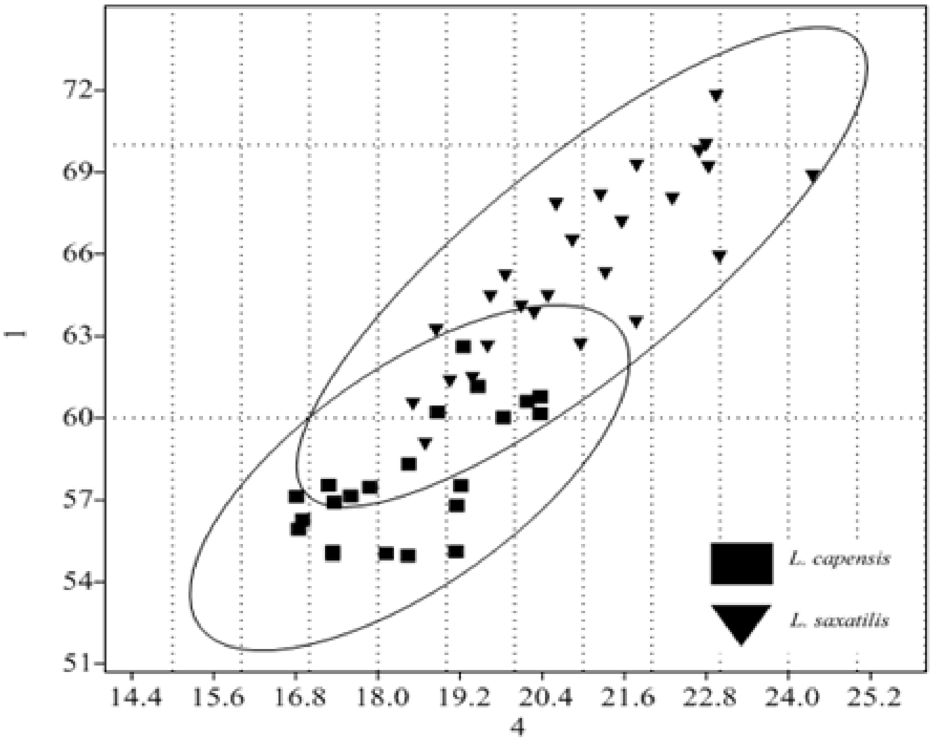


Figure 4.57: Mandible measurement #1 – Length from angle vs #4 – Length of the diastema — indicating a higher correlation in *L. saxatilis*

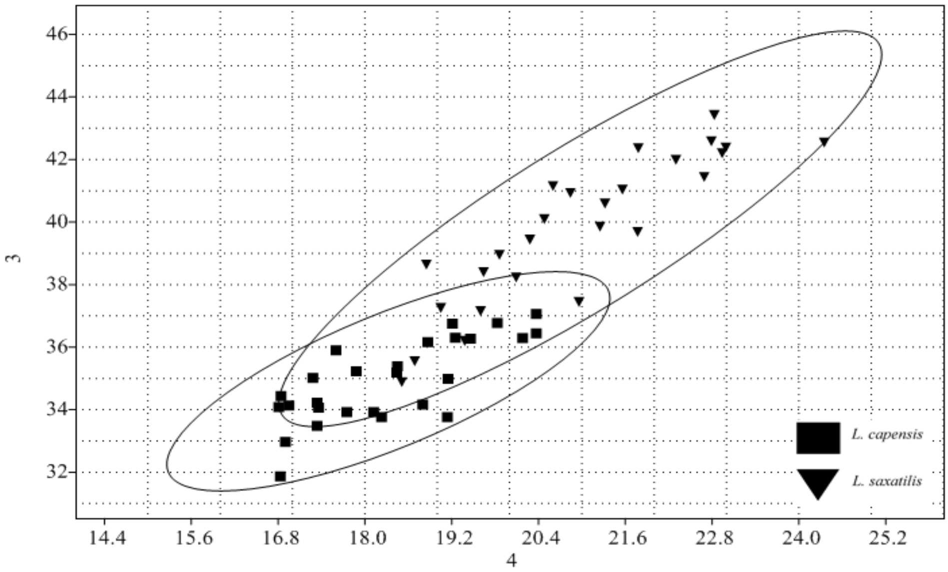


Figure 4.58: Mandible measurement #3 – Length of the aboral border of the alveolus of M3 vs #4 – Length of the diastema – indicating a high correlation in both species

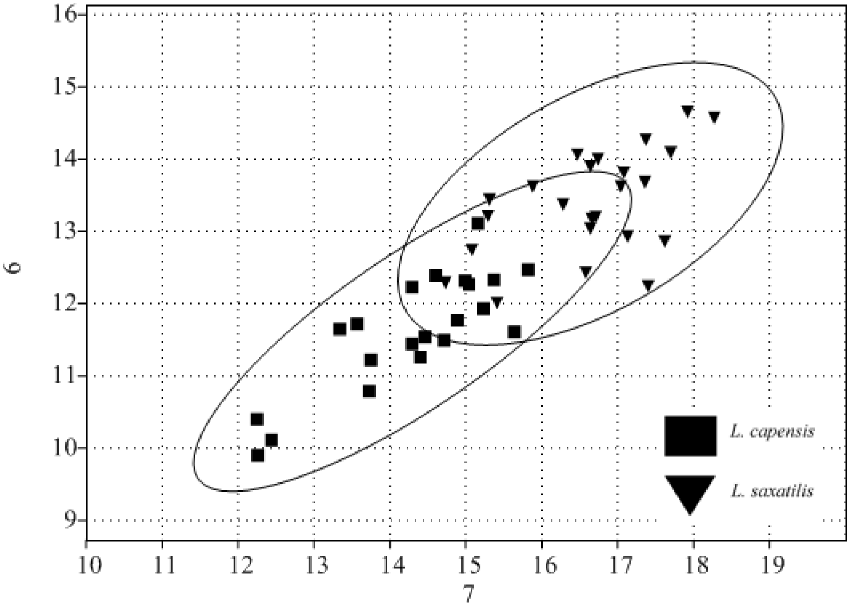


Figure 4.59: Mandible measurement #6 – Height of the mandible in front of P3 vs #7 – Height of the mandible behind M3 –– indicating a high correlation for *L. capensis* and a tighter grouping for *L. saxatilis*

All the measurements only overlap with the lower band of *L. saxatilis*. The least overlap is observed in #3 (Figure 4.62), #5 (Figure 4.64), #5a (Figure 4.65) and #6 (Figure 4.66).

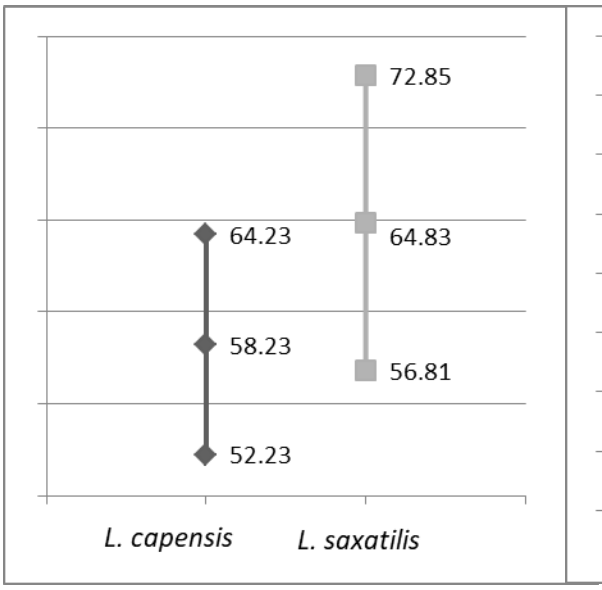


Figure 4.60: Mandible measurement #1 – Length from angle. 95% confidence levels upper bound, mean and lower bound values indicated

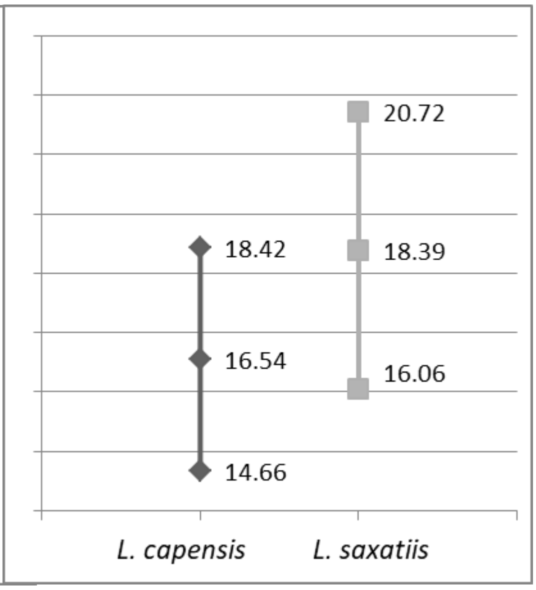


Figure 4.61: Mandible measurement #2 – Length of the cheek tooth row. 95% confidence levels upper bound, mean and lower bound values indicated

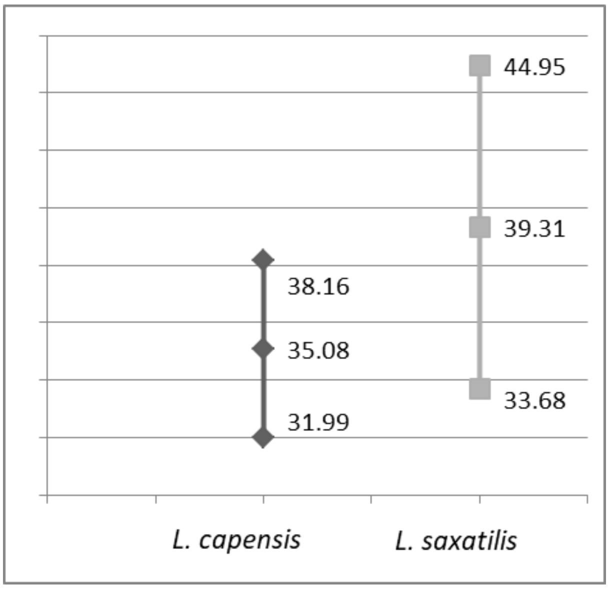


Figure 4.62: Mandible measurement #3 – Length of aboral border of the alveolus. 95% confidence levels upper bound, mean and lower bound values indicated

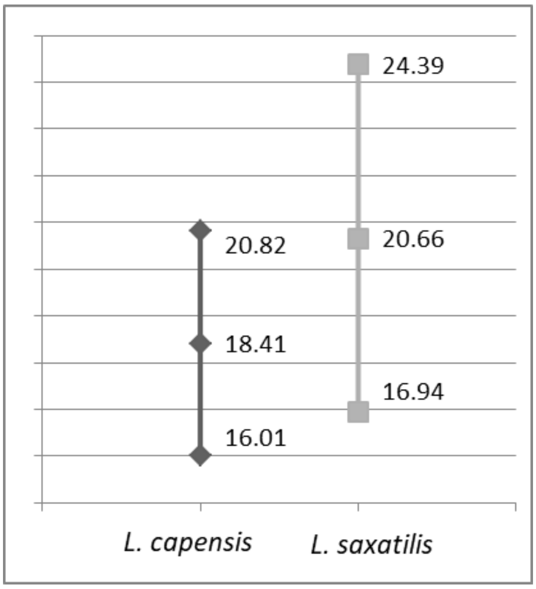


Figure 4.63: Mandible measurement #4 – Length of the diastema. 95% confidence levels upper bound, mean and lower bound values indicated

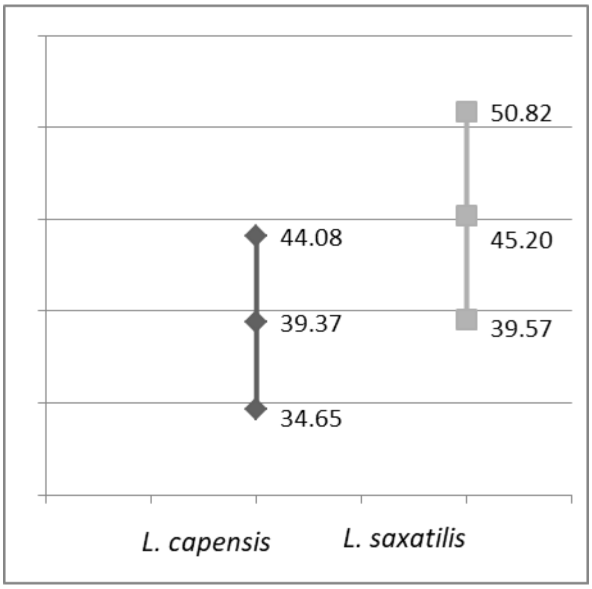


Figure 4.64: Mandible measurement #5 – Height of the vertical ramus. 95% confidence levels upper bound, mean and lower bound values indicated

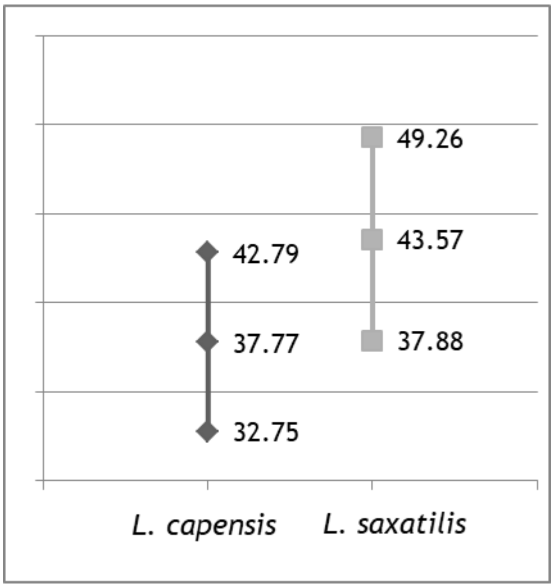


Figure 4.65: Mandible measurement #5a – Height of vertical ramus measured in projection. 95% confidence levels upper bound, mean and lower bound values indicated

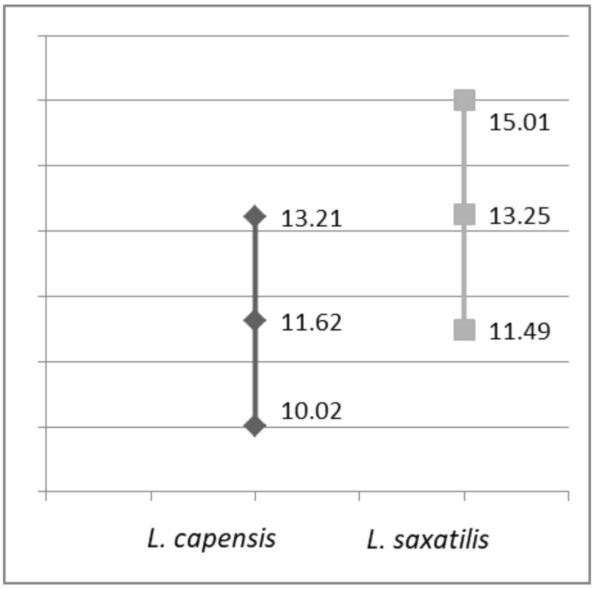


Figure 4.66: Mandible measurement #6 – Height of the mandible in front of P3. 95% confidence levels upper bound, mean and lower bound values indicated

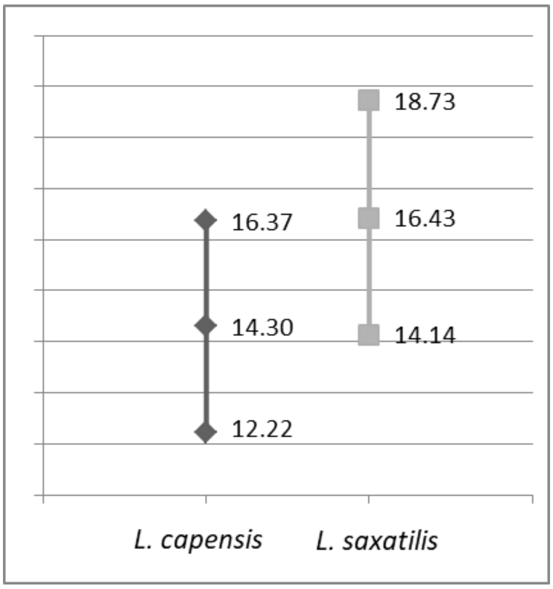


Figure 4.67: Mandible measurement #7 – Height of the mandible behind M3. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.3 Element name - Atlas

Number of individuals examined: *L. capensis* – 20; *L. saxatilis* – 22

A total of 21 scatter plots for the atlas were drawn up and seven box plots for each measurement's 95% confidence levels.

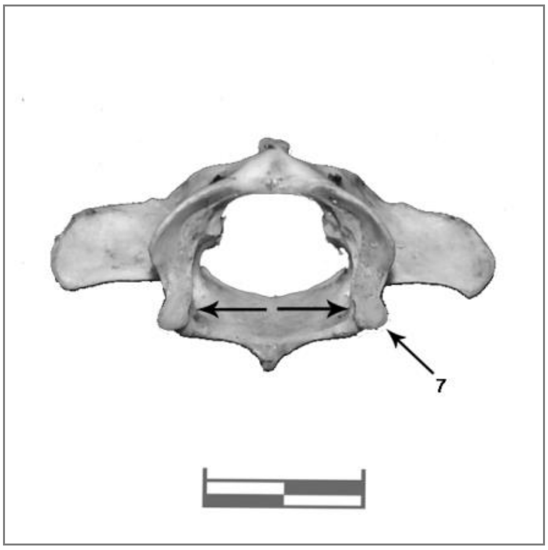
Photos of the atlas are set at a 1cm scale

Table 4.5: Atlas measurements p-values. P-values are all statistically highly significant, except Ladt which is not statistically significant

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Atlas												
GB	15	26.96	1.01	25.00	29.69		17	29.56	1.79	26.59	32.33	p<0.001
GL	12	12.38	0.65	11.19	13.39		17	13.88	0.97	12.43	15.51	p<0.001
BFCR	15	14.42	0.47	13.50	15.18		18	16.03	0.88	14.56	17.75	p<0.001
BFCD	12	11.38	0.60	10.56	12.90		18	12.45	0.87	10.43	14.56	p<0.001
GLF	12	11.39	1.15	8.93	12.61		18	13.14	1.13	10.43	14.56	p<0.001
Lad Right	12	6.57	0.63	5.61	7.54		17	7.50	0.43	6.77	8.39	p<0.001
Ladt	12	7.02	0.79	5.68	8.03		18	7.32	0.74	4.85	8.28	p>0.05

- *Fovea articularis cranialis* (7) — in *L. capensis* the 2/3^{rds} articulation remains relatively straight rimmed and the 1/3rd has a slight curve that forms a shallow cup shape. In *L. saxatilis* the 2/3^{rds} articulation flares up to a peak before dipping down to the 1/3rd. The 1/3rd has a strong twist-like appearance that almost closes the articulation surface (Figures 4.68 & 4.69).

- Ventral arch —– *Arcus ventralis* (9) — in *L. capensis* the ventral arch cranial side is very broad – open V-shape – and adds to the shallow cup shape described in (7). The ventral arch is indented on both sides, almost in line with where the arch connects in the middle. In *L. saxatilis* the ventral arch cranial side is broad with a definite step down that forms a U-shape. The ventral arch is indented more towards the wings to the middle of the arch (Figures 4.70 & 4.71).



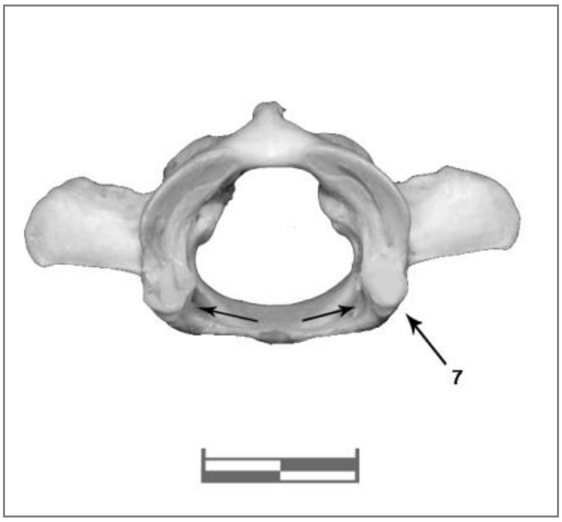


Figure 4.68: *L. capensis* – Atlas cranial articulation

Figure 4.69: *L. saxatilis* – Atlas cranial articulation

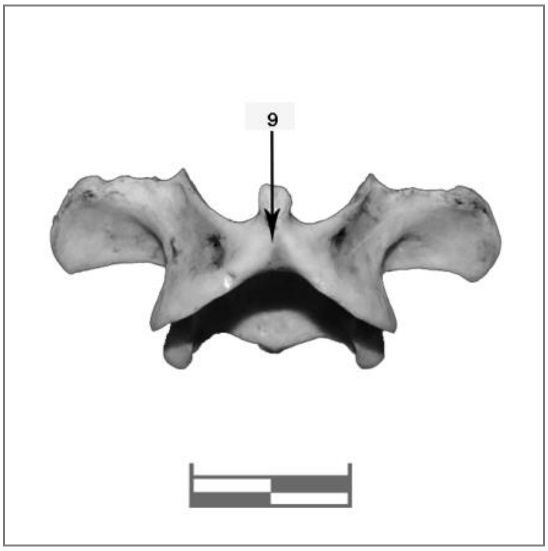


Figure 4.70: *L. capensis* – Atlas ventral side

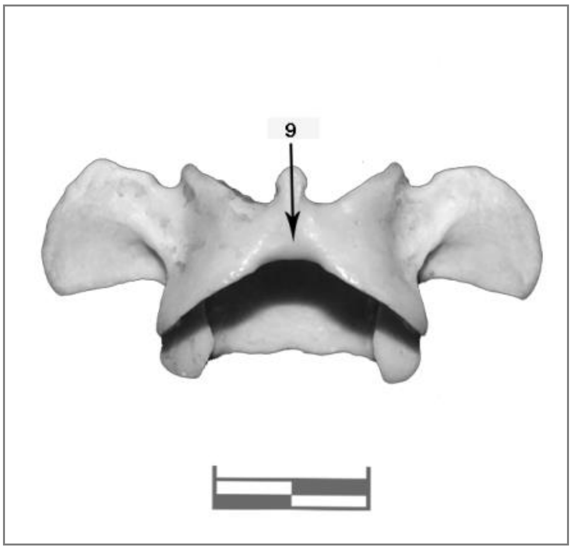


Figure 4.71: *L. saxatilis* – Atlas ventral side

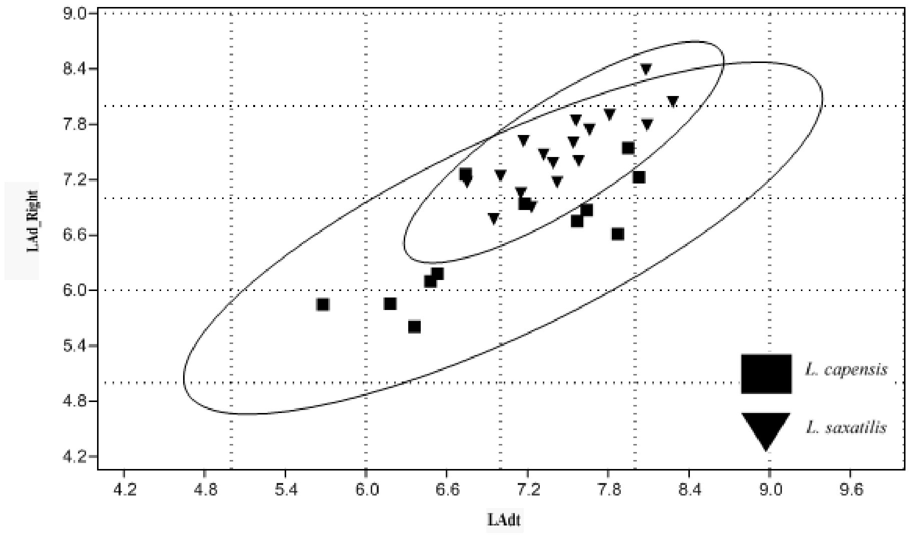


Figure 4.72: Atlas measurement LAd Right – Length of the *Arcus dorsalis* vs LAdt – Length of *Arcus dorsalis* on tuber point – indicating a high correlation for *L. saxatilis*

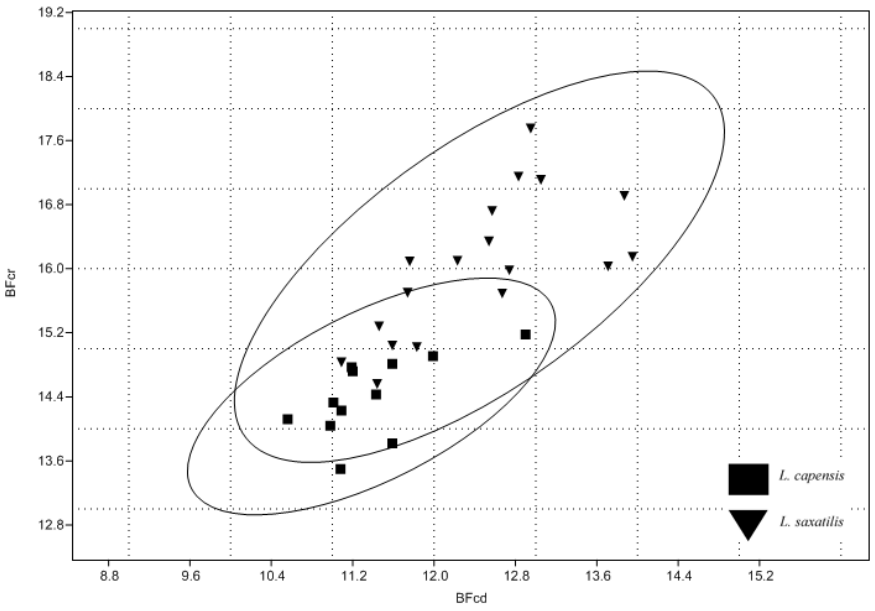


Figure 4.73: Atlas measurement BFcr – Breadth *facies cranialis* vs BFcd – Breadth *facies caudalis* — indicating a correlation in *L. saxatilis*

I am of the opinion that the scatter plots (Figures 4.72 & 4.73) for the atlas are not reliable indicators. Due to the irregular nature of the vertebrae, there is very little correlation between most measurements. A high overlap between the two species is indicated, moreover to a much higher degree than is evident in any of the other skeletal elements. The majority of the measurements are statistically highly significant (Table 4.5). Measurements GB (Figure 4.74), GL (Figure 4.75), BFcr (Figure 4.76) and BFcd (Figure 4.77) for *L. capensis* only overlap with the lower bound measurements of *L. saxatilis*. These measurements, when coupled with the morphology, should make the identification of this element easier.

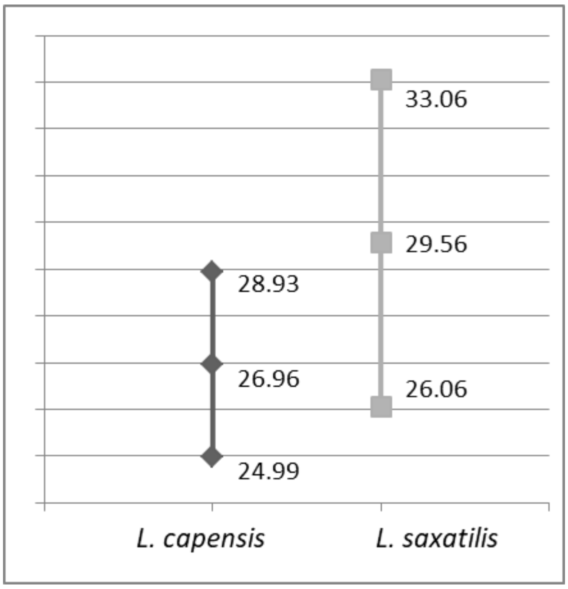


Figure 4.74: Atlas measurement GB – Greatest breadth. 95% confidence levels upper bound, mean and lower bound values indicated

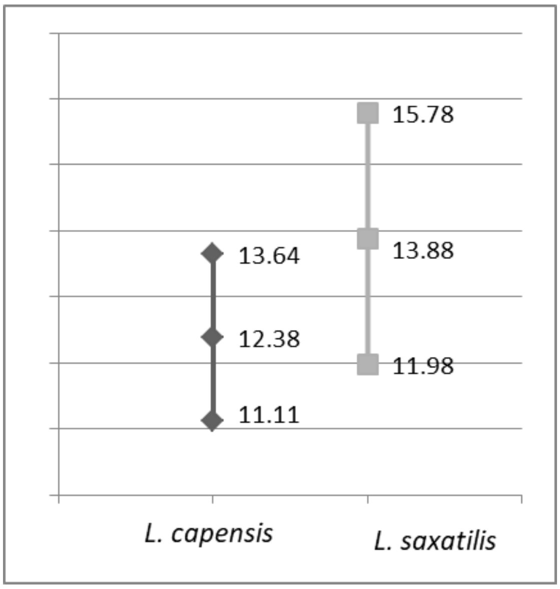


Figure 4.75: Atlas measurement GL – Greatest length. 95% confidence levels upper bound, mean and lower bound values indicated

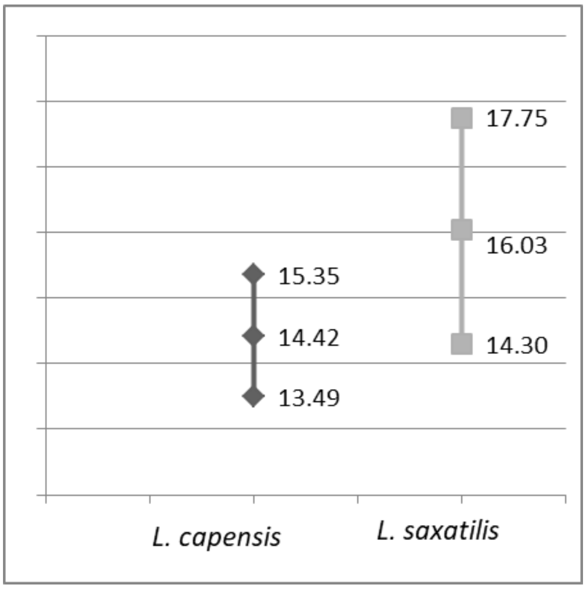


Figure 4.76: Atlas measurement BFcr – Breadth facies cranialis. 95% confidence levels upper bound, mean and lower bound values indicated

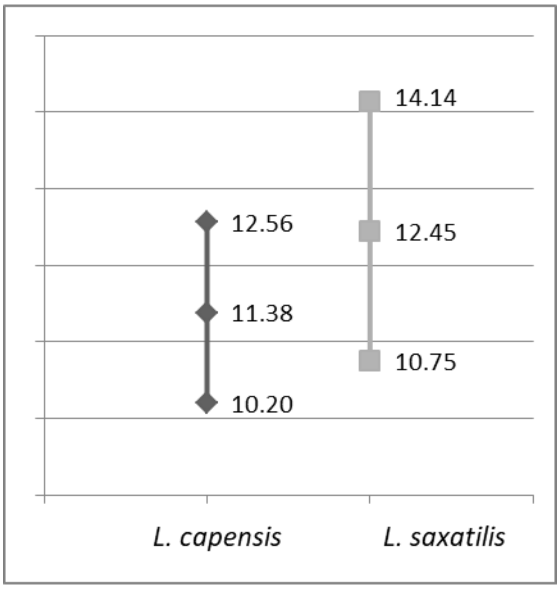


Figure 4.77: Atlas measurement BFcd – Breadth facies caudalis. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.4 Element name - Axis

Number of individuals examined: *L. capensis* – 15, *L. saxatilis* – 19

A total number of 28 individual scatter plots for the axis were drawn up and eight box plots for each measurement's 95% confidence levels.

Photos of the axis are set at a 1cm scale.

Table 4.6: Axis measurements p-values. Measurements p-values are all statistically highly significant, except H which is statistically significant

Element/ Measure-ment	***Lepus capensis***					***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**	***n***	**Mean**	**SD**	**min.**	**max.**	
Axis											
LCDe	15	17.82	0.90	16.40	19.34	19	19.54	1.61	17.04	22.38	p<0.001
LAPa	15	13.15	1.42	10.30	15.28	19	15.27	1.68	12.46	18.70	p<0.001
BFcr	12	10.36	0.37	9.75	11.24	19	11.22	0.61	10.09	12.15	p<0.001
Bfacd	15	9.10	0.61	8.30	10.49	18	10.42	0.49	9.51	11.15	p<0.001
BFtr	14	11.48	0.71	10.22	12.51	14	12.81	0.78	11.47	13.66	p<0.001
SBV	14	9.88	0.57	9.19	11.59	19	10.95	0.69	9.62	11.88	p<0.001
BFcd	8	5.80	0.17	5.57	6.04	18	7.29	2.29	5.75	13.77	p<0.001
H	11	13.80	0.90	12.75	15.55	18	14.70	0.99	13.37	16.89	p<0.05

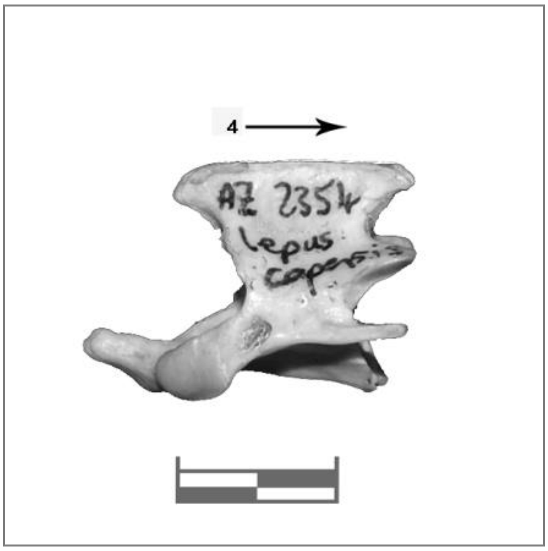


Figure 4.78: *L. capensis* – Axis lateral view

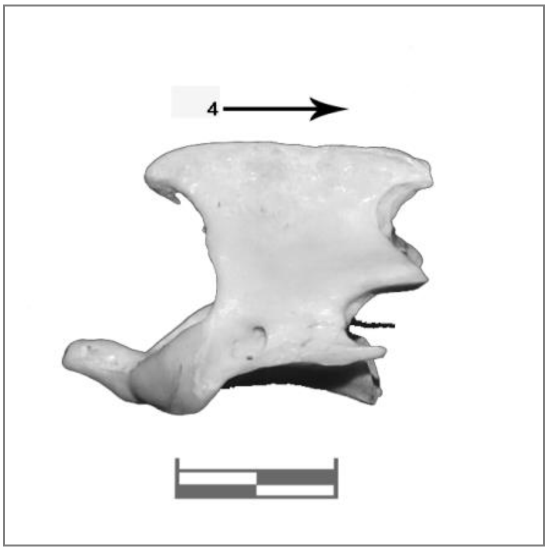


Figure 4.79: *L. saxatilis* – Axis lateral view

- *Spinous processus* (4) — in *L. capensis* is dome-shaped and converges to a point cranially. It is in line with the start of the dens and the end of the collar. The dome splits into two articulation facets caudally. In *L. saxatilis* the process is also dome-shaped although it appears flatter and elongated when compared to *L. capensis*. The process splits into two articulation facets caudally (Figures 4.78 & 4.79).

- In both species, the collar is split into two articulations, one on each side of the dens. In *L. capensis* the articulations wrap around the outer edge of the axis and do not protrude from the body. In *L. saxatilis* the articulations are bulbous and protrude from the body.

- In *L. saxatilis* there is a diagonal line running across the muscle and ligaments line on the ventral side. This line is not present in *L. capensis* (Figures 4.80 & 4.81).

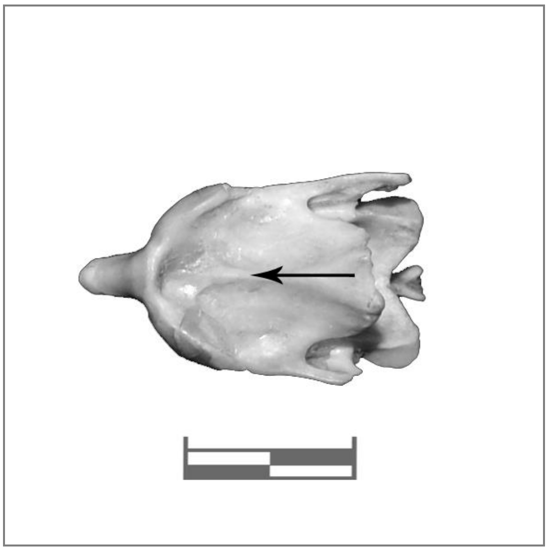


Figure 4.80: *L. capensis* – Axis dorsal view

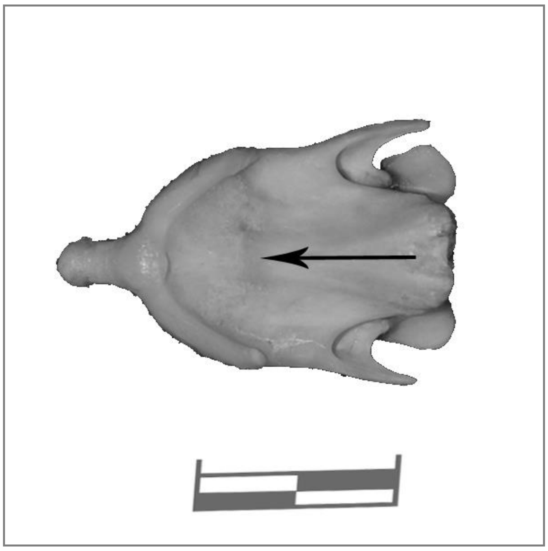


Figure 4.81: *L. saxatilis* – Axis dorsal view

Due to the irregular nature of the vertebrae, very little correlation could be found amongst the measurements. The scatter plots for the axis are not a reliable indicator since none demonstrate a high or medium correlation. The scatter plots of the two measurements that demonstrate the most variability are included (Figures 4.82 & 4.83). Except for H, all of the measurements were found to be statistically highly significant (Table 4.6).

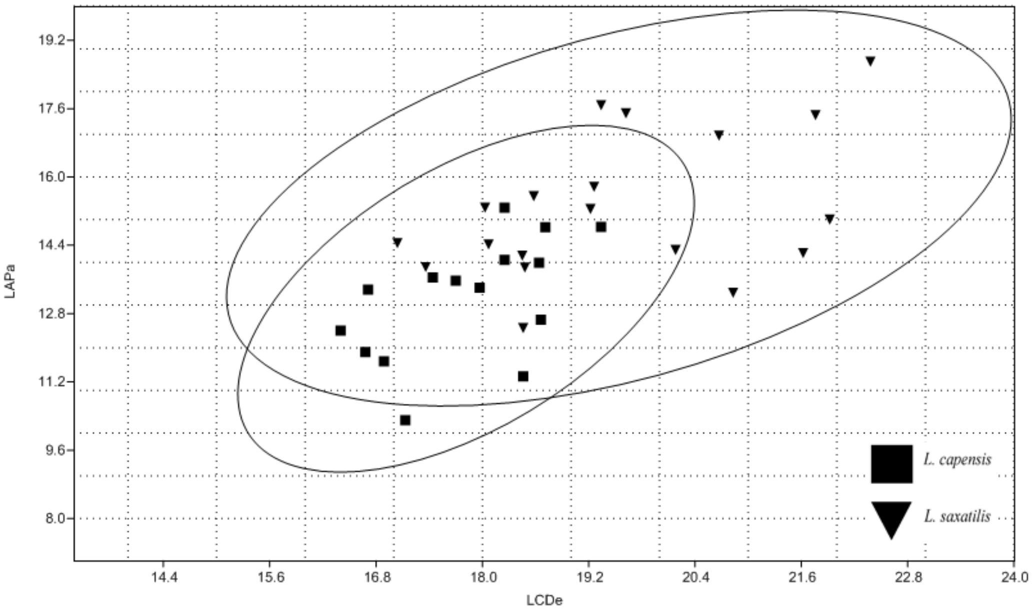


Figure 4.82: Axis measurement LAPa – Length of arch including the processus vs LCDe – Length in the region of the corpus including the dens

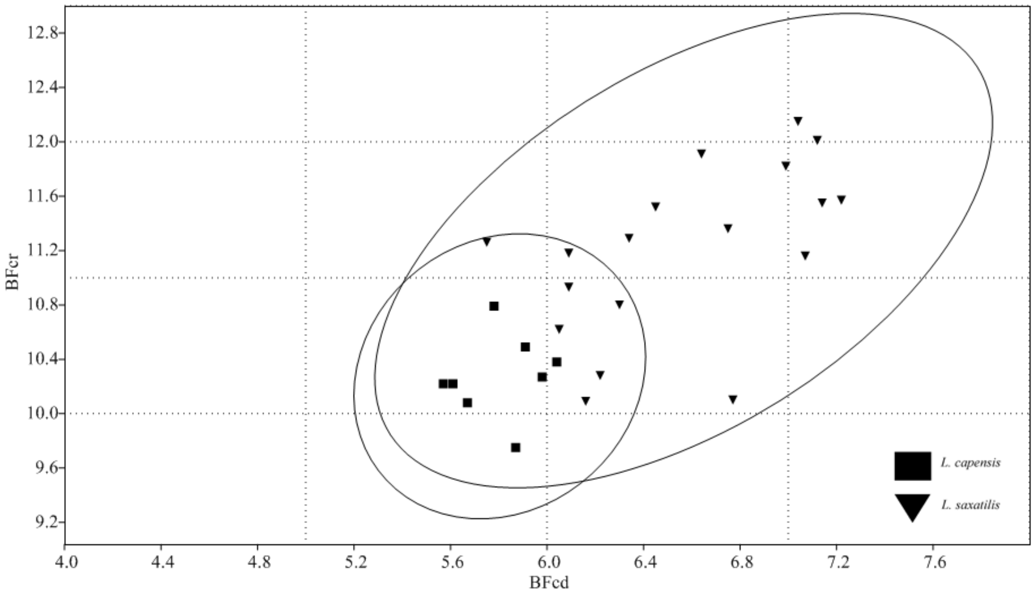


Figure 4.83: Axis measurements BFcr – Breadth *facies cranialis* vs BFcd – Breadth *facies caudalis* — indicating no correlation

This overlap is evident in the 95% confidence levels. Measurements LCDe (Figure 4.84), LAPa (Figure 4.85), BFcr (Figure 4.86), BPacd (Figure 4.87), BFtr (Figure 4.88), SBV (Figure 4.89) for *L. capensis* overlap with the lower bound measurements of *L. saxatilis*.

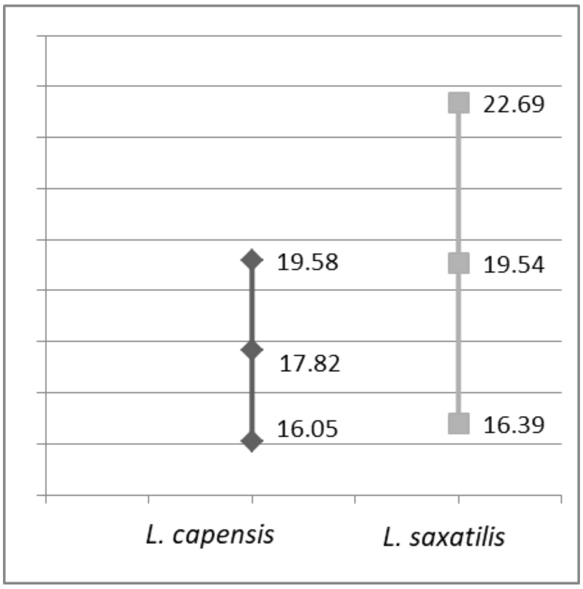


Figure 4.84: Axis measurement LCDe – Length in the region of the corpus. 95% confidence levels upper bound, mean and lower bound values indicated

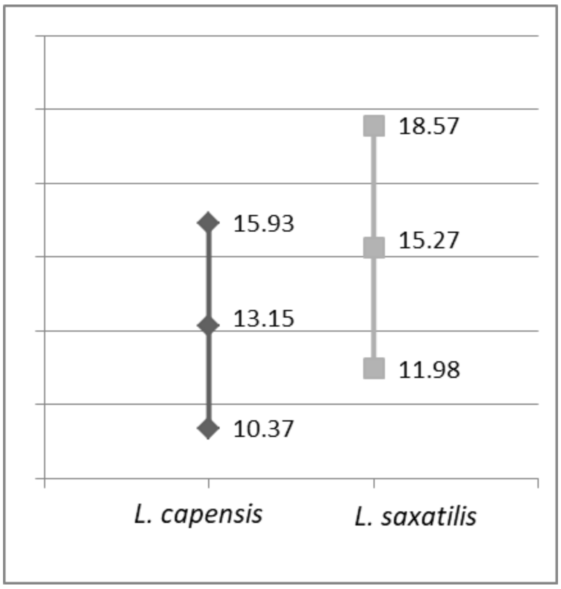


Figure 4.85: Axis measurement LAPa – Length of the *facies* arch including the *processus*. 95% confidence levels upper bound, mean and lower bound values indicated

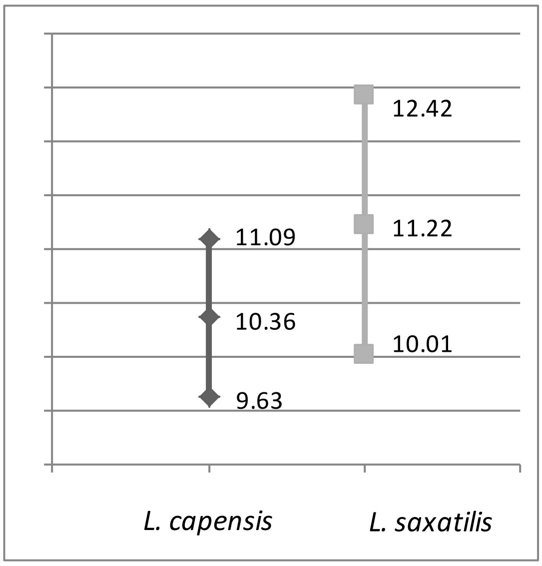


Figure 4.86: Axis measurement BFcr – Breadth *Facies cranialis*. 95% confidence levels upper bound, mean and lower bound values indicated

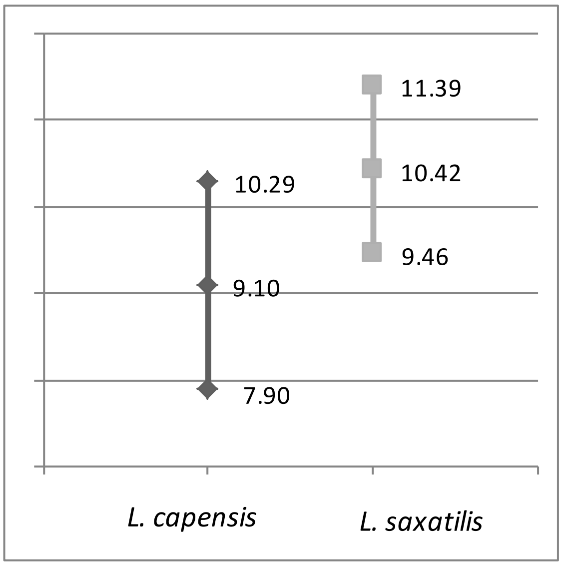


Figure 4.87: Axis measurement BPacd – Breadth across the *processus articularis caudalis*. 95% confidence levels upper bound, mean and lower bound values indicated

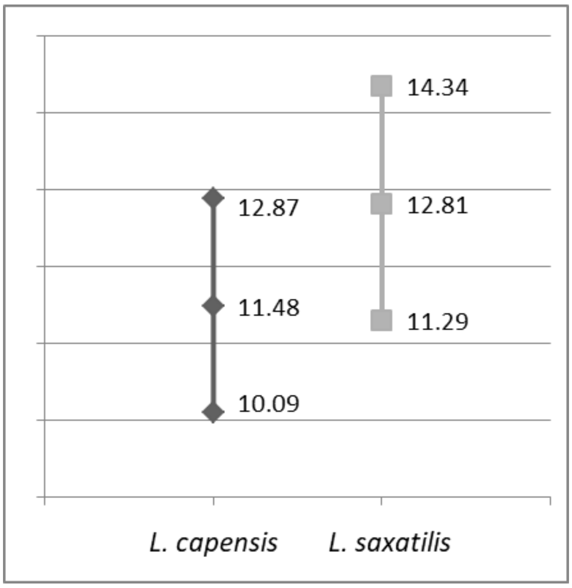


Figure 4.88: Axis measurement BFtr – Breadth across the *processus transversi*. 95% confidence levels upper bound, mean and lower bound values indicated

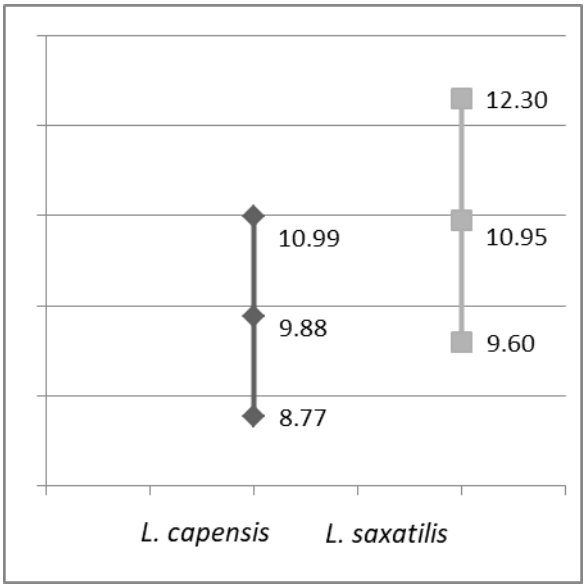


Figure 4.89: Axis measurement SBV – Smallest breadth of the vertebra. 95% confidence levels upper bound, mean and lower bound values indicated

The measurement that has the clearest distinction is Breadth *Facies terminalis caudalis* (BFcd) (Figure 4.90). This distinction may be attributed to the different locomotory habits of the species although no such clear corresponding difference could be found in the atlas. Both the atlas and the axis play a role in the characteristic head stability of the hares during locomotion (see Chapter 2).

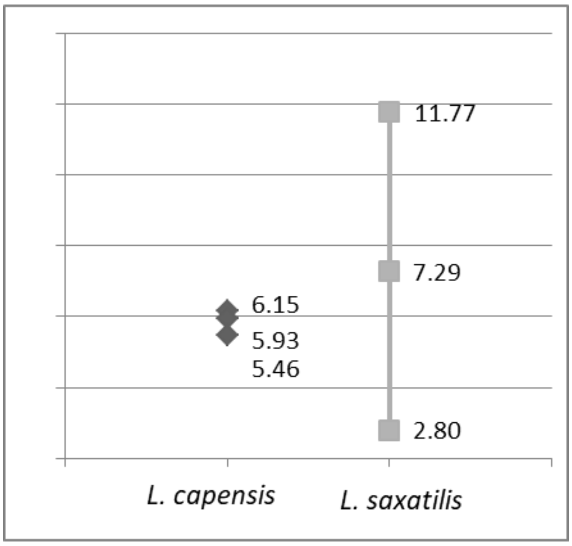


Figure 4.90: Axis measurement BFcd – Breadth *Facies terminalis caudal*is. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.5 Element name - Scapula

Number of individuals examined: *L. capensis* – 25; *L. saxatilis* – 23

A total of 21 individual scatter plots for the scapula were drawn up and seven boxplots for each measurement’s 95% confidence levels.

Photos of the scapula are set at a 2cm scale for the complete bone and a 1cm scale for the glenoid. Some of the images were greatly enlarged to make the morphology visible and no scale is included.

Table 4.7: Scapula measurements p-values. P-values are all statistically highly significant

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Scapula												
HS	22	68.39	4.32	59.34	77.90		19	76.56	4.81	69.92	84.77	p<0.001
DHA	22	67.92	4.07	60.13	78.14		19	76.83	5.01	69.64	86.42	p<0.001
Ld	22	39.33	2.27	35.04	43.70		19	43.47	3.40	38.53	50.27	p<0.001
SLC	22	6.16	0.45	5.27	7.28		19	7.04	0.64	6.02	8.41	p<0.001
GLP	22	10.46	0.61	9.56	11.87		19	11.92	1.06	10.47	14.35	p<0.001
LG	22	9.83	0.43	9.01	10.57		19	11.02	1.06	9.52	13.05	p<0.001
BG	22	9.58	0.58	8.77	10.78		19	10.91	0.91	9.61	12.56	p<0.001

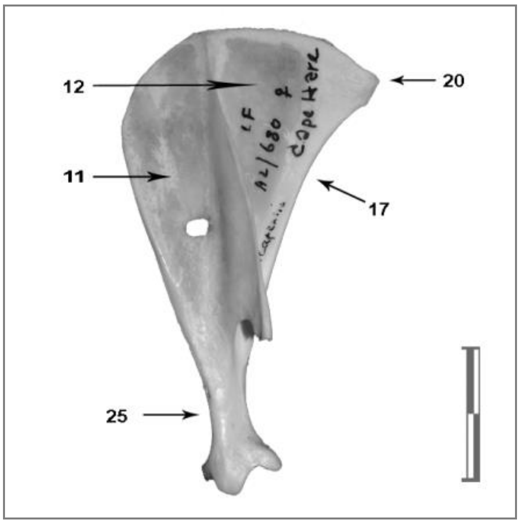


Figure 4.91: *L. capensis* – Scapula lateral view

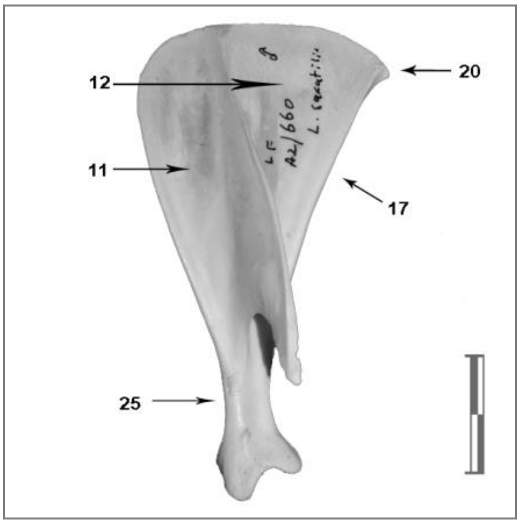


Figure 4.92: *L. saxatilis* – Scapula lateral view

- In *L. capensis*, when complete and the element is placed on its caudal side, the — *Fossa supra spinata* (11) — the 1/3rd portion of the blade's proximal portion curves medially. *Fossa supra infraspinata* (12) — the 2/3rd portion of the blade flares dramatically towards the — *Angelus caudalis* (20). It does not flare as much as in *L. saxatilis* (Figures 4.91 & 4.92).

- In *L. capensis* — *Margo caudalis* (17) — where it starts at — *Angelus caudalis* (20) — it is triangular and flat and the whole border is rounded. In *L. saxatilis* the whole of this margin is flat from where it starts down to the neck (Figures 4.91 & 4.92; Figures 4.93 & 4.94; Figures 4.95 & 4.96).

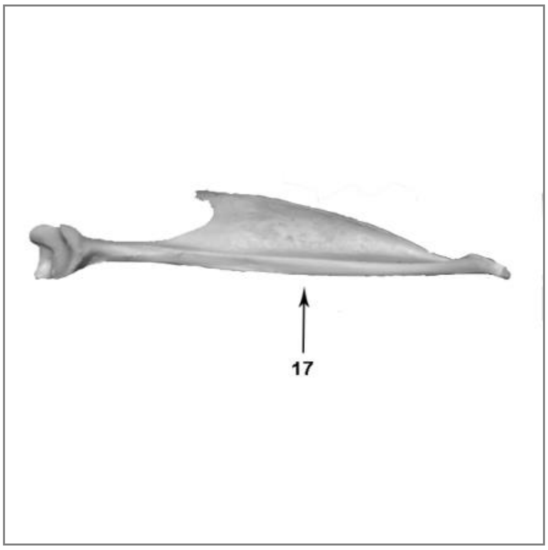


Figure 4.93: *L. capensis* – Scapula caudal view

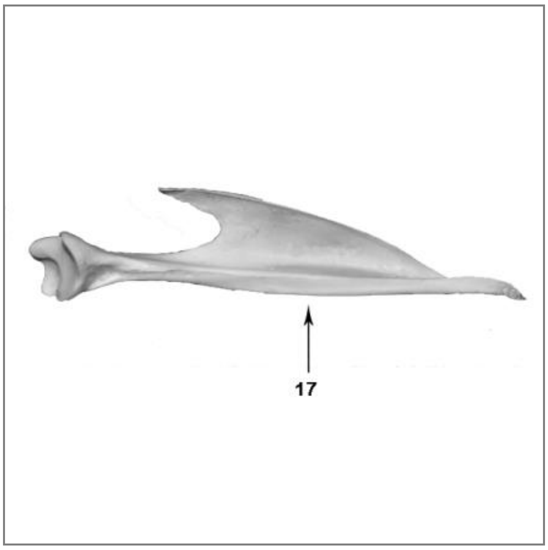


Figure 4.94: *L. saxatilis* – Scapula caudal view

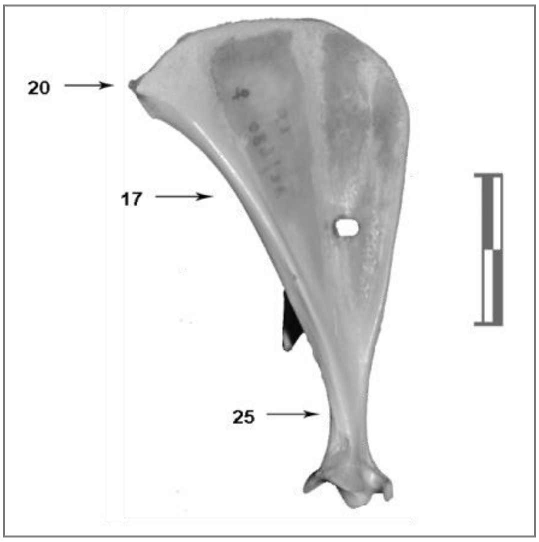


Figure 4.95: *L. capensis* – Scapula medial view

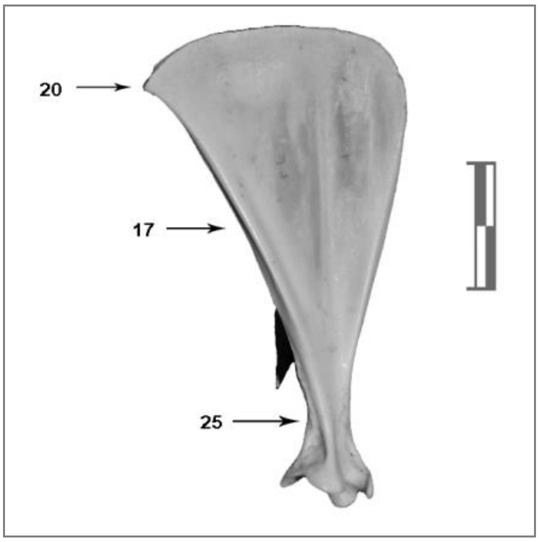


Figure 4.96: *L. saxatilis* – Scapula medial view

- The neck of the scapula — *Collum spina* (25) — is broader and flatter in *L. saxatilis* than in *L. capensis* (Figures 4.91 & 4.92; Figures 4.95 & 4.96).

- Glenoid — *Cavitas glenoidalis* (23) — in *L. capensis* the glenoid cavity is elliptical in shape with both lateral and medial sides being equally round. In *L. saxatilis* the glenoid cavity is flatter and an elongated ellipse. The lateral part of the cavity is elongated and the medial part is more round (Figures 4.97 & 4.98).

- Tuber — *Tuberculum suprageloidale* (27) — in *L. capensis* the upper part of the glenoid that forms the tuber is broad and stays broad all the way to the tip. In *L. saxatilis* the upper part of the glenoid that forms the tuber starts out slightly narrower and the whole tuber is flattened and thus gives a narrower appearance (Figures 4.97 & 4.98).

- Coracoid — *Processus coracoideus* (28) — in *L. capensis* the coracoids process ends in a bit of a bulbous shape. The process slopes down and is slightly turned at an angle to the glenoid. In *L. saxatilis* the process is slightly curved to the glenoid giving the process a flat appearance (Figures 4.97 & 4.98).

- In *L. capensis* the sulcus is generally more truncated in a narrower U-shape than in *L. saxatilis* (Figures 4.97 & 4.98).

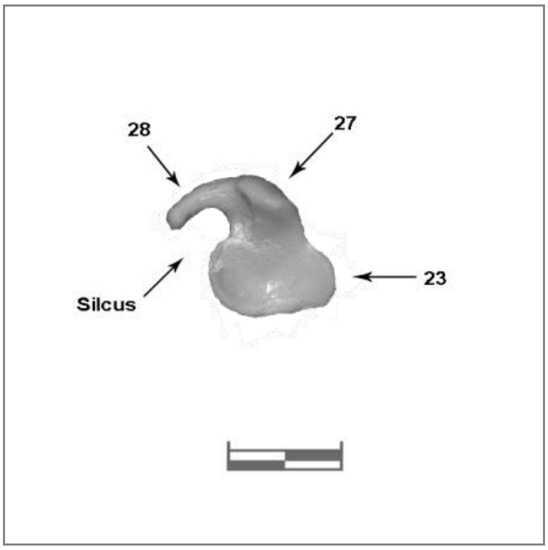


Figure 4.97: *L. capensis* – Scapula glenoid

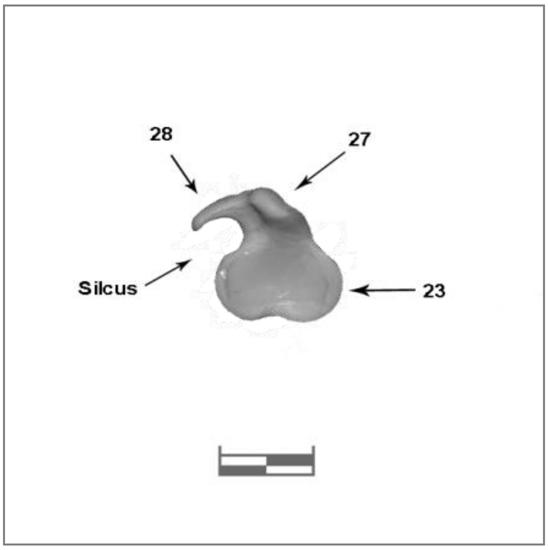


Figure 4.98: *L. saxatilis* – Scapula glenoid

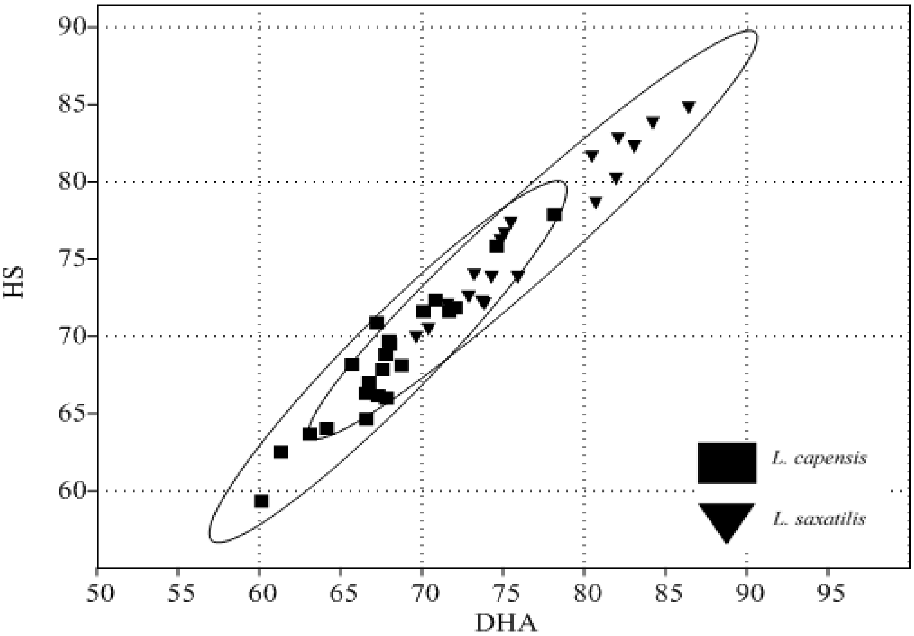


Figure 4.99: Scapula measurement HS – Height along the spine vs DHA – Diagonal height showing a high correlation in both species

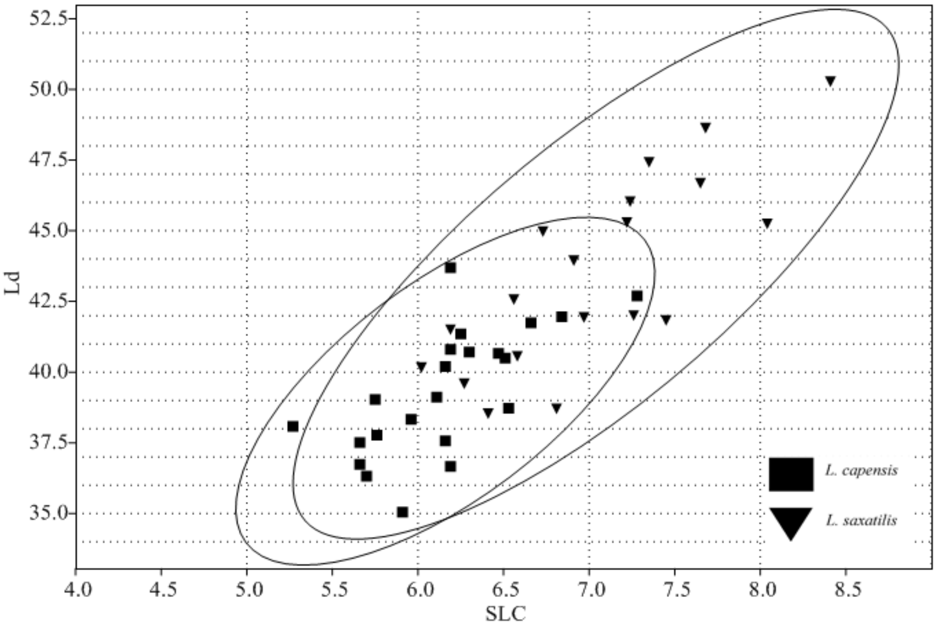


Figure 4.100: Scapula measurement Ld – Dorsal length vs SLC – Smallest length of the collum indicating a possible correlation

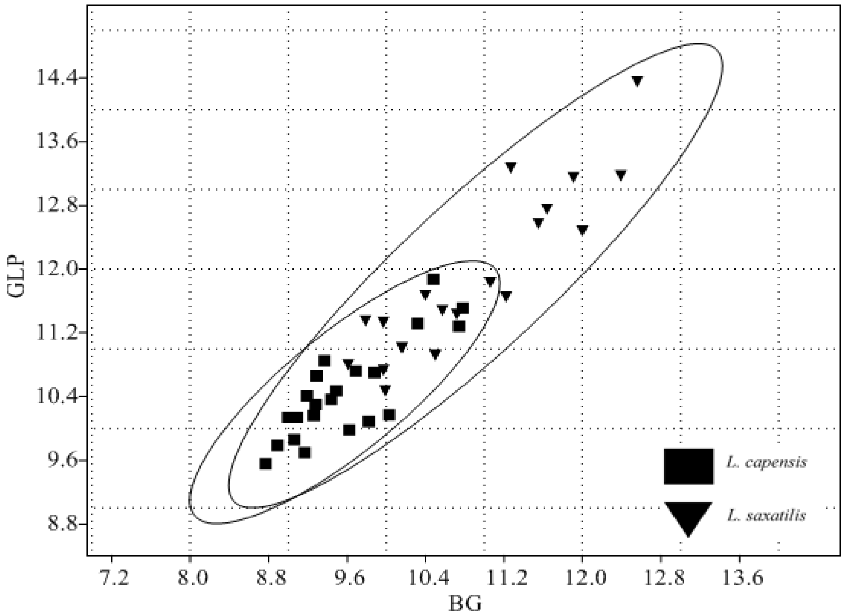


Figure 4.101: Scapula measurement GLP – Greatest length of the processus vs BG – Breadth of the glenoid showing a high correlation in both species

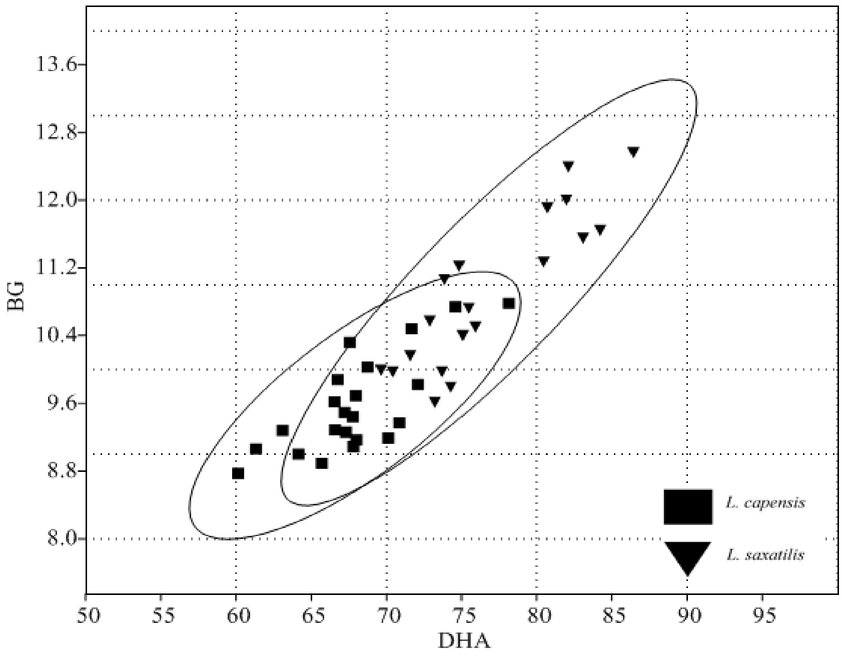


Figure 4.102: Scapula measurement BG – Breadth of the glenoid vs DHA – Diagonal height indicating a high correlation in both species

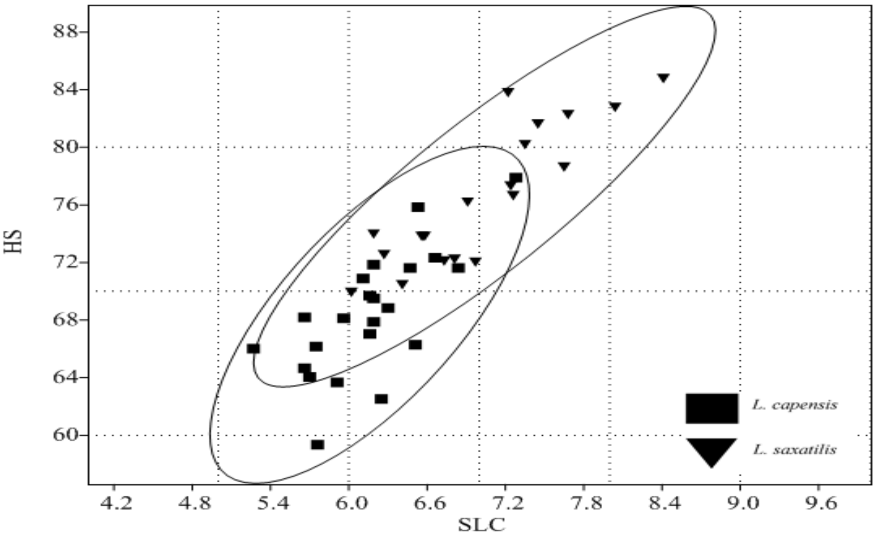


Figure 4.103: Scapula measurement HS – Height along the spine vs SLC – Smallest length of the collum indicating a high correlation in both species

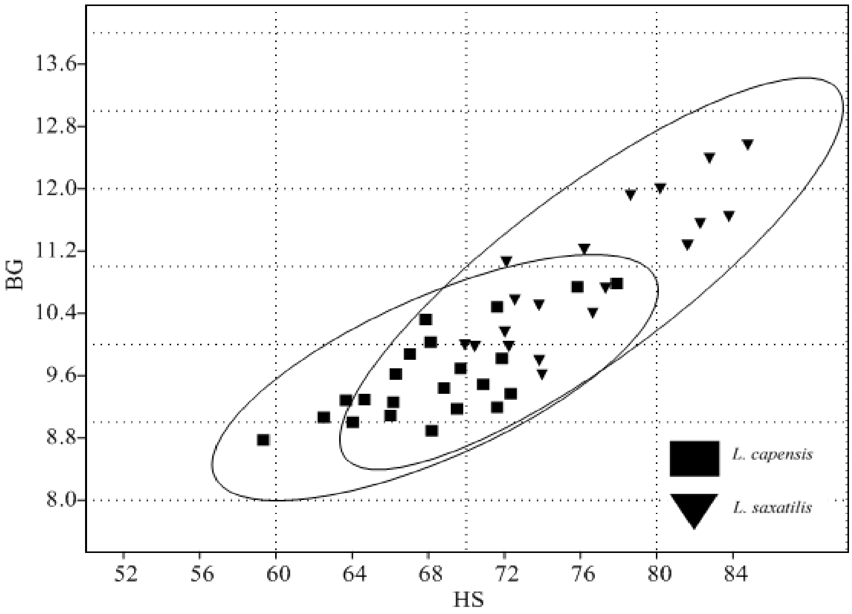


Figure 4.104: Scapula measurement BG – Breadth of the glenoid cavity vs HS – Height along the spine indicating a high correlation in both species

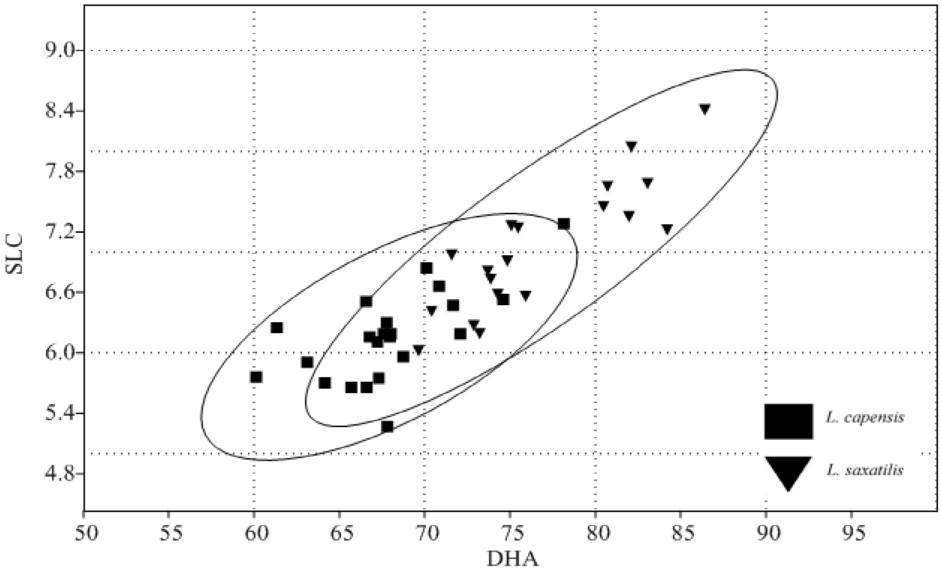


Figure 4.105: Scapula measurement SLC – Smallest length of collum vs DHA – Diagonal height indicating a height correlation in both species

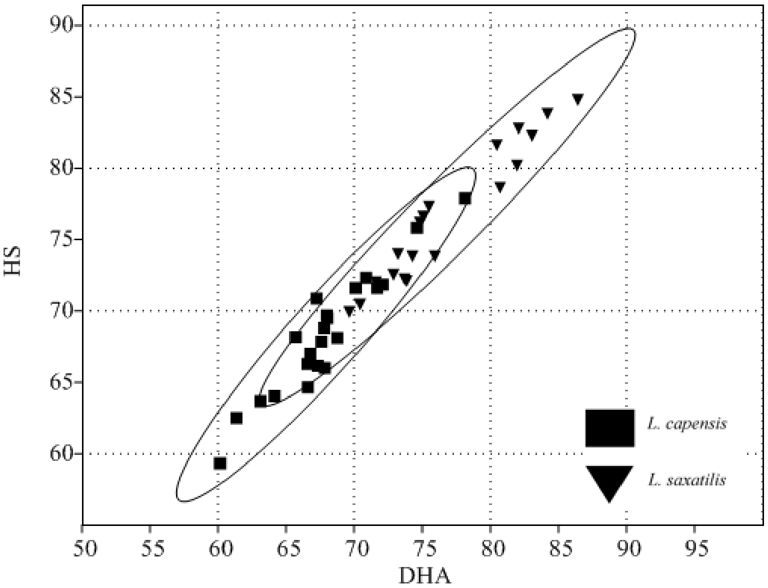
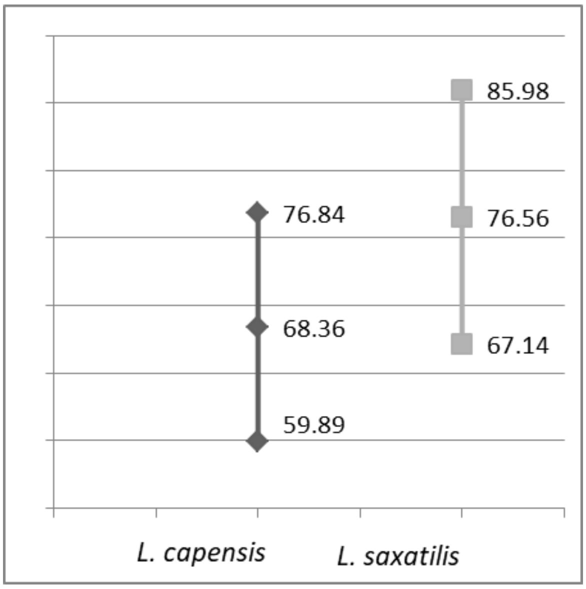


Figure 4.106: Scapula measurement HS – Height along the spine vs DHA – Diagonal height indicating a high correlation for *L. saxatilis*

All the measurements only overlap with the lower bound of *L. saxatilis*. The least overlap is observed in the GLP (Figure 4.111) and LG (Figure 4.112) measurements.



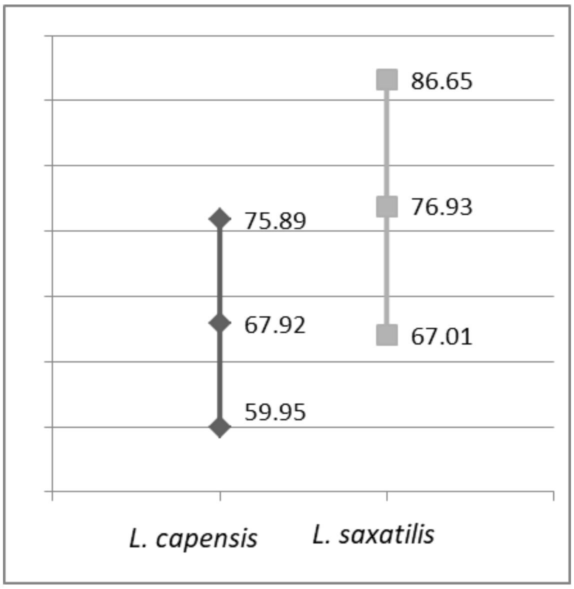


Figure 4.107: Scapula measurement HS – Height along the spine. 95% confidence levels upper bound, mean and lower bound values indicated

Figure 4.108: Scapula measurement DHA – Diagonal height. 95% confidence levels upper bound, mean and lower bound values indicated

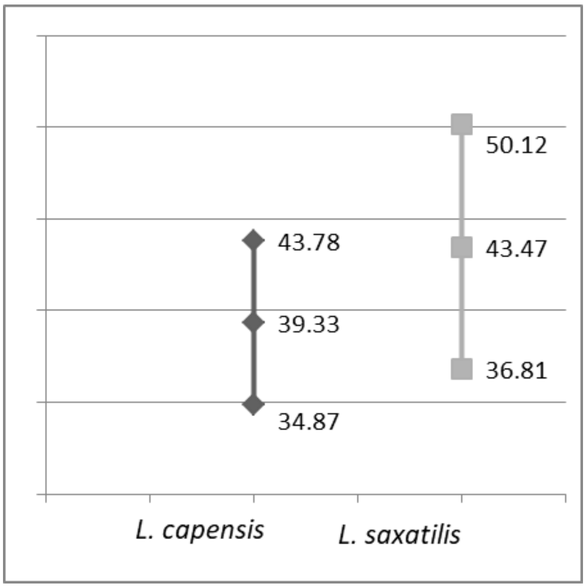


Figure 4.109: Scapula measurement Ld – Dorsal length. 95% confidence levels upper bound, mean and lower bound values indicated

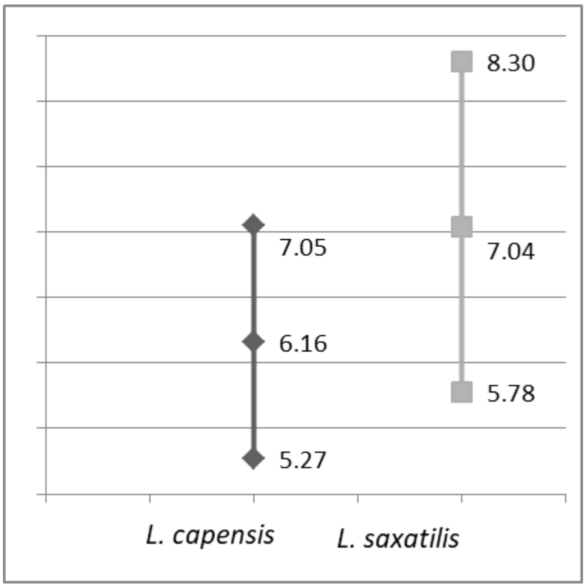


Figure 4.110: Scapula measurement SLC – Smallest length of the collum. 95% confidence levels upper bound, mean and lower bound values indicated

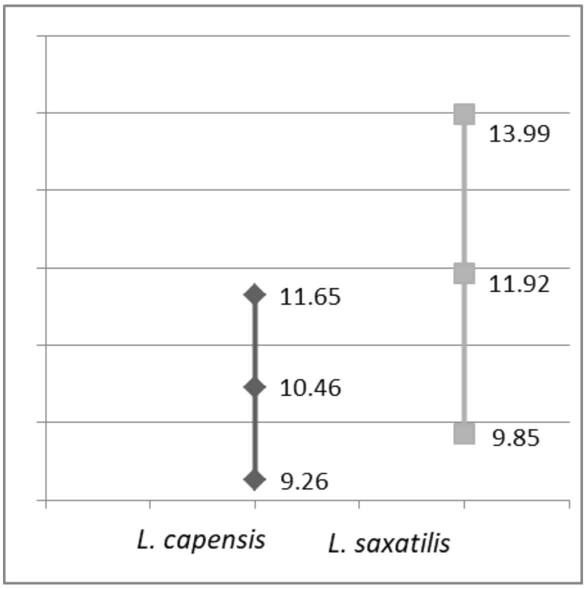


Figure 4.111: Scapula measurement GLP – Greatest length of the processus. 95% confidence levels upper bound, mean and lower bound values indicated

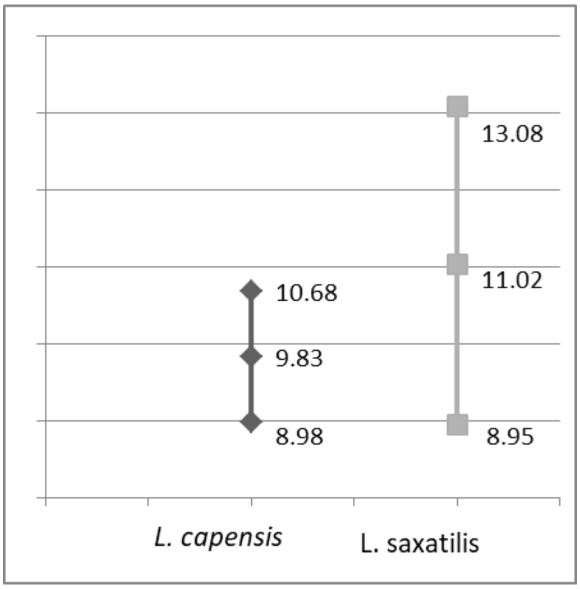


Figure 4.112: Scapula measurement LG – Length of the glenoid cavity. 95% confidence levels upper bound, mean and lower bound values indicated

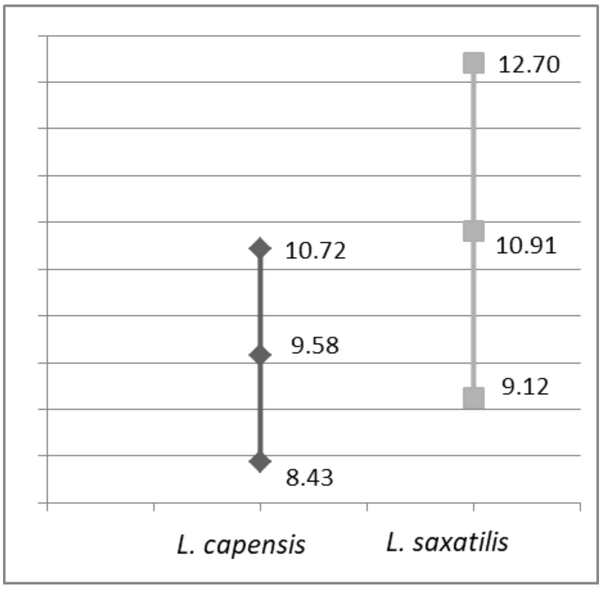


Figure 4.113: Scapula measurement BG – Breadth of the glenoid cavity. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.6 Element name - Humerus

Number of individuals examined: *L. capensis* – 25; *L. saxatilis* – 24

A total number of 21 individual scatter plots for the humerus were drawn up and six boxplots for each measurement's 95% confidence levels.

Photos of the humerus were set at a 2cm scale for the complete bone and a 1cm scale for the articulation facets.

Table 4.8: Humerus measurements p-values. P-values are all statistically highly significant

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Humerus												
GL	19	80.79	3.46	73.55	87.46		19	91.00	6.05	79.19	11.78	p<0.001
GLC	19	78.67	3.32	71.40	85.62		19	89.01	6.00	77.35	98.08	p<0.001
Dp	20	15.40	0.74	14.58	17.28		20	17.26	1.31	15.20	19.57	p<0.001
SD	20	4.68	0.25	4.15	5.13		19	5.61	0.51	4.93	6.50	p<0.001
Bd	20	9.53	0.51	8.82	10.74		20	11.25	0.86	10.20	12.81	p<0.001
DMtc	20	12.21	0.59	11.35	13.58		19	13.93	1.28	12.10	16.26	p<0.001
Cl	20	11.15	0.60	10.35	12.44		19	12.85	1.03	11.45	14.87	p<0.001

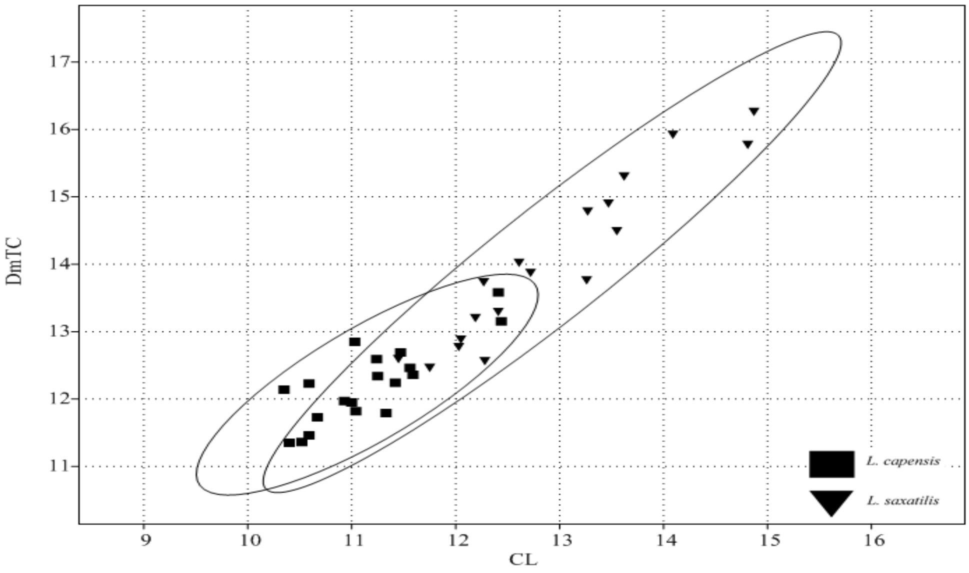


Figure 4.114: Humerus measurement DmTC – Depth of minor trochanter to caput vs CL – Length of caput

- Head — *Caput humeri* (3) — in *L. capensis* and *L. saxatilis* the proximal head is smooth and bulbous in shape with a rounded peak on the minor tuber's side. The peak in *L. saxatilis* seems to be pushed to the side almost on the side of the caput (Figures 4.115 & 4.116).

If the morphology is compared to the morphometrics it does seem that the *L. saxatilis* data indicates this slight bulge toward the side of the minor tuber.

- In *L. capensis* the greater tuber — *Tuberculum majus* (5) — is an elliptical rectangle shape and the lateral muscle scar is almost indented. The tip of the tuber has a slight overhang. In *L. saxatilis* the tuber is more elliptical in shape and has a peak. The lateral muscle attachment is a deep indent and the top remains in line with the peak (Figures 4.117 & 4.118).

- In *L. capensis* the inter-tubular muscle groove — *Sulcus inter tubercularis* (13) — is narrow and forms a clear division between the two tubers. In *L. saxatilis* the inter-tubular muscle groove is broader and forms a clear division between the two tubers (Figures 4.115 & 4.116).

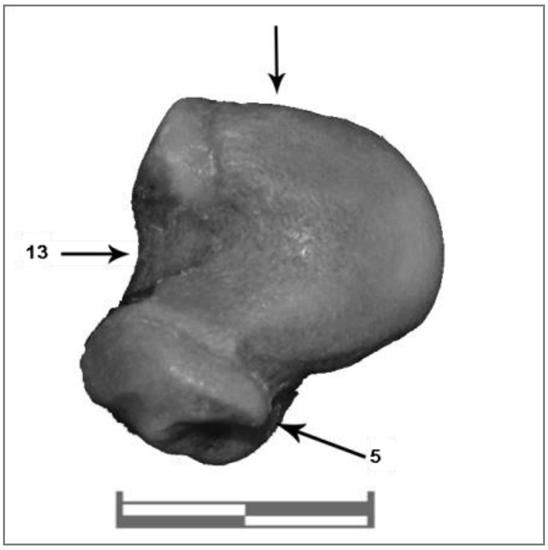


Figure 4.115: *L. capensis* – Humerus proximal view

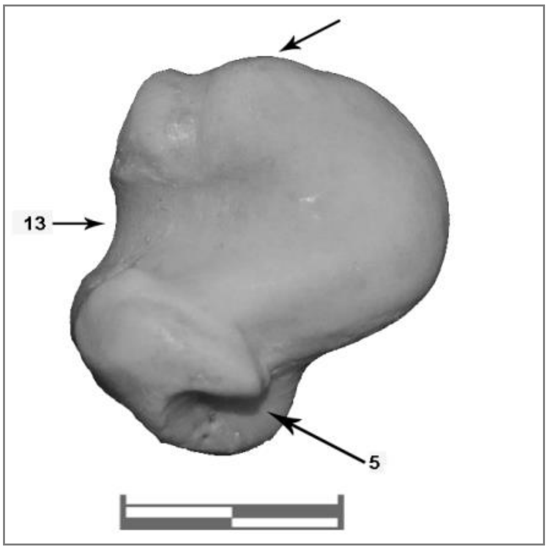


Figure 4.116: *L. saxatilis* – Humerus proximal view

Figure 4.117: *L. capensis* – Humerus proximal lateral view

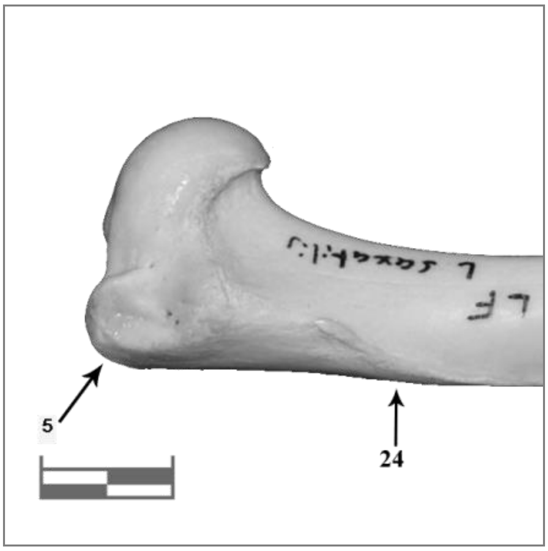


Figure 4.118: *L. saxatilis* – Humerus proximal lateral view

- In *L. capensis* the — *Corpus humeri* (18) — on the medial side of the body (shaft) is straight with no variability. In *L. saxatilis* the position is the same except that there is a visible, mostly tactile, muscle scar that runs along the proximal shaft and ends under the sulcus. This is not clearly visible in photos.

- In *L. capensis* the caudal surface — *Facies caudalis* (21) — seems sharply shaped, almost triangular in appearance, with the shaft proximally aligned with the caput. The shaft in *L. saxatilis* is round and in keeping with the proximal shaft (Figures 4.119 & 4.120).

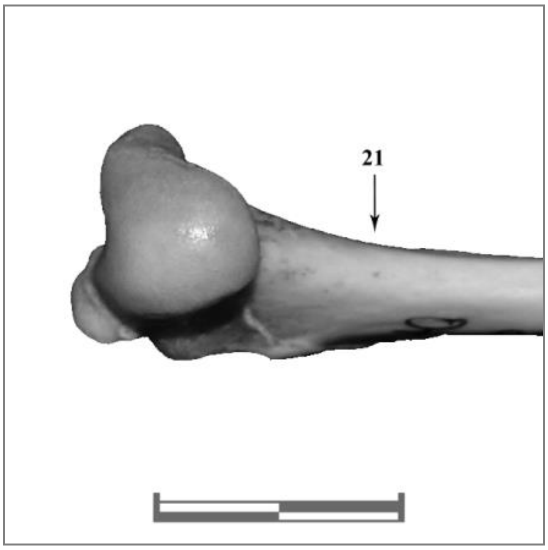


Figure 4.119: *L. capensis* – Humerus caudal view

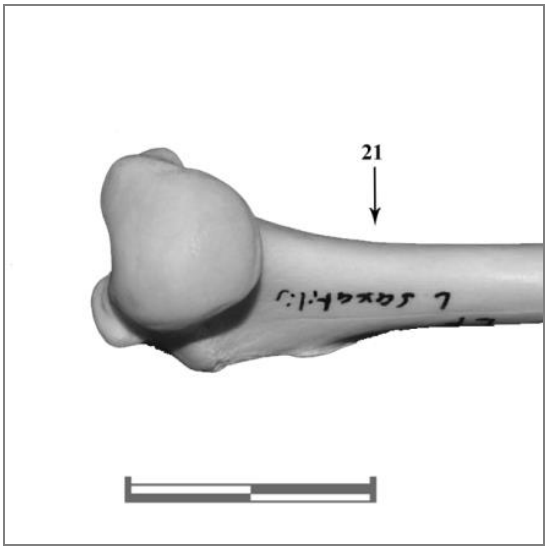


Figure 4.120: *L. saxatilis* – Humerus proximal lateral view

- ❖ The most prominent muscle attachment on the proximal shaft is the deltoid tuber — *Tuberositas deltoidea* (24) — and is placed very high proximal cranially on the shaft. When a finger is run along the spine in *L. capensis* there is a distinct 'single line' that can be felt. In the *L.saxatilis* the line has a distinct 'double line' feel (Figures 4.117 & 4.118).

- ❖ Crest distal — *Crista supra condylaris lateralis* (27) — is a slight curve in the *L. capensis* to form the distal artic. In *L. saxatilis* the curve is very prominent (Figures 4.121 & 4.122).

- ❖ The distal shaft just above the articulation and the interosseous space (above — *fossa olecrani* (31) in *L. capensis* is shallow and not that strongly formed. In the male *L. capensis* this does seem to be a stronger feature than in the females. In *L. saxatilis* this is a very strong depression (Figures 4.121 & 4.122).

- ❖ In *L. capensis* the lateral 3rd of the articulation melts into lateral crest — *Crista supra condylaris lateralis* (27) — with no clear distinction of its start or end position. In *L. saxatilis* there is a clear distinction between the articulation and the lateral crest (Figures 4.121 & 4.122).

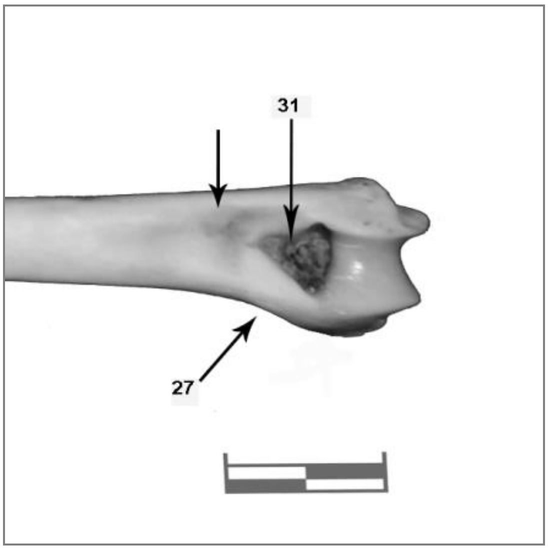


Figure 4.121: *L. capensis* – Humerus distal dorsal view

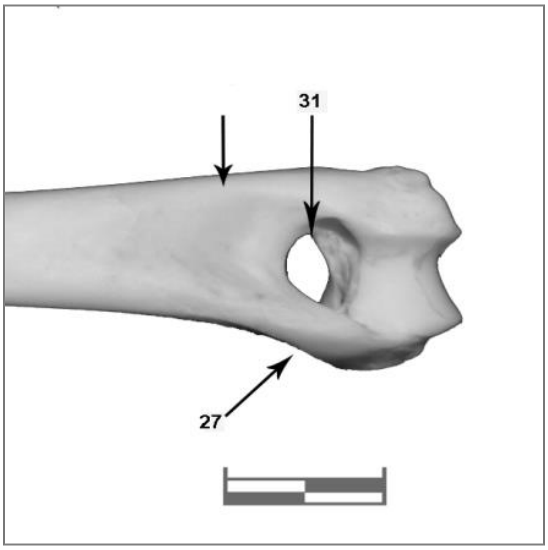


Figure 4.122: *L. saxatilis* – Humerus distal dorsal view

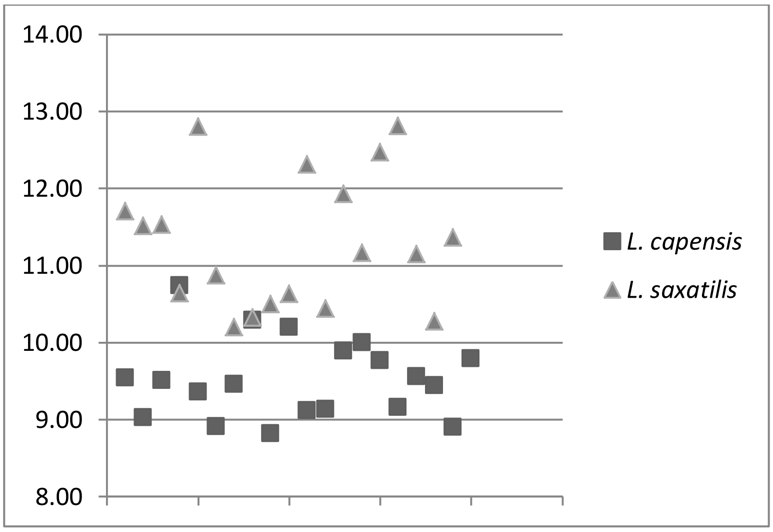


Figure 4.123: Humerus measurement Bd – Breadth of the distal end

When the distal breadth (Bd) measurements are compared, *L. saxatilis* is broader and stronger than the *L. capensis* (Figure 4.123). The 95% confidence level does not indicate the overlap seen above. There is a clear distinction in this measurement between *L. capensis* and *L. saxatilis* (Figure 4.124).

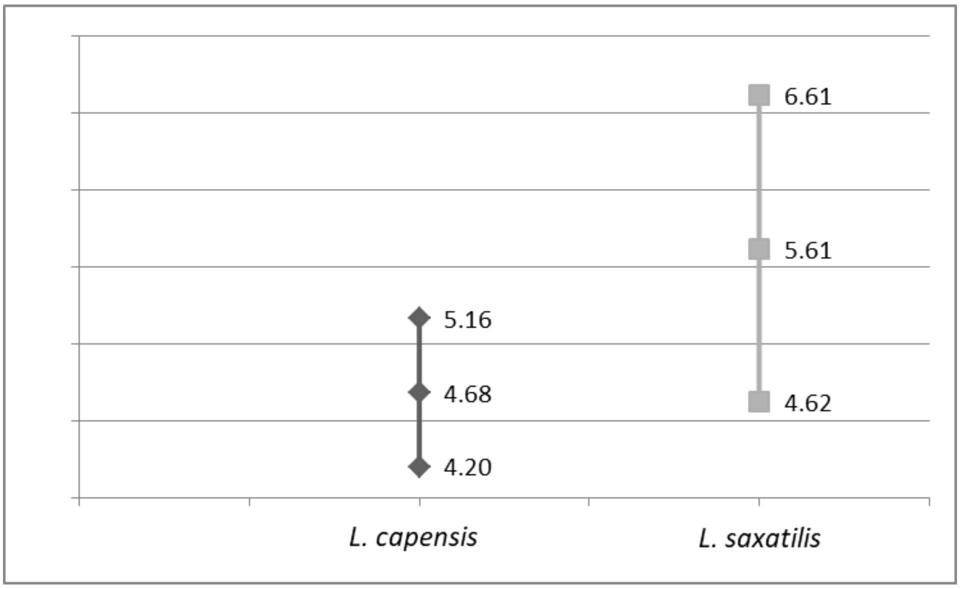


Figure 4.124: Humerus measurement Bd – Breadth of the distal end. 95% confidence levels upper bound, mean and lower bound values indicated

- In general, the complete humerus of the *L. saxatilis* is less gracile than the *L. capensis* (Figures 4.125 & 4.126)

Figure 4.125: *L. capensis* – Humerus medial view

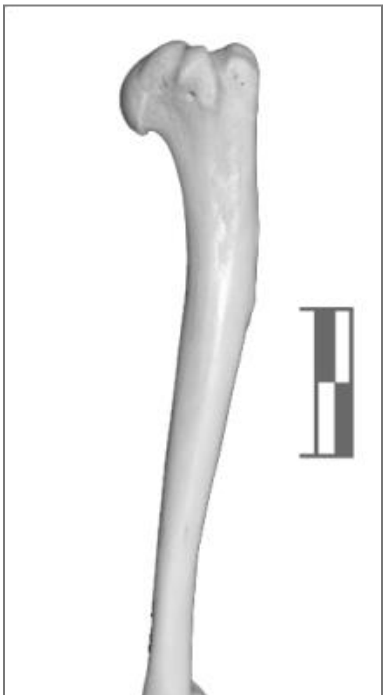


Figure 4.126: *L. saxatilis* – Humerus medial view

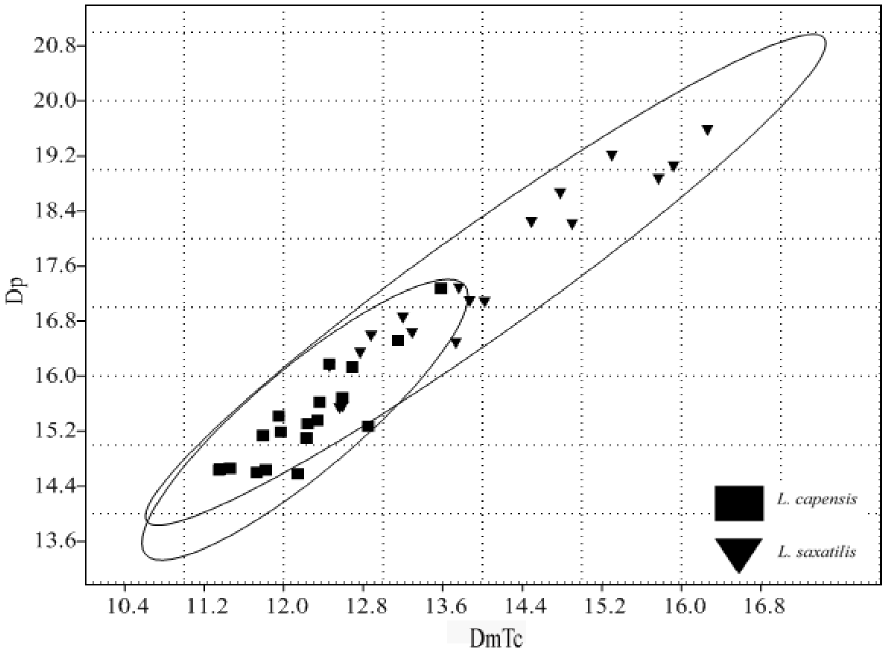


Figure 4.127: Humerus measurement Dp – Depth of proximal end vs DmTc – Depth minor trochanter to caput showing a high correlation in both species

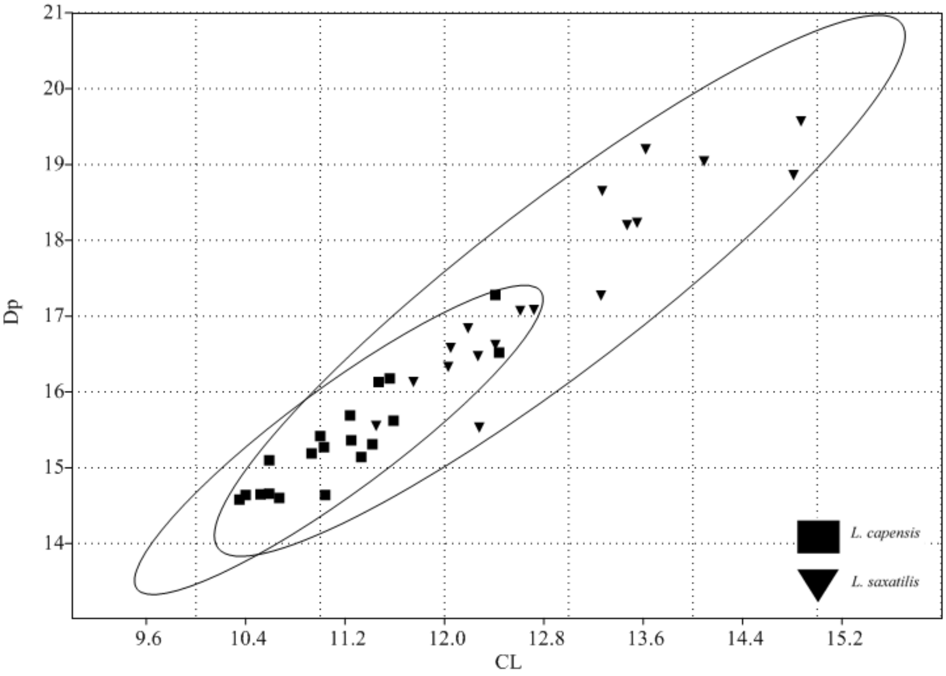


Figure 4.128: Humerus measurement Dp – Depth of proximal end vs CL – Length of caput — indicating a high correlation in both species

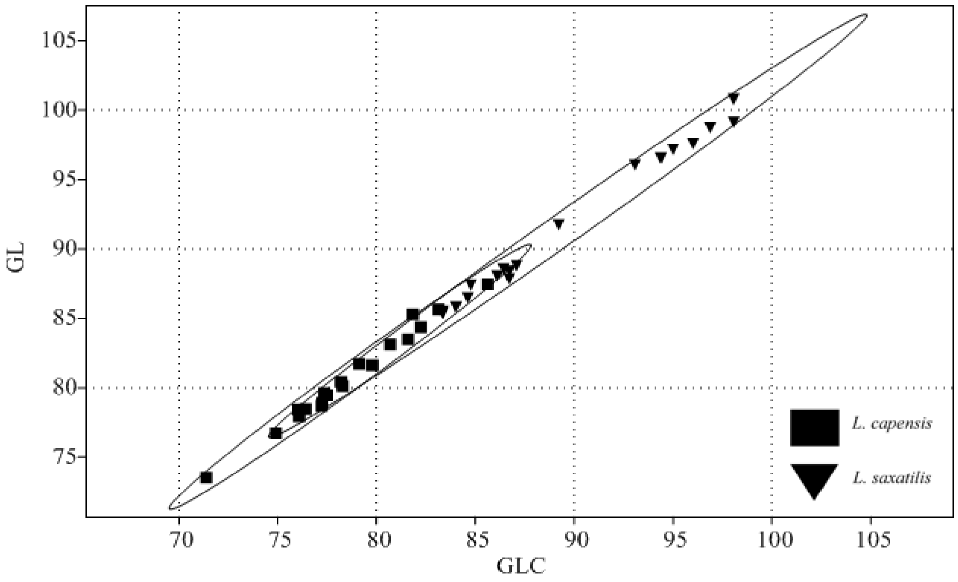


Figure 4.129: Humerus measurement GL – Greatest length vs GLC – Greatest length from caput — indicating a perfect correlation

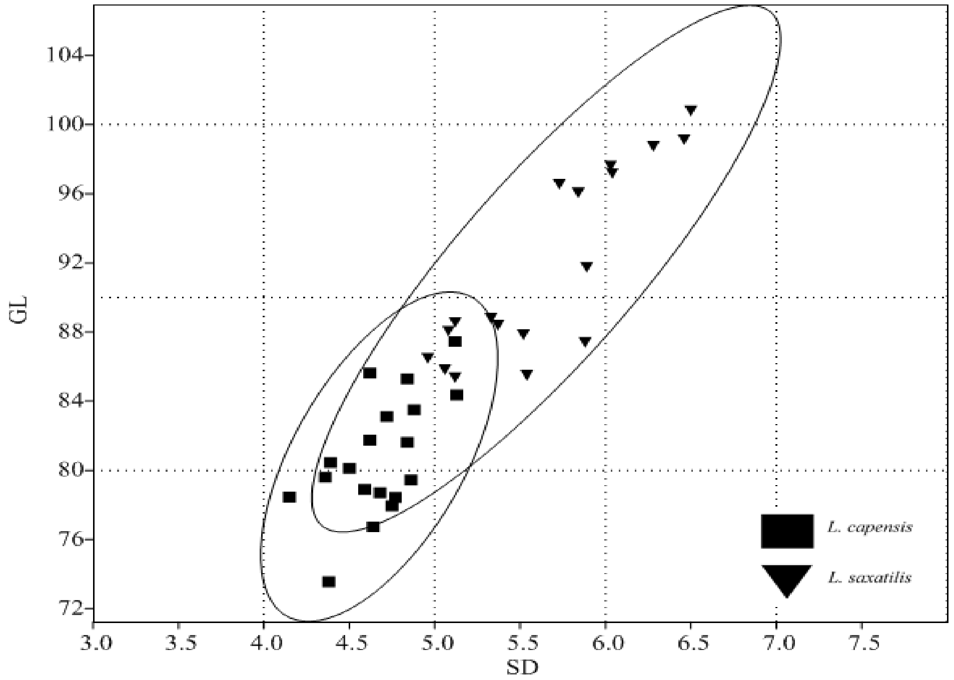


Figure 4.130: Humerus measurement GL – Greatest length vs SD – Smallest breadth of shaft — indicating a good correlation for both species

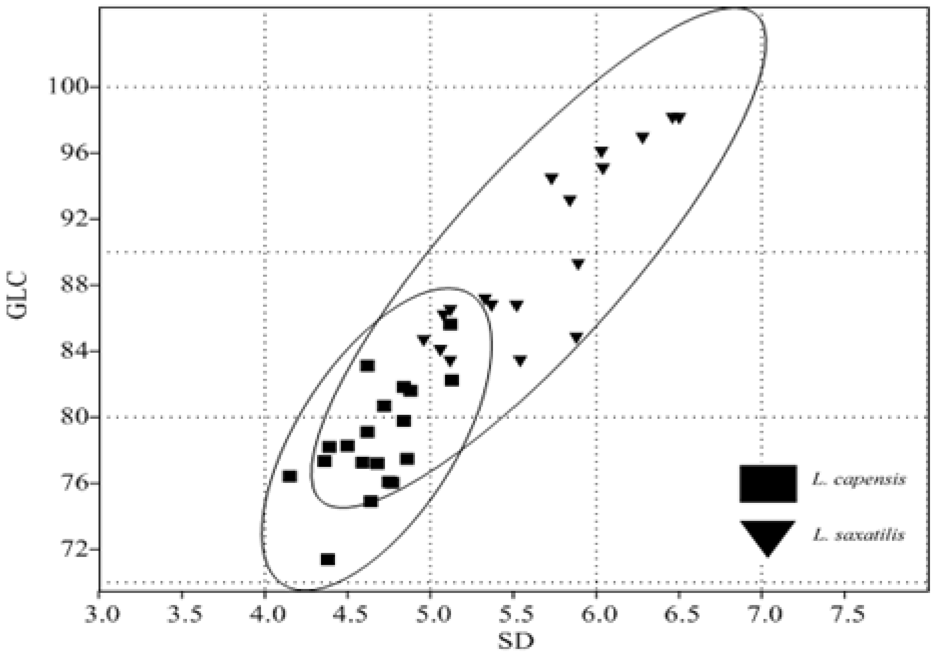


Figure 4.131: Humerus measurement GLC – Greatest length from caput vs SD – Smallest breadth of shaft — indicating a good correlation for both species

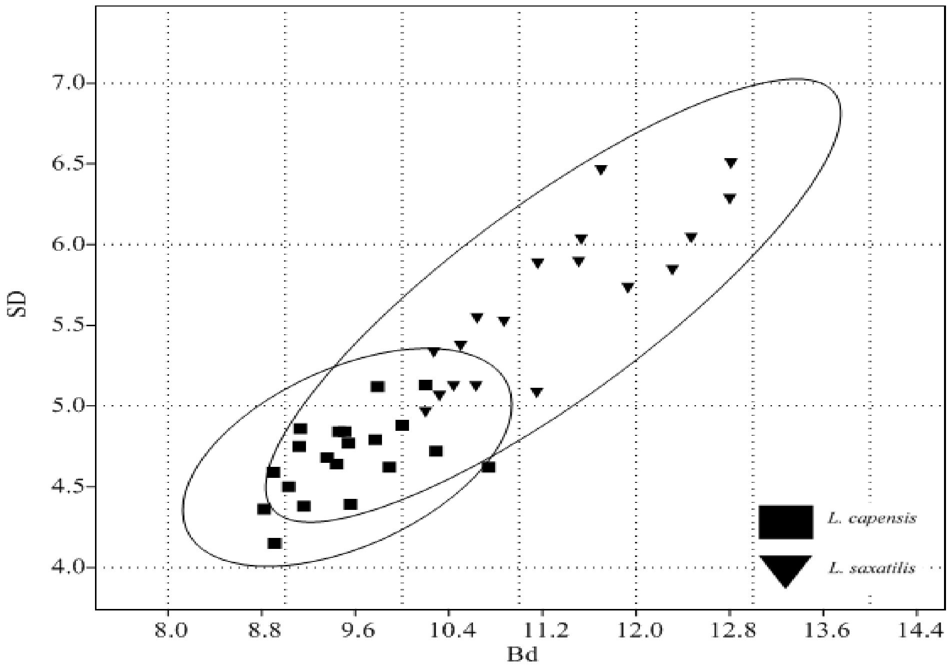


Figure 4.132: Humerus measurement SD – Smallest breadth of the shaft vs Bd – Breadth of the distal end — indicating a lower correlation for *L. capensis* than for *L. saxatilis*

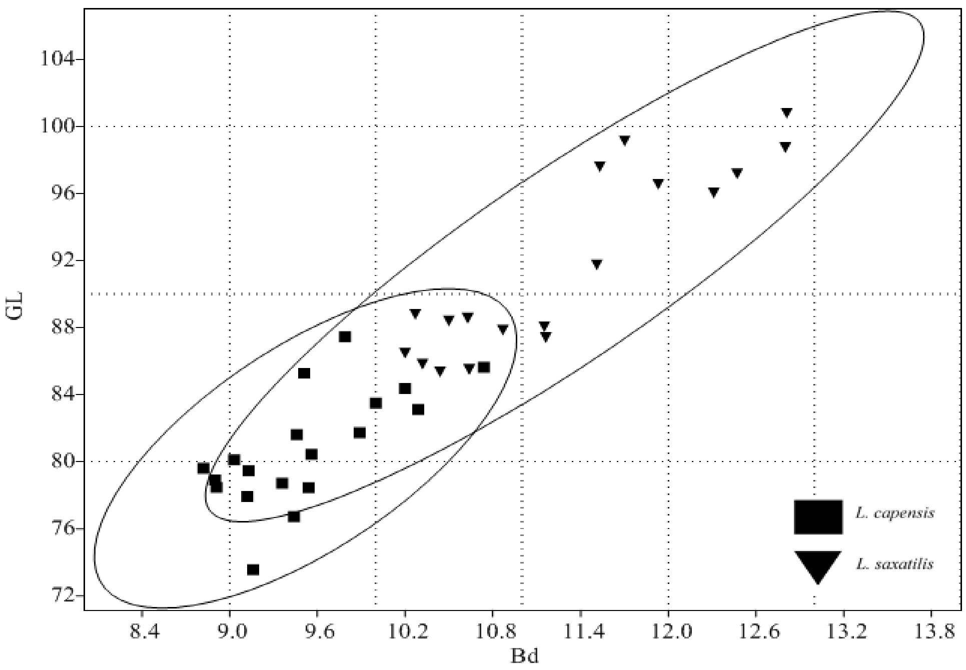


Figure 4.133: Humerus measurement GL – Greatest length vs Bd – Breadth of distal end — indicating a high correlation for *L. saxatilis*

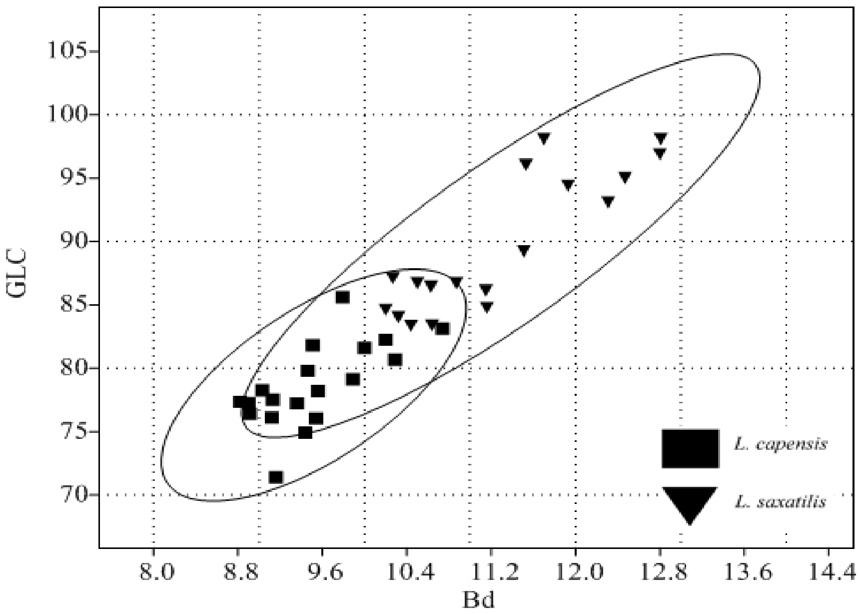


Figure 4.134: Humerus measurement GLC – Greatest length from caput vs Bd – Breadth of distal end — indicating a high correlation for *L. saxatilis*

The two measurements that have the least overlap in their confidence levels are the GLC (Figure 4.135). All the other measurements show the expected lower bound overlap.

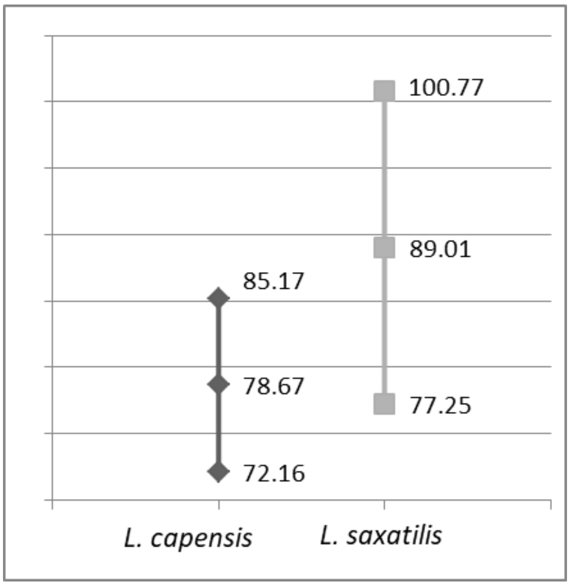


Figure 4.135: Humerus measurement GLC – Greatest length of caput. 95% confidence levels upper bound, mean and lower bound values indicated

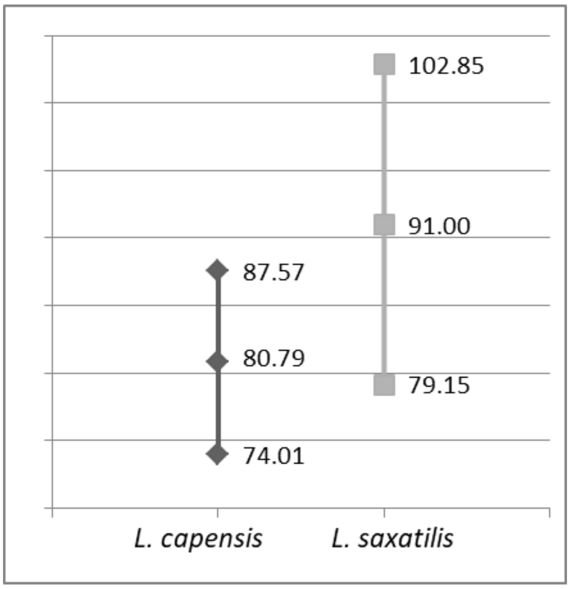


Figure 4.136: Humerus measurement GL – Greatest length. 95% confidence levels upper bound, mean and lower bound values indicated

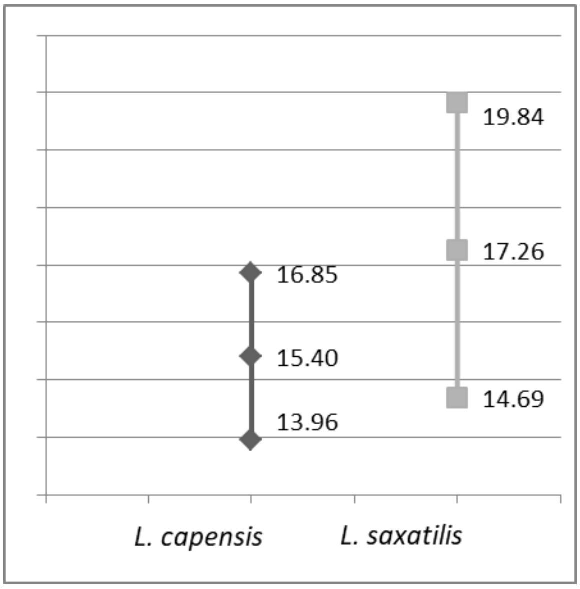


Figure 4.137: Humerus measurement Dp – Depth proximal end. 95% confidence levels upper bound, mean and lower bound values indicated

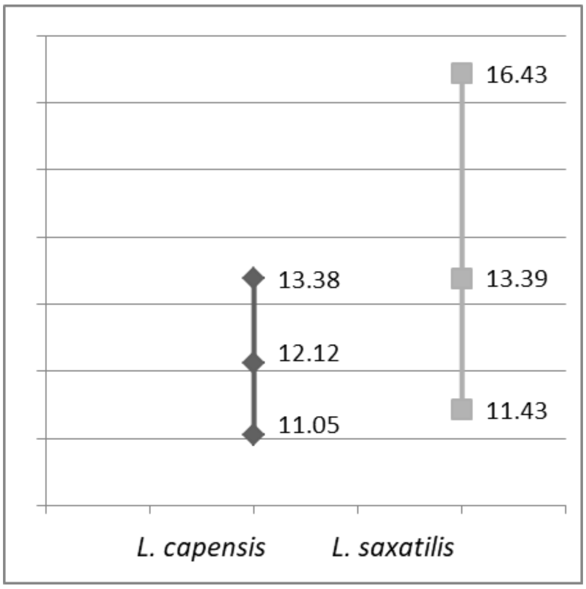


Figure 4.138: Humerus measurement DmTc – Depth of minor trochanter to caput. 95% confidence levels upper bound, mean and lower bound values indicated

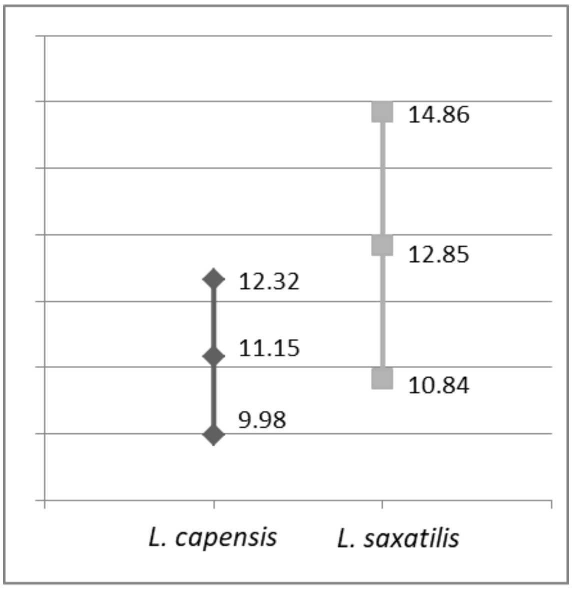


Figure 4.139: Humerus measurement CL – Length of caput. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.7 Element name - Radius

Number of individuals examined: *L. capensis* – 25; *L. saxatilis* – 23

A total number of eight individual scatter plots for the radius were drawn up and five boxplots for each measurement's 95% confidence levels.

No scale is given with the photos since the images were greatly enlarged to make the morphology visible.

Table 4.9: Radius measurement's p-values. P-values are all statistically highly significant

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Radius												
GL	18	92.03	3.40	84.98	97.17		18	100.69	5.49	92.21	110.33	p<0.001
BNP	20	7.18	0.36	6.62	7.87		20	8.30	0.67	7.38	9.69	p<0.001
Bd	19	7.95	0.52	7.12	8.89		18	9.12	0.78	7.94	10.52	p<0.001
SD	20	3.89	0.27	3.52	4.39		20	4.71	0.35	4.29	5.62	p<0.001
WD	19	5.16	0.26	4.59	5.51		20	5.99	0.51	5.18	6.80	p<0.001

- Head of the radius — *Fovea capitis radii* (9) — in *L. capensis* this division is V-shaped with the broadest part palmar and narrowing towards the dorsal edge. In *L. saxatilis* the division is an open V-shape with little or no narrowing towards the dorsal edge (Figures 4.140 & 4.141).

- In *L. capensis* the lateral articulation slopes dorsally and keeps its convex nature. In *L. saxatilis* this slopes dorsally and has a distinct bump almost on the dorsal edge. In both species the lateral articulation is higher than the medial articulation on the palmar side of the element, with the reverse being true on the dorsal edge of *L. capensis*. Due to the aforementioned bump in *L. saxatilis*, the lateral and medial articulations are on the same level on the dorsal edge (Figures 4.140 & 4.141).

- The shaft is D-shaped and there is a muscle attachment on the medial line almost midshaft. In *L. capensis* this is more prominent than in *L. saxatilis* both tactilely and visually. This feature cannot be clearly seen in a photo.

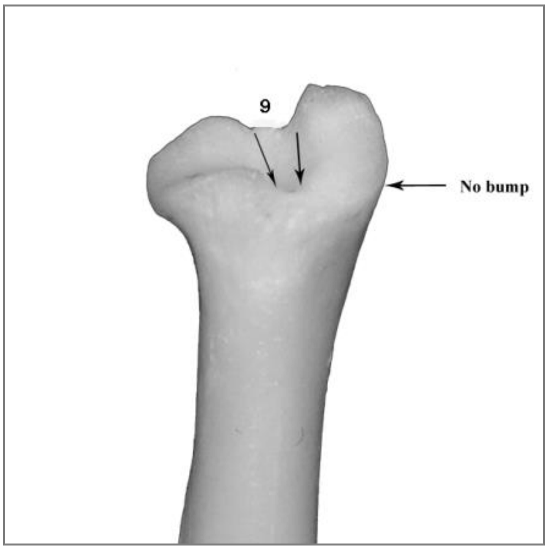


Figure 4.140: *L. capensis* – Radius proximal dorsal view

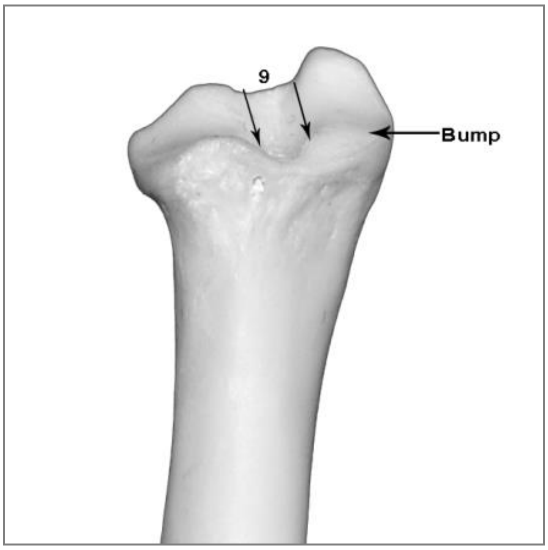


Figure 4.141: *L. saxatilis* – Radius proximal dorsal view

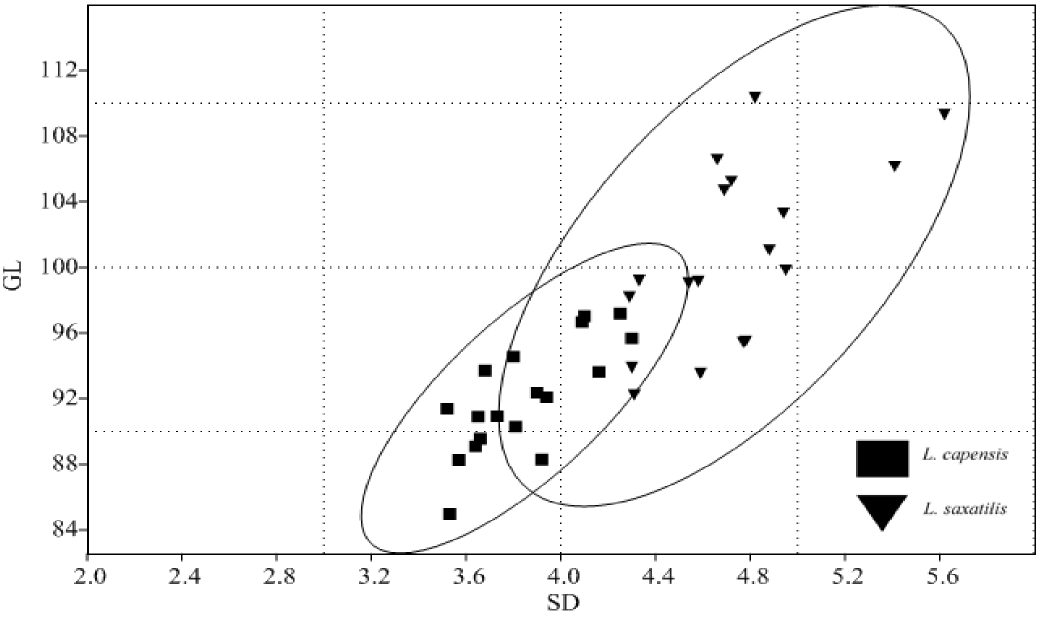


Figure 4.142: Radius measurement GL – Greatest length vs SD – Smallest breadth of the shaft – indicating a higher correlation in *L. capensis* than *L. saxatilis*

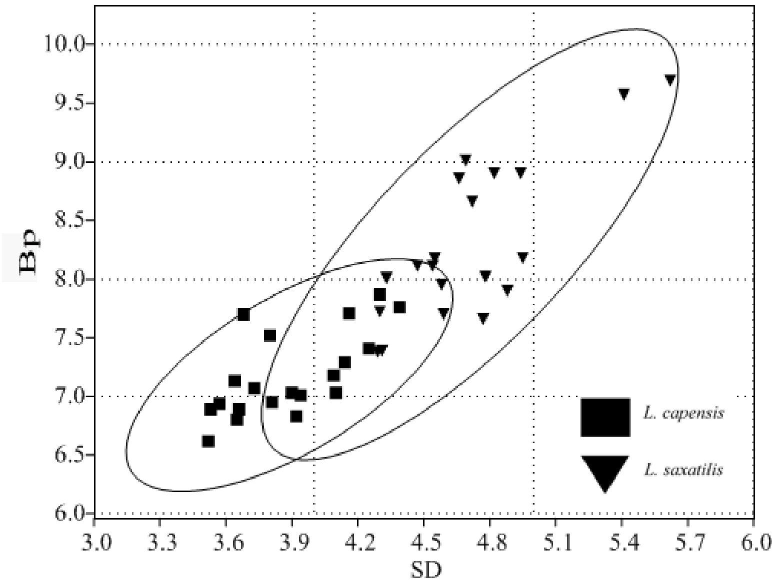


Figure 4.143: Radius measurement Bp – Breadth proximal vs SD – Smallest breadth of the shaft – indicating a good correlation for both species

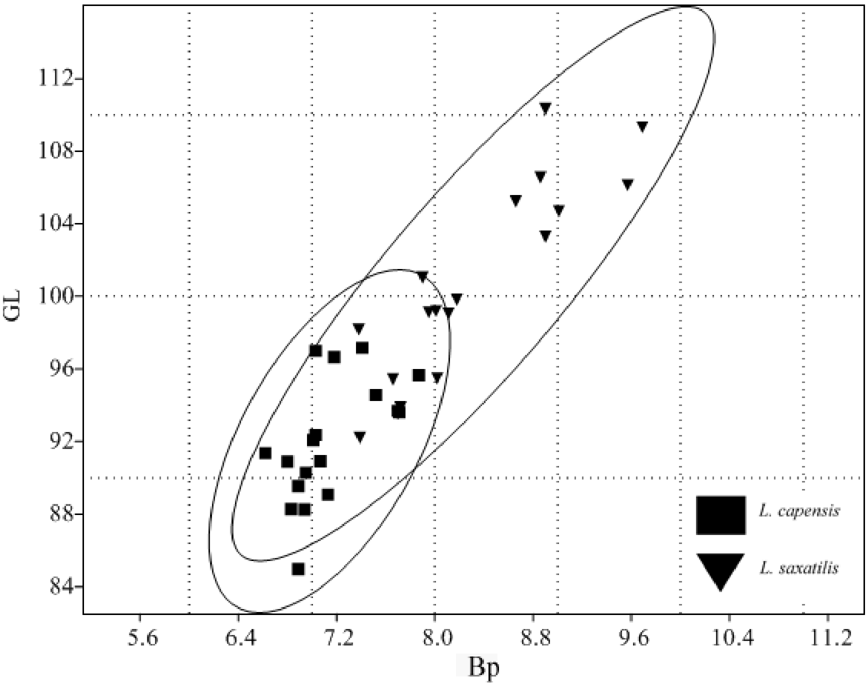


Figure 4.144: Radius measurement GL – Greatest length vs Bp – Breadth proximal – indicating a high correlation for *L. saxatilis*

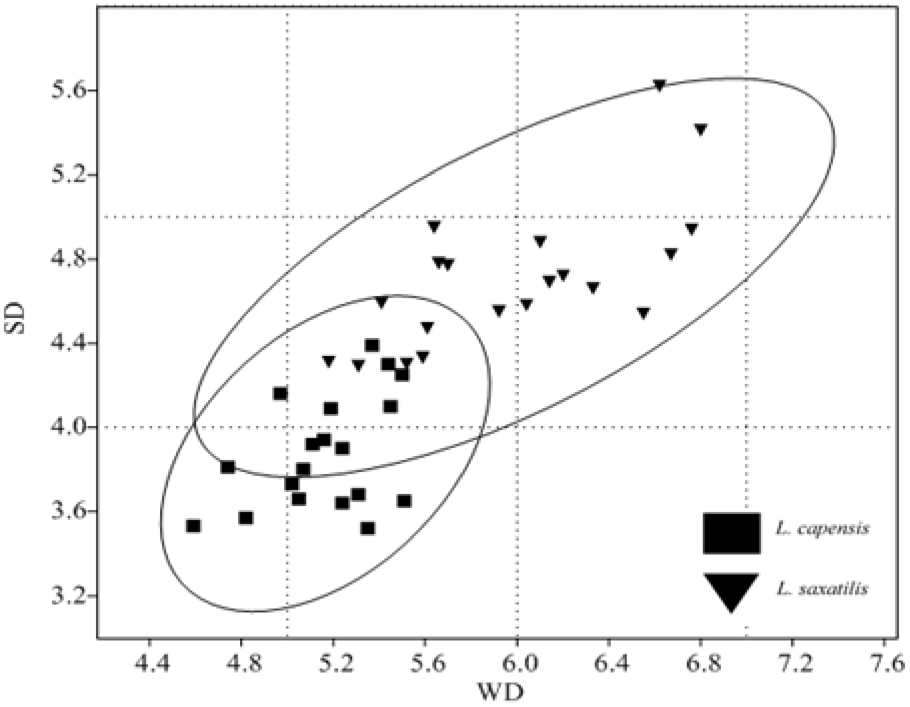


Figure 4.145: Radius measurement SD – Smallest depth of the shaft vs WD – Widest depth of the shaft – indicating a correlation for both species

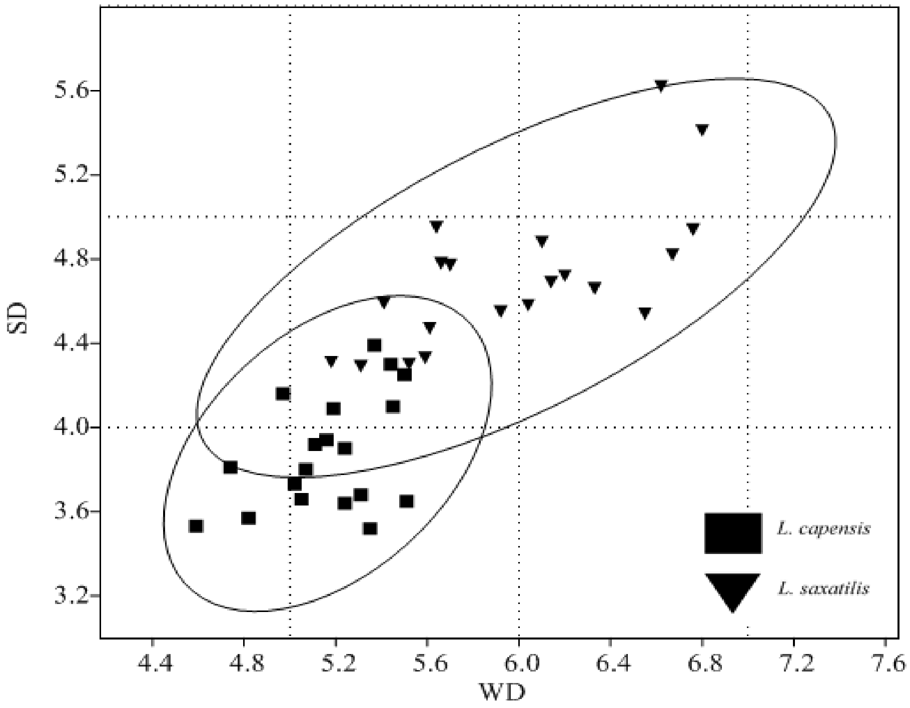


Figure 4.146: Radius measurement SD – Smallest depth of the shaft vs WD – Widest depth of the shaft – indicating a correlation for both species

All the measurements only overlap with the lower bound of *L. saxatilis*. The least overlap is observed in the BP (Figure 4.148), SD (Figure 4.150) and WD (Figure 4.151) measurement.

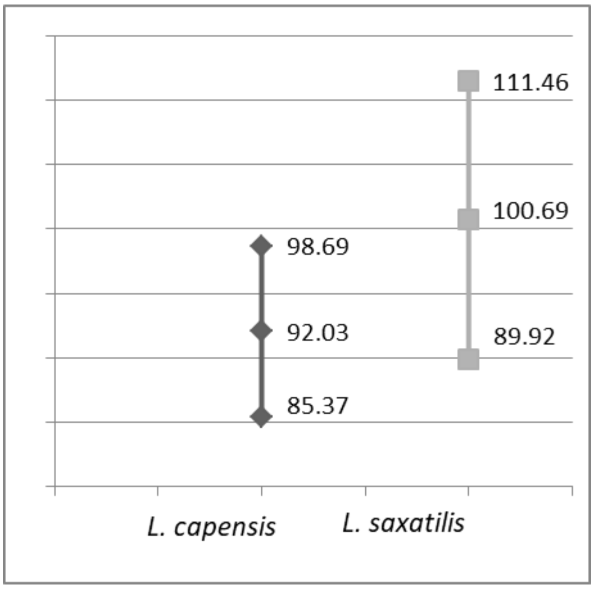


Figure 4.147: Radius measurement GL – Greatest length. 95% confidence levels upper bound, mean and lower bound values indicated

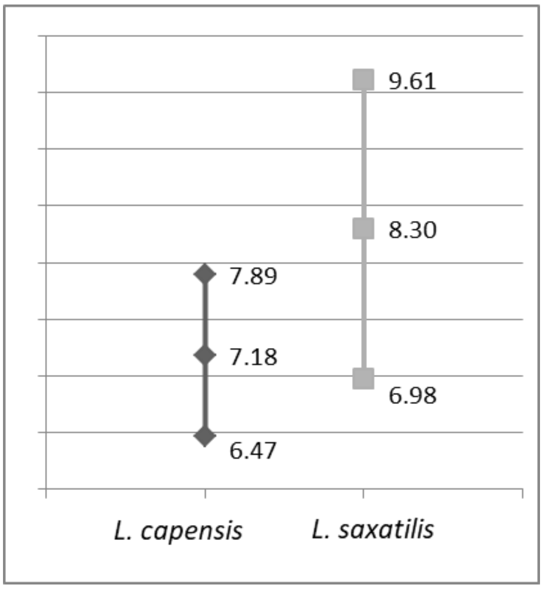


Figure 4.148: Radius measurement BP – Breadth proximal end. 95% confidence levels upper bound, mean and lower bound values indicated

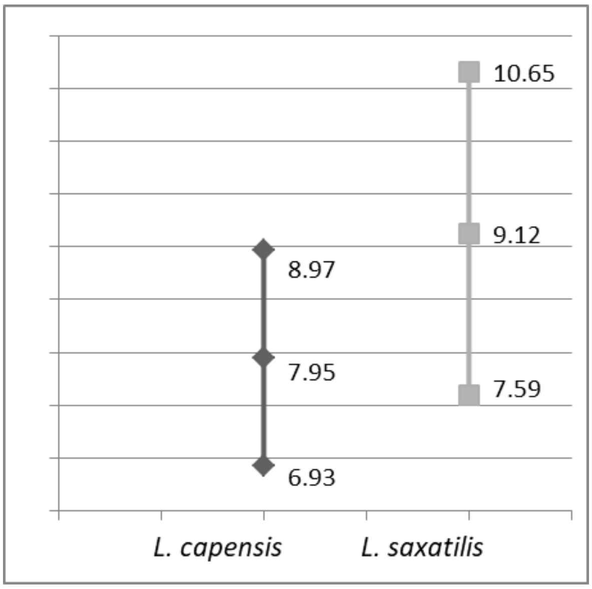


Figure 4.149: Radius measurement BD – Breadth distal end. 95% confidence levels upper bound, mean and lower bound values indicated

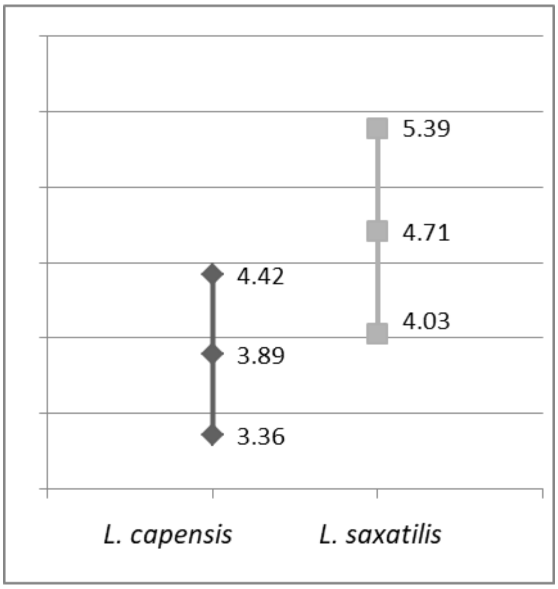


Figure 4.150: Radius measurement SD – Smallest depth of shaft. 95% confidence levels upper bound, mean and lower bound values indicated

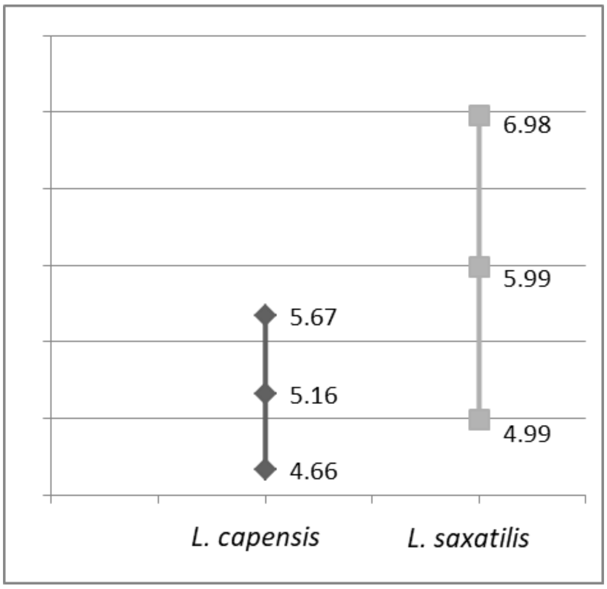


Figure 4.151: Radius measurement WD – Widest depth of shaft. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.8 Element name - Ulna

Number of individuals examined: *L. capensis* – 25; *L. saxatilis* – 24

A total of six individual scatter plots for the ulna were drawn up and four4 boxplots for each measurement’s 95% confidence levels.

Photos of the ulna are set at 2cm scale for the complete bone and 1cm scale for the articulation.

Table 4.10: Ulna measurement’s p-values. P-values are all statistically highly significant

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Ulna												
GL	17	104.70	4.19	96.02	110.86		18	115.23	6.50	105.63	127.09	p<0.001
DPA	20	9.35	0.45	8.70	10.28		20	10.75	0.87	9.32	12.17	p<0.001
SDO	20	9.19	0.45	8.34	10.22		20	10.56	0.82	9.36	11.78	p<0.001
BPC	20	6.73	0.38	6.29	7.82		20	7.63	0.66	6.75	9.30	p<0.001

- In general, the ulna of *L. saxatilis* appears stronger and more robust than *L. capensis*

- Semi-lunar notch — *Incisura radialis* (7) — in both species the articulation is only on the top part of the notch. A groove is located within the lunar notch on the lateral side. In *L. capensis* this groove is prominent and deep, whereas in *L. saxatilis* this groove is fainter and not as prominent (Figures 4.152 & 4.153).

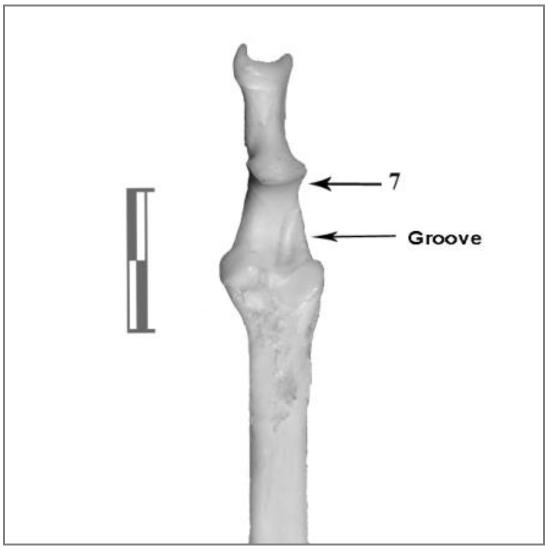


Figure 4.152: *L. capensis* – Ulna proximal dorsal view

Figure 4.153: *L. saxatilis* – Ulna proximal dorsal view

- There are marked differences in the shaft of the ulna between the two species
  - In *L. capensis* the proximal shaft is equal in width to the radius. About 1/3rd down, the shaft flattens and curves perpendicular to the radius. It maintains this width to the middle of the shaft where it abruptly tapers to 1/3rd of its width. Towards the distal part, it becomes rounded, thickening slightly to form the distal articulation (Figure 4.154). *Facies lateralis* (10) — the lateral shaft portion is thin and rises completely off of the radius, maintaining contact medially. The shaft is 'lifted' and more of the dorsal edge is visible (Figure 4.156).

  - In *L. saxatilis* the proximal shaft is equal in width to the radius and maintains its width 2/3rds down the shaft. It maintains this flat shape running parallel to the radius to just over the midshaft where it tapers to 1/3rd its width, becoming rounded and thickening slightly to form the distal articulation (Figure 4.155). *Facies lateralis* (10) — is thicker in *L. capensis* due to the concave U-shaped dorsal side of the shaft (Figure 4.157).

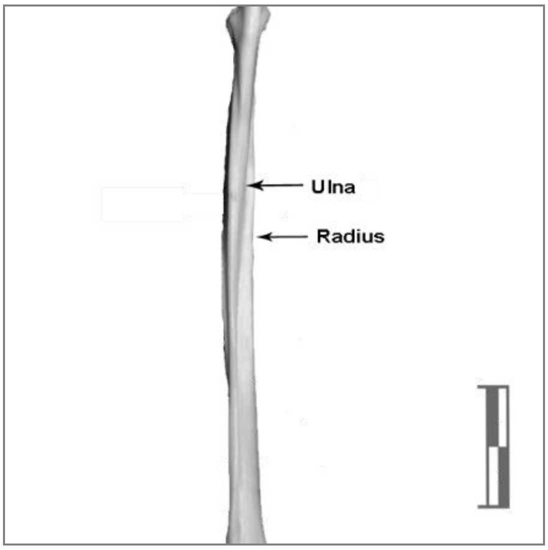


Figure 4.154: *L. capensis* – Ulna palmar view

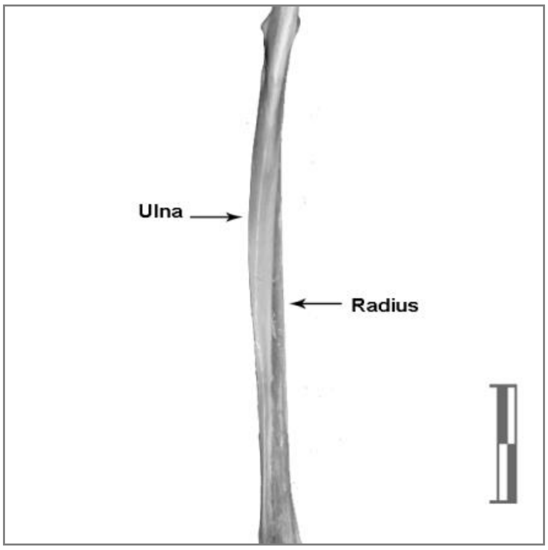


Figure 4.155: *L. saxatilis* – Ulna palmar view

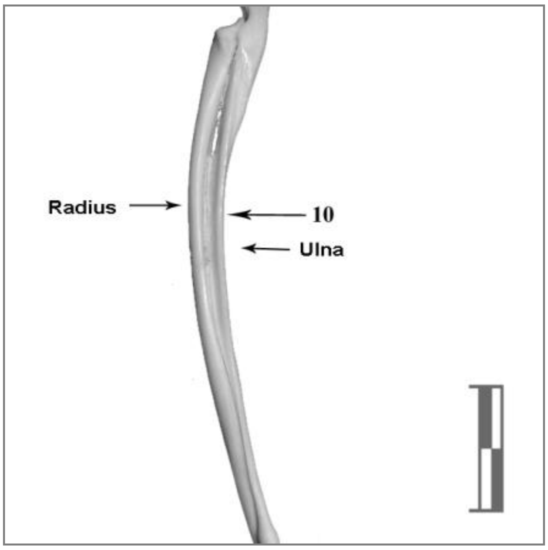


Figure 4.156: *L. capensis* – Ulna lateral view

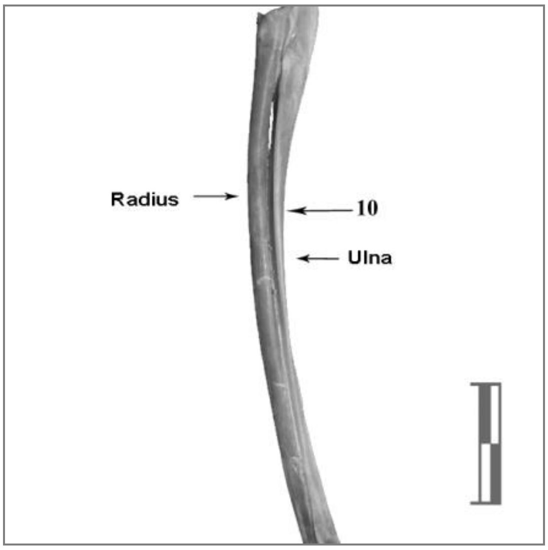


Figure 4.157: *L. saxatilis* – Ulna lateral view

As the GL (Greatest Length) has very little impact on the other measurements the two species were compared in a line graph – the graph shows that although there is overlap there is still a discernible difference between the two species (Figure 4.158). The 95% confidence levels also show that the overlap of the *L. capensis* is in the lower bound ranges of the *L. saxatilis* measurement (Figure 4.159).

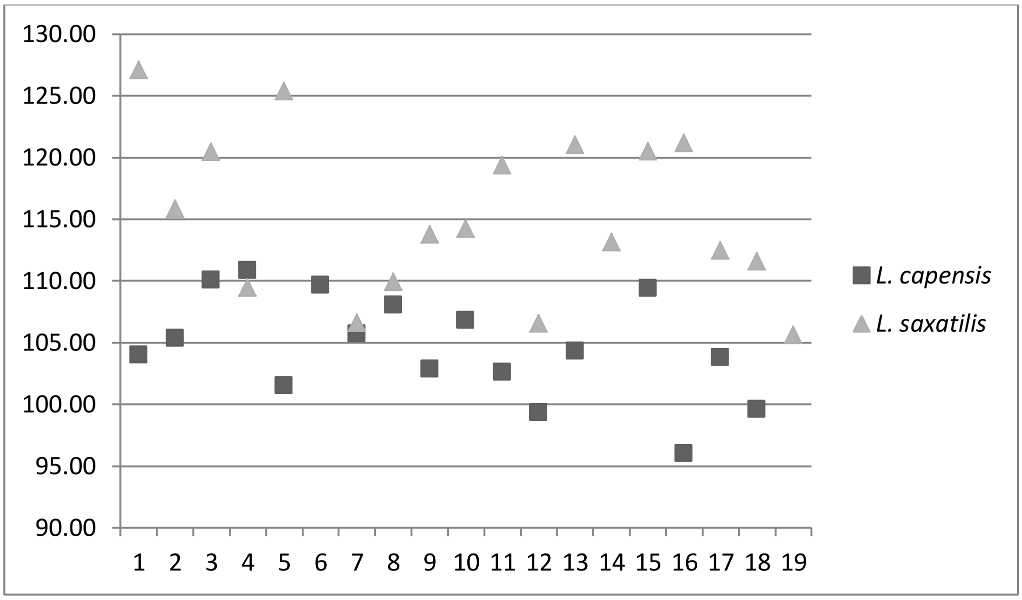


Figure 4.158: Ulna measurement GL – Greatest length

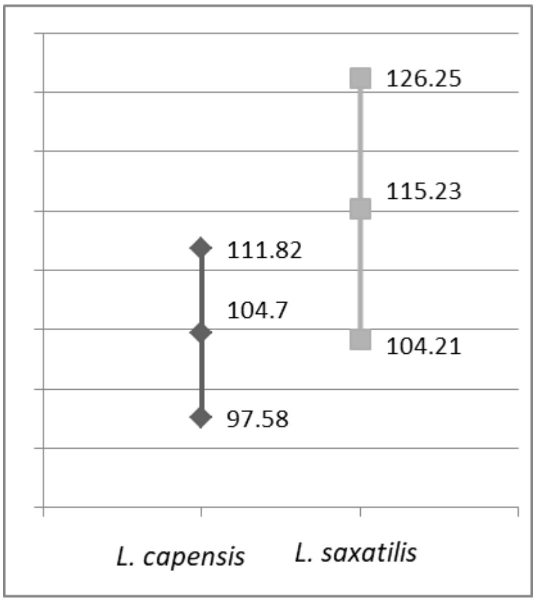


Figure 4.159: Ulna measurement GL – Greatest length 95% confidence. 95% confidence levels upper bound, mean and lower bound values indicated

The only scatter plot that indicated a possible positive correlation is DPA vs BPC (Figure 4.160).

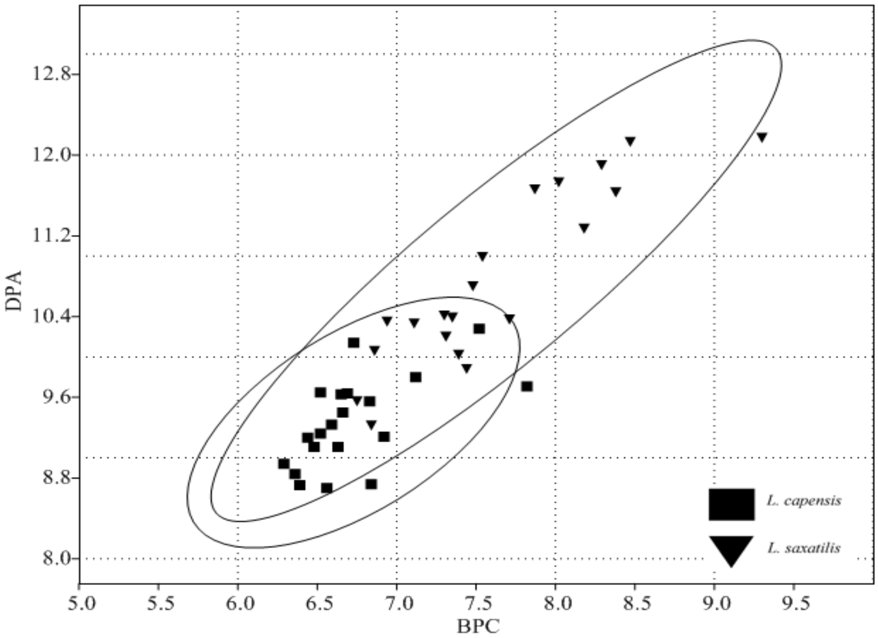


Figure 4.160: Ulna measurements DPA – Depth across *Processus anconaeus* vs BPC – Breadth across the coronoid process – indicating a high correlation especially in the *L. saxatilis*

All the measurements only overlap with the lower bound of *L. saxatilis*. The least overlap is observed in DPA (Figure 4.161) and SDO (Figure 4.162).

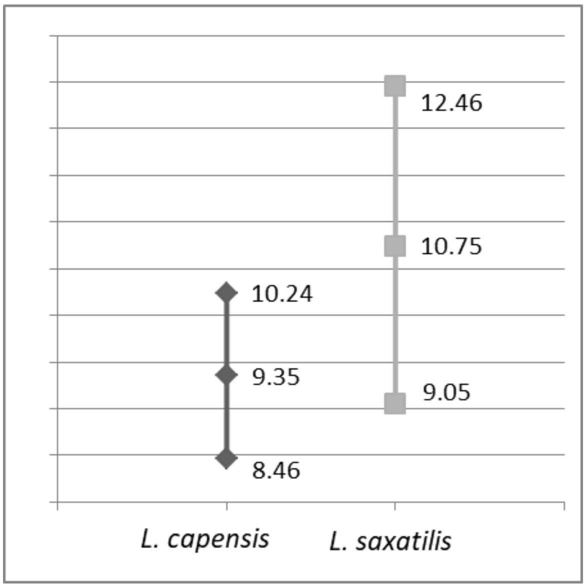


Figure 4.161: Ulna measurement DPA – Depth across the P*rocessus anconaeus*. 95% confidence levels upper bound, mean and lower bound values indicated

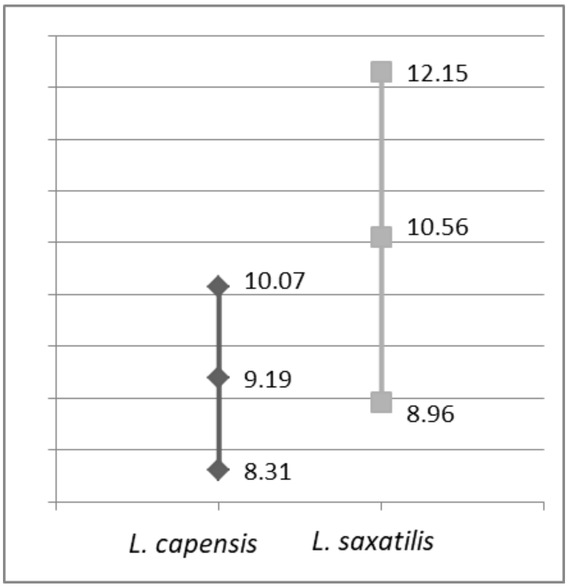


Figure 4.162: Ulna measurements SDO – Smallest depth of the olecranon. 95% confidence levels upper bound, mean and lower bound values indicated

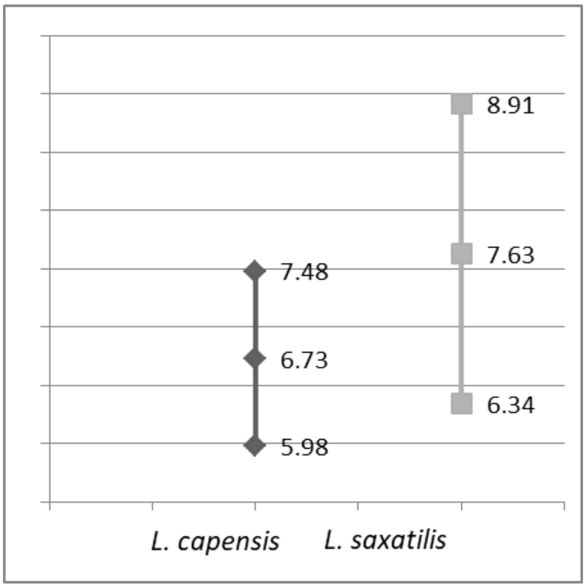


Figure 4.163: Ulna measurement BPC – Breadth across the coronoid process. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.9 Element name - Metacarpal

Number of individuals examined: *L. capensis* – 7; *L. saxatilis* – 2

The measurements comprise all specimens that have been measured and include the sub-adults. This decision was taken due to the small sample size. The reasons for the small samples size are discussed in Chapter 3.

A total of 16 boxplots were drawn up for the metacarpal's 95% confidence levels, four per metacarpal. None were drawn up for MC 1 as only one specimen was measured.

Photos of the metacarpals are set at a 1cm scale.

Table 4.11: Metacarpals I – V p-values. Due to the small sample size, none of the measurements proved to be statistically significant

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
MC I												
GL							1	8.79				
Bd								3.52				
Dp								3.53				
BP								3.21				
MC II												
GL	4	24.48	1.64	22.25	26.08		2	24.14	3.40	21.73	26.54	p>0.05
Bd	6	3.53	0.28	3.31	4.07		2	3.46	0.66	2.99	3.93	p>0.05
Dp	7	4.85	0.38	4.27	5.35		2	4.63	0.40	4.34	4.91	p>0.05
BP	7	3.73	0.28	3.14	3.95		2	3.80	0.47	3.47	4.13	p>0.05
MC III												
GL	7	26.41	1.96	23.05	28.23		2	26.29	3.63	23.72	28.85	p>0.05
Bd	7	3.37	0.38	2.98	3.97		2	3.27	0.69	2.78	3.75	p>0.05
Dp	7	4.84	0.41	4.33	5.28		2	4.66	0.71	4.16	5.16	p>0.05
BP	7	3.32	0.26	2.96	3.64		2	3.28	0.42	2.98	3.58	p>0.05
MC IV												
GL	7	20.93	1.45	18.69	22.22		2	21.33	2.85	19.31	23.34	p>0.05
Bd	7	3.37	0.31	3.09	3.83		2	3.25	0.52	2.88	3.62	p>0.05
Dp	7	4.09	0.32	3.65	4.52		2	4.07	0.64	3.61	4.52	p>0.05
BP	7	3.08	0.23	2.84	3.37		2	2.92	0.21	2.77	3.07	p>0.05
MC V												
GL	7	14.37	1.19	12.44	15.70		2	14.91	2.33	13.26	16.55	p>0.05
Bd	7	3.22	0.23	2.99	3.55		2	3.05	0.30	2.83	3.26	p>0.05
Dp	7	3.67	0.44	3.09	4.28		2	3.47	0.54	3.09	3.85	p>0.05
BP	7	3.74	0.25	3.43	4.03		2	3.53	0.29	3.32	3.73	p>0.05

In both species, the MC II, III, IV, and V articulate on top of each other, in a step-down pattern with MC II being the highest (Figures 4.164 & 4.165).

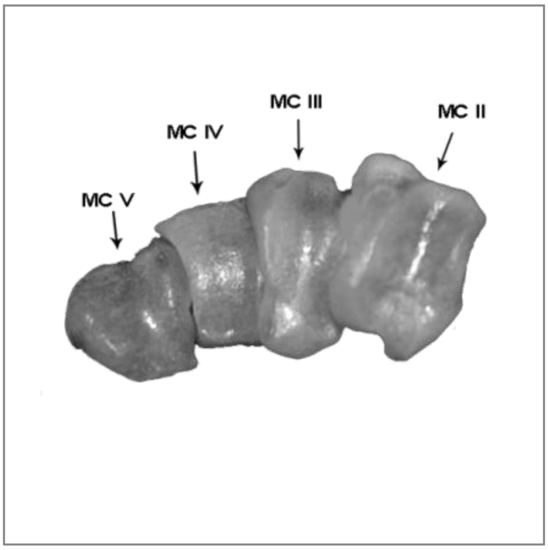


Figure 4.164: *L. capensis* – Metacarpal articulation

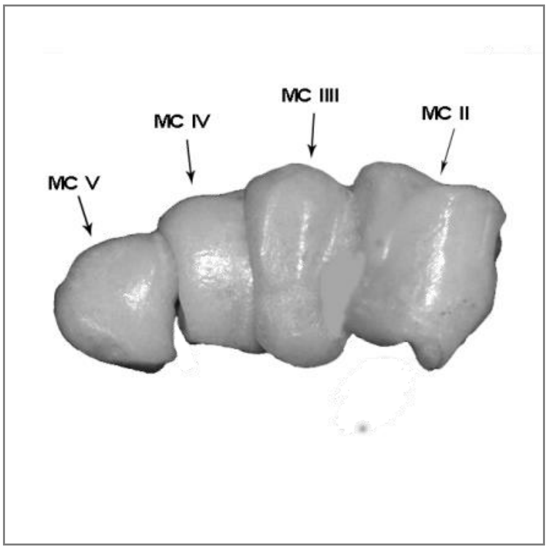


Figure 4.165: *L. saxatilis* – Metacarpal articulation

Metacarpal I – only observed in *L. saxatilis*

- Proximal end and articulation surface — *Basis* (18) — and *Facies articularis* (19) — is bulbous with a prominent bump on the lateral side. The articulation takes up most of the proximal surface and slopes medially (Figures 4.166; 4.167; 4.168; 4.169 & 4.170).

- Body *Corpus* (20) — is short and compact (Figures 4.166; 4.167; 4.168; 4.169).

- Dorsal surface — *Facies dorsalis* (21) — is flat with a slight rise towards the distal end (Figure 4.166).

- Palmar surface — *Facies palmaris* (23) — is sloped towards the dorsal end and gives the shaft a sloped appearance (Figure 4.167).

- Lateral border — *Margo lateralis* (25) — is slightly curved (Figure 4.168).

- Medial border — *Margo medialis* (24) — seems to be indented due to the bulges proximal and distal. It seems shorter than the lateral side (Figure 4.169).

- Distal articulation — *Caput* (26) — normal articulation facet for a small mammal (Figures 4.166; 4.167; 4.168; 4.169).

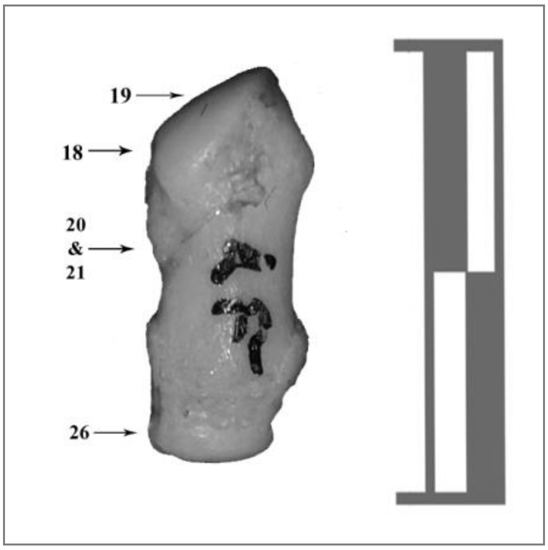


Figure 4.166: *L. saxatilis* – Metacarpal I dorsal

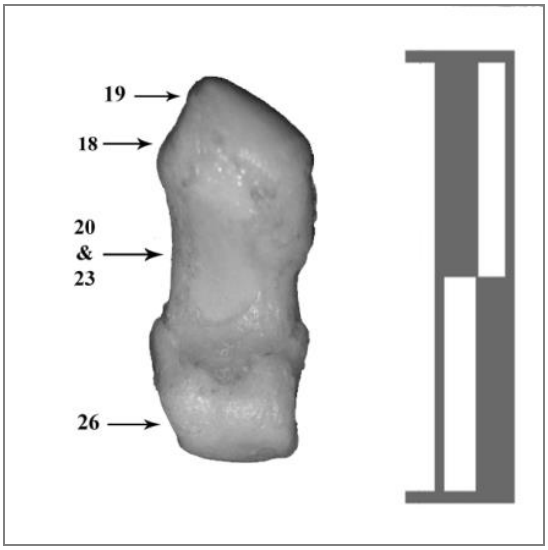


Figure 4.167: *L. saxatilis* – Metacarpal I palmar view

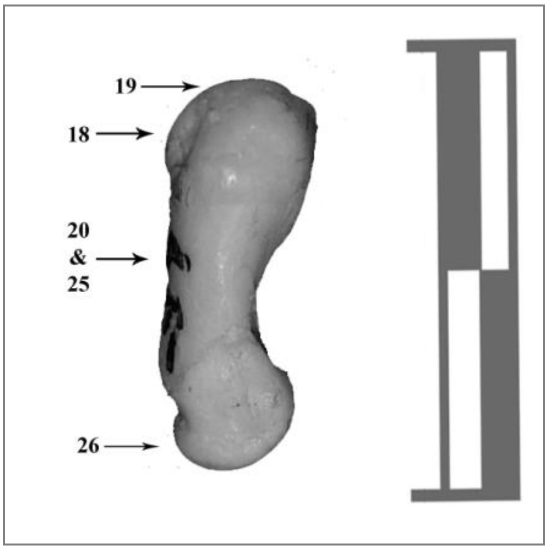


Figure 4.168: *L. saxatilis* – Metacarpal I lateral view

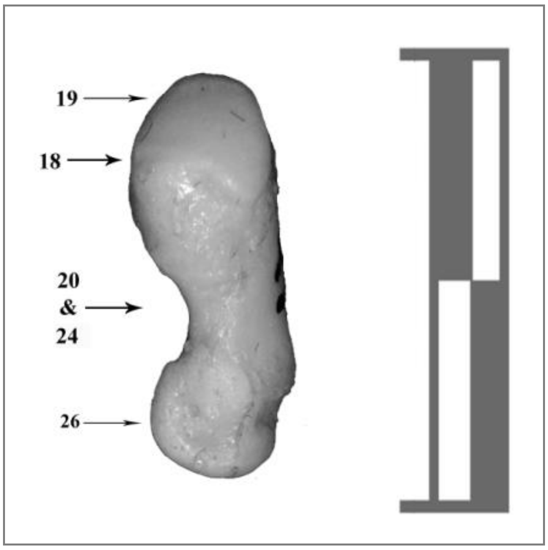


Figure 4.169: *L. saxatilis* – Metacarpal I medial view

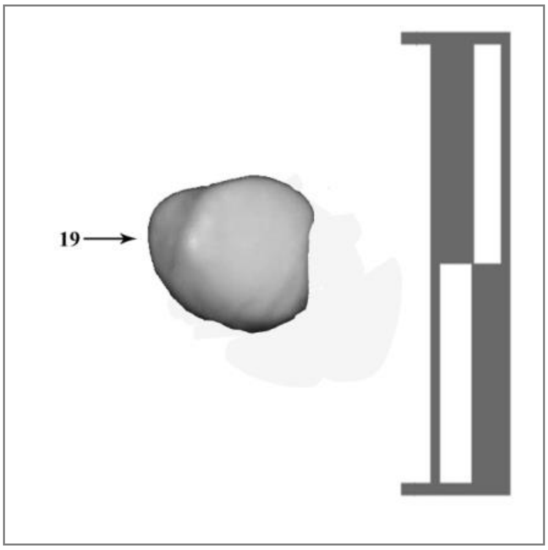


Figure 4.170: *L. saxatilis* – Metacarpal I proximal articulation

Metacarpal II

- Proximal end and articulation surface — *Basis* (18) — and — *Facies articularis* (19) —is slightly curved medially with a prominent muscle attachment. The lateral side is indented due to the articulation surface. In both species, the articulation facet is divided in two by a deep indent raising both the medial and lateral sides. The dorsal edge is divided in two. The lateral artic on the side is thick and semi-circular in shape and forms a deep indent with the articulation surface underneath the proximal articulation (Figures 4.171 & 4.172; Figures 4.173 & 4.174; Figures 4.175 & 4.176; Figures 4.177 & 4.178; Figures 4.179 & 4.180).

- *L. capensis* in general feels and looks more compact and squarer, while *L. saxatilis* feels and looks more rectangular (Figures 4.171 & 4.172; Figures 4.173 & 4.174; Figures 4.175 & 4.176; Figures 4.177 & 4.178).

- Body — *Corpus* (20) — is has a slight curve towards the lateral side (Figures 4.171 & 4.172; Figures 4.173 & 4.174; Figures 4.175 & 4.176; Figures 4.177 & 4.178.

- Dorsal surface —*Facies dorsalis* (21) — is smooth (Figures 4.181 & 4.182).

- Palmar surface — *Facies palmaris* (23) — is smooth (Figures 4.183 & 4.184).

- Lateral border — *Margo lateralis* (25) — has a slight curve towards the lateral side (Figures 4.185 & 4.186).

- Medial border —*Margo medialis* (24) — has a slight curve towards the lateral side (Figures 4.187 & 4.188)

- Distal articulation —*Caput* (26) — divided into two with a bone ridge (Figures 4.171 & 4.172; Figures 4.173 & 4.174; Figures 4.175 & 4.176; Figures 4.177 & 4.178).

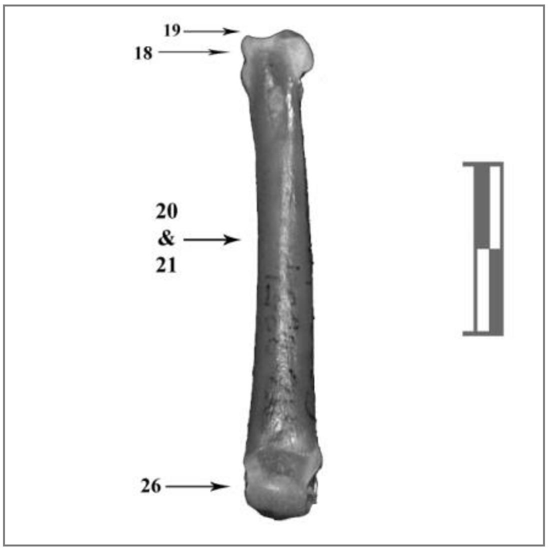


Figure 4.171: *L. capensis* – Metacarpal II dorsal view

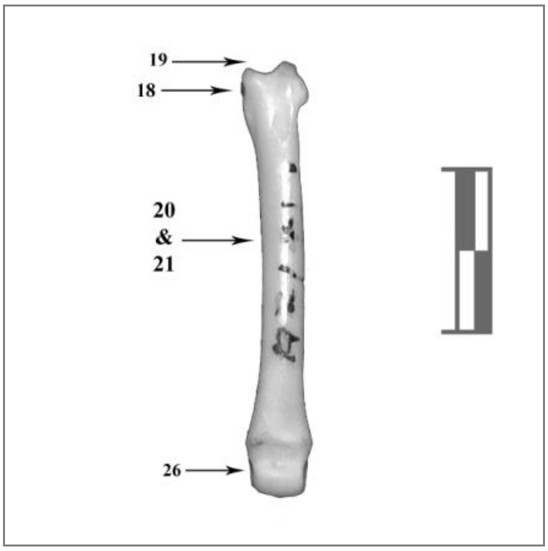


Figure 4.172: *L. saxatilis* – Metacarpal II dorsal view

Figure 4.173: *L. capensis* – Metacarpal II palmar view

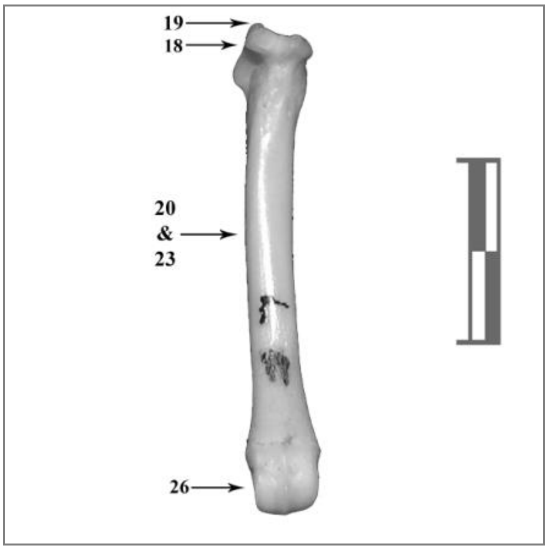


Figure 4.174: *L. saxatilis* – Metacarpal II palmar view

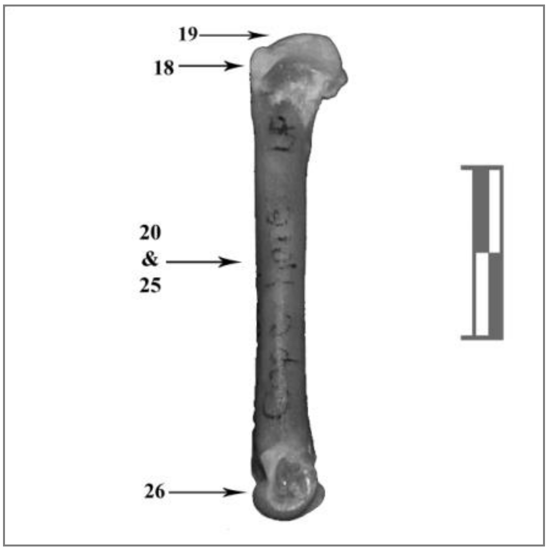


Figure 4.175: *L. capensis* – Metacarpal II lateral view

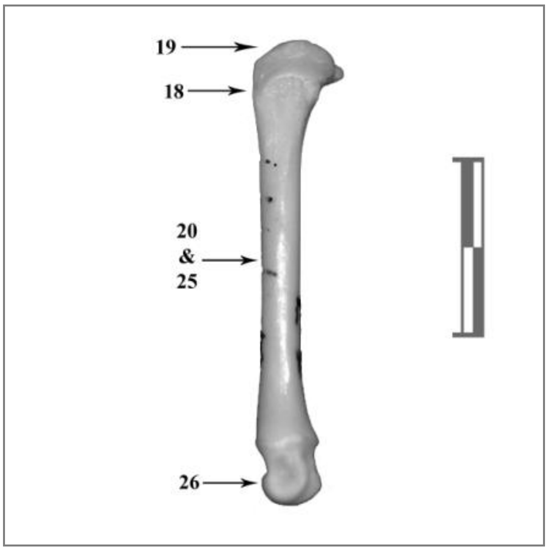


Figure 4.176: *L. saxatilis* – Metacarpal II lateral view

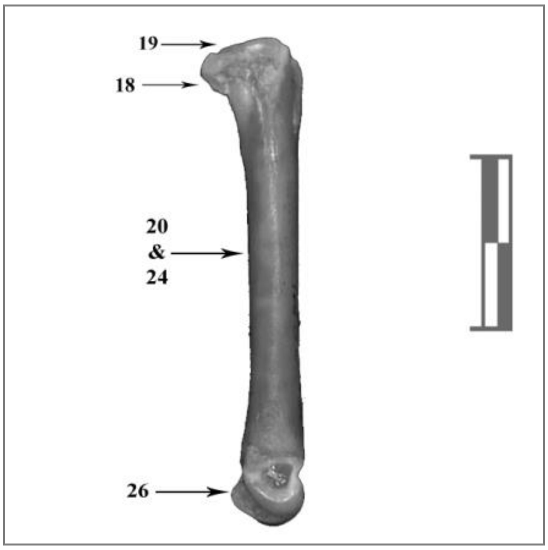


Figure 4.177: *L. capensis* – Metacarpal II medial view

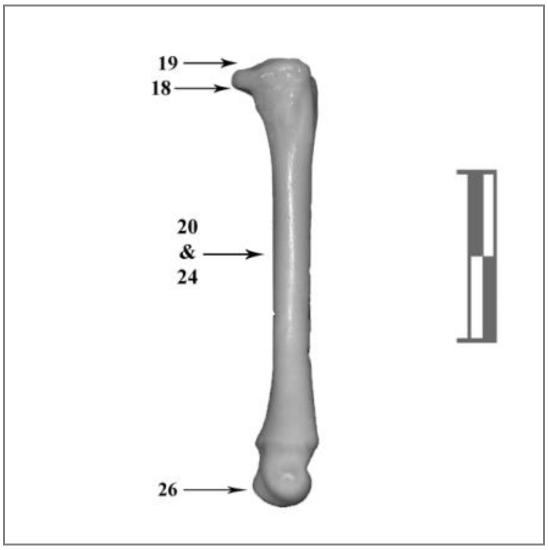


Figure 4.178: *L. saxatilis* – Metacarpal II medial view

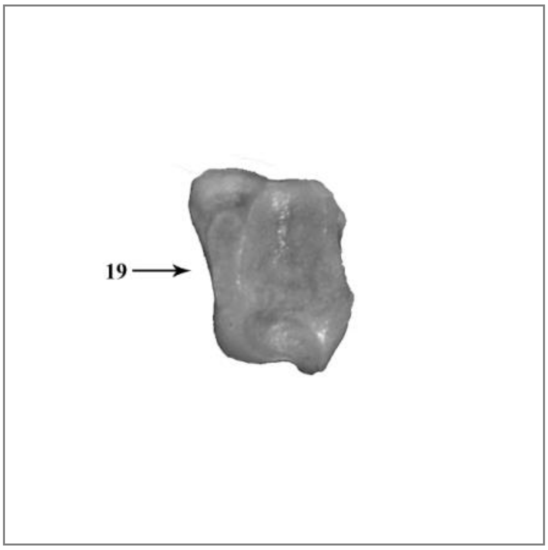


Figure 4.179: *L. capensis* – Metacarpal II proximal articulation

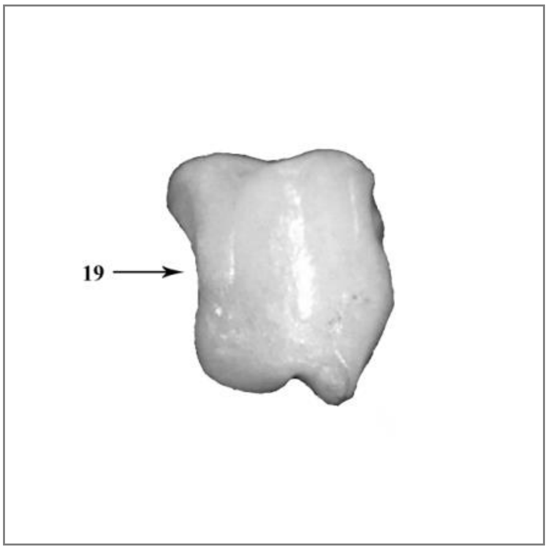


Figure 4.180: *L. saxatilis* – Metacarpal II proximal articulation

Metacarpal III

- Proximal end and articulation surface — *Basis* (18) — and — *Facies articularis* (19) — the base is in line with the shaft and no curve is evident. The articulation surface is divided in two but not as strongly as MC II. At about 2/3^{rds} the palmar extension makes a small rise. The medial articulation perfectly fits the lateral articulation described in MC II. The dorsal edge of MC II articulates with the small on MC III. The lateral articulation is on the side of the bone and is in a straight line with the proximal articulation surface with a deep indent (Figures 4.181 & 4.182; Figures 4.183 & 4.184; Figures 4.185 & 4.186; Figures 4.187 & 4.188; Figures 4.189 & 4.190).

- *L. capensis* the palmar ‘nose’ is pointed and not as elongated and snub/bulbous as that of *L. saxatilis* (Figures 4.183 & 4.184).

- Body — *Corpus* (20) — is straight (Figures 4.181 & 4.182; Figures 4.183 & 4.184; Figures 4.185 & 4.186; Figures 4.187 & 4.188).

- Dorsal surface — *Facies dorsalis* (21) — is straight (Figures 4.181 & 4.182).

- Palmar surface — *Facies palmaris* (23) — is straight (Figures 4.183 & 4.184).

- Lateral border — *Margo lateralis* (25) — is straight (Figures 4.185 & 4.186).

- Medial border — *Margo medialis* (24) — is straight (Figures 4.187 & 4.188).

- Distal articulation — *Caput* (26) — divided into two with a bone ridge (Figures 4.181 & 4.182; Figures 4.183 & 4.184; Figures 4.185 & 4.186; Figures 4.187 & 4.188).

Figure 4.181: *L. capensis* – Metacarpal III dorsal view

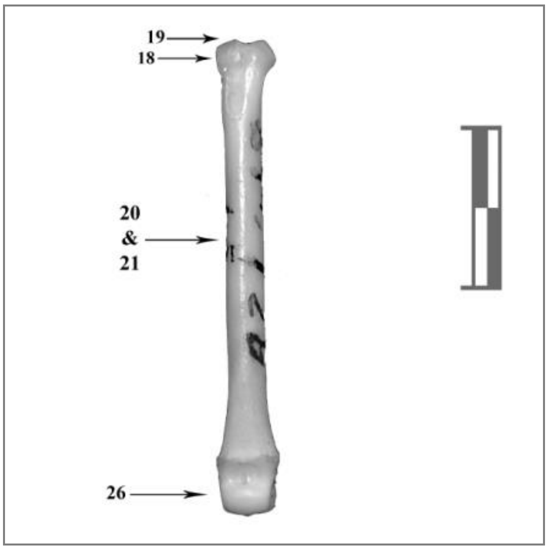


Figure 4.182: *L. saxatilis* – Metacarpal III dorsal view

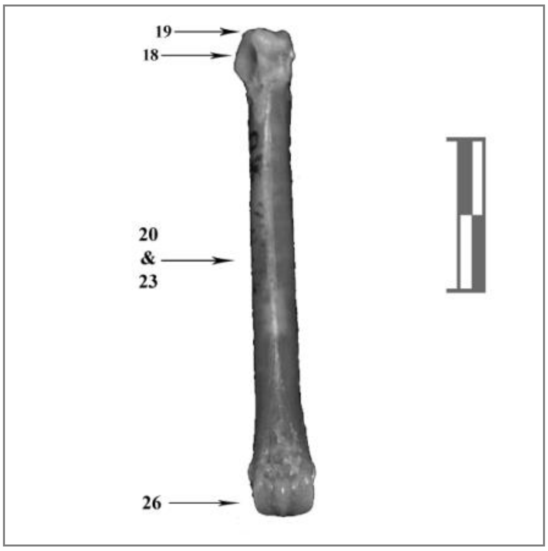


Figure 4.183: *L. capensis* – Metacarpal III palmar view

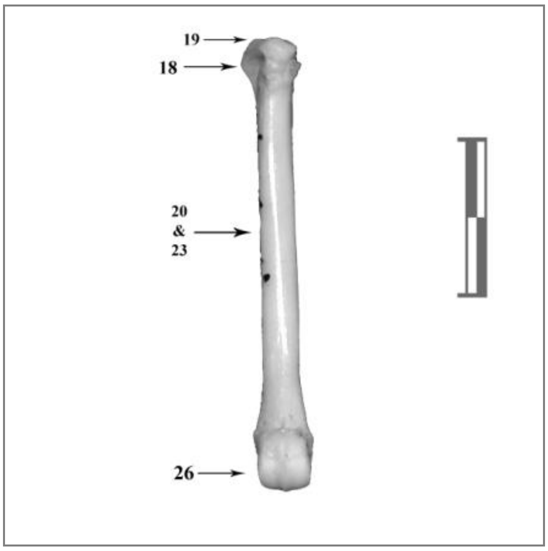


Figure 4.184: *L. saxatilis* – Metacarpal III palmar view

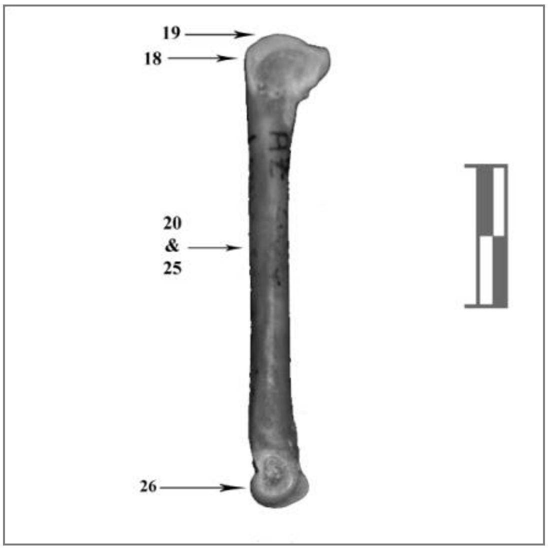


Figure 4.185: *L. capensis* – Metacarpal III lateral view

Figure 4.186: *L. saxatilis* – Metacarpal III lateral view

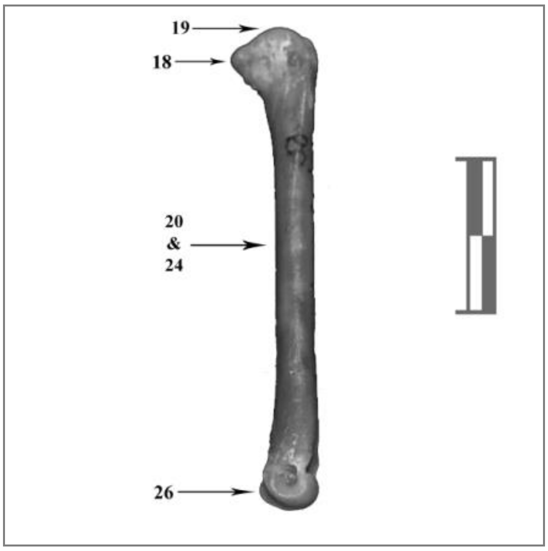


Figure 4.187: *L. capensis* – Metacarpal III medial view

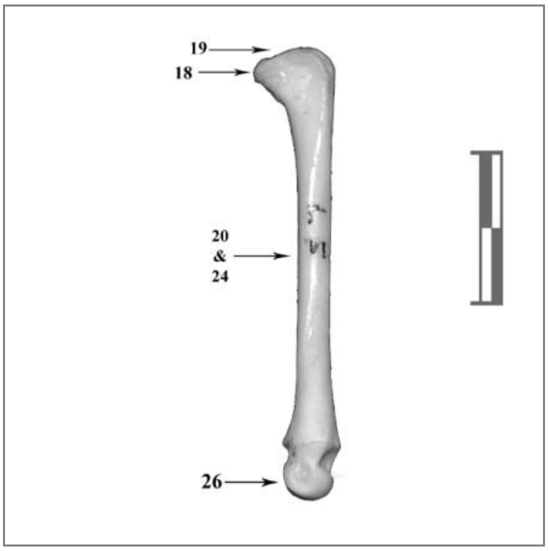


Figure 4.188: *L. saxatilis* – Metacarpal III medial view

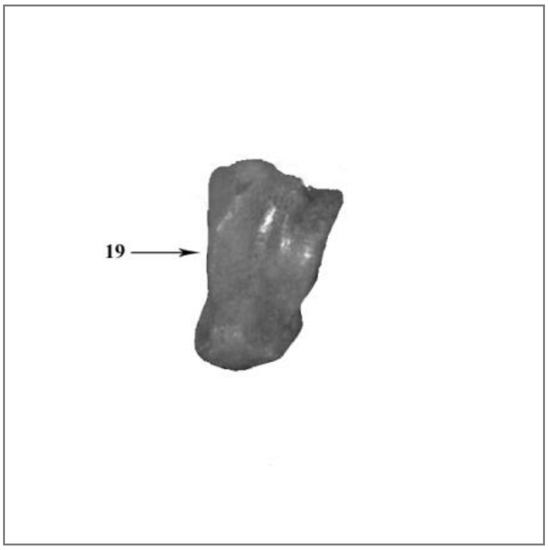


Figure 4.189: *L. capensis* – Metacarpal III proximal articulation

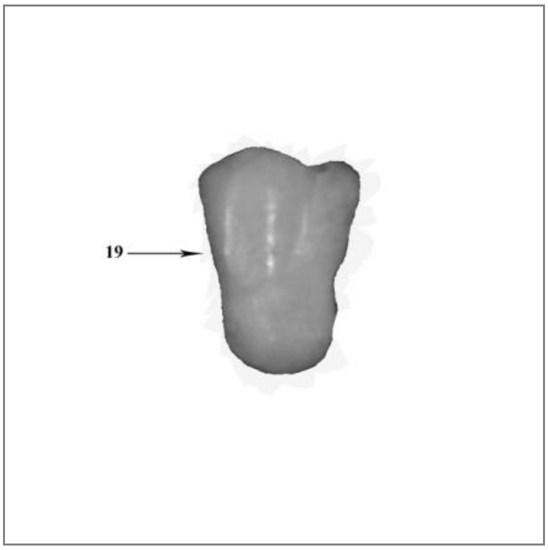


Figure 4.190: *L. saxatilis* – Metacarpal III proximal articulation

Metacarpal IV

- Proximal end and articulation surface — *Basis* (18) — and — *Facies articularis* (19) — the base is in line with the shaft and no curve is evident. Is slightly rounded with a thin division line where MC III articulates. There is a slight division in the palmar portion. Medially on the side of the bone, there is a thin articulation surface that corresponds to the surface of MC III. The lateral articulation on the side is thin with a slight thickening towards the palmar side. There is an indentation to accommodate MC V (Figures 4.191 & 4.192; Figures 4.193 & 4.194; Figures 4.195 & 4.196; Figures 4.197 & 4.198; Figures 4.199 & 4.200).

- Body — *Corpus* (20) — is straight (Figures 4.191 & 4.192; Figures 4.193 & 4.194; Figures 4.195 & 4.196; Figures 4.197 & 4.198).

- Dorsal surface — *Facies dorsalis* (21) — is straight (Figures 4.191 & 4.192).

- Palmar surface — *Facies palmaris* (23) — is straight (Figures 4.193 & 4.194).

- Lateral border — *Margo lateralis* (25) — is straight (Figures 4.195 & 4.196).

- Medial border — *Margo medialis* (24) — is straight (Figures 4.197 & 4.198).
- Distal articulation — *Caput* (26) — divided into two with a bone ridge (Figures 4.191 & 4.192; Figures 4.193 & 4.194; Figures 4.195 & 4.196; Figures 4.197 & 4.198).

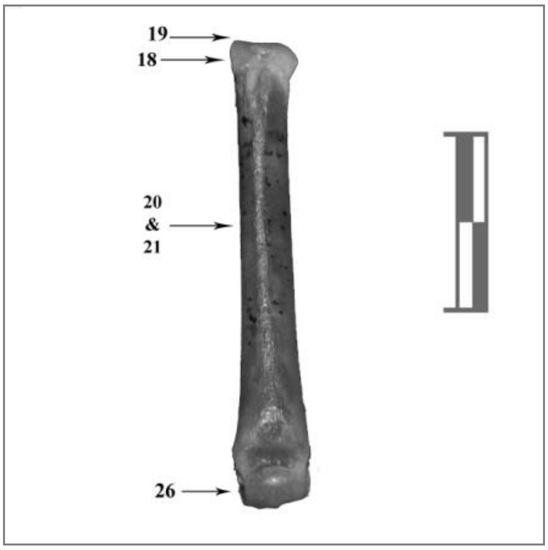


Figure 4.191: *L. capensis* – Metacarpal IV dorsal view

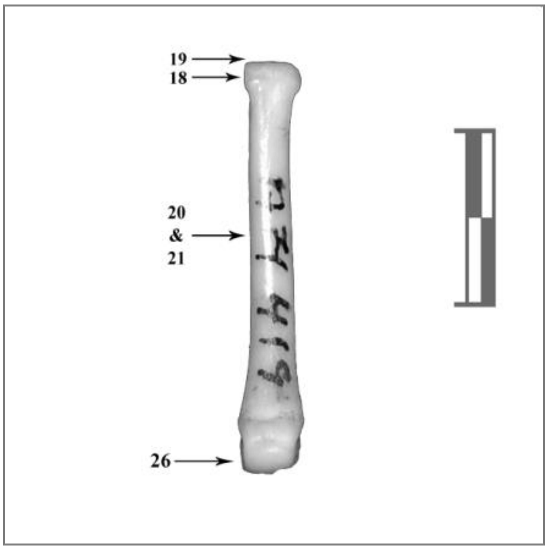


Figure 4.192: *L. saxatilis* – Metacarpal IV dorsal view

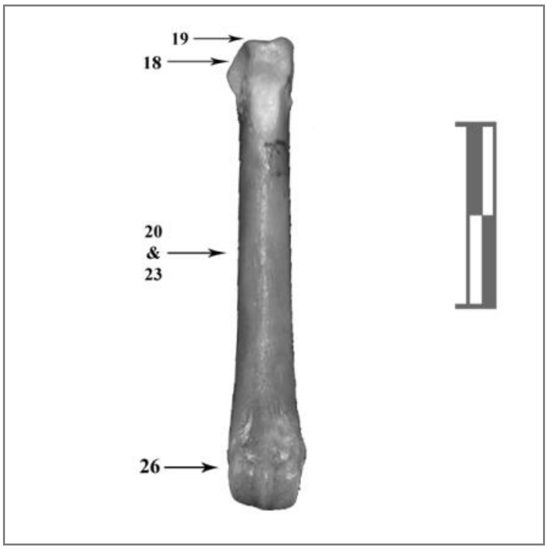


Figure 4.193: *L. capensis* – Metacarpal IV palmar view

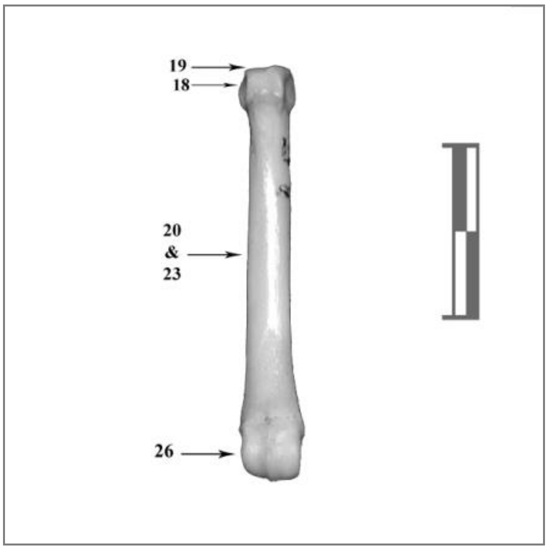


Figure 4.194: *L. saxatilis* – Metacarpal IV palmar view

Figure 4.195: *L. capensis* – Metacarpal IV lateral view

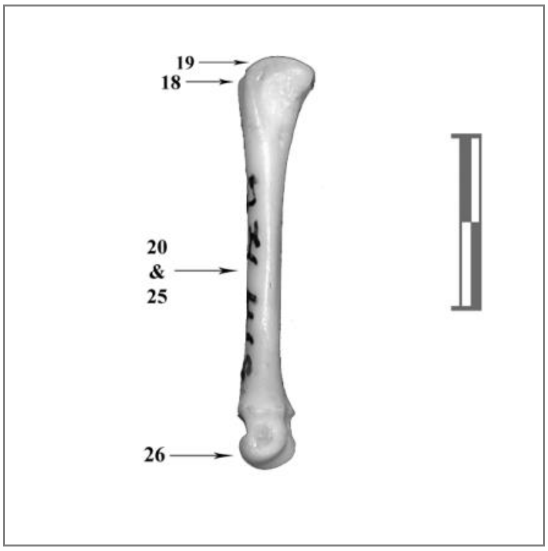


Figure 4.196: *L. saxatilis* – Metacarpal IV lateral view

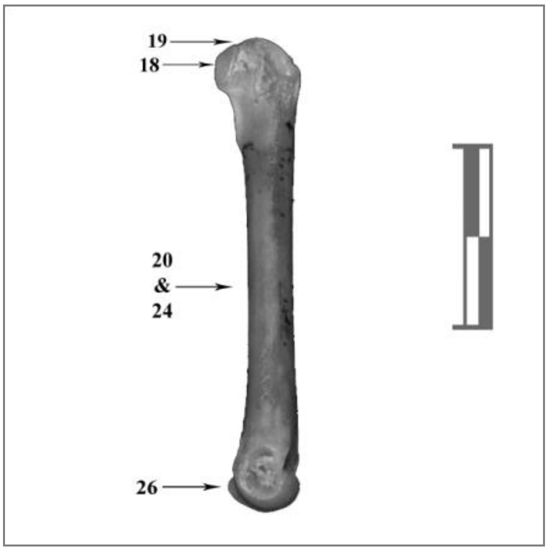


Figure 4.197: *L. capensis* – Metacarpal IV medial view

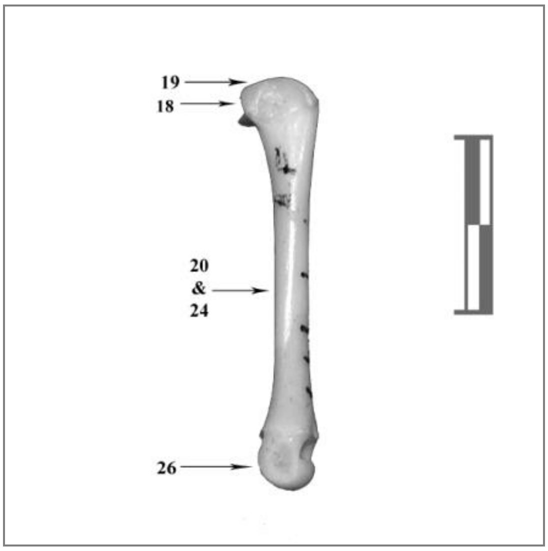


Figure 4.198: *L. saxatilis* – Metacarpal IV medial view

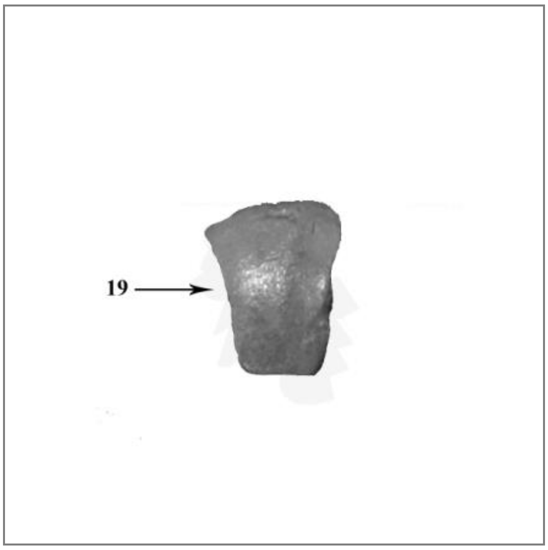


Figure 4.199: *L. capensis* – Metacarpal IV proximal articulation

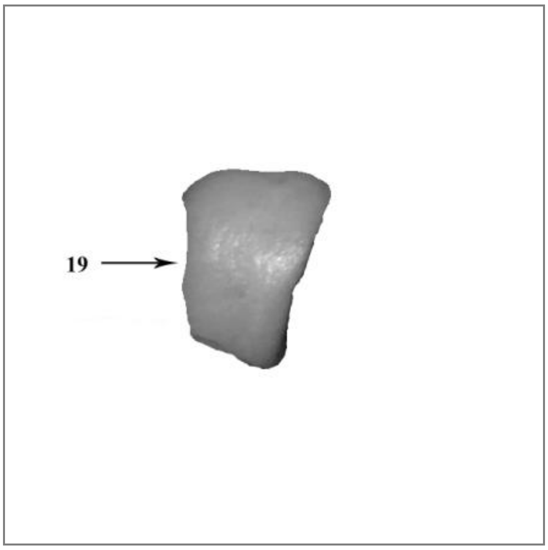


Figure 4.200: *L. saxatilis* – Metacarpal IV proximal articulation

Metacarpal V

- Proximal end and articulation surface — *Basis* (18) — and — *Facies articularis* (19) — the base is in line with the shaft. The lateral proximal flairs out to a point. The articulation facet is roughly triangular in shape with a slight indent that divides it in two (Figures 4.201 & 4.202; Figures 4.203 & 4.204; Figures 4.205 & 4.206; Figures 4.207 & 4.208; Figures 4.209 & 4.210).

- On the medial side is a small shaped articulation that corresponds with MC IV. The indent in *L. capensis* seems to be shallower than in *L. saxatilis* (Figures 4.207 & 4.208).

- Body — *Corpus* (20) — is straight (Figures 4.201 & 4.202; Figures 4.203 & 4.204; Figures 4.205 & 4.206; Figures 4.207 & 4.208).

- Dorsal surface — *Facies dorsalis* (21) — is straight (Figures 4.201 & 4.202).

- Palmar surface — *Facies palmaris* (23) — is straight (Figures 4.203 & 4.204).

- Lateral border — *Margo lateralis* (25) — is straight (Figures 4.205 & 4.206).

- Medial border — *Margo medialis* (24) — is straight (Figures 4.207 & 4.208).

- Distal articulation — *Caput* (26) — divided in two with a bone ridge (Figures 4.201 & 4.202; Figures 4.203 & 4.204; Figures 4.205 & 4.206; Figures 4.207 & 4.208).

Figure 4.201: *L. capensis* – Metacarpal V dorsal view

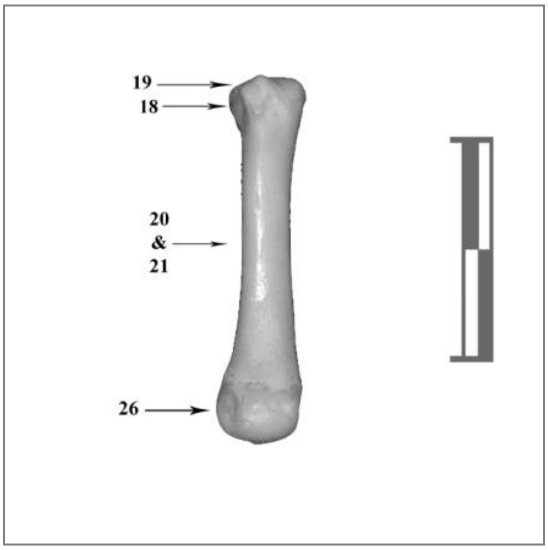


Figure 4.202: *L. saxatilis* – Metacarpal V dorsal view

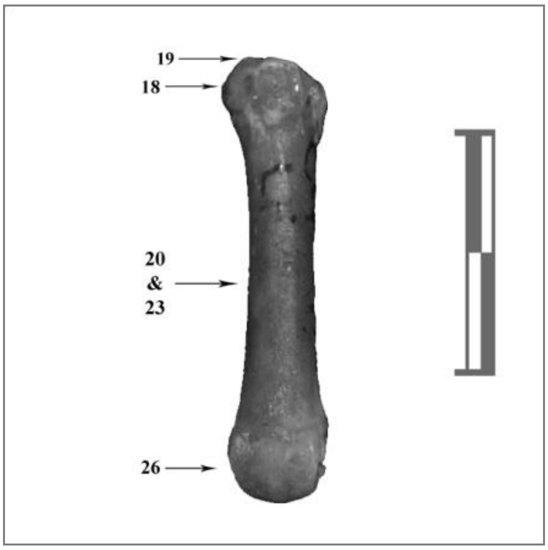


Figure 4.203: *L. capensis* – Metacarpal V palmar view

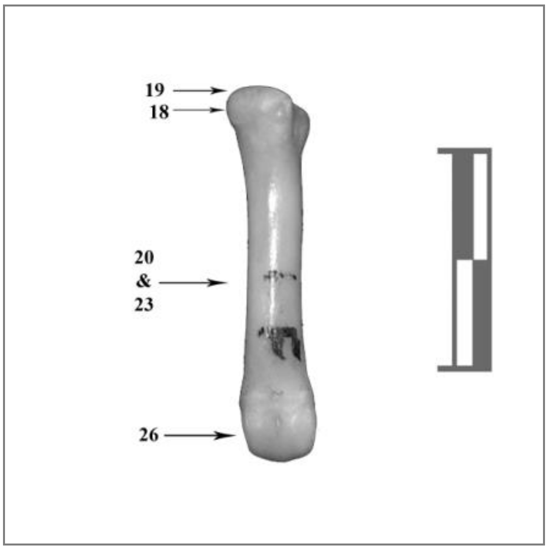


Figure 4.204: *L. saxatilis* – Metacarpal V palmar view

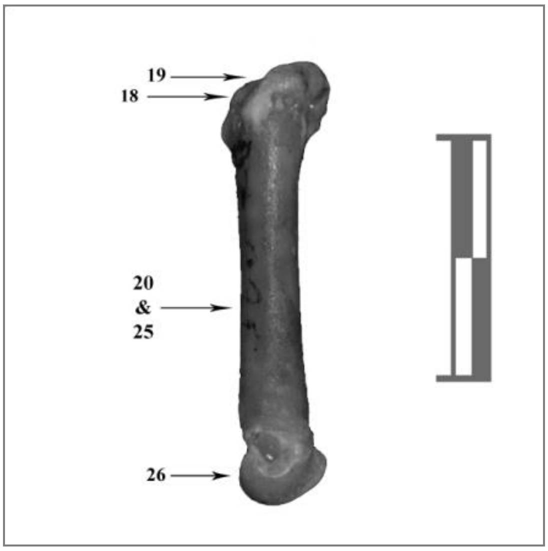


Figure 4.205: *L. capensis* – Metacarpal V lateral view

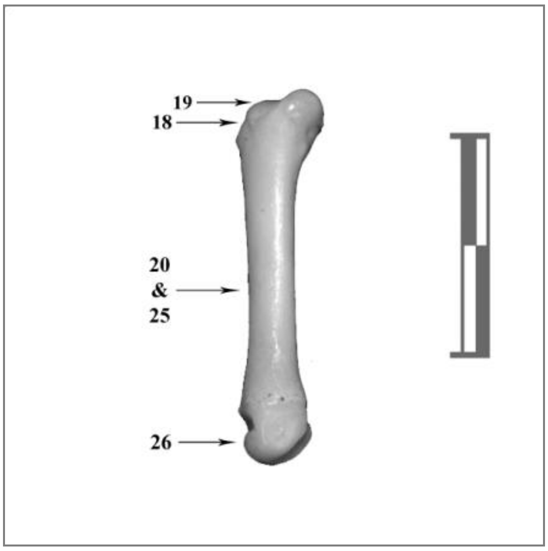


Figure 4.206: *L. saxatilis* – Metacarpal V Lateral view

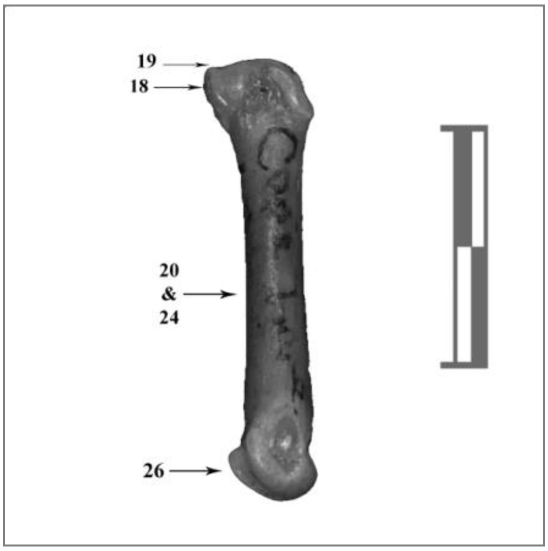


Figure 4.207: *L. capensis* – Metacarpal V medial view

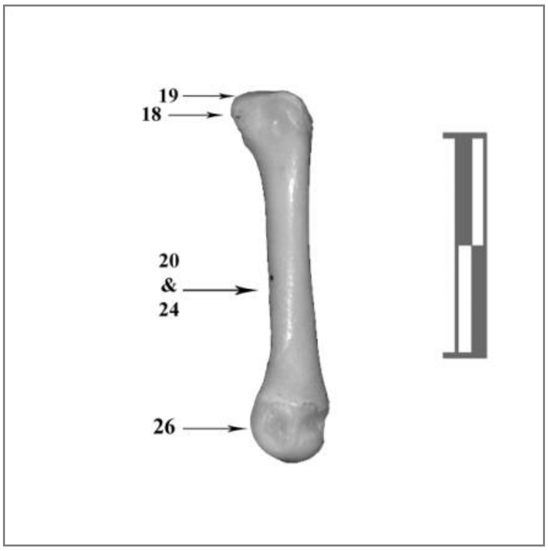


Figure 4.208: *L. saxatilis* – Metacarpal V medial view

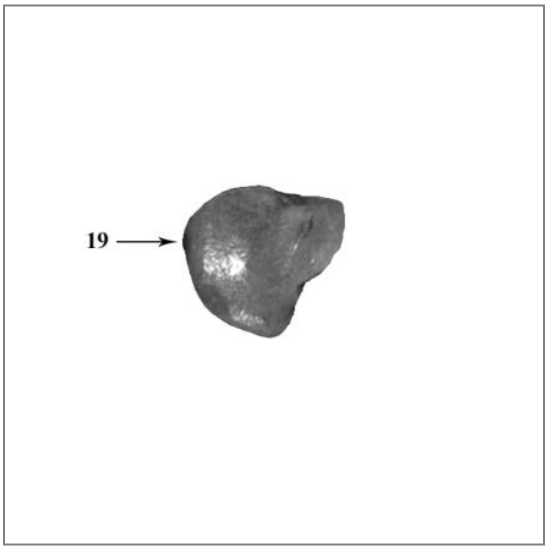


Figure 4.209: *L. capensis* – Metacarpal V proximal articulation

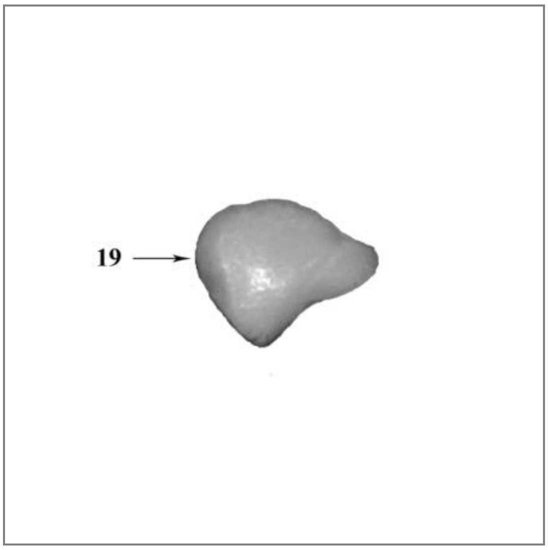


Figure 4.210: *L. saxatilis* – Metacarpal V proximal articulation

Scatter plots and 95% confidence levels indicate that there are no significant differences between the two species. MC II Dp (Figure 4.211); MC IV Bp (Figure 4.212); MC V Bd (Figure 4.213); MC V Dp (Figure 4.214); MC V Bp (Figure 4.215) show that *L. capensis* MC II, IV and V's proximal articulations are marginally bigger than those of *L. saxatilis*. Due to the small sample size the observation is speculative. The differences in locomotory habits of these two species could be a possible explanation.

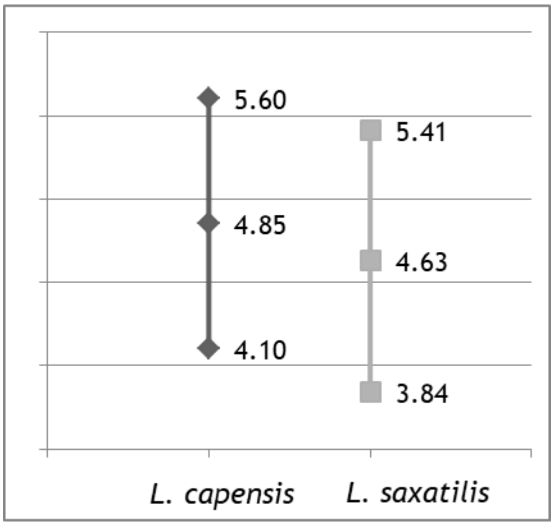


Figure 4.211: Metacarpal II measurement Dp – Depth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

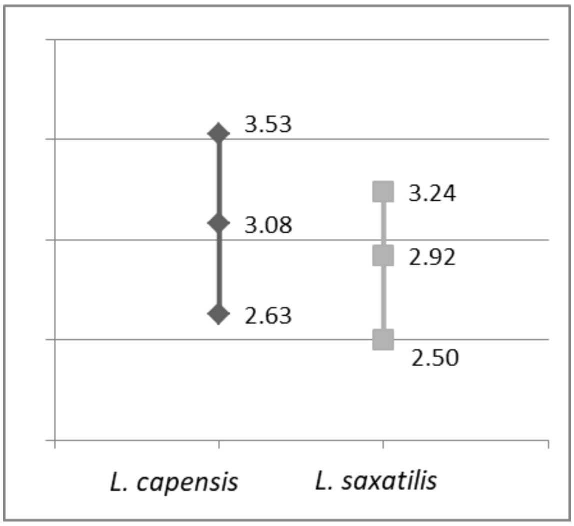


Figure 4.212: Metacarpal IV measurement Bp – Breadth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

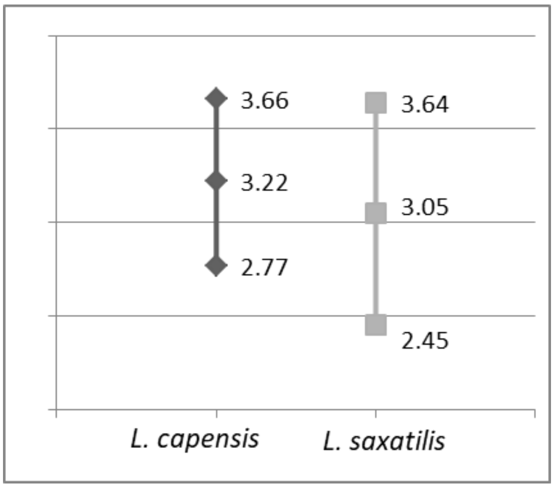


Figure 4.213: Metacarpal V measurement Bd – Breadth distal. 95% confidence levels upper bound, mean and lower bound values indicated

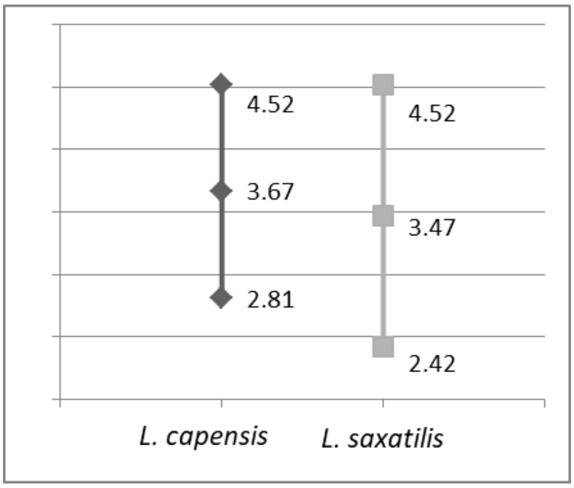


Figure 4.214: Metacarpal V Dp – Depth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

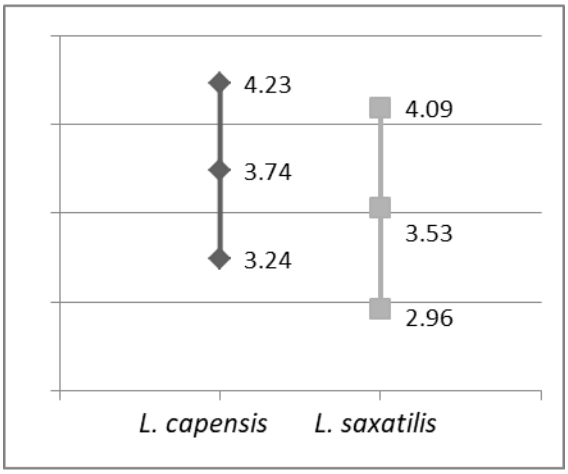


Figure 4.215: Metacarpal V measurement Bp – Breadth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.10 Element name - Pelvis

Minimum number of individuals examined: *L. capensis* – 25; *L. saxatilis* – 24

A total of 15 individual scatter plots for the pelvis were drawn up and nine box plots for each measurement’s 95% confidence levels.

Photos of the pelvis are set at a 2cm scale for the complete bone. Some images were greatly enlarged to make the morphology visible thus no scale was included.

Table 4.12: Pelvis p-values. All measurements for individual sides of the pelvis have high statistical significance. All measurements for complete pelvis are not statistically significant.

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Pelvis												
GL	18	78.48	3.03	72.43	82.97		20	91.89	5.33	82.59	102.33	p<0.001
LAR	19	9.18	0.46	8.37	10.04		20	10.36	0.93	8.79	12.68	p<0.001
SH	19	8.48	0.63	7.59	9.68		20	9.49	0.74	8.35	10.85	p<0.001
SB	19	5.21	0.46	4.44	6.11		20	5.93	0.60	5.01	7.33	p<0.001
Lfo	18	16.30	0.84	14.67	17.55		20	18.46	1.48	15.60	21.66	p<0.001
LAIIL	18	9.38	0.49	8.54	10.23		19	10.78	0.91	9.45	12.79	p<0.001
GBTc	4	52.82	4.88	46.73	57.97		8	58.28	6.62	48.55	66.18	p>0.05
GBA	4	44.52	2.91	41.39	48.79		8	50.08	6.52	40.89	58.84	p>0.05
GBTi	4	45.05	4.15	41.09	50.83		8	49.42	5.97	42.59	59.03	p>0.05
SBI	4	34.64	3.51	31.09	40.03		8	38.89	4.76	33.13	46.53	p>0.05

P 62[8]

- The ischial spine — *Spina ischiadica* (11) — connects the ischium and the ilium. It is a straight line that is not prominent or flared in any of the two species. In *L. capensis* the spina has a slight bump that can be felt more than seen. In *L. saxatilis* there is a definite thickening and lipping that forms a stronger muscle attachment. This feature cannot be clearly seen in a photo (Figures 4.218 & 4.219).

- The ilium tuber — *Tuber coxae* (20) — and — *Spina iliac aventralis cranialis* (21) — in *L. capensis* the tuber is little more than a slight bump. In *L. saxatilis* the tuber is thicker and more developed than in the *L. capensis* (Figures 4.216 & 4.217).

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[8] There are two pages of nomenclature for the pelvis in Schaller (2007) and the numbering of each starts at 1. The corresponding page number of the anatomy described are included to minimize confusion.

- The ilium crest — *Crista iliaris* (19) — is a thicker muscle attachment and forms a flattish elongated triangle shape. In *L. capensis* there is a clear distinction between 19 and 20. In the *L. saxatilis,* it forms one unit and there is no clear distinction (Figures 4.216 & 4.127).

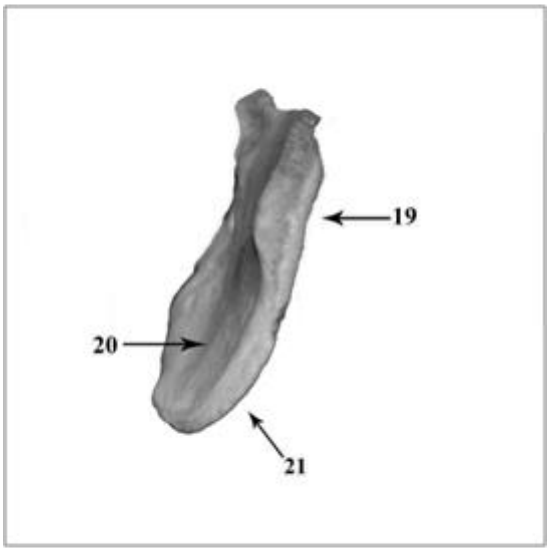

Figure 4.216: *L. capensis* – Pelvis ilium tuber

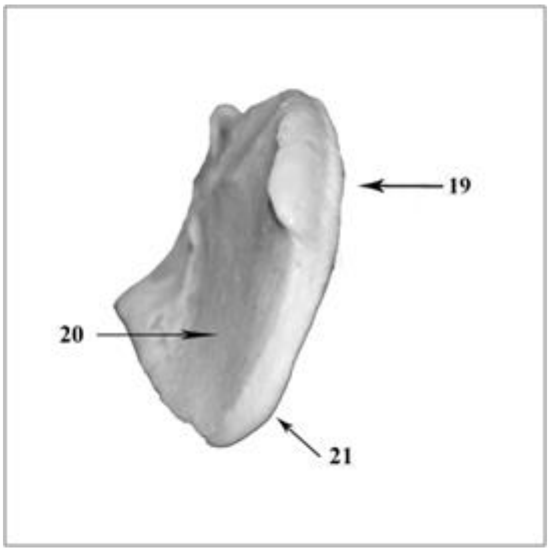

Figure 4.217: *L. saxatilis* – Pelvis ilium tuber

- The cranial dorsal spina — *Spina iliaca dorsalis cranialsis* (25) — forms in *L. capensis* a prominent overhang on the ventral border. *L. saxatilis* exhibits a less prominent overhang on the ventral border (Figures 4.222 & 4.223).

- The caudal dorsal spina — *Spina iliaca dorsalis caudalis* (26) — in *L. capensis* flares squarely from the shaft at an almost 90º angle and forms a strong articulation facet for the sacral. In *L. saxatilis* the spina also flares squarely from the shaft but at a steeper angle to form a strong articulation facet for the sacral (Figures 4.218 & 4.219).

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- The tooth/peg-like protuberance — *Incisura ischiadica minor* (7) — is located roughly in the middle of the ischium shaft. It appears to be stronger and more developed in *L. saxatilis* (Figures 4.218 & 4.219).

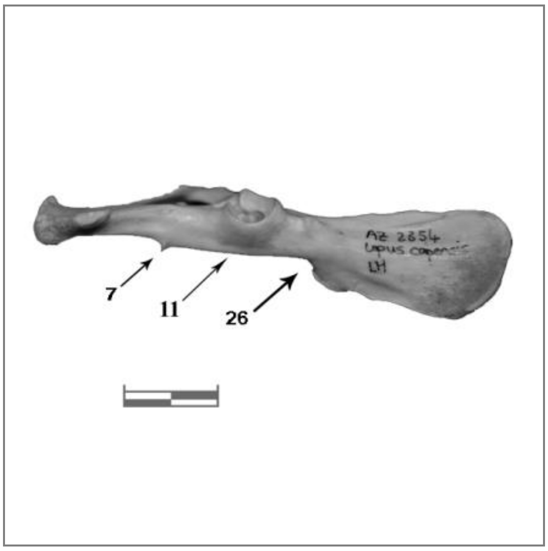


Figure 4.218: *L. capensis* – Pelvis lateral and ventral view

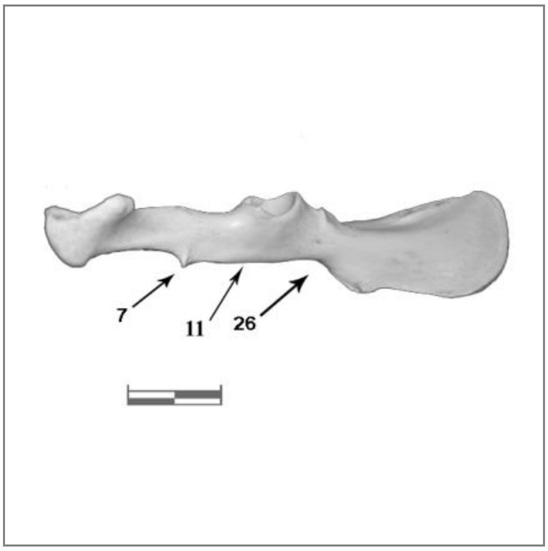


Figure 4.219: *L. saxatilis* – Pelvis lateral and ventral view

- The ischium — *Tuber ischiadicum* (6) — is roughly triangular in shape. The ventral edge of the triangle is in line with the acetabulum and protrudes at a 90º angle. The overhang has a slight back curve forming a strong muscle articulation facet. In *L. saxatilis* the protuberance of the ventral edge is flatter and more strongly developed (Figures 4.220 & 4.221).

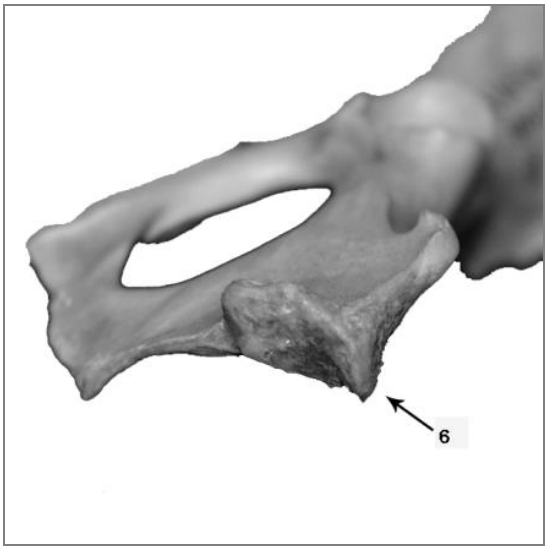


Figure 4.220: *L. capensis* – Pelvic ischial tuber

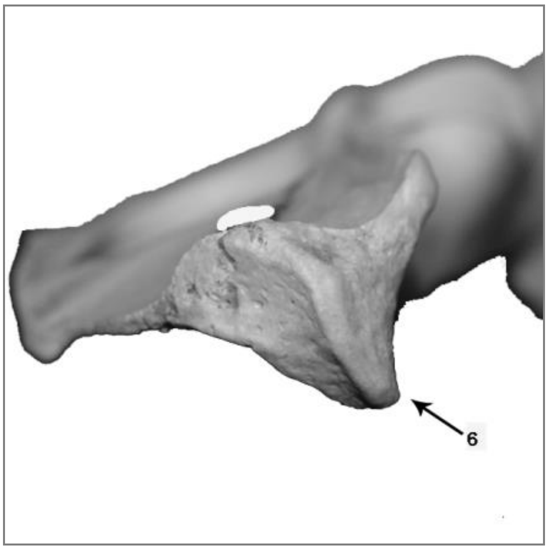


Figure 4.221: *L. saxatilis* – Pelvic ischial tuber

- The pubis — *Corpus ossis pubis* (9) — is flat and thin in both species. In *L. saxatilis* there is a marked thickening prominent bulb at the symphysis — *Ramus caudalisossis pubis* (11) (Figures 4.222 & 4.223).

- The tooth/peg-like protuberance — *Eminentia iliopublica* (14) — is located roughly on the first 1/3 of the shaft closes to the acetabulum. This muscle attachment is stronger and more developed in *L. saxatilis* (Figures 4.222 & 4.223).

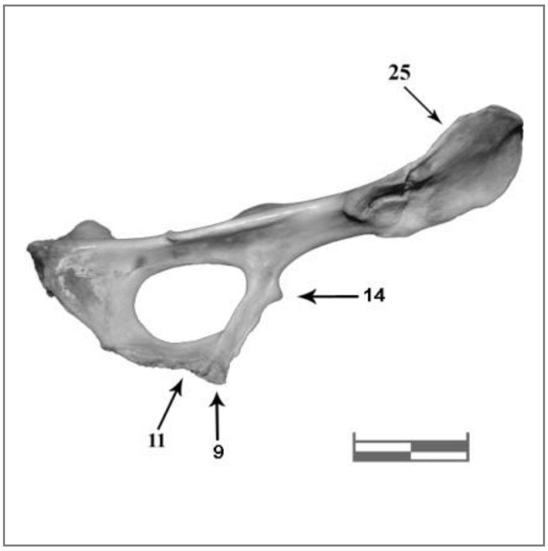


Figure 4.222: *L. capensis* – Pelvis dorsal view

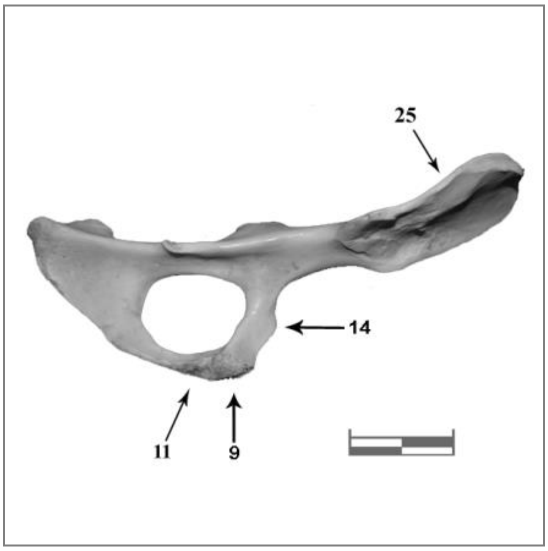


Figure 4.223: *L. saxatilis* – Pelvis dorsal view

- If the complete half of the pelvis lies on its dorsal edge the pubic symphysis of the *L. capensis* rises up while that of the *L. saxatilis* points down (Figures 4.224 & 4.225).

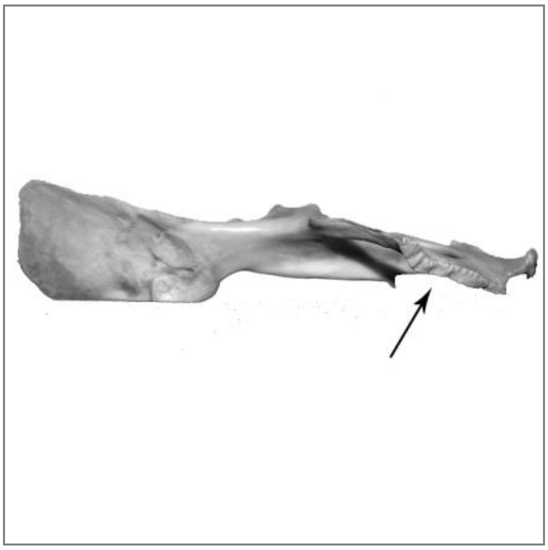


Figure 4.224: *L. capensis* – Pelvis dorsal view indicating pubic symphysis position

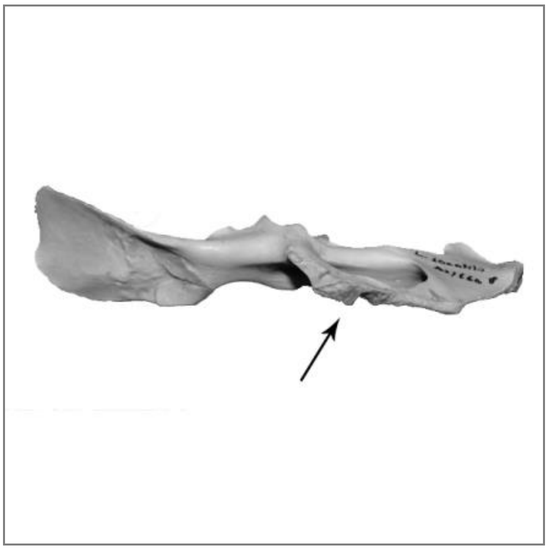


Figure 4.225: *L. saxatilis* – Pelvis dorsal view indicating pubic symphysis position

- The ilia wing of the *L. capensis* lies at an angle of almost 90º to the surface whereas the *L. saxatilis* is at a 45º angle. In this position, the acetabulum of the *L. capensis* lies at a 45º angle and the *L. saxatilis* points directly upwards (Figures 4.226 & 4.227).

Figure 4.226: *L. capensis* – Pelvis ventral view indicating ilia wing angle

Figure 4.227: *L. saxatilis* – Pelvis ventral view indicating ilia wing angle

- In the complete pelvis — *Arcus ischiadicus* (20) — the *L. saxatilis* slopes to a lesser angle than the *L. capensis*. It is less elongated and does not come down as sharply to the symphysis (Figures 4.228 & 4.229; Figures 4.230 & 4.231). Although there are morphological differences in the complete pelves, it is interesting that the measurements show no statistical significance (Table 4.12).

Figure 4.228: *L. capensis* – Complete pelvis ventral view

Figure 4.229: *L. saxatilis* – Complete pelvis ventral view

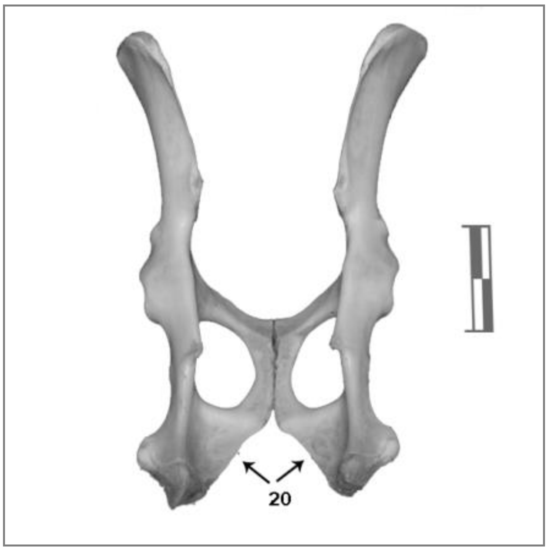


Figure 4.230: *L. capensis* – Complete pelvis dorsal view

Figure 4.231: *L. saxatilis* – Complete pelvis dorsal view

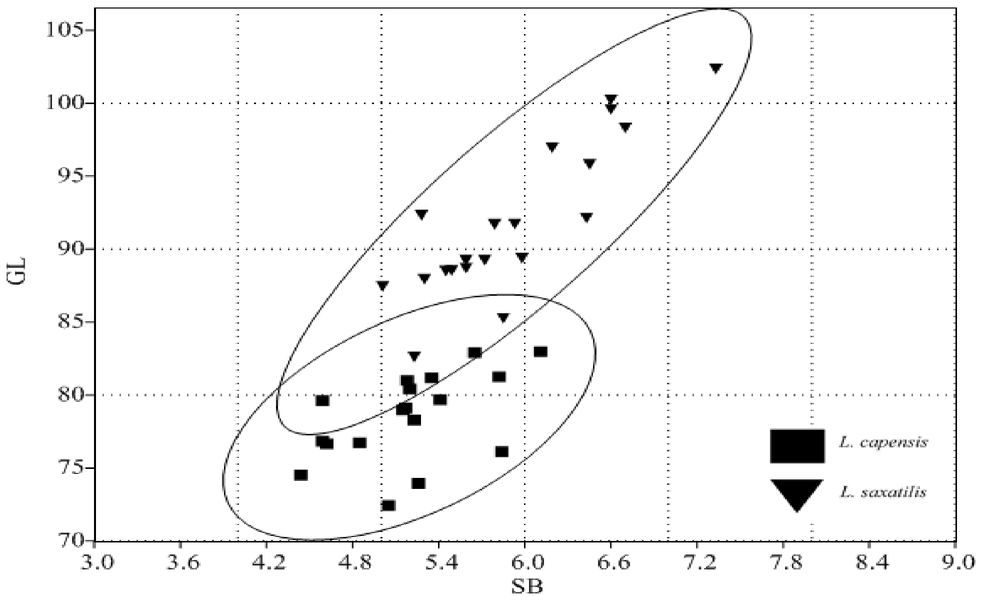


Figure 4.232: Pelvis measurement GL – Greatest length vs SB – Smallest breadth of the shaft of the ilium – indicating clear differences between the two species

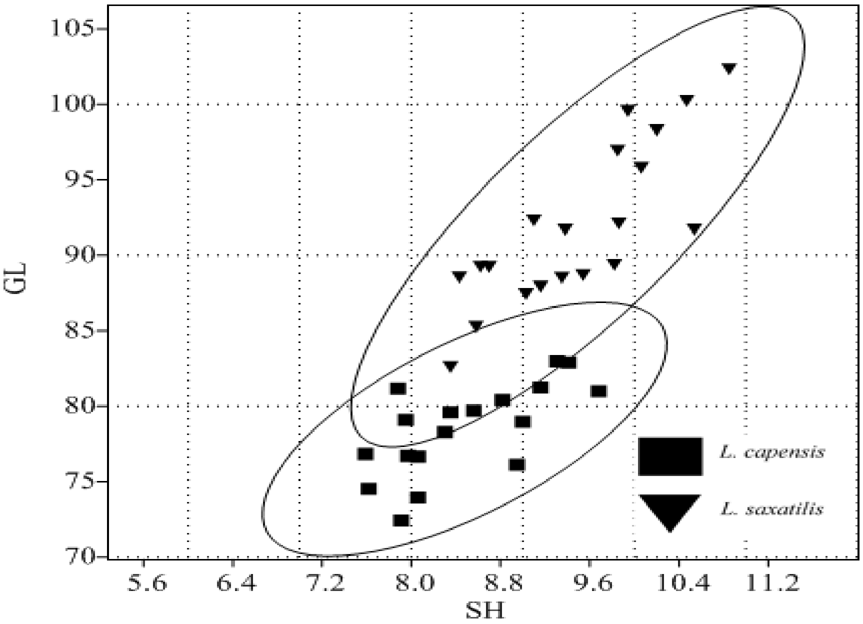


Figure 4.233: Pelvis measurement GL – Greatest length vs SH – Smallest height of the shaft of the ilium – indicating clear differences between the two species

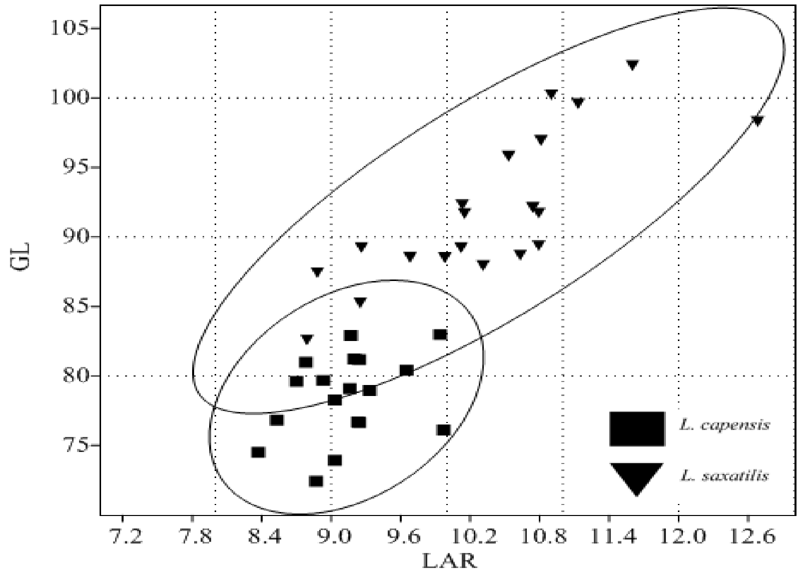


Figure 4.234: Pelvis measurement GL – Greatest length vs LAR – Length of the acetabulum on the rim showing clear differences between the two species

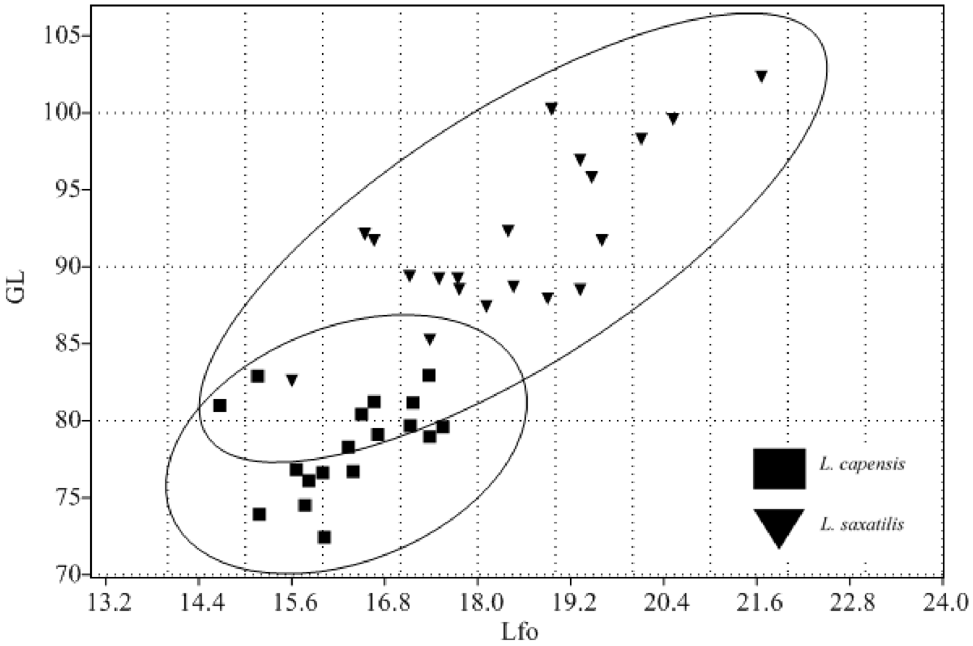


Figure 4.235: Pelvis measurement GL – Greatest length vs Lfo – Inner length of the *foramen obturatum* – indicating clear differences between the two species

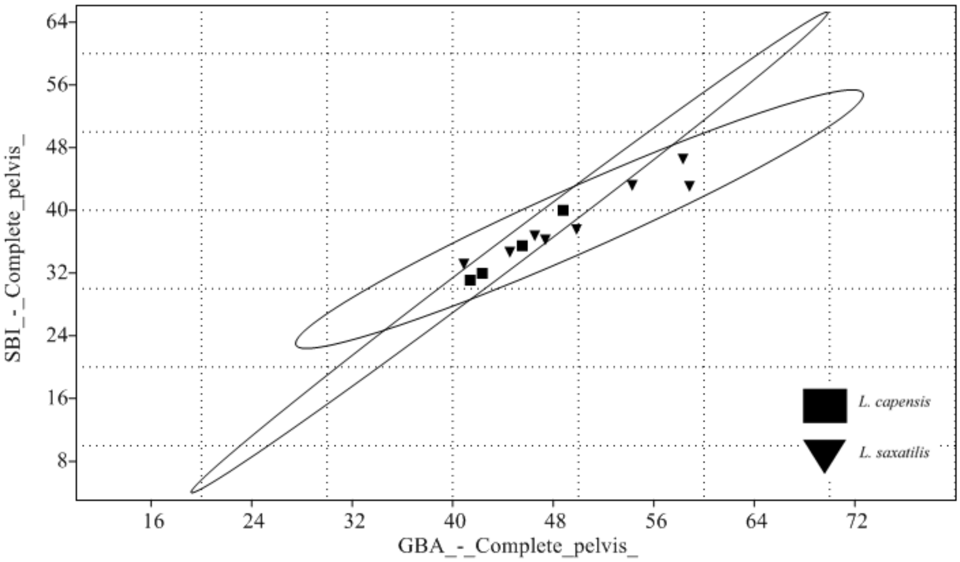


Figure 4.236: Pelvic whole measurement SBI – Smallest breadth across the bodies of the ischia vs GBA – greatest breadth across the acetabula as the sample size is small it is difficult to draw any conclusions. However, it does seem that there are correlations between these two measurement points

The measurement with the least overlap is the greatest length (GL) (Figure 4.237).

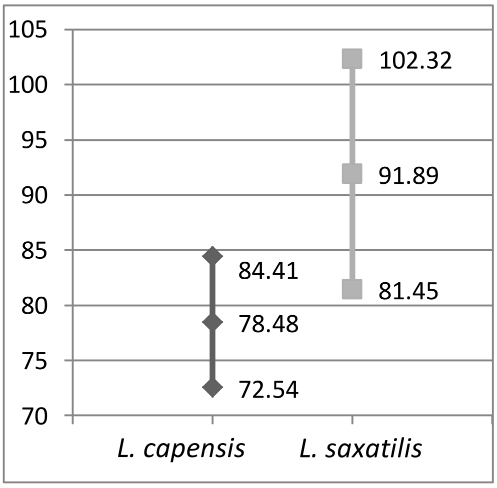


Figure 4.237: Pelvis GL – Greatest length indicating a small overlap between the two species. 95% confidence levels upper bound, mean and lower bound values indicated

When this measurement is plotted on a line graph the minimal overlap becomes clearer (Figure 4.238).

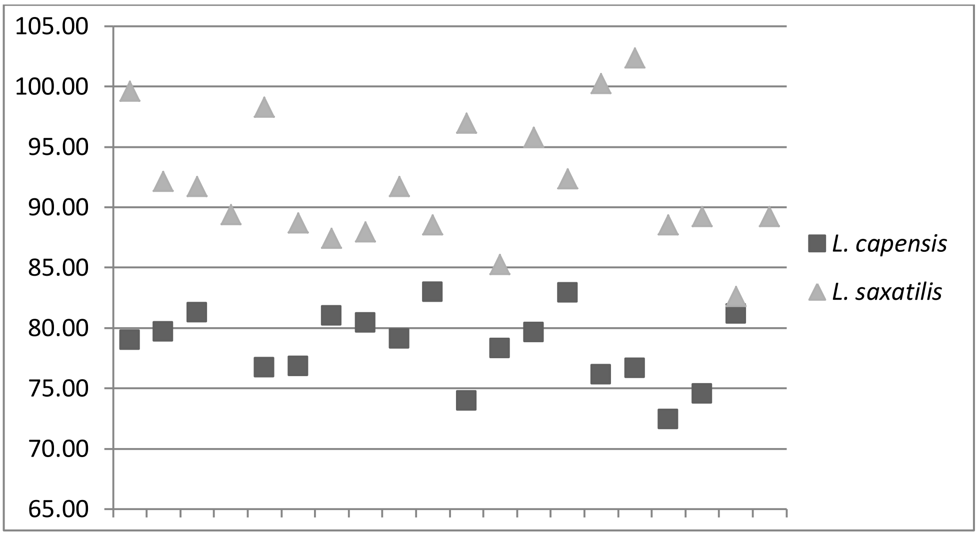


Figure 4.238: Pelvis measurement GL – Greatest length showing minimal overlap

In measurements LAR (Figure 4.239), Lfo (Figure 4.240), LAIIL (Figure 4.241) and GBA (Figure 4.242) *L. capensis* only overlaps with the lower bound measurements of *L. saxatilis*.

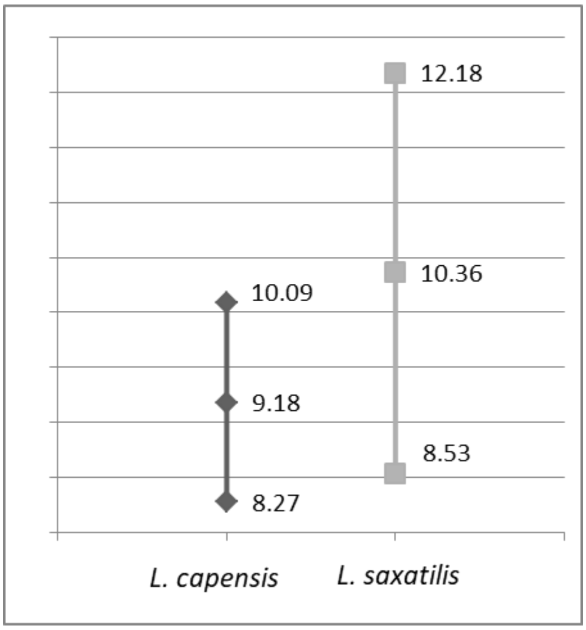


Figure 4.239: Pelvis measurement LAR – Length of the acetabelum on the rim. 95% confidence levels upper bound, mean and lower bound values indicated

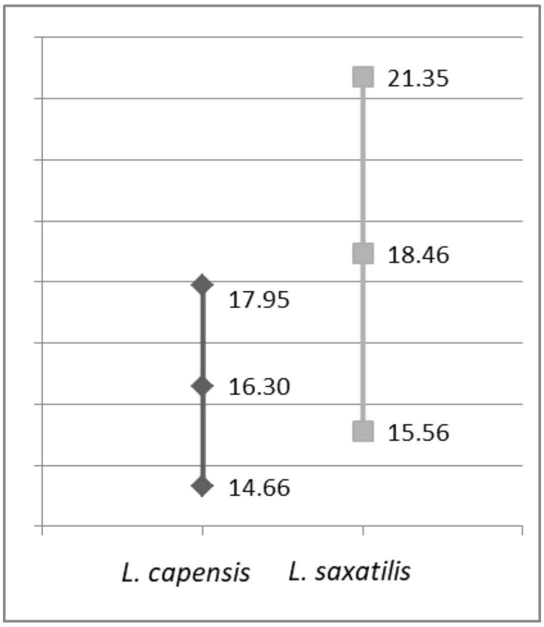


Figure 4.240: Pelvis measurement Lfo – Inner length of the foramen obturatum. 95% confidence levels upper bound, mean and lower bound values indicated

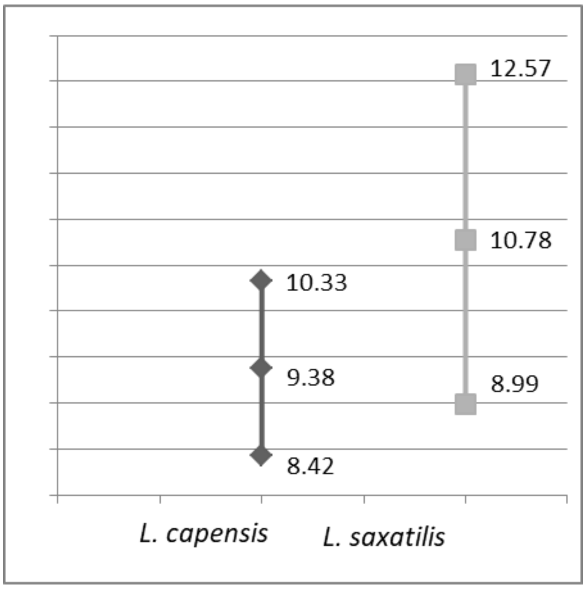


Figure 4.241: Pelvic measurement LAIIL – Length on rim from ischium to ilium. 95% confidence levels upper bound, mean and lower bound values indicated

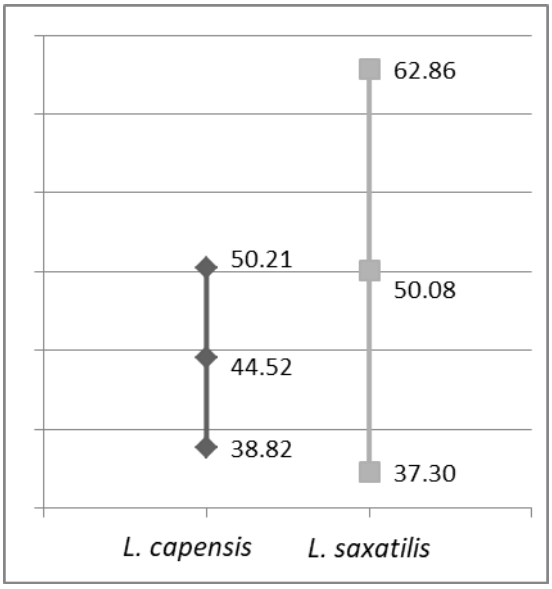


Figure 4.242: Pelvic measurement GBA – Greatest breadth across the acetabula. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.11 Element name - Femur

Number of individuals examined: *L. capensis* – 25, *L. saxatilis* – 24

A total of 45 individual scatter plots for the femur were drawn up and ten box plots for each measurement's 95% confidence levels.

Photos of the femur are set at 2cm scale for the complete bone and at 1cm scale for the articulations.

Table 4.13: Femur p-values. All measurements of the femur have high statistical significance

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Femur												
GL	20	101.32	4.11	92.45	108.72		19	115.67	7.78	103.13	130.32	p<0.001
GLC	20	95.82	3.94	86.40	102.32		19	109.45	7.46	97.78	124.24	p<0.001
Bp	20	20.04	0.98	17.72	21.13		20	22.59	1.72	20.40	26.93	p<0.001
BTr	19	19.35	0.81	17.21	20.55		20	20.93	1.30	19.08	24.07	p<0.001
DC	20	8.05	0.41	7.28	8.84		20	9.12	0.71	8.18	10.68	p<0.001
SD	20	7.62	0.36	6.89	8.22		20	8.75	0.43	7.76	9.46	p<0.001
Bd	20	15.35	0.88	13.61	17.72		20	18.10	1.50	16.10	21.18	p<0.001
CB	19	8.76	0.48	7.85	9.71		19	10.36	0.93	9.14	12.43	p<0.001
CONM	19	15.49	0.89	14.03	17.44		19	18.01	1.45	15.65	20.43	p<0.001
CONL	19	14.55	0.89	13.03	16.59		18	17.28	1.37	15.05	19.85	p<0.001

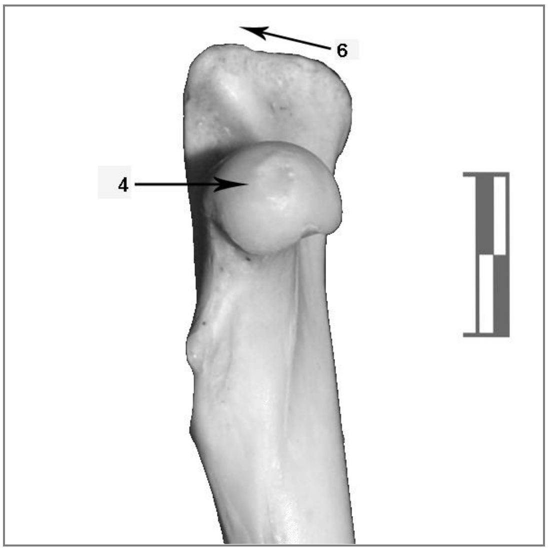


Figure 4.243: *L. capensis* – Femur caput

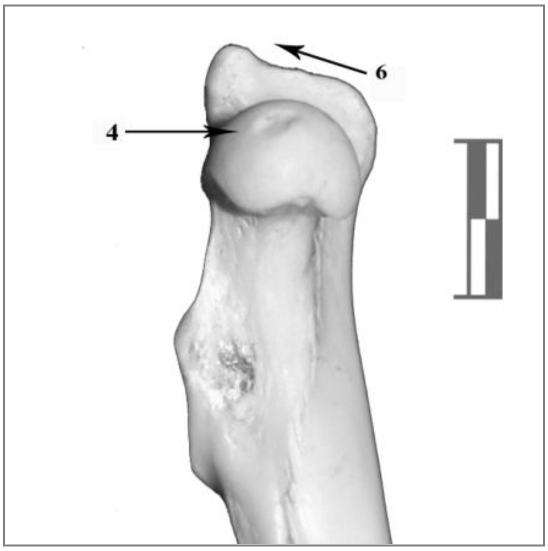


Figure 4.244: *L. saxatilis* – Femur caput

- The ligament attachment — *Fovea capitis* (4) — in *L. capensis* is not a very prominent feature and is round in shape. In *L. saxatilis* the attachment is a very prominent feature and also round in shape (Figures 4.243 & 4.244).

- The major trochanter — *Trochanter major* (6) — in both species is slender with no great protuberance laterally and extends above the caput. In *L. capensis,* the ridge keeps a gradual angle and only gradually rises caudally. In *L. saxatilis* the ridge rises at a sharpish angle caudally (Figures 4.243 & 4.244).

- *Incisura trochanterica* (9) — is present and causes a slight rise/notch roughly in the middle of the trochanter. In *L. capensis* there is a faint or less prominent line down the lateral side of the major trochanter. In *L. saxatilis* the line down the lateral side is very prominent (Figures 4.245 & 4.246).

- The trochanter fossa — *Fossa trochanterica* (10) — is deep and is caudally overhung by the C*rista intetrochanterica*. In *L. capensis* the — *Caput* (3) — pulls away from the fossa and is situated more cranially. In *L. saxatilis* the caput is more in line with the fossa. The ridge that connects the caput to the major trochanter in *L. capensis* is thin and in *L. saxatilis* it is thicker and sturdier (Figures 4.245 & 4.246).

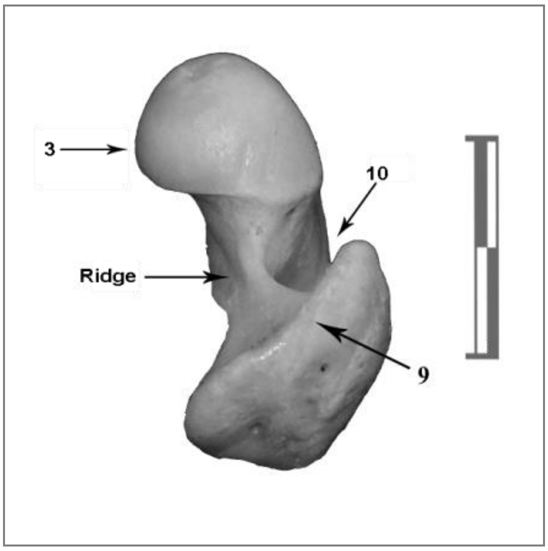


Figure 4.245*: L. capensis* – Femur proximal view

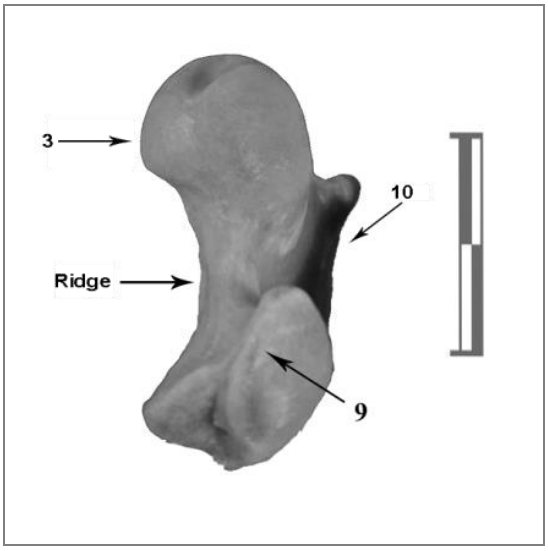


Figure 4.246: *L. saxatilis* – Femur proximal view

- In *L. capensis* the fossa's lowest edge where it joins the shaft is in line with the top margin of the third trochanter and the minor trochanter. In *L. saxatilis* the fossa's lowest edge where it joins the shaft is not in line with the third trochanter or the minor trochanter.
  - This distinction is seen in the morphology when the Depth of the Caput (DC) is put against the Caput Bulge (CB) (Figure 4.247).

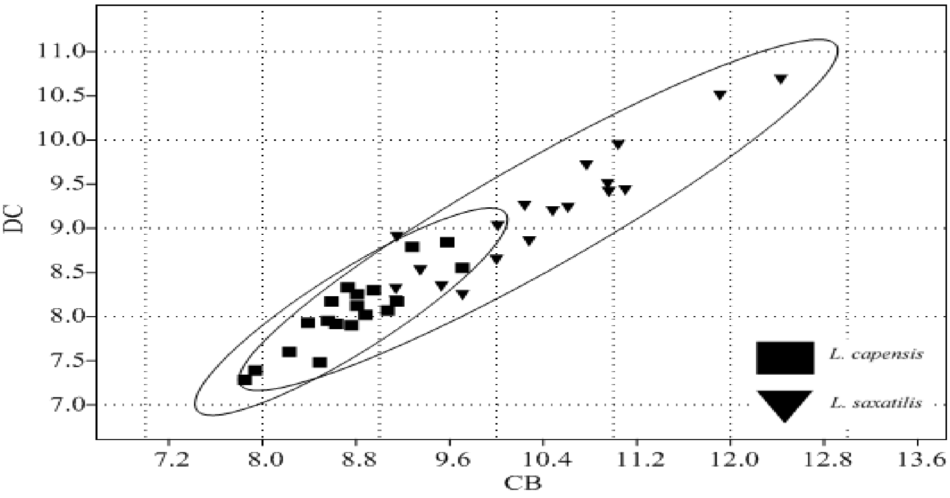


Figure 4.247: Femur measurement DC – Depth of the caput vs CB – Caput bulge indicating a high correlation in both species

- Lesser trochanter — *Trochanter minor* (11) — originates in line with the base of the fossa. In *L. capensis* a prominent ridge can be felt rather than seen on the caudal aspect extending between the fossa and the trochanter. This ridge is not present in *L. saxatilis*. The trochanter itself is peg-like and more strongly developed in *L. saxatilis*. In *L. capensis* the return to the shaft is at a rather acute angle, in *L. saxatilis* this is a more gradual angle. In the *L. capensis* specimen AZ 685, NMBF 2891, 9811 and NMB 4713 the articulation was very strong and the return to the shaft almost formed a second peg-like articulation facet (Figures 4.248 & 4.249).

- Third trochanter — *Trochanter tertius* (12) — it extends in a diagonal line down from the — *Pars cranialis* (7) — and protrudes from the shaft. In *L. capensis* it makes a strong curve cranially and forms almost a half lunar shape. It protrudes distally almost directly out of the shaft. In *L. saxatilis* the curve cranially is not as prominent. The protrusion distally rises gradually out of the shaft (Figures 4.248 & 4.249).

- *Crista intertrochanterica* (14) — in *L. capensis* it comes down from the — *Pars caudalis* (8) — with a slight curve due to the curvature and extension of the *pars*. In *L. saxatilis* there is a slight curve on the top and then comes straight down from the *pars* due to the sharp caudal rise of the trochanter (Figures 4.248 & 4.249).

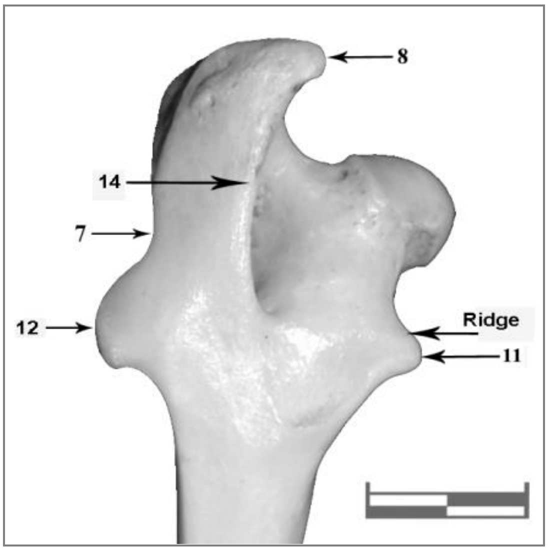


Figure 4.248: *L. capensis* – Femur proximal caudal view

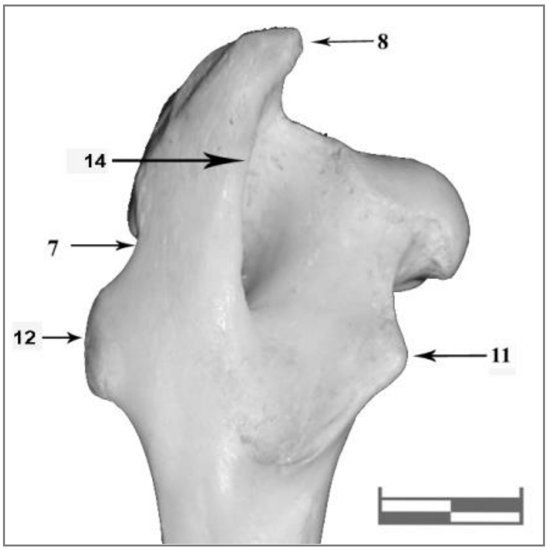


Figure 4.249: *L. saxatilis* – Femur proximal caudal view

- The shaft — *Corpus ossi femoris* (15) — the shaft is round and straight and curves proximal/distal towards the cranial aspect. In both species, the proximal shaft is less curved while the distal half seems to curve less in *L. saxatilis* than in *L. capensis* (Figures 4.250 & 4.251).

- The notch between the condyles — *Fossa intercondylaris* (33) — in *L. capensis* the notch is narrow in keeping with the gracile quality of the bone. In *L. saxatilis* the notch is wider. In male *L. capensis* specimens, the distal articulation appears to be more strongly developed than in the females (Figures 4.252 & 4.253).

- Ridge at the proximal end of the fossa — *Linea intercondylaris* (34) — in *L. capensis* the ridge is straight and in *L. saxatilis* the ridge is slightly curved (Figures 4.252 & 4.253).

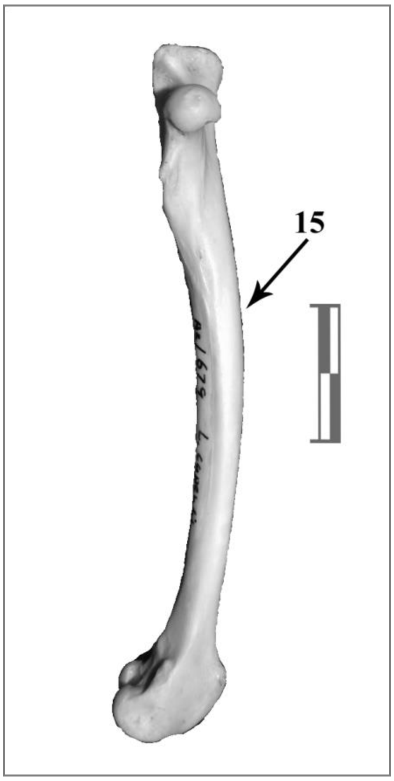


Figure 4.250: *L. capensis* – Femur medial view

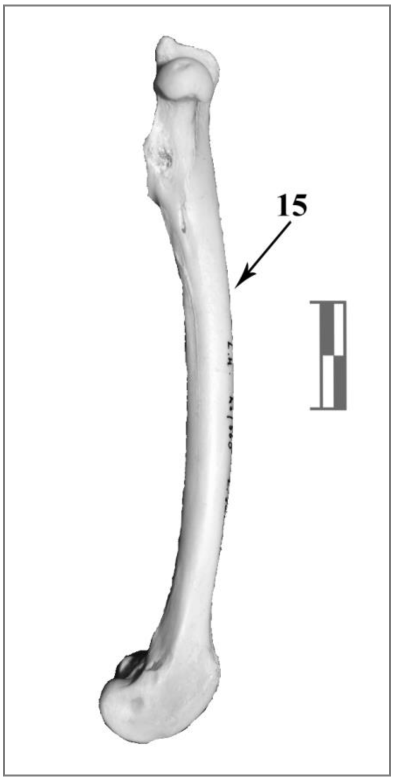


Figure 4.251: *L. saxatilis* – Femur medial view

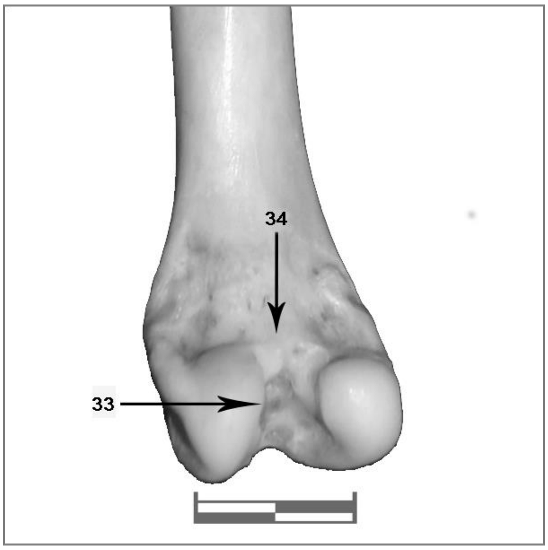


Figure 4.252: *L. capensis* – Femur distal caudal view

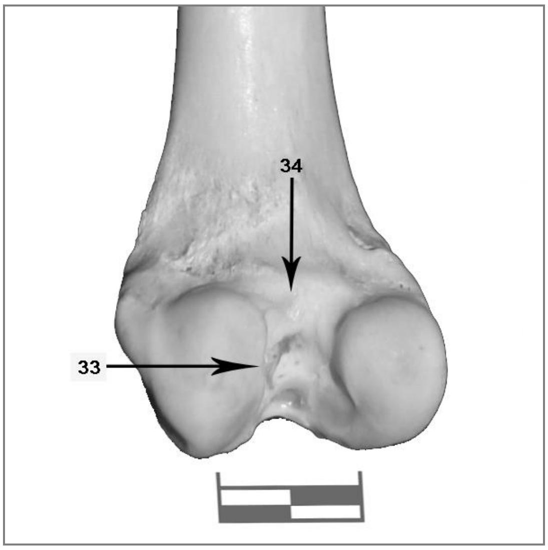


Figure 4.253: *L. saxatilis* – Femur distal caudal view

- *Tuberculum trochleae ossis femoris* (36) — in *L. capensis* there is a thickening on the medial proximal ridge end. No such thickening can be found in the *L. saxatilis* (Figures 4.254 & 4.255).

Figure 4.254: *L. capensis* – Femur distal dorsal view

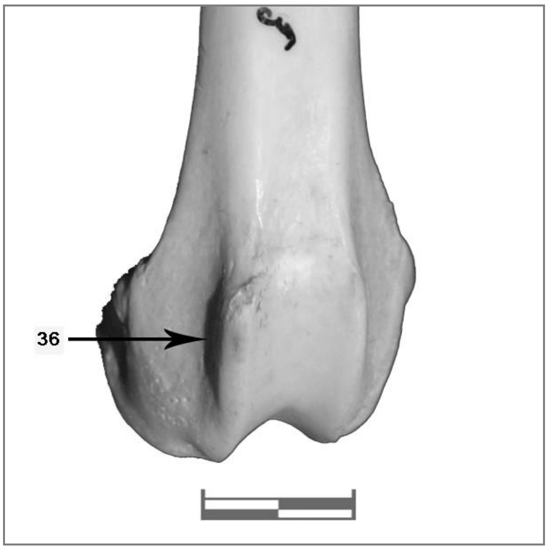


Figure 4.255: *L. saxatilis* – Femur distal dorsal view

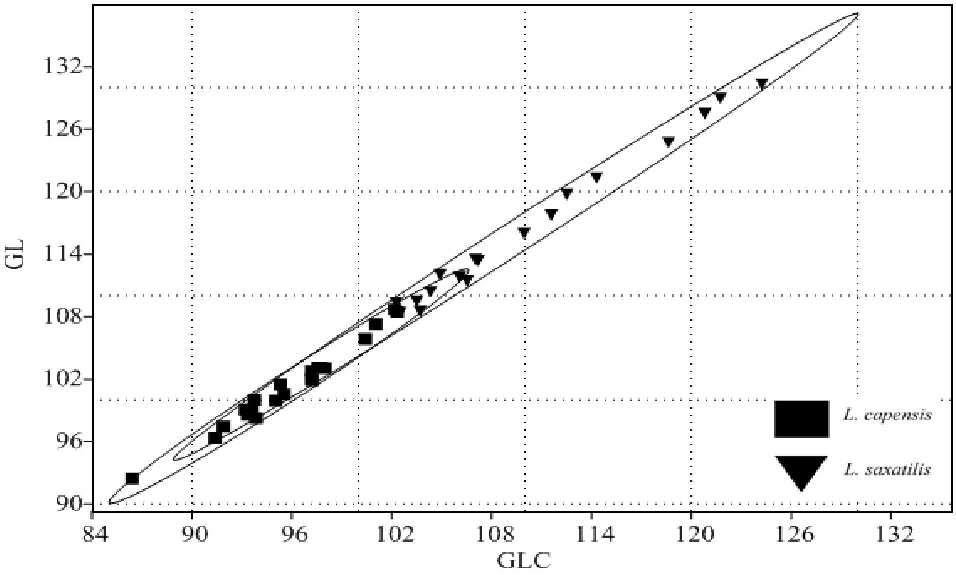


Figure 4.256: Femur measurement GL – Greatest length vs GLC – Greatest length from caput – indicating a high correlation between the two species

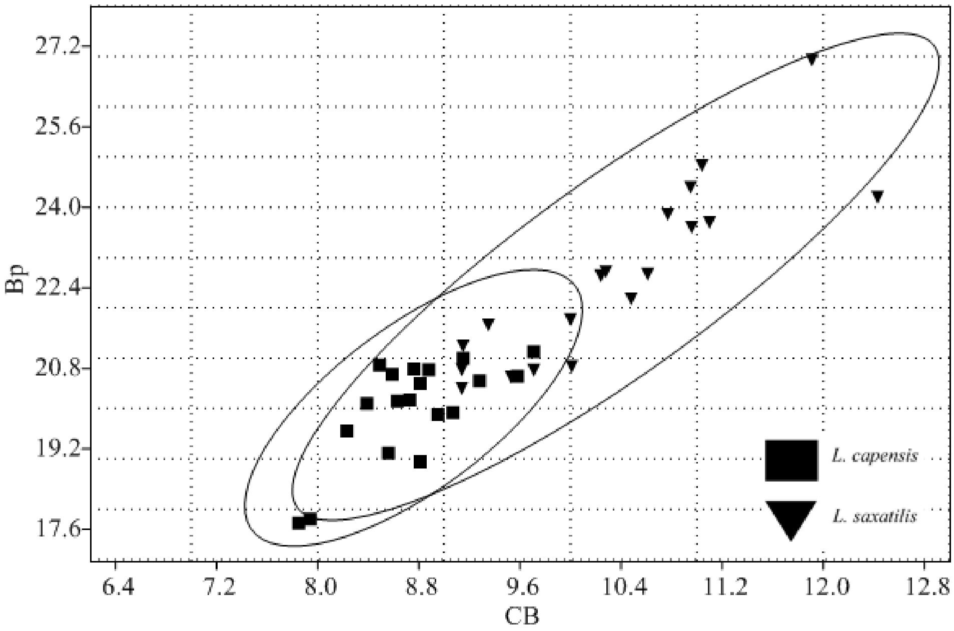


Figure 4.257: Femur measurement Bp – Breadth proximal vs CB – Caput bulge – indicating a high correlation in *L. saxatilis*

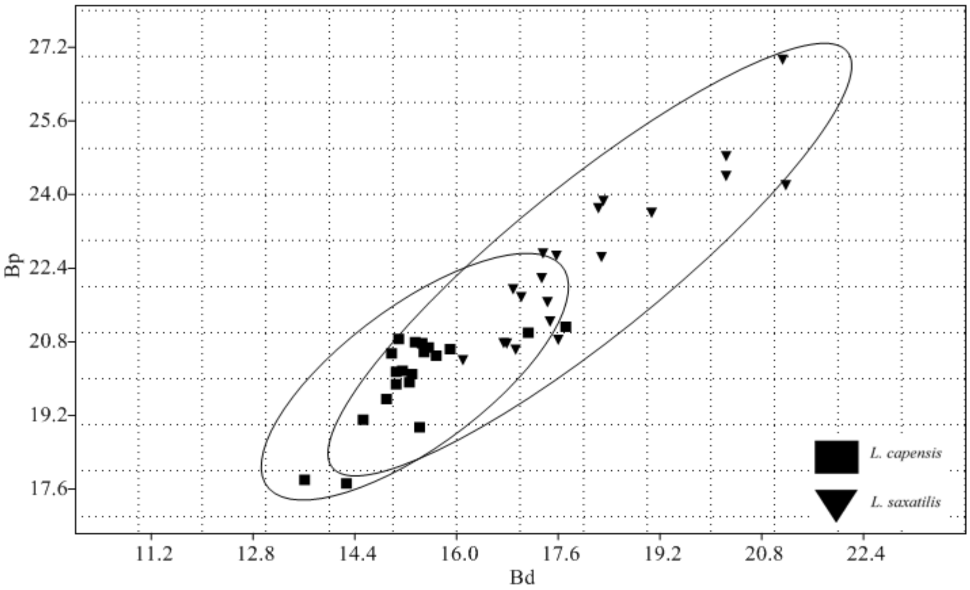


Figure 4.258: Femur measurement Bp – Breadth of proximal end vs Bd – Breadth of distal end –indicating a high correlation in each species

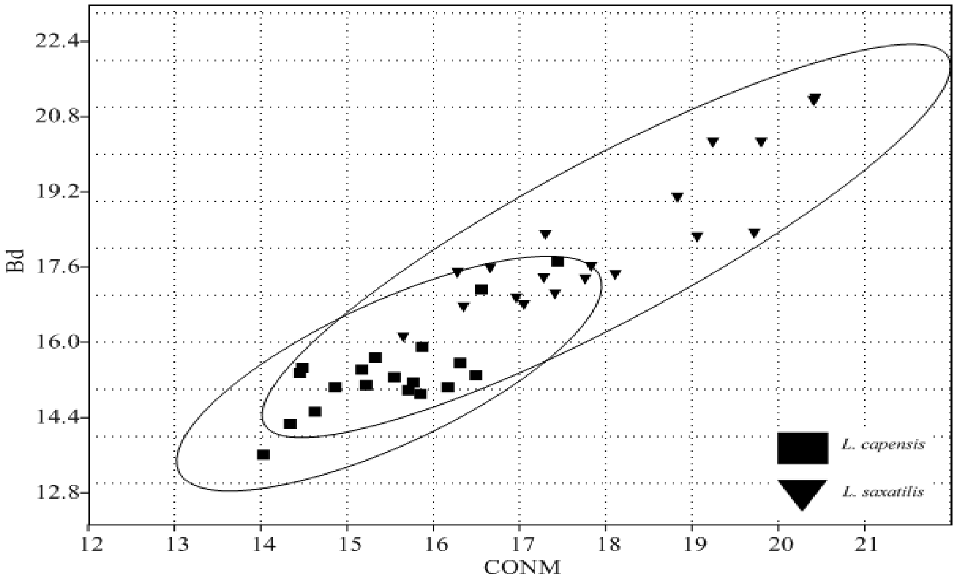


Figure 4.259: Femur measurement Bd – Breadth of distal end vs CONM – Medial condyle –indicating a high correlation in both species

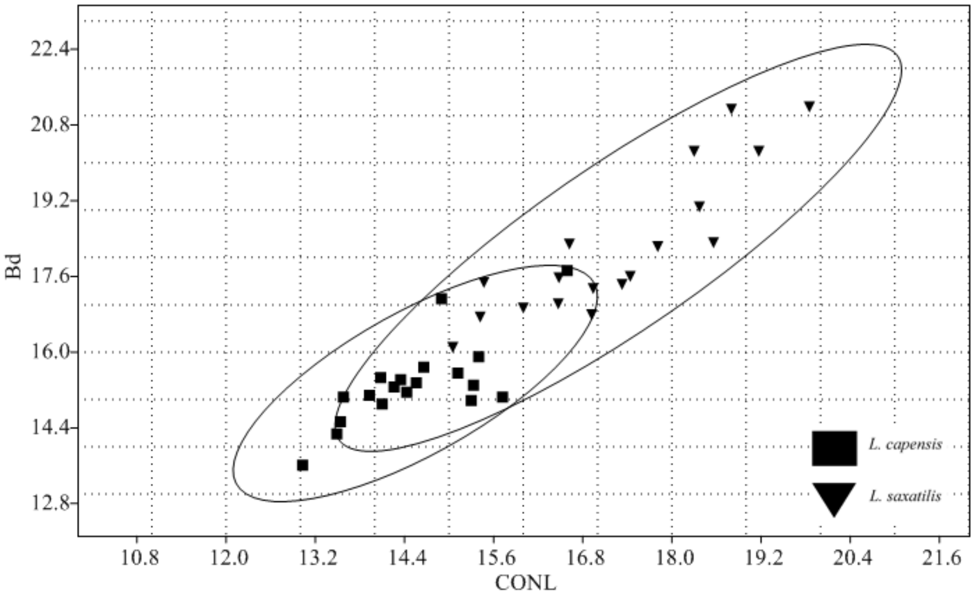
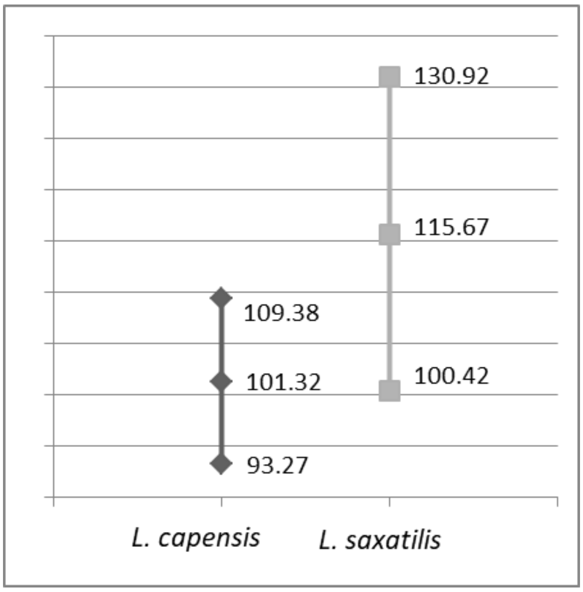


Figure 4.260: Femur measurement Bd – Breadth of the distal end vs CONL – Lateral condyle indicating a high correlation in both species

There is a definite distinction between the two species in all the measurements as is evident from the p-values which are all statistically highly significant (Table 4.13). The hind limb distinction can be attributed to the different locomotory habits of the species. In all the measurements *L. capensis* only overlaps with the lower bound measurements of *L. saxatilis* (Figures 4.261 – 4.270). The morphology coupled with the morphometrics of the femur makes it one of the most diagnostic skeletal elements between the two species.



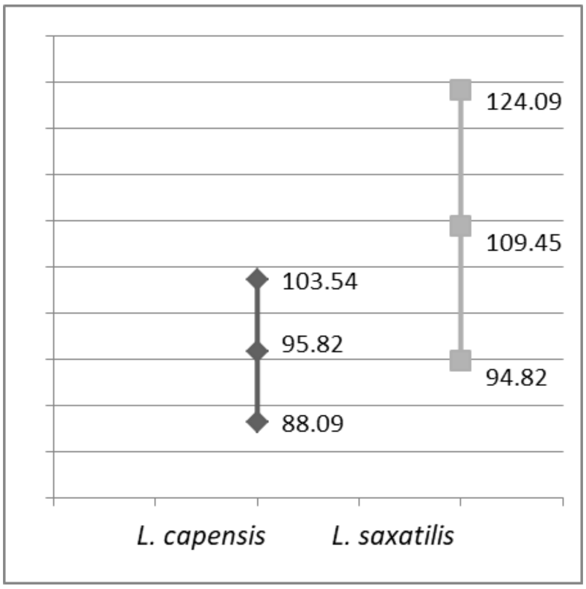


Figure 4.261: Femur measurement GL – Greatest length. 95% confidence levels upper bound, mean and lower bound values indicated

Figure 4.262: Femur measurement GLC – Greatest length from caput. 95% confidence levels upper bound, mean and lower bound values indicated

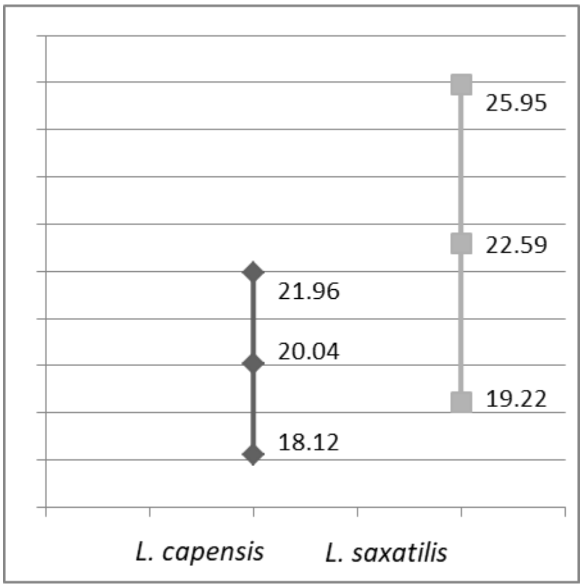


Figure 4.263: Femur measurement BP – Breadth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

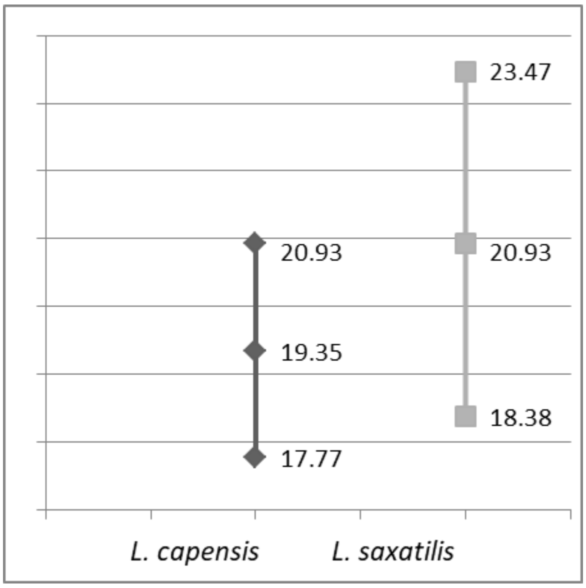


Figure 4.264: Femur measurement BTr – Breadth of region trochanter *tertius*. 95% confidence levels upper bound, mean and lower bound values indicated

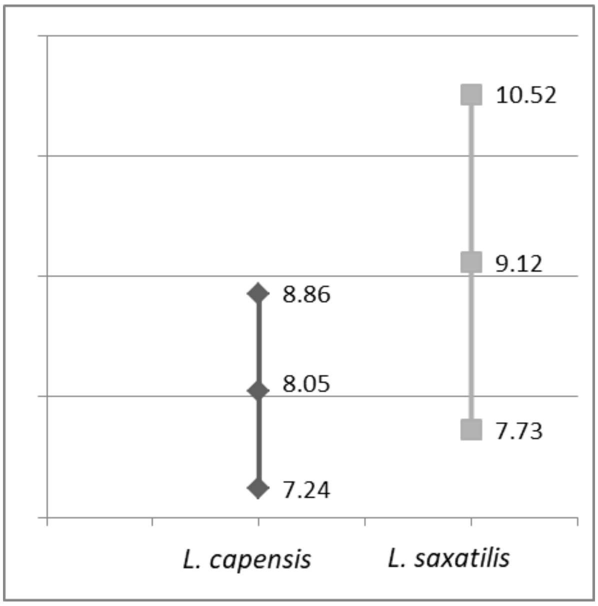


Figure 4.265: Femur measurement DC – Depth of caput. 95% confidence levels upper bound, mean and lower bound values indicated

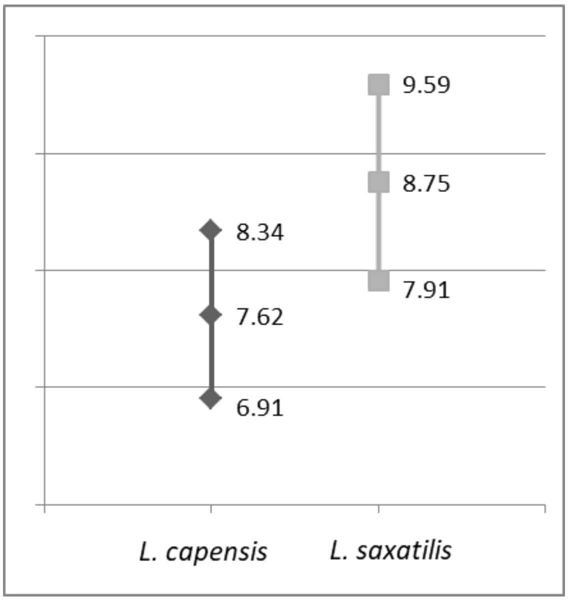


Figure 4.266: Femur measurement SD – Smallest breadth of shaft. 95% confidence levels upper bound, mean and lower bound values indicated

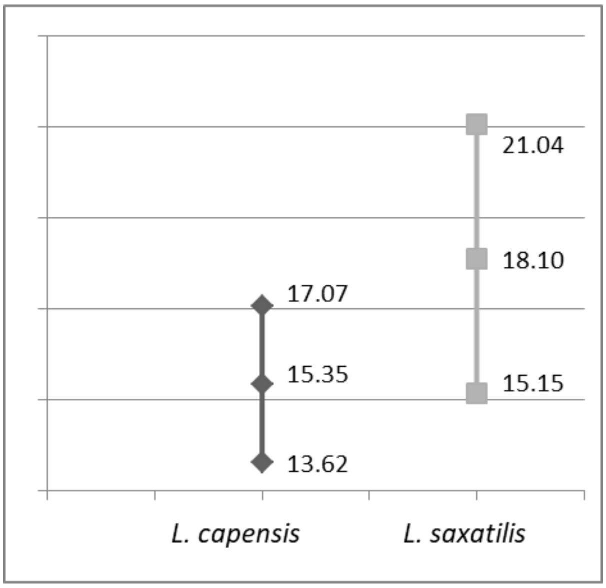


Figure 4.267: Femur measurement Bd – Breadth of the distal end. 95% confidence levels upper bound, mean and lower bound values indicated

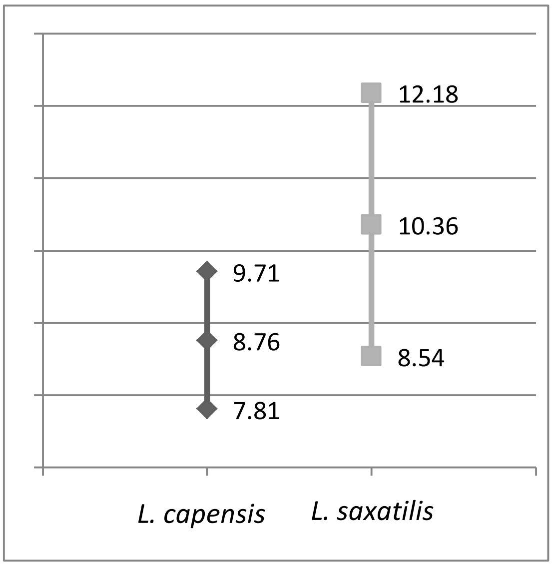


Figure 4.268: Femur measurement CB – Caput bulge. 95% confidence levels upper bound, mean and lower bound values indicated

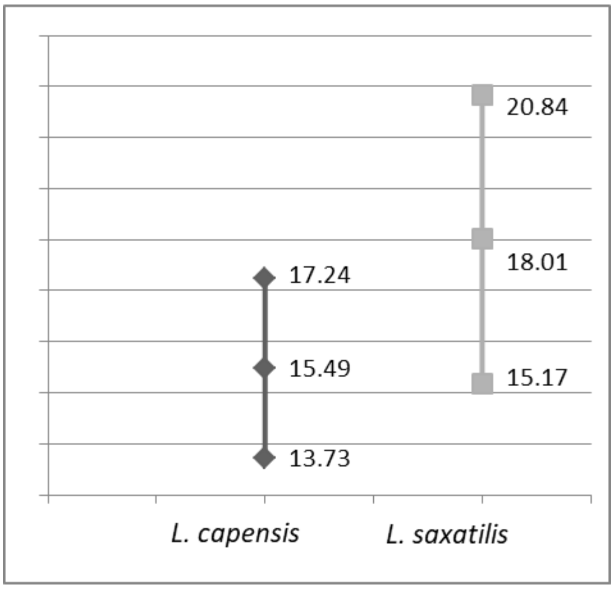


Figure 4.269: Femur measurement CONM – Medial condyle. 95% confidence levels upper bound, mean and lower bound values indicated

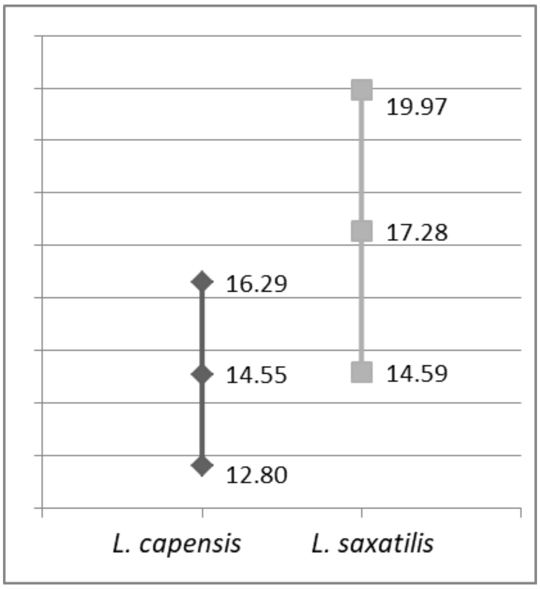


Figure 4.270: Femur measurement CONL – Lateral condyle. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.12 Element name - Patella

Number of individuals examined: L. c*apensis* – 10; L. s*axatilis* – 6

One scatter plot and two box plots for the 95% confidence levels were drawn up.

Photos of the patella are set at a 1cm scale.

Table 4.14: Patella p-values. All measurements for the patella have no statistical significance

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Patella												
GB	10	6.08	0.60	5.13	7.10		6	6.46	0.98	5.45	7.96	p>0.05
GL	10	10.37	1.13	8.92	11.92		6	10.94	1.74	8.95	13.80	p>0.05

- In *L. capensis* the patella is longer and seems stretched (Figures 4.271 & 4.273).
- In *L. saxatilis* the patella seems to me more bulbous (Figures 4.272 & 4.274).

The morphological differences observed are not reflected in the measurements. The results are difficult to interpret due to the small samples size although there seems to be no correlation between the two measurements. There is a large overlap in 95% confidence levels and thus they are not included. The measurements also show no statistical significance (Table 4.14).

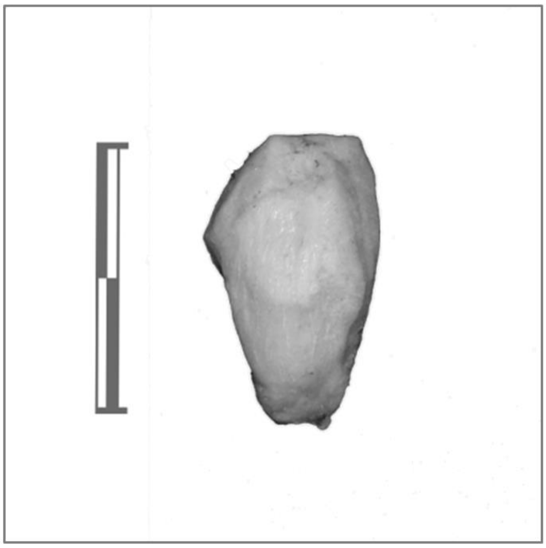


Figure 4.271: *L. capensis* – Patella dorsal view

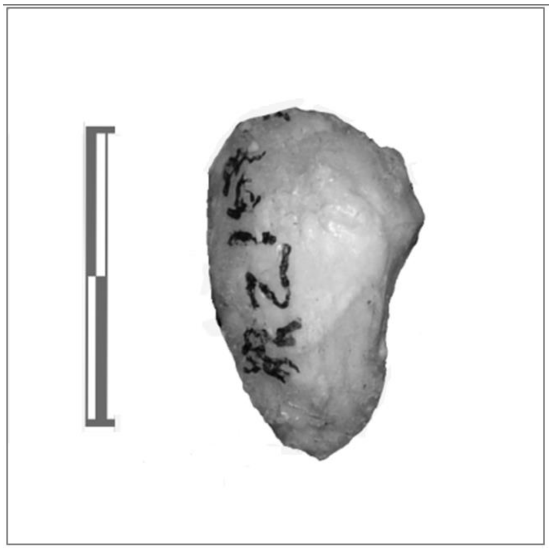


Figure 4.272: *L. saxatilis* – Patella dorsal view

Figure 4.273: *L. capensis* – Patella plantar view

Figure 4.274: *L. saxatilis* – Patella plantar view

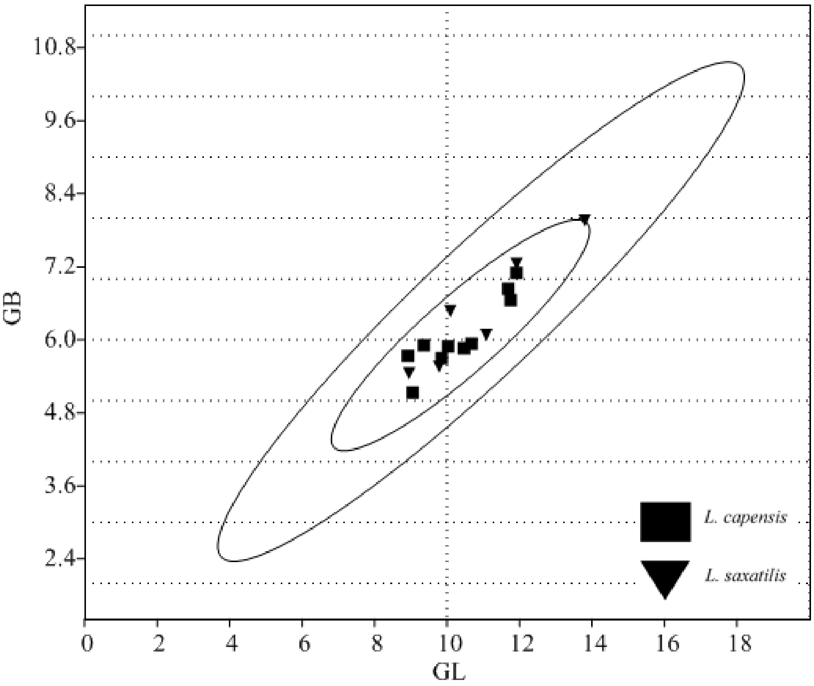


Figure 4.275: Patella measurement GB – Greatest breadth vs GL – Greatest length indicating no discernible correlation

4.2.13 Element name - Tibia

Number of individuals examined: *L. capensis:* 25; *L. saxatilis:* 24

A total of 21 individual scatter plots were drawn up and seven box plots for each measurement's 95% confidence levels.

Photos of the tibia are set at 2cm scale for the complete bone and the at 1cm scale for the articulations.

Table 4.15: Tibia p-values. All measurements of the tibia have high statistical significance

Element/ Measure-ment	***Lepus capensis***					***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**	***n***	**Mean**	**SD**	**min.**	**max.**	
Tibia											
GL	19	116.04	4.04	109.11	127.00	19	133.38	7.55	122.92	146.41	p<0.001
Bp	20	15.61	0.92	13.81	18.18	20	18.54	1.47	16.51	21.20	p<0.001
SD	19	6.12	0.35	5.53	6.72	19	7.07	0.57	6.08	8.13	p<0.001
Bd	19	12.36	0.86	11.07	14.04	19	14.60	1.12	13.03	16.67	p<0.001
Dd	19	7.63	0.44	6.65	8.35	19	9.00	0.68	7.64	10.60	p<0.001
DP	19	16.84	0.82	15.20	18.63	19	19.30	1.65	16.80	22.40	p<0.001
DDL	19	5.92	0.37	5.11	6.71	19	6.89	0.60	5.93	8.08	p<0.001

- Proximal lateral condyle — *Condylus lateralis* (13) — in both species it is narrower at the top/dorsal end and broadens out towards the plantar side. Due to the angle of the lateral aspect, the articulation has an elongated triangular shape. The sides of this elongated triangle stay more parallel in *L. saxatilis* than in *L. capensis* (Figures 4.276 & 4.277).

- Proximal sulcus next to the tuber — *Sulcus extensorius* (22) — in *L. capensis* the medial side next to the tuber is straight. The lateral condyle slopes upward at an acute angle. The sulcus is closed and narrow. In *L. saxatilis* the medial side next to the tuber exhibits a bulge and the side connecting to the lateral condyle slopes up gently. The sulcus is broad and open (Figures 4.276 & 4.277).

- Tuber — *Tuberositas tibea* (24) — in *L. capensis* the tuber protrudes above the condyles. In *L. saxatilis* the tuber stays on the same height as the condyles (Figures 4.276 & 4.277).

- Lateral tuber — *Tuber intercondylare laterale* (21) — in both species it is the complete medial length of the tubercle and exhibits a gradual rise and fall in a half ball shape. The tuber is thickened in *L. capensis* (Figures 4.276 & 4.277).

- Rough area cranial — *Area intercondylaris cranialis* (16) — Schaller (2007) refers to two areas but in these two species only one area can be observed. In *L. capensis* there is a clear division between this area and the sulcus. In *L. saxatilis* there is no rough patch between it and the tuber. There is also no clear division between this area and the sulcus (Figures 4.276 & 4.277).

- The area in between the condyles — *Area intercondylaris centralis* (17) — in *L. capensis* there is a smooth patch of bone in between the condyles. There is also a clear division line between this and — *Margo lateralis* (18). In *L. saxatilis* the area between the condyles is rough textured bone (Figures 4.276 & 4.277).

- In *L. capensis* the two proximal condyles are of equal height. In *L. saxatilis* the lateral condyle is slightly higher than the medial — *Tuberculum intercondylare mediale* (20) (Figures 4.276 & 4.277).

- Tuber — *Tuberositas tibea* (24) — in *L. capensis* it is a clear half-ball shaped muscle attachment. In *L. saxatilis* it is also a half-ball shaped muscle attachment but not as prominent as in *L. capensis* (Figures 4.276 & 4.277).

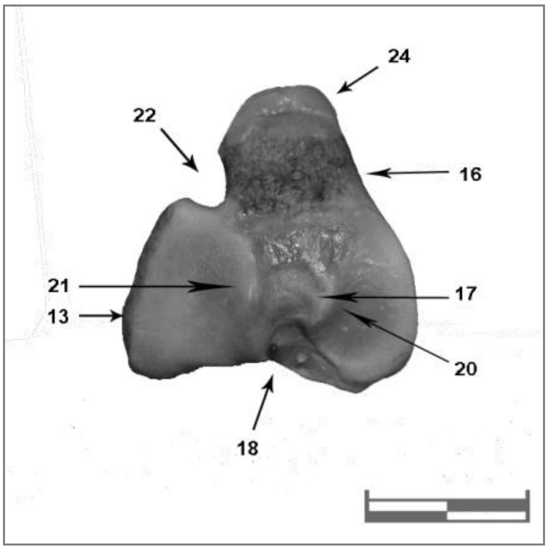


Figure 4.276: *L. capensis* – Tibia proximal view

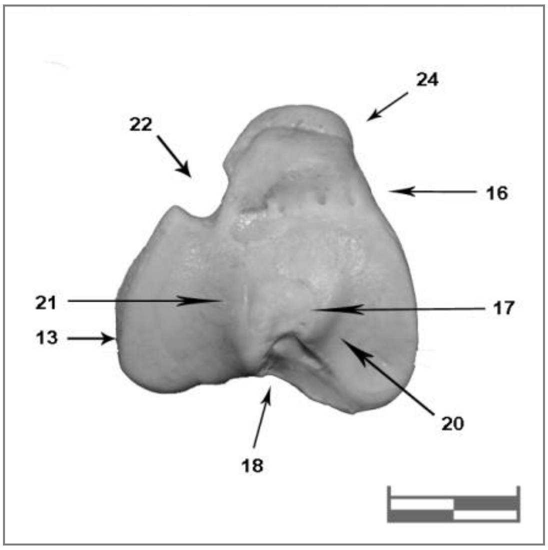


Figure 4.277: *L. saxatilis* – Tibia proximal view

- The line on the plantar side — *Linea m. poplitae* (28) — in *L. capensis* there is one line that curves upwards from the medial shaft upper third toward the middle of the shaft and then proceeds straight up ending in the curve that forms the proximal articulation. In *L. saxatilis* there is one line that curves upwards from the medial shaft upper third towards the lateral surpassing the midline and then curves upwards to end in the base of the proximal articulation (Figures 4.278 & 4.279).

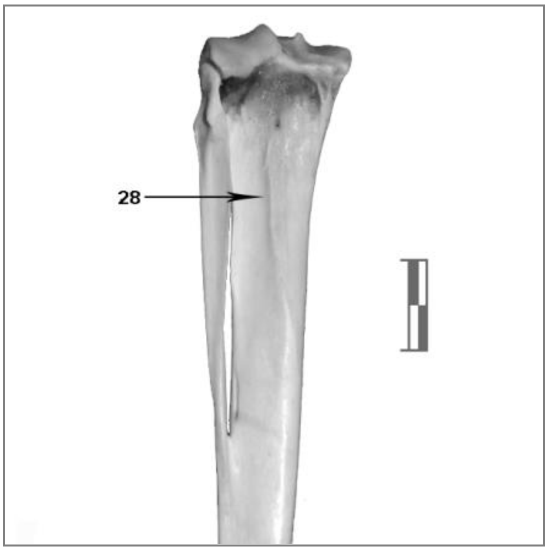


Figure 4.278: *L. capensis* – Tibia plantar view

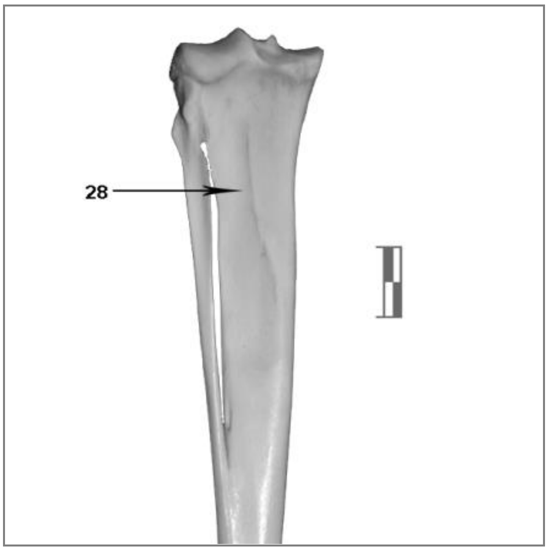


Figure 4.279: *L. saxatilis* – Tibia plantar view

- Tibial crest — *Margo cranialis* (2) — in *L. capensis* the crest gradually forms from about the midshaft but only protrudes from the shaft in the proximal 2/3^{rds} of the shaft. In *L. saxatilis* there is no gradual protrusion from the shaft. The crest immediately protrudes from the proximal 2/3^{rds} of the shaft. In both species the crest remains straight and does not twist to one side. There is a slight overhang towards the lateral side (Figures 4.280 & 4.281).

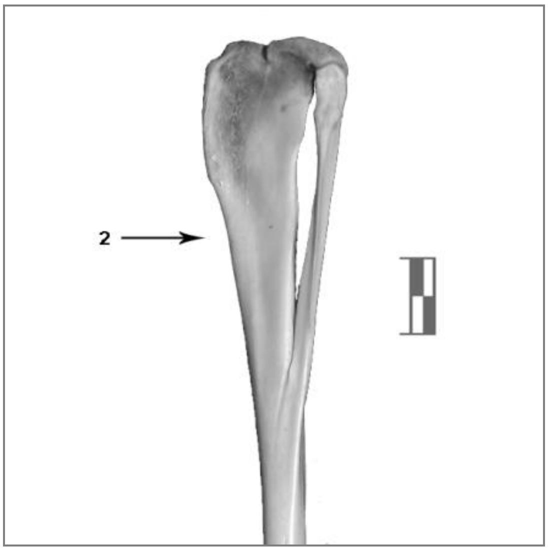


Figure 4.280: *L. capensis* – Tibia lateral view

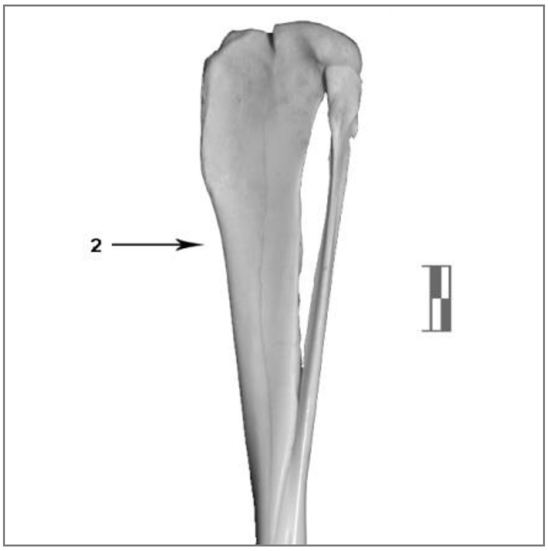


Figure 4.281: *L. saxatilis* – Tibia lateral view

- Medial — *Margo medial* (3) — and lateral — *Margo lateralis* (4) — curve in conjunction with each other. In both species, the shaft of the tibia has an S-curve. Proximally the shaft curves towards the medial and distally towards the medial shaft. The curve distally is more prominent in *L. capensis* than in *L. saxatilis* (Figures 4.282 & 4.283).

Figure 4.282: *L. capensis* – Tibia dorsal view

Figure 4.283: *L. saxatilis* – Tibia dorsal view

- Medial malleolus — *Malleolis ledialis* (6) — in *L. capensis* is not very prominent and the distal medial portion of the articulation is almost in line with the shaft. In *L. saxatilis* it flairs out from the shaft (Figures 4.284 & 4.285).

- In both species there are two very prominent bumps on the distal dorsal shaft. The lowest is placed in the centre and the other slightly higher and more medial. In *L. capensis* the bumps seem to be more prominent than in *L. saxatilis* (Figures 4.284 & 4.285).

- Lateral malleolus — *Malleolus lateralis* (9) — in both species this is part of the distal aspect of the fibula and has completely fused with the tibia. The lateral distal aspect of the articulation protrudes beyond the lateral aspect. In the *L. capensis* the lateral malleolus flares from the shaft. In the *L. saxatilis* the flare is far more dramatic (Figures 4.284 & 4.285).

- When the distal articulation is viewed straight on from the dorsal side in *L. capensis* the medial articulation surface that slopes into the middle of the articulation is almost not visible. In *L. saxatilis* the medial articulation has a very prominent ridge (Figures 4.284 & 4.285).

Figure 4.284: *L. capensis* – Tibia distal dorsal view

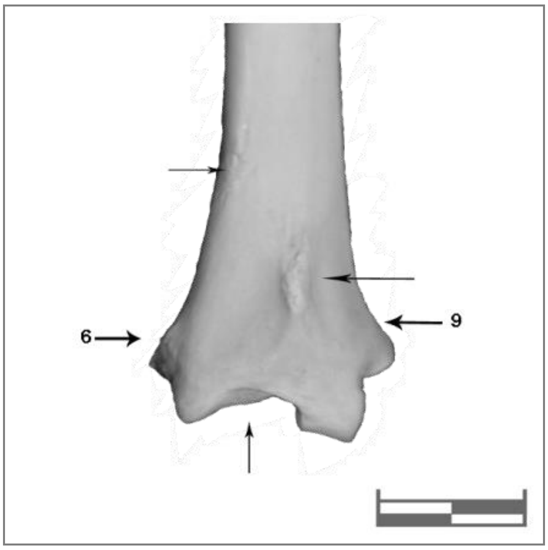


Figure 4.285: *L. saxatilis* – Tibia distal dorsal view

- *Sulcus malleolaris* (7) — in *L. capensis* is present but is not very prominent and is only a thin line. The ridge attachment formed by the sulcus sits below the articulation surface and there is a clear divide between the two. In *L. saxatilis* it is present and prominent as a broad line. The ridge attachment formed by the sulcus sits in line with the articulation surface (Figures 4.286 & 4.287).

- *Sulcus malleolaris* (10) — in *L. capensis* it is a narrow and deep groove. In *L. saxatilis* the groove is broad and deep (Figures 4.286 & 4.287).

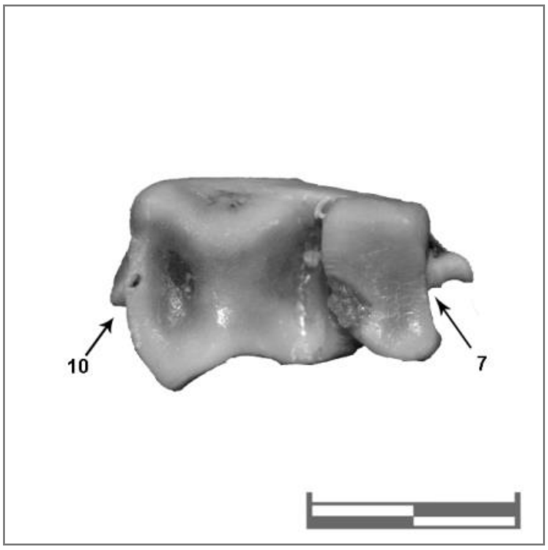


Figure 4.286: *L. capensis* – Tibia distal artic

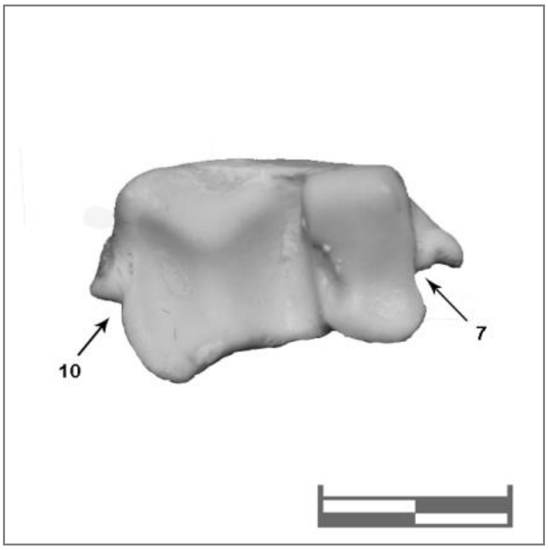


Figure 4.287: *L. saxatilis* – Tibia distal artic

- ❖ In both species the distal lateral articulation flares dorsally. When the articulation is viewed from the plantar side in *L. capensis* the lateral malleolus protrusion is less visible while it is more visible in *L. saxatilis* (Figures 4.288 & 4.289).

Figure 4.288: *L. capensis* – Tibia distal plantar view

Figure 4.289: *L. saxatilis* – Tibia distal plantar view

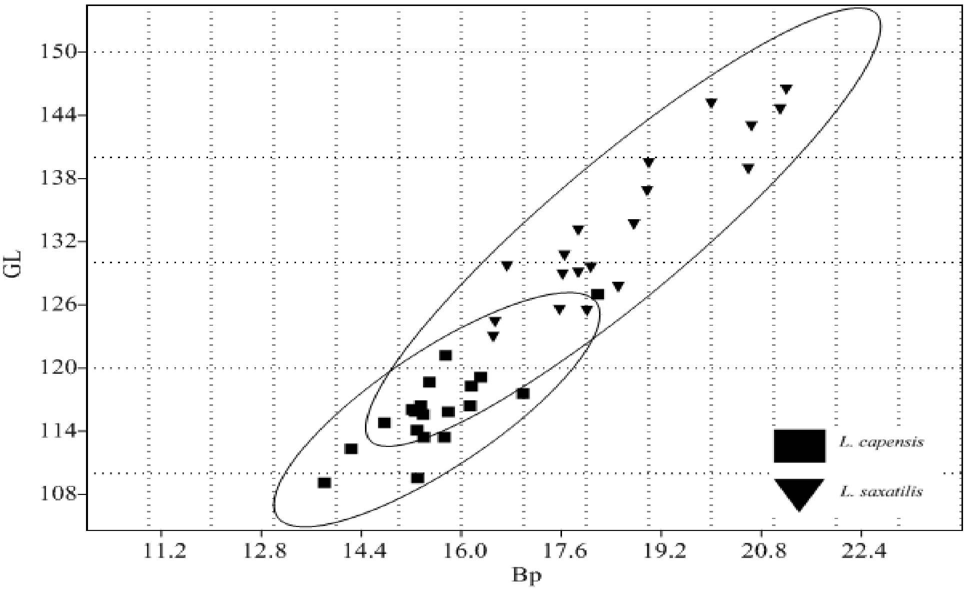


Figure 4.290: Tibia measurement GL – Greatest length vs Bp – Breadth proximal – indicating a high correlation in *L. saxatilis*

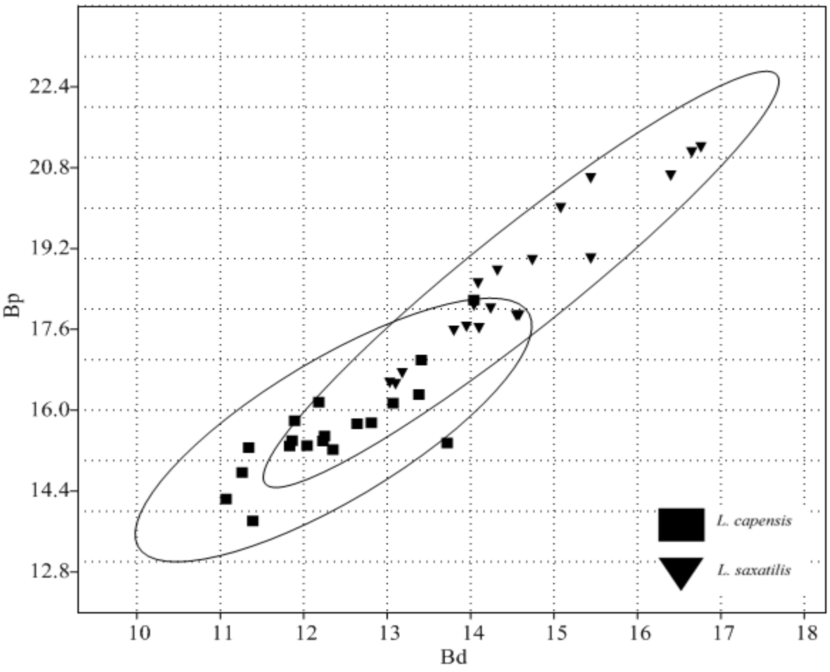


Figure 4.291: Tibia measurement Bp – Breadth proximal vs Bd – Breadth distal end – indicating a high correlation in *L. saxatilis*

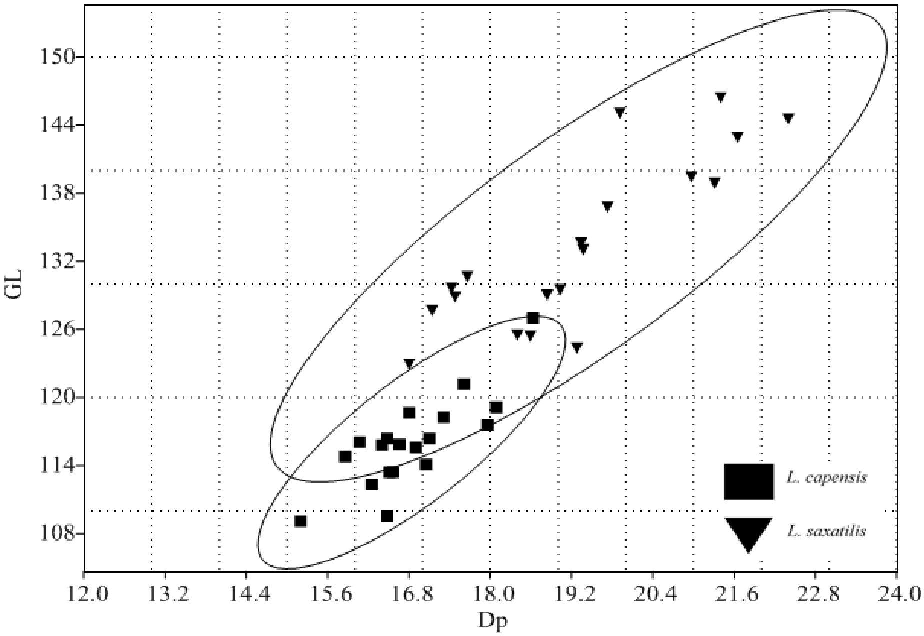


Figure 4.292: Tibia measurements GL – Greatest length vs Dp – Depth of proximal end – indicating a high correlation in *L. capensis*

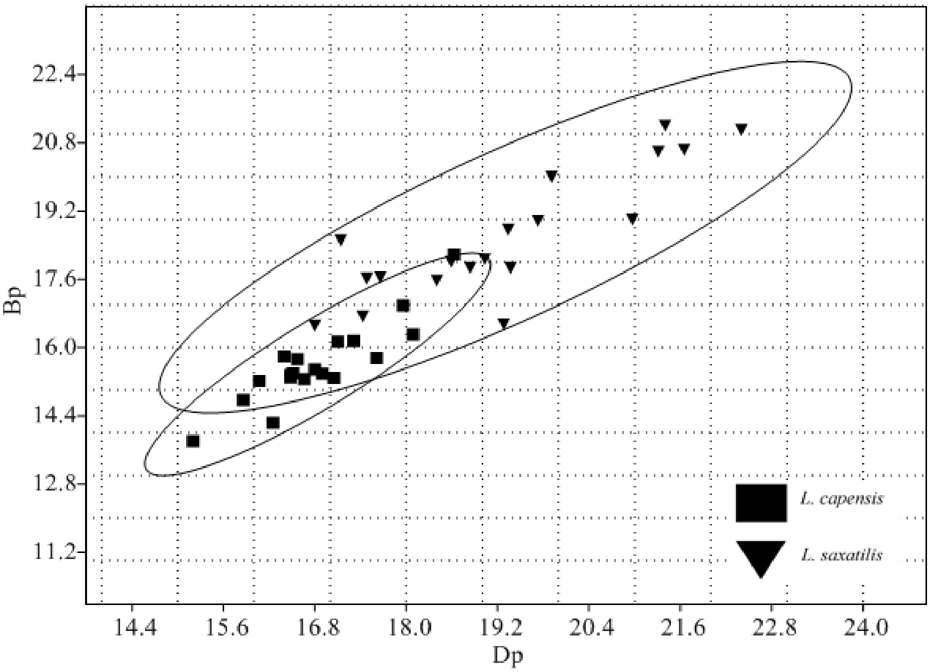


Figure 4.293: Tibia measurement Bp – Breadth proximal vs Dp – Depth of proximal articulation – indicating a high correlation in both species

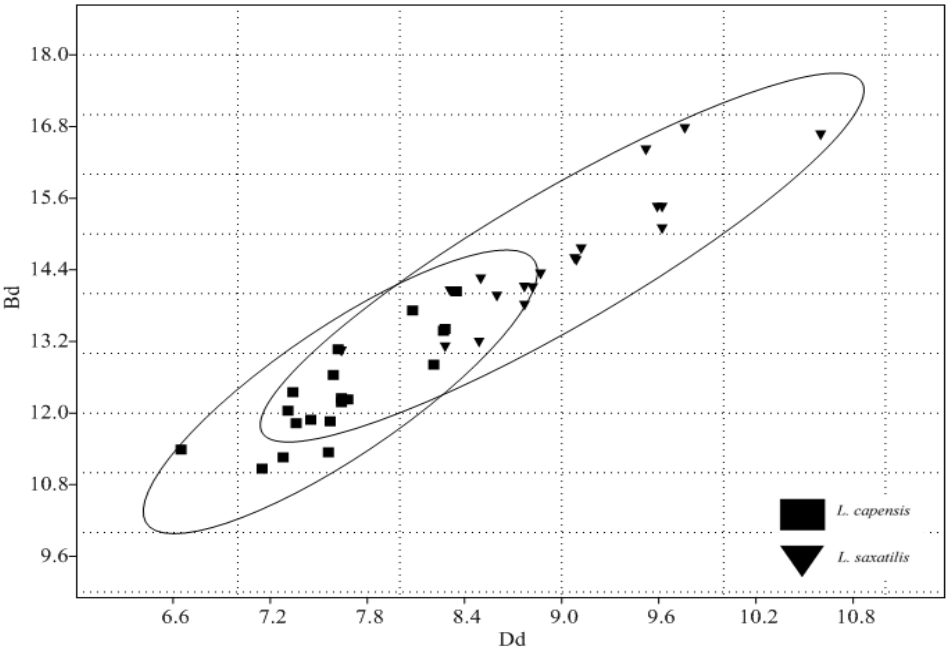


Figure 4.294: Tibia measurement Bd – Breadth distal end vs Dd – Depth of the distal end – showing a high correlation in both species

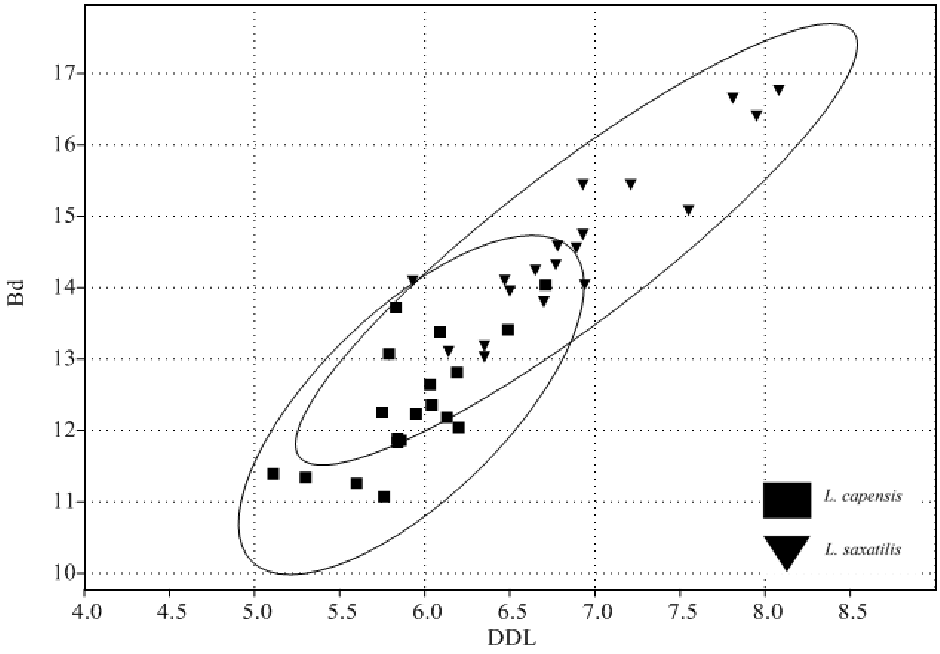


Figure 4.295: Tibia measurement Bd – Breadth of distal end vs DDL – Depth distal lateral facet – showing a high correlation in both species

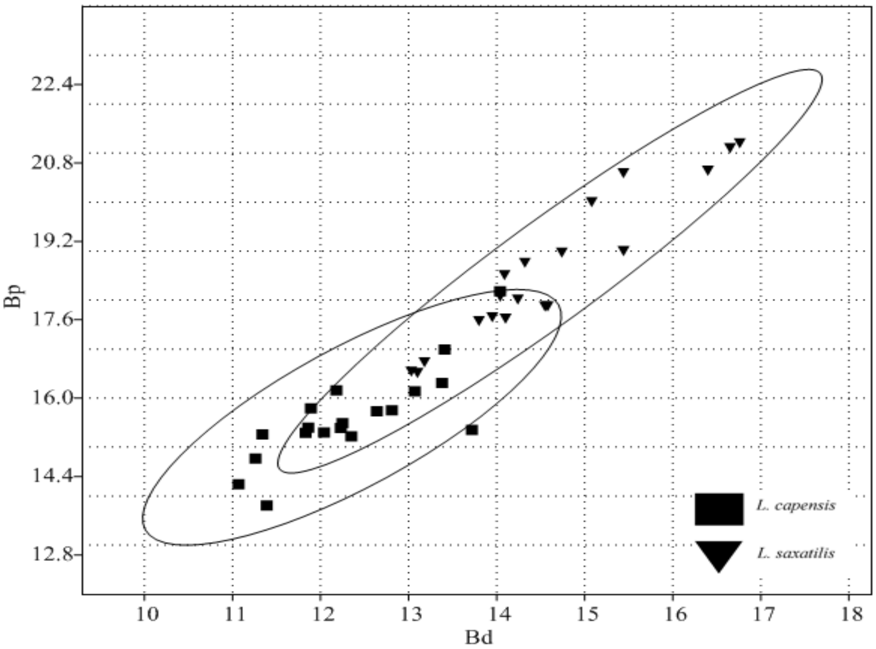


Figure 4.296: Tibia measurement Bp – Breadth of proximal end vs Bd – Breadth of distal end – indicating a high correlation between the two species

Of all the elements, the overlap in the 95% confidence levels observed is the smallest in the tibia measurements GL (Figure 4.297) and DDL (Figure 4.303). The p-values all indicate that the differences in measurements between the two species are all statistically highly significant (Table 4.15). This makes the tibia one of the most diagnostic bones between the two species based on morphometrics. The hind limb distinction can be attributed to the different locomotory habits of the species.

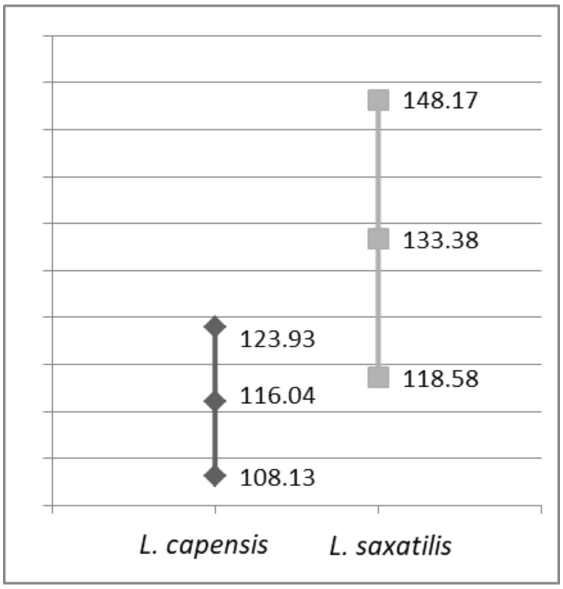


Figure 4.297: Tibia measurement GL – Greatest length. 95% confidence levels upper bound, mean and lower bound values indicated

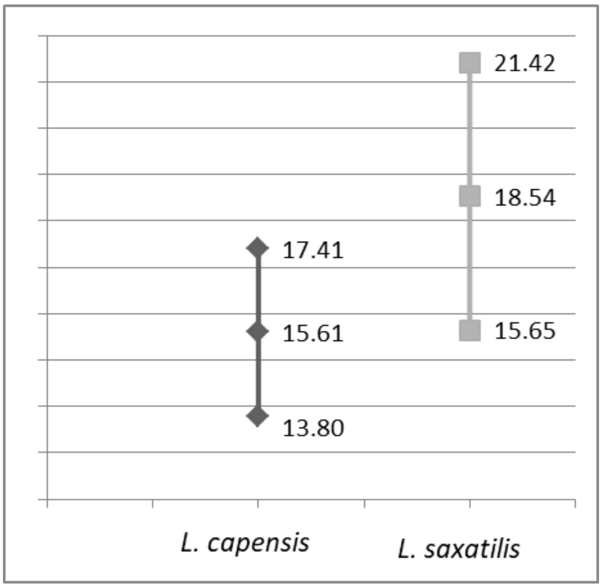


Figure 4.298: Tibia measurement Bp – Breadth proximal end. 95% confidence levels upper bound, mean and lower bound values indicated

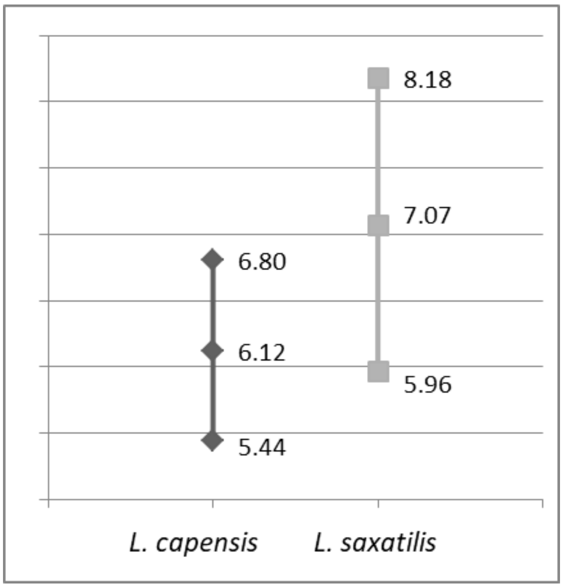


Figure 4.299: Tibia measurement Bd – Breadth of the distal end. 95% confidence levels upper bound, mean and lower bound values indicated

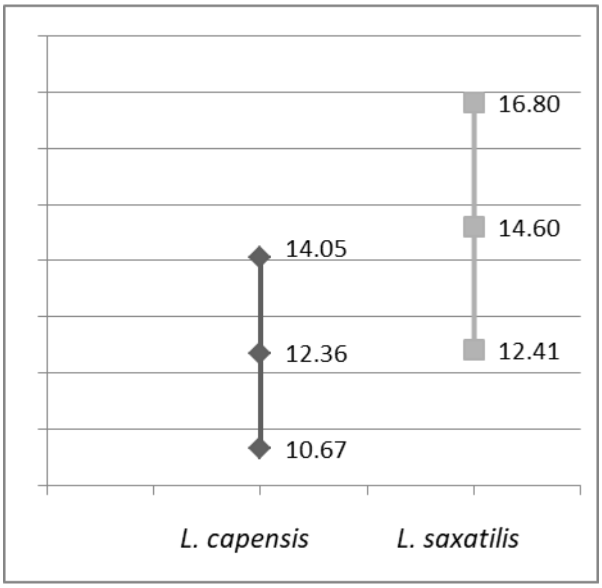


Figure 4.300: Tibia measurement SD – Smallest breadth of the shaft. 95% confidence levels upper bound, mean and lower bound values indicated

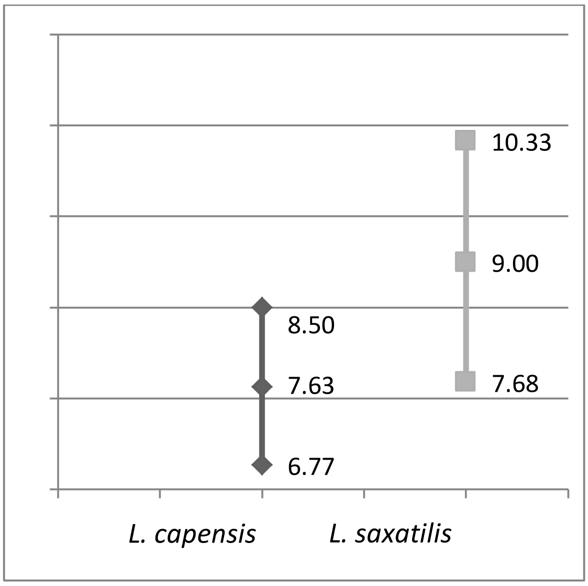


Figure 4.301: Tibia measurement Dd – Depth of distal end. 95% confidence levels upper bound, mean and lower bound values indicated

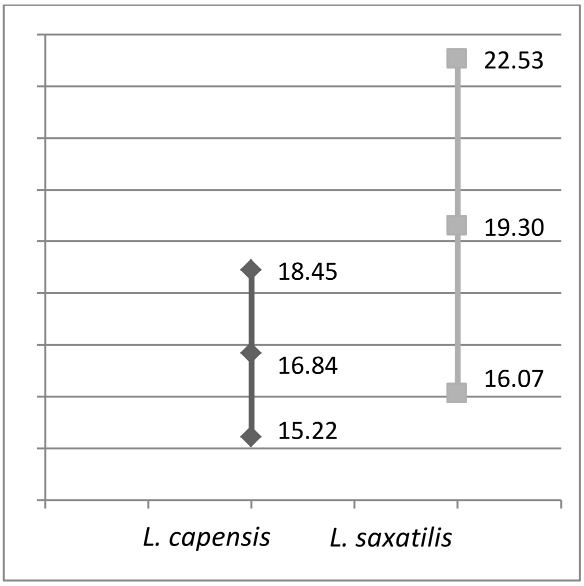


Figure 4.302: Tibia measurement Dp – Depth of proximal articulation. 95% confidence levels upper bound, mean and lower bound values indicated

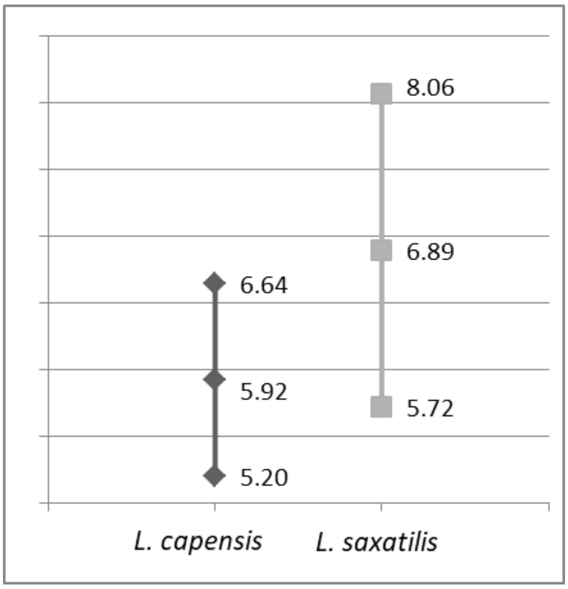


Figure 4.303: Tibia measurement DDL – Depth distal lateral facet. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.14 Element name - Calcaneus

Number of individuals examined: *L. capensis* – 8; *L. saxatilis* – 4

One scatter plot and two box plots for the 95% confidence levels were drawn up for the calcaneus.

Photos of the calcaneus are set at a 1cm scale.

Table 4.16: Calcaneus p-values. All measurements for the calcaneus have no statistical significance

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Calcaneus												
GB	8	8.72	0.67	7.76	9.67		4	9.12	0.77	8.31	9.90	p>0.05
GL	8	27.11	2.11	23.80	30.02		4	26.31	1.76	23.72	27.68	p>0.05

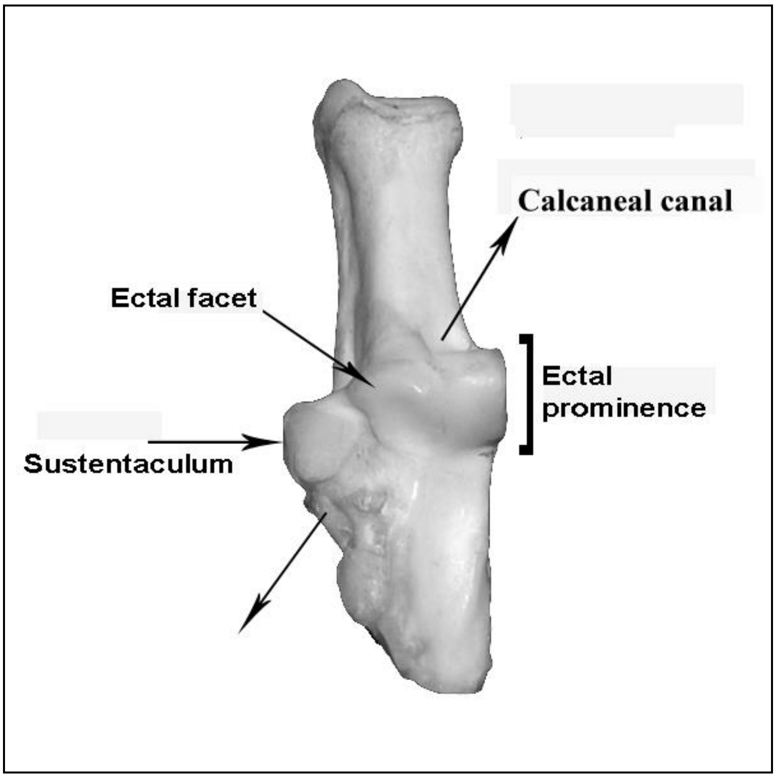


Figure 4.304: Illustrates the unique morphology of the calcaneus

The images in Figure 4.305 – 4.308 show the articulation between the calcaneus and the talus and make the differential morphology as discussed clearer.

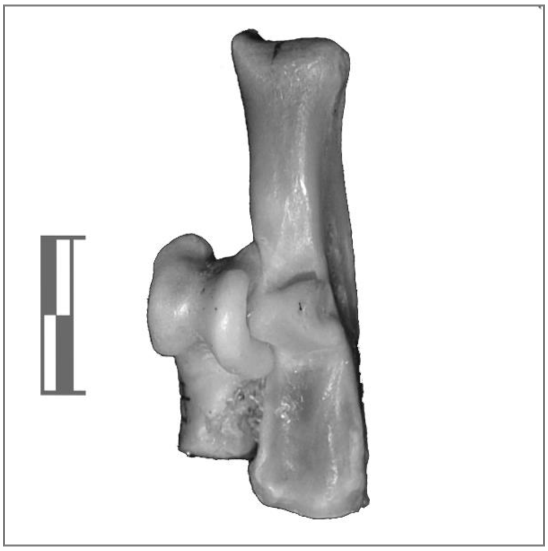


Figure 4.305: Calcaneus and Talus – dorsal view

Figure 4.306: Calcaneus and Talus – plantar view

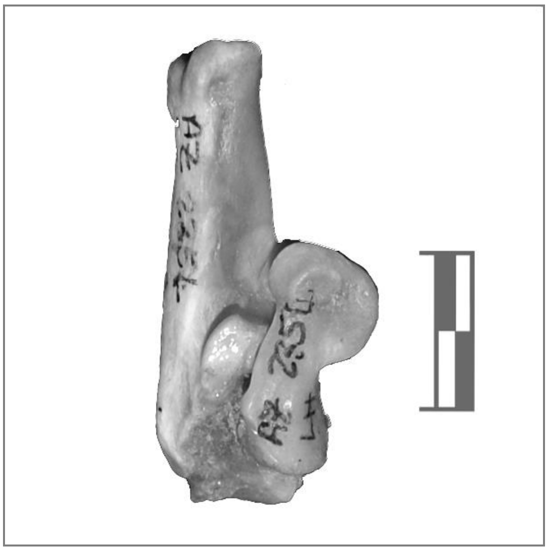


Figure 4.307: Calcaneus and Talus – lateral view

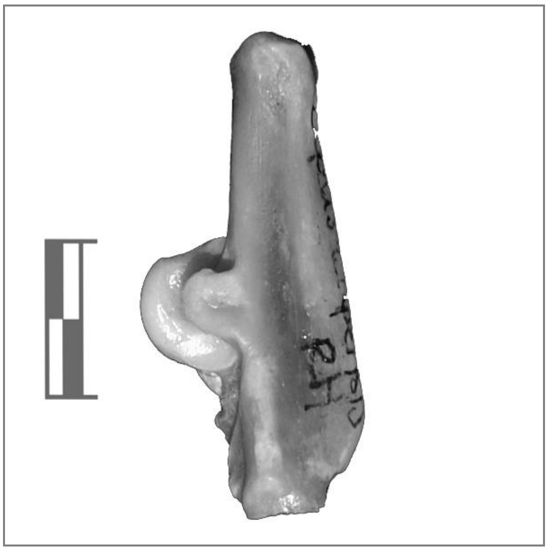


Figure 4.308: Calcaneus and Talus – medial view

❖ *Tuber calcanei* (15) — in both species this is a rectangular articulation surface that slopes medially and rises laterally. The tuber is clearly divided in 1/3rd and 2/3rds and extends down the plantar side. In *L. saxatilis* the tuber extends much further down (Figures 4.309 & 4.310).

❖ *Sulcus tendinis m. flex. Digit lateralis* (18) — in *L. capensis* is neither strong nor deep. In *L. saxatilis* it is both strong and deep (Figures 4.309 & 4.310).

- When the calcaneus is placed on the ectal prominence side and the sustentaculum is seen from above, then the ectal prominence is visible in *L. capensis* whereas in *L. saxatilis* the ectal prominence is superficial or not noticeable (Figures 4.309 & 4.310).

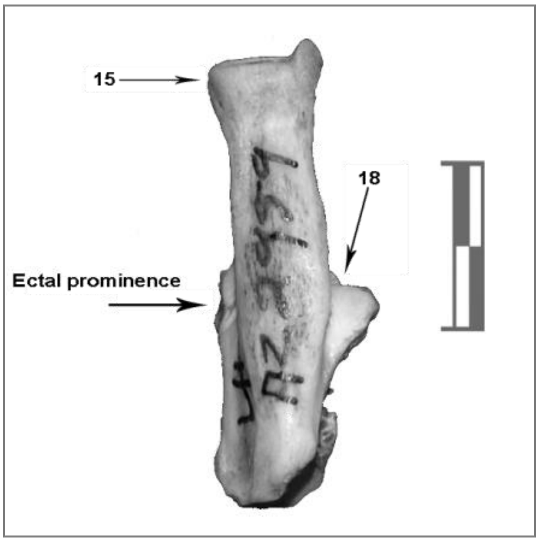


Figure 4.309: *L. capensis* – Calcaneus plantar view

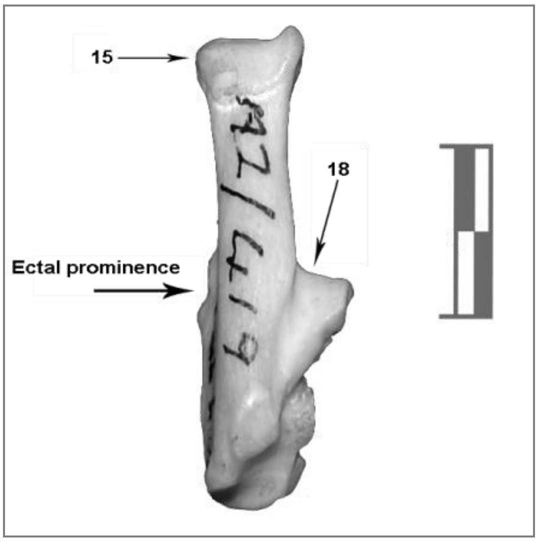


Figure 4.310: *L. saxatilis* – Calcaneus plantar view

- Sustenaculum — *Sustentaculum tali* (17) — in both species it divides into two flat articulation surfaces that are placed at an almost 90° angle to the body. The inner articulation – ectal facet (Bleefeld 2002) in the middle of the calcaneus has a second articulation surface on the top. It is this articulation that corresponds with the deep-set lateral articulation of the talus. In *L. capensis* the outer facet seems to be set more forward and at less of an angle than that of *L. saxatilis*. In *L. saxatilis* the outer facet proximal part curves plantar thus causing the facet to be at an angle (Figure 4.311 & 4.312).

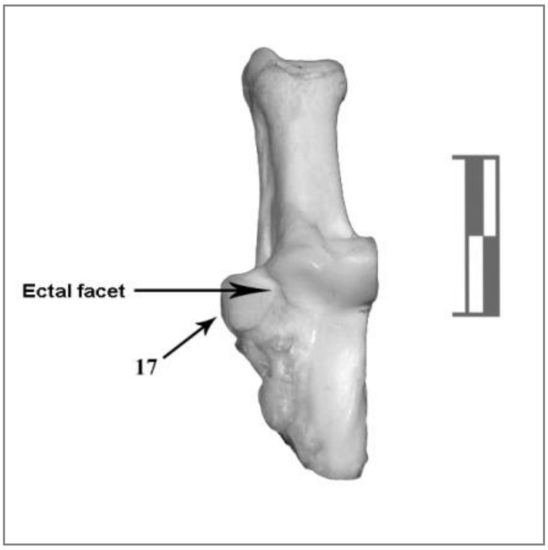


Figure 4.311: *L. capensis* – Calcaneus dorsal view

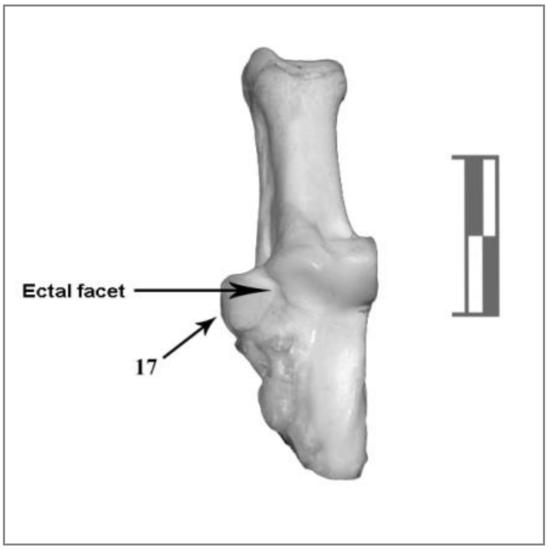


Figure 4.312: *L. saxatilis* – Calcaneus dorsal view

- Bleefeld and Bock (2002) discuss the unique calcaneal canal that runs diagonally through the body of the Lagomorpha calcaneus (Figure 4.304). In Table 4.17 the observed calcaneal canal openings are presented using the same letter system as Bleefeld and Bock (2002).
  - The letters after the specimen number indicate the condition of the calcaneal canal:
  - **L** – large; **R** – reduced; **M** – minute (greatly reduced); **A** – absent (lost); **MO** – multiple openings;
  - The first letter refers to the proximal opening of the calcaneal canal; i.e. **A** = Absent
  - The second letter refers to the distal calcaneal canal opening; i.e. **L** = Large

Table 4.17: Calcaneal canal openings observed

Lepus capensis				***Lepus saxatilis***		
Specimen Number	**Left**	**Right**		**Specimen Number**	**Left**	**Right**
AZ 2922	AL	AL		**AZ 419**	AM	AM
AZ 2959	AL			**AZ 511**	A – the end is not visible due to articulation	A – the end is not visible due to articulation
TM 33802	AA			**AZ 1791**	A the end is not visible	AL
NMBF 9881	AL			**TM 41151**	AM	AM
NMBF 2891	AM	AM				
NMBF 9893	AL	AL				
NMBF 9901	AL	AL				
NMBF 9910	AR	AL				

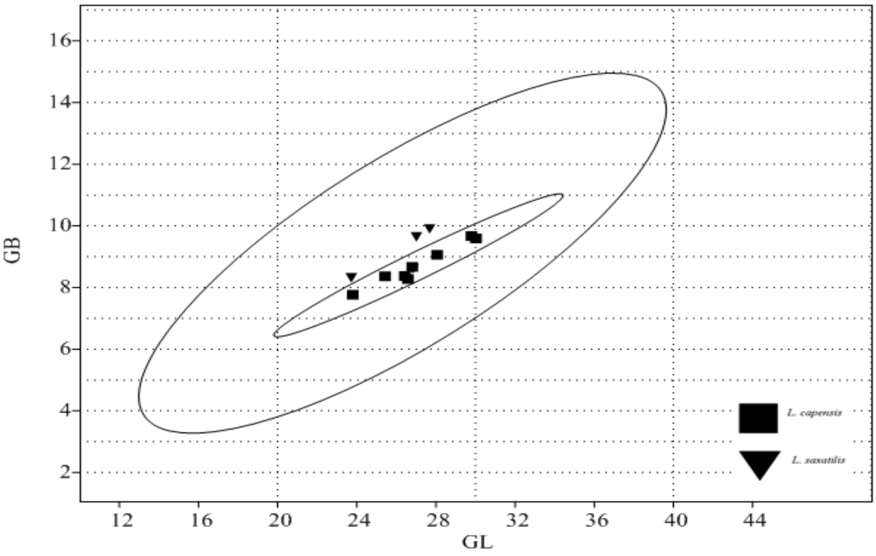


Figure 4.313: Calcaneus measurement GB – Greatest breath vs GL – Greatest length is difficult to interpret due to the small sample size although it seems that there is a progression in the species

This overlap is evident in the 95% confidence levels and in the p-values (Table 4.16). It is interesting to note that where the *L. saxatilis* has consistently been longer than the *L. capensis* on almost every element, the GL - greatest length measurement - of the calcaneus indicates the *L. capensis* to be the longer of the two (Figure 4.314).

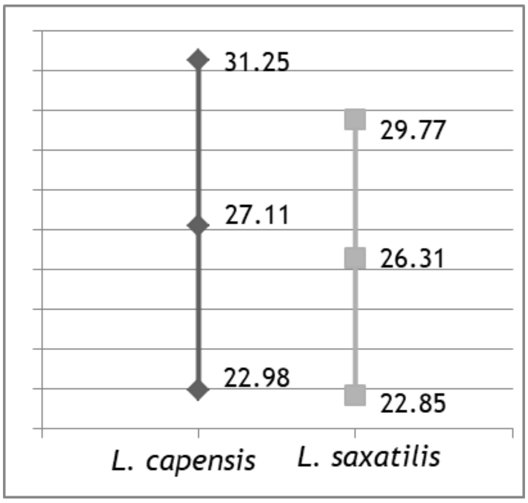


Figure 4.314: Calcaneus measurement GL – Greatest length. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.15 Element name - Talus

Minimum number of individuals examined: *L. capensis* – 7; *L. saxatilis* – 5

One scatter plot and two box plots for the 95% confidence levels were drawn up for the talus.

Photos of the talus are set at a 1cm scale.

Table 4.18: Talus p-values. All measurements for the talus have no statistical significance

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
Talus												
GL	8	13.06	1.22	11.27	14.85		5	12.70	1.11	10.95	13.68	p>0.05
DC	8	6.71	0.57	5.76	7.34		5	6.26	0.13	6.16	6.48	p>0.05

- In *L. capensis* there is a smaller and more indented medial surface that articulates to the calcaneus. In *L. saxatilis* this medial surface is large (Figures 4.315 & 4.316).

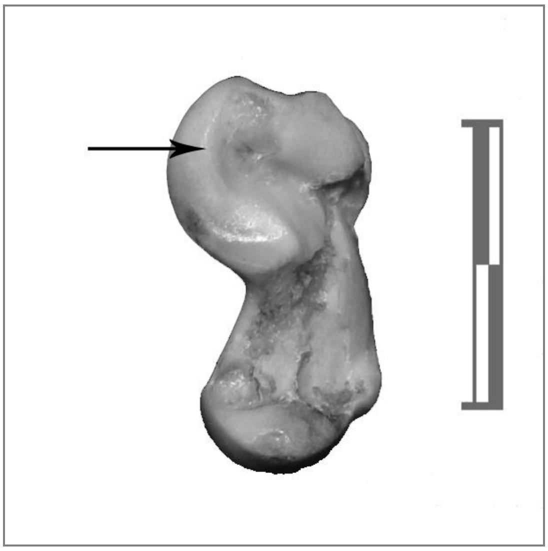


Figure 4.315: *L. capensis* – Talus medial view

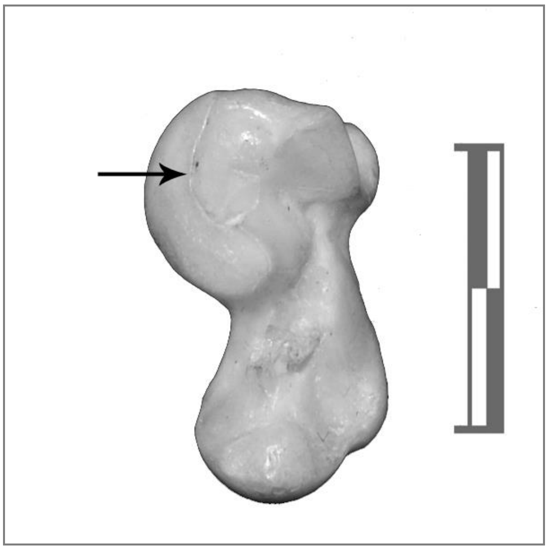


Figure 4.316: *L. saxatilis* – Talus medial view

- *Caput tali* (4) — in *L. capensis* the rounded articulation surface — *Facies articulates navicularis* (12) — that articulates with the tarsals comes to a rounded curve. The facet broadens out and then sharply tapers to connect with the plantar articulation surface. In *L. saxatilis* it is a rounded articulation surface that comes to a point dorsally. It broadens out much more than in *L. capensis* and then gradually tapers to connect with the plantar articulation surface (Figures 4.317 & 4.318).

- Neck — *Collum tali* (5) — is prominent in both species. In the *L. capensis* the neck is slender and less robust (for muscle attachments) than in *L. saxatilis* (Figures 4.317 & 4.318).

- Body and trochlea — *Corpus tali* (6) and *Trochlea tali* (7) — in *L. capensis* the medial articulation exhibits a bulge to accommodate a strong ligament attachment. The medial ridge of the trochlea seems to curve inwards. In *L. saxatilis* the medial side of the trochlea exhibits a shallow depression. The medial ridge of the trochlea is straight (Figures 4.317 & 4.318).

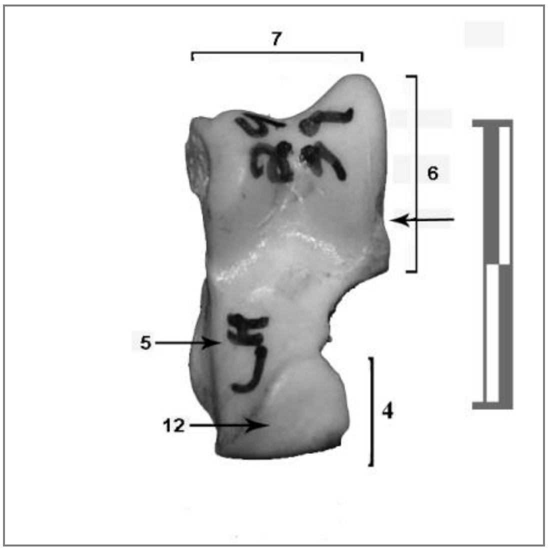


Figure 4.317: *L. capensis* – Talus dorsal view

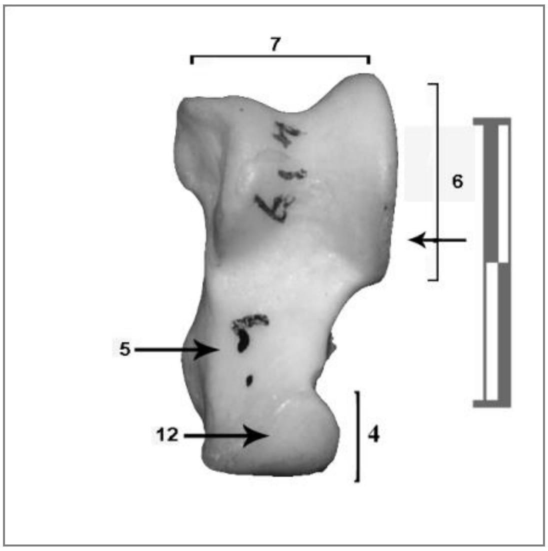


Figure 4.318: *L. saxatilis* – Talus dorsal view

- The lateral surface of the trochlea in both species is a deep-set ligament attachment. This articulation is much smaller in *L. capensis* than in *L. saxatilis* (Figures 4.319 & 4.320).

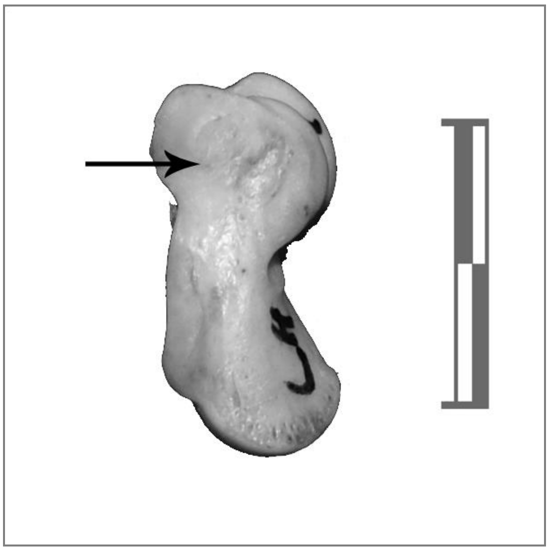


Figure 4.319: *L. capensis* – Talus lateral view

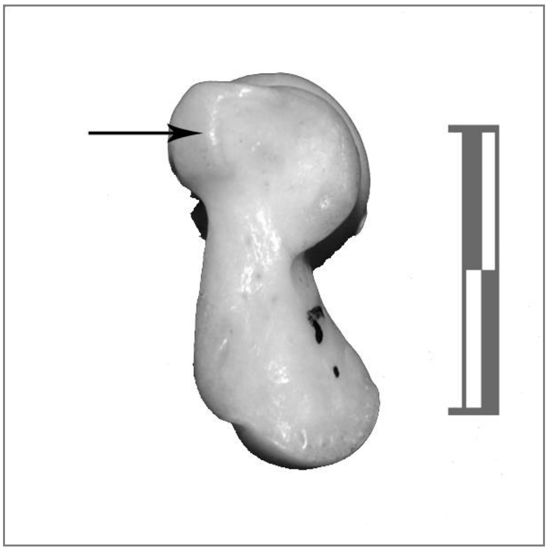


Figure 4.320: *L. saxatilis* – Talus lateral view

GL vs DC is difficult to interpret on account of the small sample size. It appears that there is a progression in *L. capensis* and a clustering in *L. saxatilis* (Figure 4.321).

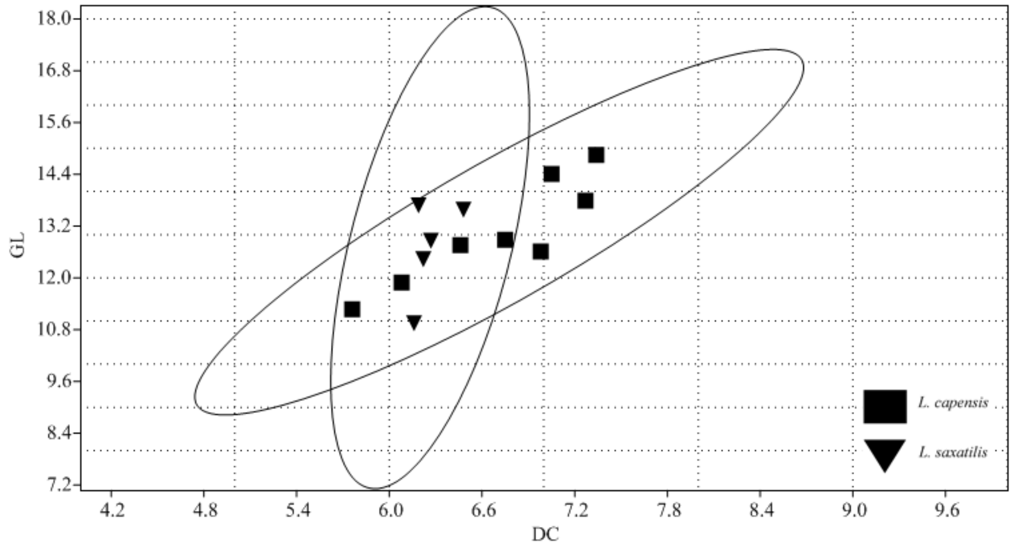


Figure 4.321: Talus measurement GL – Greatest length vs DC – Depth of the condyles

This overlap is evident in the 95% confidence levels and in the p-values that show no statistical significance (Table 4.18). There is almost no difference in the GL (Figure 4.322). As with the calcaneus, the talus of *L. capensis* is the longer of the two species. In the depth of the condyles (DC), there is overlap by *L. saxatilis* in the lower ranges of the *L. capensis* (Figure 4.323). While this hints at a possible species difference, any conclusions will be speculative in view of the small sample size.

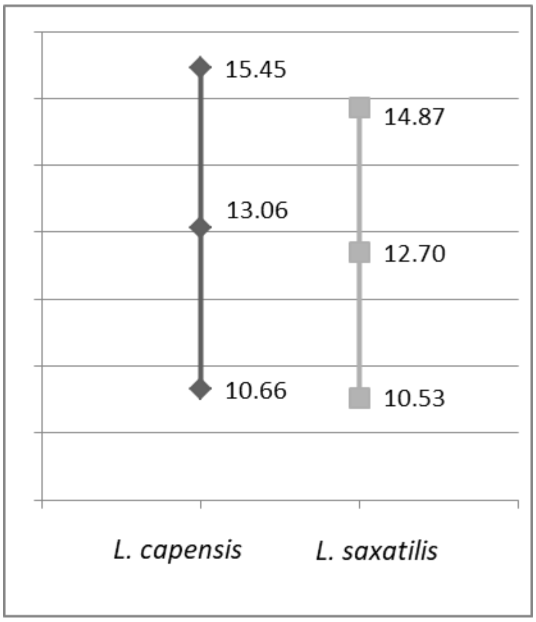


Figure 4.322: Talus measurement GL – Greatest length. 95% confidence levels upper bound, mean and lower bound values indicated

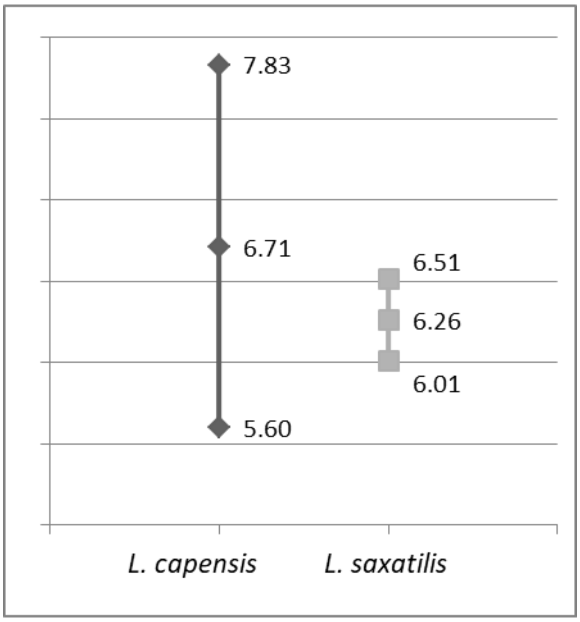


Figure 4.323: Talus measurement DC – Depth of condyle. 95% confidence levels upper bound, mean and lower bound values indicated

4.2.16 Element name - Metatarsal

Minimum number of individuals examined: *L. capensis* – 8; *L. saxatilis* – 2

The measurements comprise all specimens measured including the sub-adults. This decision was taken due to the small sample size. The reasons for the small samples size are discussed in Chapter 3.

A total of 16 box plots were drawn up, four per metatarsal, for each metacarpal's 95% confidence levels.

Photos of the metacarpals are set at a 1cm scale. Some images were greatly enlarged to make the morphology visible thus no scale was included.

Table 4.19: Metatarsals I – IV p-values. Due to the small sample size, none of the measurements proved to be statistically significant

Element/ Measure-ment	***Lepus capensis***						***Lepus saxatilis***					**p-value**
	n	**Mean**	**SD**	**min.**	**max.**		***n***	**Mean**	**SD**	**min.**	**max.**	
MT I												
GL	8	42.84	2.63	38.73	45.63		2	42.32	4.14	39.39	45.24	p>0.05
Bd	8	4.72	0.53	4.24	5.60		2	4.50	0.71	3.99	5.00	p>0.05
Dp	8	6.71	0.61	6.11	7.64		2	5.47	2.41	3.76	7.17	p>0.05
BP	8	4.02	0.38	3.58	4.65		2	5.23	1.34	4.28	6.18	p>0.05
MT II												
GL	8	43.69	3.34	36.58	46.64		2	43.70	4.48	40.53	46.86	p>0.05
Bd	8	4.59	0.57	4.13	5.65		2	4.50	0.79	3.94	5.06	p>0.05
Dp	8	7.07	0.49	6.51	7.79		2	6.79	1.04	6.05	7.52	p>0.05
BP	8	4.30	0.39	3.86	4.96		2	4.07	0.09	4.00	4.13	p>0.05
MT III												
GL	8	42.22	2.23	38.42	45.01		2	42.28	3.90	39.52	45.04	p>0.05
Bd	8	4.42	0.55	3.96	5.39		2	4.41	0.68	3.93	4.89	p>0.05
Dp	8	6.38	0.36	5.88	6.91		2	5.98	0.66	5.51	6.45	p>0.05
BP	8	4.59	0.62	3.80	5.60		2	4.40	0.14	4.30	4.50	p>0.05
MT IV												
GL	8	37.78	2.03	34.65	40.06		2	37.46	4.02	34.61	40.30	p>0.05
Bd	8	3.88	0.43	3.48	4.69		2	3.83	0.71	3.33	4.33	p>0.05
Dp	8	5.71	0.67	5.07	6.72		2	5.45	0.76	4.91	5.98	p>0.05
BP	8	5.92	0.66	4.82	6.86		2	5.77	1.11	4.98	6.55	p>0.05

In both species the MT I, II, III and IV articulate securely, forming an almost flat surface with MT I's protrusion forming the highest point (Figures 4.324 & 4.325).

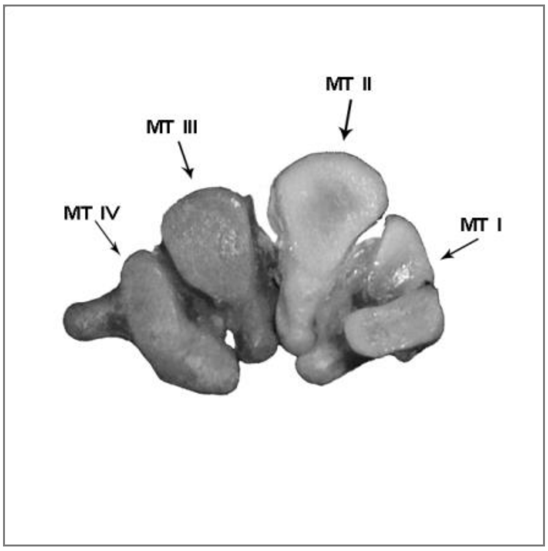


Figure 4.324: *L. capensis* – Metatarsal articulation

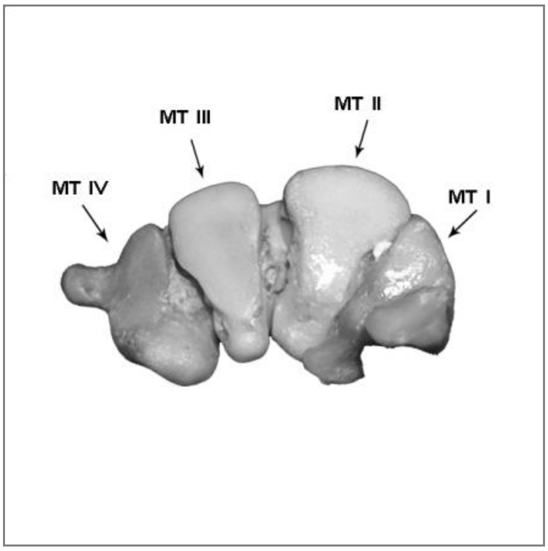


Figure 4.325: *L. saxatilis* – Metatarsal articulation

Metatarsal I

- ❖ Proximal end and articulation surface — *Basis* (2) — and — *Facies articularis* (3) — is triangular in shape with a prominent articulation groove for the MT II plantar protrusion. The articulation is an open triangle with a medial rise ending in a squarish/rectangular articulation in *L. capensis* and in a flat oval in *L. saxatilis*. There is a prominent division between the lateral protrusion and the rest of the articulation surface. The articulation facet sits on top of the MT II articulation (Figures 4.326 & 4.327; Figures 4.228 & 4.329; Figures 4.330 & 4.331; Figures 4.332 & 4.333; Figures 4.334 & 4.335).

- ❖ Body — *Corpus* (4) — is flat on the lateral side where it articulates to the MT II. The remainder of the shaft is D-shaped, rounding out towards the distal shaft after about midway (Figures 4.326 & 4.327; Figures 4.228 & 4.329; Figures 4.330 & 4.331; Figures 4.332 & 4.333).

- ❖ Dorsal surface — *Facies dorsalis* (5) — is round with a slight proximal curve laterally (Figures 4.326 & 4.327).

- Plantar surface — *Facies plantaris* (7) — is round with a slight proximal curve laterally (Figures 4.238 & 4.329)

- Lateral border — *Margo lateralis* (9) — is flat and rounding out towards the distal. The shaft curves medially (Figures 4.330 & 4.331)

- Medial border — *Margo medialis* (8) — is round and forms the 'crest' of the triangle. It extends smoothly up into the medial proximal protrusion and exhibits strong muscle and ligament attachments (Figures 4.332 & 4.333)

- Distal articulation — *Caput* (10) — is divided into two with a bone ridge (Figures 4.326 & 4.327; Figures 4.238 & 4.329; Figures 4.330 & 4.331; Figures 4.332 & 4.333)

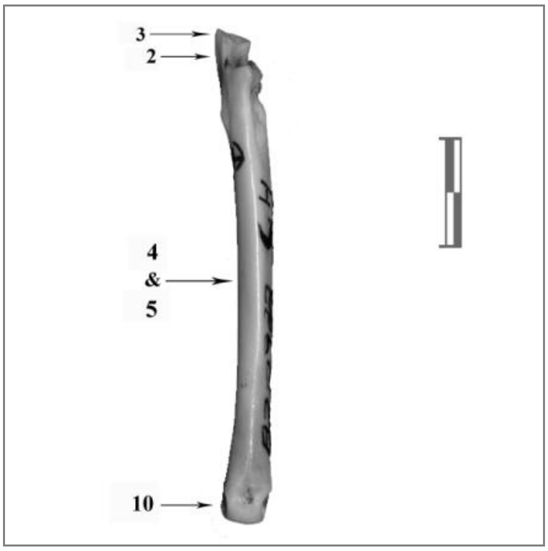


Figure 4.326: *L. capensis* – Metatarsal I dorsal view

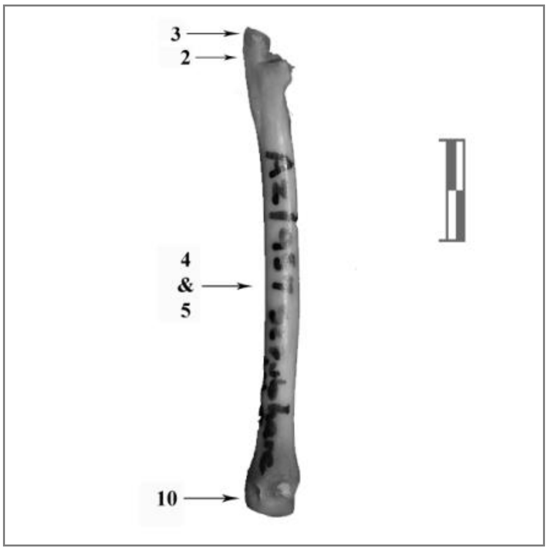


Figure 4.327: *L. saxatilis* – Metatarsal I dorsal view

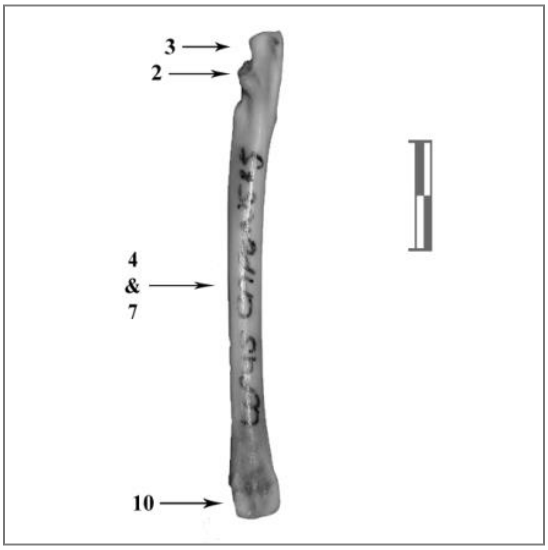


Figure 4.328: *L. capensis* – Metatarsal I plantar view

Figure 4.329: *L. saxatilis* – Metatarsal I plantar view

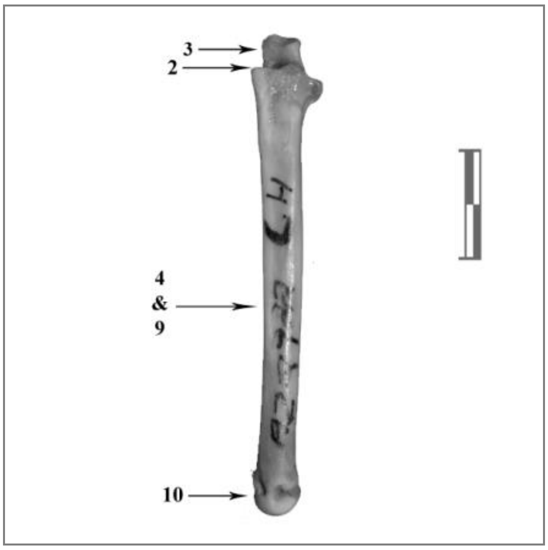


Figure 4.330: *L. capensis* – Metatarsal I lateral view

Figure 4.331: *L. saxatilis* – Metatarsal I lateral view

Figure 4.332: *L. capensis* – Metatarsal I medial view

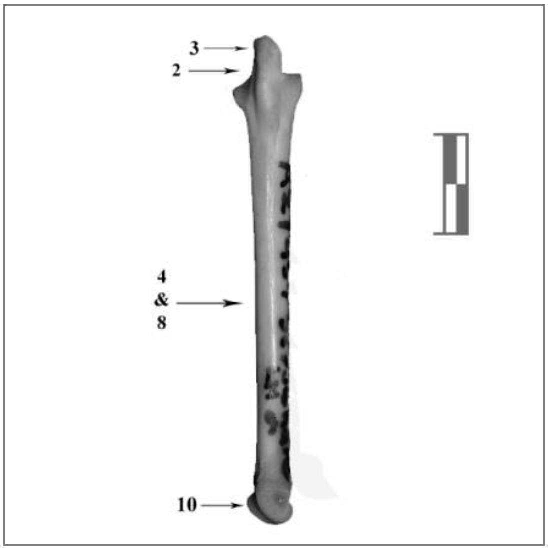


Figure 4.333: *L. saxatilis* – Metatarsal I medial view

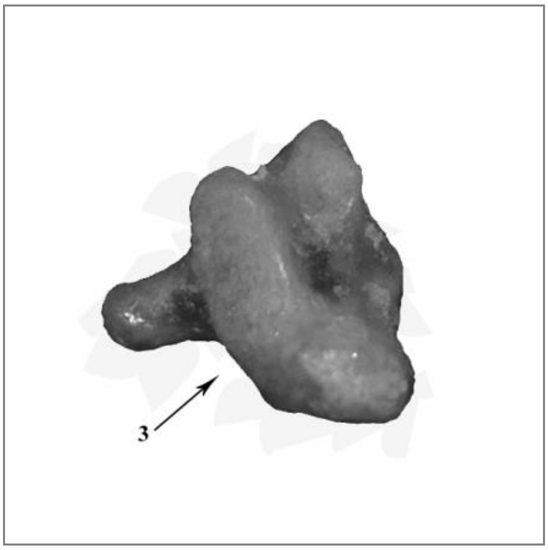


Figure 4.334: *L. capensis* – Metatarsal I proximal articulation

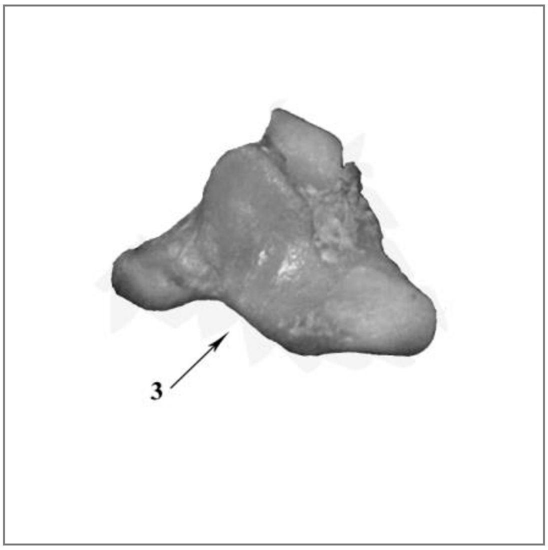


Figure 4.335: *L. saxatilis* – Metatarsal I proximal articulation

Metatarsal II

- The proximal end and articulation surface — *Basis* (2) — and — *Facies articularis* (3) — is triangular in shape in keeping with the shaft and the articulation. The articulation is triangular in shape with the base of the triangle dorsal and the point plantar. It is this point that articulates on MT I in *L. capensis.* The point is not as prominent as in *L. saxatilis*. The point curves medially as if to wrap around the shaft of MT I (Figures

4.336 & 4.337; Figures 4.338 & 4.339; Figures 4.340 & 4.341; Figures 4.342 & 4.343; Figures 4.344 & 4.345).

- Body — *Corpus* (4) — is straight (Figures 4.336 & 4.337; Figures 4.338 & 4.339; Figures 4.340 & 4.341; Figures 4.342 & 4.343).

- Dorsal surface — *Facies dorsalis* (5) — is round (Figures 4.336 & 4.337).

- Plantar surface — *Facies plantaris* (7) — is round and tapers proximally to form the point discussed (Figures 4.338 & 4.339).

- Lateral border — *Margo lateralis* (9) — is distally round and flattens out proximally to form the triangle. The proximal shaft just under the articulation is a deep indent running the entire width of the shaft (Figures 4.340 & 4.341).

- Medial border — *Margo medialis* (8) — is distally round and flattens out proximally to form the triangle (Figures 4.342 & 4.343).

- Distal articulation — *Caput* (10) — is strongly developed articulation divided into two with a bone ridge (Figures 4.336 & 4.337; Figures 4.338 & 4.339; Figures 4.340 & 4.341; Figures 4.342 & 4.343).

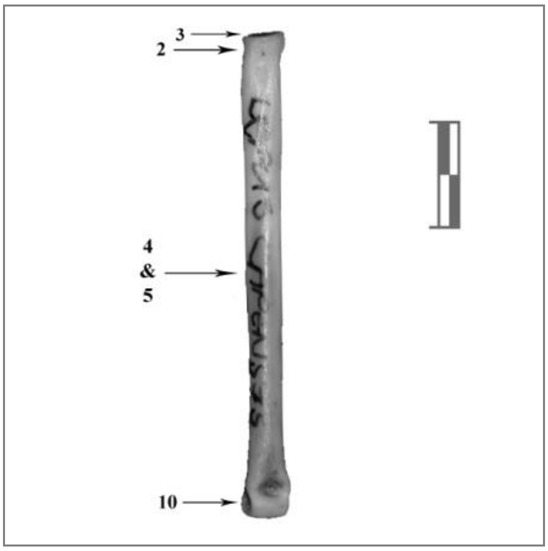


Figure 4.336: *L. capensis* – Metatarsal II dorsal view

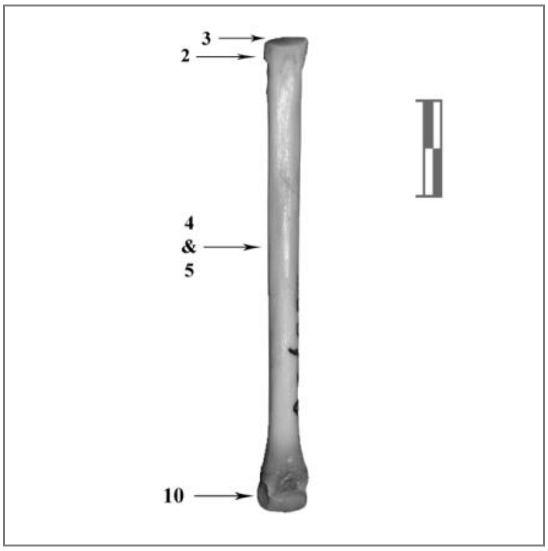


Figure 4.337: *L. saxatilis* – Metatarsal II dorsal view

Figure 4.338: *L. capensis* – Metatarsal II plantar view

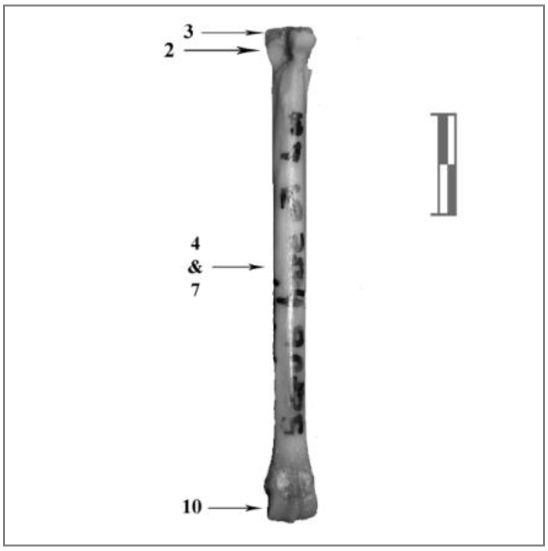


Figure 4.339: *L. saxatilis* – Metatarsal II plantar view

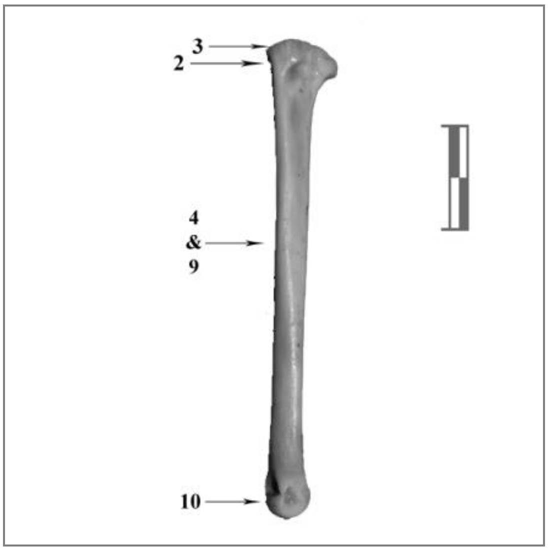


Figure 4.340: *L. capensis* – Metatarsal II lateral view

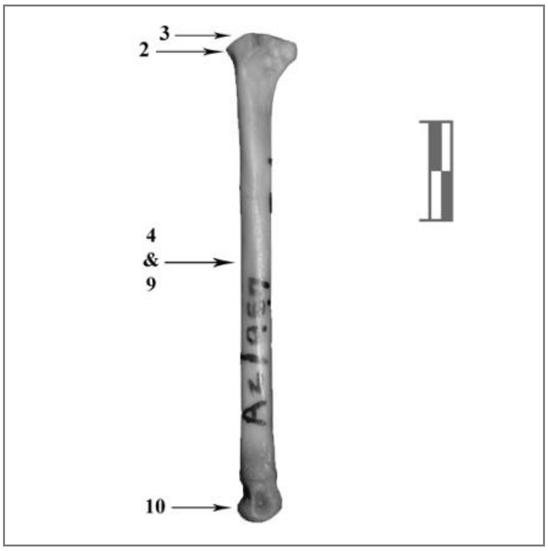


Figure 4.341: *L. saxatilis* – Metatarsal II lateral view

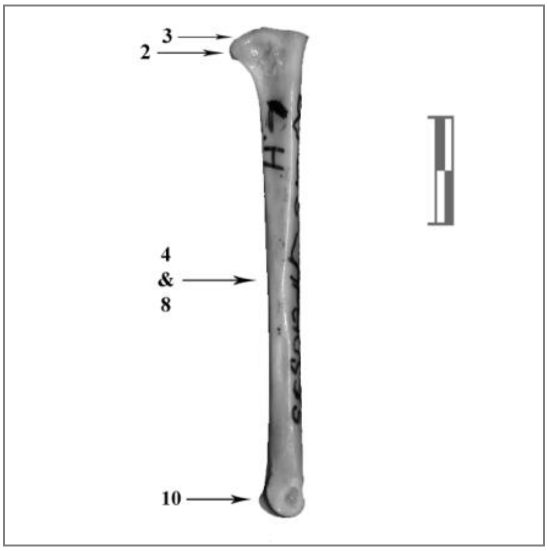


Figure 4.342: *L. capensis* – Metatarsal II medial view

Figure 4.343: *L. saxatilis* – Metatarsal II medial view

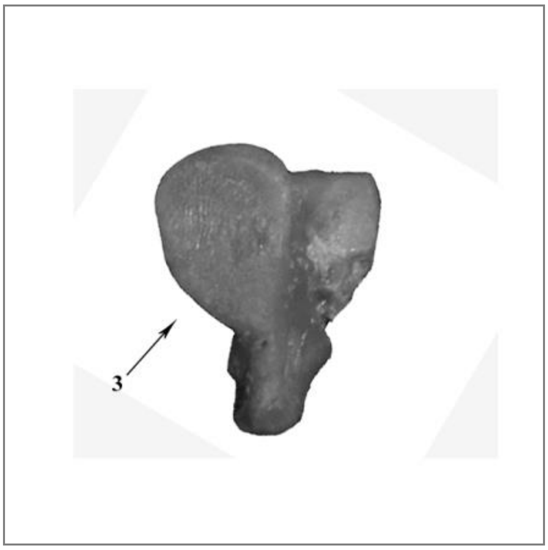


Figure 4.344: *L. capensis* – Metatarsal II proximal articulation

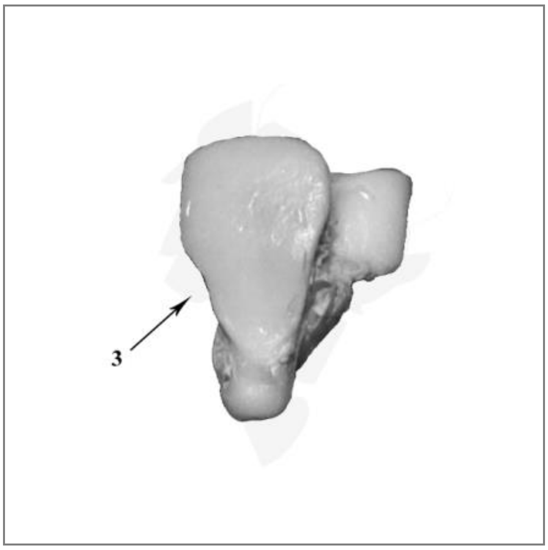


Figure 4.345: *L. saxatilis* – Metatarsal II proximal articulation

Metatarsal III

- The proximal end and articulation surface — *Basis* (2) — and — *Facies articularis* (3) — is square to the touch with a lateral curve. The articulation sits at an angle laterally to the shaft and is roughly triangular in shape. There is a second articulation on the medial side that is bulbous and fits into the lateral proximal deep indent of MT II. The main articulation in *L. capensis* is much rounder and flatter than in *L. saxatilis*. In *L. capensis* there is a clear division between the articulation facet and the protruding tip palmar (Figures 4.346 & 4.347; Figures 4.348 & 4.349; Figures 4.350 & 4.351; Figures 4.352 & 4.353; Figures 4.354 & 4.355).

- Body — *Corpus* (4) — is straight (Figures 4.346 & 4.347; Figures 4.348 & 4.349; Figures 4.350 & 4.351; Figures 4.352 & 4.353).

- Dorsal surface — *Facies dorsalis* (5) — is straight and flat proximally. It does become more rounded distally (Figures 4.346 & 4.347).

- Plantar surface — *Facies plantaris* (7) — is round with a prominent muscle attachment proximally (Figures 4.348 & 4.349).

- Lateral border — *Margo lateralis* (9) — is distally round and flattens out proximally (Figures 4.350 & 4.351).

- Medial border — *Margo medialis* (8) — is distally round and flattens out proximally (Figures 4.352 & 4.353).

- Distal articulation — *Caput* (10) — is strongly developed articulation divided into two with a bone ridge (Figures 4.346 & 4.347; Figures 4.348 & 4.349; Figures 4.350 & 4.351; Figures 4.352 & 4.353).

Figure 4.346: *L. capensis* – Metatarsal III dorsal view

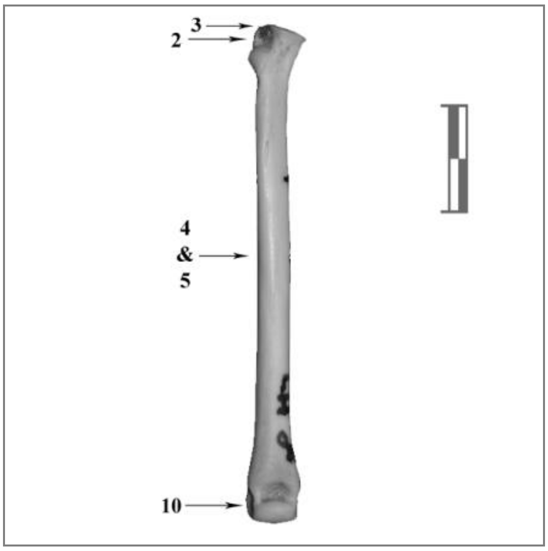


Figure 4.347: *L. saxatilis* – Metatarsal III dorsal view

Figure 4.348: *L. capensis* – Metatarsal III plantar view

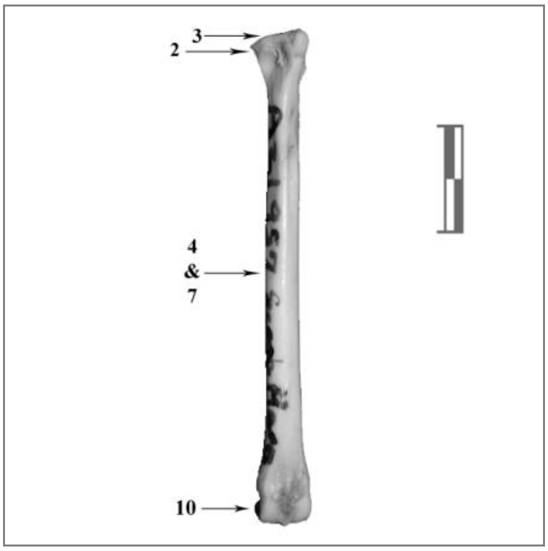


Figure 4.349: *L. saxatilis* – Metatarsal III plantar view

Figure 4.350: *L. capensis* – Metatarsal III lateral view

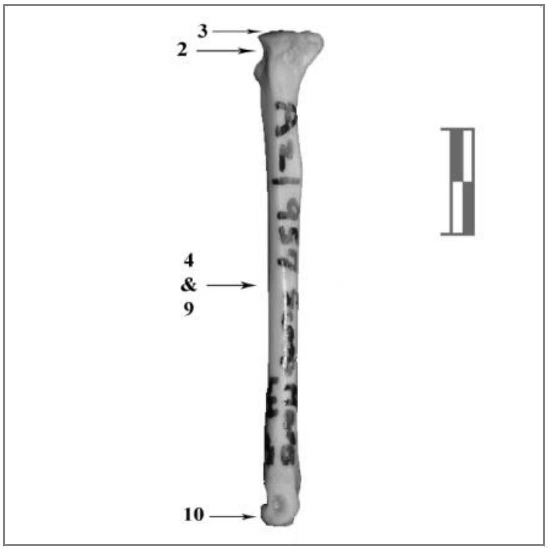


Figure 4.351: *L. saxatilis* – Metatarsal III lateral view

Figure 4.352: *L. capensis* – Metatarsal III medial view

Figure 4.353: *L. saxatilis* – Metatarsal III medial view

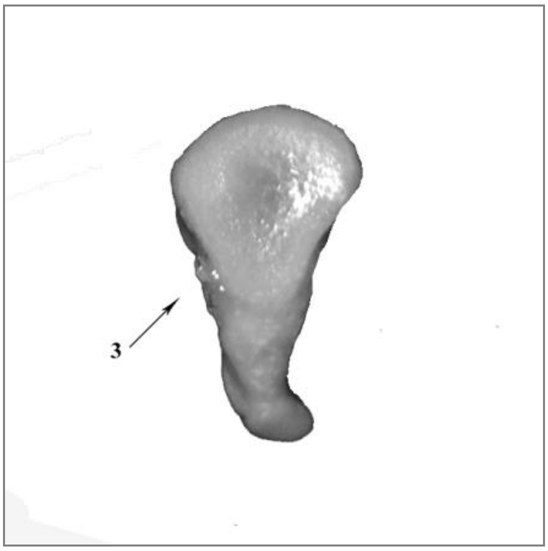


Figure 4.354: *L. capensis* – Metatarsal III proximal articulation

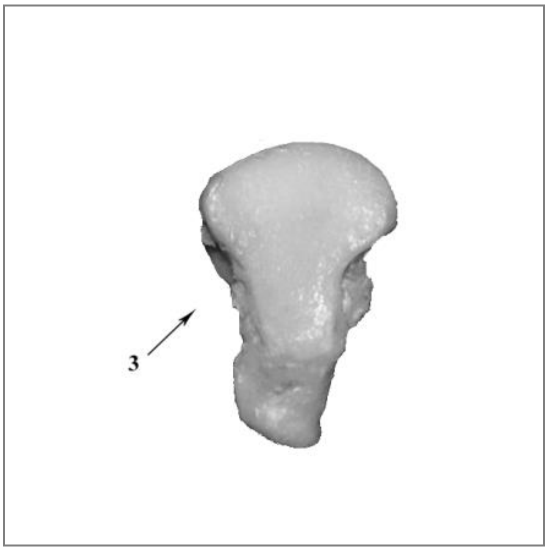


Figure 4.355: *L. saxatilis* – Metatarsal III proximal articulation

Metatarsal IV

- The proximal end and articulation surface — *Basis* (2) — and — *Facies articularis* (3) — is triangularly shaped with a flair to the medial side that forms a prominent point. The articulation surface runs at an angle and slants towards the lateral edge with an area that extends up the dorsal rise. There is a clear distinction between the articulation surface and the lateral protrusion. In *L. capensis* the articulation is smaller and more elongated than in *L. saxatilis*. It also rises higher when viewed from the lateral side and protrudes further palmar (Figures 4.356 & 4.357; Figures 4.358 & 4.359; Figures 4.360 & 4.361; Figures 4.362 & 4.363; Figures 4.364 & 4.365).

- Body — *Corpus* (4) — is flat on the lateral side where it articulates to the MT III and the remainder is D-shaped (Figures 4.356 & 4.357; Figures 4.358 & 4.359; Figures 4.360 & 4.361; Figures 4.362 & 4.363).

- Dorsal surface — *Facies dorsalis* (5) — is rounded and straight with a slight curve proximal laterally (Figures 4.356 & 4.357).

- Palmar surface — *Facies plantaris* (7) — is rounded and straight with a slight curve proximal laterally (Figures 4.358 & 4.359).

- Lateral border — *Margo lateralis* (9) — is distally round and almost tapers to a ridge to form the protuberance (Figures 4.360 & 4.361).

- Medial border — *Margo medialis* (8) — is distally round and flattens out proximally (Figures 4.362 & 4.363).

- Distal articulation — *Caput* (10) — is strongly developed articulation divided into two with a bone ridge (Figures 4.356 & 4.357; Figures 4.358 & 4.359; Figures 4.360 & 4.361; Figures 4.362 & 4.363).

Figure 4.356: *L. capensis* – Metatarsal IV dorsal view

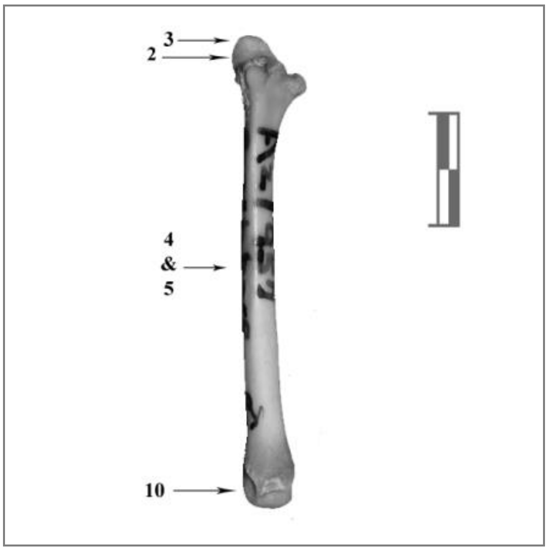


Figure 4.357: *L. saxatilis* – Metatarsal IV dorsal view

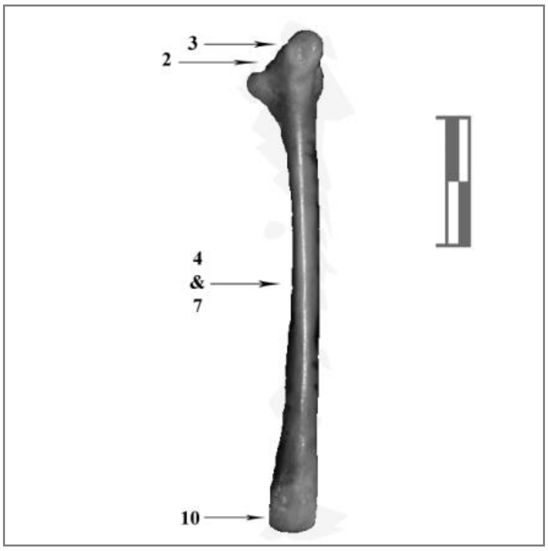


Figure 4.358: *L. capensis* – Metatarsal IV plantar view

Figure 4.359: *L. saxatilis* – Metatarsal IV plantar view

Figure 4.360: *L. capensis* – Metatarsal IV lateral view

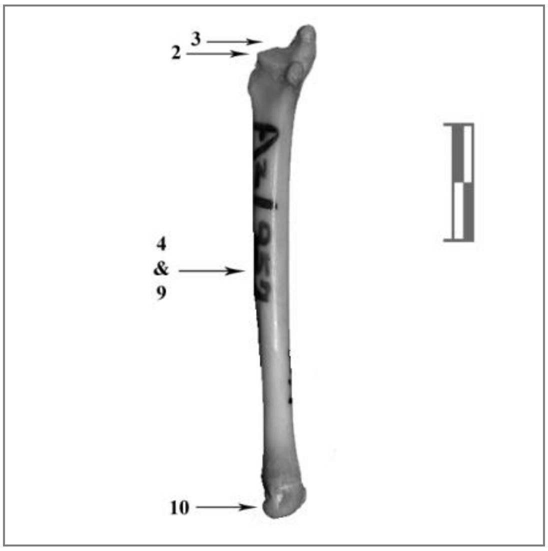


Figure 4.361: *L. saxatilis* – Metatarsal IV lateral view

Figure 4.362: *L. capensis* – Metatarsal IV medial view

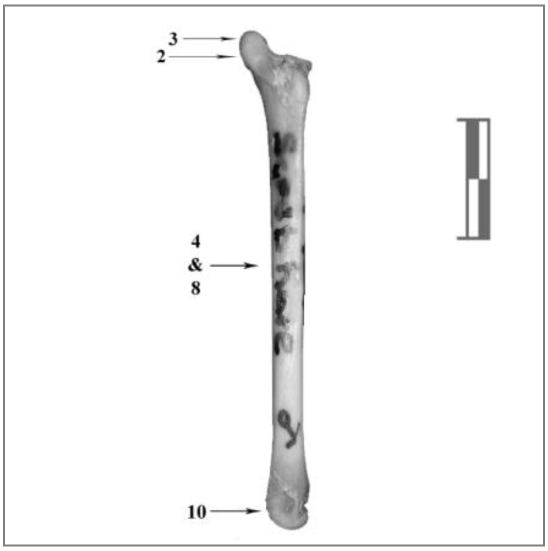


Figure 4.363: *L. saxatilis* – Metatarsal IV medial view

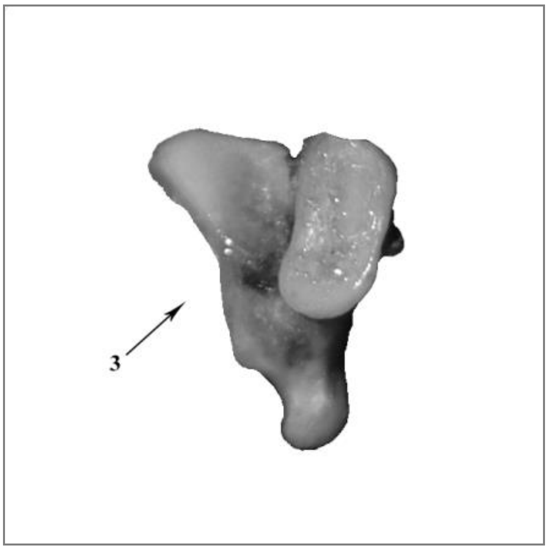


Figure 4.364: *L. capensis* – Metatarsal IV proximal articulation

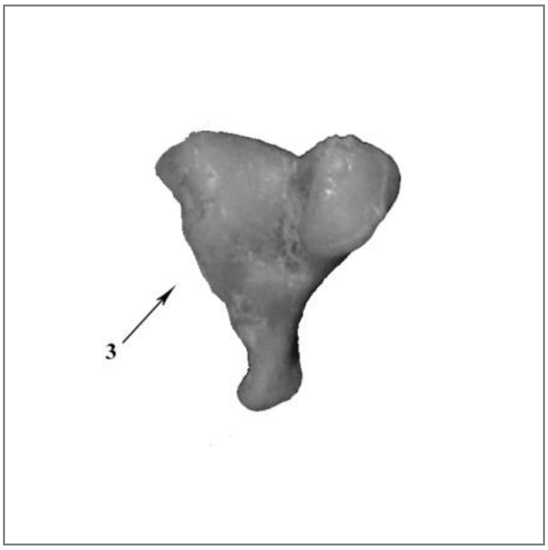


Figure 4.365: *L. saxatilis* – Metatarsal IV proximal articulation

Scatter plots and 95% confidence levels, coupled with the p-values (Tables 4.19), indicate that there are no significant differences between the two species. In measurements MT I Bd (Figure 4.366), MT III Dp (Figure 4.370), MT IV Dp (Figure 4.372), *L.* capensis exhibits the same top margin as *L. saxatilis.* In measurements MT I Dp (Figure 4.367); MT I Bp (Figure 4.368), *L. capensis* falls in the middle of the *L. saxatilis* range. In measurements MT II Bp (Figure 4.369); MT III Bp (Figure 4.371), the reverse is the case and *L. saxatilis* falls in the middle of the *L. capensis* range. Due to the small sample size the observation speculative. The differences in locomotory habits of these two species could be a possible explanation.

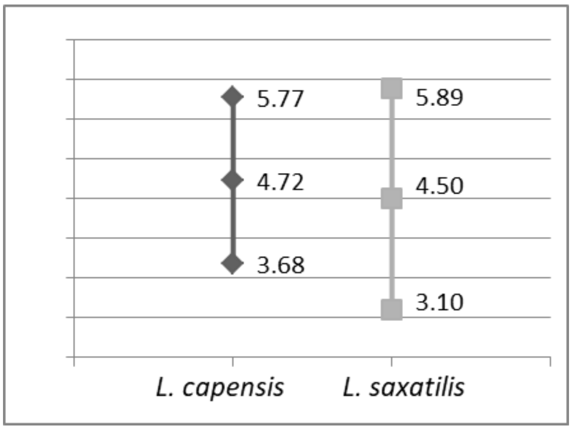


Figure 4.366: Metatarsal I measurement Bd – Breadth distal. 95% confidence levels upper bound, mean and lower bound values indicated

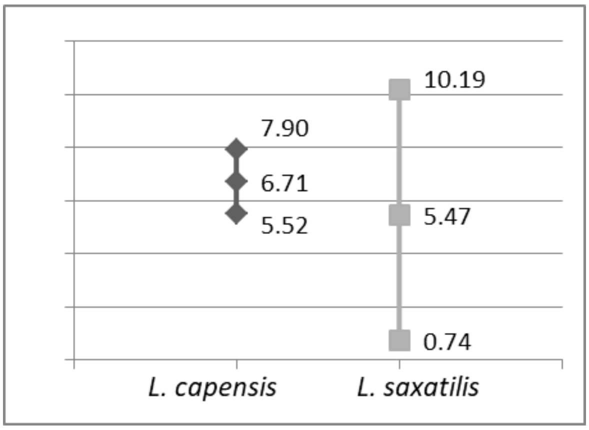


Figure 4.367: Metatarsal I measurement Dp – Depth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

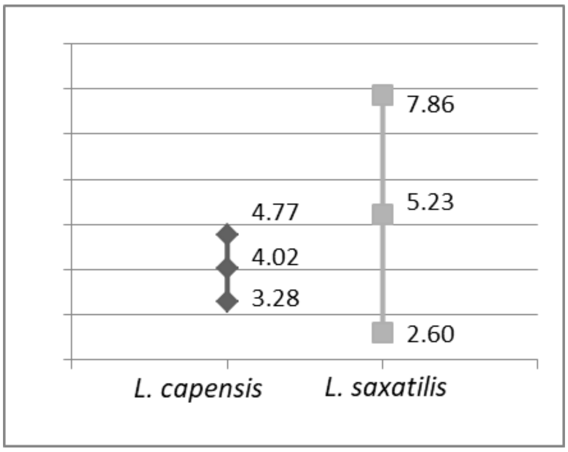


Figure 4.368: Metatarsal I measurement Bp – Breadth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

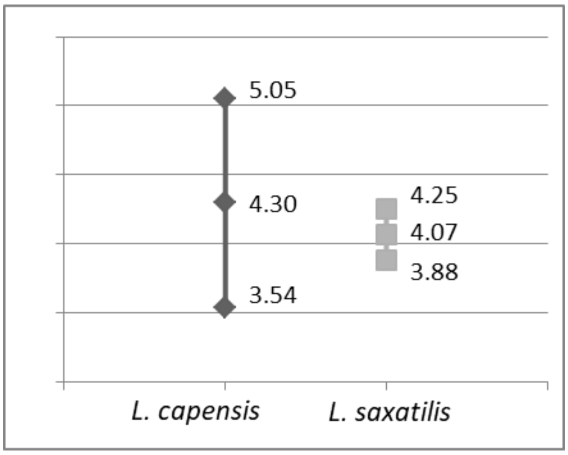


Figure 4.369: Metatarsal II measurement Bp – Breadth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

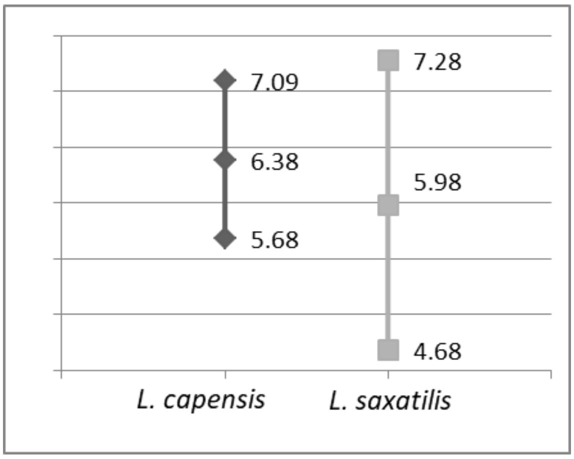


Figure 4.370: Metatarsal III measurement Dp – Depth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

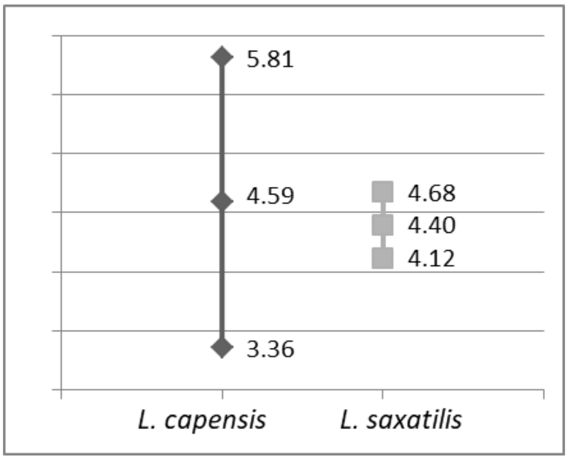


Figure 4.371: Metatarsal III measurement Bp – Breadth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

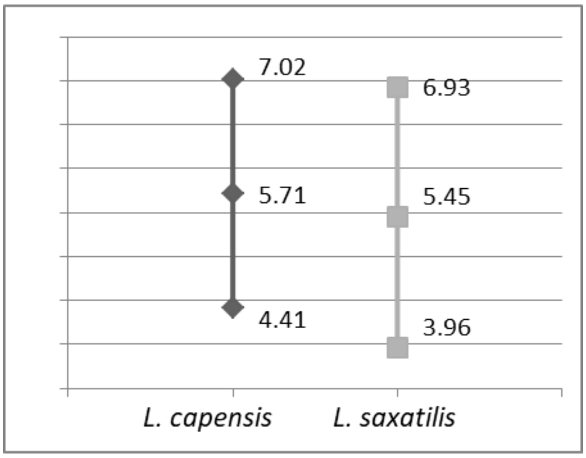


Figure 4.372: Metatarsal IV measurement Dp – Depth proximal. 95% confidence levels upper bound, mean and lower bound values indicated

4.3 Archaeological applications

4.3.1 Blydefontein and Meerkat

Blydefontein and Meerkat are two rock shelters in the Zeekoe River Valley (Eastern Cape Province) located along a small tributary close to the Middle Orange River (Figure 4.373). Blydefontein Rock Shelter is located on a cliff face a few kilometres east of the Zeekoe River Basin in the upper reaches of the Oorlogspoort River. Meerkat Rock Shelter is about 0.75km south (upstream) from Blydefontein and on the opposite cliff face (Figure 4.374). Both these shelters yielded deep stratified Later Stone Age deposits dating to the Pleistocene and Holocene with relatively well preserved pollen and faunal material (Bousman 1991: 2, 3, 175).

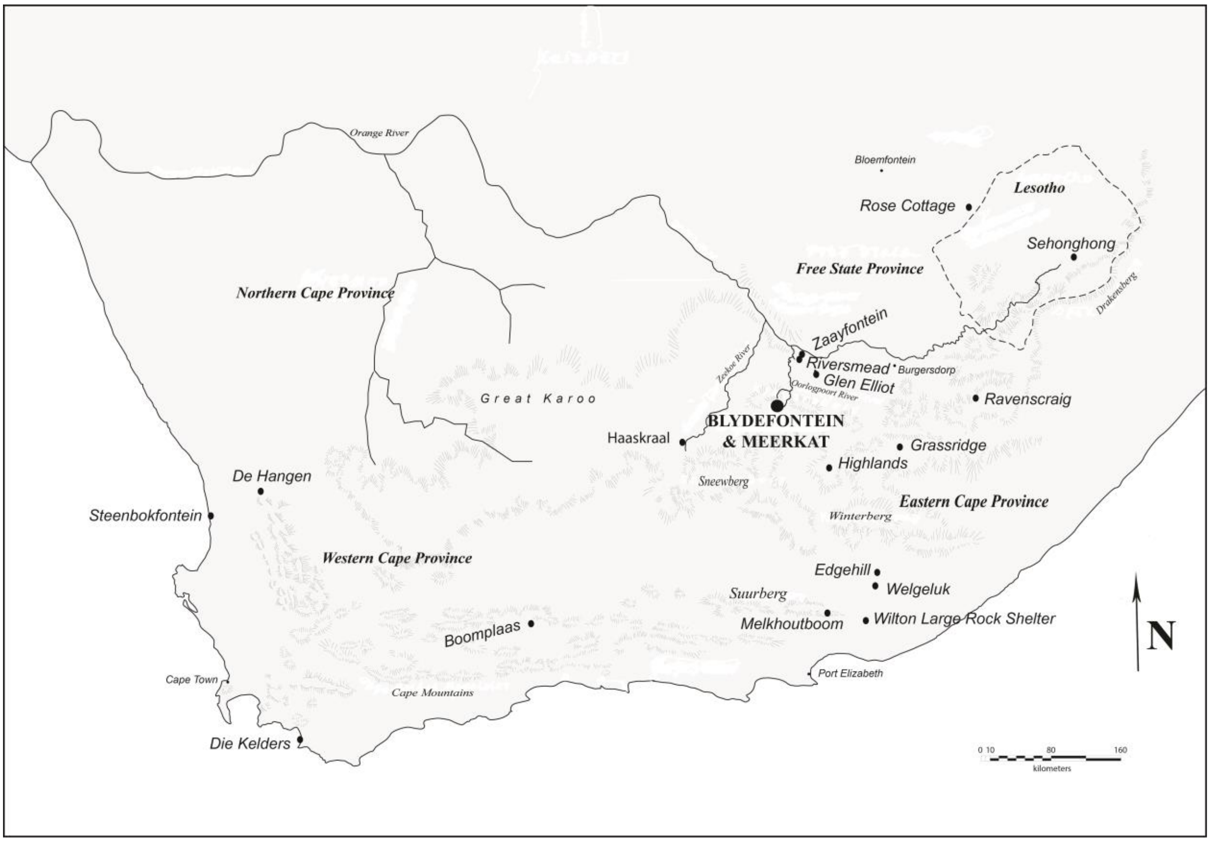


Figure 4.373: Location map for Blydefontein and Meerkat LSA Rock Shelters. Several other Stone Age localities are indicated

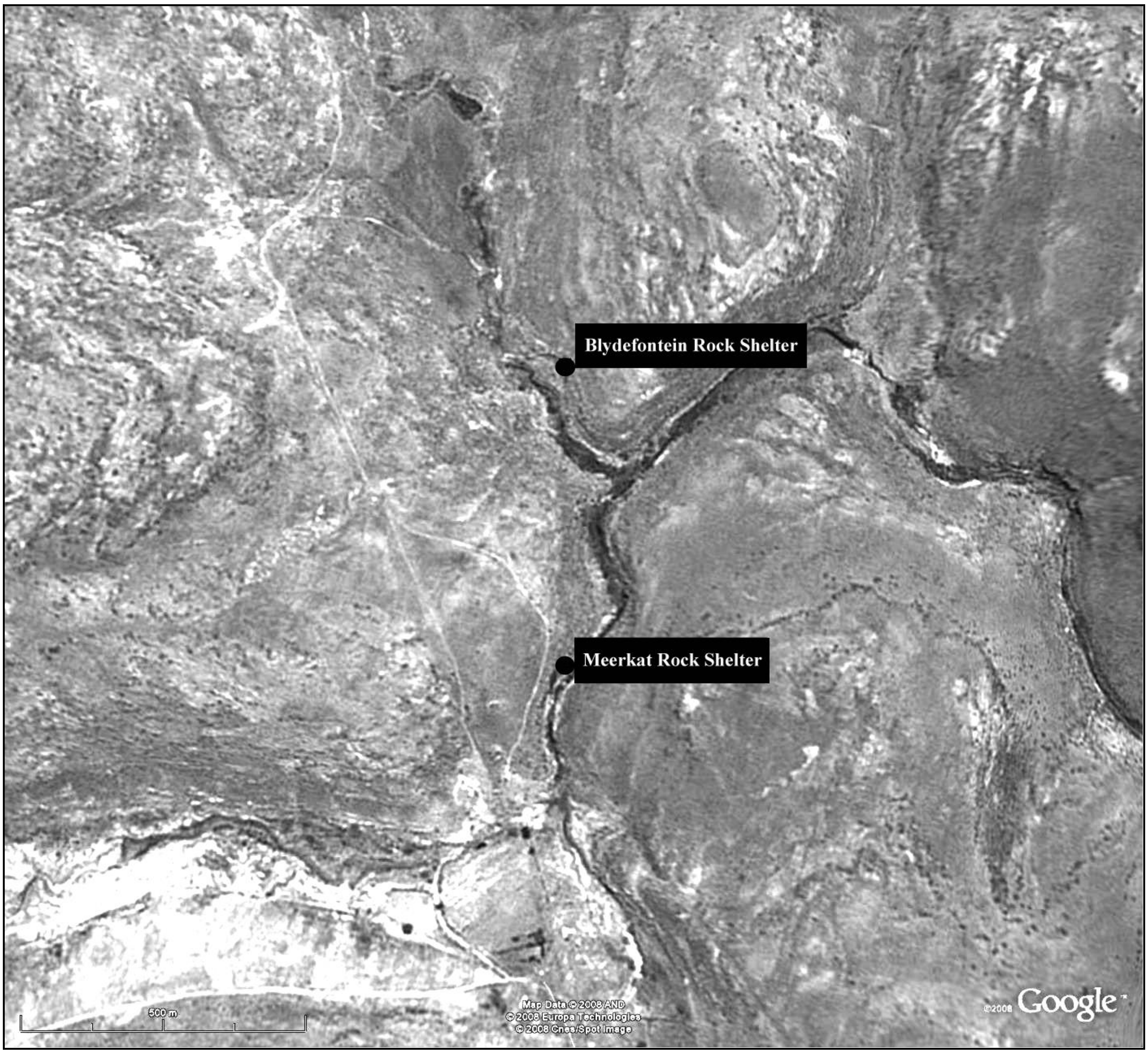


Figure 4.374: Enlarged Google satellite image of the locations of Blydefontein and Meerkat Rock Shelters

The shelters occur in a treeless grassveld basin near the eastern boundary of the semi-desert Karoo (Bousman 2005: 199). The vegetation was classified by Acocks (1975) as Karroid *Merxmuellera* Mountain Veld with a mixture of C_3 and C_4 grasses. The Zeekoe River Valley vegetation comprises mainly typical dwarf C_3 bushes of the False Upper Karoo communities (Acocks 1975; Bousman 2005: 199). Since the Late Pleistocene the vegetation of the basin and adjacent regions alternated between grassveld and Karoo, changes that continued during the historic period (Bousman & Scott 1994: 575; Bousman 2005: 199).

A small section of the Blydefontein site was excavated in 1967 (Sampson 1970). Bousman conducted more extensive excavations in 1985 as part of his doctoral research. During this fieldwork period, the new site of Meerkat was pointed out and subsequently also excavated

(Bousman 1991). The faunal assemblages from these excavations were originally analysed in 1990 by Klein and Cruz-Uribe. Although a species list was compiled, it was never entirely published. Some of the data was, however, used in a 2005 article by Bousman. After this initial analysis the faunal material was stored in the Iziko Museum of Cape Town collections. In 2008 the material was made available for reanalysis, which was completed in 2011 (Bousman et al. 2016: 47; Scott & Plug 2016). The faunal material from the original Sampson excavation (1967) could not be located and subsequently did not form part of the reanalyses. Sampson did report 11 *Lepus* spp. specimens from his earlier excavation (Bousman 1991: 282).

The very rich faunal complement of the Blydefontein Basin has in the past 200 years been significantly impacted on by European hunting and stock farming (Bousman 1991: 28). The results of the reanalysis are as yet unpublished but the historically rich and diverse fauna is reflected in the species lists. Blydefontein yielded a NISP count of 6527 which incorporates a diversity of 49 species. Meerkat produced a NISP of 1891 with a species count of 41. I co-analysed the faunal material and was familiar with the preservation of the material as well as the identification methods employed. Permission was obtained from Prof. Bousman to use the Lagomorpha material from both Blydefontein and Meerkat to test the protocols established during the current research. Only specimens identified as Lagomorpha were extracted from the faunal assemblage.

Bousman makes specific reference to the two Lagomorpha species found in the basin – the Cape hare and a species of rabbit (1991: 31). According to the distribution maps in Skinner and Chimimba (2005), both the Cape hare (p. 67) and the scrub hare (p. 70) occur in the region. The only *Pronolagus* sp. is Smith's red rock rabbit (p. 72). This rabbit, as well as the other two rabbit species, is smaller than both the hares according to the measurement tables provided in Skinner and Chimimba (2005).

For the reanalysis both the morphology and morphometrics established for the *Lepus* spp. were applied. The new analyses verified that the protocols established in this study are indeed applicable and meaningful and that they are valuable in distinguishing between the two species that form the subject of this dissertation. The protocols, in addition, allow the identification of specimens from the *Pronolagus* group, although not to species level. Even though the distribution maps indicate that only one species of rabbit occurs in the region, it has to be kept in mind that these maps indicate current/modern distributions and not historical distributions. The protocols moreover enabled the researcher to detect previously misidentified specimens. The detailed morphological analysis conducted in this study established major and minor morphological traits that need to be present for species level identification. These features are species specific and are not a one-size-fits-all. Upon reanalyses some specimens that were previously considered identifiable were found to lack these major and minor morphological features that are now known to be necessary for species identification. The re-identification of the latter specimens was therefore not possible.

Not all specimens examined are illustrated. In section 4.4 the most significant differences are highlighted and those specimens that exhibited these specific features were used in the photographs. The specimens that are illustrated are coloured grey in Tables 4.20 and 4.21 with the specific figure number given. The faunal remains that provided firm species identification for either *L. capensis* or *L. saxatilis* were photographed. *Pronolagus* spp. identification was used to show the Lagomorpha morphology and that it does not conform to that established for the *Lepus* spp. Specimens that were found to have originated from other species were re-identified as non-*Lepus* spp.

4.3.2 Blydefontein

The faunal assemblage of Blydefontein produced a NISP of 191 specimens. These were originally identified to Lagomorpha (174), *Pronolagus* spp. (5), *Lepus* spp. (10) and *Lepus saxatilis* (2). A total of 85 specimens were either individual teeth or part mandibles identified as Lagomorpha and were not reexamined nor listed in Table 4.21. For a summary of the results see Table 6.22.

Table 4.20: Blydefontein Rock Shelter reanalyses results

Block	Original ID	Skeletal element	NISP	New ID	Reason
B Clearings	Lagomorpha	Right - maxilla with molars	6	*L. capensis*	Measurement #9 - 15.78 falls within the range and although the oral zygomatic is broken the morphology resembles *L. capensis*.
CL 25	Lagomorpha	Radius distal articulation	1	*Pronolagus* spp.	Based on morphology Bd - 7.45 is smaller than *Lepus* spp. Morphology still Lagomorpha.

A 8 + 16 (1) A 7 + 15 (1)	Lagomorpha	Right - scapula glenoid and blade	1	Non-*Lepus* spp.	Morphology different and measurements too small.
C10 (3)	Lagomorpha	Humerus distal	1	Non-*Lepus* spp.	Measurement Bd - 7.95 falls outside the *Lepus* spp. range.
C25 (4)	Lagomorpha	Humerus distal	1		Too fragmented for identification.
A7 – 8(3) A15 – 16(3)	Lagomorpha	Maxilla	1		Too fragmented for identification.
B29 (9)	Lagomorpha	Humerus distal	1	Non-*Lepus* spp.	Identification was made based on measurement Bd - 8.02 that falls outside the *Lepus* spp. range.
C42 (3)	Lagomorpha	Humerus distal	1	cf. *L. saxatilis*	Measurement Bd - 11.05 is within the range for *L. saxatilis*.
A16 (6)	Lagomorpha	Humerus distal	1	Non-*Lepus* spp.	Measurement Bd - 8.2 is too small and falls outside those established for *Lepus* spp.
D9-4	Lagomorpha	Femur distal	1		Juvenile.
C17 (4)	Lagomorpha	Pelvis acetabulum	1	cf. *L. saxatilis*	Estimated measurement LAR - 10.44 puts it in the *L. saxatilis* range. It is too broken for firm morphological identification. Hence cf.
D9 (5)	Lagomorpha	Right - scapula glenoid	1	Non-*Lepus* spp.	Measurements BG - 6.34; GLP - 7.85 is too small for *Lepus* spp.
Clearings NP	Lagomorpha	Humerus distal	2		Too fragmented for identification.
C10 (3)	Lagomorpha	Tibia shaft	1		Too small a fragment piece for identification.
C26 (12)	Lagomorpha	Pelvis acetabulum	1	Non-*Lepus* spp.	Measurement LAR - 7.53 too small for *Lepu*s spp. and the fragment originated from an adult. Morphology is different from Lagomorpha.
D9 (12)	Lagomorph	Patella	1	Non-*Lepus* spp.	Misidentification.
Floor sweepings	Lagomorph	Left - ulna anconaeus and shaft	1	Non-*Lepus* spp.	On account of rodent damage no firm morphological identification is possible. Measurement BPC is estimated in the 5mm range and is outside the range established for *Lepus* spp.
D57(26)	Lagomorpha	Maxilla	1	*Pronolagus* spp.	Morphology similar to Lagomorpha although not a *Lepus* spp.
C18 (11)	Lagomorpha	Maxilla	1		Cannot identify to species level.
A48 (26)	Lagomorpha	Left + Right - mandible with 4	6	*L. saxatilis*	Measurement #6 - 11.84 (for the left) and measurement #4 - 20.16 (for the

		molars			right) and 4 -20 (for the left). Is within the established range.
Clearings NP	Lagomorpha	Maxilla frag	1	*Pronolagus* spp.	Measurement #9 - 14.13 falls outside the range established for *Lepus* spp. The morphology does fit Lagomorpha.
C1 (7.5)	Lagomorpha	Right - scapula glenoid and blade	1		Too broken for identification.
D10 (9)	Lagomorpha	Right - ulna proximal artic	1	Non-*Lepus* spp.	DPA - 8.25; BPC - 7.15 While the measurements are in line for *Lepus* spp., the morphology is different to that observed for the hares.
C50 (11)	Lagomorpha	Femur caput	1		Juvenile unfused and no identification is possible.
B31 (18)	Lagomorpha	Femur proximal shaft	1		Too fragmented for identification.
C50 (11)	Lagomorpha	Femur distal condyle	2		Too fragmented for identification.
Clearings NP	Lagomorpha	Pelvic acetabulum	1	*Pronolagus* spp.	Measurement LAR - 8.34. Too small for *L. capensis*. The morphology is consistent with Lagomorpha.
C50 (11)	Lagomorpha	Ulna proximal artic + shaft	1	Non-*Lepus* spp.	Measurement BPC - 6.71 falls outside the range established for *Lepus* spp. The morphology is consistent with Lagomorpha.
B9-16	Lagomorpha	Ulna shaft	1	*Lepus* spp.	The fragment is too broken for firm morphological identification. Measurements, however, place it firmly within the *Lepus* spp. range
B20 (3)	Lagomorpha	Metapodial proximal artic + shaft	1	Non-*Lepus* spp.	Misidentification. Morphology indicates that the specimen is metatarsal. The specimen is now more accurately identified as originating from the hind foot.
C18 (6)	Lagomorpha	Left - ulna lateral artic + shaft	1	*L. saxatilis*	Measurement BPC - 7.68 falls within the range established for *Lepus* spp.
C18 (6)	Lagomorpha	Radius shaft	2		Midshaft fragments and thus not possible to identify to species.
C 26 (9)	Lagomorpha	Humerus distal artic	1	Non-*Lepus* spp.	Measurement Bd - 7.23 too small for *Lepus* spp.
B24 (17)	Lagomorpha	Metapodial	6	5 - *L. capensis*	1 - (Left) MC V - Bp 3.75;

		proximal artic + shaft		1 - misidentification	Dp 3.48 – *L. capensis*; 1 - (Right) MC V - Bp 3.61; Dp 3.41 – *L. capensis*; 1 - (Right) MC IV Bp 3.21; Dp 3.73 – *L. capensis* (articulates with MC V above) 1 - (Left) MC II Bp - 3.78; Dp 5.02 – *L. capensis* 1 - (Right) MC II (broken) Bp 3.41; Dp 4.84 – cf. *L. capensis*; 1 - (Left) MT III morphology is different to that of Lagomorpha.
B24 (17)	Lagomorpha	Metapodial distal artic + shaft	3		Identification not possible.
B24 (2)	Lagomorpha	Humerus distal artic	1	Non-*Lepus* spp.	Measurement - Bd 8.16 falls outside the range for *Lepus* spp.
C1 (2)	Lagomorpha	Femur shaft	1		Juvenile not possible to identify species.
D10 (5)	Lagomorpha	Femur proximal	1	Non-*Lepus* spp.	Measurement - Bp 8.74 is far too small and the morphology observed is not consistent with Lagomorpha. Misidentification.
C9 (6)	Lagomorpha	Metapodial distal shaft	1		Too fragmented for identification.
C3 (3.5)	Lagomorpha	Humerus distal shaft	1	Non-*Lepus* spp.	Measurement Bd - 7.33 too small for *Lepus* spp.
D17 (15)	Lagomorpha	Left - ulna proximal	1	*L. saxatilis*	Measurements SDO - 10.56; DPA - 11.99 coupled with the observed morphology.
D2 (13)	Lagomorpha	Left - ulna proximal artic	1	Non-*Lepus* spp.	Measurements SDO - 6.39; DPA - 7.22 fall outside the ranges established for *Lepus* spp.
C1 (25)	Lagomorpha	Metapodial proximal artic + shaft	2	*Pronolagus* spp.	1 - (Left) MC II burnt - Bp - 3.25; Dp - 4.74, does not place the specimen in any of the clear ranges. Thus possibly not *Lepus* spp. Definitely Lagomorpha. 1 - (Right) MC II Morphology is just too different to be *Lepus* spp.
D9 (7)	Lagomorpha	Right - ulna olecranon	1	cf. *L. capensis*	Based on morphology coupled with measurement DPA - 8.74.
DS10 (15)	Lagomorpha	Ulna olecranon	1		No identification. Possible juvenile.

Clearings NP	Lagomorpha	Left - pelvis acetabulum + ilium	1	cf. *L. saxatilis*	Measurement LAR - 9.57 and based on the morphological thickening of the ischial spine.
D10 (15)	Lagomorpha	Left - ulna proximal artic	1	Non-*Lepus* spp.	Misidentification.
D17 (7)	Lagomorpha	Right - ulna lateral artic + shaft	1		Too broken to measure or identify beyond group.
C25 (17)	Lagomorpha	Radius proximal artic + shaft	1	Non-*Lepus* spp.	Misidentification.
Clearings	Lagomorpha	Ulna proximal artic	2	Non-*Lepus* spp.	Much smaller than observed specimens.
C 26 (1)	Lagomorpha	Left - mandible with incisor and 3 molars	5	*Pronolagus* spp.	Measurements #2 - 14.50; #6 - 10.49; #7 - 11.70 are smaller than those for *L. capensis.* The morphology is Lagomorpha.
A16 (12)	Lagomorpha	Left - mandible with teeth	3	cf. *L. capensis*	Measurement #6 - 11.26 is well within the range established.
C2 (4)	*Pronolagus* spp.	Right - mandible with 3 molars	4	*Pronolagus* spp.	Measurements #6 - 11.52 is smaller than the range established for *L. capensis.*
C58 (2)	*Pronolagus* spp.	Tibia proximal	1		No identification possible. Juvenile.
B23 (4)	*Lepus* spp.	Left - scapula glenoid	1	Non-*Lepus* spp.	Morphology different and Measurement BG - 5.92 much too small for *Lepus* spp.
B23 (9)	*Lepus* spp.	Right - scapula blade	1	*L capensis*	Identification based on the caudal margin of the scapula blade.
C18 (24)	*Lepus* spp.	Metapodial proximal artic including shaft	1	Non-*Lepus* spp.	Right MC IV - Morphology different to that of Lagomorpha.
D18 (25)	*Lepus* spp.	Ulna proximal artic + shaft	1	Non-*Lepus* spp.	Identification based on the observed morphology.
B24 (17)	*Lepus saxatilis*	Scapula glenoid	1	*L. capensis*	Measurements BG - 9.54; LG - 9.83; GLP - 10.78 coupled with observed morphology.

Continuation of Table 4.20: Blydefontein Rock Shelter reanalyses results. These specimens were selected to illustrate the morphology (photo's) and morphometrics (line graphs and scatter plots) employed in the reanalyses (Figures 4.375 – 4.424).

B Clearings	Lagomorpha	Right - ulna proximal articulation	1	*L. capensis*	Measurements SDO - 9.35; DPA - 9.83 falls within the range and there is a groove (Figures 4.375 & 4.376; Figures 4.377 & 4.378; Figure 4.379).

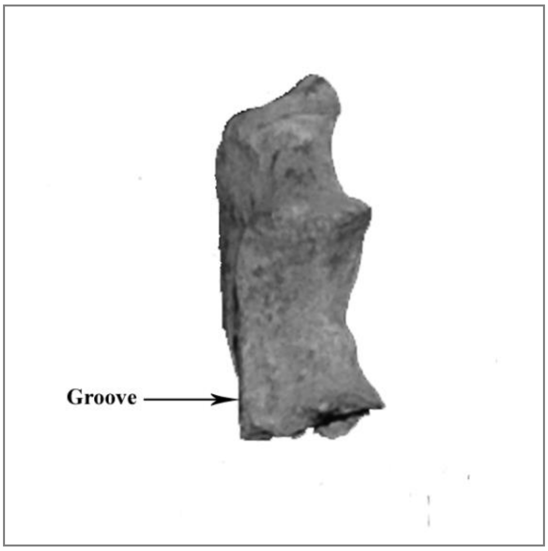


Figure 4.375: B Clearings – *L. capensis* – Right ulna proximal articulation indicating the groove. Greatly enlarged, no scale is given

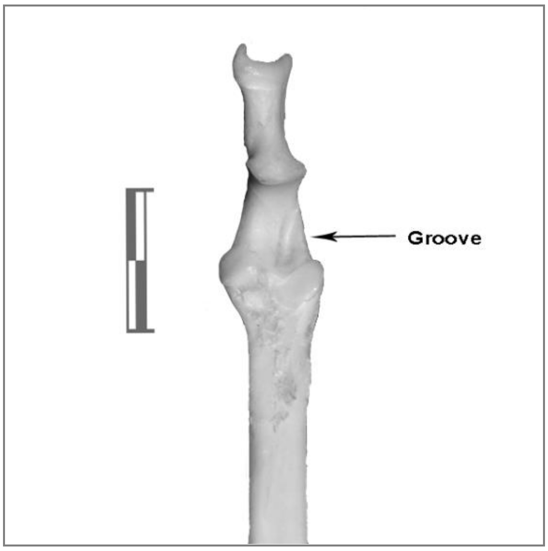


Figure 4.376: *L. capensis* – Left proximal articulation with groove for comparison

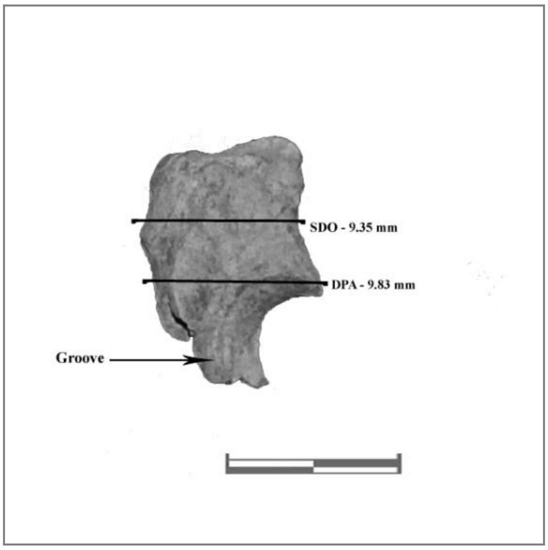


Figure 4.377: B Clearings – *L. capensis* – Right ulna proximal articulation with measurements DPA and SDO indicated.

Figure 4.378: *L. capensis* – Left ulna proximal articulation for comparison

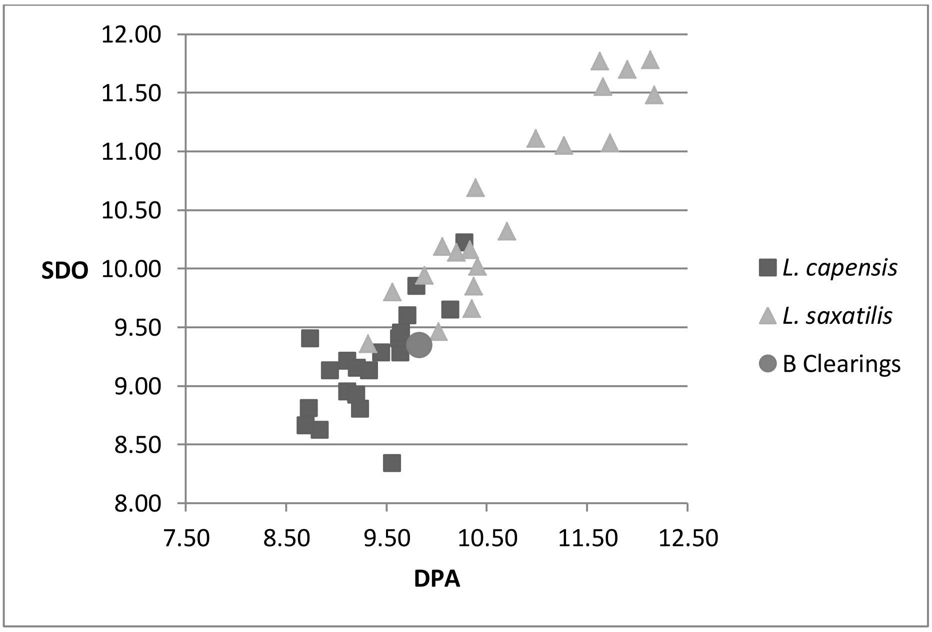


Figure 4.379: Ulna measurement SDO vs DPA indicating the archaeological specimen’s position in the scatter plot

C26 (3)	Lagomorpha	Right - pelvis	1	Non-*Lepus* spp.	Measurements GL - 76.92; LAR - 10.14; SH - 6.93 older juvenile measurements fit with those taken on sub-adults based on the morphology and the angle of the pubis (Figures 4.380 & 4.381; Figures 4.382 - 4.384).

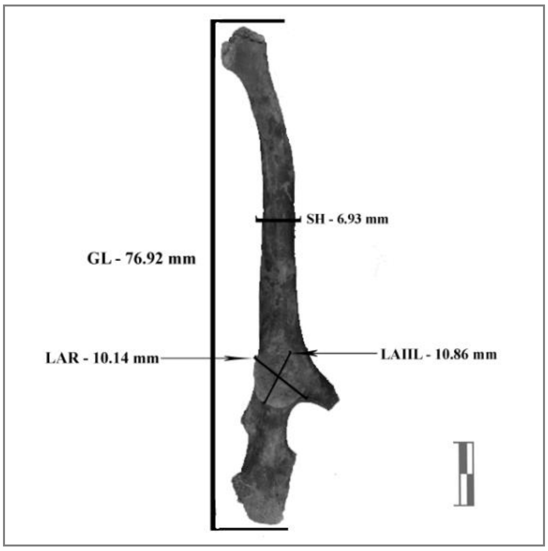


Figure 4.380: C26 (3) – Non-*Lepus* spp. – Right pelvis. Measurements GL; LAR; LAIIL and SH indicated

Figure 4.381: *L. saxatilis* – Left pelvis for comparison

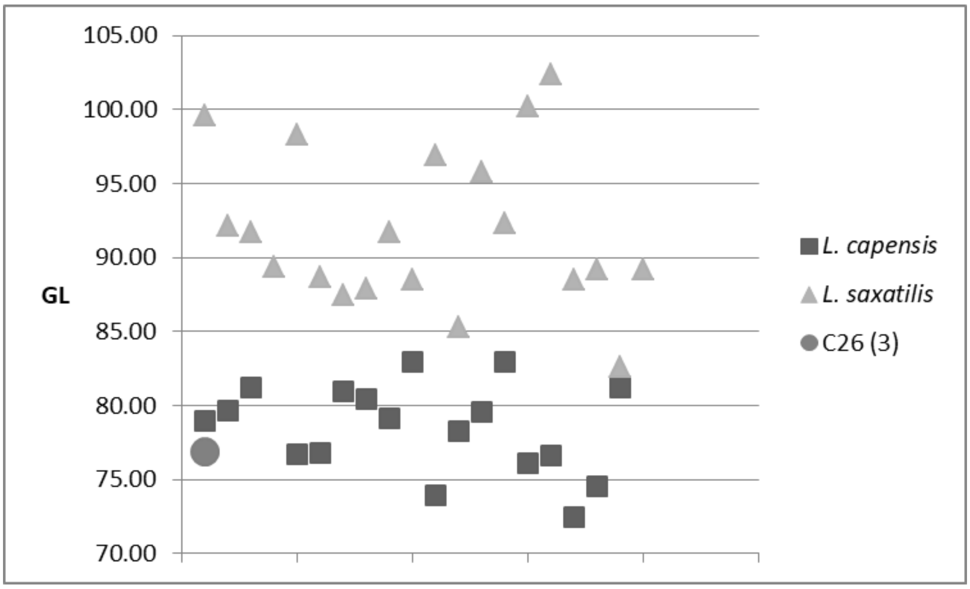


Figure 4.382: Pelvis measurement GL indicating the archaeological specimen's position in the line graph

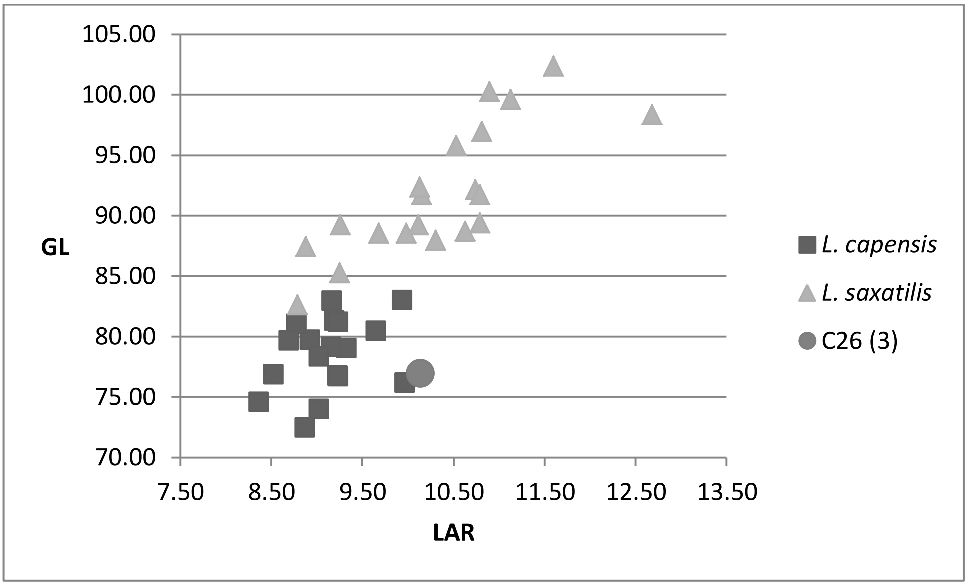


Figure 4.383: Pelvis measurement GL vs LAR indicating the archaeological specimen's position in the scatter plot

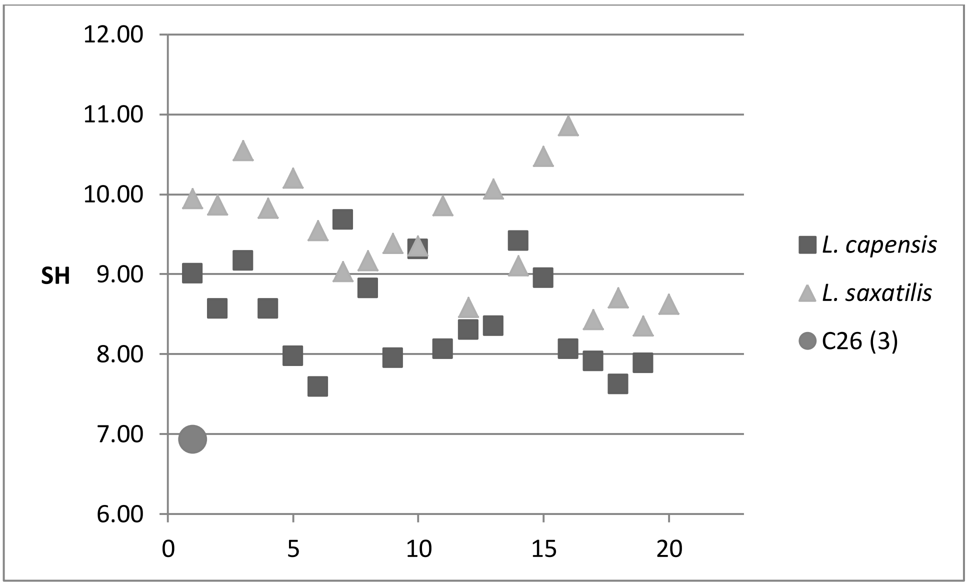


Figure 4.384: Pelvis measurement SH indicating the archaeological specimen's position in the line graph

C33 (18)	Lagomorpha	Left - tibia distal	1	*Pronolagus* spp.	Measurement Bd - 10.15; Dd – 4.92; DDL – 4.86 and is smaller than *Lepus* spp. Morphology is similar to Lagomorpha (Figures 4.385 & 4.386; Figures 4.387 & 4.388; Figures 4.389 & 4.390; Figures 391 - 393).

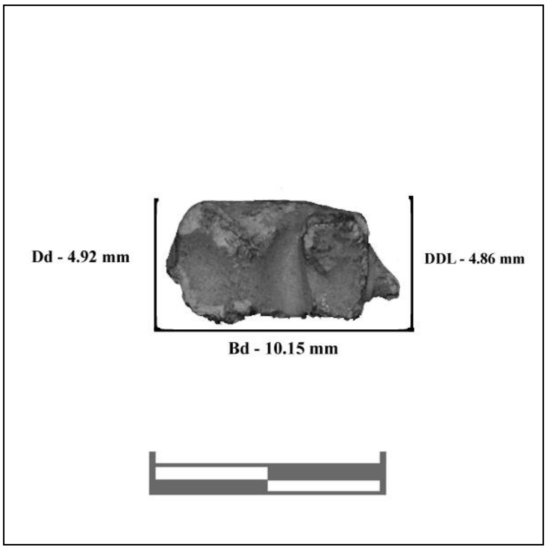


Figure 4.385: C33 (18) – *Pronolagus* spp. – Left tibia distal articulation. Measurements Bd; DDL and Dd indicated

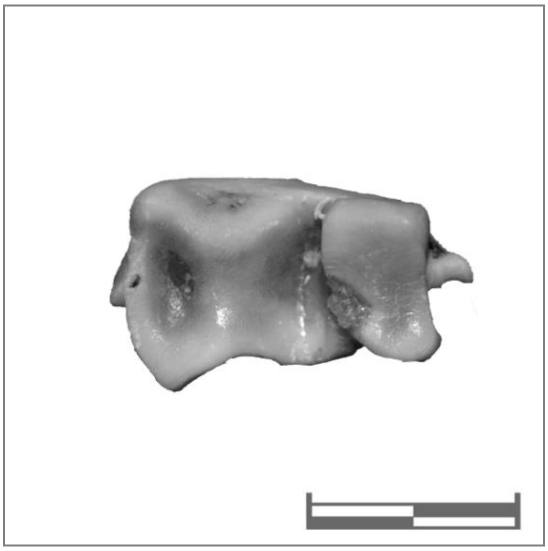


Figure 4.386: *L. capensis* – Left tibia distal articulation for comparison

Figure 4.387: C33 (18) – *Pronolagus* spp. – Left tibia distal plantar view

Figure 4.388: *L. capensis* – Left tibia distal plantar view for comparison

Figure 4.389: C33 (18) – *Pronolagus* spp. – Left tibia distal dorsal view

Figure 4.390: *L. capensis* – Left tibia distal dorsal view for comparison

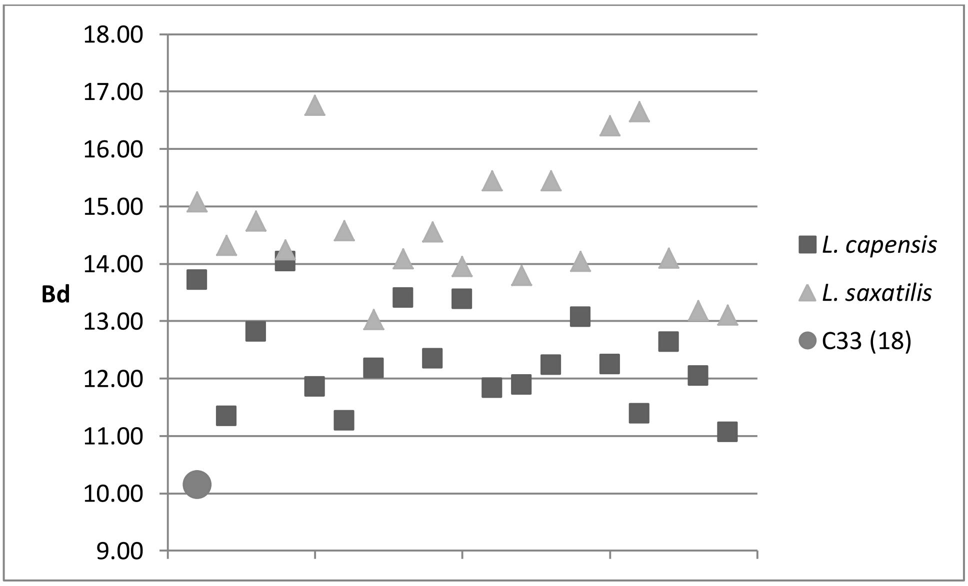


Figure 4.391: Tibia measurement Bd indicating the archaeological specimen's position in the line graph

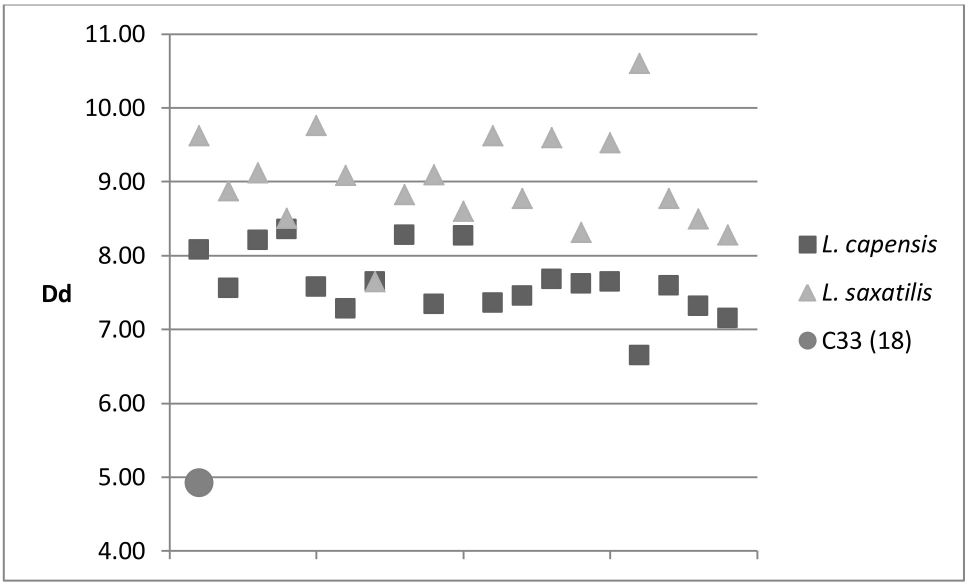


Figure 4.392: Tibia measurement Dd indicating the archaeological specimen’s position in the line graph

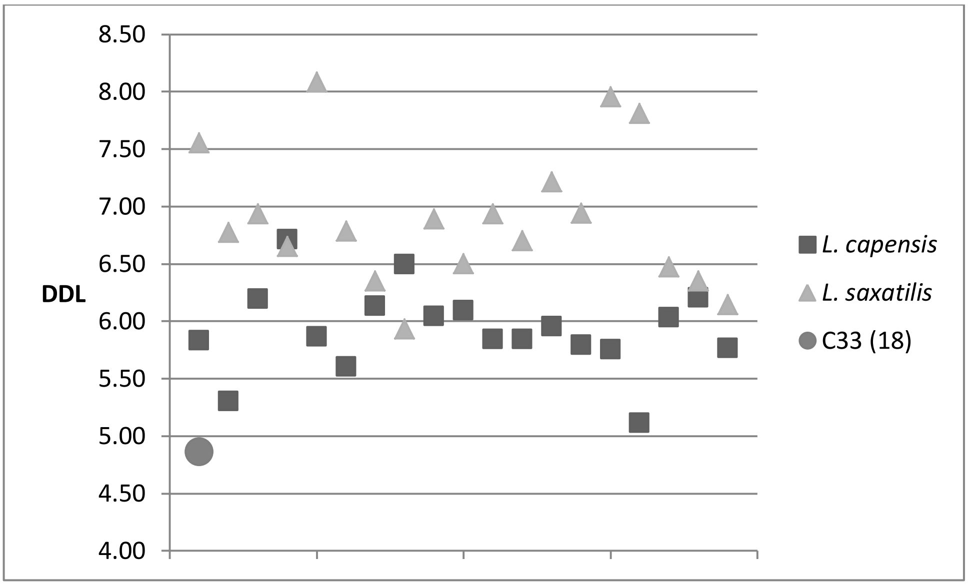


Figure 4.393: Tibia measurement DDL indicating the archaeological specimen’s position in the line graph

Clearings NP	Lagomorpha	Left - mandible 3 molars	4	*L. capensis*	Measurement #6 - 11.57; #7 12.05 and the morphology of the *Margo interalveolaris* (8) are those of *L. capensis* (Figures 4.394 & 4.395; Figure 4.396).

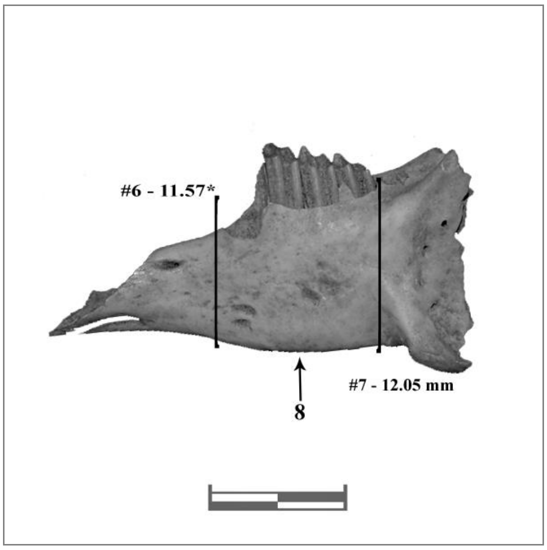


Figure 4.394: Clearings NP – *L. capensis* – Left mandible with 3 molars. * - due to breakage measurement #6 is estimated

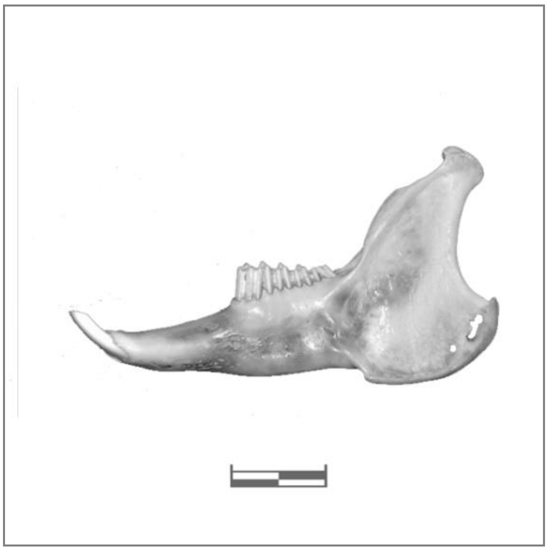


Figure 4.395: *L. capensis* – Left mandible for comparison

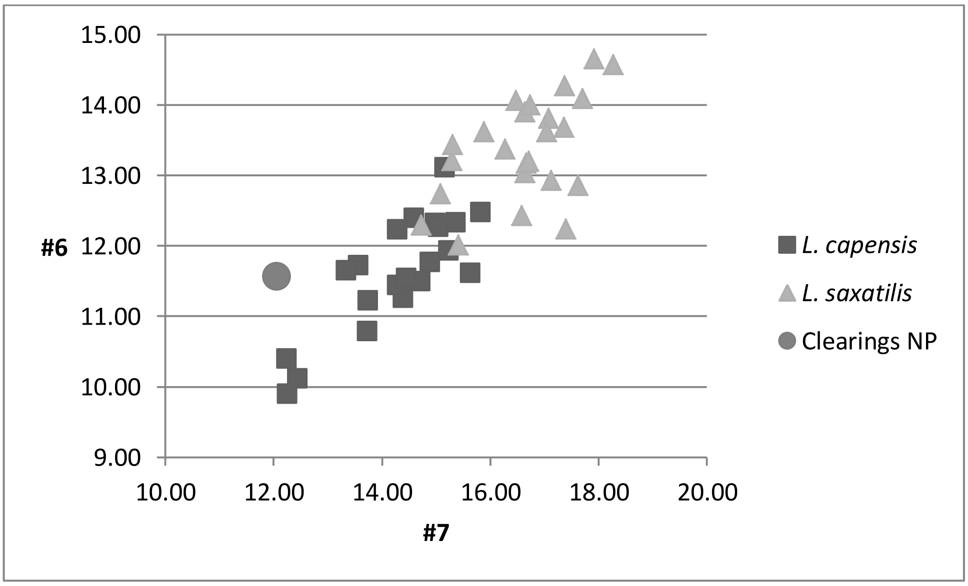


Figure 4.396: Mandible measurement #6 vs #7 indicating the archaeological specimen's position in the scatter plot

Floor sweepings	Lagomorpha	Right radius proximal artic + shaft	1	*L. capensis*	The morphology and measurements support the species identification. Measurement Bp – 7.13 (Figures 4.397 & 4.398; Figure 4.399).

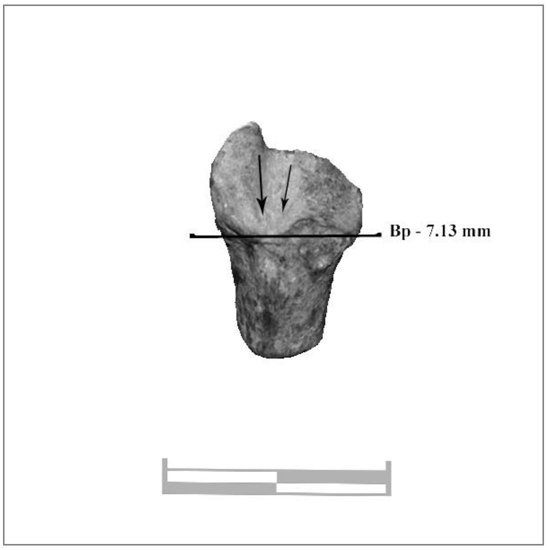


Figure 4.397: Floor sweepings – *L. capensis* – Right radius proximal articulation and shaft indicating the V shape

Figure 4.398: *L. capensis* – Left radius proximal articulation for comparison

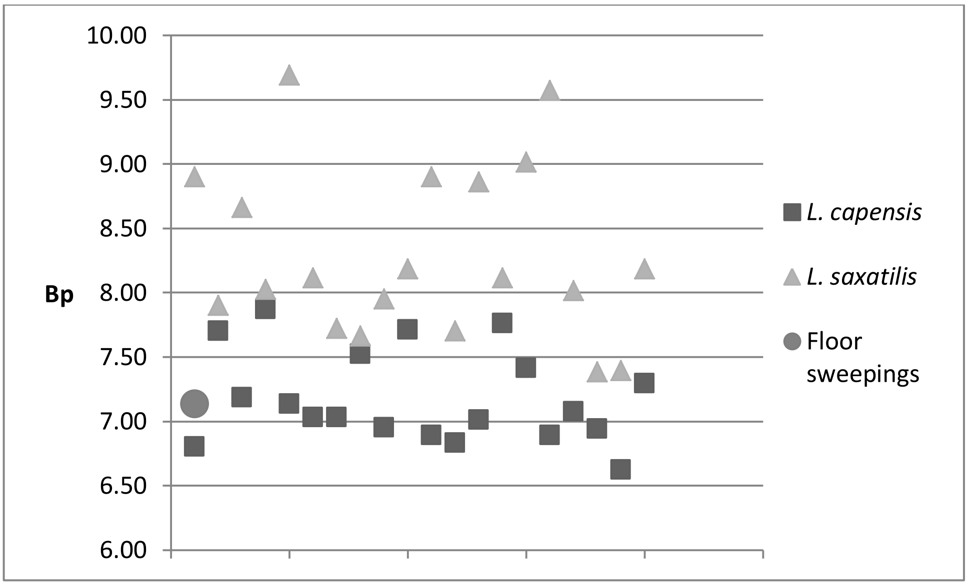


Figure 4.399: Radius measurement Bp indicating the archaeological specimen's position in the line graph

Floor sweepings	Lagomorpha	Left radius distal artic + shaft	1	*L.* cf. *saxatilis*	Measurement Bd - 8.55 falls within the ranges established for both *L. capensis* and *L. saxatilis*. Based on the mean established it falls more within the range of *L. saxatilis* (Figures 4.400 & 4.401; Figure 4.402).

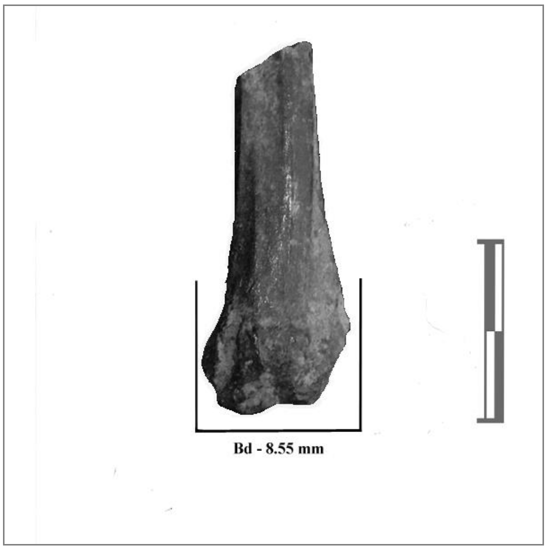


Figure 4.400: Floor sweepings – *L.* cf. *saxatilis* – Left radius distal articulation and shaft. Measurement Bd indicated

Figure 4.401: *L. saxatilis* – Left radius distal articulation and shaft for comparison

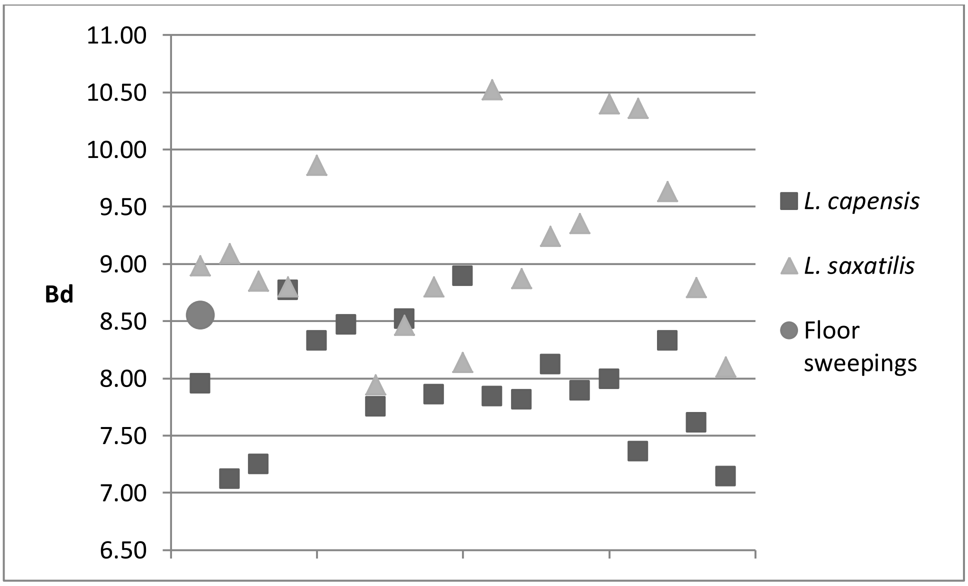


Figure 4.402: Radius measurement Bd indicating the archaeological specimen's position in the line graph

C 17 (6)	Lagomorph	Left radius proximal + shaft	1	*L. capensis*	Measurement Bp - 7.84 and the morphology observed are consistent with the protocols established for *L. capensis* (Figures 4.403 & 4.404; Figure 4.405).

Figure 4.403: C 17 (6) – *L. capensis* – Left radius proximal articulation and shaft indicating the V-shape. Measurement Bd is shown

Figure 4.404: *L. capensis* – Left radius proximal articulation for comparison

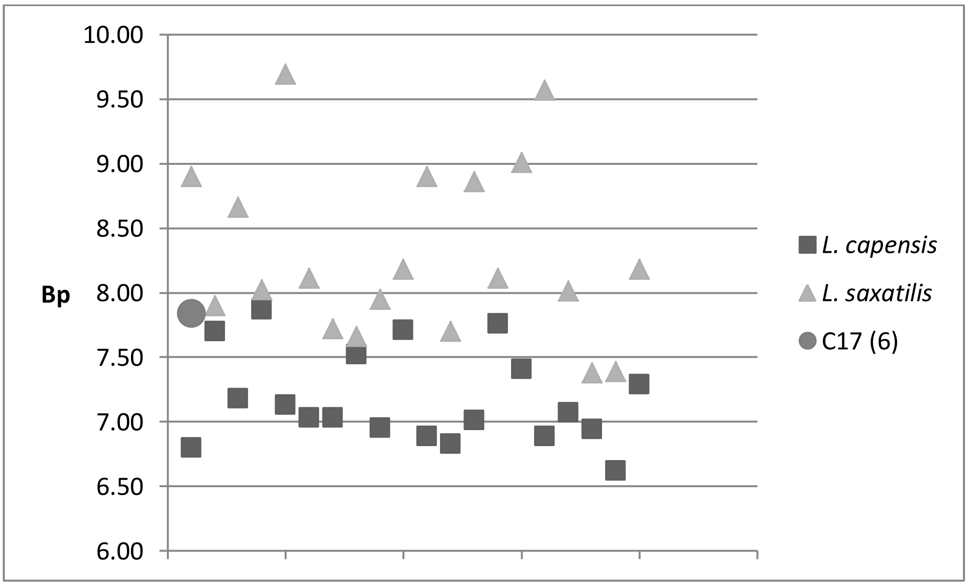


Figure 4.405: Radius measurement Bp indicating the archaeological specimen's position in the line graph

C57 (7)	Lagomorpha	Right humerus distal articulation	1	*L. saxatilis*	Measurement - Bd 11.47 (Figures 4.406 & 4.407; Figure 4.408).

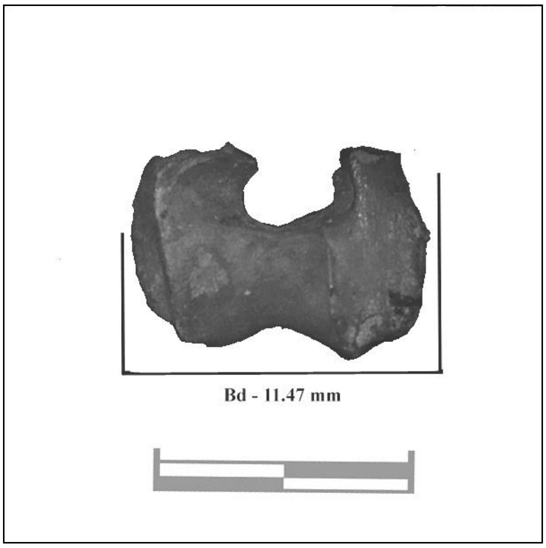


Figure 4.406: C57 (7) – *L. saxatilis* – Right humerus distal articulation. Measurement Bd indicated

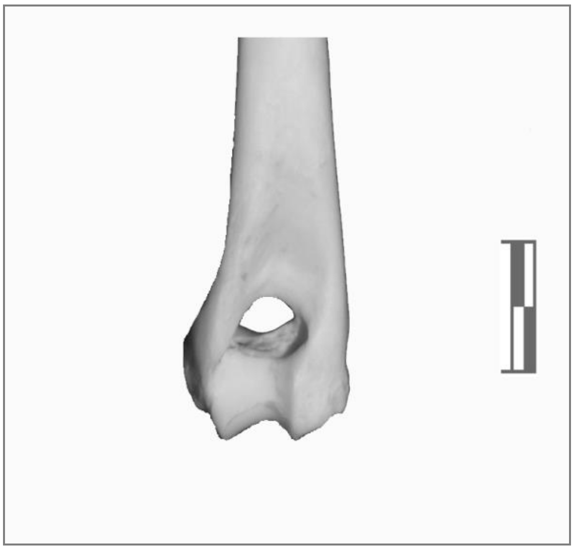


Figure 4.407: *L. saxatilis* – Left humerus distal articulation for comparison

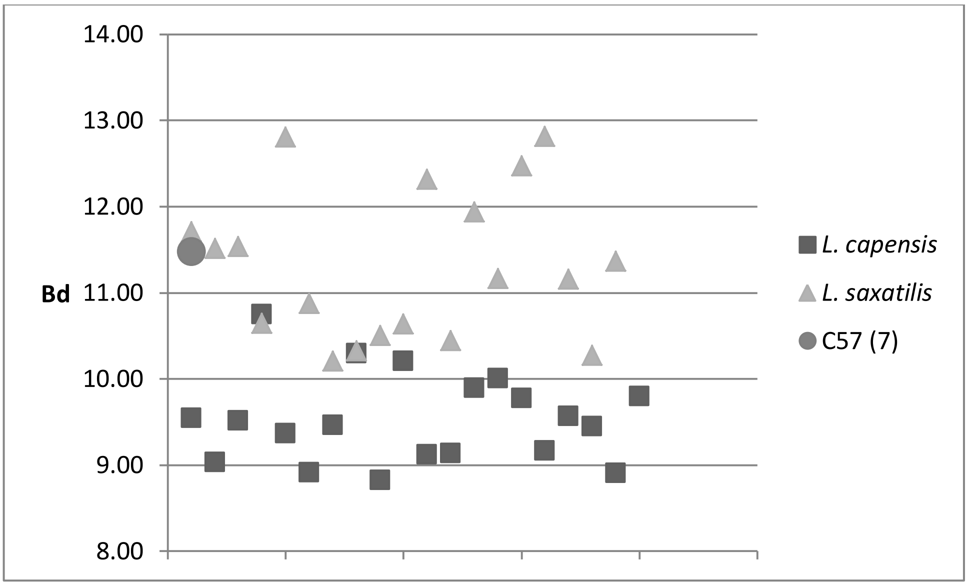


Figure 4.408: Humerus measurement Bd indicating the archaeological specimen's position in the line graph

D17 (25)	Lagomorpha	Left - ulna proximal articulation	1	*L. capensis*	The deep groove matches and the measurements are in range. SDO - 9.01; DPA - 10.05 (Figures 4.409 & 4.410; Figures 4.411 &4.412; Figure 4.413).

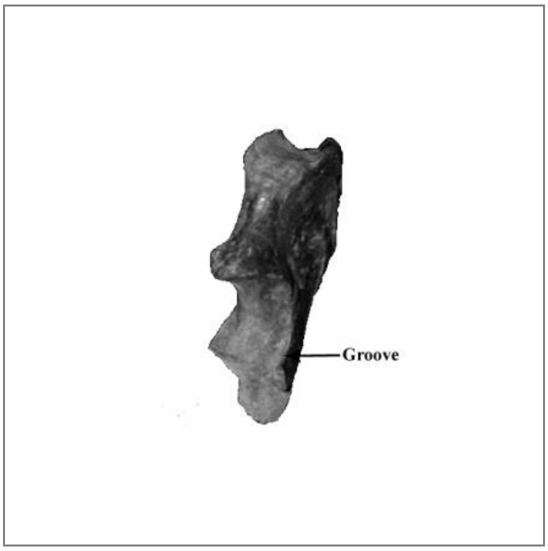


Figure 4.409: D17 (25) – *L. capensis* – Left ulna proximal articulation with groove indicated. Greatly enlarged, no scale is given

Figure 4.410: *L. capensis* – Left ulna proximal articulation for comparison

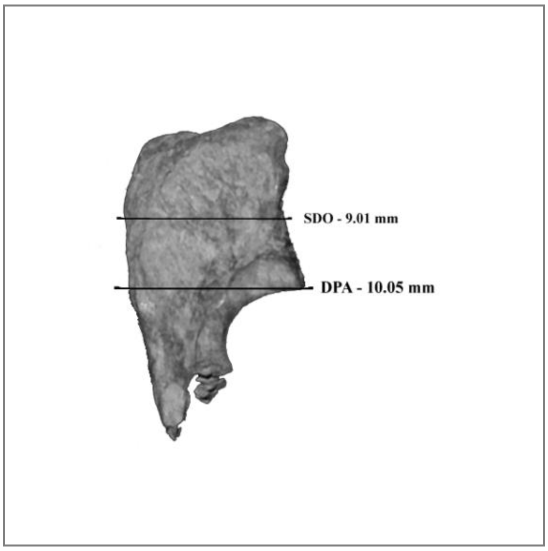


Figure 4.411: D17 (25) – *L. capensis* – Left ulna proximal medial articulation. Measurements DPA and SDO indicated. Greatly enlarged, no scale is given

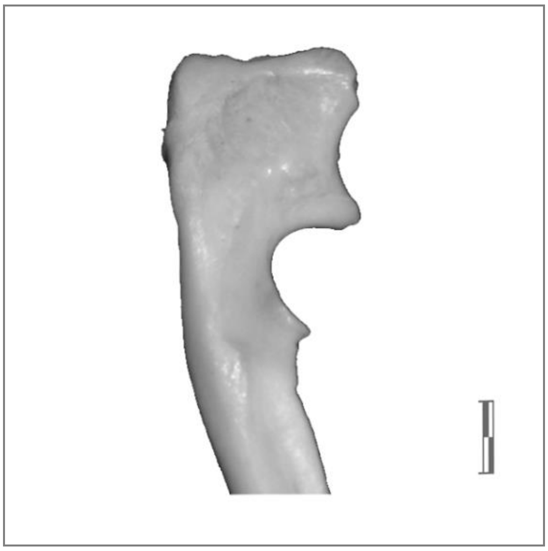


Figure 4.412: *L. capensis* – Left ulna proximal medial articulation for comparison

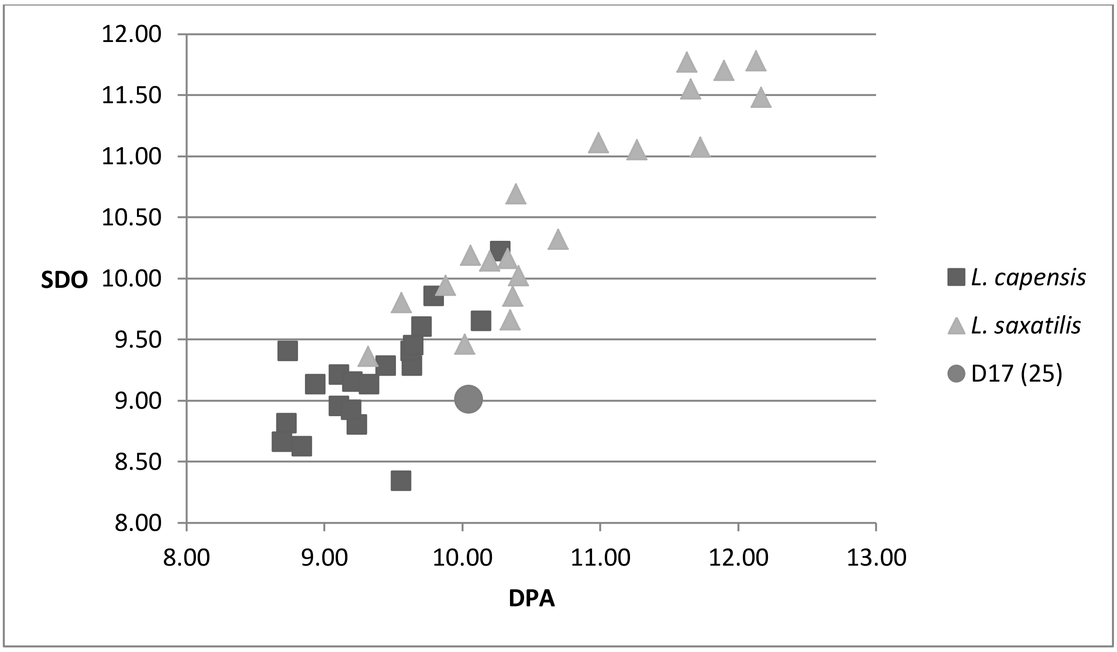


Figure 4.413: Ulna measurement SDO vs DPA indicating the archaeological specimen's position in the scatter plot

D17 (25)	Lagomorpha	Right - tibia distal medial articulation	1	*L. capensis*	The observed morphology matches the protocols established. Measurement DDL - 6.05 falls within the established mean (Figures 4.414 & 4.415; Figure 4.416).

Figure 4.414: D17 (25) – *L. capensis* – Right tibia distal medial articulation. Measurement DDL indicated. Greatly enlarged, no scale given

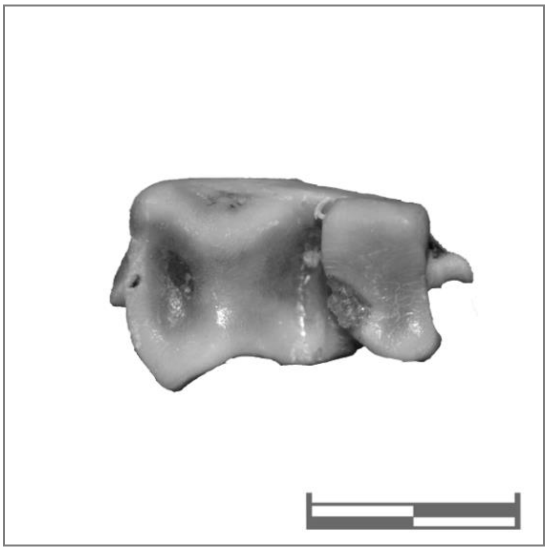


Figure 4.415: *L. capensis* – Left tibia distal articulation for comparison

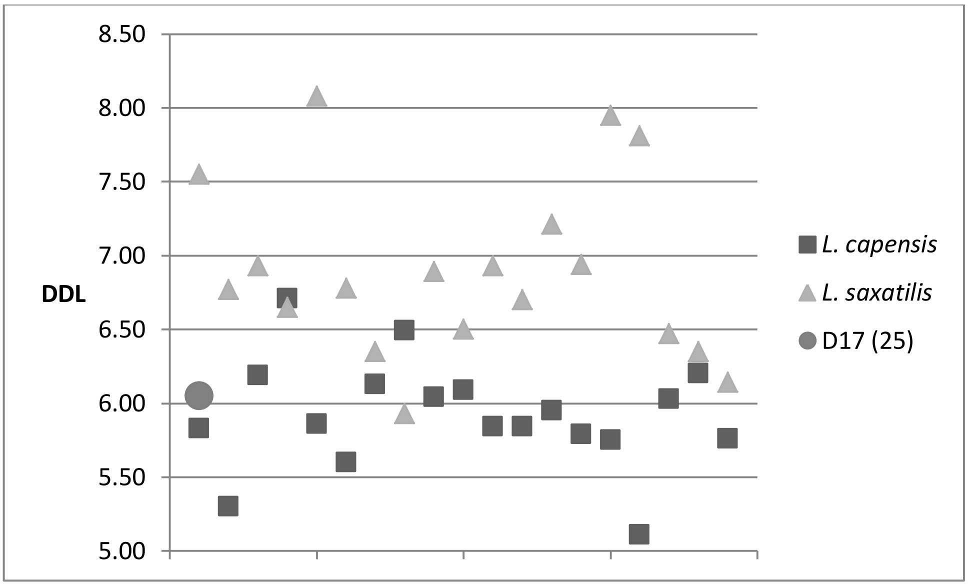


Figure 4.416: Tibia measurement DDL indicating the archaeological specimen's position in the line graph

C 134 (15)	*Lepus* spp.	Right - femur caput	1	Non-*Lepus* spp.	Measurements DC - 11.19; CB - 11.17 falls outside the biggest measurements for *L. saxatilis*. The morphology observed does not match either (Figures 4.417 & 4.418; Figure 4.419).

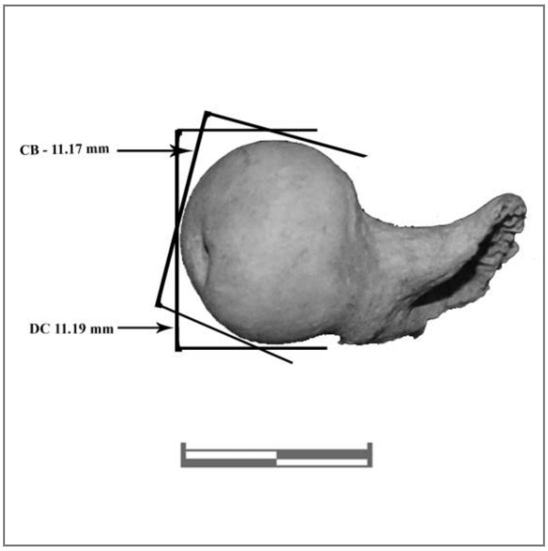


Figure 4.417: C 134 (15) – Non-*Lepus* spp. – Right femur caput. Measurements CB and DC indicated.

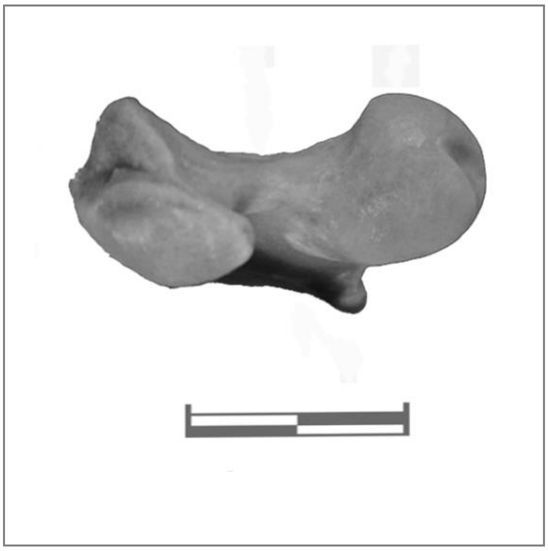


Figure 4.418: *L. saxatilis* – Left femur caput for comparison

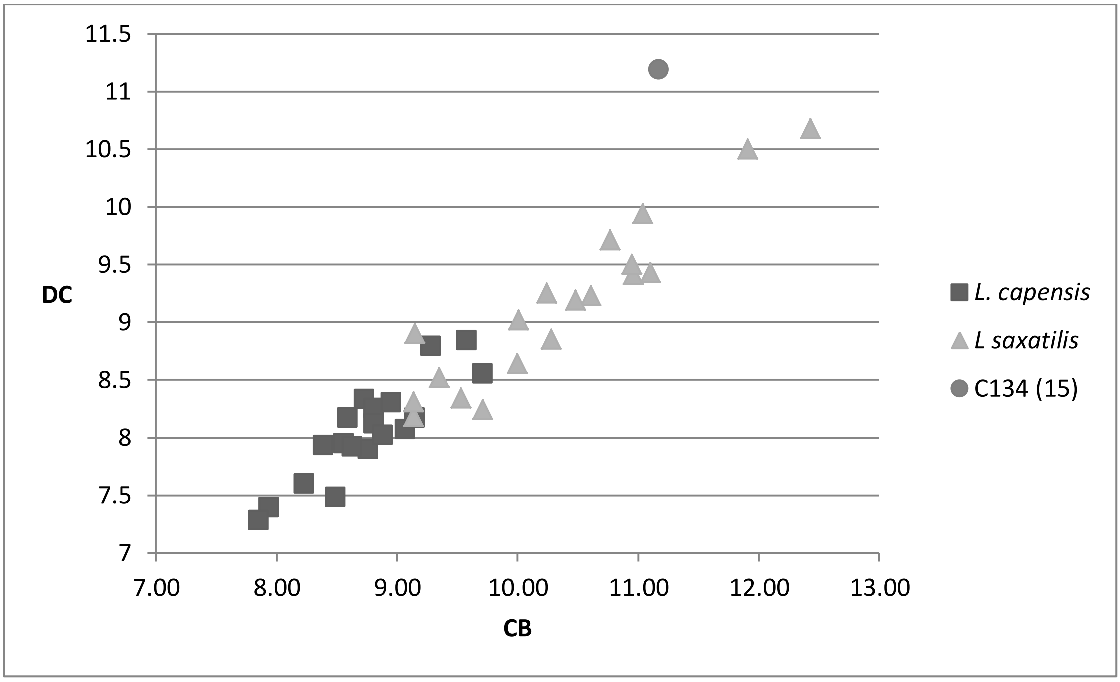


Figure 4.419: Femur measurement DC vs CB indicating the archaeological specimen's position in the scatter plot

B24 (17)	*Lepus saxatilis*	Right talus	1	Confirmed identification *L saxatilis*	Identification based on measurements DC - 6.63 and GL - 12.72 (Figures 4.420 & 4.421; Figures 4.422 & 4.423; Figure 4.424).

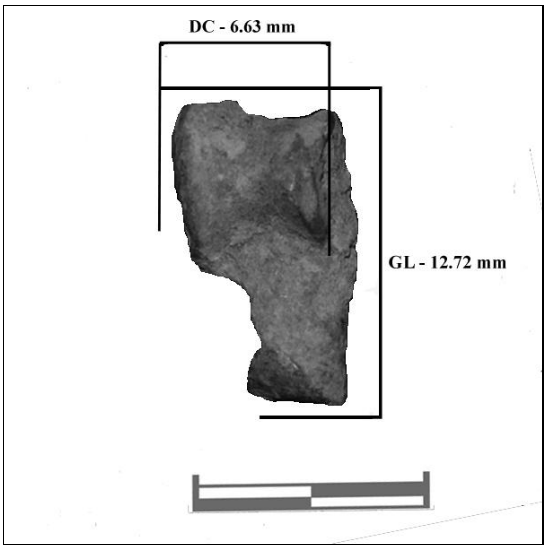


Figure 4.420: B 24 (17) – *L. saxatilis* – Right talus dorsal view. Measurements DC and GL indicated

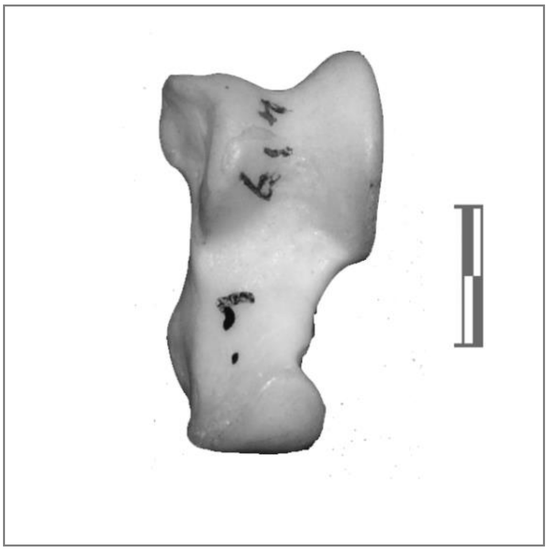


Figure 4.421: *L. saxatilis* – Left talus dorsal view for comparison

Figure 4.422: B 24 (17) – *L. saxatilis* – Right talus plantar view

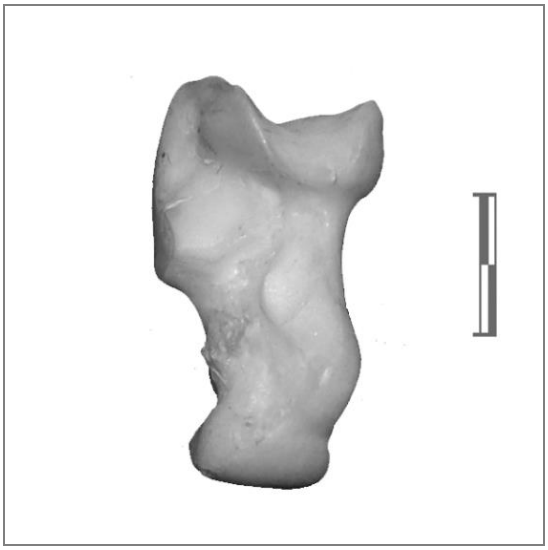


Figure 4.423: *L. saxatilis* – Left talus plantar view for comparison

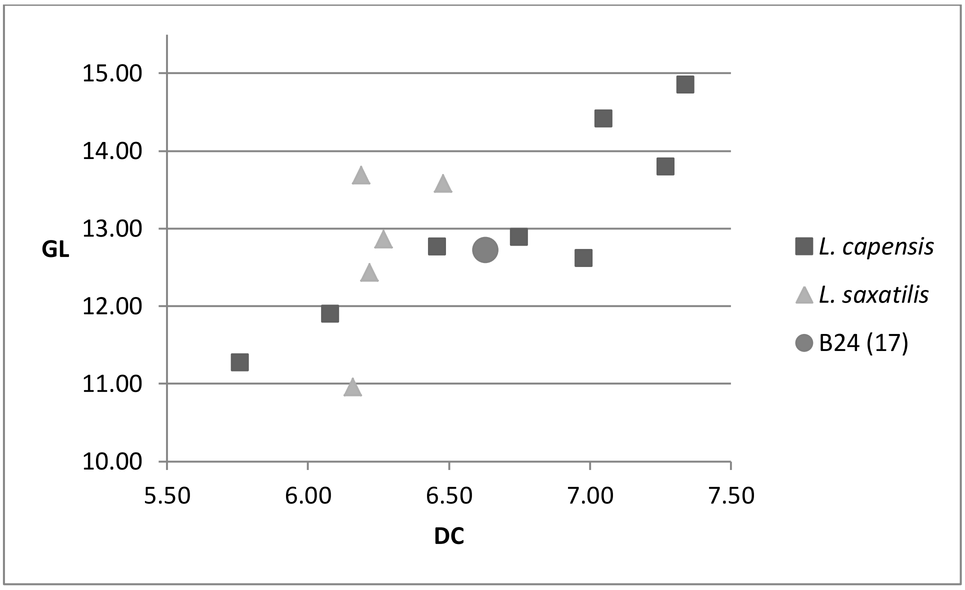


Figure 4.424: Talus measurement GL vs DC indicating the archaeological specimen's position in the scatter plot

4.3.3 Meerkat

The faunal assemblage of Meerkat produced a NISP of 53 Lagomorpha specimens. 49 specimens were originally identified as either Lagomorpha or Lagomorpha-size and four specimens were identified as cf. *Pronolagus* spp. Fifteen of the specimens comprised Lagomorpha teeth and were not re-examined nor listed in Table 4.21. For a summary of the results see Table 6.23.

Table 4.21: Meerkat Rock Shelter reanalyses results

Block	**Original ID**	**Skeletal element**	**NISP**	**New ID**	**Reason**
MC A East fall collapse	Lagomorpha	Right - tibia midshaft	1	Non-*Lepus* spp.	Measurement SD 4.21 makes it too small for *Lepus* spp.
MC A 15(5)	Lagomorpha	Humerus distal articulation and shaft	1	Non-*Lepus* spp.	Misidentification.
MC A3 (8)	Lagomorpha	Right - ulna proximal articulation	1	Non-*Lepus* spp.	Misidentification.
MC A3 (9)	Lagomorpha	Left - femur caput	1	*Pronolagus* spp.	Measurements DC - 6.44; CB - 6.62 makes it too small for *L. capensis*.
MC A5 (5)	Lagomorpha	Left - ulna shaft lateral proximal artic	1	cf. *L. capensis*	Measurement BPC - 7.13 places it in the range of *L. capensis*. It is too fragmented to identify species.
MC A8 (4)	Lagomorpha	Ulna lunar notch + shaft	1		Too juvenile for identification.
MC A12 (12)	Lagomorpha	Left - femur proximal shaft	1		Too fragmented for identification.
MC B4 (5)	Lagomorpha	Tibia distal articulation	1		Juvenile – misidentification.
MC A15 (6)	Lagomorpha	Left - scapula glenoid and neck	1	Non-*Lepus* spp.	Measurement Bg - 6.49 makes it too small for *L. capensis*. Appearance looks juvenile.
MC B1 (6) Grey	Lagomorpha	Left pelvis acetabulum	1	*Pronolagus* spp.	Measurement LAR - 7.45 makes it too small for *L. capensis*. The morphology makes it Lagomorpha.
MC B1 (8)	Lagomorpha	Left pelvis acetabulum	1		Too fragmented - no measurements or identification possible.
MC B6 (6)	Lagomorpha	Left – tibia distal articulation	1		Juvenile - misidentification
MC B2 (6)	Lagomorpha	Mandible articulation	1	cf. *Pronolagus*	The morphology is different to that of *Lepus* spp. but gross morphology is still

				spp.	Lagomorpha.
MC B15 (7.5)	Lagomorpha	Acetabulum	1		Too fragmented for measurement or species identification.
MC B14 (7.5)	Lagomorpha	Acetabulum	1		Too fragmented for identification.
MC B11 (5)	Lagomorpha	Right - scapula blade	1		Midblade difficult to identify to species.
MC B5 (6)	Lagomorpha	Right - ulna proximal articulation	1	cf. *L. saxatilis*	Measurements BPC - 7.56 articulation measures to *L. saxatilis*, DPA - 7.50 olecranon measurement falls outside the ranges. Morphology of olecranon looks different to that of *L. saxatilis* hence the cf. identification.
MC B5 (7.5)	Lagomorpha	Left - ulna proximal articulation and shaft	1	*Pronolagus* spp.	Measurement BPC - 6.16 is too small for *L. capensis* and morphology looks different. The gross morphology is still Lagomorpha. Juvenile.
MC B10 (5)	Lagomorpha	Left - tibia distal articulation	1	Non-*Lepus* spp.	Juvenile - misidentification.
MC B 6(7)	Lagomorpha	Tibia distal articulation	1	*Pronolagus* spp.	Juvenile and very worn. Measurement Bd - 10.32 is smaller than the *L. capensis* range.
MC B 6(7)	Lagomorpha	Right - humerus proximal articulation and shaft	1	*Pronolagus* spp.	Measurement Dp - 10.51 is smaller than the range for *L. capensis*.
MC B 6(7)	Lagomorpha	Femur condyle	1		Too fragmented for identification.
MC B8 (6)	Lagomorpha	Left - Astragalus	1	Non-*Lepus* spp.	Misidentification.
MC B5 (6)	Lagomorpha	Scapula blade	1		No species identification possible.
MC A9 (10)	Lagomorpha size	Right - tibia proximal - midshaft	1		Too juvenile for identification.
MC A7 (9)	cf. *Pronolagus* spp.	Radius proximal articulation and shaft	1	Non-*Lepus* spp.	Misidentification.
MC A10 (8)	cf. *Pronolagus* spp.	Left - ulna proximal artic	1	Non-*Lepus* spp.	Misidentification.

Continuation of Table 4.21: Meerkat Rock Shelter reanalyses results. These specimens were selected to illustrate the morphology (photo's) and morphometrics (line graphs and scatter plots) employed in the reanalyses (Figures 4.425 – 4.454).

MC B6 (5)	Lagomorpha	Left - mandible and molars	4	*Pronolagus* spp.	Measurements #6 - 9.60 and #4 - 15.81 places the fragment outside the *Lepus* spp. range. The morphology is still Lagomorpha (Figures 4.425 & 4.426; Figure 4.427).

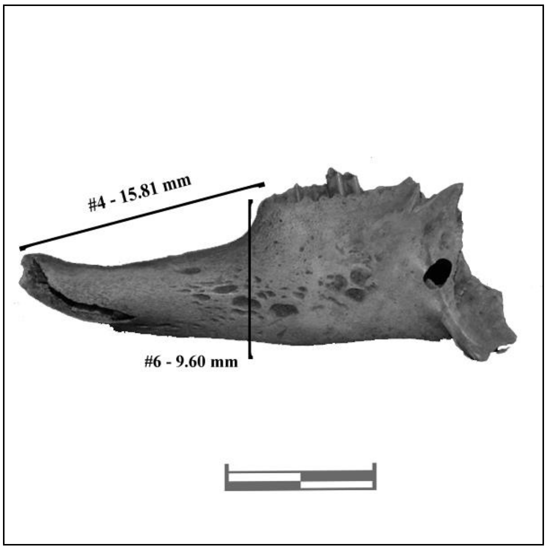


Figure 4.425: MC B6 (5) – *Pronolagus* spp. – Left mandible

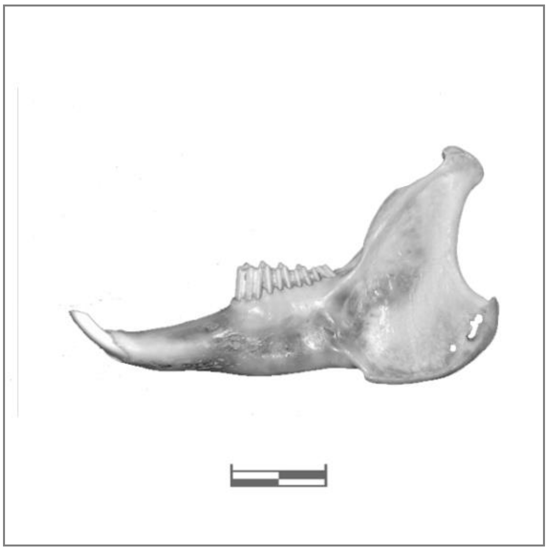


Figure 4.426: *L. capensis* – Left mandible for comparison

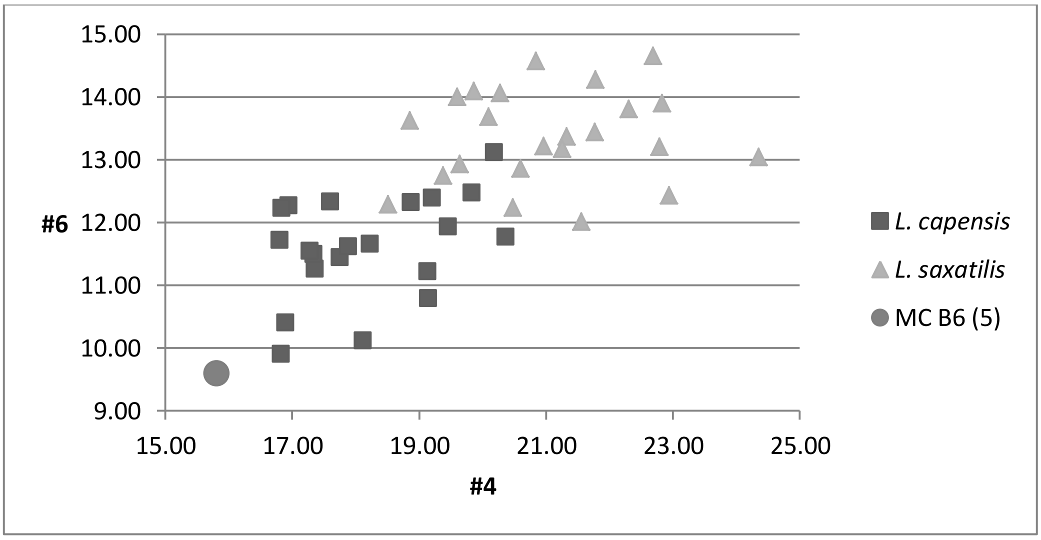


Figure 4.427: Mandible measurement #6 vs #4 indicating the archaeological specimen's position in the scatter plot

MC B15 (7.5)	Lagomorpha	Right - ulna proximal artic	1	Non-*Lepus* spp.	Measurement BPC - 7.52 is in line with *Lepus* spp. although the morphology is not. Misidentification (Figures 4.428 & 4.429; Figures 4.430 & 4.431; Figures 4.432 & 4.433; Figure 4.434)

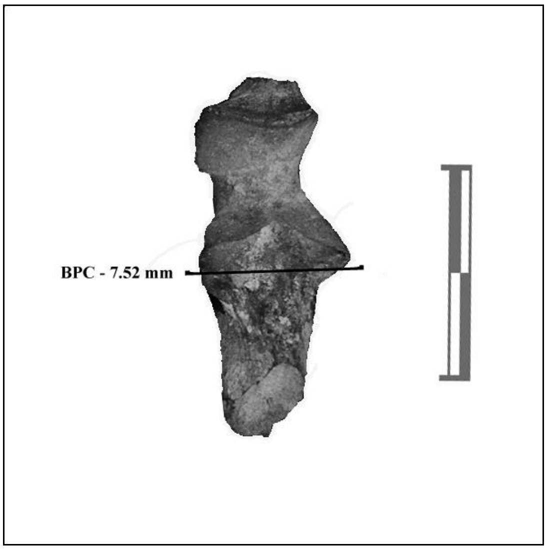


Figure 4.428: MC B15 (7.5) – Non-*Lepus* spp. – Right ulna proximal articulation with measurement BPC indicated

Figure 4.429: *L. capensis* – Left proximal ulna for comparison

Figure 4.430: MC B15 (7.5) – Non-*Lepus* spp. – Right ulna proximal lateral view

Figure 4.431: *L. capensis* – Left ulna proximal lateral view for comparison

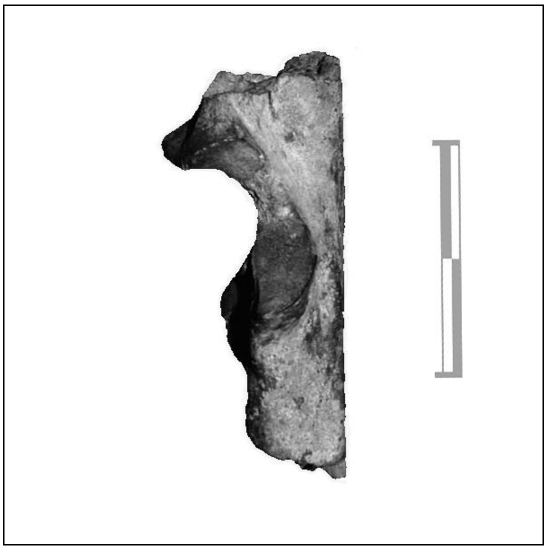


Figure 4.432: MC B15 (7.5) – Non-*Lepus* spp. – Right ulna proximal medial view

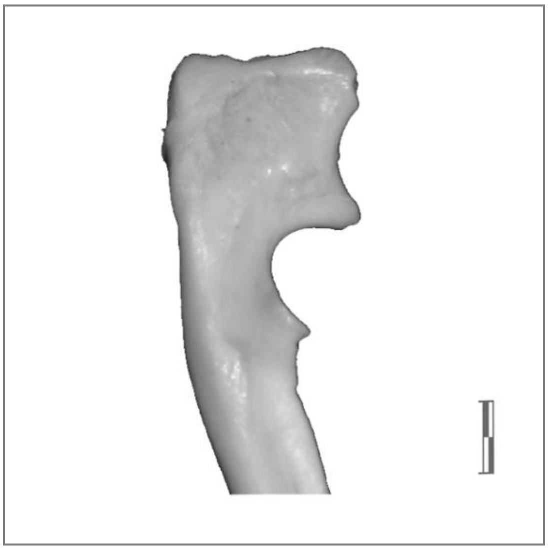


Figure 4.433: *L. capensis* – Left ulna proximal medial view for comparison

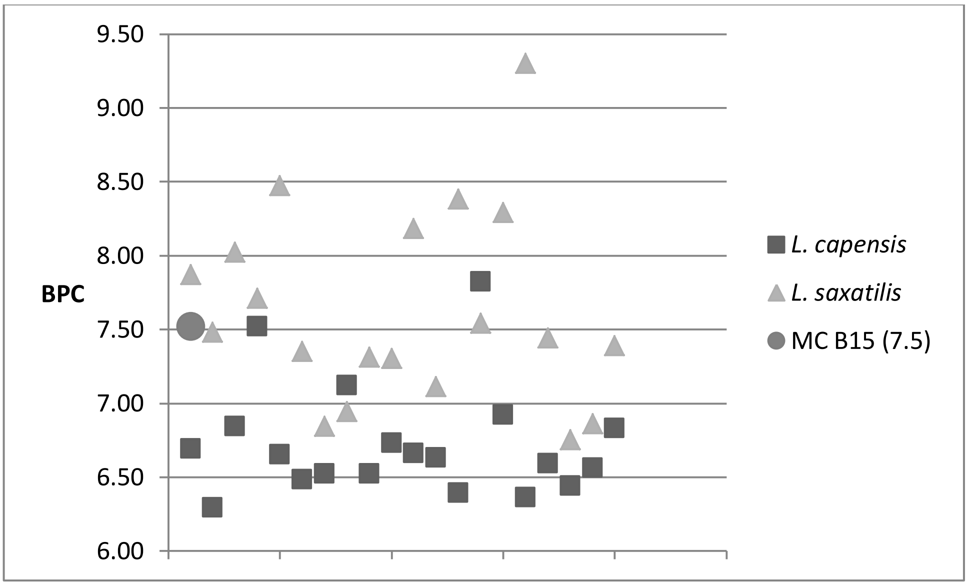


Figure 4.434: Ulna measurement BPC indicating the archaeological specimen's position in the line graph

MC B16 (3)	Lagomorpha	Right - scapula glenoid and neck	1	cf. *L. capensis*	The measurements BG - 9.13; GLP - 10.52; LG 8.85; SLC - 6.35 all fall within the ranges of both *L. capensis* and *L. saxatilis*. Based on the morphology the specimen is *L. capensis* (Figures 4.435 & 4.436; Figure 4.437; Figures 4.438 & 4.439; Figure 4.440).

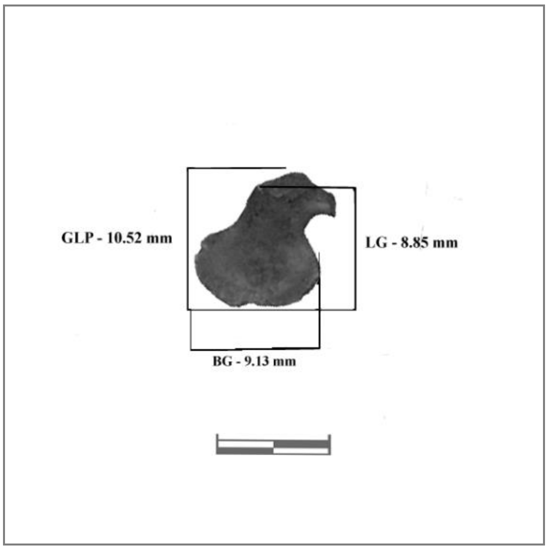


Figure 4.435: MC B16 (3) – cf. *L. capensis* – Right scapula glenoid. Measurements GLP, LG and BG indicated

Figure 4.436: *L. capensis* – Left scapula glenoid for comparison

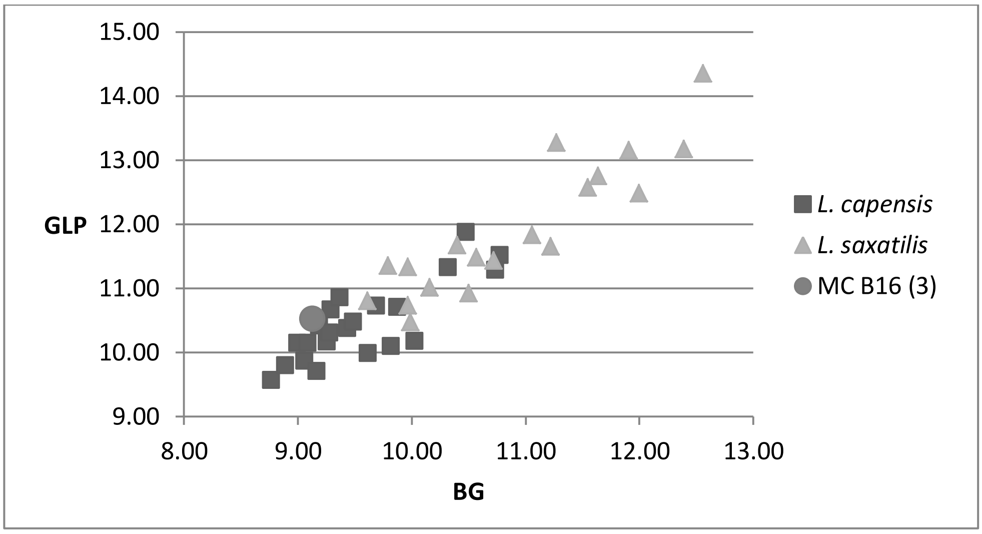


Figure 4.437: Scapula measurement GLP vs BG indicating the archaeological specimen's position in the scatter plot

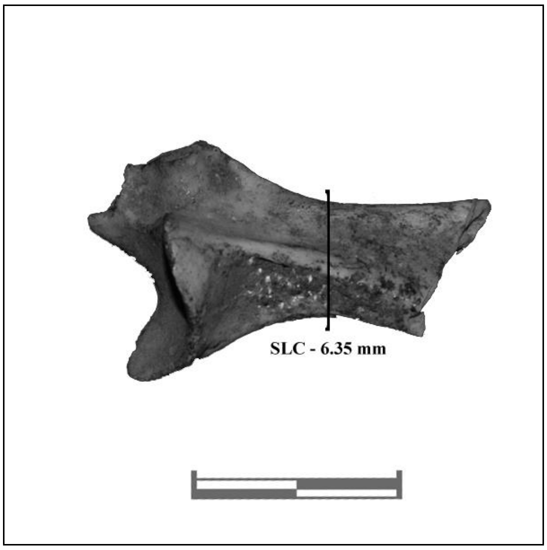


Figure 4.438: MC B16 (3) – cf. *L. capensis* – right scapula medial view. Measurement SLC indicated

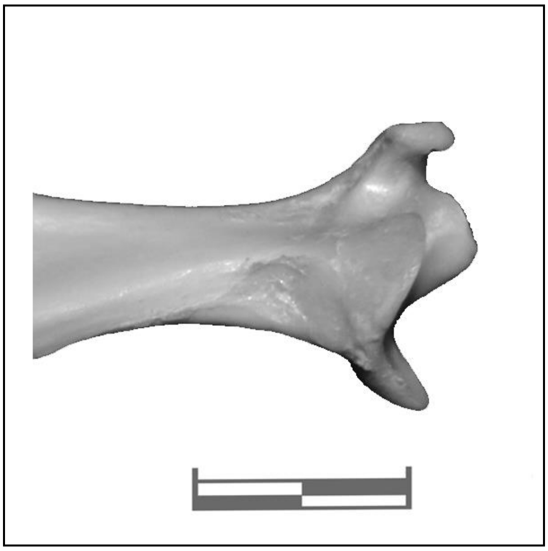


Figure 4.439: *L. capensis*– Left scapula medial view for comparison

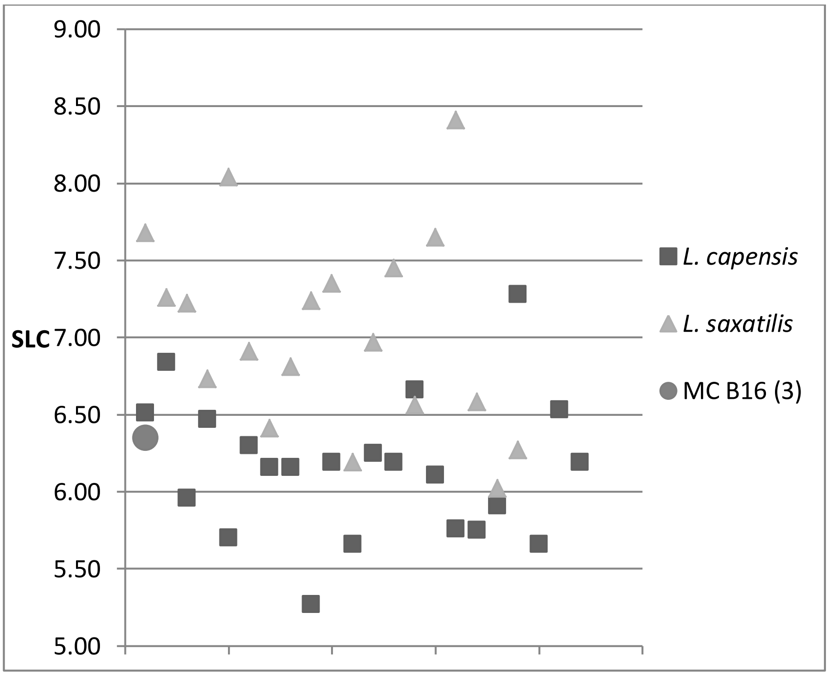


Figure 4.440: Scapula measurement SLC indicating the archaeological specimen's position in the line graph

MC A 3 (10)	cf. *Pronolagus* spp.	Right - pelvis acetabulum, ilium and ischium	1	Non-*Lepus* spp.	Measurements LAR - 8.00; SH - 7.87; SB - 4.31 are all smaller than *L. capensis*. The morphology is also different - misidentification (Figures 4.441 & 4.442; Figure 4.443, 4.444; Figures 4.445 & 4.446; Figure 4.447).

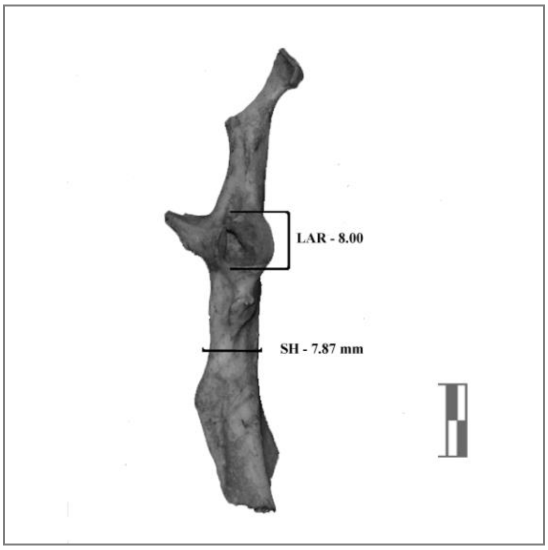


Figure 4.441: MC A3 (10) – Non-*Lepus* spp. – Right pelvis with LAR and SH measurements indicated

Figure 4.442: *L. saxatilis* – Left pelvis for comparison

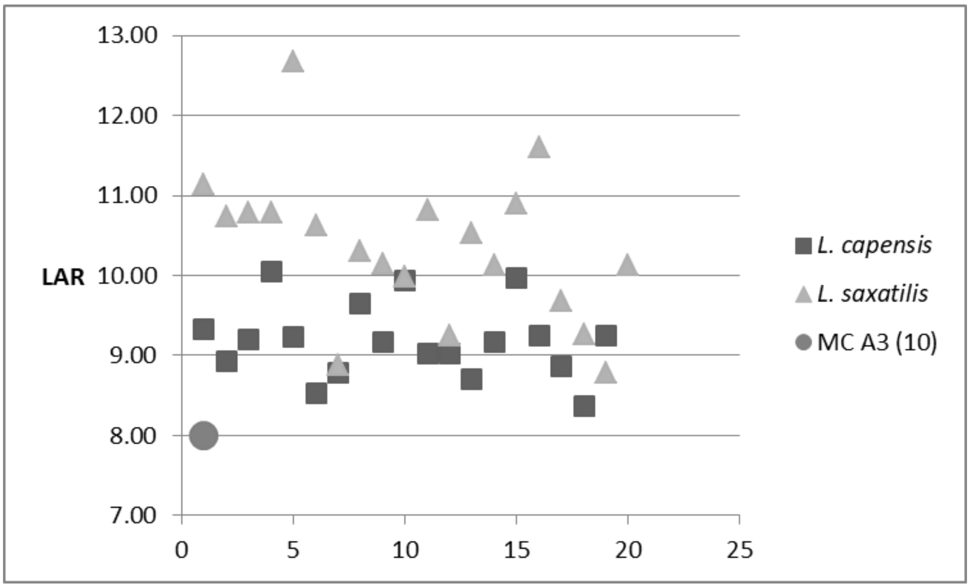


Figure 4.443: Pelvis measurement LAR indicating the archaeological specimen's position in the line graph

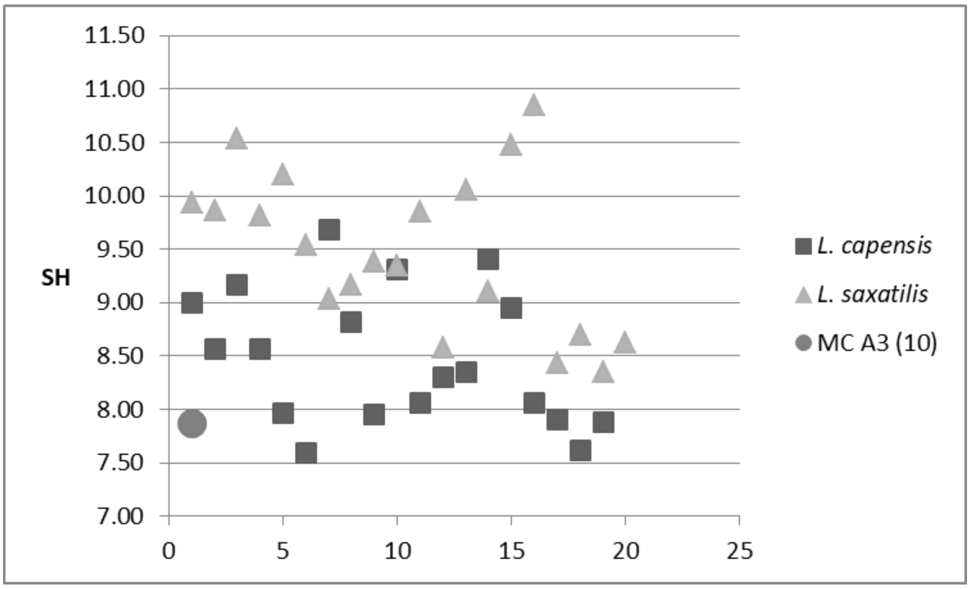
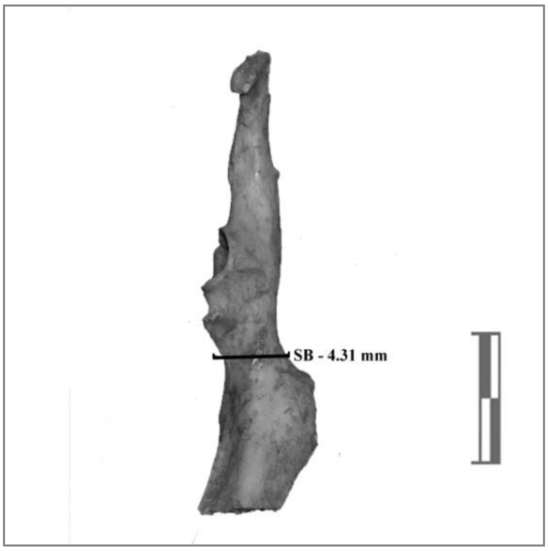


Figure 4.444: Pelvis measurement SH indicating the archaeological specimen’s position in the line graph



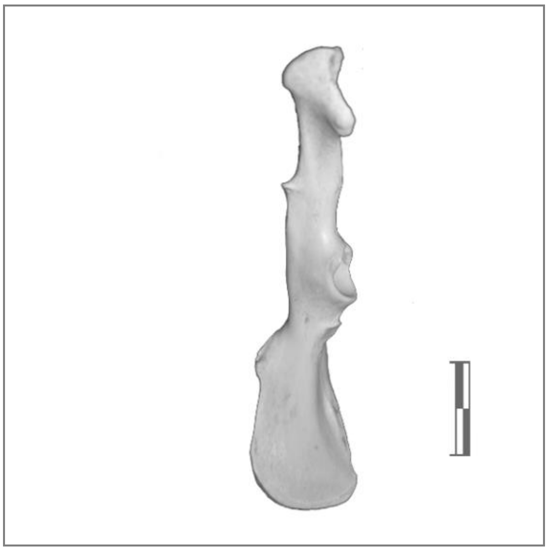


Figure 4.445: MC A3 (10) – Non-*Lepus* spp. – Right pelvis with SB measurements indicated

Figure 4.446: *L. saxatilis* – Left pelvis for comparison

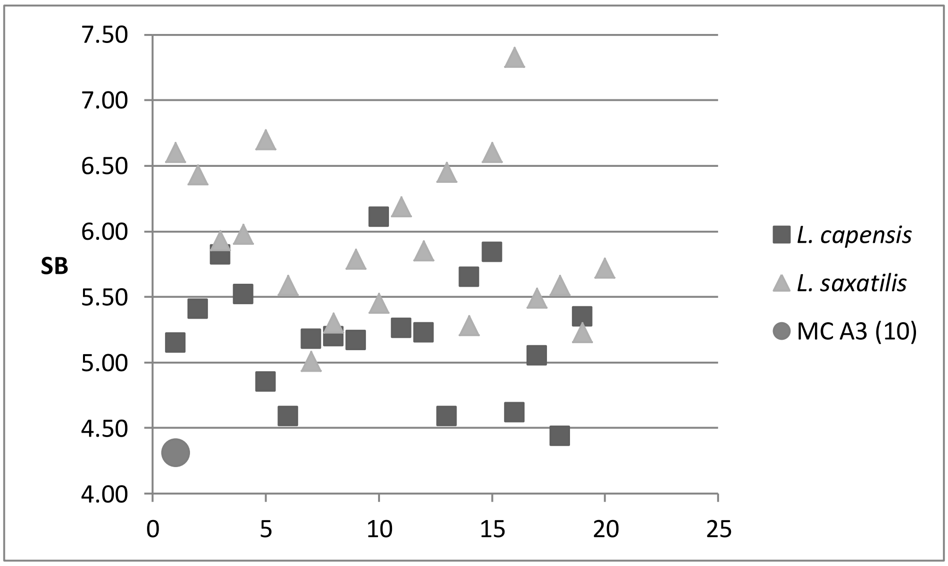


Figure 4.447: Pelvis measurement SB indicating the archaeological specimen’s position in the line graph

MC A7 (9)	cf. *Pronolagus* spp.	Right - scapula glenoid to midblade	1	Confirmed	Measurement BG - 7.10, LG - 7.24; GLP - 9.27; SLC - 4.74; coupled with the observed morphology makes the specimen Lagomorpha but not *Lepus* spp. (Figures 4.448 & 4.449; Figures 4.450. 4 451; Figures 4.452 & 4.453; Figure 4.454).

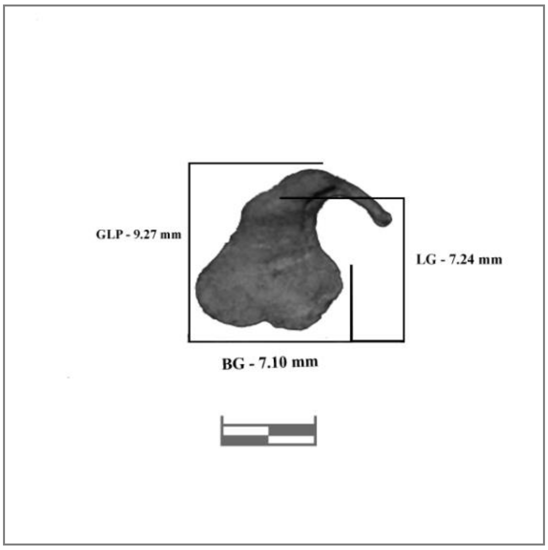


Figure 4.448: MC A7 (9) – cf. *Pronolagus* spp. – Right scapula glenoid with measurements GLP, LG and BG indicated

Figure 4.449: *L. capensis* – Left scapula glenoid for comparison

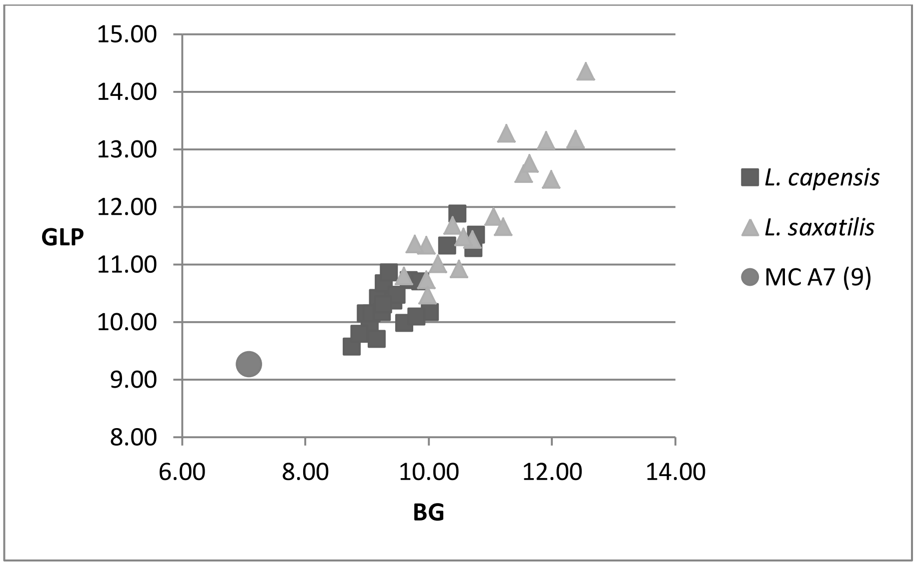


Figure 4.450: Scapula measurement GLP vs BG indicating the archaeological specimen's position in the scatter plot

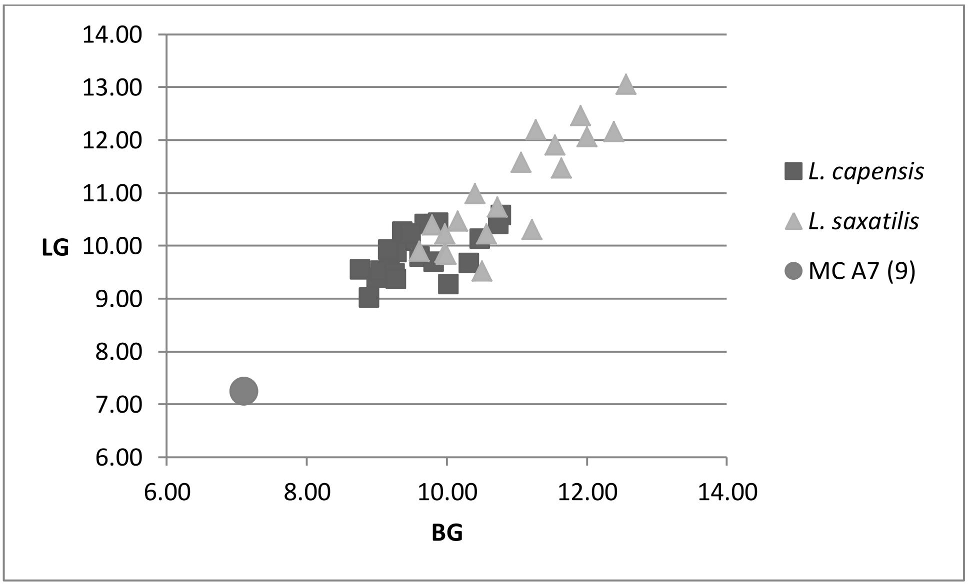


Figure 4.451: Scapula measurement LG vs BG indicating the archaeological specimen's position in the scatter plot

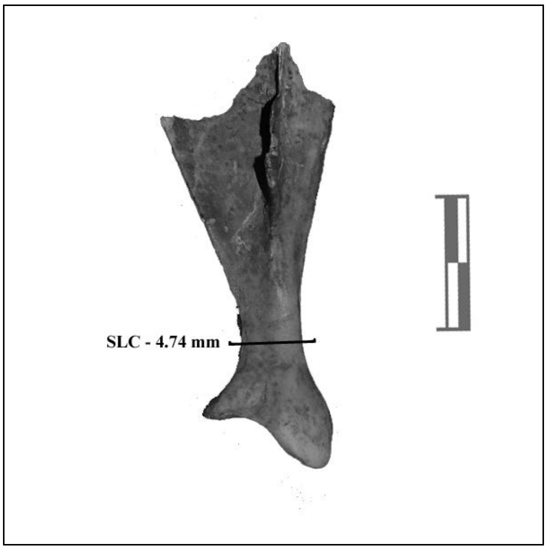


Figure 4.452: MC A7 (9) – cf. *Pronolagus* spp. – Right scapula lateral view. Measurement SLC indicated

Figure 4.453: *L. capensis* – Left scapula lateral view for comparison

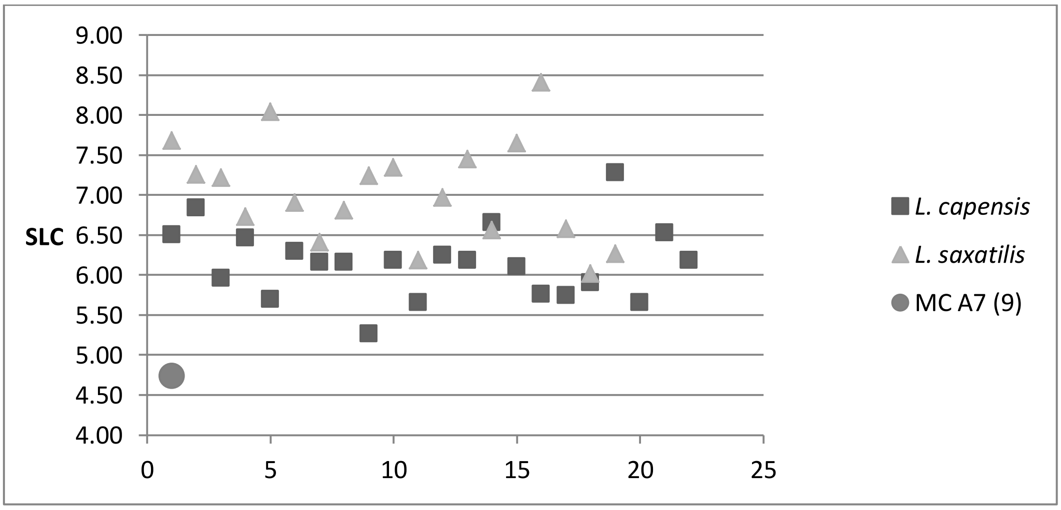


Figure 4.454: Scapula measurement SLC indicating the archaeological specimen’s position in the line graph

4.4 Summary of Chapter 4

The protocols that I have established clearly reflect differences and similarities between each element of the two species of *L. capensis* and *L. saxatilis*. On almost all measurements *L. saxatilis* has proven to be larger than *L. capensis.* Most of the acquired measurements have yielded high statistical significance at p<0.001. The sexual differences observed in parts of certain elements definitely need to be explored in future studies.

4.4.1 Skull

- All measurements proved statistically highly significant.
- Of the new measurements that have been added on account of the observed morphology, number 22 (*bullae* diagonally across) proved to be statistically significant. The 95% confidence levels of this measurement demonstrate that *L. capensis* has larger *bullae* than *L. saxatilis*. Larger *bullae* are an evolutionary adaptation for open grassland living (Ge et al. 2015: 278), the preferred habitat of the Cape hare. The most useful identified morphological differences are in the orientation of the nasal area when the complete skull is placed on the cranium.
- The differences in the orientation of the *foramen magnum* and the differences in the shapes of the *occiputs* between the two species of hare are very useful for identification when a full or partial skull is examined.

4.4.2 Mandible

- All measurements proved statistically highly significant.
- The mandible of *L. saxatilis* appears much stronger than that of *L. capensis*. This could possibly be attributed to their differing food preferences. Where *L. capensis* grazes and browses, *L. saxatilis* eats leaves, stems and rhizomes.

4.4.3 Atlas

- All measurements proved statistically highly significant.
- The morphometrics alone are not useful on account of the irregular shape of this bone.
- When dealing with fragmentary material, the differences observed in the cranial articulation and the ventral arch of the two species of hare are noteworthy.

4.4.4 Axis

- All measurements proved statistically highly significant.
- The morphometrics alone are not very useful on account of the irregular shape of this bone.
- When dealing with fragmentary material, the shape of the collar and the presence or absence of the line on the dorsal side will be very useful.

4.4.5 Scapula

- All measurements proved statistically highly significant.
- In the fragmentary archaeological record, the glenoid is the most commonly found part of this element. When portions of the blade are present, they seldom have diagnostic features to allow for group or species identification.
- The caudal margin differences are thus very beneficial in fragmentary material.
- The differences in the glenoid are exceptionally valuable for taxonomic identification.
- The differences observed in the glenoid of the male and female specimens need further exploration, since it will provide useful information on population dynamics.

4.4.6 Humerus

- All measurements proved statistically highly significant.
- The proximal articulation is seldom found in faunal assemblages. When present, the differences observed in this region will be useful.
- Humerus shafts are often present and the observation regarding the deltoid tuber and the morphology that can be felt when the element is handled will aid identification.
- The distal articulation, with or without the shaft attached, is often present in archaeological faunal assemblages. The differences reported between the two hares will definitely enable secure species identification.
- The differences between male and female specimens observed in the area above the interosseous space need to be further explored. If the observed differences hold up under further scrutiny, it will be of great assistance when questions regarding population dynamics are investigated.

- The measurement of the breadth of the distal articulation between *L. capensis* and *L. saxatilis* proves to be a very useful distinction.

4.4.7 Radius

- All measurements proved statistically highly significant.
- As the proximal articulation is often all that is present in fragmented faunal material, the observed differences will aid in species identification.

4.4.8 Ulna

- All measurements proved statistically highly significant.
- The groove on the semi-lunar notch that is present in *L. capensis* and absent or very faint in *L. saxatilis* is very advantageous as this is often the only part of the ulna that is recovered.

4.4.9 Radius and Ulna

- For the identification of shafts, the differences observed between the two species are extremely beneficial, not only for species identification but also for species elimination.

4.4.10 Pelvis

- All measurements for the disarticulated pelvis are statistically significant. Interestingly, although there are clear morphological distinctions observed in the complete pelves, the measurements of the few articulated pelves are not statistically significant at all.
- *L. saxatilis* definitely exhibits much stronger muscle attachments.
- The most significant difference established between the two species of hare is the orientation of the pubis when the complete disarticulated pelvis is laid on its dorsal edge.
- The orientation of the ilia wing also aids in the identification of fragmented material.
- The GL measurement is the most clearly distinct measurement observed in the two species.
- The hind limbs of both species are very diagnostic in both their morphology and their morphometrics. This can be attributed to the differences in the way these two hares run and hop.

4.4.11 Femur

- All measurements proved statistically highly significant.
- The differences observed in the proximal shaft and articulation facets of each of the species of *Lepus* spp. are beneficial as this part of the element is often found among faunal material:
    - This applies especially to the ridge connecting the caput and the major trochanter,
    - Diagnostic differences in the orientation of the *inter trochanterica* can be used to differentiate between the two hare species.
- The distal articulation is sometimes preserved in an archaeological assemblage. The distinctive thickening of the medial ridge of the trochlea in *L. capensis* is an exceptionally valuable feature to differentiate between hare species in fragmented material.

4.4.12 Tibia

- All measurements proved statistically highly significant.
- The differences observed in the proximal articulation are very advantageous for the identification of fragmented *Lepus* spp. material, especially the differences observed in the sulcus and the tuber.
- The curvature of the shaft could prove useful in fragmented material although this remains untested.
- Differences in the distal articulations of these two hares are particularly beneficial as this part of the element is often present.

On account of the small sample sizes the differences in the smaller bones are only hinted at and could not be confirmed. No statistical significance could be determined in the measurements taken on the smaller elements, although some of the 95% indexes did produce interesting results.

4.4.13 Patella

- The observed morphology will have to be examined further, using an increased sample size, in order to validate the observations that were made.

4.4.14 Calcaneus and Talus

- There are definite morphological differences between *L. capensis* and *L. saxatilis* in these two skeletal elements. These bones have a high skeletal density and are often present in the archaeological faunal record. The differences are extremely valuable for identification.

4.4.15 Metacarpals and Metatarsals

- There are distinct differences between the metacarpals and the metatarsals especially in the proximal articulations.
- Each individual metacarpal and metatarsal bone exhibits unique proximal features that make them distinguishable from each other. Furthermore, the distinctions will positively contribute to the identification on species level in fragmented material.
- According to the 95% confidence level, the proximal articulations of the front and hind feet of *L. capensis* are larger than those of *L. saxatilis*.
- It will be interesting to see if this trend holds ground when a larger sample size is available for examination.
- Although not statistically significant at the moment, the individual measurements have proved very useful for species identification as well as elimination.

4.4.16 Archaeological applications

From the discussion it is evident that *L. capensis* and *L. saxatilis* can now be taxonomically distinguished from each other. The established protocols also make it easier to separate their remains from those of other Lagomorphs and similarly-sized small mammals. Both hares and at least one rabbit species occurred in the area when the two rock shelters were occupied. It is clear that they, and several other small mammal species, formed part of the diet during the occupation phases of the sites. No other conclusions can be drawn from the reanalysis at this time as it will require the inclusion of the full faunal lists compiled for both sites.

In the next chapter, the potential applications and value of identifying the Lagomorpha and other small mammals to species level are discussed. This discussion is rooted in southern African ethnoarchaeology and encompasses both dietary and non-dietary utilisation. Examples and case studies on procurement and consumptive patterns during the southern

African prehistorical and historical periods are explored. The discussion will also point out future research directions.

CHAPTER 5

ARCHAEOLOGICAL APPLICATIONS

5.1 Introduction

Historically, the emphasis in archaeozoological research in South Africa has fallen on large animals. These animals are generally procured through hunting and to a lesser degree, through scavenging at carnivore kills. Less attention has been paid to medium-sized and smaller animals that were gathered or trapped. The research generally focused on large herbivores, which resulted in an over-emphasis on their contribution to overall dietary protein. This disregard for medium/smaller animals, in part, relates to the reasons discussed in Chapter 2.

The premise of my research is that smaller species (with an adult weight of less than 15kg) were utilised to a greater extent than has formerly been acknowledged. Study on small game remains recovered from archaeological deposits can yield new insights on their importance in prehistoric diet and subsistence practices as well as possible cultural significances. The current research was primarily aimed at establishing skeletal differences between the two southern African species of hare, *Lepus capensis* and *Lepus saxatilis*. The ability to distinguish between the two species will be meaningless if the data are not used to enhance our understanding of the faunal and archaeological record. Granted, it is difficult for archaeologists to determine the abstract roles of animals in culture or to accurately identify non-dietary exploitation practices (Speth 2013: 181, 183; Dueppen & Gokee 2014; Badenhorst 2015: 48). As the remains of small and medium animals are present in most, if not all, archaeological faunal samples the role they played in diet and culture should be investigated.

In South Africa, the remains of micro and small mammals are used more extensively in Stone Age research in studies that range from cognitive behaviour to environmental reconstruction (Avery 1988; Clark & Plug 2008; Armstrong 2016). These mammals, although certainly present, are seldom mentioned or discussed in Iron Age studies and are often listed and dismissed as intrusive or pest species (Voigt & Von den Driesch 1984: 100; Nelson 2008: 57; Atwood 2014: 193; Badenhorst 2015: 45; Badenhorst et al. 2016). Not all the small animal species in archaeological assemblages can be explained away as ‘self-introduced’ or the prey of commensal human predators or that they inhabited the area around the settlement (Driver 1985: 18 in Shaffer 1992b: 686; Morlan 1994).

In this chapter, the possible uses and extent of exploitation of both hares are discussed. It is, however, difficult in the southern African archaeological context to isolate specific small mammal species as ethnographic information on their utilisation is somewhat limited. The ethnographic records were written by European travellers and missionaries who were not trained as anthropologists and had their own areas of interest supplemented by their own cultural biases. Thus, inferences have to be made, since small game certainly represented an important food and by-product source for humans through time. In light of the above explanation, ethnographic information on hares will be mentioned. For the rest, it is necessary to place both hares within the general context of all small mammals and animals.

5.2 Background

A long standing debate amongst specialists is whether abundance of large animal remains actually reflects historical encounter rates. Do they not rather reflect inadequate sampling, taphonomic impact, the hunter’s choice - ‘schlepp effect’ - or the limitations of identification practices (Lupo & Schmitt 2016: 194-195). Optimal Foraging Theory (OFT), prey choice and Dietary Breadth models all explain a ranking order for procurement based on energy yield (kilocalories). Larger animals will rank higher than small animals as they have a higher net-energy return rate (Haws & Hockett 2004: 174).

Foraging is divided into two categories, i.e. search and handling. Search is random and is calculated across all resources encountered. Handling time includes the pursuit, processing and consumption of the resource in question. The assumption is that people attempt to maximise returns by adding resources to their diet in ranking order. In these models, people will always pursue high ranked resources and only add lower ranked prey because they are encountered while higher ranking resources are sought (Lupo 2007: 147-148). Women tend to focus on low-ranking prey, since they are often accompanied by children on foraging trips. Available technology and assistance from a person or group, abundance of game, taboos, believes, kinship, politics, culture and many other factors play a role in decisions of which prey to acquire (Haws & Hockett 2004: 177; Lupo 2007: 149; Speth 2013: 180-181). The largest mammalian prey, the African elephant, ranks lowest when pursuit and handling are taken into account. This huge animal ranks eighth on the scale placing it below the duiker (*Sylvicapra grimmia*), springhare (*Pedetes capensis*) and steenbok (*Raphicerus campestris*) that occupy the top three positions (Lupo & Schmitt 2016: 192). Prey profitability is not based on size but on the availability of technology and the ecology of the species in question.

Humans as broad spectrum omnivores make use of an extensive range of food resources that are available in their particular environments. The nutritional ecology approach looks at what is needed for optimal human health of both individuals and populations. Energy consumption still plays a role although the focus has shifted to intake of a diversity of essential nutrients for a balanced diet. This approach assumes that humans make dietary choices that promote their wellbeing (either accidentally or intentional), and that a wide variety of food is better for the individual as well as the sustained thriving of the group (Haws & Hockett 2004; Hockett & Haws 2005; Kyriacou et al. 2014; Thompson & Henshilwood 2014; Kyriacou et al. 2016). Humans generally eat only what they believe is consumable. Although the above approach assumes that dietary choices are made to promote wellbeing, in practice dietary habits are determined by culture, religion, personal choice, food allergies, food taboos or seasonality amongst many other factors.

5.2.1 What constitutes a 'small mammal'?

There are approximately 4700 mammal species in the world, a quarter (1229) of them occurring in Africa, of which 960 are located in sub-Saharan Africa. Eastern and southern savannas host large populations of mammals, including 79 species of antelope (Scholes et al. 2006: 227). The southern African sub-region has 354 mammal species in 152 genera (Skinner & Chimimba 2005: xvii). Sub-Saharan Africa has about 1600 endemic species of birds (Encyclopaedia of Earth 2011), and Africa as a whole has 950 amphibian species and a conservative estimate of 2000 fish species (Encyclopaedia of Earth 2011). According to Branch (2005), southern Africa has the richest diversity of reptiles on the continent that currently comprises 498 species. Given this diversity, the lines that separate micro/small animals from medium and large animals are difficult to define.

The terms micro and small mammals are fluid and the species included can change from country to country and site to site. In zoology, the term micromammal is used for rats and mice (Avenant 2000), while Stewart et al. (1999) include hares. Small mammal, as used by

Yellen (1991a), includes common duikers and steenbok. In the palaeontology of Corsica, the term small mammal is used for rodents, insectivores and a Lagomorpha species (Vigne & Valladas 1996). Ferguson and Forsyth (1979) discuss rodents and shrews under the term small mammal. The species included or excluded depends on the author of the particular publication, in what discipline they specialise and on the research question(s) being asked. For the sake of argument, let us say that micromammals are less than 1kg and small mammals are less than 5kg which species are included or excluded? It is essential that adult weight is used, as most juveniles of other taxa could, at some stage of their development, be classed as a micro or small mammal.

If the above weight division is investigated following *The mammals of the southern African subregion* (Skinner & Chimimba 2005), micromammals include, apart from the rodents, the suricate (*Suricata suricatta*), two mustelinae (*Poecilogale albinucha* and *Ictonyx striatus*), four mongoose species (*Cynictis penicillata, Galerella sanguinea, Galerella pulverulenta,* and *Helogale parvula*), the hedgehog (*Atelerix frontalis*) and two primates (*Galagoides granti* and *Galago moholi*). Not all rodents are micromammals, as greater cane rat (*Thryonomys swinderianus*) males on average have a weight of 4.1kg and the females 1.8kg.

For the purposes of this chapter, the term *small mammal* is defined as those mammals (and animals) with an adult weight of less than 15kg. This conclusion was reached by examining all listed articles in the reference list of Plug and Badenhorst (2001). Subsequent editions of the journals included in the 2001 reference list by the aforementioned authors were then consulted to find additional faunal data. The published data indicate that the common duiker is one of the most frequently found small bovid species in faunal assemblages. The lowest average weight for the common duiker in northern South Africa is 15kg and thus its weight is used to delineate the term ‘small mammal’(Skinner & Chimimba 2005: 673).

5.2.2 What constitutes hunting or collection?

The importance of an animal as a food source is sometimes defined through whether it was hunted or collected. This is problematic. Small mammals are sometimes classed as animals that can be collected (picked up), snared and trapped but that are not hunted with bows and arrows, clubs or spears. However, duikers (*Cephalophus natalensis, Philantomba monticola,* and *Sylvicapra grimmia*), as one example, vary between 9–21kg in weight can be trapped and also hunted with clubs and bows and arrows (Lupo & Schmitt 2002: 150; Wadley 2010: 181). The same hunting methods apply to hares and rabbits (Bleek & Lloyd 1871; Shaw & van Warmelo 1981: 321-322). Bradfield (2014) examined over 300 bone points from 12 Stone Age archaeological sites in South Africa for use-wear as well as manufacturing techniques. On bone points from the Pitt-Rivers sample, hair fibres were found embedded in the poison residue. The location attests to them being contemporary to the point and not modern contaminants. On one bone point originating from Likoeang (Lesotho), a distal hair shaft was embedded in the material surrounding the tool. Since modern contamination after excavation is unlikely, the hairs were inferred to be of the same age as the tool. In the Pitt-Rivers specimens the characteristics of the medullas indicate that the hair belonged to the group *Rodentia* (Bradfield 2014: 72-73). The internal structure of the hair from Likoaeng indicates that it possibly came from *Procavia capensis* (hyrax) (Bradfield 2014: 102). It is significant that two hair samples from two different archaeological contexts belonged to the same mammal group (Bradfield 2014: 144). The differences in age of the contexts are also significant, as Likoeang dates from c. 1700 BCE to CE 900 (Mitchell 2009: 117) and, while the samples from the Pitt-Rivers collection are fairly recent it indicates that small mammal hunting with bows and arrows has a long-standing history.

5.2.3 Do Lagomorpha feature in the archaeological record?

Lagomorpha feature in almost all archaeological faunal reports for southern African archaeological sites published since 1966 (see Appendix D). Although listed, little or no attention is paid to their presence nor is their possible role in diet or material culture explored.

The remains of small mammals, and specifically Lagomorphs, have been studied in many parts of the world (Linares 1976; Hockett & Haws 2002; Jones 2006; Karmiris & Nastis 2010; Lloveras et al. 2010; Lloveras et al. 2011; Medina et al. 2012; Fa et al. 2013; Rodríguez-Hidalgo et al. 2013). There is a notable body of work on small mammal fauna from southern African Stone Age (>200 ka–<2 ka) contexts (Fernandez-Jalvo & Avery 2015; Iziko-Museums 2016). However more needs to be done to fully incorporate all species sizes in behavioural and dietary interpretations (Thompson 2010b; Armstrong 2016: 18). Iron/historical Age (CE 200 – 1840) research stands in contrast, since only one article that deals specifically with small mammals could be sourced (Badenhorst et al. 2016). Another article exploring the possibility of intensification of hunting during the Iron Age (Badenhorst

2015) provides tantalising proof of small mammal use from four sites from southern Africa. Publications on this period mainly focus on large mammals that were traditionally hunted or herded (Beukes 2000; Plug 2000; Hutten 2005; Nelson 2008).

Agriculture was the mainstay of people during this period and yet archaeobotany is a vastly understudied (Antonites & Antonites 2014: 225). Small mammals were probably attracted by activities at the settlements as well as the crops cultivated and stored. The ethnographic record does provide information that these animals were hunted and eaten (e.g. Krige & Krige 1980: 39, 45, 108; Shaw & van Warmelo 1981: 321), but their dietary use has been overshadowed by the larger ungulate remains. Small mammals were traditionally procured by women, children and the aged or infirm (Lupo & Schmitt 2002; Wadley 2000: 932-933; Badenhorst et al. 2016). If small mammal remains are retrieved and analysed to the same extent as their larger counterparts it will be possible to start filling the gaps in our understanding of food and lifeways. Species-level identification of small mammal remains will add to the knowledge base of related disciplines; i.e. historical distribution studies for ecology, zoology, nature conservation and environmental management (Skinner and Chimimba 2005: 673).

In archaeology direct and/or indirect methods are employed to identify human utilisation of animals. Bones found within human coprolites would provide direct evidence but these are very rare finds in southern African contexts. Coprolites can be difficult to identify as originating from a human and the bones within may prove unidentifiable. Human burials can possibly provide answers as new techniques, such as isotopes markers, do recognise small mammal dietary exploitation (Yeakel et al. 2007; Ugan & Coltrain 2012; Coltrain & Janetski 2013).

The sparse local ethnographic record necessitates the use of ethnographic analogy coupled with the behaviours of extant hunter-gatherer and rural societies that could provide insights into the dietary and non-dietary exploitation of these animals. Indirect evidence provided by cultural artefacts such as clothes or ceremonial artefacts (e.g. headdresses, staffs decorated with hide or fur), housed in museum and university collections can be analysed to determine which species they originated from (Hollemeyer et al. 2008; Püntener & Moss 2010; Brandt 2014; Brandt et al. 2014; Van Steendam et al. 2014; Fiddyment et al. 2015; Manfredi et al.

2017). Equipment that commonly feature in the procurement of small mammals also provides indirect evidence of their deliberate sourcing (Wadley 2010).

5.3 Dietary use of small mammals

The method most commonly used in determining animal species utilisation is the examination of osteological remains. This method, coupled with the study of taphonomic traces left by anti-, peri- and post-mortem attritions, provides the most complete record of faunal procurement and utilisation. The study of taphonomy provides information on hunting practices, butchering techniques and cooking methods employed. Unfortunately, there is generally a lack of taphonomy on the remains of small animals because of their small body size. This makes the extrapolation of information mentioned above even more difficult (Yellen 1991a; Lloveras & Moreno-García 2009: 180; Biginagwa 2012: 293; Howard 2013).

5.3.1 The role of the archaeologist and archaeozoologist: Extrapolating from the incomplete

Small mammals have been part of the human diet from ancient to modern times (Fiedler 1990: 149). So too have the human diet varied from time period to time period, region to region and even village to village (Thompson 2010b; Dueppen and Gokee 2014; Fiorenza et al. 2015; Sykes 2017). Archaeozoologists are expected to reconstruct dietary habits from an incomplete record. The data recovered during excavations and identified during analyses, are the result of pre- and post-depositional attritions and field methodology employed and not necessarily a complete record of what was consumed or deposited. This cannot be done comprehensively or with any degree of truthfulness if (i) field methods are not aimed at maximum retrieval and (ii) the information on every class of fauna identified during analyses is not utilised to the fullest possible extent. Nutritional ecology makes sense as a model to follow when the full spectrum of the diet of our ancestors is analysed.

5.3.2 Evidence supporting the use and/or exclusion of small mammals

Ugan and Coltrain (2012) studied the stable carbon and nitrogen isotope ratios of three prehistoric human burials associated with a single valley in the southeastern Great Basin region of America. They present the results as a percentage in which each taxon identified would have been consumed, and compared this to the ratios of these taxa found to be present during the archaeozoological analysis by Ugan (2005). The isotopic analysis indicated that there was a significantly higher reliance on small mammals than was evident from the physical faunal remains. The lack of small mammal remains in the faunal record was attributed to the taphonomic processes the bones were subjected to since their deposition, and also the excavation methods employed (Ugan & Coltrain 2012: 1408).

Ethnographic and historical accounts document the consumption of hares, rabbits, hyraxes and small antelope and their presence in the faunal record are generally accepted as culinary (Mönnig 1967; Schrire et al. 1993). The consumption of rodents and carnivores is sometimes questioned as they are considered pest species and/or undesirable to eat (Stahl 1982; Nelson 2009; Badenhorst et al. 2016), even though there is archaeological and ethnographic evidence for rodent consumption (Quin 1959; Grivetti 1976; Maggs & Ward 1980: 58-59; Mazel 1989: 56-58; Dewar & Jerardino 2007).

Rodents are still consumed today in many parts of the world and by many cultures (Assogbadjo et al. 2005; Juwayeyi 2008: 91; Suwannarong & Chapman 2014; Meyer-Rochow et al. 2015; Suwannarong et al. 2015; Gruber 2016). A quick internet search brings up websites that offer delicious recipes for the rodent of your choice (Nick 2009). The future use of rodents to alleviate food scarcities is being put forward in many forums (Fiedler 1990; Hoffman & Cawthorn 2013; Gruber 2015). The farming of cane rats (*Thryonomys swinderianus*) and other small animals is being encouraged (Akinbobola 2015) as a sustainable meat source, an export product, and as a strategy for curbing the bushmeat trade (as the latter is decimating local ecologies); although it is not always successful (Baptist & Mensah 1986; Jori & Chardonnet 2001; Jori et al. 2004; Mockrin et al. 2005; Hayward 2009; Kumasi 2017). Rats and other small mammals are very nutritious thus they can be a valuable resource within the human diet (Oyarekua & Ketiku 2010; Kyriacou et al. 2014; Thompson & Henshilwood 2014; Kyriacou et al. 2016).

5.3.3 Possible explanations behind the lack of anthropogenic taphonomy

The absence of anthropogenic taphonomy, such as cut marks on bones, is offered as support for the non-dietary use of rodents, although this is not a valid argument. This lack has been noted worldwide and can be attributed to different methods of capture, preparation techniques and consumption between small and large animals (Lloveras & Moreno-García 2009: 180;

Biginagwa 2012: 293). A similar absence of taphonomy holds true for hares, rabbits, hyraxes and small antelope, but their use as food is not questioned. Small mammal taphonomy has been limited to skeletal part profile analyses with almost no bone surface modification analysis. There are notable exceptions such as modifications induced by humans (Yellen 1991a; Yellen 1991b; Schmitt et al. 2002; Lupo & Schmitt 2005; Landt 2007; Schmitt & Lupo 2008; Lloveras & Moreno-García 2009; Lloveras et al. 2010; Howard 2013; Armstrong 2015), carnivores (Andrews & Nesbit Evans 1983; Cohen & Kibii 2015) and birds of prey (Hockett 1991; Cruz-Uribe & Klein 1998; Armstrong & Avery 2014; Badenhorst et al. 2014).

Roasting of the whole animal is a preferred method for preparing small mammals, as butchering is labour intensive and sectioning impractical. Depending on the species, the head and paws are removed before roasting, and in others these elements may be left intact (Yellen 1991b: 174, 186). Localised burning, especially on the distal ends of the long bones and exposed ends of chopped bones, are good indicators of such practices (Biginagwa 2012: 245, 257, 265). The proximal ends are protected from direct contact with the flames as they are surrounded by substantially more meat than the distal ends (Lloveras & Moreno-García 2009: 196; Medina et al. 2012: 739). Due to the relatively small amount of meat on these sections, the bones are consumed whole and subsequently crushed and pulverised during mastication (Yellen 1991a: 23; Juwayeyi 2008: 91). If removed, they are thrown away and possibly consumed by carnivores (Yellen 1991a: 9), or flung into the fire where they are exposed to high temperatures, becoming fragile and more easily fragmented (Lloveras & Moreno-García 2009: 190; 195; Medina et al. 2012: 739; 742).

The presence or absence of burning patterns on skeletal elements depends on the preferred cooking method. At Blombos Cave in the southern Cape, a distinctive burning pattern of the upper and lower incisors and premaxillas of the Cape Dune mole-rat in the archaeological fauna was observed. Henshilwood (1997) noted that the local farm workers who assisted with the excavations caught and roasted these animals. They placed the complete carcass, fur and all, on coals to roast. The thin layer of skin surrounding the nose and jaw of the animal was the only parts exposed to the heat and these bones showed charring. The observations of the results of the modern cooking methods squared with those observed in the faunal record (Henshilwood 1997). Thompson (2010a) found little evidence of burning on the small mammal specimens from Pinnacle Point. The burning patterns that le Roux (2014: 120-123) observed on the 715 NISP rodents from Sibudu Cave were attributed to post-depositional disturbances of humans making fire in the cave.

5.3.4 Examples of clearly defined anthropogenic taphonomy

The small mammal archaeofaunas of Die Kelders and Pinnacle Point (both located in the Cape) exhibited cut marks indicative of both skinning and dismemberment, thus supporting the hypothesis that humans were the main accumulators of this prey size (Armstrong 2016). Direct evidence of human exploitation of birds and small mammals has been identified after careful analysis of their remains at two MSA sites in South Africa. Val et al. (2016) demonstrated clear evidence for the skinning and cooking of birds at Sibudu Cave in KwaZulu-Natal. In her groundbreaking thesis, Howard (2013) extensively experimented on the remains of rabbits to establish anthropomorphic taphonomy on small game. She applied her experimental results to small mammal remains from Britain and North America with great success. Her work will assist future analysts to identify anthropogenic-induced taphonomy on small animals.

Dewar and Jerardino (2007) provide compelling evidence for the consumption of small mammals at KV502, a LSA site in Namaqualand, South Africa. In the GRM 5 shell midden a human burial was excavated and the surrounding sediment sieved through a 2mm mesh. A total of 104 bone fragments were identified as micromammal remains, all preserved in the areas of the lower thorax (stomach area) and the pelvis (bowel area). The gastric acid damage to the – bones rounded edges and damage to the cortical bone – coupled with the excavation context indicated that the animals were consumed (Dewar & Jerardino, 2007: 9, 11). The gastric acid damage produced by human consumption is very similar to that of carnivores (Andrews & Nesbit Evans 1983: 300; Thompson 2010a).

Skeletal parts representation can also be telling of the preferred cooking and eating method. Juwayeyi (2008: 91) attributes the high frequency of maxillae and mandibles in relation to post-cranial remains of rodents at Malowa Rock Shelter, to the preferred eating method of these species in Malawi. The “African sausages”, as they are so aptly referred to, are eaten whole after roasting, with only the maxillae and mandibles discarded due to the hardness of the teeth.

5.3.5 The research bias against small mammals

Despite abundant evidence of rodents being consumed by humans throughout history, their presence in the Bosutswe (Botswana) faunal lists are dismissed as intrusive, a pest species and it is indeed stated that they did not form part of the diet (Atwood 2014: 183, 184, 193). If the NISP values (Atwood 2014: 235–248) for the identified Lagomorpha (and species) and rodents (all sizes) are calculated, the counts are Lagomorpha – 82 NISP, and Rodent – 595 NISP. Although being more abundantly present than any known culinary species, and in the light of modern ethnographic evidence in support of rodent consumption in Botswana, their possible dietary role is still dismissed out of hand. Beukes (2000: 39) acknowledges a dietary possibility for the small mammal accumulation at KwaGandaganda (KZN), although no specific analysis was conducted on the remains. At both these Iron Age sites small mammals that fall within the adult weight division (15kg) are numerous. Yet the data their remains hold was not incorporated in the analyses.

Badenhorst (2015) investigated possible resource depression at four Iron Age sites: Bosutswe, Nqoma (Botswana), KwaGandaganda and Mamba (KZN). He attributes the previous lack of small mammal remains to the assumed preference for larger animals (Badenhorst 2015: 44) and did not include rodents in his calculations as "…they are often thought natural intrusions…" (Badenhorst 2015: 45). He concluded that the rise in the NISP numbers of so-called low ranking prey can possibly be ascribed to resource depression due to intensive hunting.

The great demand for fresh meat for passing ships at the Cape of Good Hope led to the establishment of provisioning stations. With the exception of the faunal study of Oudepost I (Cruz-Uribe & Schrire 1991) and a study of the meat industry of the Dutch East India Company, also known as the VOC (Heinrich 2010); not much work has been conducted on the use of animals of any size for their meat or products during this period.

Game, and specifically wild bovids, was targeted by Dutch hunters employed to provide fresh meat for the VOC (Heinrich 2010: 37). Dassies (*Procavia capensis*) were collected in large quantities and shipped to the fort at the Cape (Heinrich 2010: 38). As from 1654 European rabbits (*Oryctolagus* sp.) were imported to Robben and Dassen islands (Mentzel 1921: 76; Thom 1952: 223; Robertson 1945: 10; Raven-Hart 1970: 26; Skead 1980: 630-636). The introduction of this species by the Dutch poses a challenge to archaeozoologists. Cruz-Uribe and Schrire (1991: 95), in their report on Oudepost I (1669–1732) on the Cape West Coast, point out that "[A]mong the most common animals at Oudepost are the Leporids, which are also among the most problematic in terms of identification". The larger Leporid bones on the site could be identified, based on size, as derived from the Cape hare, but smaller bones could belong to either the local *Pronolagus* spp.or the European rabbit (Cruz-Uribe & Schrire 1991: 95). This raises two prominent questions: (i) to what extent did the European settlers import and bred the European rabbit for meat, and (ii) to what extent did they hunted native rabbits and hares? At Oudepost I no conclusions could be reached. The identification of the Cape hare, based purely on its size (Cruz-Uribe & Schrire 1991: 95), is also debatable as no morphometric data was available to support such an identification.

According to Fitzsimons (1920: 190), scrub hare was plentiful around Port Elizabeth and surrounds, and during the gaming season great numbers were sent to market.

5.3.6 Crop cultivation and garden hunting

The last 2000 years have seen the development of pastoralism and agriculture in southern Africa, with more sedentary societies establishing permanent settlements (Huffman 2007: xi). When the focus of agriculture is shifted from what is grown and eaten to the impact and change the act of intentionally growing food plants has on the natural ecosystem, we can see what effect these selective pressures have on plants and animals (Neusius 2008: 299). The symbiotic relationship between plants and animals is such that a change in one brings about a change in the other (Grayson 2001). Rodents, insectivores and other small mammals, i.e. Leporids and mongooses, are attracted to human activities (e.g. land clearances and crop cultivation) and as a result they readily occur within, or close to, human settlements.

It was through the cultivation of crops that Iron Age societies were able to support larger populations (Meyer 1998; Huffman 2000: 57). The ethnographic and archaeological records provide information on the types of crops that were cultivated. The initial staples were sorghum and millet with maize coming in after 1800 (Bryant 1909: 109; Schapera 1971: 29; Klapwijk 1974; Hanisch 1980; Breutz 1981: 37-39; Maggs 1984; Maggs & Ward 1984; Antonites & Antonites 2014). Beans, nuts, and gourds of many varieties were also planted (Bryant 1909: 190; Schapera 1971: 29; Krige & Krige 1980: 40; Breutz 1981: 37-39). These crops were protected from wildlife and domestic stock by erecting fences of brushwood and aloes (Kay 1829: 131; Bryant 1909; Hammond-Tooke 1962: 33).

Specific animals are attracted to certain crops and it is consequently important to know which crops were cultivated in order to ascertain potential species. The reverse will also hold true, as the accurate identification of small mammal remains could give an indication of the crops being cultivated. Hares are opportunistic feeders and are known to feed on cultivated crops (Frylestam 1986: 160; Vidus-Rosin et al. 2009: 102; Atona et al. 2010: 97), causing extensive damage amounting to millions of US dollars annually (Fitzsimons 1920: 192–193; Fagerstone et al. 1980: 229). Although hares prefer wheat (Fagerstone et al. 1980: 229; Frylestam 1986: 160; Atona et al. 2010: 97), this preference does not mean that they would disregard or exclude other plant species from their diets. They have been known to consume cabbage, clover, soya beans, root crops, and tomatoes (Fagerstone et al. 1980: 229). As mature crops are unsuitable for hare consumption, they would wreak the most damage at the beginning of each growing season (Frylestam 1986: 160). Since these studies were conducted in North-America and Europe, and in the absence of similar studies in South Africa, inferences have to be made. It is clear that hares prefer crops (e.g. wheat) that share similarities with those grown during the southern African Iron Age (e.g. sorghum and millet).

Similarly rodents are known to be agricultural pests and eating them has been proposed as an effective means of pest control (Fiedler 1990: 149; Hill 1997; Jori et al. 2004: 6; Gruber 2016) The ECORAT project 2007 – 2009 (Development of Ecologically Based Rodent Management for the Southern African Region) was established to find ecological solutions to pest rodents in African agriculture (ECORAT 2010). The project has many implications for research on small mammals from the southern African Iron Age. The population dynamics of species such as the multimammate field mouse (*Mastomys natalensis*) are affected by field cultivation techniques. Therefore, information on the remains of these species in archaeological agricultural contexts could provide information to zoologists and ecologists (Massawe et al. 2007).

L. capensis is a mixed feeder and was observed to extensively browse in the Karoo. This behaviour could place them in competition with domestic stock (Kerley 1990). A study conducted in the Western USA concluded that cattle were in higher competition with the local black-tailed jackrabbit (*Lepus californicus*) (34.1%) for grazing in rangeland than with bison (13.7%) (Ranglack et al. 2015). Could the same possibly hold true in South Africa, specifically during our Iron Age? There is a marked increase in Lagomorpha numbers on the three Iron Age sites Badenhorst (2015: 47) investigated for resource depression.

It has to be taken into account that not only rodents and Lagomorphs are attracted to cultivated crops. Many species within and outside the 15kg weight category are seen as agricultural pests. Depending on the crops planted pests can range from elephants, primates, pigs and granivorous birds to insects (Hill 1997; Fairet 2012). Since it is not straightforward to find explanations for the presence of specific animals in the faunal assemblage, inferences have to be made. Badenhorst et al. (2016) could not confirm nor refute that garden hunting was partly responsible for the presence of certain species at Iron Age sites in the Limpopo region. Ethnographic evidence for garden hunting and/or deterring animals from cultivated land cannot be disregarded (Badenhorst et al. 2016: 2-3). Coupled with modern evidence of the destructive power of specifical rodents to crop cultivation, it stands to reason that historical African farmers would have been engaged in whichever means necessary to protect their harvests.

In the historical period, after the VOC and European hunters had decimated most of the wild fauna in the region, proclamations regarding hunting were issued. One such proclamation allowed frontier residents to hunt wild game that were damaging crops. Wild fauna, which are known agricultural pests, are present in faunal assemblages from sites dating to the 18th century. Research into whether or not these reflect the restrictions of this period could yield interesting results (Heinrich 2010: 36-37). Closer cooperation and combined research efforts between the fields of archaeozoology and archaeobotany within the southern African archaeological context will produce extremely insightful results.

5.4 Non-dietary and zootherapeutic uses of small mammals

Secondary, non-dietary uses of small mammals and animals are almost impossible to detect in the archaeological record. However, it is an aspect that has to be kept in mind during the analysis and interpretation of any faunal assemblage. Ethnographic and historical records can provide valuable information on possible practices that involved small mammals. For example, in South Africa, small mammal skins and tails were utilised for clothes, belts, tassels, headdress decorations and traditional medicines (e.g. Quin 1959: 127; Shaw 1959: 117; Morton & Hitchcock 2014: 422-424). The syrupy urine of dassie was used to bind rock art pigments (Biesele 1974, cited by Watchman 1993: 59). Animal products such as teeth, claws and feathers were used for adornment and skins had a variety of uses. Following a careful examination of bird remains from Sibudu Cave (Val et al. 2016) the authors tentatively proposed that they found evidence of disarticulations that did not originate from butchering. These cut marks have been attributed to the intentional removal of claws and flight feathers (Val et al. 2016: 14).

The use of animal derivatives in the treatment of ailments affecting both humans and livestock (zootherapy) has a long and rich history around the world (Anyinam 1995; Lev 2000, 2003; Betlu 2013). Zootherapy is not easily defined as it is a subdivision of living culture and is ever growing and changing (Coetzee 1962: 2). People tend to believe that illness or bad fortune is a visitation from their creator, forefathers or even the work of a sorcerer (Coetzee 1962: 4). Most studies tend to focus on the traditional use of plants largely ignoring the many remedies and medicines that feature animal substances (Williams & Whiting 2016: 266). Despite the wealth of indigenous knowledge, coupled with the importance of animals to modern-day indigenous consumers, the curative role of animal products is often presented as amusing anecdotes and superstition (Krige 1974: 63; Grivetti 1976: 327).

Studies on the current use of animals in traditional medicine found that mammals make up around 60% of zootherapeutic remedies (Simelane & Kerley 1998; Whiting et al. 2011; Williams and Whiting 2016). Whiting et al. (2011: 88) provide a list of mammals, reptiles and bird species recorded at the Faraday traditional medicine market in Johannesburg. Of the 25 mammal species listed, 11 fall within the 15kg weight category for small mammals. Similarly, Simelane and Kerley (1998: 122-123), list 31 mammal species used by Xhosa traditional healers in the Eastern Cape, of which 17 are within the defined weight category for small mammals.

The Dutch brought many traditional medicines with them when they settled at the Cape. Many local species were found to be substitutes, that is, apart from the local zootherapeutic remedies used (de Weerd 2010). In the 2010 edition of *Volksgeneeskuns in Suid-Afrika* (pp. 123, 153, 165, 173, 205, 242, 361, 380, 381, 397, 400, 476) remedies are described that include various parts of hares and rabbits to cure diseases and discomforts. These range from teething, stomach ache, burn wounds, diarrhoea, deafness and earache to inflammation.

The habits, morphological traits and social behaviours of the animals offered as remedies can sometimes play a part in the types of treatment (Williams & Whiting 2016: 269). For example, hedgehog spines offer protection from bodily harm, while jackals and rabbits are cunning and will assist the wearer in avoiding bad fortune (like rabbits avoiding predators). It is important to note that these remedies are not always ingested, but are often applied to the skin, worn as an amulet or buried near the home (Williams & Whiting 2016: 272).

Similarly, local ethnographies also mention medicinal uses. Among the Pedi, for example, the bladder and dried urine of the Cape hare is applied to the head of a child suffering from hydrocephalus (Quin 1959: 127). The Tlokwa encouraged their children to eat scrub hare as they believed the flesh would make them clever (Grivetti 1976: 327). Pregnant Zulu women did not consume some animals in an effort to avoid transferring a trait of that animal onto the unborn child. For example, guinea-fowl will produce long and flat heads, rock rabbits will give children long front teeth and swallows will leave the children unable to make decent nests (huts) (Krige 1974: 63).

5.5 The lack of interpretation of small mammal remains

In the 16th century, European explorers began sailing around the coast of Africa. Their accounts of the people they met are imprecise and few hold any relevance to archaeozoology (Plug & Badenhorst 2009: 187). Ethnographers and explorers were predominantly western European males and had, either intentionally or unintentionally, biased their accounts as a result of their own cultural prejudice (Gifford-Gonzalez 1993). These biases have perpetuated myths and stereotypes related to labour divisions (Kent 1998: 14), as well as the relative importance of different subsistence methods. Wadley (1998) shows that there is no ‘one-size-fits-all’ regarding gender roles in the South African Stone Age (>200 ka–<2 ka). The ‘traditional’ roles of ‘man the hunter’ and ‘women the gatherer’ are not always as clear-cut. She suggests the term *meat provider*, to refocus the view on the percentage of dietary protein contributed (Wadley 2000: 93).

Biesele and Barclay (2001) observed a *Ju/'hoansi* husband and wife in Namibia hunting together with practised ease. Further investigation revealed that this practice has substantial time depth. They speculate that the travellers' and anthropological accounts of men being the primary hunters might have been skewed by the questions asked, or the observer's presence and personal biases. In this example the wife stood back to let her husband, the more experienced bow hunter, take the kill shot although she was the main tracker during the pursuit. Women, as the primary gatherers, have knowledge of the veld and bring information on animals and tracks back to camp. Much emphasis is placed in the ethnographic record on the kill when tracking and rousing efficiency are as important, or even more so than the kill itself. There are recent ethnographic accounts of women hunting small or immature animals. Women routinely make snares and kill small animals with digging sticks or clubs (Kent 1993: 489). A young *Ju/'hoansi* girl was observed killing a juvenile steenbok and then a young kudu (*Tragelaphus strepsiceros*) by herself (Shostak 1981: 94, 102). In *G/ui* society, traps for birds and small mammals were set by boys and girls (Silberbauer 1981: 214). As a result of an often too narrow research focus, the roles of women in active hunting have almost been invisible and their roles in society regarded as passive.

Women, children and the infirm or aged did hunt small mammals in the course of foraging or tending the fields and slower animals can be gathered without expending much effort (Wadley 2000: 93; Lupo & Schmitt 2002; Badenhorst et al. 2016). However, this is considered collecting and not hunting (Cucchiari 1981: 42; Thompson & Henshilwood 2014: 44). Sykes (2014: 54) maintains that analysts often overlook smaller prey animals in favour of larger bovids and other animals, perpetuating the male-centred view of the past.

5.6 Intrusion or inclusion through non-human agents

It is possible that rodents, specifically, are intrusive on archaeological sites (Nelson 2008: 18; Badenhorst 2015: 45; Badenhorst et al. 2016:3). If positive evidence of intrusion cannot be shown (e.g. fresh bones or post-depositional disturbance of archaeological deposits), to then dismiss the presence of their remains as the result of burrowing or being commensal is 'sloppy research' (Morlan 1994: 135). Animals make burrows to escape weather or predators and to raise their young. They almost never construct burrows to die in. Some other animals, for example, suricates, mongooses, foxes and hyenas also excavate, make use of or live in burrows, but their remains are not seen as intrusive (Shaffer 1992b: 687; Morlan 1994: 135-

136). Archaeological rodent remains are generally not found in burrows but occur in the areas routinely excavated such as middens. Driver (1985: 18 in Shaffer 1992b: 686) argues that if an animal is seen as intrusive, one would expect to find the complete or near complete skeleton. He also notes that the bones can be dispersed by other burrowing animals, geological processes and by excavations. Even if this was the case, the skeletal elements of that individual should still be relatively unbroken and most of the bones should be present. If the rodent remains in an archaeological assemblage are not in the aforementioned condition, then other interpretations should be considered.

Another possible explanation for the occurrence of small mammals is that they were brought in by non-human predators. If the bones are found in carnivore scat, then their presence is self-evident. If, as is likely, the scat has deteriorated, the possibility of carnivore involvement will still be visible in the form of gastric acid and bile damage on the bones. The degree of acid destruction seems to be influenced by the time of consumption (time of day and/or season), the species consumed and the species of carnivore involved (Andrews & Nesbit Evans 1983: 300). Andrews and Nesbit Evans (1983) provide an account of the damage caused by three families of mammalian carnivores (Viverridae, Canidae, and Mustelidae) on small mammal bones. They found that the preservation pattern has a direct correlation with the density of the skeletal element and that the densest elements have the best rate of survival against carnivore teeth. The canids exhibited higher levels of bone breakage as well as the most extensive stomach acid damage. Interestingly, in this study tooth marks on bones were rare except in canid-derived bones. If the predator(s) that could have been responsible for part of the accumulation of a faunal assemblage is known (e.g. *Africanis*), their dietary biases could potentially be seen in the faunal record.

Most southern African Iron Age settlements are open-air sites. Houses were generally constructed either entirely out of pole and thatch or had walls made of wooden poles that were covered with *dhaka* (hard clay). The floors of these dwellings were smoothed compacted *dhaka* (Mitchell 2002: 279; Huffman 2007: 4). The huts were circular with dome-shaped roofs. Some were constructed entirely out of thatch e.g. beehive structures, while others had *dhaka* walls with an average height of 2m. The thatch roof was 3–3.5m in height (van der Waal 1981). Due to the natural materials used in construction, a dwelling would have to burn down to be preserved in the archaeological record (Huffman 2007: 4). If the structures were not burnt, it would not take long to fall into severe disrepair due to natural process after abandonment. As these structures were not permanent buildings made of stone, nor of sufficient height, they would be unsuitable for avian predators to build their nests in.

It is possible that birds of prey would be attracted to small mammals in fields around settlements and in the vicinity of homesteads and might even hunt them. However, as they normally shy away from contact with humans and other predators that could rob them of their prey, they will not eat within the immediate vicinity of the settlement. Since they prefer consuming food at their nests, it would thus be highly unlikely for raptors to be considered as accumulators of small mammal remains on open-air sites (S Hoffman and WW Howells pers. comm. 2016). After a site had been abandoned, owls could have made use of thatch roofs for a short period of time to prey on the rodents that were attracted to the human activities (S. Hoffman pers. comm. 2016). As some raptors utilise a perch-and-wait strategy in hunting, it is possible that a human-built structure could be used to perch upon and consume prey (Hockett 1991: 674). However, this scenario is unlikely, as raptors would choose higher perches in surrounding trees to hunt from (S. Hoffman pers. comm. 2016).

In addition, certain species of South African birds of prey do consume prey on the ground in the open if the captured prey was too large to return to the nest intact (S. Hoffman and WW Howells pers. comm. 2016). Such remains could become part of the archaeological record but the distinctive patterning of raptor damaged bone would be recognised as not being part of the settlement history.

Feeding habits (e.g. owls generally swallow their rodent prey whole), food preferences, regurgitated pellets and distinctive damage to small mammal bones by various South African bird of prey species are well documented (Hockett 1991; Cruz-Uribe & Klein 1998; Armstrong & Avery 2014; Badenhorst et al. 2014). Even in cave sites, birds of prey are not always the accumulators of small mammals. Both Maggs and Ward (1980: 58) and Mazel (1989: 57), ruled them out as accumulators based on their behaviour, prey and feeding preferences as well as the taphonomy identified on skeletal material.

Snakes seem an unlikely accumulator as they tend to completely digest all ingested bone material (Stevenson et al. 1983: 49).

5.7 The applications of small mammal data

The data derived from the analysis of small mammals from archaeological assemblages have been instrumental in recreating life-ways and answering questions about past environmental changes, human adaptation and the effect of agriculture on subsistence and culture. Lupo and Schmitt (2005: 335-337), for example, provide a detailed overview of a prey choice model and discuss the applicability of the model in concise terms. They show that choices made in protein procurement are not as simple as effort invested versus highest kilocalorie yield. Combining prey animal diversity with the prey choice model proved to be a powerful tool for the interpretation of faunal data between sites and through time. This tool can aid in distinguishing changes in foraging efficiency, predicting climate change, prey depletion and technological innovation. Individual hunting variations can produce vastly different faunal assemblages with different species lists. These differences in taxonomic abundances and diversity in the data are currently underutilised in faunal research (Lupo & Schmitt 2005:350; Thompson 2010b; Clark & Kandel 2013; Faith 2013).

Applied archaeozoology is a major expanding field that can provide valuable information for nature conservation because of its time depth. Such examples include introducing taxa to certain areas to (re)create natural biotas, identifying exotic species that should be removed and defining boundaries of biological reserves for the maintenance of healthy indigenous habitats (Frazier 2007: 163; Lyman 2012a: 110). Notable examples in southern Africa are the use of archaeozoological data in the conservation management plans of the Cape mountain zebra (*Equus zebra zebra*) and roan antelope (*Hippotragus equinus*). The Cape Floristic Region is a global conservation action. The faunal record revealed that the roan antelope is native to the region and needs to be included in conservation efforts. The goal is now to re-establish a viable population in the conservation area (Faith 2012a). The archaeozoological data demonstrated that access to open grassland is crucial to the maintenance of mountain zebra herds. As a result, the management plans include the acquisition of agricultural land in an effort to convert it to open grassland to help support population growth (Faith 2012b).

Avenant (2000) investigated the biodiversity of small mammals as indicators of disturbances in the natural ecosystem of the Willem Pretorius Nature Reserve in the Free State, South Africa. Although he did not make use of archaeozoological data, his work shows the importance of small mammals to a healthy ecosystem. For healthy ecosystems to support management and conservation plans, all levels of taxa should be considered.

5.8 Summary of Chapter 5

Animals of all families, genera, and species constituted sources of food as well as playing a role in the material and spiritual culture. Although large animals are important, much information can be gleaned from studying small mammal remains. Small mammals can highlight unseen and often neglected aspects in the faunal and cultural records. They provide valuable information about the vegetation around a site, agricultural practices as well as the environment and climate during the occupation. The information can further assist disciplines beyond archaeology, since it has far-reaching implications in, for example, historical distribution studies for ecology, zoology, nature conservation and environmental management.

Small mammals played a much larger role in the dietary habits and culture of archaeological societies than has been acknowledged up to now. The examples provided clearly illustrate that a concerted effort to retrieve such remains and a careful examination of this faunal class can add considerably to our knowledge of the past. The data gathered does not only have bearing in archaeology it also is beneficial in related disciplines. Their remains might not be that insightful when a single archaeological site is investigated, but if the data from several sites are combined, the value increases exponentially (Simonetti 1989; Reynolds 2012; Weissbrod et al. 2013; Weissbrod et al. 2014).

Steele (2015: 173, emphasis added) makes it clear that humans do not only *respond* to environmental change but that human actions *cause* environmental change. The archaeological faunal record can reflect said changes. Small mammals are environmental indicators and the change can be more easily detected when their remains are analysed fully. South African archaeozoologists often do not deliberate on the full implications of the data sets that they produce. Archaeozoologists have ' …narrowed their interpretations by seeing animals only in terms of protein and calories' (Russell 2011: 7).

In the next chapter, the conclusions drawn are highlighted and several new research avenues that this study opened up are discussed.

CHAPTER 6

DISCUSSION AND CONCLUSIONS

6.1 Introduction

This study aimed to discover and describe the discernible skeletal morphological and morphometric differences between the two *Lepus* spp. that occur in southern Africa. Skeletal remains of *L. capensis* and *L. saxatilis*, stored in the collections of the Ditsong National Museum of Natural History and The National Museum in Bloemfontein, were examined to this end. The outcomes of the morphological and morphometric investigations were applied to a reexamination of the Lagomorpha faunas from Blydefontein and Meerkat, two Later Stone Age rock shelters in the eastern Karoo, to determine the usefulness and application of the data collected.

The hypothesis that there are discernible morphological differences between these two species is supported by the data presented in Chapter 4. The effectiveness of the data sets in terms of the accurate identification of the remains of not only hares but other small mammals in the archaeological record was demonstrated. Being better equipped to accurately identify species in the faunal record has advantages for archaeological research in southern Africa. The utilisation and roles of hares and other small mammals in southern African archaeological contexts for meat and secondary products were explored in Chapter 5 and are supported by this study as a whole.

The DNA studies discussed in Chapter 2 have identified taxonomic sub-species. Genetic variations are often not detectable in the osteology. During my analyses, apart from the expected variations between individuals, I did not find any indication for genetic variations on the cranial or the post-cranial material of these sub-species. My results thus differ from those of Maduray et al. (2007).

It is necessary to place the ability to distinguish between these two closely related species in the service of the archaeological discipline. I proposed that hares and other small mammals were more intensively utilised than is currently reflected in the archaeological and faunal records. The ethnographic data coupled with their frequency in faunal lists (Appendix D) clearly show that they are an underutilised information resource.

6.2 New Measurements Established

In Chapter 3, the new measurements that I added to support the morphological observation are explained and illustrated. These measurements are in addition to, or adaptations of the existing ones, in von den Driesch (1976). Most of the new measurements proved to be valuable additions.

6.2.1 Skull

Of the three measurements added specifically for the *bullae* #20 — from the bottom of the skull to the top of the process and #22 — *bulla* diagonally across showed that *L. capensis* is larger than *L. saxatilis*. It is only measurement #22 that has any statistical significance at $p<0.05$ (Table 4.3). Larger *bullae* are associated with open grassland habitats, i.e. *L. capensis*.

6.2.2 Mandible

The two added measurements — #6 and #7 — for the mandible, proved statistically highly significant at $p<0.001$ (Table 4.4).

6.2.3 Atlas

The measurement in von den Driesch (1976) LAd is only measured in carnivores. I decided to include the measurement due to the similarities in the gross morphology of the atlas between carnivores and Lagomorpha, and also the prominence of the tuber and the dorsal arch. I changed the abbreviation to LADt to indicate that the measurement was taken on the tuber. I adjusted the measurement to the right of the tuber, hence Lad Right. That is the right side when the atlas is held in the correct anatomical position with the cranial articulations facing away from the researcher. The original measurement LAd (now LADt) proved to be statistically significant at $p>0.05$ and the new measurement highly so at $p>0.001$ (Table 4.5).

6.2.4 Humerus

The measurement in (von den Driesch 1976) Dp measures from the major trochanter to the edge of the caput. Since the observed morphology indicated differences in the minor trochanter, the measurement CL was consequently introduced. In *L. saxatilis*, a bulge was observed on the side of the minor tuber. The measurement DMtc was accordingly added, which supports the observed morphology and is statistically highly significant at $p<0.001$ (Table 4.8).

6.2.5 Radius

In the radius, the SD measurement as indicated by von den Driesch (1976) was moved from the middle of the shaft to just below the proximal articulation as in Lagomorpha this is the smallest part of the radius shaft. The original measurement point was kept and renamed WD – Widest Depth – as the morphology showed a distinct widening of the shaft at this point in both species. Both these measurements are statistically significant at $p<0.001$ (Table 4.9).

6.2.6 Ulna

Both the DSO and DPA measurements were moved in orientation from those indicated by von den Driesch (1976: 79). The explanation given for the DPA measurement is "… the shortest distance from the *Processes anconaeus* to the caudal border" (von den Driesch 1976: 79). In Lagomorpha, this is straight across. For the SDO measurement it reads "… smallest depth of the olecranon" (von den Driesch 1976: 79), and in Lagomorpha, because of the distinctive indent, this is straight across. Both these measurements proved to be statistically highly significant at $p<0.001$ (Table 4.10).

6.2.7 Pelvis

The pelvis measurement by von den Driesch (1976: 83) of LAR is measured on the rim of the acetabulum from the pubis to the ilium. During the morphological investigation there was a distinct difference in the rim when it is looked at from the pubis to the ilium. For this reason, the additional measurement of LAIIL was introduced. It has proved to be statistically highly significant at $p<0.001$ and has a lower overlap in the 95% confidence levels than the other pelvic measurements (Table 4.12).

6.2.8 Femur

There is a distinct difference in the orientation of the femur caput between the two species. The fossa in *L. capensis* seems to be pulling away from the caput. For this reason, the measurement CB was included as I considered that the DC measurement by von den Driesch (1976: 84) would not measure the observed orientation shift. The measurement has proved statistically highly significant at $p<0.001$ (Table 4.13).

The observed morphological differences in the thickening of the medial condyle ridge in *L. capensis* prompted the inclusion of the measurements CONM and CONL for of the condyles to support the observed morphology. A thickening of the condyle ridge is a feature associated with an enhanced running ability. Both these measurements are statistically highly significant at $p<0.001$, they are also the two points with the lowest overlap in the 95% confidence levels (Table 4.13).

6.2.9 Tibia

On account of the differences observed in the tibia tuber, the complete depth of the proximal articulation – Dp – needed to be measured. This measurement is statistically highly significant at $p<0.001$ (Table 4.15).

Von den Driesch (1976: 86) only measures the depth of the distal articulation on the medial side. The DDL measurement is on the lateral side as this side exhibits a more prominent protrusion in *L. saxatilis.* The morphological differences observed for the lateral malleolus were encapsulated by this measurement and are statistically highly significant at $p<0.001$ (Table 4.15).

6.2.10 Talus

In view of the different locomotory habits of the two species, coupled with the differences observed in the talus, the measurement of the depth of the condyles – DC – was added. Neither the new nor the existing GL measurement (von den Driesch 1976: 91) proved to be statistically significant, although there are definite morphological differences (Table 4.18).

There are distinct hindlimb differences between the two species. *L. capensis* exhibits specific adaptations to support running, i.e. in the thickening of the femur medial condyle ridge coupled with the longer calcaneum and talus. *L. saxatilis* exhibits specific addaptations that support its hopping abilities, i.e. stronger and broader tibia distal articulation and a shorter and more compact calcaneum and talus. These could point to evolutionary adaptations in locomotion and would be an interesting research avenue to pursue, specifically in the light of the undescribed lagomorph fossil material from South Africa (see sections 1.1.3 and 1.1.4).

6.3 Morphology and Morphometrics and Archaeological Applications

In Chapter 4, every observed difference is illustrated and discussed. As is often the case, the ability to identify a single archaeological bone depends on the features of the skeletal element in question and the way it has fractured. Even an almost complete bone may lack the diagnostic part required for species identification. Due to the high fragmentation rate of southern African archaeological material and the number of small mammals yet to be osteologically and osteometrically differentiated, the observed morphological variances are both very advantageous and limiting. The overlap between the species makes it difficult to utilise isolated measurements for species identification unless the specimen is either very large or very small. The measurements, coupled with the morphological criteria established for each species, greatly improve the ability of the faunal analyst to identify even fragmented material to species level (see sections 4.3.2 and 4.3.3).

As detailed in Chapter 2, the information we are able to extract from faunal remains is often biased due to inadequate recovery strategies and methods. This severely limits our ability to satisfactorily address pertinent research questions. The importance of the full and unbiased recovery of all remains, not just faunal, cannot be over-emphasised (VanDerwaker & Peres 2010: 21). Another aspect of the problem is that when small mammal remains are recovered their identification to species or even group level is hampered by the lack of available skeleton keys. New research techniques such as trace wear and isotope studies have and will continue to assist in filling gaps in our knowledge bases.

Sexual differences reported for most species, as discussed in Chapter 1, can be attributed to seasonality, breeding habits, or the extent of their home range. Zoological texts record that in the two species under discussion the females are larger than the males based on external morphological measurements. Identifying sexual differences falls beyond the scope of this research, although the related morphometric data are provided in Appendix B. The morphology of the scapula and the humerus did hint at possible sexual differences and this should be further explored. A cursory consideration of the data does indicate that some of the skeletal elements of females are larger than males. As no reproduction histories of the female specimens in the collections are available a detailed examination of the data will possibly yield only speculative answers.

The reanalyses of the archaeological faunas from Blydefontein and Meerkat only focused on the application of the morphology and measurements. No further attempt to interpret the remains was made since it is beyond the scope of this study. Tables 6.22 and 6.23 present the results of the reanalyses. The study convincingly demonstrates that variations in morphology and measurements make it possible to differentiate between the two hare species. Furthermore, the data can be applied to eliminate *Lepus* as a species of origin for Lagomorpha remains. The implications are that, in the southern African context, it is possible to identify *Pronolagus* spp. with a degree of certainty. In addition, the remains of other small mammals can now be distinguished from those of Lagomorpha.

Table 6.22: Blydefontein reanalysis results

Group / Species identification	NISP count of original analysis	NISP count after reanalysis
Lagomorpha	174	
Lepus saxatilis	2	13
Lepus capensis		26
***Pronolagus* spp.**	5	16
Non-*Lepus* spp.		26
No identification		24
***Lepus* spp.**	10	1

Table 6.23: Meerkat reanalysis results

Group / Species identification	NISP count of original analysis	NISP count after reanalysis
Lagomorpha	49	
Lepus saxatilis	2	1
Lepus capensis		2
***Pronolagus* spp.**	4	11
Non-*Lepus* spp.		10
No identification		11
***Lepus* spp.**	10	

Appendix D confirms that the majority of identifications of archaeological Lagomorpha material are to group level, i.e. Lagomorpha, Leporidae or *Lepus* spp. Few archaeological specimens have been identified to species level. In the light of this research those species identifications require reevaluation. Similarly, a reanalysis will sort the Lagomorpha material into their respective species or reclassify them as the results for the archaeological assemblages from Blydefontein and Meerkat have demonstrated (Tables 6.22 and 6.23).

Hutten (2005) and Raath (2014) proved that the reanalyses of archaeological faunal material are necessary and crucial to gain fresh insights into archaeological and faunal research. Both these authors scrutinised complete faunal assemblages and changed long-held beliefs about the archaeological sites in question (K2, Schroda and Pont Drift in the Limpopo Province). I am convinced that similar results can be obtained with a reexamination of Lagomorpha material from archaeological faunal assemblages. New insights will be gained into the extent to which specific species were exploited and will also record species previously thought to be absent. Intersite and regional comparisons will become possible along with investigations into garden hunting and resource depression. In Chapter 1 and section 5.3.5 the problems and questions relating to the Lagomorpha material at Oudepost 1 (Cruz-Uribe and Schrire 1991) serve as an example of a faunal assemblage that can now be reassessed following on the outcomes of this study

There are other advantages that a closer analysis of small mammal exploitation brings, such as time-based and regional variations in subsistence practices between different cultural groups. It will be possible to reconstruct environments, which could potentially answer questions related to plant utilisation and cultivation. To gain a better understanding of any subsistence system, it is necessary to integrate as many lines of enquiry as possible (VanDerwaker & Peres 2010: 2). Although there are many differences between the recovery and interpretation of plant and animal remains, both food groups were equally important (VanDerwaker & Peres 2010: 6) (see the discussions on the need for archaeobotany in sections 5.2.3 and 5.3.6).

6.4 Discussion

When archaeofaunal lists and ethnographic reports from other regions of the world are scrutinised, it is clear that all prey species, regardless of size, were acquired. Local species lists are no different (see the discussion on the nutritional ecology approach in section 5.2). Modern-day bushmeat practises and traditional markets attest to the array of species that are still being utilized. There is also a lucrative trade in secondary products obtained from animal species: ornaments, other adornments and clothing as well as medicines and remedies offered to cure or treat a variety of ailments and complaints.

The investigation into the use of small animals presented in this dissertation has opened up an important research avenue into the role of the often ignored members of society. Women, children and the aged were actively engaged in the foodways and cultural practices of their communities. This crucial role is often overshadowed by the fixation on the hunting of larger game animals that is traditionally seen as the work of men. The research inspires a rethink on what the term 'hunting' actually means. Is it merely the act of killing an animal or does it involve the entire process, from tracking the animal to the disposal of the carcass? Is the term only applicable to larger prey or should smaller less dangerous prey be included? By broadening our definition of hunting and prey choices, our interpretation of archaeological faunal remains is affected (please refer to the discussion on the '*schlepp* effect' and prey choice in sections 2.10.1 and 5.2). This broader definition will increase our understanding of people's lifeways and not only their foodways during prehistory and the recent past. The research focus needs to move beyond the killing of large animals to include all animals present in the archaeological faunal record. Moreover, questions need to be asked that go further than dietary contribution. Why are the remains on site? What were they used for? Who brought them in? How where they hunted? How was the carcass prepared? The information obtained could shed light on the influence that culture, social dynamics and available technologies had on the decision-making processes of people as they interacted with and changed their environments. We need to start moving outside the boundaries that are placed on our current understanding and reconstructed narratives.

The interpretation of small mammal remains is to some extent more challenging than is the case with larger mammals. The carcasses are often not sectioned and are thus prepared or consumed whole. Human modifications that offer explanations on the utilisation of larger mammals are often absent in small mammals. This should not exclude smaller species from interpretative analyses. A case in point is the investigations that Henshilwood (1997) conducted into the processing of the Cape mole-rat. Skeletal part representation, as demonstrated in Chapter 5, is highly dependent on processing, cooking and consumption patterns. Evidence, such as Juwayeyi's (2008:91) explanation that: "a well-roasted mouse is eaten whole… except for the mandibles and maxillae due to the hardness of the teeth…", has a direct bearing on faunal analyses, interpretations and inferences. To attribute the presence of small mammals in a faunal assemblage as intrusive or brought in by commensal human predators is not a valid assumption and marginalise their contribution. In the absence of a complete or near-complete skeleton the presence of merely faunal elements in the archaeological record demands alternative explanations. Experimental archaeology coupled with ethnographic knowledge can shed light on the taphonomy or lack thereof observed on archaeological small mammal remains. These experiments should include, but not be limited to, different hunting methods, cooking methods, i.e. boiling, roasting (with or without feet), taphonomy and fracture patterns resulting from dismemberment or sectioning either by force or the use of tools; evidence left of consumption by either human and carnivore i.e. cutmarks, marks left by teeth and gastric acid.

There are many non-dietary uses for animals. Although difficult to identify in the archaeological record cultural aspects should feature more prominently in the deductions we make. Ethnographic and anthropological collections need to be researched and analysed (if possible) to determine the origin of the materials used in their manufacture. The results could prove invaluable to our understanding of the non-dietary uses of animals.

6.5 Conclusion

The three main aims of this study, as set out in Chapter 1, have been met. The first was to discover and describe discernible skeletal morphological and morphometric differences between the two *Lepus* spp. that occur in southern Africa. I provided detailed descriptions in chapters 3 and 4 on the methodology applied in order to distinguish between *Lepus capensis* (Cape hare) and *Lepus saxatilis* (scrub hare), even with fragmented archaeological material. The morphological variations and different measurements, moreover, allow the identification of material as originating from *Pronolagus* spp., albeit not to species level.

The second was to record variables that would allow the identification of faunal remains of these two Lagomorpha to species level. In Chapter 4 and Appendices B and C I provided detailed osteological morphological descriptions and skeletal morphometrics upon which future species identifications of complete and fragmented faunal remains of *Lepus capensis* and *Lepus saxatilis* can be based.

The third was to apply the established protocols for the taxonomic distinction between the two hare species to the Later Stone Age faunal assemblages from Blydefontein Rock Shelter and Meerkat Rock Shelter located in the eastern Karoo. This was done with great success. The results of the reanalyses along with the criteria used to make the new identifications were presented through mathematical diagrams and photographs that highlighted the variables established between the two species of hare. Some elements were selected to visually demonstrate the application of the established keys (see 4.3.2 and 4.3.3). In Chapter 6 the results of this reanalysis and implications in relation to the archaeozoological record and future research within southern Africa are presented.

With the protocols that I have now established to differentiate between *L. capensis* and *L. saxatilis*, it is possible to more accurately identify their remains in not only the archaeological but also the palaeontological record. This research opens up new avenues of exploration from refined field methodology and experimental archaeology to studies on gender roles. Small mammals and animals with an adult weight of less than 15kg are presently vastly understudied resource in southern African archaeological faunal collections. A reconsideration of how archaeozoological data is analysed and interpreted within the southern African context is required. There is a real need for the establishment of osteological keys for all mammals (animals), especially small mammals (animals). This will assist in the accurate identification of bone material to at least group, if not species, level. Integration of data between disciplines, within and without archaeology, is crucial for the betterment and advancement of the sciences.

REFERENCES

Acocks, A.J.P., 1975. Veld types of South Africa. 2nd edition. *Memoirs of the Botanical Survey of South Africa* 40, 1–128.

Akinbobola, A., 2015. 6 reasons why you should raise grasscutters or cane rats. *Livestocking*. Available at: https://www.livestocking.net/6-reasons-why-you-need-to-raise-grasscutter-cane-rat [Accessed October 21, 2017].

Allentoft, M.E., Collins, M., Harker, D., Haile, J., Oskam, C.L., Hale, M.L., Campos, P.F., Samaniego, J.A., Gilbert, M.T.P., Willerslev, E., Zhang, G., Scofield, R.P., Holdaway, R.N. and Bunce, M., 2012. The half-life of DNA in bone: Measuring decay kinetics in 158 dated fossils. *Proceedings of the Royal Society B: Biological Sciences*, 279(1748), p.4724–4733.

Alroy, J., 2002. How many named species are valid? *Proceedings of the National Academy of Sciences of the United States of America*, 99(6), p.3706–3711.

Andrews, P. and Nesbit Evans, E.M., 1983. Small mammal bone accumulations produced by mammalian carnivores. *Paleobiology*, 9(3), p.289–307.

Angermann, R., 1983. The taxonomy of Old World *Lepus*. *Acta Zoologica Fennica*, 174, p.17–21.

Angermann, R., Flux, J.E.C., Chapman, J.A. and Smith, A.T., 1990. Lagomorph classification. In J. A. Chapman & J.E.C. Flux, eds. *Rabbits, hares and pikas*. Oxford: IUCN, Gland, Switzerland, pp. 7–13.

Antonites, A., 2013. *Political and economic interactions in the hinterland of the Mapungubwe Polity, c. AD 1200 - 1300, South Africa.* Unpublished PhD Thesis. Yale University.

Antonites, A. and Antonites, A.R., 2014. The archaeobotany of farming communities in South Africa: A review. In C.J. Stevens et al., eds. *Archaeology of African plant use*. California: Left Coast Press, pp. 225–232.

Anyinam, C., 1995. Ecology and ethnomedicine: Exploring links between current environmental crisis and indigenous medical practices. *Social Science Medicine*, 40(3), p.321–329.

Apps, P. ed., 2000. *Smithers' mammals of southern Africa: a field guide.* Cape Town: Struik.

Armstrong, A.J., 2015. *Small mammal taphonomy and utilization by Middle Stone Age humans in the Caper Floristic region of South Africa*. University of Minnesota.

Armstrong, A.J., 2016. Small mammal utilization by Middle Stone Age humans at Die Kelders Cave 1 and Pinnacle Point Site 5 - 6, Western Cape Province, South Africa. *Journal of Human Evolution*, 101, p.17–44.

Armstrong, A. and Avery, G., 2014. Taphonomy of Verreaux's Eagle (*Aquila verreauxii*) prey accumulations from the Cape Floral Region, South Africa: Implications for archaeological interpretations. *Journal of Archaeological Science*, 52, p.163–183.

Assogbadjo, A.E., Codjia, J.T.C., Sinsin, B., Ekue, M.R.M. and Mensah, G.A., 2005. Importance of rodents as a human food source in Benin. *Belgian Journal of Zoology*, 135(supplement), p.11–15.

Atona, K., Biró, Z., Szemethy, L., Demes, T. and Nyeste, M., 2010. Spatial, temporal and individual variability in the autumn diet of European hare (*Lepus europaeus*) in Hungary. *Acta Zoologica Academiae Scientiarum Hungaricae*, 56(1), p.89–101.

Atwood, K.M., 2014. *Eating Inequality: Food, animals, and people at Bosutswe.* Unpublished PhD Thesis. University of Texas at Austin.

Avenant, N.L., 2000. Small mammal community characteristics as indicators of ecological disturbance in the Willem Pretorius Nature Reserve, Free State, South Africa. *South African Journal of Wildlife Research*, 30(1), p.26–33.

Averianov, A., 1995. Osteology and adaptations of the early Pliocene rabbit *Trischizolagus dumitrescuae* (Lagomorpha: Leporidae). *Journal of Vertebrate Paleontology*, 15(2), p.375–386.

Avery, D.M., 1988. Micromammals and paleoenvironmental interpretation in southern Africa. *Geoarchaeology*, 3(1), p.41–52.

Badenhorst, S., 2003. The archaeofauna from iNkolimahashi Shelter, a Later Stone Age shelter in the Thukela Basin, KwaZulu-Natal, South Africa. *Southern African Humanities*, 15, p.45–57.

Badenhorst, S., 2015. Intensive hunting during the Iron Age of southern Africa. *Environmental Archaeology*, 20(1), p.41–51.

Badenhorst, S., Ashley, C. and Barkhuizen, W., 2016. A consideration of garden hunting by Iron Age farmers in the Limpopo Valley and surrounding regions of southern Africa. *Annals of the Ditsong National Museum of Natural History*, 6, p.1–8.

Badenhorst, S., van Niekerk, K. and Henshilwood, C.S., 2014. Rock hyraxes (*Procavia capensis*) from Middle Stone Age levels at Blombos Cave, South Africa. *African Archaeological Review*, 31, p.25–43.

Baptist, R. and Mensah, G.A., 1986. The cane rat. Farm animal of the future. *World review of Animal Production*, 60, p.2–6.

Beach, D.N., 1984. *The Shona and Zimbabwe 900-1850.* Gweru: Mambo Press.

Bello-Hellegouarch, G., Potau, J.M., Arias-Martorell, J., Pastor, J.F. and Pérez-Pérez, A., 2013. Brief communication: Morphological effects of captivity: A geometric morphometric analysis of the dorsal side of the scapula in captive-bred and wild-caught Hominoidea. *American Journal of Physical Anthropology*, 152(2), p.306–310.

Ben Slimen, H., Suchentrunk, F. and Ben Ammar Elgaaied, A., 2008. On shortcomings of using mtDNA sequence divergence for the systematics of hares (genus *Lepus*): An example from cape hares. *Mammalian Biology - Zeitschrift für Säugetierkunde*, 73(1), p.25–32.

Ben Slimen, H., Suchentrunk, F., Memmi, A., Sert, H., Kryger, U., Alves, P.C. and Ben Ammar Elgaaied, A., 2006. Evolutionary relationships among hares from North Africa (*Lepus* sp. or *Lepus* spp.), Cape hares (*L. capensis*) from South Africa, and brown hares (*L. europaeus*), as inferred from mtDNA PCR-RFLP and allozyme data. *Journal of Zoological Systematics and Evolutionary Research*, 44(1), p.88–99.

Betlu, S., 2013. Indigenous knowledge of zootherapeutic use among the Biate tribe of Dima Hasao District, Assam, northeastern India. *Journal of Ethnobiology and Ethnomedicine,* 9(56), p.1–15.

Betts, M.W., Maschner, H.D.G., Schou, C.D., Schlader, R., Holmes, J., Clement, N. and Smuin, M., 2011. Virtual zooarchaeology: Building a web-based reference collection of northern vertebrates for archaeofaunal research and education. *Journal of Archaeological Science*, 38(4), p.755–762.

Beukes, C.F., 2000. *KwaGandaganda: An archaeozoological case study of the exploitation of animal resources during the Early Iron Age in KwaZulu-Natal.* Unpublished MA Dissertation. University of South Africa, Pretoria.

Biesele, M., 1974. A contemporary Bushman's comments on the Brandberg paintings. *Newsletter South West Africa Scientific Society*, 15(7), p.3–9.

Biesele, M. and Barclay, S., 2001. *Ju/'hoan* women's tracking knowledge and its contribution to their husbands' hunting success. *African Study Monographs,* Suppl. 26 (March), p.67–84.

Bigalke, R.C., 1968. The contemporary mammal fauna of Africa. *The Quarterly Review of Biology,* 43(3), p.265–300.

Biginagwa, T.J., 2012. *Historical archaeology of the 19th century caravan trade in North-Eastern Tanzania: A zooarchaeological perspective.* Unpublished PhD Thesis. University of York.

Bleefeld, A.R. and Bock, W.J., 2002. Unique anatomy of Lagomorph calcaneus. *Acta Palaeontoligica Polonica*, 47(1), p.181–183.

Bleek, W. and Lloyd, L., 1871. The digital Bleek and Lloyd. Available at: http://lloydbleekcollection.cs.uct.ac.za/stories/173/index.html [Accessed February 1, 2016]

Bochenski, Z.M., 2008. Identification of skeletal remains of closely related species: The pitfalls and solutions. *Journal of Archaeological Science*, 35(5), p.1247–1250.

Boessneck, J., Müller, H-H. and Teichert, M., 1964. Osteologische unterscheidungsmerkmale zwischen schaf (*Ovis aries* Linné) und ziege (*Capra hircus* Linné). *Kühn-Archiv*, p.1–129.

Bollongino, R. and Vigne, J-D., 2008. Temperature monitoring in archaeological animal bone samples in the Near East arid area, before, during and after excavation. *Journal of Archaeological Science*, 35(4), p.873–881.

Boroni, N.L., Lobo, L.S., Romano, P.S.R. and Lessa, G., 2017. Taxonomic identification using geometric morphometric approach and limited data: an example using the upper molars of two sympatric species of *Calomys* (Cricetidae: Rodentia). *Zoologia*, 34, p.1–11.

Bousman, C.B., 1991. *Holocene paleoecology and Later Stone Age hunter-gatherer adaptations in the South African interior plateau.* Unpublished PhD Thesis. Southern Methodist University.

Bousman, C.B., 2005. Coping with risk: Later Stone Age technological strategies at Blydefontein Rock Shelter, South Africa. *Journal of Anthropological Archaeology*, 24(3), p.193–226.

Bousman, C.B., Mauldin, R., Zoppi, U., Higham, T., Scott, L. and Brink, J., 2016. The quest for evidence of domestic stock at Blydefontein Rock Shelter. *South African Humanities*, 28, p.39–60.

Bousman, B. and Scott, L., 1994. Climate or overgrazing?: the palynological evidence for vegetation change in the eastern Karoo. *South African Journal for Science*, 90, p.575-578.

Bowman, B.M. and Miller, S.C., 1999. Skeletal mass, chemistry, and growth during and after multiple reproductive cycles in the rat. *Bone*, 25(5), p.553–559.

Bowman, B.M. and Miller, S.C., 2001. Skeletal adaptations during mammalian reproduction. *Journal of Musculoskeletal & Neuronal Interactions*, 1(4), p.347–355.

Bradfield, J., Holt, S. and Sadr, K., 2009. The last of the LSA on the Makgabeng plateau, Limpopo Province. *South African Archaeological Bulletin*, 64(190), p.176–183.

Bradfield, J.S., 2014. *Pointed bone tool technology in southern Africa*. Unpublished PhD Thesis. University of Johannesburg.

Brain, C.K. ed., 2004. *Swartkrans: A cave's chronicle of early man.* 2nd edition., Transvaal Museum Monograph No. 8.

Branch, B., 2005. Introduction to southern Africa's reptile fauna. Available at: http://sarca.adu.org.za/intro.php [Accessed January 16, 2016].

Brandt, L.Ø., 2014. *Species identification of skins and development of sheep wool. An interdisciplinary study combining textile research, archaeology, and bimolecular methods*. Unpublished PhD Thesis. University of Copenhagen.

Brandt, L.Ø., Schmidt, A.L., Mannering, U., Sarret, M., Kelstrup, C.D., Olsen, J. V. and Cappellini, E., 2014. Species identification of archaeological skin objects from Danish bogs: Comparison between mass spectrometry-based peptide sequencing and microscopy-based methods. *PLoS ONE*, 9(9).

Breutz, P.L., 1981. *Die stamme van die distrik Ventersdorp.* Pretoria: Die Staatsddrukker.

Brink, J.S., 1987. The archaeozoology of Florisbad, Orange Free State. *Memoirs of the National Museum Bloemfontein*, 24, p.1–151.

Brink, J.S., 1993. Postcranial evidence for the evolution of the black wildebeest, *Connochaetes gnou*: An exploratory study. *Palaeontologica Africana*, 30, p.61–69.

Brink, J.S., 1994. An ass, *Equus* (*Asinus*) sp., from the late Quaternary mammalian assemblages of Florisbad and Vlakkraal, central southern Africa. *South African Journal of Science*, 90, p.497–500.

Brink, J.S., 2005. *The evolution of the Black Wildebeest, Connochaetes gnou, and modern large mammal faunas in central southern Africa.* Unpublished PhD Thesis. University of Stellenbosch.

Brink, J.S., Holt, S. and Horwitz, L., 2016. The Oldowan and early Acheulean mammalian fauna of Wonderwerk Cave (Northern Cape Province, South Africa). *African Archaeological Review*, 33(3), p.223–250.

Bryant, A.T., 1909. Zulu medicine and medicine-men. Part 1. *Annals of the Natal Museum*, 2(1), p.1–76.

Butler, V.L. and Lyman, R.L., 1996. Taxonomic identifications and faunal summaries: What should we be including in our faunal reports? *Society for American Archaeology Bulletin*, 14, p.22.

Callou, C., 1997. Diagnose différentielle des principaux éléments squelettiques du lapin (genre *Oryctolagus*) et du liévre (genre *Lepus*) en Europe occidentale. *Fiches D'Ostéologie Animale Pour L'Archaéologie. Series B: Mammiferes.*, 8, p.3–20.

Campbell, J., 1815. *Travels in South Africa, undertaken at the request of the Missionary Society.* 3rd edition., London: Black and Parry.

Campana, M.G., Bower, M.A. and Crabtree, P.J., 2013. Ancient DNA for the archaeologist: The future of African research. *African Archaeological Review*, 30, p.21–37.

Caumul, R. and Polly, P.D., 2005. Phylogenetic and environmental components of morphological variation: skull, mandible, and molar shape in marmots (*Marmota*, Rodentia). *Evolution*, 59(11), p.2460–2472.

Chapman, J.A. and Flux, J.E.C. eds., 1990. *Rabbits, hares and pikas: Status survey and conservation action plan.* Oxford: Information Press.

Clark, J.L. and Kandel, A.W., 2013. The evolutionary implications of variation in human hunting strategies and diet breadth during the Middle Stone Age of southern Africa. *Current Anthropology*, 54(S8), p.269–287.

Clark, J.L. and Plug, I., 2008. Animal exploitation strategies during the South African Middle Stone Age: Howiesons Poort and post-Howiesons Poort fauna from Sibudu Cave. *Journal of Human Evolution*, 54(6), p.886–898.

Coetzee, A., 1962. Some folkloristic aspects of Afrikaans folk medicine. *The Institute for the study of man in Africa*, (5), p.1–23.

Cohen, B.F. and Kibii, J.M., 2015. Experimental study of bone modification by captive caracal (*Caracal caracal*); a model for fossil assemblage analysis. *Journal of Archaeological Science*, 62, p.92–104.

Coltrain, J.B. and Janetski, J.C., 2013. The stable and radio-isotope chemistry of southeastern Utah Basketmaker II burials: Dietary analysis using the linear mixing model SISUS, age and sex patterning, geolocation and temporal patterning. *Journal of Archaeological Science*, 40(12), p.4711–4730.

Cooke, H.B.S., 1963. Pleistocene mammal faunas of Africa with particular reference to southern Africa. In F.C. Howell & F. Bourlière, eds. *African Ecology and Human Evolution*. Chicago, Illinois: Aldine Press, pp. 65–116.

Cornette, R., Herrel, A., Stoetzel, E., Moulin, S., Hutterer, R., Denys, C. and Baylac, M., 2015. Specific information levels in relation to fragmentation patterns of shrew mandibles: Do fragments tell the same story? *Journal of Archaeological Science*, 53, p.323–330.

Cruz-Uribe, K. and Klein, R.G., 1998. Hyrax and hare bones from modern South African eagle roosts and the detection of eagle involvement in fossil bone assemblages. *Journal of Archaeological Science*, 25(2), p.135–147.

Cruz-Uribe, K. and Schrire, C., 1991. Analysis of faunal remains from Oudepost I, an early outpost of the Dutch East India Company, Cape Province. *South African Archaeological Bulletin*, 46, p.92–106.

Cucchiari, S., 1981. The gender revolution and the transition from bisexual horde to patrilocal band: The origins of gender hierarchy. In S.B. Ortner & H. Whitehead, eds. *Sexual meaning: The cultural construction of gender and sexuality*. Cambridge: Cambridge University Press.

Dalquest, W.W., Stangl Jr, F.B. and Grimes, J.V., 1989. The third lower premolar of the cottontail, genus *Sylvilagus* and its value in the discrimination of three species. *American Midland Naturalist*, 121(2), p.293–301.

Daly, P., 1969. Approaches to faunal analysis in archaeology. *American Antiquity*, 34(2), p.146–153.

Darwent, C.M., Butler, V.L. and O'Brien, M.J., 2013. Introduction to zooarchaeological method and theory: A special issue honouring R. Lee Lyman. *Journal of Archaeological Method and Theory*, 20(3), p.365–380.

Davis, C.M. and Roth, V.L., 2008. The evolution of sexual size dimorphism in cottontail rabbits (*Sylvilagus*, Leporidae). *Biological Journal of the Linnean Society*, (95), p.141–156.

Densmore, N., 2009. Discussion of screen size and resource depression: Using an examination of Faleloa, Tonga. *Nexus: The Canadian Student Journal of Anthropology*, 21, p.41–48.

Dewar, G. and Jerardino, A., 2007. Micromammals: When humans are the hunters. *Journal of Taphonomy*, 5(1), p.1–14.

de Weerd, K. ed., 2010. *Volksgeneeskuns in Suid-Afrika. 'n Kultuurhistoriese oorsig, benewens 'n uitgebreide versameling boererate*. 2nd edition., Pretoria: Protea Boekhuis.

Dias, R., Detry, C. and Bicho, N., 2016. Changes in the exploitation dynamics of small terrestrial vertebrates and fish during the Pleistocene–Holocene transition in the SW Iberian Peninsula: A review. *The Holocene*, 26(6), p.964–984.

Dobney, K. and Rielly, K., 1988. A method for recording archaeological animal bones: The use of diagnostic zones. *Circaea*, 5(2), p.79–96.

Dollion, A.Y., Cornette, R., Tolley, K.A., Boistel, R., Euriat, A., Boller, E., Fernandez, V., Stynder, D and Herrel, A., 2015. Morphometric analysis of chameleon fossil fragments from the Early Pliocene of South Africa : A new piece of the chamaeleonid history. *Naturwissenschaften*, 102(2).

Driver, J.C., 1985. Zooarchaeology of six prehistoric sites in the Sierra Blanca Region, New Mexico. *Research report in archaeology. Museum of Anthropology, University of Michigan*, Technical.

Driver, J.C., 1992. Identification, classification and zooarchaeology. *Circaea*, 9(1), p.35–47.

Driver, J.C., 2011. Identification, classification and zooarchaeology. *Ethnobiology*, 2, p.19–39.

Dueppen, S.A. and Gokee, C., 2014. Hunting on the margins of medieval West African states: A preliminary study of the zooarchaeological record at Diouboye, Senegal. *Azania*, 49(3), p.354–385.

ECORAT, 2010. Development of ecologically based rodent management for the southern African region. Available at: http://projects.nri.org/ecorat/index.html [Accessed October 21, 2017].

Edwards, C.J., MacHugh, D.E., Dobney, K.M., Martin, L., Russell, N., Horwitz, L.K., McIntosh, S.K., MacDonald, K.C., Helmer, D., Tresset, A., Vigne, J-D. and Bradley, D.G., 2004. Ancient DNA analysis of 101 cattle remains: limits and prospects. *Journal of Archaeological Science*, 31(6), p.695–710.

Encyclopedia of Earth, T., 2011. Biodiversity in Africa. Available at: http://www.eoearth.org/view/article/150570/ [Accessed January 16, 2016].

Esterhuysen, A.B., 2010. Excavations of Historic Cave, Makapan’s Valley, Limpopo: 2001-2005. *South African Archaeological Bulletin*, 65(191), p.67–83.

Fa, J.E., Stewart, J.R., Lloveras, L. and Vargas, J.M., 2013. Rabbits and hominin survival in Iberia. *Journal of Human Evolution*, 64(4), p.233–241.

Fagerstone, K.A., Lavoie, G.K. and Griffith, R.E., 1980. Black-tailed jackrabbit diet and density on rangeland and near agricultural crops. *Journal of Range Management*, 33(3), p.229–233.

Fairet, E., 2012. *Vulnerability to crop-raiding: an interdisciplinary investigation in Loango National Park, Gabon*. Unpublished PhD Thesis. Durham University.

Faith, J.T., 2012a. Conservation implications of fossil roan antelope (*Hippotragus equinus*) in southern Africa's Cape Floristic Region. In J. Louys, ed. *Paleontology in Ecology and Conservation*. Berlin: Springer, pp.239–252.

Faith, J.T., 2012b. Palaeozoological insights into management options for a threatened mammal: Southern Africa's Cape mountain zebra (*Equus zebra zebra*). *Diversity and Distributions*, 18(5), p.438–447.

Faith, J.T., 2013. Taphonomic and paleoecological change in the large mammal sequence from Boomplaas Cave, Western Cape, South Africa. *Journal of Human Evolution*, 65(6), p.715–730.

Ferguson, M.B.W. and Forsyth, G., 1979. Small mammals and habitat structure along altitudinal gradients in the southern Cape mountains. *South African Journal of Zoology*, 15(1), p.34–43.

Fernández-Jalvo, Y. and Avery, D.M., 2015. Pleistocene micromammals and their predators at Wonderwerk Cave, South Africa. *African Archaeological Review*, 32(4), p.751–791.

Fiddyment, S., Holsinger, B., Ruzzier, C., Devine, A., Binois, A., Albarella, U., Fischer, R., Nichols, E., Curtis, A., Cheese, E., Teasdale, M.D., Checkley-Scott, C., Milner, S.J., Rudy, K.M., Johnson, E.J., Vnouček, J., Garrison, M., McGrory, S., Bradley, D.G and Collins, MJ., 2015. Animal origin of 13th-century uterine vellum revealed using non-invasive peptide fingerprinting. *Proceedings of the National Academy of Sciences of the United States of America*, 112(49), p.15066–15071.

Fiedler, L.A., 1990. Rodents as a food source. *Proceedings of the Fourteenth Vertebrate Pest Conference*, (March), p.148–155.

Fiorenza, L., Benazzi, S., Henry, A.G., Salazar-García, D.C., Blasco, R., Picin, A., Wroe, S. and Kullmer, O., 2015. To meat or not to meat? New perspectives on Neanderthal ecology. *American Journal of Physical Anthropology*, 156(S59), p.43–71.

Fitzsimons, F.W., 1920. *The natural history of South Africa. Mammals Vol IV*. London: Longmans, Green and Co.

Flux, J.E.C., 1983. Introduction to taxonomic problems in hares. *Acta Zoologica Fennica*, (174), p.7–10.

Flux, J.E.C. and Angermann, R., 1990. The hares and jackrabbits. In J. A. Chapman & J. E. C. Flux, eds. *Rabbits, Hares and Pikas*. Oxford: IUCN, Gland, Switzerland, pp.61–94.

Fostowicz-Frelik, Ł. and Meng, J., 2013. Comparative morphology of premolar foramen in lagomorphs (Mammalia: *Glires*) and its functional and phylogenetic implications. *PLoS ONE*, 8(11), p.1–18.

Frazier, J., 2007. Sustainable use of wildlife: The view from archaeozoology. *Journal for Nature Conservation*, 15(3), p.163–173.

Frylestam, B., 1986. Agricultural land use effects on the winter diet of brown hares (*Lepus europaeus Pallas*) in southern Sweden. *Mammal Review*, 16(3–4), p.157–161.

Gazin, C.L., 1934. Fossil hares from the late Pliocene of southern Idaho. *Proceedings of the United States National Museum*, 83(2976), p.111–121.

Ge, D., Wen, Z., Xia, L., Zhang, Z., Erbajeva, M., Huang, C. and Yang, Q., 2013. Evolutionary history of Lagomorphs in response to global environmental change. *PloS ONE*, 8(4), p.e59668.

Ge, D., Yao, L., Xia, L., Zhang, Z. and Yang, Q., 2015. Geometric morphometric analysis of skull morphology reveals loss of phylogenetic signal at the generic level in extant lagomorphs (Mammalia: Lagomorpha). *Contributions to Zoology*, 84(4), p.267–284.

Gelfand, S.M., Mavi, S., Drummond, R.B. and Ndemera, B., 1985. *The traditional medical practitioner in Zimbabwe. His principles of practice and pharmacopoeia.* Gweru: Mambo Press.

Gidley, J.W., 1912. The Lagomorphs an independent order. *Science*, 36(922), p.285–286.

Gifford-Gonzalez, D., 1993. Gaps in zooarchaeological analyses of butchery: is gender an issue? In J. Hudson, ed. *From bones to behaviour. Ethnoarchaeological and experimental contributions to the interpretation of faunal remains*. Southern Illinois University: Carbondale, pp.181–199.

Gifford-Gonzalez, D., 2013. Animal genetics and African archaeology: Why it matters. *African Archaeological Review*, 30, p.1–20.

Glenny, F.H., 1951. Use of the scapula as a means of differentiation between the Mearns' cotton-tail and the Australian imported and domestic hare. *The Ohio Journal of Science*, 51(5), p.271–272.

Gobalet, K.W., 2001. A critique of faunal analysis; inconsistency among experts in blind tests. *Journal of Archaeological Science*, 28(4), p.377–386.

Gordon, E.A., 1993. Screen size and differential faunal recovery: A Hawaiian example. *Journal of Field Archaeology*, 20(4), p.453–460.

Graur, D., Duret, L. and Gouy, M., 1996. Phylogenetic position of the order Lagomorpha (rabbits, hares and allies). *Nature*, 379(6563), p.333–335.

Grayson, D.K., 2001. The archaeological record of human impacts on animal populations. *Journal of World Prehistory*, 15(1), p.1–68.

Grivetti, L.E., 1976. *Dietary resources and social aspects of food use in a Tswana tribe.* Unpublished PhD Thesis. University of California.

Gruber, K., 2015. The countries where rats are on the menu. *BBC*. Available at: http://www.bbc.com/future/story/20151207-the-countries-where-rats-are-on-the-menu [Accessed October 21, 2017].

Gruber, K., 2016. Rodent meat - A sustainable way to feed the world? Using rodents as food has a long tradition in many parts of the world. *EMBO Reports*, 17(5), p.630–633.

Hammer, Ø., Harper, D.A.T. and Ryan, P.D., 2001. PAST: Paleontological statistics software package for education and data analyses. *Palaeontologia Electronica*, 4(1), p.9.

Hammond-Tooke, W.D., 1962. *Bacha society: A people of the Transkeian upland, South Africa.* Oxford: Oxford University Press.

Hanisch, E.O.M., 1980. *An archaeological interpretation of certain Iron Age sites in the Limpopo/Shashe valley.* Unpublished MA Dissertation. University of Pretoria.

Hanot, P., Guintard, C., Lepetz, S. and Cornette, R., 2017. Identifying domestic horses, donkeys and hybrids from archaeological deposits: A 3D morphological investigation on skeletons. *Journal of Archaeological Science*, 78, p.88–98.

Happold, D.C.D., 2013. *Mammals of Africa Volume 3: Rodents, hares and rabbits.*London: Bloomsbury Academic.

Haws, J.A. and Hockett, B.S., 2004. Theoretical perspectives on the dietary role of small animals in human evolution. *Petits Animaux Societes Humaines*, p.173–184.

Hayward, M.W., 2009. Bushmeat hunting in Dwesa and Cwebe Nature Reserves, Eastern Cape, South Africa. *South African Journal of Wildlife Research*, 39(April), p.70–84.

Heinrich, A.R., 2010. *A zooarchaeological investigation into the meat industry established at the Cape of Good Hope by the Dutch East India Company in the seventeenth and eighteenth centuries.* Unpublished PhD Thesis. State University of New Jersey.

Henshilwood, C.S., 1997. Identifying the collector: Evidence for human processing of the Cape mole-rat, *Bathyergus suillus*, from Blombos Cave, southern Cape, South Africa. *Journal of Archaeological Science*, p.659–662.

Hibbard, C.W., 1963. The origin of the P3 pattern of *Sylvilagus*, *Caprolagus*, *Oryctolagus* and *Lepus*. *Journal of Mammalogy*, 44(1), p.1–15.

Hill, C.M., 1997. Crop-raiding by wild vertebrates: The farmer’s perspectives in an agricultural community in western Uganda. *International Journal of Pest Management*, 43(1), p.77–84.

Hockett, B.S., 1991. Toward distinguishing human and raptor patterning on leporid bones. *American Antiquity*, 56(4), p.667–679.

Hockett, B. and Haws, J.A., 2002. Taphonomic and methodological perspectives of leporid hunting during the Upper Paleolithic of the western Mediterranean basin. *Journal of Archaeological Method and Theory*, 9(3), p.269–302.

Hockett, B. and Haws, J.A., 2005. Nutritional ecology and the human demography of Neandertal extinction. *Quaternary International*, 137(1), p.21–34.

Hoffman, L.C. and Cawthorn, D., 2013. Exotic protein sources to meet all needs. *Meat Science*, 95(4), p.764–771.

Hoffmann, R.S. and Smith, A.T., 2005. Order Lagomorpha. In D. Wilson & D. M. Reeder, eds. *Mammal species of the world: A taxonomic and geographic reference*. Baltimore: John Hopkins University Press, pp.185–211.

Hollemeyer, K., Altmeyer, W., Heinzle, E. and Pitra, C., 2008. Species identification of Oetzi’s clothing with matrix-assisted laser desorption/ionization time-of-flight mass spectrometry based on peptide pattern similarities of hair digests. *Rapid Communications in Mass Spectrometry*, 22, p.2751-2767.

Howard, W.J., 2013. *Commensal or comestible? The role and exploitation of small, non-ungulate mammals in early European prehistory: towards a methodology for improving identification of human utilisation.* Unpublished PhD Thesis. University of Exeter.

Huffman, T., 2000. Archaeological evidence for climate change during the last 2000 years in southern Africa. *Quaternary International*, 33, p.55–60.

Huffman, T., 2007. *Handbook to the Iron Age: The archaeology of pre-colonial farming societies in southern Africa.* Scottsville: University of KwaZulu-Natal Press.

Hutten, L., 2005. *K2 revisited: an archaeozoological study of an Iron Age site in the Northern Province, South Africa.* Unpublished MA Dissertation. University of Pretoria.

Iziko-Museums, 2016. Publications: D Margaret Avery. Available at: http://www.iziko.org.za/images/uploads/averydm_publications.pdf [Accessed January 16, 2016].

Jacobs, Z., Roberts, R.G., Galbraith, R.F., Deacon, H.J., Grün, R., Mackay, A., Mitchell, P., Vogelsang, R. and Wadley, L., 2008. Ages for the Middle Stone Age of southern Africa: Implications for human behaviour and dispersal. *Science*, 322(5902), p.733–735.

Jerardino, A., Horwitz, L.K., Mazel, A. and Navarro, R., 2009. Just before van Riebeeck: Glimpses into terminal LSA lifestyle at Connies Limpet Bar, west coast of South Africa. *South African Archaeological Bulletin*, 64(189), p.75–86.

Jones, E.L., 2006. Prey choice, mass collecting, and the wild European rabbit (*Oryctolagus cuniculus*). *Journal of Anthropological Archaeology*, 25(3), p.275–289.

Jori, F. and Chardonnet, P., 2001. Cane rat farming in Gabon. Status and perspectives. *5th International Wildlife Ranching Symposium*, p.34–51.

Jori, F., Edderai, D. and Houben, P., 2004. *The potential of rodents for minilivestock in Africa.* Report for Autre Institute Internationale, France.

Juwayeyi, Y.M., 2008. Human and animal interaction on the Shire Highlands, Malawi: The evidence from Malowa Rockshelter. In S. Badenhorst, P. Mitchell, & J. C. Driver, eds. *Animals and people: archaeozoological papers in honour of Ina Plug*. Oxford: Oxford Archaeopress, pp. 83–93.

Karmiris, I.E. and Nastis, A.S., 2010. Diet overlap between small ruminants and the European hare in a Mediterranean scrubland. *Central European Journal of Biology*, 5(5), p.729–737.

Kay, S. 1833. *Travels and researches in Caffraria: describing the character, customs, and moral condition of the tribes inhabiting that portions of Southern Africa. With historical and topographical remarks illustrative of the state and prospects of the British settlement in its borders, the introduction of Christianity, and the progress of civilization.* London: John Mason.

Kent, S., 1993. Sharing in an egalitarian Kalahari community. *Man*, 28(3), p.479–514.

Kent, S. ed., 1998. *Gender in African prehistory.* Walnut Creek: AltaMira Press.

Kerley, G.I.H., 1990. Short communications browsing by *Lepus capensis* in the Karoo. *South African Journal of Zoology*, 25(3), p.199–200.

Kimura, B., Marshall, F., Beja-Pereira, A. and Mulligan, C., 2013. Donkey domestication. *African Archaeological Review*, 30, p.83–95.

Klapwijk, M., 1974. A preliminary report on pottery from the north-eastern Transvaal. *South African Archaeological Bulletin*, 29, p.19–23.

Klein, R.G., 1974. Environment and subsistence of prehistoric man in Southern Cape Province, South Africa. *World Archaeology*, 5(3), p.249–284.

Klein, R.G., 1978. A preliminary report on the larger mammals from the Boomplaas Stone Age cave site. *South African Archaeological Bulletin*, 33(127), p.66–75.

Klein, R.G., 1989. Why does skeletal part representation differ between smaller and larger bovids at Klasies River Mouth and other archaeological sites? *Journal of Archaeological Science*, 16(4), p.363–381.

Klein, R.G., Avery, G., Cruz-Uribe, K., Halkett, D., Hart, T., Milo, R.G. and Volman, T.P., 1999. Duinefontein 2: An Acheulean site in the Western Cape Province of South Africa. *Journal of Human Evolution*, 37(2), p.153–90.

Kreutzer, L.A., 1992. Bison and deer bone mineral densities: Comparisons and implications for the interpretation of archaeological faunas. *Journal of Archaeological Science*, 19(3), p.271–294.

Krige, E.J., 1974. *The social system of the Zulu*. Pietermaritzburg: Shuter and Shooter.

Krige, E.J. and Krige, J.D., 1980. *The realm of the rain queen: A study of the pattern of Lovedu society.* Cape Town: Juta & Company.

Kryger, U., 2002. *Genetic variation among South African hares (Lepus spec.) as inferred from mitochondrial DNA and microsatellites.* Unpublished PhD Thesis. University of Pretoria.

Kryger, U., Robinson, T.J. and Bloomer, P., 2004. Population structure and history of southern African scrub hares *Lepus saxatilis*. *Journal of Zoology London*, 263(2), p.121–133.

Kumasi, 2017. The grasscutter shows why it is hard to stop bushmeat hunting. *The Economist*. Available at: https://www.economist.com/news/middle-east-and-africa/21727918-farming-delicious-cane-rats-turns-out-be-harder-hunting-them [Accessed October 21, 2017].

Kyriacou, K., Blackhurst, D.M., Parkington, J.E. and Marais, A.D., 2016. Marine and terrestrial foods as a source of brain-selective nutrients for early modern humans in the south-western Cape, South Africa. *Journal of Human Evolution*, 97, p.86–96.

Kyriacou, K., Parkington, J.E., Marais, A.D. and Braun, D.R., 2014. Nutrition, modernity and the archaeological record: Coastal resources and nutrition among Middle Stone Age hunter-gatherers on the Western Cape coast of South Africa. *Journal of Human Evolution*, 77, p.64–73.

Landt, M.J., 2007. Tooth marks and human consumption: Ethnoarchaeological mastication research among foragers of the Central African Republic. *Journal of Archaeological Science*, 34(10), p.1629–1640.

Lee, R.B., 1985. *The !Kung San. Men, women, and work in a foraging society.* Cambridge: Cambridge University Press.

le Roux, A., 2014. *Iron Age fauna from Sibudu Cave, Kwazulu-Natal, South Africa.* Unpublished MSc Dissertation. University of the Witwatersrand.

Lev, E., 2000. The doctrine of signatures in the medieval and Ottoman Levant. *Vesalius*, 7(1), p.13–22.

Lev, E., 2003. Traditional healing with animals (zootherapy): Medieval to present-day Levantine practice. *Journal of Ethnopharmacology*, 85(1), p.107–118.

Lewton, K.L., 2017. The effects of captive versus wild rearing environments on long bone articular surfaces in common chimpanzees (*Pan troglodytes*). *PeerJ*, 5, p.1–21.

Linares, O.F., 1976. "Garden hunting" in the American tropics. *Human Ecology*, 4(4), p.331–349.

Lloveras, L., Moreno-García, M., Nadal, J., 2009. Butchery, cooking and human consumption marks on rabbit (*Oryctolagus cuniculus*) bones: an experimental study. *Journal of Taphonomy*, 7(2–3), p.179–201.

Lloveras, L., Moreno-Garcia, M., Nadal, J., Maroto, J., Soler, J. and Soler, N., 2010. The application of actualistic studies to assess the taphonomic origin of Musterian rabbit accumulations from Arbreda Cave (North-East Iberia). *Archaeofauna*, 19, p.99–119.

Lloveras, L., Moreno-García, M., Nadal, J. and Zilhão, J., 2011. Who brought in the rabbits? Taphonomical analysis of Mousterian and Solutrean leporid accumulations from Gruta do Caldeirão (Tomar, Portugal). *Journal of Archaeological Science*, 38(9), p.2434–2449.

Lowe, A., Harris, S. and Ashton, P., 2004. *Ecological genetics: design, analysis and application.* Malden, MA: Blackwell.

Lupo, K.D., 2007. Evolutionary foraging models in zooarchaeological analysis: Recent applications and future challenges. *Journal of Archaeological Research*, 15(2), p.143–189.

Lupo, K.D., 2011. Comments on "Identification, classification and zooarchaeology." *Ethnobiology*, 2, p.31–33.

Lupo, K.D. and Schmitt, D.N., 2002. Upper Paleolithic net-hunting, small prey exploitation, and women's work effort: A view from the ethnographic and ethnoarchaeological record of the Congo Basin. *Journal of Archaeological Method and Theory*, 9(2), p.147–179.

Lupo, K.D. and Schmitt, D.N., 2005. Small prey hunting technology and zooarchaeological measures of taxonomic diversity and abundance: Ethnoarchaeological evidence from Central African forest foragers. *Journal of Anthropological Archaeology*, 24(4), p.335–353.

Lupo, K.D. and Schmitt, D.N., 2016. When bigger is not better: The economics of hunting megafauna and its implications for Plio-Pleistocene hunter-gatherers. *Journal of Anthropological Archaeology*, 44(July), p.185–197.

Lyman, R.L., 1984. Bone density and differential survivorship of fossil classes. *Journal of Anthropological Archaeology*, 3(4), p.259–299.

Lyman, R.L., 2002. Taxonomic identification of zooarchaeological remains. *The Review of Archaeology*, 23(2), p.13–20.

Lyman, R.L., 2010. Paleozoology's dependence on natural history collections. *Journal of Ethnobiology*, 30(1), p.126–136.

Lyman, R.L., 2011. Comments on "Identification, classification and zooarchaeology." *Ethnobiology*, 2, p.33–34.

Lyman, R.L., 2012a. Applied zooarchaeology history, value and use. In S. Wolverton & R. L. Lyman, eds. *Conservation biology and applied zooarchaeology*. Tucson: University of Arizona Press, pp. 208–232.

Lyman, R.L., 2012b. The influence of screen mesh size, and size and shape of rodent teeth on recovery. *Journal of Archaeological Science*, 39(6), p.1854–1861.

Lyman, R.L., Houghton, L.E. and Chambers, A.L., 1992. The effect of structural density on marmot skeletal part representation in archaeological sites. *Journal of Archaeological Science*, (19), p.557–573.

Macdonald, K.C., 1992. The domestic chicken (*Gallus gallus*) in sub-Saharan Africa: A background to its introduction and its osteological differentiation from indigenous fowls (Numidinae and *Francolinus* sp.). *Journal of Archaeological Sciences*, 19(3), p.303–318.

Madeira, P.C., 1909. *Hunting in British East Africa*. Philadelphia and London: J. B. Lippincott Company.

Maduray, S., Kryger, U. and Chimimba, C.T., 2007. Analysis of morphometric variation in the genus *Lepus* (Lagomorpha: Leporidae) from southern Africa. *Durban Museum Novitates*, 32, p.60–70.

Maggs, T., 1984. Ndondonwane: A preliminary report on an Early Iron Age site in the lower Tugela River. *Annals of the Natal Museum*, 26(1), p.71–94.

Maggs, T. and Ward, V., 1980. Driel Shelter : Rescue at a Late Stone Age site on the Tugela River. *Annals of the Natal Museum*, 24(1), p.35–70.

Maggs, T. and Ward, V., 1984. Early Iron Age sites in the Muden area of Natal. *Annals of the Natal Museum*, 26(1), p.105–140.

Mallye, J-B., 2011. Badger (*Meles meles*) remains within caves as an analytical tool to test the integrity of stratified sites: the contribution of Unikoté Cave (Pyrénées-Atlantiques, France). *Journal of Taphonomy*, 9(1), p.15–22.

Manfredi, M., Barberis, E., Gosetti, F., Conte, E., Gatti, G., Mattu, C., Robotti, E., Zilberstein, G., Koman, I., Zilberstein, S., Marengo, E. and Righetti, P.G., 2017. Method for noninvasive analysis of proteins and small molecules from ancient objects. *Analytical Chemistry,* 89(6), p.3310–3317.

Marean, C.W., 1991. Measuring the post-depositional destruction of bone in archaeological assemblages. *Journal of Archaeological Science*, (18), p.677–694.

Maschner, H.D.G., Betts, M.W. and Schou, C.D., 2011. Virtual zooarchaeology of the Arctic project (VZAP). *The SAA Archaeological Record*, p.41–43.

Massawe, A.W., Rwamugira, W., Leirs, H., Makundi, R.H. and Mulungu, L.S., 2007. Do farming practices influence population dynamics of rodents? A case study of the multimammate field rats, *Mastomys natalensis*, in Tanzania. *African Journal of Ecology*, 45(3), p.293–301.

Matisoo-Smith, E. and Horsburgh, K.A., 2012. *DNA for archaeologists.* Walnut Creek, California: Left Coast Press.

Mayr, E., 1969. *Principles of systematic zoology.* New York: McGraw-Hill Inc.

Mayr, E., 2002. *What evolution is.* 2nd edition., London: Phoenix.

Mazel, A.D., 1989. People making history: the last ten thousand years of hunter-gatherer communities in the Thukela Basin. *Natal Museum Journal of Humanities*, 1, p.1–168.

Mazel, A.D., 1990. Mhlwazini Cave: the excavation of Late Holocene deposits in the northern Natal Drakensberg, Natal, South Africa. *Natal Museum Journal of Humanities*, 2, p.95–133.

Medina, M.E., Teta, P. and Rivero, Y.D., 2012. Burning damage and small-mammal human consumption in Quebrada del Real 1 (Cordoba, Argentina): An experimental approach. *Journal of Archaeological Science,* 39(3), p.737–743.

Meester, .J.A.J., Rautenbach, I.L., Dippenaar, N.J., and Baker, C.M., 1986. *Classification of Southern African Mammals*. Pretoria: Transvaal Museum Monograph No. 5.

Mentzel, O.F., 1921. *A Geographical and Topographical Description of the Cape of Good Hope, Part One. Translated by H. J. Mandelbrote.* Cape Town: Van Riebeeck Society.

Meyer, A., 1998. *The archaeological sites of Greefswald: Stratigraphy and chronology of sites and a history of investigations.* Pretoria: University of Pretoria.

Meyer-Rochow, V.B., Megu, K. and Chakravorty, J., 2015. Rats: if you can’t beat them eat them! (Tricks of the trade observed among the Adi and other North-East Indian tribals). *Journal of Ethnobiology and Ethnomedicine*, 11, p.1–11.

Miller, H. and Sykes, N., 2016. Zootherapy in archaeology: the case of the fallow deer (*Dama dama dama*). *Journal of Ethnobiology,* 36(2), p.257–276.

Mitchell, P., 2002. *The archaeology of southern Africa.* Cambridge: Cambridge University Press.

Mitchell, P., 2009. The flaked stone artefact assemblages from Likoaeng: A late Holocene sequence in the Lesotho Highlands and its regional context. *Southern African Humanities,* 21, p.117–155.

Mockrin, M.H., Bennett, E.L. and Labruna, D.T., 2005. Wildlife farming: A viable alternative to hunting in tropical forests? *Wildlife Conservation*, 23(November), p.1–32.

Mohandesan, E., Speller, C.F., Peters, J., Uerpmann, H.P., Uerpmann, M., De Cupere, B., Hofreiter, M. and Burger, P.A., 2017. Combined hybridization capture and shotgun sequencing for ancient DNA analysis of extinct wild and domestic dromedary camel. *Molecular Ecology Resources*, 17(2), p.300–313.

Mönnig, H.O., 1967. *The Pedi.* Pretoria: Van Schaik Limited.

Morimoto, N., de León, M.S.P. and Zollikofer, C.P.E., 2011. Exploring femoral diaphyseal shape variation in wild and captive chimpanzees by means of morphometric mapping: A test of Wolff’s Law. *Anatomical Record,* 294(4), p.589–609.

Morlan, R.E., 1994. Dialogue: Rodent bones in archaeological sites. *Canadian Journal of Archaeology*, 18(1), p.135–142.

Morton, F. and Hitchcock, R., 2014. Tswana hunting: Continuities and changes in the Transvaal and Kalahari after 1600. *South African Historical Journal*, 66(3), p.418–439.

Nagaoka, L., 2005. Differential recovery of Pacific Island fish remains. *Journal of Archaeological Science*, 32(6), p.941–955.

Nelson, C., 2008. *An archaeozoological and ethnographic investigation into animal utilisation practices of the Ndzundza Ndebele of the Steelpoort River Valley, South Africa, 1700AD - 1900AD.* Unpublished MA Dissertation. University of Pretoria.

Nelson, C., 2009. An archaeozoology of the Ndzundza Ndebele in the Steelpoort River Valley, Mpumalanga, South Africa c. 1700 AD – 1883 AD. *South African Archaeological Bulletin*, 64(190), p.184–192.

Neusius, S.W., 2008. Game procurement among temperate horticulturists: The case for garden hunting by the Dolores Anasazi. In E.J. Reitz, C.M. Scarry, & S.J. Scudder, eds. *Case studies in environmental archaeology*. New York: Springer.

Nick, 2009. Now that’s nifty: 18 Delicious rodents - How to cook rodents - Rodents as a food source. Available at: http://nowthatsnifty.blogspot.co.za/2009/05/18-delicious-rodents-how-to-cook.html [Accessed October 21, 2017].

Nickel, R., Schummer, A. and Seiferle, E., 1992. *Lehrbuch der anatomie der haustiere. Band I: Bewegungsaparaat.* 6th edition., Hamburg: Paul Parey.

O’Connor, T.P., 1996. A critical overview of archaeological animal bone studies. *World Archaeology*, 28(1), p.5–19.

Olsen, S.J., 1960. *Post cranial skeletal characters of Bison and Bos.* Cambridge, MA: Harvard University Press.

O’Regan, H.J. and Kitchener, A.C., 2005. The effects of captivity on the morphology of captive, domestic and feral mammals. *Mammal Review*, 35(3&4), p.215–230.

Orton, J., Hart, T. and Halkett, D., 2005. Shell middens in Namaqualand: Two Later Stone Age sites at Rooiwalbaai, Northern Cape Province, South Africa. *South African Archaeological Bulletin*, 60(181), p.24–32.

Oyarekua, M.A. and Ketiku, A.O., 2010. The nutrient composition of South African rat. *Advance Journal of Food Science and Technology*, 2(6), p.318–324.

Palacios, F., Angelone, C., Alonso, G. and Reig, S., 2008. Morphological evidence of species differentiation within *Lepus capensis* Linnaeus, 1758 (Leporidae, Lagomorpha) in Cape Province, South Africa. *Mammalian Biology - Zeitschrift für Säugetierkunde*, 73(5), p.358–370.

Pavao, B. and Stahl, P.W., 1999. Structural density assays of Leporid skeletal elements with implications for taphonomic, actualistic and archaeological research. *Journal of Archaeological Science*, 26(1), p.53–66.

Pelletier, M., Stoetzel, E., Cochard, D. and Lenoble, A., 2017. Sexual dimorphism in the pelvis of Antillean fruit-eating bat (*Brachyphylla cavernarum*) and its application to a fossil accumulation from the Lesser Antilles. *Geobios*, 50(4), p.311–318.

Penzhorn, B.L., Horak, I.G., Spickett, A.M. and Braack, L.E.O., 1993. Observations on reproduction and morphometrics of scrub hares in the Kruger National Park. *Suid Afrikaanse Tydskrif vir Natuurnavorsing*, 23(3), p.74–77.

Peters, J. and Brink, J.S., 1992. Comparative postcranial osteomorphology and osteometry of springbok, *Antidorcas marsupialis* (Zimmerman, 1780) and grey rhebok, *Pelea capreolus* (Forster, 1790) (Mammalia: Bovidae). *Navorsinge van die Nasionale Museum, Bloemfontein*, 8(4), p.162–207.

Peters, J., van Neer, W. and Plug, I., 1997. Comparative postcranial osteology of hartebeest (*Alcelaphus buselaphus*), scimitar oryx (*Oryx dammah*) and addax (*Addax nasomaculatus*), with notes on the osteometry of gemsbok (*Oryx gazella*) and Arabian oryx (*Oryx leucoryx*). *Annales Du Musée Royal de l'Afrique Centrale Sciences Zoologiques 280.*

Plug, I., 1997. Late Pleistocene and Holocene hunter-gatherers in the eastern highlands of South Africa and Lesotho: a faunal interpretation. *Journal of Archaeological Science*, 24(8), p.715–727.

Plug, I., 2000. Overview of Iron Age fauna from the Limpopo Valley. *South African Archaeological Society Goodwin Series*, 8, p.117–126.

Plug, I. and Badenhorst, S., 2001. *The distribution of macromammals in southern Africa over the past 30 000 years as reflected in animal remains from archaeological sites.* Pretoria: Transvaal Museum Monograph No. 12.

Plug, I. and Badenhorst, S., 2009. Ethnography and southern African archaeozoology. In G. Grupe, G. McGlynn, & J. Peters, eds. *Tracking down the past ethnohistory meets archaeology*. Munchen: Verlag Marie Leidorf GmbH, pp. 187–201.

Plug, I. and Peters, J., 1991. Osteomorphological differences in the appendicular skeleton of *Antidorcas marsupialis* (Zimmer, 1780) and *Antidorcas bondi* (Cook & Wells, 1951) (Mammalia: Bovidae) with notes on the osteometry of *Antidorcas bondi*. *Annals of the Transvaal Museum*, 35(1), p.253–263.

Pruvost, M., Schwarz, R., Correia, V.B., Champlot, S., Braguier, S., Morel, N., Fernández-Jalvo, Y., Grange, T. and Geigl, E.-M., 2007. Freshly excavated fossil bones are best for amplification of ancient DNA. *Proceedings of the National Academy of Sciences*, 104(3), p.739–744.

Püntener, A.G. and Moss, S., 2010. Ötzi, the Iceman and his leather clothes. *CHIMIA International Journal for Chemistry*, 64(5), p.315–320.

Quin, P.J., 1959. *Food and feeding habits of the Pedi with special reference to identification, classification, preparation and nutritive value of the respective foods.* Johannesburg: Witwatersrand University Press.

Raath, A. 2014. *An archaeological investigation of Zhizo/Leokwe foodways at Schroda and Pont Drift, South Africa.* Unpublished PhD. Yale University.

Ranglack, D.H., Durham, S. and du Toit, J.T., 2015. Competition on the range: science vs. perception in a bison-cattle conflict in the western USA. *Journal of Applied Ecology*, 52(2), p.467–474.

Raven-Hart, R., 1970. *Cape Good Hope 1652-1702: The first fifty years of Dutch colonization as seen by callers.* Volume I., Cape Town: Balkema.

Reitz, E.J. and Wing, E.S., 2008. *Zooarchaeology*. 2nd edition., Cambridge: Cambridge University Press.

Reynolds, C.R., 2012. *Meat at the origins of agriculture: faunal use and resource pressure at the origins of agriculture in the Northern U.S. Southwest.* Unpublished PhD Thesis. University of Iowa.

Ridley. M., 1986. *Evolution and classification: The reformation of cladism.* London: Longman.

Robertson, H.M., 1945. The economic development of the Cape under Van Riebeek. *The South African Journal of Economics*, 13, p.1–17.

Robinson, T.J., 1981. *Systematics of the South African Leporidae*. Unpublished PhD. University of Pretoria.

Robinson, T.J., 1986. Incisor morphology as an aid in the systematics of the South African Leporidae (Mammalia: Lagomorpha). *South African Journal of Zoology*, 21, p.297–302.

Robinson, T.J. and Dippenaar, N.J., 1983. The status of *Lepus saxatilis*, *L. whytei* and *L. crawshayi* in southern Africa. *Acta Zoologica Fennica*, (174), p.35–39.

Robinson, T.J. and Dippenaar, N.J., 1987. Morphometrics of the South African Leporidae II: *Lepus* Linnaeus, 1758, and *Bunolugus* Thomas, 1929. *Annals of the Transvaal Museum*, 34(18), p.379–404.

Robinson, T.J. and Matthee, C.A., 2005. Phylogeny and evolutionary origins of the Leporidae: a review of cytogenetics, molecular analyses and a supermatrix analysis. *Mammal Review*, 35(3–4), p.231–247.

Robinson, T.J. and Skinner, J.D., 1983. Karyology of the riverine rabbit, *Bunolagus monticularis*, and its taxonomic implications. *Journal of Mammalogy*, 64, p.678–681.

Rodríguez-Hidalgo, A.J., Saladié, P. and Canals, A., 2013. Following the white rabbit: A case of a small game procurement site in the upper Palaeolithic (Sala de las Chimeneas, Maltravieso Cave, Spain). *International Journal of Osteoarchaeology*, 23(1), p.34–54.

Rose, K.D., DeLeon, V.B., Missiaen, P., Rana, R.S., Sahni, A., Singh, L. and Smith, T., 2008. Early Eocene lagomorph (Mammalia) from Western India and the early diversification of Lagomorpha. *Proceedings of the Royal Society / Biological Sciences*, 275, p.1203–8.

Rossel, S., Marshall, F., Peters, J., Pilgram, T., Adams, M.D. and O’Connor, D., 2008. Domestication of the donkey: timing, processes, and indicators. *Proceedings of the National Academy of Sciences of the United States of America*, 105(10), p.3715–3720.

Russell, N., 2011. *Social zooarcaheology*. Cambridge: Cambridge University Press.

Sadr, K., 2007. Early first millennium pastoralists on Kasteelberg? The UB/UCT excavation at KBA. *South African Archaeological Bulletin*, 62(186), p.154–161.

Sampson, C.G., 1970. Smithfield Industrial Complex: further field results. *Memoir No. 5 Bloemfontein National Museum*.

Schaller, O. ed., 2007. *Illustrated veterinary anatomical nomenclature*. 2nd edition., Stuttgart: Enke.

Schapera, I., 1971. *Ethnographic survey of Africa. Southern Africa part III: The Tswana.* London: International African Institute.

Schmitt, D.N. and Lupo, K.D., 1995. On mammalian taphonomy, taxonomic diversity, and measuring subsistence data in zooarchaeology. *American Antiquity*, 60(3), p.496–514.

Schmitt, D.N. and Lupo, K.D., 2008. Do faunal remains reflect socioeconomic status? An ethnoarchaeological study among Central African farmers in the northern Congo Basin. *Journal of Anthropological Archaeology*, 27(3), p.315–325.

Schmitt, D.N., Madsen, D.B. and Lupo, K.D., 2002. Small-mammal data on early and middle Holocene climates and biotic communities in the Bonneville Basin, USA. *Quaternary Research*, 58(3), p.255–260.

Scholes, R.J., Kuper, W. and Biggs, R., 2006. Biodiversity. *Africa Environment Outlook 2: Our environment, our wealth*, p.226–261. Available at: http://researchspace.csir.co.za/dspace/handle/10204/1179 [Accessed January 16, 2016].

Schrire, C., Cruz-Uribe, K. and Klose, J., 1993. The site history of the historical site at Oudepost I, Cape. *South African Archaeological Society Goodwin Series*, 7, p.21–32.

Schutz, H., Donovan, E.R. and Hayes, J.P., 2009. Effects of parity on pelvic size and shape dimorphism in *Mus*. *Journal of Morphology*, 270(7), p.834–842.

Schutz, H., Polly, P.D., Krieger, J.D. and Guralnick, R.P., 2009. Differential sexual dimorphism: size and shape in the cranium and pelvis of grey foxes (*Urocyon*). *Biological Journal of the Linnean Society*, 96(2), p.339–353.

Scott, K. and Plug, I., 2016. Osteomorphology and osteometry versus aDNA in taxonomic identification of fragmentary sheep and sheep/goat bones from archaeological deposits: Blydefontein Shelter, Karoo, South Africa. *South African Journal of Humanities*, 28, p.67–79.

Scott-Ram, N.R., 1990. *Transformed cladistics, taxonomy and evolution*. Cambridge: Cambridge University Press.

Shaffer, B.S., 1992a. Quarter-inch screening: understanding biases in recovery of vertebrate faunal remains. *American Antiquity*, 57(1), p.129–136.

Shaffer, B.S., 1992b. Interpretation of gopher remains from south-western archaeological assemblages. *American Antiquity*, 57(4), p.683–691.

Shaffer, B.S. and Sanchez, J.L.J., 1994. Comparison of 1/8“ and 1/4” mesh recovery of controlled samples of small to medium-sized mammals. *American Antiquity*, 59(3), p.525–530.

Shaw, E.M., 1959. Material culture. In W. D. Hammond-Took, ed. *The Bantu-speaking peoples of southern Africa*. London: Routledge & Kegan Paul.

Shaw, E.M. and van Warmelo, N.J., 1981. The material culture of the Cape Nguni: Part 3 - Subsistence. *Annals of the South African Museum*, 58.

Shostak, M., 1981. *Nisa: The life and words of a !Kung woman*. Harvard University Press.

Silberbauer, G., 1981. *Hunter and habitat in the Central Kalahari Desert*. Cambridge: Cambridge University Press.

Simelane, T.S. and Kerley, G.I.H., 1998. Conservation implications of the use of vertebrates by Xhosa traditional healers in South Africa. *South African Journal of Wildlife Research*, 28(4), p.121–126.

Simonetti, J.A., 1989. Small mammals as paleoenvironmental indicators: validation for species of central Chile. *Revista Chilena de Historia Natural*, 62, p.109–114.

Skead, C.J., 1980. *Historical mammal incidence in the Cape Province Volume 1*. Cape Town: The Department of Nature and Environmental Conservation of the Provincial Administration of the Cape of Good Hope.

Skinner, J.D. and Chimimba, C.T. eds., 2005. *The mammals of the southern African subregion*. Cambridge: Cambridge University Press.

Speth, J.D., 2013. Thoughts about hunting: Some things we know and some things we don’t know. *Quaternary International*, 297, p.176–185.

Stahl, P.W., 1982. On small mammal remains in archaeological context. *American Antiquity*, 47(4), p.822–829.

Steele, T.E., 2015. The contributions of animal bones from archaeological sites: The past and future of zooarchaeology. *Journal of Archaeological Science*, 56, p.168–176.

Stein, B.R., 1989. Bone density and adaptation in semiaquatic mammals. *Journal of Mammalogy*, 70(3), p.467–476.

Stevenson, R.D., Peterson, C.R. and Tsuji, J.S., 1983. The thermal dependence of locomotion, tongue flicking, digestion, and oxygen consumption in the wandering garter snake. *Physiological Zoology*, 56(1), p.46–87.

Stewart, K.M., Leblanc, L., Matthiesen, D.P. and West, J., 1999. Microfaunal remains from a modern East African raptor roost: Patterning and implications for fossil bone scatters. *Paleobiology*, 25(4), p.483–503.

Stiner, M.C., Munro, N.D., Surovell, T.A., Tchernov, E. and Bar-Yosef, O., 1999. Paleolithic population growth pulses evidenced by small animal exploitation. *Science*, 283, p.190–194.

Suchentrunk, F., Ben Slimen, H. and Kryger, U., 2009. Molecular evidence of conspecificity of South African hares conventionally considered *Lepus capensis* L., 1758. *Mammalian Biology - Zeitschrift für Säugetierkunde*, 74(5), p.325–343.

Suchentrunk, F. and Flux, J.E.C., 1996. Minor dental traits in East African Cape hares and savanna hares (*Lepus capensis* and *Lepus victoria*): A study intra- and interspecific variability. *Journal of Zoology London*, 238, p.495–511.

Suwannarong, K. and Chapman, R.S., 2014. Rodent consumption in Khon Kaen Province, Thailand. *The Southeast Asian Journal of Tropical Medicine and Public Health*, 45(5), p.1209–1220.

Suwannarong, K., Chapman, R.S., Lantican, C., Michaelides, T. and Zimicki, S., 2015. Hunting, food preparation, and consumption of rodents in Lao PDR. *PLoS ONE*, 10(7), p.1–14.

Sykes, N., 2014. *Beastly questions: Animal answers to archaeological issues.* London: Bloomsbury Academic.

Sykes, N., 2017. Fair game: Exploring the dynamics, perception and environmental impact of “surplus” wild foods in England 10kya–present. *World Archaeology*, 49(1), p.61–72.

Thom, H.B., 1952. *Journal of Jan van Riebeeck Volume I: 1651- 1655.* Cape Town: Balkema.

Thomas, D.H., 1969. Great basin hunting patterns: A quantitative method for treating faunal remains. *American Antiquity*, 34(4), p.392–401.

Thompson, J.C., 2010a. Taphonomic analysis of the Middle Stone Age faunal assemblage from Pinnacle Point Cave 13B, Western Cape, South Africa. *Journal of Human Evolution*, 59(3–4), p.321–339.

Thompson, J.C., 2010b. Variability in Middle Stone Age faunal exploitation and use of the physical and social landscapes in the southwestern Cape, South Africa. *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age III*, p.1–28.

Thompson, J.C. and Henshilwood, C.S., 2014. Nutritional values of tortoises relative to ungulates from the Middle Stone Age levels at Blombos Cave, South Africa: Implications for foraging and social behaviour. *Journal of Human Evolution*, 67, p.33–47.

Ugan, A., 2005. Climate, bone density, and resource depression: What is driving variation in large and small game in Fremont archaeofaunas? *Journal of Anthropological Archaeology*, 24(3), p.227–251.

Ugan, A. and Coltrain, J., 2012. Stable isotopes, diet, and taphonomy: A look at using isotope-based dietary reconstructions to infer differential survivorship in zooarchaeological assemblages. *Journal of Archaeological Science*, 39(5), p.1401–1411.

Val, A., de la Peña, P. and Wadley, L., 2016. Direct evidence for human exploitation of birds in the Middle Stone Age of South Africa: The example of Sibudu Cave, KwaZulu-Natal. *Journal of Human Evolution*, 99, p.1–17.

Vale, D. and Gargett, R.H., 2002. Size matters: 3-mm sieves do not increase richness in a fishbone assemblage from Arrawarra I, an Aboriginal Australian shell midden on the Mid-north Coast of New South Wales, Australia. *Journal of Archaeological Science*, 29, p.57–63.

van der Waal, C.S., 1981. Boukonstruksie van die Venda. *Suid-Afrikaanse tydskrif vir Etnologie*, 4(1), p.15–32.

VanDerwaker, A.M. and Peres, T.M. eds., 2010. *Integrating zooarchaeology and paleoethnobotany: A consideration of issues, methods, and cases.* New York: Springer.

van Doornum, B., 2007. Tshisiku Shelter and the Shashe-Limpopo confluence area hunter-gatherer sequence. *South African Humanities*, 19, p.17–67.

van Steendam, K., De Wulf, O., Dhaenens, M. and Deforce, D., 2014. Species identification from hair by means of spectral library searches. *International Journal of Legal Medicine*, 128(5), p.873–878.

Vidus Rosin, A., Montagna, A., Meriggi, A. and Serrano Perez, S., 2009. Density and habitat requirements of sympatric hares and cottontails in northern Italy. *Hystrix: The Italian Journal of Mammalogy*, 20(2), p.101–110.

Vigne, J-D. and Valladas, H., 1996. Small mammal fossil assemblages as indicators of environmental change in Northern Corsica during the last 2500 years. *Journal of Archaeological Science*, 23, p.199–215.

Viscardi, P., Sakamoto, M. and Sigwart, J.D., 2010. How long is a piece of Strix? Methods in measuring and measuring the measurers. *Zoomorphology*, 129, p.185–194.

Voigt, E.A. and von den Driesch, A., 1984. Preliminary report on the faunal assemblage from Ndondondwane, Natal. *Annals of the Natal Museum*, 26(1), p.95–104.

von den Driesch, A., 1976. *A guide to the measurements of animal bones from archaeological sites*. Massachusetts: Harvard.

Wadley, L., 1998. Invisible meat providers: Women in the Stone Age of South Africa. In S. Kent, ed. *Gender in African Prehistory*. Walnut Creek: AltaMira Press.

Wadley, L., 2000. South African archaeology, gender, and the African renaissance. *South African Historical Journal*, 43, p.81–95.

Wadley, L., 2008. The Howieson's Poort industry of Sibudu Cave. *South African Archaeological Society Goodwin Series*, 10, p.122–132.

Wadley, L., 2010. Were snares and traps used in the Middle Stone Age and does it matter? A review and a case study from Sibudu, South Africa. *Journal of Human Evolution*, 58(2), p.179–192.

Wall, W.P., 1983. The correlation between high limb-bone density and aquatic habits in recent mammals. *Journal of Paleontology*, 57(2), p.197–207.

Watchman, A., 1993. Perspectives and potentials for absolute dating prehistoric rock paintings. *Antiquity*, 67(254), p.58–65.

Watson, V. and Plug, I., 1995. *Oreotragus major* Wells and *Oreotragus oreotragus* (Zimmerman) (Mammalia: Bovidae): Two species? *Annals of the Transvaal Museum*, 36(13), p.183–191.

Weissbrod, L., Bar-Oz, G., Cucchi, T. and Finkelstein, I., 2013. The urban ecology of Iron Age Tel Megiddo: Using microvertebrate remains as ancient bio-indicators. *Journal of Archaeological Science*, 40(1), p.257–267.

Weissbrod, L., Malkinson, D., Cucchi, T., Gadot, Y., Finkelstein, I. and Bar-Oz, G., 2014. Ancient urban ecology reconstructed from archaeozoological remains of small mammals in the Near East. *PloS ONE*, 9(3), p.e91795.

Wessels, W., Fejfar, O., Peláez-Campomanes, P., Meulen, A.J. and Bruijn, H., 2003. Miocene small mammals from Jebel Zelten, Libya. *Coloquios de Paleontología*, p.619–715. Available at: http://fossilworks.org [Accessed August 11, 2014]

West, B., 1990. A tale of two innominates. *Circaea*, 6(2), p.107–114.

Whiting, M.J., Williams, V.L. and Hibbitts, T.J., 2011. Animals traded for traditional medicine at the Faraday market in South Africa: Species diversity and conservation implications. *Journal of Zoology*, 284, p.84–96.

Wible, J.R., 2007. On the cranial osteology of the Lagomorpha. In K. C. Beard & Z. Luo, eds. *Bulletin of the Carnegie Museum of Natural History - mammalian palaeontology on a global stage: Papers in honour of Mary R. Dawson.* Pittsburgh: Carnegie Museum of Natural History.

Wiley, E.O., Siegel-Causey, D., Brooks, D.R. and Funk, V.A., 1991. *The complete cladist. A primer of phylogenetic procedures.* J. T. Collins, ed., Lawrence, Kansas: The University of Kansas Printing Service.

Williams, D.M. and Ebach, M.C., 2009. What, exactly, is cladistics? Re-writing the history of systematics and biogeography. *Acta Biotheoretica*, 57, p.249–268.

Williams, V.L. and Whiting, M.J., 2016. A picture of health? Animal use and the Faraday traditional medicine market, South Africa. *Journal of Ethnopharmacology*, 179, p.265–273.

Winkler, A.J. and Avery, D.M., 2010. Lagomorpha. In L. Werdelin & J. W. Sanders, eds. *Cenozoic mammals of Africa*. Berkley; Los Angeles; London: University of California Press, pp. 305–317.

Wolverton, S., 2012. Data quality in zooarchaeological faunal identification. *Journal of Archaeological Method and Theory*, 20(3), p.381–396.

Yang, D.Y., Woiderski, J.R. and Driver, J.C., 2005. DNA analysis of archaeological rabbit remains from the American Southwest. *Journal of Archaeological Science*, 32(4), p.567–578.

Yeakel, J.D., Bennett, N.C., Koch, P.L. and Dominy, N.J., 2007. The isotopic ecology of African mole rats informs hypotheses on the evolution of human diet. *Proceedings of the Royal Society B: Biological Sciences*, 274(1619), p.1723–1730.

Yellen, J.E., 1991a. Small mammals*: !Kung* San utilization and the production of fauna assemblages. *Journal of Anthropological Archaeology*, 10(1), p.1–26.

Yellen, J.E., 1991b. Small mammals: Post-discard patterning of *!Kung* San faunal remains. *Journal of Anthropological Archaeology*, 10(2), p.152–192.

Yeshurun, R., Bar-Oz, G. and Weinstein-Evron, M., 2009. The role of foxes in the Natufian economy. *Before Farming*, 2009(1), p.1–15.

Zachos, F.E., Apollonio, M., Bärmann, E.V., Festa-Bianchet, M., Göhlich, U., Habel, J.C., Haring, E., Kruckenhauser, L., Lovari, S., McDevitt, A.D., Pertoldi, C., Rössner, G.E., Sánchez-Villagra, M.R., Scandura, M. and Suchentrunk, S., 2013. Species inflation and taxonomic artefacts – a critical comment on recent trends in mammalian classification. *Mammalian Biology*, 78, p.1–6.

APPENDIX A

SPECIMENS USED IN THE STUDY

Explanatory notes

- In this Appendix I provide the accession information on each specimen that was examined and measured.
- There is a complete list of the skeletal elements that were present for each specimen.
- A number of the specimens from the Ditsong National Museum of Natural History have two accession numbers, i.e. TM (Transvaal Museum) and AZ (Archaeozoology). The reason for this is that when the Transvaal Museum first came into being all mammal specimens were accessioned with the abbreviation TM. When the Archaeozoology Department was formed most of the skeletal material housed in the Mammal Department was moved to the new department. This required that the specimens had to be were de-accessioned from the mammal department (TM) and accessioned into the new department under the abbreviation AZ. Museum practice dictates that both numbers are retained for record purposes. Both numbers are provided in this appendix in keeping with this practice.
- Tables A-2 and A-4 indicate the live weight and measurements as recorded by the collectors upon capturing the specimen. Not all the specimens had this information recorded on the specimen cards.
- Table A-5 provides the list of specimen and the respective elements that were used in the photo’s included in Chapters 3 and 4. As museum specimens are not always complete or elements are broken or not cleaned properly, various specimens were used for the photos.

Legend for tables:

- **NP** = Not present
- **NI** = Not indicated

Table A-2: *L. capensis* specimens used – museum accession information of measurements taken

Accession Number	Total length (including tail) (mm)	Tail length (mm)	Hind foot length (mm)	Ear length (mm)	Mass (g)
AZ 680	470	120	120	105	2150
AZ 686	465	105	110	110	1850
AZ 2756	495	110	115	130	2250
AZ 2761	450	65	120	110	1750
AZ 2791	455	105	120	100	1950
AZ 2922	562	101	115	116	3000
AZ 2959	550	100	111	110	2100
TM 28187	543	120	125	114	1700
TM 12609	390	90	100	100	NI
TM 19602	500	72	110	101	2000
TM 33802	540	80	105	125	1500
NMB 4713	570	100	110	112	1900

Table A-4: *L. saxatilis* specimens used – museum accession information of measurements taken

Accession Number	Total length (including tail) (mm)	Tail Length (mm)	Hind Foot length (mm)	Ear length (mm)	Mass (mm)
AZ 670	510	120	135	125	2700
AZ 2379	510	110	130	100	2550
AZ 673	535	115	140	125	2800
AZ 654	590	125	138	140	3550
AZ 655	545	110	135	115	3500
AZ 658	530	110	130	110	2600
AZ 656	530	125	135	120	3300
AZ 660	555	115	150	140	3750
AZ 671	500	130	125	115	1900
AZ 2595	555	125	135	110	3050
AZ 2598	540	120	130	120	3050
AZ 2716	525	100	125	110	2200
AZ 2706	590	150	140	130	3750
AZ 2737	570	135	135	125	3250
AZ 2740	545	80	135	120	2750
AZ 2774	545	125	138	130	3450
TM 13509	579	74	125	105	NI
TM 41151	540	88	110	107	1900
TM 37987	500	120	130	120	2250
TM 37981	570	175	150	140	3650
TM 29605	863	103	135	139	2900
TM 37972	500	90	115	98	2000
TM 38047	530	140	135	110	3000
TM 38006	535	80	125	120	2700
TM 30036	424	62	112	99	1800
NMB 4712	610	110	115/123	125	2140

Table A-5: Specimens used in the photos

Element	***Lepus capensis***	***Lepus saxatilis***
Skull	TM 2056	TM 20714
Mandible	TM 2056	TM 20714
Atlas	AZ 2354	AZ 2959
Axis	AZ 2354	AZ 2959
Scapula	AZ 680	AZ 660
Humerus	AZ 2922	AZ 660
Radius	AZ 679	AZ 656
Ulna	AZ 679	AZ 656
Metacarpals	AZ 419	AZ 957
Pelvis	AZ 2354	AZ 660
Sacrum	AZ 2922	AZ 673
Femur	AZ 679	AZ 660
Tibia	AZ 2922	AZ 660
Patella	AZ 2354	AZ 670
Calcaneus	AZ 2959	AZ 419
Talus	AZ 2922	AZ 419
Metatarsals	AZ 2922	AZ 957

APPENDIX B

REWORKED DATA

Explanatory notes

- In this Appendix I provide the reworked data as per Table 3.2 (Chapter 3)

Mean	of all the data points measured
Standard deviation	of all the data points measured
Confidence coefficient	1.96 was used to calculate the 95% confidence levels
<u>Average</u> margin of error	confidence coefficient x standard deviations ÷ sample size ^0.5
<u>Average</u> upper bound	mean + margin of error
<u>Average</u> lower bound	mean - the margin of error
<u>Data</u> margin of error	confidence coefficient x standard deviations
<u>Data</u> upper bound	the mean + margin of error
<u>Data</u> lower bound	mean - margin of error
Minimum	of all the measurements taken
Maximum	of all the measurements taken
Range	minimum - maximum

- The tables are organised in the following manner
    - Calculations for all *L. capensis* specimens
    - Calculations for all *L. saxatilis* specimens
    - Calculations for all ♀ *L. capensis* specimens
    - Calculation for all ♂ *L capensis* specimens
    - Calculations for all ♀ *L. saxatilis* specimens
    - Calculation for all ♂ *L saxatilis* specimens
- Only specimens of known sex (see Appendix A) were used in the ♀ and ♂ calculation.
- The majority of calculations were made using the skeletal element of the left side. When that side was broken or absent the measurements of the right side were subsituted.
- The sex data calculations are provided in the light of the discussion on sexual dimorphism in Chapter 1 section 1.1.3

APPENDIX B

Skull

Table B-1: Skull measurements for *L. capensis*

Measurement	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Sample size	31	30	31	31	29	30	31	30	31	30	31	30	27	31	31	28	29	31	31	30	30	30
Mean	86.29	79.74	69.65	41.00	36.58	19.5	35.78	31.94	15.55	23.56	5.88	14.32	33.92	28.94	23.20	37.00	39.97	19.08	11.40	11.60	8.15	10.18
Standard deviation	4.30	3.80	3.50	5.50	2.38	1.76	9.18	3.66	0.95	1.49	0.68	0.69	1.89	0.97	1.43	2.41	1.69	1.47	0.83	0.84	0.57	0.76
Average margin of error	1.51	1.36	1.23	1.94	0.87	0.63	3.23	1.31	0.33	0.53	0.24	0.25	0.71	0.34	0.50	0.89	0.62	0.52	0.29	0.30	0.21	0.27
Average upper bound	87.81	81.09	70.88	42.94	37.45	20.15	39.02	33.25	15.89	24.09	6.12	14.57	34.63	29.28	23.71	37.90	40.59	19.60	11.69	11.90	8.35	10.45
Average lower bound	84.75	78.38	68.42	39.07	35.72	18.89	32.55	30.63	15.22	23.02	5.64	14.08	33.02	28.59	22.70	36.11	39.36	6.05	2.89	3.68	2.04	3.08
Data margin of error	8.43	7.44	6.86	10.78	4.67	3.44	18.00	7.18	1.86	2.91	1.34	1.35	3.70	1.90	2.80	4.72	3.32	2.89	1.63	1.65	1.13	1.48
Data upper bound	94.73	87.18	76.51	51.78	41.25	22.96	53.78	39.12	17.42	26.47	7.22	15.67	37.61	30.83	26.01	41.72	43.29	21.97	13.03	13.25	9.27	11.66
Data lower bound	77.86	72.29	62.79	30.22	31.91	16.07	17.78	24.76	13.69	20.64	4.55	12.97	30.22	27.04	20.40	32.28	36.66	16.20	9.77	9.95	7.02	8.70
Minimum	79.60	73.82	63.49	14.37	32.46	15.88	29.71	24.65	13.95	21.38	4.39	12.51	30.81	27.46	20.29	33.61	37.37	15.90	10.20	9.61	7.27	8.44
Maximum	97.05	89.22	77.70	47.96	41.56	24.23	83.05	38.90	17.40	26.68	7.44	15.10	39.38	31.45	26.15	42.83	44.42	21.95	13.09	13.29	9.31	11.52
Range	17.45	15.40	14.21	33.59	9.10	8.35	53.34	14.25	3.45	5.30	3.05	2.59	8.57	3.99	5.86	9.22	7.05	6.05	2.89	3.68	2.04	3.08

APPENDIX B

Table B-2: Skull measurements for *L. saxatilis*

Measurement	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Sample size	31	30	30	31	31	31	31	31	31	31	31	30	29	30	31	29	28	31	31	31	31	31
Mean	94.43	87.15	76.00	46.49	40.69	20.72	39.28	34.27	17.14	26.15	6.77	15.24	36.03	30.51	25.43	41.75	43.16	21.30	12.46	11.39	8.15	9.77
Standard deviation	6.25	5.58	5.20	3.26	3.45	1.73	2.87	5.08	1.20	2.17	0.71	0.98	2.56	1.58	2.19	2.49	2.31	2.04	0.90	0.72	0.68	0.57
Average margin of error	2.20	2.00	1.86	1.15	1.21	0.61	1.01	1.79	0.42	0.76	0.25	0.35	0.93	0.57	0.77	0.91	0.86	0.72	0.32	0.26	0.24	0.20
Average upper bound	96.63	89.15	77.86	47.64	41.91	21.33	40.29	36.05	17.56	26.91	7.02	15.59	36.96	31.08	26.21	42.65	44.02	22.01	12.78	11.65	8.39	9.98
Average lower bound	92.23	85.15	74.04	45.35	39.48	20.11	38.27	32.48	16.72	25.37	6.51	14.89	35.10	29.92	15.66	40.84	42.30	20.58	12.14	11.14	7.91	9.57
Data margin of error	12.24	10.94	10.19	6.40	6.76	3.40	5.63	9.96	2.34	4.25	1.39	1.92	5.02	3.10	4.30	4.88	4.53	17.30	1.77	1.42	1.32	1.12
Data upper bound	106.68	98.09	86.19	52.89	47.45	24.11	44.91	44.23	19.48	30.39	8.16	17.16	41.05	33.61	29.73	46.63	47.70	25.29	14.23	12.81	9.47	10.90
Data lower bound	82.19	76.21	65.81	40.10	33.94	17.32	33.65	24.30	14.79	21.90	5.37	13.32	31.01	27.41	21.14	36.87	38.63	4.00	10.69	9.97	6.83	8.65
Minimum	81.13	75.55	63.99	40.38	34.43	16.62	33.53	26.40	14.47	21.28	5.11	13.20	30.65	27.60	21.59	35.09	38.38	17.24	10.50	9.67	6.96	8.70
Maximum	104.37	97.36	84.81	52.49	46.26	24.38	43.62	47.28	18.99	31.14	8.10	17.28	40.22	33.81	30.85	45.05	47.46	25.21	13.90	12.58	9.46	11.13
Range	23.24	21.81	20.82	12.11	11.83	7.76	10.09	20.88	4.52	9.86	2.99	4.08	9.57	6.21	9.26	9.96	9.08	7.97	3.40	2.91	2.50	2.43

Table B-3: Skull measurements for ♀ *L. capensis*

Measurement	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Sample size	14	14	14	13	13	14	14	14	14	14	14	14	12	14	14	12	13	14	14	14	14	14
Mean	86.48	79.69	69.39	39.94	36.90	19.31	37.49	32.82	15.63	23.43	5.97	14.19	33.66	28.52	22.93	37.27	39.76	18.82	11.47	11.66	8.04	10.18
Standard deviation	3.94	3.34	3.55	7.63	2.55	2.19	13.25	3.43	1.10	1.56	0.57	0.72	1.25	0.87	1.60	2.39	1.68	1.61	0.79	0.75	0.54	0.87
Average margin of error	2.06	1.75	1.86	4.00	1.39	1.19	6.94	1.80	0.57	0.82	0.30	0.37	0.71	0.46	0.84	1.35	0.91	0.84	0.42	0.39	0.28	0.45
Average upper bound	88.55	81.44	71.22	43.93	28.33	20.48	44.43	34.62	16.21	24.25	6.27	14.57	34.37	28.98	23.76	38.62	40.67	19.67	11.88	12.05	8.32	10.63
Average lower bound	84.42	77.94	67.50	35.56	18.12	30.55	31.02	15.06	22.62	5.68	13.82	13.82	32.96	28.07	22.09	35.92	38.85	17.98	11.05	11.27	7.76	9.72
Data margin of error for the data	7.72	6.55	6.95	14.96	5.01	4.29	25.96	6.73	2.15	3.05	1.11	1.40	2.44	1.71	3.14	4.69	3.28	3.15	1.56	1.46	1.05	1.70
Data upper bound	94.21	86.24	76.31	54.89	41.95	23.59	63.45	39.55	17.78	26.48	7.09	15.60	36.10	30.23	26.07	41.96	43.05	21.98	13.02	13.12	9.09	11.87
Data lower bound	78.76	73.15	62.40	24.98	31.94	15.02	11.52	26.09	13.48	20.38	4.86	12.79	31.22	26.82	19.78	32.58	36.48	15.67	9.91	10.20	6.99	8.48
Minimum	80.80	74.84	63.49	14.37	33.21	15.88	29.87	28.00	14.16	21.49	5.22	12.51	31.99	27.46	20.29	33.61	37.37	15.90	10.25	10.91	7.27	8.81
Maximum	94.80	87.01	75.30	45.83	41.56	24.23	83.05	38.90	17.40	25.85	7.08	15.10	36.83	30.33	26.15	40.59	42.62	21.27	12.55	13.26	9.24	11.52
Range	14.00	12.17	11.81	31.46	8.35	8.35	53.18	10.90	3.24	4.36	1.86	2.59	4.84	2.87	5.56	6.98	5.25	5.37	2.30	2.35	1.97	2.71

Table B- 4: Skull measurements for ♂ *L. capensis*

Measurement	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Sample size	9	9	9	9	8	9	9	8	9	8	9	9	7	9	9	8	8	9	9	8	8	8
Mean	84.38	78.11	68.77	41.13	35.60	19.42	32.90	31.00	15.39	23.38	5.50	14.20	33.68	29.03	23.14	35.83	39.40	18.84	11.05	11.90	8.24	10.38
Standard deviation	3.18	3.06	2.54	2.38	2.33	1.07	1.82	3.85	0.63	1.20	0.64	0.79	1.84	0.64	1.00	1.79	0.92	1.08	0.67	0.89	0.72	0.33
Average margin of error	2.08	2.00	1.66	1.56	1.61	0.70	1.19	2.67	0.41	0.83	0.42	0.52	1.36	0.42	0.65	1.24	0.64	0.71	0.44	0.61	0.50	0.23
Average upper bound	86.46	80.11	70.42	42.68	37.21	20.12	34.09	33.67	15.80	24.22	5.92	14.72	35.05	29.45	23.79	7.07	40.04	19.55	11.49	12.51	8.74	10.60
Average lower bound	82.31	76.11	67.11	39.57	33.99	18.72	31.71	28.34	14.99	22.55	5.09	13.68	32.32	28.62	22.49	34.59	39.76	18.13	10.61	11.29	7.74	10.15
Data margin of error	6.23	5.99	4.97	4.67	4.56	2.10	3.56	7.54	1.23	2.35	1.25	1.56	3.61	1.25	1.96	3.50	1.81	2.12	1.32	1.74	1.41	0.64
Data upper bound	90.61	84.10	73.74	45.80	40.16	21.52	36.47	38.54	16.62	25.74	6.76	15.75	37.29	30.29	24.10	39.33	41.21	20.96	12.37	13.64	9.65	11.01
Data lower bound	78.15	72.12	63.80	36.45	31.04	17.32	29.34	23.46	14.17	21.03	4.25	12.64	30.08	27.78	21.18	32.33	37.60	16.72	9.73	10.17	6.83	9.74
Minimum	79.60	73.82	64.38	37.95	32.46	18.12	29.71	23.37	14.58	21.38	4.39	12.87	31.86	28.04	21.67	33.76	38.23	16.39	10.20	10.31	7.37	9.88
Maximum	88.65	82.52	71.93	43.84	39.74	10.96	34.99	38.32	16.33	24.94	6.48	15.03	36.65	30.00	25.03	388.50	41.16	19.99	12.24	13.26	9.31	10.67
Range	9.05	8.70	7.55	5.89	7.28	2.84	5.28	11.95	1.75	3.56	2.09	2.16	4.79	1.96	3.36	4.74	2.93	3.60	2.04	2.98	1.94	0.79

Table B-5: Skull measurements for ♀ *L. saxatilis*

Measurement	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Sample size	15	15	15	15	15	15	15	15	15	15	15	15	14	14	15	14	14	15	15	15	15	15
Mean	96.38	88.44	77.38	47.26	41.53	20.58	39.94	35.60	17.38	26.54	7.01	15.51	36.94	30.84	25.26	42.39	43.79	21.58	12.75	11.57	8.32	9.73
Standard deviation	5.86	5.52	4.84	3.46	3.33	1.73	2.60	4.73	1.38	2.01	0.74	1.06	2.72	1.69	1.92	2.70	2.28	1.67	0.79	0.66	0.81	0.67
Average margin of error	2.97	2.80	2.45	1.75	1.69	0.88	1.31	2.39	0.70	1.02	0.37	0.54	1.43	0.89	0.97	1.42	1.19	0.85	0.40	0.33	0.41	0.34
Average upper bound	99.35	91.24	79.83	49.14	43.22	21.46	41.26	37.99	18.08	27.56	7.39	16.05	38.36	31.75	26.23	43.81	44.98	22.43	13.15	11.90	8.73	10.07
Average lower bound	93.41	85.65	74.94	45.51	39.84	19.71	38.63	33.21	16.68	25.53	6.64	14.97	35.51	29.98	24.29	40.98	42.59	20.74	12.35	11.24	7.91	9.39
Data margin of error	11.50	10.83	9.48	6.77	6.53	3.39	5.09	9.27	2.71	3.94	1.45	2.08	5.34	3.31	3.77	5.30	4.47	3.28	1.54	1.29	1.59	1.31
Data upper bound	107.87	99.27	86.87	54.03	48.07	23.98	45.04	44.87	20.10	30.48	8.46	17.59	42.27	34.18	29.03	47.69	48.25	24.87	14.29	12.86	9.91	11.04
Data lower bound	84.88	77.61	67.90	40.48	35.00	17.19	34.85	26.33	14.67	22.60	5.56	13.43	31.60	27.55	21.46	37.09	39.32	18.30	11.21	10.28	6.73	8.42
Minimum	86.15	78.03	69.11	40.98	35.69	16.62	35.04	27.09	14.47	23.63	5.11	13.20	30.65	27.60	21.59	35.09	38.50	18.30	11.33	10.35	6.96	8.70
Maximum	104.37	97.36	84.81	52.49	46.26	23.16	43.62	47.24	18.99	28.75	8.10	17.28	40.22	33.81	29.00	45.05	46.96	24.74	13.90	12.58	9.46	11.13
Range	18.22	19.33	15.70	11.51	10.57	6.54	8.58	20.15	4.52	6.12	2.99	4.08	9.57	6.21	7.41	9.96	8.46	6.44	2.57	2.23	2.50	2.43

Table B- 6: Skull measurements for ♂ *L. saxatilis*

Measurement	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Sample size	15	14	14	15	15	15	15	15	15	15	15	14	14	15	15	14	13	15	15	15	15	15
Mean	92.91	86.14	74.86	45.87	40.11	21.06	39.68	33.23	16.94	25.85	6.55	14.99	35.20	30.25	25.65	41.24	42.56	21.09	12.13	11.19	7.98	9.83
Standard deviation	6.30	5.62	5.45	3.09	3.50	1.61	3.16	5.33	1.00	2.37	0.64	0.87	2.23	1.49	2.55	2.24	2.34	2.42	0.95	0.78	0.51	0.50
Average margin of error	3.19	2.94	2.85	1.56	1.77	0.81	1.60	2.70	0.51	1.20	0.32	0.46	1.17	0.76	1.29	1.17	1.27	1.23	0.48	0.40	0.26	0.25
Average upper bound	96.11	89.08	77.71	47.44	41.88	21.87	40.28	38.93	17.45	27.05	6.87	15.45	36.37	31.01	26.94	42.42	43.84	22.32	12.61	11.59	8.24	10.09
Average lower bound	89.72	83.20	72.01	44.31	38.34	20.25	37.08	30.54	16.44	24.65	6.23	14.53	34.03	29.50	24.35	40.07	41.29	19.87	11.65	10.80	7.73	9.58
Data margin of error	12.36	11.01	10.68	6.05	6.85	3.15	6.20	10.45	1.96	4.64	1.25	1.71	4.37	2.93	5.00	4.39	4.59	4.75	1.87	1.54	0.99	0.98
Data upper bound	105.27	97.15	85.54	51.93	46.96	24.21	44.88	43.69	18.90	30.49	7.80	16.70	39.57	33.18	30.64	45.63	47.16	25.84	14.00	12.73	8.97	10.81
Data lower bound	80.56	75.13	64.19	39.82	33.26	17.91	32.48	22.78	14.98	21.21	5.30	13.28	30.83	27.32	20.65	36.86	37.97	16.34	10.27	9.66	6.99	8.85
Minimum	81.13	75.55	63.99	40.38	34.43	18.21	33.53	26.40	15.32	21.28	5.37	13.51	31.58	27.84	22.74	37.47	38.38	17.24	10.50	9.67	7.17	9.05
Maximum	104.20	95.17	93.21	50.52	46.01	24.38	43.20	47.28	18.45	31.14	7.67	16.16	39.30	33.36	30.85	43.56	47.46	25.21	13.63	12.40	9.15	10.65
Range	23.07	20.16	19.22	10.14	11.58	6.17	9.67	20.88	3.13	9.86	2.30	2.65	7.72	5.52	8.11	6.09	9.08	7.97	3.13	2.73	1.98	1.60

Mandible

Table B-7: Mandible measurements for *L. capensis*

Measurement	**1**	**2**	**3**	**4**	**5**	**5a**	**6**	**7**
Sample size	23	28	28	28	28	28	21	21
Mean	58.23	16.54	35.08	18.41	39.37	37.77	11.62	14.30
Standard deviation	3.06	0.96	1.58	1.23	2.41	2.56	0.81	1.06
Average margin of error	1.25	0.36	0.58	0.46	0.89	0.95	0.35	0.45
Average upper bound	59.48	16.90	35.66	18.87	40.26	38.72	11.96	14.75
Average lower bound	56.98	16.19	34.49	17.96	38.47	36.82	11.27	13.84
Data margin of error	6.00	1.88	3.09	2.41	4.72	5.02	1.59	2.08
Data upper bound	64.23	18.43	38.16	20.82	44.08	42.79	13.21	16.37
Data lower bound	52.23	14.66	31.99	16.01	34.65	32.75	10.02	12.22
Minimum	54.95	14.60	31.87	16.81	35.17	32.94	9.90	12.25
Maximum	67.59	18.45	39.64	20.85	46.79	46.05	13.11	15.82
Range	12.64	3.84	7.77	4.04	11.62	13.08	3.21	3.57

Table B-8: Mandible measurements for *L. saxatilis*

Measurement	**1**	**2**	**3**	**4**	**5**	**5a**	**6**	**7**
Sample size	28	29	28	28	29	29	26	26
Mean	64.83	18.39	39.31	20.66	45.20	43.57	12.25	16.43
Standard deviation	4.09	1.19	2.88	1.90	2.87	2.90	0.90	1.17
Average margin of error	5.73	0.43	1.07	0.70	1.05	1.06	0.35	0.45
Average upper bound	70.56	18.82	40.38	21.37	46.24	44.63	13.60	16.89
Average lower bound	59.11	17.96	38.25	19.96	44.15	42.52	12.90	15.98
Data margin of error	8.02	2.33	5.64	3.72	5.63	5.69	1.76	2.30
Data upper bound	72.85	20.72	44.95	24.39	50.82	49.26	15.01	18.73
Data lower bound	56.81	16.06	33.68	16.94	39.57	37.88	11.49	14.14
Minimum	54.31	15.96	32.25	16.00	37.74	36.39	10.54	13.33
Maximum	71.77	20.68	43.42	24.35	50.13	48.75	14.65	18.27
Range	17.46	4.72	11.17	8.35	12.39	12.36	4.11	4.94

Table B-9: Mandible measurements for ♀ *L. capensis*

Measurement	**1**	**2**	**3**	**4**	**5**	**5a**	**6**	**7**
Sample size	10	13	13	13	13	13	9	9
Mean	58.68	16.48	34.87	18.40	39.25	37.77	11.55	14.17
Standard deviation	2.64	1.04	1.63	1.28	2.19	2.18	0.97	1.29
Average margin of error	1.64	0.57	0.89	0.69	1.19	1.18	0.63	0.84
Average upper bound	60.32	17.04	35.76	19.10	40.45	38.96	12.18	15.01
Average lower bound	57.04	15.91	33.99	17.71	38.06	36.59	10.92	13.33
Data margin of error	5.18	2.04	3.19	2.51	4.30	4.27	1.90	2.52
Data upper bound	63.86	18.51	38.06	20.91	43.55	42.04	13.44	16.96
Data lower bound	53.50	14.44	31.68	15.90	34.96	33.50	9.65	11.65
Minimum	55.00	14.60	31.87	16.83	35.89	34.43	9.90	12.25
Maximum	62.61	17.87	37.06	20.37	43.37	41.67	13.11	15.82
Range	7.61	3.27	5.19	3.54	7.48	7.24	3.21	3.57

Table B-10: Mandible measurements for ♂ *L. capensis*

Measurement	**1**	**2**	**3**	**4**	**5**	**5a**	**6**	**7**
Sample size	9	9	9	9	9	9	8	8
Mean	57.07	16.40	1.11	0.91	2.35	2.42	0.82	0.88
Standard deviation	2.26	0.83	1.11	0.91	2.35	2.42	0.82	0.88
Average margin of error	1.47	0.54	0.73	0.59	1.53	1.58	0.57	0.61
Average upper bound	58.55	16.94	35.79	19.10	40.44	38.65	12.10	14.79
Average lower bound	55.60	15.86	34.33	17.92	37.37	35.50	10.96	13.57
Data margin of error	4.42	1.63	2.18	1.78	4.60	4.73	1.61	1.72
Data upper bound	61.49	18.03	37.24	20.29	43.51	41.81	13.15	15.90
Data lower bound	52.65	14.77	32.87	16.73	34.30	32.34	9.92	12.46
Minimum	54.95	15.02	33.76	16.84	35.17	32.94	10.11	12.44
Maximum	61.16	17.42	36.75	19.46	43.37	41.67	12.39	15.23
Range	6.21	2.40	2.99	2.62	8.20	8.73	2.28	2.79

Table B-11: Mandible measurements for ♀ *L. saxatilis*

Measurement	**1**	**2**	**3**	**4**	**5**	**5a**	**6**	**7**
Sample size	14	14	14	14	14	14	14	14
Mean	66.04	18.67	39.84	20.93	46.53	44.89	13.37	16.77
Standard deviation	3.94	1.17	2.73	1.68	2.93	2.92	1.07	1.27
Average margin of error	5.52	0.62	1.43	0.88	1.54	1.53	0.56	0.67
Average upper bound	71.56	19.28	41.27	21.71	48.07	46.42	13.94	17.43
Average lower bound	60.51	18.05	37.41	19.95	44.99	43.36	12.81	16.10
Data margin of error	7.73	2.30	5.34	3.29	5.75	5.73	2.10	2.49
Data upper bound	73.76	20.97	45.18	24.11	52.28	50.62	15.48	19.26
Data lower bound	58.31	16.36	34.50	17.54	40.78	39.17	11.27	14.28
Minimum	57.32	16.56	34.14	17.21	37.74	36.39	10.54	13.33
Maximum	71.77	20.68	43.42	22.94	50.13	48.75	14.65	18.27
Range	14.45	4.12	9.27	5.73	12.39	12.36	4.11	4.94

Table B-12: Mandible measurements for ♂ *L. saxatilis*

Measurement	**1**	**2**	**3**	**4**	**5**	**5a**	**6**	**7**
Sample size	13	14	13	13	14	14	12	12
Mean	63.81	18.17	38.91	20.61	44.02	42.45	13.11	16.05
Standard deviation	4.12	1.22	3.12	2.20	2.32	2.40	0.66	0.95
Average margin of error	5.76	0.64	1.69	1.19	1.21	1.26	0.37	0.54
Average upper bound	69.57	18.81	40.60	21.81	45.23	43.71	13.48	16.59
Average lower bound	58.04	17.53	37.21	19.42	42.81	41.19	12.73	15.51
Data margin of error	8.07	2.39	6.11	4.30	4.54	4.71	1.30	1.87
Data upper bound	71.88	20.56	45.01	24.92	48.56	47.16	14.40	17.92
Data lower bound	55.74	15.78	32.80	16.31	39.48	37.73	11.81	14.18
Minimum	54.31	15.96	32.25	16.00	40.31	38.59	12.01	14.66
Maximum	68.84	20.05	42.54	24.35	47.43	56.61	14.06	17.40
Range	14.53	4.06	10.29	8.35	7.12	8.02	2.05	2.74

Atlas

Table B-13: Atlas measurements for *L. capensis*

Measurement	GB	GL	BFcr	BFcd	GLF	Lad Right	LAdt
Sample size	15	12	15	12	12	12	12
Mean	26.96	12.38	14.42	11.38	11.39	6.57	7.02
Standard deviation	10.1	0.65	0.47	0.60	1.15	0.63	0.79
Average margin of error	0.51	0.37	0.24	0.34	0.65	0.36	1.11
Average upper bound	27.47	12.74	14.66	11.72	12.04	6.93	8.12
Average lower bound	26.45	12.01	14.18	11.04	10.73	6.21	5.91
Data margin of error	1.97	1.27	0.93	1.18	2.26	1.24	1.55
Data upper bound	28.93	13.64	15.35	12.56	13.64	7.81	8.57
Data lower bound	24.99	11.11	13.49	10.20	9.13	5.32	5.47
Minimum	25.00	11.19	13.50	10.56	8.93	5.61	5.68
Maximum	29.69	13.39	15.18	12.90	12.61	7.54	8.03
Range	4.69	2.20	1.68	2.34	3.68	1.93	2.35

Table B-14: Atlas measurements for *L. saxatilis*

Measurement	GB	GL	BFcr	BFcd	GLF	Lad Right	LAdt
Sample size	17	17	18	18	18	17	18
Mean	29.56	13.88	15.90	12.57	12.14	7.50	7.32
Standard deviation	1.79	0.97	1.00	1.19	1.13	0.43	0.74
Average margin of error	0.85	0.46	0.46	0.55	0.52	0.20	0.34
Average upper bound	30.41	14.34	16.37	13.12	13.66	7.70	7.67
Average lower bound	28.71	13.42	15.44	12.02	12.62	7.29	6.98
Data margin of error	3.50	1.90	1.72	1.70	2.21	0.84	1.45
Data upper bound	33.06	15.78	17.75	14.14	15.36	8.34	8.78
Data lower bound	26.06	11.98	14.30	10.75	10.93	6.66	5.87
Minimum	26.59	12.43	13.98	11.09	10.43	6.77	4.85
Maximum	32.33	12.51	17.75	16.15	14.56	8.39	8.28
Range	5.74	3.08	3.80	5.06	4.13	1.62	3.43

Table B-15: Atlas measurements ♀ *L. capensis*

Measurement	**GB**	**GL**	**BFcr**	**BFcd**	**GLF**	**Lad Right**	**LAdt**
Sample size	12	10	12	10	10	10	10
Mean	27.14	12.28	14.46	11.36	11.25	6.40	6.95
Standard deviation	0.94	0.62	0.50	0.66	1.21	0.55	0.81
Average margin of error	0.53	0.39	0.28	0.41	0.75	0.34	1.13
Average upper bound	27.67	12.67	14.75	11.77	12.00	6.74	8.08
Average lower bound	26.61	11.90	14.18	10.95	10.50	6.06	5.82
Data margin of error	1.84	1.22	0.98	1.30	2.37	1.08	1.58
Data upper bound	28.98	13.50	15.45	12.65	13.63	7.48	8.54
Data lower bound	25.30	11.06	13.48	10.06	8.88	5.32	5.37
Minimum	26.19	11.19	13.50	10.60	8.93	5.61	5.68
Maximum	29.69	13.34	15.18	12.90	12.61	7.23	8.03
Range	3.50	2.15	1.68	2.34	3.68	1.62	2.35

Table B-16: Atlas measurements ♂ *L. capensis*

Measurement	**GB**	**GL**	**BFcr**	**BFcd**	**GLF**	**Lad Right**	**LAdt**
Sample size	3	2	3	2	2	2	2
Mean	26.27	12.84	14.23	11.51	12.05	7.40	7.35
Standard deviation	1.15	0.78	0.36	0.11	0.58	0.20	0.86
Average margin of error	1.30	1.09	0.41	0.16	0.80	0.27	1.20
Average upper bound	27.56	13.92	14.64	11.67	12.85	7.67	8.54
Average lower bound	24.97	11.75	13.83	11.35	11.25	7.13	6.15
Data margin of error	2.25	1.54	0.70	0.22	1.14	0.39	1.68
Data upper bound	28.51	14.37	14.94	11.73	13.19	7.79	9.02
Data lower bound	24.02	11.30	13.53	11.29	10.91	7.01	5.67
Minimum	25.00	12.28	13.82	11.43	11.64	7.26	6.74
Maximum	27.23	13.39	14.45	11.59	12.46	7.54	7.95
Range	2.23	1.11	0.63	0.16	0.82	0.28	1.21

Table B-17: Atlas measurements ♀ *L. saxatilis*

Measurement	**GB**	**GL**	**BFcr**	**BFcd**	**GLF**	**Lad Right**	**LAdt**
Sample size	9	9	9	9	9	9	9
Mean	30.24	14.28	16.12	12.82	13.48	7.41	7.42
Standard deviation	1.53	1.09	1.24	1.42	1.05	0.41	0.46
Average margin of error	1.00	0.71	0.81	0.93	0.69	0.27	0.30
Average upper bound	31.24	14.99	16.93	13.75	14.17	7.68	7.72
Average lower bound	29.24	13.57	15.32	11.89	12.79	7.14	7.12
Data margin of error	3.00	2.13	1.83	1.67	2.06	0.81	0.90
Data upper bound	33.24	16.41	18.19	14.24	15.54	8.22	8.32
Data lower bound	27.24	12.15	14.54	10.91	11.42	6.61	6.52
Minimum	27.92	12.64	13.95	11.09	11.82	6.90	6.75
Maximum	32.33	15.51	17.75	16.15	14.56	8.04	8.28
Range	4.41	2.87	3.80	5.06	2.74	1.14	1.53

Table B-18: Atlas measurements ♂ *L. saxatilis*

Measurement	**GB**	**GL**	**BFcr**	**BFcd**	**GLF**	**Lad Right**	**LAdt**
Sample size	7	7	8	8	8	7	8
Mean	28.80	13.41	15.68	12.27	12.79	7.59	7.19
Standard deviation	1.98	0.64	0.76	0.97	1.24	0.49	1.03
Average margin of error	1.46	0.47	0.53	0.67	0.86	0.36	0.71
Average upper bound	30.26	13.89	16.21	12.94	13.65	7.96	7.90
Average lower bound	27.34	12.94	15.15	11.60	11.93	7.23	6.48
Data margin of error	3.87	1.25	1.50	1.89	2.43	6.64	2.02
Data upper bound	32.67	14.67	17.18	14.16	15.23	8.55	9.21
Data lower bound	24.93	12.16	14.18	10.38	10.36	6.64	5.17
Minimum	26.59	12.43	14.56	11.44	10.43	6.77	4.85
Maximum	31.93	14.17	16.91	13.78	14.22	8.39	8.09
Range	5.34	1.74	2.35	2.43	3.79	1.62	3.24

Axis

Table B-19: Axis measurements for *L. capensis*

Measurement	**LCDe**	**LAPa**	**BFcr**	**BPacd**	**BPtr**	**SBV**	**Bfcd**	**H**
Sample size	15	15	12	15	14	14	8	11
Mean	17.82	13.15	10.36	9.10	11.48	9.88	5.93	13.80
Standard deviation	0.90	1.42	0.37	0.61	0.71	0.57	0.45	0.90
Average margin of error	0.46	0.72	0.21	0.31	0.37	0.30	0.31	0.53
Average upper bound	18.27	13.87	10.57	9.40	11.85	10.18	6.24	14.34
Average lower bound	17.36	12.40.	10.15	8.79	11.11	9.59	5.61	12.27
Data margin of error	1.76	2.78	0.73	1.19	1.39	1.11	0.34	1.76
Data upper bound	19.58	15.93	11.09	10.29	12.87	10.99	6.15	15.57
Data lower bound	16.05	10.37	9.63	7.90	10.09	8.77	5.45	12.04
Minimum	16.40	10.30	9.75	8.30	10.22	9.19	5.57	12.75
Maximum	19.34	15.28	11.24	10.49	12.51	11.59	6.98	15.55
Range	2.94	4.98	1.49	2.19	2.29	2.40	1.14	2.80

Table B-20: Axis measurements for *L. saxatilis*

Measurement	**LCDe**	**LAPa**	**BFcr**	**BPacd**	**BPtr**	**SBV**	**Bfcd**	**H**
Sample size	19	19	19	18	14	19	18	18
Mean	19.54	15.27	11.22	10.42	12.81	10.95	7.29	14.70
Standard deviation	1.61	1.68	0.61	0.49	0.78	0.69	2.29	0.99
Average margin of error	0.72	0.76	0.28	0.23	0.41	0.31	1.06	0.46
Average upper bound	20.26	16.03	11.40	10.65	13.22	11.26	8.35	15.16
Average lower bound	18.82	14.52	10.94	10.19	12.41	10.64	6.23	14.25
Data margin of error	3.15	3.30	1.20	0.96	1.52	1.35	4.48	1.94
Data upper bound	22.69	18.57	12.42	11.38	14.34	12.30	11.77	16.64
Data lower bound	16.39	11.98	10.01	9.46	11.29	9.60	2.80	12.77
Minimum	17.04	12.46	10.09	9.51	11.47	9.62	5.75	13.37
Maximum	22.38	18.70	12.15	11.15	13.66	11.88	13.77	16.89
Range	5.34	6.24	2.06	1.64	2.19	2.26	8.02	3.52

Table B-21: Axis measurements for ♀ *L. capensis*

Measurement	**LCDe**	**LAPa**	**BFcr**	**BPacd**	**BPtr**	**SBV**	**Bfcd**	**H**
Sample size	12	12	10	12	11	11	6	9
Mean	17.79	13.18	10.35	9.16	11.50	9.90	5.91	13.84
Standard deviation	0.85	1.56	0.41	0.62	0.66	0.64	0.53	0.94
Average margin of error	0.48	0.88	0.25	0.35	0.39	0.38	0.43	0.62
Average upper bound	18.27	14.06	10.60	9.51	11.89	10.28	6.34	14.46
Average lower bound	17.31	12.30	10.09	8.81	11.11	9.52	5.90	13.22
Data margin of error	1.66	3.05	0.80	1.21	1.30	1.26	0.31	1.85
Data upper bound	19.46	16.23	11.15	10.37	12.80	11.16	6.06	15.69
Data lower bound	16.13	10.13	9.55	7.95	10.20	8.64	5.43	11.99
Minimum	16.68	10.30	9.75	8.44	10.37	9.19	5.57	12.75
Maximum	19.34	15.28	11.24	10.49	12.51	11.59	6.98	15.55
Range	2.66	4.98	1.49	2.05	2.14	2.40	1.42	2.80

Table B-22: Axis measurements for ♂ *L. capensis*

Measurement	**LCDe**	**LAPa**	**BFcr**	**BPacd**	**BPtr**	**SBV**	**Bfcd**	**H**
Sample size	3	3	2	3	3	3	2	2
Mean	17.90	13.02	10.44	8.83	11.42	9.83	5.98	13.65
Standard deviation	1.30	0.85	0.08	0.62	1.03	0.12	0.09	0.93
Average margin of error	1.47	0.97	0.11	0.70	1.17	0.13	0.13	1.29
Average upper bound	19.37	13.98	10.54	9.53	12.58	9.96	6.10	14.94
Average lower bound	16.43	12.05	10.33	8.13	10.24	9.70	5.85	12.36
Data margin of error	2.55	1.67	0.15	1.21	2.03	0.23	0.18	1.83
Data upper bound	20.45	14.69	10.59	10.04	13.44	10.05	6.16	15.48
Data lower bound	15.35	11.34	10.28	7.62	9.38	9.60	5.79	11.82
Minimum	16.40	12.40	10.38	8.30	10.20	9.75	5.91	12.99
Maximum	18.66	13.99	10.49	9.51	12.08	9.96	6.04	14.31
Range	2.26	1.59	0.11	1.21	1.86	0.21	0.13	1.32

Table B-23: Axis measurements for ♀ *L. saxatilis*

Measurement	**LCDe**	**LAPa**	**BFcr**	**BPacd**	**BPtr**	**SBV**	**Bfcd**	**H**
Sample size	9	9	9	6	9	8	9	9
Mean	20.20	15.34	11.27	10.51	12.95	11.21	7.37	15.06
Standard deviation	1.85	1.99	0.66	0.56	0.80	0.69	2.39	1.06
Average margin of error	1.21	1.30	0.43	0.37	0.64	0.48	1.66	0.69
Average upper bound	21.42	16.64	11.69	10.88	13.58	11.67	9.02	15.76
Average lower bound	18.99	14.05	10.84	10.15	12.31	10.76	5.71	14.37
Data margin of error	3.63	3.89	1.29	1.10	1.56	1.36	4.68	2.08
Data upper bound	23.84	19.24	12.55	11.61	14.51	12.57	12.05	17.14
Data lower bound	16.57	11.45	9.98	9.42	11.39	9.89	2.68	12.99
Minimum	17.36	12.46	10.09	9.54	11.47	10.04	5.75	13.74
Maximum	22.38	18.70	12.01	11.15	13.66	11.88	13.14	16.89
Range	5.02	6.24	1.92	1.64	2.19	1.84	7.39	3.15

Table B-24: Axis measurements for ♂ *L. saxatilis*

Measurement	**LCDe**	**LAPa**	**BFcr**	**BPacd**	**BPtr**	**SBV**	**Bfcd**	**H**
Sample size	7	7	7	7	6	7	7	6
Mean	18.74	15.24	11.04	10.25	12.53	10.77	7.40	14.54
Standard deviation	1.05	1.21	0.66	0.44	0.85	0.74	2.83	0.83
Average margin of error	0.78	0.90	0.49	0.33	0.68	0.55	2.10	0.66
Average upper bound	1.52	16.14	11.53	10.58	13.20	11.32	9.50	15.20
Average lower bound	17.96	14.35	10.55	9.92	11.85	10.22	5.30	13.88
Data margin of error	2.06	2.38	1.29	0.87	1.66	1.45	5.55	1.62
Data upper bound	20.80	17.62	12.34	11.12	14.18	12.22	12.95	16.16
Data lower bound	16.68	12.87	9.75	9.38	10.87	9.32	1.85	12.93
Minimum	17.04	13.88	10.10	9.54	11.58	9.62	6.05	13.67
Maximum	20.18	17.49	2.15	10.78	13.44	11.76	13.77	16.08
Range	3.14	3.61	2.05	1.24	1.86	2.14	7.72	2.41

Scapula

Table B-25: Scapula measurements for *L. capensis*

Measurement	**HS**	**DHA**	**Ld**	**SLC**	**GLP**	**LG**	**BG**
Sample size	22	22	22	22	22	22	22
Mean	68.36	67.92	39.33	6.16	10.46	9.83	9.58
Standard deviation	4.32	4.07	2.27	0.45	0.61	0.43	0.58
Average margin of error	1.81	1.70	0.95	0.19	0.25	0.18	0.24
Average upper bound	70.17	69.62	40.28	6.35	10.71	10.01	9.82
Average lower bound	66.56	66.22	38.38	5.97	10.20	9.65	9.33
Data margin of error	8.47	7.97	4.45	0.89	1.19	0.85	1.14
Data upper bound	76.84	75.89	43.78	7.05	11.65	10.68	10.72
Data lower bound	59.89	59.95	34.87	5.27	9.26	8.98	8.43
Minimum	59.34	60.13	35.04	5.27	9.56	9.01	8.77
Maximum	77.90	78.14	43.70	7.28	11.87	10.57	10.78
Range	18.56	18.01	8.66	2.01	2.31	1.56	2.01

Table B-26: Scapula measurements for *L. saxatilis*

Measurement	**HS**	**DHA**	**Ld**	**SLC**	**GLP**	**LG**	**BG**
Sample size	19	19	19	19	19	19	19
Mean	76.56	76.83	43.47	7.04	11.92	11.02	10.91
Standard deviation	4.81	5.01	3.40	0.64	1.06	1.06	0.91
Average margin of error	2.16	2.25	1.53	0.29	0.47	0.47	0.41
Average upper bound	78.72	79.08	44.99	7.33	12.39	11.49	11.32
Average lower bound	74.40	74.58	41.94	6.75	11.44	10.54	10.50
Data margin of error	9.42	9.82	6.66	1.26	2.07	2.07	1.79
Data upper bound	85.98	86.65	50.12	8.30	13.99	13.08	12.70
Data lower bound	67.14	67.01	36.81	5.78	9.85	8.95	9.12
Minimum	69.92	69.64	38.53	6.02	10.47	9.52	9.61
Maximum	84.77	86.42	50.27	8.41	14.35	13.05	12.56
Range	14.85	16.78	11.74	2.39	3.88	3.53	2.95

Table B-27: Scapula measurements for ♀ *L. capensis*

Measurement	**HS**	**DHA**	**Ld**	**SLC**	**GLP**	**LG**	**BG**
Sample size	13	13	13	13	13	13	13
Mean	68.69	67.92	39.34	6.20	10.31	9.78	9.46
Standard deviation	4.04	4.01	2.33	0.53	0.50	0.48	0.50
Average margin of error	2.20	2.18	1.27	0.29	0.27	0.26	0.27
Average upper bound	70.89	70.09	40.61	6.49	10.58	10.04	9.73
Average lower bound	66.49	65.74	38.07	5.91	10.04	9.52	9.18
Data margin of error	7.92	7.86	4.57	1.04	0.97	0.94	0.98
Data upper bound	76.61	75.77	43.91	7.24	11.29	10.71	10.44
Data lower bound	60.76	60.06	34.77	5.15	9.34	8.84	8.47
Minimum	62.52	61.33	35.04	5.27	9.70	9.01	8.89
Maximum	77.90	78.14	42.70	7.28	11.51	10.57	10.78
Range	15.38	16.81	7.66	2.01	1.81	1.56	1.89

Table B-28: Scapula measurements for ♂ *L. capensis*

Measurement	**HS**	**DHA**	**Ld**	**SLC**	**GLP**	**LG**	**BG**
Sample size	8	8	8	8	8	8	8
Mean	66.91	67.09	39.38	6.05	10.59	9.85	9.63
Standard deviation	4.17	3.86	2.47	0.30	0.73	0.34	0.61
Average margin of error	2.89	2.67	1.71	0.21	0.51	0.24	0.42
Average upper bound	69.80	69.76	41.09	6.26	11.10	10.09	10.05
Average lower bound	46.01	64.42	37.67	5.84	10.08	9.61	9.20
Data margin of error	8.18	7.56	4.85	0.60	1.43	0.68	1.19
Data upper bound	75.09	74.65	44.23	6.65	12.02	10.53	10.82
Data lower bound	58.72	59.53	34.53	5.46	9.15	9.17	8.43
Minimum	5.34	60.13	36.32	5.66	9.56	9.39	8.77
Maximum	71.86	72.09	43.70	6.47	11.87	10.43	10.48
Range	12.52	11.96	7.39	0.81	2.31	1.04	1.71

Table B-29: Scapula measurements for ♀ *L. saxatilis*

Measurement	**HS**	**DHA**	**Ld**	**SLC**	**GLP**	**LG**	**BG**
Sample size	11	11	11	11	11	11	11
Mean	77.64	77.81	44.04	7.10	11.95	11.10	10.87
Standard deviation	3.97	4.36	2.81	0.48	0.92	0.99	0.85
Average margin of error	2.35	2.58	1.66	0.28	0.54	0.58	0.50
Average upper bound	79.99	80.39	45.70	7.39	12.49	11.68	11.37
Average lower bound	75.29	75.24	42.38	6.82	11.40	10.51	10.37
Data margin of error	7.79	8.55	5.52	0.94	1.80	1.93	1.66
Data upper bound	85.43	86.36	49.56	8.04	13.75	13.03	12.53
Data lower bound	69.85	69.26	38.52	6.17	10.14	9.16	9.20
Minimum	72.02	71.58	40.56	6.19	10.80	9.52	9.61
Maximum	83.79	84.22	48.63	7.68	13.27	12.46	12.00
Range	11.77	12.64	8.07	1.49	2.47	2.94	2.39

Table B-30: Scapula measurements for ♂ *L. saxatilis*

Measurement	**HS**	**DHA**	**Ld**	**SLC**	**GLP**	**LG**	**BG**
Sample size	8	8	8	8	8	8	8
Mean	75.08	75.48	42.68	6.95	11.88	10.91	10.97
Standard deviation	5.70	5.81	4.14	0.85	1.29	1.20	1.05
Average margin of error	3.95	4.02	2.87	0.59	0.89	0.83	0.73
Average upper bound	79.03	79.50	45.54	7.54	12.77	11.74	11.69
Average lower bound	71.13	71.46	39.81	6.36	10.98	10.07	10.24
Data margin of error	11.18	11.38	8.11	1.66	2.52	2.36	2.06
Data upper bound	86.26	86.86	50.79	8.61	14.40	13.27	13.03
Data lower bound	63.90	64.10	34.56	5.29	9.35	8.54	8.91
Minimum	69.92	69.64	38.53	6.02	10.47	9.83	9.97
Maximum	84.77	86.42	50.27	8.41	14.35	13.05	12.56
Range	14.85	16.78	11.74	2.39	3.88	3.22	2.59

Humerus

Table B-31: Humerus measurements for *L. capensis*

Measurement	**GL**	**GLC**	**Dp**	**SD**	**Bd**	**DmTc**	**CL**
Sample size	19	19	20	20	20	20	20
Mean	80.79	78.67	15.40	4.68	9.53	12.21	11.15
Standard deviation	3.46	3.32	0.74	0.25	0.51	0.59	0.60
Average margin of error	1.55	1.49	0.65	0.11	0.23	0.26	0.26
Average upper bound	82.34	80.16	16.06	4.79	9.78	12.47	11.41
Average lower bound	79.24	77.17	14.75	4.57	9.31	11.95	10.89
Data margin of error	6.78	6.51	1.44	0.48	1.01	1.17	1.17
Data upper bound	87.57	85.17	16.85	5.16	10.54	13.38	12.32
Data lower bound	74.01	72.16	13.96	4.20	8.52	11.05	9.98
Minimum	73.55	71.40	14.58	4.15	8.82	11.35	10.35
Maximum	87.46	85.62	17.28	5.13	10.74	13.58	12.44
Range	13.91	14.22	2.70	0.98	1.92	2.23	2.09

Table B-32: Humerus measurements for *L. saxatilis*

Measurement	**GL**	**GLC**	**Dp**	**SD**	**Bd**	**DmTc**	**CL**
Sample size	19	19	20	19	20	19	19
Mean	91.00	89.01	17.26	5.61	11.25	13.93	12.85
Standard deviation	6.05	6.00	1.31	0.51	0.86	1.28	1.03
Average margin of error	2.72	2.70	0.58	0.23	0.38	0.57	0.46
Average upper bound	93.72	91.71	17.84	5.84	11.63	14.50	13.31
Average lower bound	88.28	86.31	16.69	5.39	10.87	13.36	12.39
Data margin of error	11.85	11.76	2.58	1.00	1.69	2.50	2.01
Data upper bound	102.85	100.77	19.84	6.61	12.94	16.43	14.86
Data lower bound	79.15	77.25	14.69	4.62	9.56	11.43	10.84
Minimum	79.19	77.35	15.20	4.93	10.20	12.10	11.45
Maximum	100.78	98.08	19.57	6.50	12.81	16.26	14.87
Range	21.59	20.73	4.37	1.57	2.61	4.16	3.42

Table B-33: Humerus measurements for ♀ *L. capensis*

Measurement	**GL**	**GLC**	**Dp**	**SD**	**Bd**	**DmTc**	**CL**
Sample size	11	11	12	12	12	12	12
Mean	80.53	78.35	15.17	4.67	9.42	12.10	11.02
Standard deviation	2.40	2.13	0.49	0.18	0.38	0.42	0.38
Average margin of error	1.42	0.96	0.42	0.08	0.17	0.18	0.17
Average upper bound	81.95	79.31	15.59	4.75	9.59	12.29	11.19
Average lower bound	79.11	77.39	14.75	4.59	9.25	11.92	10.85
Data margin of error	4.71	4.18	0.96	0.36	0.75	0.82	0.75
Data upper bound	85.24	82.53	16.13	5.04	10.17	12.92	11.77
Data lower bound	75.82	74.17	14.21	4.31	8.68	11.28	10.27
Minimum	76.73	74.91	14.58	4.36	8.82	11.35	10.35
Maximum	85.28	81.83	16.18	4.88	10.00	12.85	11.56
Range	8.55	6.92	1.60	0.52	1.18	1.50	1.21

Table B-34: Humerus measurements for ♂ *L. capensis*

Measurement	**GL**	**GLC**	**Dp**	**SD**	**Bd**	**DmTc**	**CL**
Sample size	8	8	8	8	8	7	7
Mean	81.15	79.10	15.75	4.69	9.70	12.40	11.37
Standard deviation	4.71	4.63	0.93	0.33	0.66	0.82	0.84
Average margin of error	3.27	2.08	0.91	0.15	0.29	0.36	0.37
Average upper bound	84.42	81.18	16.67	4.84	9.99	12.76	11.74
Average lower bound	77.88	77.02	14.84	4.55	9.41	12.04	11.01
Data margin of error	9.24	9.08	1.82	0.65	1.29	1.61	1.64
Data upper bound	90.39	88.18	17.57	5.35	10.99	14.01	13.02
Data lower bound	71.91	70.02	13.94	4.04	8.40	10.80	9.73
Minimum	73.55	71.40	14.65	4.15	8.91	11.36	10.52
Maximum	87.46	85.62	17.28	5.13	10.74	13.58	12.44
Range	13.91	14.22	2.63	0.98	1.83	2.22	1.92

Table B-35: Humerus measurements for ♀ *L. saxatilis*

Measurement	**GL**	**GLC**	**Dp**	**SD**	**Bd**	**DmTc**	**CL**
Sample size	11	11	11	11	11	11	11
Mean	92.43	90.38	17.41	5.71	11.31	13.97	12.83
Standard deviation	4.95	5.08	1.24	0.43	0.77	1.12	0.99
Average margin of error	2.92	3.00	0.54	0.25	0.34	0.66	0.58
Average upper bound	95.35	93.38	17.95	5.96	11.65	14.63	13.41
Average lower bound	89.50	87.37	16.87	5.46	10.98	13.31	12.25
Data margin of error	9.69	9.95	2.42	0.83	1.51	2.19	1.93
Data upper bound	102.12	100.33	19.84	6.54	12.83	16.16	14.76
Data lower bound	82.73	80.42	14.99	4.88	9.80	11.79	10.90
Minimum	85.35	83.35	15.55	5.12	10.27	12.59	11.45
Maximum	99.13	98.08	19.20	6.46	12.47	15.77	14.81
Range	13.78	14.73	3.65	1.34	2.20	3.18	3.36

Table B-36: Humerus measurements for ♂ *L. saxatilis*

Measurement	**GL**	**GLC**	**Dp**	**SD**	**Bd**	**DmTc**	**CL**
Sample size	8	8	9	8	9	8	8
Mean	89.05	87.14	17.08	5.48	11.17	13.87	12.88
Standard deviation	7.18	6.99	1.46	0.61	1.00	1.55	1.15
Average margin of error	4.98	4.84	0.64	0.42	0.44	1.07	0.80
Average upper bound	94.02	91.98	17.72	5.91	11.61	14.94	13.68
Average lower bound	84.07	82.30	16.44	5.06	10.73	12.80	12.09
Data margin of error	14.07	13.69	2.85	1.19	1.97	3.04	2.25
Data upper bound	103.12	100.83	19.94	6.68	13.14	16.90	15.14
Data lower bound	74.97	73.45	14.23	4.29	9.20	10.83	10.63
Minimum	79.19	77.35	15.20	4.93	10.20	12.10	11.49
Maximum	100.78	98.07	19.57	6.50	12.81	16.26	14.87
Range	21.59	20.72	4.37	1.57	2.61	4.16	3.38

Radius

Table B-37: Radius measurements for *L. capensis*

Measurement	**GL**	**Bp**	**Bd**	**SD**	**WD**
Sample size	18	20	19	20	19
Mean	92.03	7.18	7.95	3.89	5.16
Standard deviation	3.40	0.36	0.52	0.27	0.26
Average margin of error	4.76	0.16	0.23	0.12	0.12
Average upper bound	96.79	7.34	8.18	4.01	5.28
Average lower bound	87.27	7.02	7.71	3.77	5.05
Data margin of error	6.66	0.71	1.02	0.53	0.51
Data upper bound	98.69	7.89	8.97	4.42	5.67
Data lower bound	85.37	6.47	6.93	3.36	4.66
Minimum	84.98	6.62	7.12	3.52	4.59
Maximum	97.17	7.87	8.89	4.39	5.51
Range	12.19	1.25	1.77	0.87	0.92

Table B-38: Radius measurements for *L. saxatilis*

Measurement	**GL**	**Bp**	**Bd**	**SD**	**WD**
Sample size	18	20	18	20	20
Mean	110.69	8.30	9.12	4.71	5.99
Standard deviation	5.49	0.67	0.78	0.35	0.51
Average margin of error	2.54	0.29	0.36	0.15	0.22
Average upper bound	103.23	8.59	9.48	4.86	6.21
Average lower bound	98.16	8.00	8.76	4.56	5.76
Data margin of error	10.77	1.31	1.53	0.68	1.00
Data upper bound	111.46	9.61	10.65	5.39	6.98
Data lower bound	89.92	6.98	7.59	4.03	4.99
Minimum	92.21	7.38	7.94	4.29	5.18
Maximum	110.33	9.69	10.52	5.62	6.80
Range	18.12	2.31	2.58	1.33	1.62

Table B-39: Radius measurements ♀ for *L. capensis*

Measurement	**GL**	**Bp**	**Bd**	**SD**	**WD**
Sample size	11	12	12	12	12
Mean	92.00	7.11	7.74	3.87	5.19
Standard deviation	2.92	0.35	0.39	0.27	0.24
Average margin of error	4.08	0.20	0.22	0.15	0.14
Average upper bound	96.08	7.31	7.95	4.02	5.33
Average lower bound	87.92	6.91	7.52	3.72	5.06
Data margin of error	5.71	0.69	0.76	0.53	0.48
Data upper bound	97.72	7.80	8.49	4.40	5.67
Data lower bound	86.29	6.42	6.98	3.35	4.72
Minimum	88.26	6.62	7.12	3.52	4.74
Maximum	97.17	7.76	8.33	4.39	5.51
Range	8.91	1.14	1.21	0.87	0.77

Table B-40: Radius measurements ♂ for *L. capensis*

Measurement	**GL**	**Bp**	**Bd**	**SD**	**WD**
Sample size	7	8	7	8	7
Mean	92.07	7.29	8.31	3.92	5.12
Standard deviation	4.31	0.37	0.54	0.29	0.30
Average margin of error	6.03	0.26	0.40	0.20	0.22
Average upper bound	98.10	7.55	8.71	4.14	5.34
Average lower bound	86.03	7.03	7.91	3.71	4.89
Data margin of error	8.44	0.73	1.06	0.57	0.59
Data upper bound	100.51	8.02	9.37	4.49	5.70
Data lower bound	83.62	6.56	7.26	3.34	4.53
Minimum	84.98	6.89	7.36	3.53	4.59
Maximum	97.01	7.87	8.89	4.30	5.45
Range	12.03	0.98	1.53	0.77	0.86

Table B-41: Radius measurements ♀ for *L. saxatilis*

Measurement	**GL**	**Bp**	**Bd**	**SD**	**WD**
Sample size	11	11	11	11	11
Mean	101.90	8.32	9.18	4.70	6.10
Standard deviation	4.67	0.57	0.70	0.20	0.48
Average margin of error	2.76	0.33	0.42	0.12	0.29
Average upper bound	104.66	8.66	9.60	4.81	6.39
Average lower bound	99.13	7.99	8.77	4.58	5.82
Data margin of error	9.16	1.11	1.38	0.39	0.95
Data upper bound	111.05	9.43	10.56	5.08	7.05
Data lower bound	92.74	7.21	7.81	4.31	5.16
Minimum	93.53	7.38	8.14	4.29	5.31
Maximum	110.33	9.01	10.52	4.95	6.76
Range	16.80	1.63	2.38	0.66	1.45

Table B-42: Radius measurements ♂ for *L. saxatilis*

Measurement	**GL**	**Bp**	**Bd**	**SD**	**WD**
Sample size	7	9	7	9	9
Mean	98.81	8.26	9.02	4.73	5.84
Standard deviation	6.51	0.82	0.94	0.48	0.53
Average margin of error	4.82	0.53	0.69	0.32	0.35
Average upper bound	103.63	8.79	9.71	5.04	6.19
Average lower bound	93.99	7.73	8.33	4.41	5.50
Data margin of error	12.76	1.60	1.83	0.95	1.04
Data upper bound	111.56	9.86	10.85	5.68	6.88
Data lower bound	86.05	6.66	7.19	3.78	4.81
Minimum	92.21	7.39	7.94	4.30	5.18
Maximum	109.31	9.69	10.36	5.62	6.80
Range	17.10	2.30	2.42	1.32	1.62

Ulna

Table B-43: Ulna measurements for *L. capensis*

Measurement	**GL**	**DPA**	**SDO**	**BPC**
Sample size	17	20	20	20
Mean	104.70	9.35	9.19	6.73
Standard deviation	4.19	0.45	0.45	0.38
Average margin of error	1.99	0.20	0.20	0.17
Average upper bound	106.69	9.55	9.39	6.90
Average lower bound	102.71	9.15	9.00	6.56
Data margin of error	8.20	0.89	0.88	0.75
Data upper bound	112.90	10.24	10.07	7.48
Data lower bound	96.49	8.46	8.31	5.98
Minimum	96.02	8.70	8.34	6.29
Maximum	110.86	10.28	10.22	7.82
Range	14.84	1.58	1.88	1.53

Table B-44: Ulna measurements for *L. saxatilis*

Measurement	**GL**	**DPA**	**SDO**	**BPC**
Sample size	18	20	20	20
Mean	115.23	10.75	10.56	7.63
Standard deviation	6.50	0.87	0.82	0.66
Average margin of error	3.00	0.38	0.36	0.29
Average upper bound	118.23	11.13	10.91	7.91
Average lower bound	112.23	10.37	10.20	7.34
Data margin of error	12.73	1.71	1.60	1.28
Data upper bound	127.96	12.46	12.15	8.91
Data lower bound	102.50	9.05	8.96	6.34
Minimum	105.63	9.32	9.36	6.75
Maximum	127.09	12.17	11.78	9.30
Range	21.46	2.85	2.42	2.55

Table B-45: Ulna measurements for ♀ *L. capensis*

Measurement	**GL**	**DPA**	**SDO**	**BPC**
Sample size	10	12	12	12
Mean	104.44	9.18	9.11	6.68
Standard deviation	3.52	0.36	0.29	0.40
Average margin of error	2.18	0.20	0.16	0.23
Average upper bound	106.62	9.39	9.27	6.91
Average lower bound	102.26	8.98	8.94	6.46
Data margin of error	6.90	0.71	0.57	0.78
Data upper bound	111.34	9.89	9.67	7.47
Data lower bound	97.54	8.48	8.54	5.90
Minimum	99.33	8.70	8.66	6.29
Maximum	110.07	9.71	9.60	7.82
Range	10.74	1.01	0.94	1.53

Table B-46: Ulna measurements for ♂ *L. capensis*

Measurement	**GL**	**DPA**	**SDO**	**BPC**
Sample size	7	8	8	8
Mean	105.07	9.60	9.32	6.79
Standard deviation	5.28	0.48	0.62	0.37
Average margin of error	3.91	0.34	0.43	0.26
Average upper bound	108.98	9.94	9.75	7.05
Average lower bound	101.16	9.27	8.89	6.54
Data margin of error	10.34	0.95	1.21	0.73
Data upper bound	115.41	10.55	10.53	7.52
Data lower bound	94.73	8.65	8.11	6.07
Minimum	96.02	8.84	8.34	6.36
Maximum	110.86	10.28	10.22	7.52
Range	14.84	1.44	1.88	1.16

Table B-47: Ulna measurements for ♀ *L. saxatilis*

Measurement	**GL**	**DPA**	**SDO**	**BPC**
Sample size	11	11	11	11
Mean	116.69	10.94	10.79	7.66
Standard deviation	5.65	0.76	0.72	0.53
Average margin of error	3.34	0.45	0.43	0.31
Average upper bound	120.03	11.39	11.22	7.97
Average lower bound	113.35	10.49	10.36	7.35
Data margin of error	11.08	1.49	1.42	1.04
Data upper bound	127.76	12.44	12.21	8.69
Data lower bound	105.61	9.45	9.37	6.62
Minimum	106.57	9.56	9.80	6.75
Maximum	127.09	11.90	11.77	8.38
Range	20.52	2.34	1.97	1.63

Table B-48: Ulna measurements for ♂ *L. saxatilis*

Measurement	**GL**	**DPA**	**SDO**	**BPC**
Sample size	7	9	9	9
Mean	112.94	10.52	10.27	7.59
Standard deviation	7.50	0.98	0.87	0.82
Average margin of error	5.56	0.64	0.57	0.53
Average upper bound	118.50	11.16	10.84	8.12
Average lower bound	107.38	9.88	9.70	7.05
Data margin of error	14.71	1.92	1.71	1.60
Data upper bound	127.64	12.44	11.97	9.19
Data lower bound	98.23	8.60	8.56	5.99
Minimum	105.63	9.32	9.36	6.84
Maximum	125.38	12.17	11.78	9.30
Range	19.75	2.85	2.42	2.46

Metacarpal

Table B-49: Metacarpal II measurements for *L. capensis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	4	6	7	7
Mean	24.48	3.53	4.85	3.73
Standard deviation	1.64	0.28	0.38	0.28
Average margin of error	1.61	0.23	0.28	0.21
Average upper bound	26.09	3.76	5.13	3.93
Average lower bound	22.87	3.31	4.56	3.52
Data margin of error	3.22	0.55	0.75	0.54
Data upper bound	27.70	4.08	5.60	4.27
Data lower bound	21.26	2.98	4.10	3.18
Minimum	22.25	3.31	4.27	3.14
Maximum	26.08	4.07	5.35	3.95
Range	3.83	0.76	1.08	0.81

Table B-50: Metacarpal III measurements for *L. capensis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	7	7	7	7
Mean	26.41	3.37	4.84	3.32
Standard deviation	1.96	0.38	0.42	0.26
Average margin of error	1.45	0.28	0.30	0.19
Average upper bound	27.86	3.65	5.14	3.51
Average lower bound	24.96	3.09	4.53	3.12
Data margin of error	3.83	0.75	0.81	0.51
Data upper bound	30.24	4.11	5.64	3.83
Data lower bound	22.58	2.62	4.03	2.81
Minimum	23.05	2.98	4.33	2.96
Maximum	28.23	3.97	5.28	3.64
Range	5.18	0.99	0.95	0.68

Table B-51: Metacarpal IV measurements for *L. capensis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	7	7	7	7
Mean	20.93	3.37	4.09	3.08
Standard deviation	1.45	0.31	0.32	0.23
Average margin of error	1.07	0.23	0.24	0.17
Average upper bound	22.00	3.61	4.33	3.25
Average lower bound	19.85	3.14	3.86	2.91
Data margin of error	2.84	0.61	0.63	0.45
Data upper bound	23.77	3.99	4.72	3.53
Data lower bound	18.09	2.76	3.47	2.63
Minimum	18.69	3.09	3.65	2.84
Maximum	22.22	3.83	4.52	3.37
Range	3.53	0.74	0.87	0.53

Table B-52: Metacarpal V measurements for *L. capensis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	7	7	7	7
Mean	14.37	3.22	3.67	3.74
Standard deviation	1.19	0.23	0.44	0.25
Average margin of error	0.89	0.17	0.32	0.19
Average upper bound	15.25	3.38	3.99	3.92
Average lower bound	13.48	3.05	3.34	3.55
Data margin of error	2.34	0.45	0.86	0.50
Data upper bound	16.71	3.66	4.52	4.23
Data lower bound	12.03	2.77	2.81	3.24
Minimum	12.44	2.99	3.09	3.43
Maximum	15.70	3.55	4.28	4.03
Range	3.26	0.56	1.19	0.60

Table B-53: Metacarpal II measurements for *L. saxatilis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	2	2	2	2
Mean	24.14	3.46	4.63	3.80
Standard deviation	3.40	0.66	0.40	0.47
Average margin of error	4.71	0.92	0.56	0.65
Average upper bound	28.85	4.38	5.18	4.45
Average lower bound	19.42	2.54	4.07	3.15
Data margin of error	6.67	1.30	0.79	0.91
Data upper bound	30.80	4.76	5.41	4.71
Data lower bound	17.47	2.19	3.84	2.89
Minimum	21.73	2.99	4.34	3.47
Maximum	26.54	3.93	4.91	4.13
Range	4.81	0.94	0.57	0.66

Table B-54: Metacarpal III measurements for *L. saxatilis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	2	2	2	2
Mean	26.29	3.27	4.66	3.28
Standard deviation	3.63	0.69	0.71	0.42
Average margin of error	5.03	0.95	0.98	0.59
Average upper bound	31.31	4.22	5.64	3.87
Average lower bound	21.26	2.31	3.68	2.69
Data margin of error	7.11	1.34	1.39	0.83
Data upper bound	33.39	4.61	6.05	4.11
Data lower bound	19.18	1.92	3.27	2.45
Minimum	23.72	2.78	4.16	2.98
Maximum	28.85	3.75	5.16	3.58
Range	5.13	0.97	1.00	0.60

Table B-55: Metacarpal IV measurements for *L. saxatilis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	2	2	2	2
Mean	21.33	3.25	4.07	2.92
Standard deviation	2.85	0.52	0.64	0.21
Average margin of error	3.95	0.73	0.89	0.29
Average upper bound	25.27	3.98	4.96	3.21
Average lower bound	17.38	2.52	3.17	2.63
Data margin of error	5.59	1.03	1.26	0.42
Data upper bound	26.91	4.28	5.33	3.34
Data lower bound	15.74	2.22	2.80	2.50
Minimum	19.31	2.88	3.61	2.77
Maximum	23.34	3.62	4.52	3.07
Range	4.03	0.74	0.91	0.30

Table B-56: Metacarpal V measurements for *L. saxatilis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	2	2	2	2
Mean	14.91	3.05	3.47	3.53
Standard deviation	2.33	0.30	0.54	0.29
Average margin of error	3.22	0.42	0.74	0.40
Average upper bound	18.13	3.47	4.21	3.93
Average lower bound	11.68	2.62	2.73	3.12
Data margin of error	4.56	0.60	1.05	0.57
Data upper bound	19.46	3.64	4.52	4.09
Data lower bound	10.35	2.45	2.42	2.96
Minimum	13.26	2.83	3.09	3.32
Maximum	16.55	3.26	3.85	3.73
Range	3.29	0.43	0.76	0.41

Sacrum

Table B-57: Sacrum measurements for *L. capensis*

Measurement	**GL**	**PL**	**GB**	**BFcr**	**HFcr**
Sample size	9	9	10	8	8
Mean	41.02	36.70	32.51	12.73	4.95
Standard deviation	1.32	2.01	2.95	1.07	0.77
Average margin of error	0.86	2.82	4.14	0.74	0.54
Average upper bound	41.88	39.52	36.64	12.47	5.48
Average lower bound	40.16	33.89	28.37	11.99	4.41
Data margin of error	2.58	3.95	5.79	2.09	1.52
Data upper bound	43.60	40.65	38.30	14.82	6.46
Data lower bound	38.44	32.76	26.72	10.64	3.43
Minimum	39.43	34.43	26.81	11.06	4.24
Maximum	43.25	39.77	35.96	14.56	6.80
Range	3.82	5.34	9.15	3.50	2.56

Table B-58: Sacrum measurements for *L. saxatilis*

Measurement	**GL**	**PL**	**GB**	**BFcr**	**HFcr**
Sample size	14	14	14	12	11
Mean	46.76	41.75	35.21	13.99	6.09
Standard deviation	5.28	5.23	4.99	1.07	0.49
Average margin of error	2.76	2.74	2.61	0.60	0.29
Average upper bound	49.52	44.49	37.82	14.60	6.38
Average lower bound	44.00	39.04	32.59	13.39	5.80
Data margin of error	10.34	10.25	9.78	2.09	0.97
Data upper bound	57.10	52.00	44.98	16.08	7.06
Data lower bound	36.42	31.50	25.43	11.90	5.12
Minimum	36.18	31.23	28.36	11.70	5.39
Maximum	58.03	53.06	43.76	15.52	6.91
Range	21.85	21.83	15.40	3.82	1.52

Table B-59: Sacrum measurements for ♀ *L. capensis*

Measurement	**GL**	**PL**	**GB**	**BFcr**	**HFcr**
Sample size	7	7	8	7	7
Mean	41.34	37.11	32.47	12.79	4.96
Standard deviation	1.31	2.07	3.23	1.14	0.83
Average margin of error	0.97	2.90	4.52	0.84	0.62
Average upper bound	42.31	40.01	36.98	13.63	5.58
Average lower bound	40.37	34.21	27.95	11.95	4.35
Data margin of error	2.56	4.06	6.33	2.23	1.64
Data upper bound	43.90	41.17	38.79	15.02	6.60
Data lower bound	38.77	33.05	26.14	10.56	3.33
Minimum	39.97	35.17	26.81	11.06	4.24
Maximum	43.25	39.77	35.96	14.56	6.80
Range	3.28	4.60	9.15	3.50	2.56

Table B-60: Sacrum measurements for ♂ *L. capensis*

Measurement	**GL**	**PL**	**GB**	**BFcr**	**HFcr**
Sample size	2	2	2	1	1
Mean	39.91	35.28	32.69	12.31	4.82
Standard deviation	0.68	1.20	2.35	Articulated not measured	Articulated not measured
Average margin of error	0.94	1.67	3.30	Articulated not measured	Articulated not measured
Average upper bound	40.85	36.95	35.98	Articulated not measured	Articulated not measured
Average lower bound	38.97	33.60	29.39	Articulated not measured	Articulated not measured
Data margin of error	1.33	2.34	4.62	Articulated not measured	Articulated not measured
Data upper bound	41.24	37.62	37.30	Articulated not measured	Articulated not measured
Data lower bound	38.58	32.93	28.07	Articulated not measured	Articulated not measured
Minimum	39.43	34.43	31.02	12.31	4.82
Maximum	40.39	36.12	34.35	12.31	4.82
Range	0.96	1.69	3.33	Articulated not measured	Articulated not measured

Table B-61: Sacrum measurements for ♀ *L. saxatilis*

Measurement	**GL**	**PL**	**GB**	**BFcr**	**HFcr**
Sample size	7	7	7	6	6
Mean	48.41	43.58	39.23	14.44	6.21
Standard deviation	2.13	2.63	3.07	0.61	0.48
Average margin of error	1.58	1.95	2.27	0.49	0.38
Average upper bound	49.99	45.53	41.50	14.93	6.59
Average lower bound	46.83	41.63	36.96	13.95	5.83
Data margin of error	4.18	5.16	6.01	1.20	0.93
Data upper bound	52.59	48.74	45.24	15.64	7.14
Data lower bound	44.23	38.42	33.22	13.23	5.28
Minimum	44.91	40.17	35.18	13.30	5.47
Maximum	50.78	48.36	43.76	15.02	6.91
Range	5.87	8.19	8.58	1.72	1.44

Table B-62: Sacrum measurements for ♂ *L. saxatilis*

Measurement	**GL**	**PL**	**GB**	**BFcr**	**HFcr**
Sample size	7	7	7	6	5
Mean	45.11	39.93	31.18	13.55	5.95
Standard deviation	7.03	6.67	2.60	1.29	0.53
Average margin of error	5.21	4.94	1.93	1.03	0.47
Average upper bound	50.31	44.87	33.11	14.58	6.41
Average lower bound	39.90	34.98	29.26	12.52	5.48
Data margin of error	13.78	13.08	5.10	2.52	1.04
Data upper bound	58.88	53.01	36.28	16.07	6.99
Data lower bound	31.33	26.84	26.09	11.03	4.91
Minimum	36.18	31.23	28.36	11.70	5.39
Maximum	58.03	53.06	36.13	15.52	6.79
Range	21.85	21.83	7.77	3.82	1.40

Pelvis

Table B-63: Pelvis measurements for *L. capensis*

Measurement	**GL**	**LAR**	**SH**	**SB**	**Lfo**	**LAIIL**	**GBTc**	**GBA**	**GBTi**	**SBI**
Sample size	18	19	19	19	18	18	4	4	4	4
Mean	78.48	9.18	8.48	5.21	16.30	9.38	52.82	44.52	45.05	34.64
Standard deviation	3.03	0.46	0.63	0.46	0.84	0.49	4.88	2.91	4.15	3.51
Average margin of error	1.40	0.21	0.29	0.21	0.39	0.23	4.79	2.85	4.06	3.44
Average upper bound	79.87	9.39	8.77	5.42	16.69	9.60	57.60	47.37	49.11	38.09
Average lower bound	77.08	8.97	8.20	5.01	15.92	9.15	48.03	41.67	40.99	31.20
Data margin of error	5.93	0.91	1.24	0.90	1.64	0.96	9.57	5.70	8.13	6.89
Data upper bound	84.41	10.09	9.72	6.11	17.95	10.33	62.39	50.21	53.18	41.53
Data lower bound	72.54	8.27	7.24	4.31	14.66	8.42	43.25	38.82	36.92	27.75
Minimum	72.43	8.37	7.59	4.44	14.67	8.54	46.73	41.39	41.09	31.09
Maximum	82.97	10.04	9.68	6.11	17.55	10.23	57.97	18.79	50.83	40.03
Range	10.54	1.67	2.09	1.67	2.88	1.69	11.24	7.40	9.74	8.94

Table B-64: Pelvis measurements for *L. saxatilis*

Measurement	**GL**	**LAR**	**SH**	**SB**	**Lfo**	**LAIIL**	**GBTc**	**GBA**	**GBTi**	**SBI**
Sample size	20	20	20	20	20	19	8	8	8	8
Mean	91.89	10.36	9.49	5.93	18.46	10.78	58.28	50.08	49.42	38.89
Standard deviation	5.33	0.93	0.74	0.60	1.48	0.91	6.62	6.52	5.97	4.76
Average margin of error	2.33	0.41	0.33	0.26	0.65	0.41	4.59	4.52	4.13	3.30
Average upper bound	94.22	10.77	9.82	6.19	19.10	11.19	62.86	54.60	53.55	42.18
Average lower bound	89.55	9.95	9.17	5.66	17.81	10.37	53.69	45.56	45.29	35.59
Data margin of error	10.44	1.83	1.45	1.18	2.90	1.79	12.97	12.78	11.69	9.33
Data upper bound	102.32	12.18	10.95	7.11	21.35	12.57	71.25	62.86	61.11	48.22
Data lower bound	81.45	8.53	8.04	4.74	15.56	8.99	45.31	37.30	37.73	29.56
Minimum	82.59	8.79	8.35	5.01	15.60	9.45	48.55	40.89	42.59	33.13
Maximum	102.33	12.68	10.85	7.33	21.66	12.79	66.18	58.84	59.03	46.53
Range	19.74	3.89	2.50	2.32	6.06	3.34	17.63	17.95	16.44	13.40

Table B-65: Pelvis measurements for ♀ *L. capensis*

Measurement	**GL**	**LAR**	**SH**	**SB**	**Lfo**	**LAIIL**	**GBTc**	**GBA**	**GBTi**	**SBI**
Sample size	12	12	12	12	12	12	2	2	2	2
Mean	78.38	9.06	8.58	5.18	16.27	9.37	50.98	45.57	45.96	36.01
Standard deviation	2.99	0.39	0.65	0.46	0.87	0.50	6.00	3.22	4.87	4.02
Average margin of error	1.69	0.22	0.37	0.26	0.49	0.28	8.32	4.46	6.75	5.58
Average upper bound	80.06	9.29	8.95	5.44	16.76	9.65	59.30	50.03	52.71	41.58
Average lower bound	76.69	8.84	8.21	4.92	15.77	9.09	42.65	41.11	39.21	30.43
Data margin of error	5.85	0.77	1.28	0.91	1.71	0.98	11.77	6.31	9.55	7.89
Data upper bound	84.23	9.84	9.86	6.08	17.97	10.34	62.74	51.88	55.51	43.89
Data lower bound	72.52	8.29	7.30	4.27	14.56	8.39	39.21	39.26	36.41	28.12
Minimum	72.43	8.37	7.62	4.44	14.67	8.54	46.73	42.35	41.09	31.98
Maximum	82.91	9.97	9.68	5.84	17.55	10.23	55.22	48.79	50.83	40.03
Range	10.48	1.60	2.06	1.40	2.88	1.69	8.49	6.44	9.74	8.05

Table B-66: Pelvis measurements for ♂ *L. capensis*

Measurement	**GL**	**LAR**	**SH**	**SB**	**Lfo**	**LAIIL**	**GBTc**	**GBA**	**GBTi**	**SBI**
Sample size	6	7	7	7	6	6	2	2	2	2
Mean	78.68	9.38	8.31	5.27	16.38	9.39	54.66	54.47	44.14	33.28
Standard deviation	3.39	0.53	0.61	0.49	0.84	0.51	4.68	2.07	3.00	2.19
Average margin of error	2.71	0.40	0.45	0.36	0.68	0.41	6.49	2.88	4.16	3.04
Average upper bound	81.39	9.78	8.76	5.63	17.05	9.80	61.15	46.34	48.30	36.32
Average lower bound	75.96	8.98	7.86	4.91	15.70	8.98	48.17	40.59	39.98	30.24
Data margin of error	6.64	1.05	1.19	0.95	1.65	1.00	9.17	4.07	5.88	4.29
Data upper bound	85.32	10.43	9.50	6.22	18.03	10.40	63.83	47.53	50.02	37.57
Data lower bound	72.03	8.33	7.12	4.32	14.72	8.39	45.49	39.40	38.26	28.99
Minimum	73.94	8.53	7.59	4.59	15.18	8.85	51.35	41.39	41.14	31.09
Maximum	82.97	10.04	9.31	6.11	17.37	10.21	57.97	45.54	47.14	35.47
Range	9.03	1.51	1.72	1.52	2.19	1.36	6.62	4.15	6.00	4.38

Table B-67: Pelvis measurements for ♀ *L. saxatilis*

Measurement	**GL**	**LAR**	**SH**	**SB**	**Lfo**	**LAIIL**	**GBTc**	**GBA**	**GBTi**	**SBI**
Sample size	11	11	11	11	11	11	3	3	3	3
Mean	93.03	10.3	9.62	6.01	18.54	10.76	63.63	55.67	52.09	42.38
Standard deviation	4.67	0.64	0.66	0.47	1.30	0.79	3.76	5.05	7.23	4.53
Average margin of error	2.76	0.38	0.39	0.28	0.77	0.47	4.25	5.71	8.18	5.13
Average upper bound	95.79	10.71	10.01	6.29	19.30	11.23	67.88	61.39	60.27	47.51
Average lower bound	90.27	9.95	9.23	5.74	17.77	10.29	59.37	49.96	43.91	37.26
Data margin of error	9.15	1.26	1.29	0.92	2.54	1.55	7.37	9.90	14.16	8.88
Data upper bound	102.18	11.59	10.91	6.93	21.08	12.32	70.99	65.57	66.25	51.26
Data lower bound	83.88	9.08	8.34	5.09	15.99	9.21	56.26	45.78	37.93	33.51
Minimum	85.25	9.25	8.58	5.28	16.54	9.45	59.31	49.85	44.61	37.55
Maximum	100.22	11.13	10.54	6.60	20.52	11.88	66.8	58.84	59.03	46.53
Range	14.97	1.88	1.96	1.32	3.98	2.43	6.87	8.99	14.42	8.98

Table B-68: Pelvis measurements for ♂ *L. saxatilis*

Measurement	**GL**	**LAR**	**SH**	**SB**	**Lfo**	**LAIIL**	**GBTc**	**GBA**	**GBTi**	**SBI**
Sample size	9	9	9	9	9	8	5	5	5	5
Mean	90.49	10.39	9.33	5.82	18.36	10.81	55.07	46.73	47.82	36.79
Standard deviation	6.01	1.24	0.85	0.75	1.75	1.12	5.94	4.91	5.26	3.84
Average margin of error	3.93	0.81	0.55	0.49	1.14	0.77	5.20	4.30	4.61	3.36
Average upper bound	94.42	11.20	9.89	6.31	19.50	11.58	60.27	51.03	52.42	40.15
Average lower bound	86.56	9.57	8.78	5.33	17.21	10.04	49.87	42.42	43.21	33.43
Data margin of error	11.79	2.44	1.66	1.47	3.43	2.19	11.63	9.63	10.30	7.52
Data upper bound	102.27	12.82	10.99	7.29	21.79	13.00	66.70	56.35	58.12	44.31
Data lower bound	78.70	7.95	7.67	4.34	14.92	8.63	43.43	37.10	37.52	29.27
Minimum	82.59	8.79	8.35	5.01	15.60	9.46	48.55	40.59	42.59	33.13
Maximum	102.33	12.68	10.85	7.33	21.66	12.79	63.45	54.29	55.56	43.16
Range	19.74	3.89	2.50	2.32	6.06	3.33	14.90	13.40	12.97	10.03

Femur

Table B-69: Femur measurements for *L. capensis*

Measurement	**GL**	**GLC**	**Bp**	**BTr**	**DC**	**SD**	**Bd**	**CB**	**CONM**	**CONL**
Sample size	20	20	20	19	20	20	20	19	19	19
Mean	101.32	95.82	20.04	19.35	8.05	7.62	15.35	8.76	15.49	14.55
Standard deviation	4.11	3.94	0.98	0.81	0.41	0.36	0.88	0.48	0.89	0.89
Average margin of error	1.80	1.73	0.43	0.36	0.18	0.16	0.39	0.2	0.40	0.40
Average upper bound	103.13	97.54	20.47	19.72	8.23	7.78	15.73	8.98	15.89	14.95
Average lower bound	99.52	94.09	19.61	18.99	7.87	7.46	14.96	8.54	15.08	14.15
Data margin of error	8.05	7.73	1.92	1.58	0.81	0.72	1.73	0.95	1.75	1.74
Data upper bound	109.38	103.54	21.96	20.93	8.86	8.34	17.07	9.71	17.24	16.29
Data lower bound	93.27	88.09	18.12	17.77	7.24	6.91	13.62	7.81	13.73	12.80
Minimum	92.45	86.40	17.72	17.21	7.28	6.89	13.61	7.85	14.03	13.03
Maximum	108.72	102.32	21.13	20.55	8.84	8.22	17.72	9.71	17.44	16.59
Range	16.27	15.92	3.41	3.34	1.56	1.33	4.11	1.86	3.41	3.56

Table B-70: Femur measurements for *L. saxatilis*

Measurement	**GL**	**GLC**	**Bp**	**BTr**	**DC**	**SD**	**Bd**	**CB**	**CONM**	**CONL**
Sample size	19	19	20	20	20	20	20	19	19	18
Mean	115.67	109.45	22.59	20.93	9.12	8.75	18.10	10.36	18.01	17.28
Standard deviation	7.78	7.46	1.72	1.30	0.71	0.43	1.50	0.93	1.45	1.37
Average margin of error	10.89	3.36	0.75	0.57	0.31	0.19	0.66	0.42	0.65	0.63
Average upper bound	126.56	112.81	23.34	21.46	9.44	8.94	18.75	10.78	18.66	17.91
Average lower bound	104.77	06.10	21.84	20.36	8.81	8.56	17.44	9.14	15.65	15.05
Data margin of error	15.25	14.63	3.36	2.55	1.39	0.84	2.95	1.82	2.84	2.69
Data upper bound	130.92	124.08	25.95	23.47	10.52	9.59	21.04	12.18	20.84	19.97
Data lower bound	100.42	94.82	19.22	18.38	7.73	7.91	15.15	8.54	15.17	14.59
Minimum	103.13	97.78	20.40	19.08	8.18	7.76	16.10	9.14	15.65	15.05
Maximum	130.32	97.78	20.40	19.08	8.18	7.76	16.10	9.14	15.65	15.05
Range	27.19	26.46	6.53	4.99	2.50	1.70	5.08	3.29	4.78	4.80

Table B-71: Femur measurements for ♀ *L. capensis*

Measurement	**GL**	**GLC**	**Bp**	**BTr**	**DC**	**SD**	**Bd**	**CB**	**CONM**	**CONL**
Sample size	12	12	12	12	12	12	12	12	12	12
Mean	101.19	95.81	19.99	19.39	8.03	7.70	15.20	8.67	15.47	14.62
Standard deviation	3.07	2.74	0.90	0.64	0.37	0.27	0.37	0.38	0.73	0.64
Average margin of error	1.74	1.55	0.51	0.36	0.21	0.15	0.21	0.21	0.42	0.36
Average upper bound	102.93	97.36	20.49	19.75	8.24	7.85	15.41	8.88	15.88	14.98
Average lower bound	99.45	94.26	19.48	19.03	7.82	7.55	14.99	8.45	10.05	14.25
Data margin of error	6.03	5.38	1.75	1.25	0.73	0.52	0.73	0.74	1.44	1.25
Data upper bound	107.21	101.19	21.74	20.64	8.76	8.22	15.93	9.41	16.91	15.87
Data lower bound	95.16	90.43	18.23	18.14	7.30	7.18	14.46	7.93	14.03	13.36
Minimum	96.36	91.38	17.72	18.38	7.28	7.26	14.27	7.85	14.34	13.49
Maximum	108.72	102.18	20.79	20.55	8.79	8.11	15.68	9.28	16.49	15.72
Range	12.36	10.80	3.07	2.17	1.51	0.82	1.41	1.43	2.15	2.23

Table B-72: Femur measurements for ♂ *L. capensis*

Measurement	**GL**	**GLC**	**Bp**	**BTr**	**DC**	**SD**	**Bd**	**CB**	**CONM**	**CONL**
Sample size	8	8	8	7	8	8	8	7	7	7
Mean	101.53	95.82	20.13	19.29	8.08	7.50	15.57	8.91	15.52	14.42
Standard deviation	5.56	5.51	1.15	1.10	0.50	0.47	1.34	0.63	1.19	1.26
Average margin of error	3.85	3.82	0.80	0.81	0.34	0.33	0.93	0.47	0.88	0.93
Average upper bound	105.38	99.64	20.92	20.10	8.42	7.83	16.49	9.38	16.39	15.36
Average lower bound	97.68	92.00	19.33	18.48	7.73	7.18	14.64	8.44	14.64	13.49
Data margin of error	10.89	10.80	2.26	2.15	0.97	0.92	2.63	1.24	2.32	2.47
Data upper bound	112.42	106.63	22.38	21.44	9.05	8.43	18.19	10.15	17.84	16.90
Data lower bound	90.64	85.02	17.87	17.15	7.11	6.58	12.94	7.67	13.19	11.95
Minimum	92.45	86.40	17.80	17.21	7.39	6.89	13.61	7.94	14.03	13.03
Maximum	108.47	102.30	21.13	20.51	8.84	8.22	17.72	9.71	17.44	16.59
Range	16.02	15.92	3.33	3.33	1.45	1.33	4.11	1.77	3.41	3.56

Table B-73: Femur measurements for ♀ *L. saxatilis*

Measurement	**GL**	**GLC**	**Bp**	**BTr**	**DC**	**SD**	**Bd**	**CB**	**CONM**	**CONL**
Sample size	11	11	11	11	11	11	11	11	11	11
Mean	116.86	110.51	22.61	21.09	9.09	8.78	18.19	10.28	18.24	17.41
Standard deviation	6.70	6.70	1.55	1.15	0.59	0.40	1.23	0.73	1.17	1.17
Average margin of error	9.38	3.96	0.91	0.68	0.35	0.24	0.73	0.43	0.69	0.69
Average upper bound	126.24	114.47	23.52	21.78	9.43	9.02	18.92	10.71	18.93	18.10
Average lower bound	107.48	106.55	21.70	20.14	8.74	8.55	17.46	9.85	17.55	16.72
Data margin of error	13.13	13.14	3.03	2.26	1.15	0.79	2.42	1.42	2.29	2.30
Data upper bound	129.99	123.65	25.64	23.35	10.24	9.57	20.61	11.71	20.52	19.71
Data lower bound	103.73	97.37	19.58	18.83	7.94	8.00	15.77	8.86	15.95	15.11
Minimum	109.32	102.27	20.63	19.37	8.18	8.31	16.74	9.14	16.35	15.42
Maximum	130.32	124.24	24.83	22.58	9.94	9.46	20.24	11.10	19.80	19.17
Range	21.00	21.97	4.20	3.21	1.76	1.15	3.50	1.96	3.45	3.75

Table B-74: Femur measurements for ♂ *L. saxatilis*

Measurement	**GL**	**GLC**	**Bp**	**BTr**	**DC**	**SD**	**Bd**	**CB**	**CONM**	**CONL**
Sample size	8	8	8	7	8	8	8	7	7	7
Mean	101.53	95.82	20.13	19.29	8.08	7.50	15.57	8.91	15.52	14.42
Standard deviation	5.56	5.51	1.15	1.10	0.50	0.47	1.34	0.63	1.19	1.26
Average margin of error	3.85	3.82	0.80	0.81	0.34	0.33	0.93	0.47	0.88	0.93
Average upper bound	105.38	99.64	20.92	20.10	8.42	7.83	16.49	9.38	16.39	15.36
Average lower bound	97.68	92.00	19.33	18.48	7.73	7.18	14.64	8.44	14.64	13.49
Data margin of error	1.89	10.80	2.26	2.15	0.97	0.92	2.63	1.24	2.32	2.47
Data upper bound	112.42	106.63	22.38	21.44	9.05	8.43	18.19	10.15	17.84	16.90
Data lower bound	90.64	85.02	17.87	17.15	7.11	6.58	12.94	7.67	13.19	11.95
Minimum	92.45	86.40	17.80	17.21	7.39	6.89	13.61	7.94	14.03	13.03
Maximum	108.47	102.32	21.13	20.54	8.84	8.22	17.72	9.71	17.44	16.59
Range	16.02	15.92	3.33	3.33	1.45	1.33	4.11	1.77	3.41	3.56

Tibia

Table B-75: Tibia measurements for *L. capensis*

Measurement	**GL**	**Bp**	**SD**	**Bd**	**Dd**	**DP**	**DDL**
Sample size	19	20	19	19	19	19	19
Mean	116.04	15.61	6.12	12.36	7.63	16.84	5.92
Standard deviation	4.04	0.92	0.35	0.86	0.44	0.82	0.37
Average margin of error	1.82	0.40	0.16	0.39	0.20	0.37	0.17
Average upper bound	117.86	16.01	6.28	12.74	7.83	17.21	6.09
Average lower bound	114.23	15.20	5.96	11.97	7.43	16.47	5.76
Data margin of error	7.91	1.81	0.68	1.69	0.87	1.61	0.72
Data upper bound	123.96	17.41	6.80	14.05	8.50	18.45	6.64
Data lower bound	108.13	13.80	5.44	10.67	6.77	15.22	5.20
Minimum	109.11	13.81	5.56	11.07	6.65	15.20	5.11
Maximum	127.00	18.18	6.72	14.04	8.35	18.62	6.71
Range	17.89	4.37	1.16	2.97	1.70	3.43	1.60

Table B-76: Tibia measurements for *L. saxatilis*

Measurement	**GL**	**Bp**	**SD**	**Bd**	**Dd**	**DP**	**DDL**
Sample size	19	20	19	19	19	19	19
Mean	133.38	18.54	7.07	14.60	9.00	19.30	6.89
Standard deviation	7.55	1.47	0.57	1.12	0.68	1.65	0.60
Average margin of error	3.39	0.65	0.25	0.50	0.30	0.74	0.27
Average upper bound	136.77	19.18	7.32	15.11	9.31	20.04	7.16
Average lower bound	129.98	17.89	6.81	14.10	8.70	18.56	6.62
Data margin of error	14.80	2.88	1.11	2.20	1.32	3.23	1.17
Data upper bound	148.17	21.42	8.18	16.80	10.33	22.53	8.06
Data lower bound	118.58	15.65	5.96	12.41	7.68	16.07	5.72
Minimum	122.92	16.51	6.08	13.03	7.64	16.80	5.93
Maximum	146.41	21.20	8.13	16.76	10.60	22.40	8.08
Range	23.49	4.69	2.05	3.73	2.96	5.60	2.15

Table B-77: Tibia measurements for ♀ *L. capensis*

Measurement	**GL**	**Bp**	**SD**	**Bd**	**Dd**	**DP**	**DDL**
Sample size	12	12	12	12	12	12	12
Mean	115.80	15.49	6.11	12.30	7.61	16.72	5.90
Standard deviation	3.02	0.51	0.30	0.72	0.30	0.45	0.25
Average margin of error	1.71	0.29	0.17	0.41	0.17	0.24	0.14
Average upper bound	117.51	15.77	6.28	12.71	7.78	16.97	6.04
Average lower bound	114.09	15.20	5.94	11.89	7.44	16.47	5.76
Data margin of error	5.92	1.00	0.59	1.41	0.59	0.88	0.49
Data upper bound	121.73	16.48	6.70	13.71	8.19	17.60	6.39
Data lower bound	109.88	14.49	5.52	10.89	7.02	15.84	5.41
Minimum	109.56	14.24	5.72	11.07	7.15	16.07	5.30
Maximum	121.18	16.16	6.72	13.72	8.21	17.61	6.20
Range	11.62	1.92	1.00	2.65	1.06	1.54	0.90

Table B-78: Tibia measurements for ♂ *L. capensis*

Measurement	**GL**	**Bp**	**SD**	**Bd**	**Dd**	**DP**	**DDL**
Sample size	7	8	7	7	7	7	7
Mean	116.45	15.79	6.14	12.45	7.68	17.04	5.96
Standard deviation	5.64	1.35	0.44	1.12	0.40	1.26	0.54
Average margin of error	4.18	0.94	0.33	0.83	0.48	0.93	0.40
Average upper bound	120.63	16.73	6.47	13.29	8.16	17.98	6.36
Average lower bound	112.27	14.85	5.81	11.62	7.20	16.11	5.56
Data margin of error	11.06	2.65	0.87	2.20	1.26	2.47	1.05
Data upper bound	127.51	18.44	7.01	14.66	8.94	19.51	7.01
Data lower bound	105.39	13.14	5.27	10.25	6.42	14.57	4.90
Minimum	109.11	13.81	5.56	11.26	6.65	15.20	5.11
Maximum	127.00	18.18	6.69	14.04	835	18.63	6.71
Range	17.89	4.37	1.13	2.78	1.70	3.43	1.60

Table B-79: Tibia measurements for ♀ *L. saxatilis*

Measurement	**GL**	**Bp**	**SD**	**Bd**	**Dd**	**DP**	**DDL**
Sample size	11	11	11	11	11	11	11
Mean	135.00	18.71	7.14	14.63	9.05	19.53	6.97
Standard deviation	6.13	1.29	0.47	0.91	0.48	1.39	0.46
Average margin of error	3.62	0.76	0.28	0.54	0.29	0.82	0.27
Average upper bound	138.62	19.47	7.42	15.17	9.34	20.35	7.24
Average lower bound	131.37	17.95	6.86	4.09	8.77	18.70	6.70
Data margin of error	12.02	2.52	0.93	1.79	0.95	2.73	0.89
Data lpper bound	147.02	21.23	8.07	16.42	10.00	22.26	7.87
Data lower bound	122.98	16.19	6.22	12.84	8.11	16.80	6.08
Minimum	125.50	16.73	6.31	13.18	8.31	17.43	6.35
Maximum	145.07	20.64	7.80	16.40	9.62	21.62	7.95
Range	19.57	3.91	1.49	3.22	1.30	4.22	1.60

Table B-80: Tibia measurements for ♂ *L. saxatilis*

Measurement	**GL**	**Bp**	**SD**	**Bd**	**Dd**	**DP**	**DDL**
Sample size	8	9	8	8	8	8	8
Mean	131.15	18.32	6.96	14.57	8.93	18.99	6.78
Standard deviation	9.11	1.73	0.70	1.43	0.91	2.01	0.77
Average margin of error	6.31	1.13	0.48	0.99	0.63	1.39	0.54
Average upper bound	137.46	19.45	7.45	15.56	9.56	20.38	7.31
Average lower bound	124.83	17.20	6.48	13.58	8.30	17.60	6.24
Data margin of error	17.85	3.39	1.36	2.79	1.79	3.93	1.51
Data upper bound	149.00	21.71	8.33	17.36	10.72	22.93	8.29
Data lower bound	113.29	14.49	5.60	11.78	7.15	15.06	5.26
Minimum	122.92	16.51	6.08	13.03	7.64	16.80	5.93
Maximum	146.41	21.20	8.13	16.76	10.60	22.40	8.08
Range	23.49	4.69	2.05	3.73	2.96	5.60	2.15

Patella

Table B-81: Patella measurements for *L. capensis*

Measurement	**GB**	**GL**
Sample size	10	10
Mean	6.08	10.37
Standard deviation	0.60	1.13
Average margin of error	0.37	0.70
Average upper bound	6.45	11.07
Average lower bound	5.70	9.67
Data margin of error	1.18	2.21
Data upper bound	7.25	12.58
Data lower bound	4.90	8.07
Minimum	5.13	8.92
Maximum	7.10	11.92
Range	1.97	3.00

Table B-82: Patella measurements for *L. saxatilis*

Measurement	**GB**	**GL**
Sample size	6	6
Mean	6.46	10.94
Standard deviation	0.98	1.74
Average margin of error	0.79	1.39
Average upper bound	7.25	12.33
Average lower bound	5.67	9.54
Data margin of error	1.93	3.42
Data upper bound	8.39	14.35
Data lower bound	4.53	7.52
Minimum	5.45	8.95
Maximum	7.96	13.80
Range	2.51	4.85

Table B-83: Patella measurements for ♀ *L. capensis*

Measurement	**GB**	**GL**
Sample size	7	7
Mean	5.96	10.15
Standard deviation	0.32	0.93
Average margin of error	0.24	0.69
Average upper bound	6.19	10.84
Average lower bound	5.72	9.46
Data margin of error	0.62	1.82
Data upper bound	6.58	11.97
Data lower bound	5.33	8.01
Minimum	5.70	8.92
Maximum	6.65	11.75
Range	0.95	2.83

Table B-84: Patella measurements for ♂ *L. capensis*

Measurement	**GB**	**GL**
Sample size	2	2
Mean	6.12	10.49
Standard deviation	1.39	2.03
Average margin of error	1.93	2.81
Average upper bound	8.05	13.30
Average lower bound	4.18	7.67
Data margin of error	2.73	3.98
Data upper bound	8.85	14.46
Data lower bound	3.38	10.43
Minimum	5.13	9.05
Maximum	7.10	11.93
Range	1.97	2.87

Table B-85: Patella measurements for ♀ *L. saxatilis*

Measurement	**GB**	**GL**
Sample size	2	2
Mean	6.28	10.59
Standard deviation	0.28	0.70
Average margin of error	0.38	0.97
Average upper bound	6.66	11.56
Average lower bound	5.89	9.61
Data margin of error	0.54	1.37
Data upper bound	6.82	11.96
Data lower bound	5.73	9.21
Minimum	6.08	10.09
Maximum	6.47	11.08
Range	0.39	0.99

Table B-86: Patella measurements for ♂ *L. saxatilis*

Measurement	**GB**	**GL**
Sample size	4	4
Mean	6.56	11.11
Standard deviation	1.25	2.19
Average margin of error	1.22	2.14
Average upper bound	7.78	13.25
Average lower bound	5.33	8.97
Data margin of error	2.44	4.28
Data upper bound	9.00	15.40
Data lower bound	4.11	6.83
Minimum	5.45	8.95
Maximum	7.96	13.80
Range	2.51	4.85

Calcaneus

Table B-87: Calcaneus measurements for *L. capensis*

Measurement	**GB**	**GL**
Sample size	8	8
Mean	8.72	27.11
Standard deviation	0.67	2.11
Average margin of error	0.46	1.46
Average upper bound	9.18	28.58
Average lower bound	8.26	25.65
Data margin of error	1.31	4.14
Data upper bound	10.03	31.25
Data lower bound	7.41	22.98
Minimum	7.76	23.80
Maximum	9.67	30.02
Range	1.91	6.22

Table B-88: Calcaneus measurements for *L. saxatilis*

Measurement	**GB**	**GL**
Sample size	4	4
Mean	9.12	26.31
Standard deviation	0.77	1.76
Average margin of error	0.76	1.73
Average upper bound	9.87	28.04
Average lower bound	8.36	24.58
Data margin of error	1.52	3.46
Data upper bound	10.63	29.77
Data lower bound	7.60	22.85
Minimum	8.31	23.72
Maximum	9.90	27.68
Range	1.59	3.96

Table B-89: Calcaneus measurements for ♀ *L. capensis*

Measurement	**GB**	**GL**
Sample size	6	6
Mean	8.74	27.18
Standard deviation	0.54	1.53
Average margin of error	0.43	1.22
Average upper bound	9.17	28.41
Average lower bound	8.30	25.96
Data margin of error	9.17	28.41
Data upper bound	9.80	30.18
Data lower bound	7.67	24.18
Minimum	8.28	25.43
Maximum	9.67	29.79
Range	1.39	4.36

Only one ♂ *L. capensis* was measured and hence no statistical data can be given. The measurements were **GB** – 7.76 and **GL** – 23.80

Table B-90: Calcaneus measurements for ♂ *L. saxatilis*

Measurement	**GB**	**GL**
Sample size	3	3
Mean	8.85	25.85
Standard deviation	0.70	1.85
Average margin of error	0.79	2.09
Average upper bound	9.64	27.95
Average lower bound	8.06	23.76
Data margin of error	1.37	3.63
Data upper bound	10.22	29.48
Data lower bound	7.49	22.23
Minimum	8.31	23.72
Maximum	9.64	27.95
Range	1.33	3.29

Only one ♀ *L. saxatilis* was measured and hence no statistical data can be given. The measurements were **GB** – 9.90 and **GL** – 27.68

Talus

Table B-91: Talus measurements for *L. capensis*

Measurement	**GL**	**DC**
Sample size	8	8
Mean	13.06	6.71
Standard deviation	1.22	0.57
Average margin of error	0.85	0.80
Average upper bound	13.90	7.51
Average lower bound	12.21	5.92
Data margin of error	2.40	1.11
Data upper bound	15.45	7.83
Data lower bound	10.66	5.60
Minimum	11.27	5.76
Maximum	14.85	7.34
Range	3.58	1.58

Table B-92: Talus measurements for *L. saxatilis*

Measurement	**GL**	**DC**
Sample size	5	5
Mean	12.70	6.26
Standard deviation	1.11	0.13
Average margin of error	0.97	0.11
Average upper bound	13.67	6.38
Average lower bound	11.73	6.15
Data margin of error	0.97	0.11
Data upper bound	14.87	6.51
Data lower bound	10.53	6.01
Minimum	10.95	6.16
Maximum	13.68	6.48
Range	2.73	0.32

Table B-93: Talus measurements for ♀ *L. capensis*

Measurement	**GL**	**DC**
Sample size	5	5
Mean	13.12	6.83
Standard deviation	0.99	0.46
Average margin of error	0.87	0.64
Average upper bound	13.99	7.47
Average lower bound	12.25	6.19
Data margin of error	1.95	0.89
Data upper bound	15.06	7.72
Data lower bound	11.17	5.93
Minimum	11.89	6.08
Maximum	14.41	7.27
Range	2.52	1.19

Only one ♂ *L. capensis* was measured and hence no statistical data can be given. The measurements were **GL** – 11.27 and **DC** – 5.76

Table B-94: Talus measurements for ♀ *L. saxatilis*

Measurement	**GL**	**DC**
Sample size	2	2
Mean	13.63	6.34
Standard deviation	0.07	0.21
Average margin of error	0.10	0.28
Average upper bound	13.73	6.62
Average lower bound	13.53	6.05
Data margin of error	0.14	0.40
Data upper bound	13.77	6.74
Data lower bound	13.49	5.93
Minimum	13.58	6.19
Maximum	13.68	6.48
Range	0.10	0.29

Table B-95: Talus measurements for ♂*L. saxatilis*

Measurement	**GL**	**DC**
Sample size	3	3
Mean	12.08	6.22
Standard deviation	1.00	0.06
Average margin of error	1.13	0.06
Average upper bound	13.21	6.28
Average lower bound	10.95	6.15
Data margin of error	1.96	0.11
Data upper bound	14.04	6.32
Data lower bound	10.12	6.11
Minimum	10.95	6.16
Maximum	12.86	6.27
Range	1.91	0.11

Metatarsal

Table B-96: Metatarsal I measurements for *L. capensis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	8	8	8	8
Mean	42.84	4.72	6.71	4.02
Standard deviation	2.63	0.53	0.61	0.38
Average margin of error	1.82	0.37	0.42	0.26
Average upper bound	44.66	5.09	7.13	4.29
Average lower bound	41.01	4.35	6.29	3.76
Data margin of error	5.16	1.05	1.19	0.75
Data upper bound	48.00	5.77	7.90	4.77
Data lower bound	37.68	3.68	5.52	3.28
Minimum	38.73	4.24	6.11	3.58
Maximum	45.63	5.60	7.64	4.65
Range	6.90	1.36	1.53	1.07

Table B-97: Metatarsal II measurements for *L. capensis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	8	8	8	8
Mean	43.69	4.59	7.07	4.30
Standard deviation	3.34	0.57	0.49	0.39
Average margin of error	2.32	0.39	0.34	0.27
Average upper bound	46.01	4.98	7.41	4.57
Average lower bound	41.37	4.20	6.73	4.03
Data margin of error	6.56	1.11	0.96	0.76
Data upper bound	50.25	5.70	8.03	5.05
Data lower bound	37.14	3.48	6.12	3.54
Minimum	36.58	4.13	6.51	3.86
Maximum	46.64	5.65	7.79	4.96
Range	10.06	1.52	1.28	1.10

Table B-98: Metatarsal III measurements for *L. capensis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	8	8	8	8
Mean	42.22	4.42	6.38	4.59
Standard deviation	2.23	0.55	0.36	0.62
Average margin of error	1.54	0.38	0.25	0.43
Average upper bound	43.76	4.80	6.63	5.02
Average lower bound	40.67	4.04	6.13	4.15
Data margin of error	4.37	1.07	0.70	1.22
Data upper bound	46.58	5.49	7.09	5.81
Data lower bound	37.85	3.34	5.68	3.36
Minimum	38.42	3.96	5.88	3.80
Maximum	45.01	5.39	6.91	5.60
Range	6.59	1.43	1.03	1.80

Table B-99: Metatarsal IV measurements for *L. capensis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	8	8	8	8
Mean	37.78	3.88	5.71	5.92
Standard deviation	2.03	0.43	0.67	0.66
Average margin of error	1.41	0.30	0.46	0.45
Average upper bound	39.19	4.18	6.18	6.38
Average lower bound	36.37	3.58	5.25	5.47
Data margin of error	3.99	0.85	1.31	1.28
Data upper bound	41.77	4.73	7.02	7.21
Data lower bound	33.79	3.03	4.41	4.64
Minimum	34.65	3.48	5.07	4.82
Maximum	40.06	4.69	6.72	6.86
Range	5.41	1.21	1.65	2.04

Table B-100: Metatarsal I measurements for *L. saxatilis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	2	2	2	2
Mean	42.32	4.50	5.47	5.23
Standard deviation	4.14	0.71	2.41	1.34
Average margin of error	5.73	0.99	3.34	1.86
Average upper bound	48.05	5.48	8.81	7.09
Average lower bound	36.58	3.51	2.12	3.37
Data margin of error	8.11	1.40	4.73	2.63
Data upper bound	50.42	5.89	10.19	7.86
Data lower bound	34.21	3.10	0.74	2.60
Minimum	39.39	3.99	3.76	4.28
Maximum	45.24	5.00	7.17	6.18
Range	5.85	1.01	3.41	1.90

Table B-101: Metatarsal II measurements for *L. saxatilis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	2	2	2	2
Mean	43.70	4.50	6.79	4.07
Standard deviation	4.48	0.79	1.04	0.09
Average margin of error	6.20	1.10	1.44	0.13
Average upper bound	49.90	5.60	8.23	4.19
Average lower bound	37.49	3.40	5.34	3.94
Data margin of error	8.77	1.55	2.04	0.18
Data upper bound	52.47	6.05	8.82	4.25
Data lower bound	34.92	2.95	4.75	3.88
Minimum	40.53	3.94	6.05	4.00
Maximum	46.86	5.06	7.52	4.13
Range	6.33	1.12	1.47	0.12

Table B-102: Metatarsal III measurements for *L. saxatilis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	2	2	2	2
Mean	42.28	4.41	5.98	4.40
Standard deviation	3.90	0.68	0.66	0.14
Average margin of error	5.41	0.94	0.92	0.20
Average upper bound	47.69	5.35	6.90	4.60
Average lower bound	36.87	3.47	5.06	4.20
Data margin of error	7.65	1.33	1.30	0.28
Data upper bound	49.93	5.74	7.28	4.68
Data lower bound	34.63	3.08	4.68	4.12
Minimum	39.52	3.93	5.51	4.30
Maximum	45.04	4.89	6.45	4.50
Range	5.52	0.96	0.94	0.20

Table B-103: Metatarsal IV measurements for *L. saxatilis*

Measurement	**GL**	**Bd**	**Dp**	**Bp**
Sample size	2	2	2	2
Mean	37.46	3.83	5.45	5.77
Standard deviation	4.02	0.71	0.76	1.11
Average margin of error	5.58	0.98	1.05	1.54
Average upper bound	43.03	4.81	6.49	7.30
Average lower bound	31.88	2.85	4.40	4.23
Data margin of error	7.89	1.39	1.48	2.18
Data upper bound	45.34	5.22	6.93	7.94
Data lower bound	29.57	2.44	3.96	3.59
Minimum	34.61	3.33	4.91	4.98
Maximum	40.30	4.33	5.98	6.55
Range	5.69	1.00	1.07	1.57

APPENDIX C

RAW DATA

Explanatory notes

- In this Appendix I present the complete set of measurements that were taken of each specimen.
- The data is organised in the following order:
  - Measurements for *L. capensis*
  - Measurements for *L. saxatilis*
- Where measurements were not taken the reason is provided

Legend for tables:

- **M** = The entire element of that side is not in the collection
- **B** = Element or part of the element was broken
- **I** = Element is incomplete – applicable to the pelvis.
  - The two sides of the pelvis are not fused and as a result it was not possible to take the whole pelvis measurements in von den Driesch (1976: 83).

APPENDIX C

Skull

Table C-1: Skull measurements 1 – 10 for *L. capensis*

Specimen Number	Sex	Age	1	2	3	4	5	6	7	8	9	10
AZ 2922 / TM 27001	**F**	**A**	88.92	80.93	71.98	42.73	39.45	19.97	33.03	38.90	16.32	24.44
AZ 684 / TM 28454	**M**	**A**	79.60	73.82	64.38	37.95	B	18.37	33.77	B	14.76	B
AZ 678 / TM 28459	**F**	**A**	81.23	74.93	64.56	14.37	33.89	18.51	33.46	33.26	14.22	21.52
AZ 681 / TM 28464	**F**	**A**	89.74	82.22	73.48	43.66	38.52	15.88	35.03	36.48	14.79	25.85
AZ 2366 / TM 28976	**F**	**A**	81.45	75.21	64.97	38.49	B	20.50	29.87	30.14	14.34	21.49
AZ 2367 / TM 28977	**M**	**A**	82.79	76.78	67.15	39.55	34.24	19.82	31.83	38.32	14.58	23.35
AZ 2368 / TM 27979	**F**	**A**	85.72	80.62	69.35	40.49	33.94	19.53	33.32	32.35	15.35	22.51
AZ 2369 / TM 28980	**M**	**A**	86.85	79.72	70.25	41.84	35.34	18.88	29.71	33.15	15.13	24.09
TM 33802	**M**	**A**	82.96	74.06	66.68	38.10	32.46	18.33	30.83	27.98	14.88	22.42
AZ 680 / TM 38033	**F**	**A**	89.24	80.96	71.45	43.86	38.86	20.29	36.25	31.13	16.35	24.88
AZ 2761 / TM 38035	**M**	**A**	87.21	80.41	71.44	43.84	39.74	20.30	34.34	32.48	16.29	24.94
AZ 686 / TM 38039	**M**	**SA**	B	B	B	39.76	36.80	18.38	35.59	31.03	14.26	22.75
TM 634	**Not indicated**	**A**	85.02		68.23	41.72	35.00	19.53	32.83	31.27	14.81	23.06
TM 655	**F**	**A**	82.62	76.62	65.29	39.44	33.21	17.63	31.83	28.00	14.28	21.80
TM 5545	**Not indicated**	**A**	87.24	80.51	70.46	42.73	37.33	21.24	30.61	33.51	16.44	23.29
TM 6021	**Not indicated**	**A**	88.56	81.84	71.94	41.07	36.27	19.64	35.55	29.97	14.69	24.49
TM 7821	**M**	**A**	88.65	82.52	71.93	43.77	37.44	20.68	34.99	32.06	15.52	24.56
TM 12609	**Not indicated**	**A**	84.30	78.89	68.72	42.58	36.29	20.80	34.66	31.00	16.16	23.05
TM 13719	**Not indicated**	**A**	83.73	77.36	67.50	40.84	36.93	17.42	39.45	28.10	15.68	21.65
TM 19602	**F**	**A**	86.05	79.85	70.09	41.70	37.92	19.43	35.88	29.34	16.23	22.49

TM 28187	**M**	**A**	82.03	76.92	68.26	39.90	36.76	18.12	33.16	29.85	15.55	21.38
TM 28975	**F**	**A**	80.80	74.84	63.49	38.88	34.13	18.93	34.48	29.71	14.16	22.12
NMBF 9901	**F (M?)**	**A**	88.45	81.78	71.62	42.48	36.86	17.90	83.05	32.72	15.83	24.89
NMBF 9881	**F**	**A**	87.65	80.17	69.26	42.51	36.26	B	36.28	35.21	16.18	23.97
NMBF 9891	**F**	**A**	86.10	80.11	69.84	42.01	38.66	16.55	32.40	37.98	16.86	22.58
NMBF 3004	**Not indicated**	**A**	82.95	77.52	67.28	38.59	34.44	19.78	35.71	24.65	13.95	23.08
NMBF 3003	**M**	**A**	81.90	77.62	67.86	41.35	33.55	19.30	32.71	26.37	15.51	22.55
NMBF 3011	**M**	**A**	87.45	81.15	70.96	43.83	35.27	20.96	34.78	27.81	16.33	23.78
NMBF 3012	**F**	**A**	88.00	80.45	70.33	42.64	37.02	21.62	33.91	29.47	16.57	23.71
NMBF 9910	**Not indicated**	**A**	96.01	88.01	77.43	46.36	38.22	22.99	36.25	34.71	15.72	26.20
NMBF 9893	**F**	**A**	94.80	87.01	75.30	45.83	41.56	24.23	36.02	34.80	17.40	25.83
NBMF 9231	**Not indicated**	**A**	97.05	89.22	77.70	47.69	41.33	18.43	43.33	37.51	17.28	26.68

Table C-2: Skull measurements 11 – 22 for *L. capensis*

Specimen Number	**Sex**	**Age**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
AZ 2922 / TM 27001	**F**	**A**	5.79	14.56	33.62	28.95	24.47	40.59	42.01	20.09	12.51	11.77	9.24	6.68
AZ 684 / TM 28454	**M**	**A**	5.68	14.18	32.68	28.77	22.76	38.50	39.84	19.13	1.91	11.93	8.56	10.60
AZ 678 / TM 28459	**F**	**A**	6.17	14.20	33.39	27.68	20.29	37.39	38.27	17.97	11.24	10.94	7.40	8.81
AZ 681 / TM 28464	**F**	**A**	6.73	14.34	34.21	28.47	24.14	B	B	21.23	12.55	10.91	8.04	8.93
AZ 2366 / TM 28976	**F**	**A**	5.68	15.00	31.99	28.27	22.47	33.61	37.37	17.68	10.32	12.48	8.03	10.92
AZ 2367 / TM 28977	**M**	**A**	4.39	14.64	31.86	28.04	23.30	34.20	38.23	16.39	10.71	11.64	7.37	10.34
AZ 2368 / TM 27979	**F**	**A**	5.62	13.64	34.13	30.04	22.87	34.04	39.26	18.00	10.25	13.26	8.25	11.30
AZ 2369 / TM 28980	**M**	**A**	4.87	15.01	36.65	29.91	21.67	34.26	38.47	18.23	10.96	13.29	9.31	10.66
TM 33802	**M**	**A**	5.30	13.25	35.11	30.00	24.05	33.76	39.38	19.20	10.94	12.47	9.11	10.67
AZ 680 / TM 38033	**F**	**A**	5.76	14.86	34.68	29.50	24.23	B	41.93	20.27	10.86	12.36	8.49	10.90
AZ 2761 / TM 38035	**M**	**A**	6.14	14.62	B	29.45	25.03	B	B	19.99	10.86	B	B	B
AZ 686 / TM 38039	**M**	**SA**	5.43	B	B	B	23.32	35.97	39.41	18.91	11.56	B	B	B
TM 655	**F**	**A**	5.59	12.51		27.88	22.22	35.39	39.00	18.54	10.32	11.61	7.89	10.60
TM 634	**Not indicated**	**A**	5.04	B	33.63	28.85	22.31	37.45	39.77	17.11	10.67	9.61	7.52	8.44
TM 5545	**Not indicated**	**A**	6.16	14.71	33.48	29.58	23.07	37.26	40.50	21.95	11.36	10.86	8.32	10.35
TM 6021	**Not indicated**	**A**	5.88	14.25	35.23	28.87	22.13	34.87	38.15	20.05	11.11	12.53	8.90	11.49
TM 7821	**M**	**A**	6.48	14.65	B	29.01	23.58	36.88	39.74	18.70	10.54	12.15	8.22	10.58
TM 12609	**Not indicated**	**A**	5.53	14.67	32.62	30.11	24.07	36.28	40.25	20.52	11.51	11.60	8.57	10.31
TM 13719	**Not indicated**	**A**	6.35	15.10	33.66	29.19	23.63	36.31	40.31	19.48	10.44	10.75	7.89	9.85
TM 19602	**F**	**A**	5.90	15.10	32.60	28.28	22.29	38.15	40.21	21.27	11.26	11.13	7.52	9.45
TM 28187	**M**	**A**	5.68	13.52	32.77	28.67	22.28	35.21	38.87	19.99	10.20	11.21	7.47	9.89
TM 28975	**F**	**A**	5.22	13.85	33.61	28.24	24.68	35.43	38.81	17.34	11.17	12.64	8.43	11.52
NMBF 9901	**F (M?)**	**A**	5.98	13.97	32.94	27.46	22.30	36.52	38.63	17.28	11.09	11.02	7.27	9.93

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NMBF 9881	**F**	**A**	5.77	13.64	B	28.23	22.23	37.19	39.63	18.31	11.85	11.34	7.73	9.96
NMBF 9891	**F**	**A**	5.38	15.08	32.97	27.79	20.99	38.26	38.09	15.90	12.30	10.93	7.58	9.33
NMBF 3004	**Not indicated**	**A**	5.72	14.77	30.81	27.70	22.80	35.91	40.02	18.41	12.17	10.78	7.66	9.33
NMBF 3003	**M**	**A**	5.22	15.03	31.93	28.66	22.61	35.92	39.53	18.76	12.24	12.21	8.14	9.88
NMBF 3011	**M**	**A**	5.78	12.87	34.79	28.80	22.98	37.91	41.16	19.17	12.07	10.31	7.75	10.38
NMBF 3012	**F**	**A**	6.95	14.19	32.96	28.22	21.62	40.32	41.10	19.83	11.63	11.31	8.10	10.37
NMBF 9910	**Not indicated**	**A**	7.44	14.77	39.38	30.60	26.13	41.30	43.68	19.84	13.03	12.03	8.28	9.81
NMBF 9893	**F**	**A**	7.08	13.77	36.83	30.33	26.15	40.35	42.62	19.82	12.17	11.54	8.58	10.78
NBMF 9231	**Not indicated**	**A**	7.10	14.95	37.18	31.45	25.90	42.83	44.42	21.14	13.09	11.34	8.85	10.30

Table C-3: Skull measurements 1 – 10 for *L. saxatilis*

Specimen Number	**Sex**	**Age**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
AZ 419	**F**	**A**	87.49	80.58	70.12	41.97	35.69	16.62	35.04	32.73	15.36	24.17
AZ 511	**M**	**SA**	81.53	75.54	65.56	38.85	B	19.17	33.14	31.42	15.64	21.43
AZ 2710 / TM 28444	**F**	**A**	90.13	82.89	72.69	44.87	38.63	18.81	38.55	31.41	17.71	24.21
AZ 2778 / TM 28456	**M**	**A**	95.50	89.26	77.83	47.03	41.09	19.49	39.05	36.26	17.36	26.96
TM 28471	**M**	**A**	92.04	83.28	72.27	44.95	39.92	21.72	36.19	33.78	16.88	24.37
AZ 657 / TM 28476	**F**	**SA**	81.10	75.02	64.68	39.97	35.98	18.08	34.74	29.34	14.90	22.28
TM 29605	**F**	**A**	86.15	78.03	69.11	40.98	36.40	19.72	36.28	29.86	14.47	23.63
TM 30036	**M**	**A**	81.13	75.55	63.99	40.38	35.26	18.21	37.38	26.40	15.34	21.28
TM 37972	**M**	**A**	86.33	79.34	68.54	42.04	34.43	20.27	38.64	28.97	15.32	23.61
AZ 2598 / TM 37978	**F**	**A**	96.72	87.06	77.65	46.40	39.63	19.21	41.22	36.39	17.47	25.72
AZ 2774 / TM 37979	**M**	**A**	104.20	95.71	83.21	50.52	46.01	22.91	42.00	40.63	17.60	31.14
TM 37981	**F**	**A**	103.94	97.36	84.81	52.49	46.26	21.29	41.09	41.98	18.72	29.75
TM 37987	**M**	**A**	96.82	89.85	79.53	47.18	42.00	20.31	43.20	30.83	17.27	26.36
AZ 2765 / TM 37991	**F**	**A**	96.47	89.61	78.22	48.85	42.21	20.00	42.90	36.11	18.32	26.65
TM 37996	**F**	**A**	101.88	92.85	81.39	49.81	44.24	20.86	42.22	35.03	18.64	28.83
AZ 2737 / TM 38000	**F**	**A**	99.49	91.26	80.35	49.36	44.58	23.16	38.52	35.91	17.93	27.49
AZ 655 / TM 38001	**F**	**A**	100.63	92.24	81.77	49.37	42.55	21.07	40.01	35.58	17.82	28.27
AZ671 / TM 38003	**M**	**A**	90.58	B	B	43.77	37.46	19.60	36.98	29.49	15.90	24.04
TM 38006	**F**	**A**	96.28	88.87	75.92	47.51	43.42	21.77	38.62	36.86	17.86	26.56
AZ 2740 / TM 38007	**F**	**A**	92.71	85.30	73.86	45.74	39.59	19.46	43.62	27.09	17.26	25.80
AZ 670 / TM 38013	**M**	**A**	97.87	89.62	79.11	48.41	44.92	21.16	42.79	32.99	17.93	27.25
AZ 2706 / TM 38021	**F**	**A**	104.37	94.77	82.40	51.27	45.90	23.10	42.85	47.24	18.99	28.31

AZ 656 / TM 38024	**F**	**A**	102.79	94.31	82.63	50.83	44.32	22.51	41.47	37.30	17.76	29.20
AZ 2773 / TM 38025	**M**	**A**	100.09	91.36	78.79	49.33	42.73	24.38	40.61	47.28	18.25	27.44
AZ 2714 / TM 38030	**F**	**A**	91.54	84.59	73.35	43.34	40.84	20.62	36.76	35.24	14.85	24.82
TM 38047	**F**	**A**	95.07	86.92	76.50	46.06	38.71	20.55	40.01	35.28	17.58	24.75
AZ 2379 / TM 38053	**M**	**A**	92.90	85.92	75.21	45.86	41.43	22.88	33.53	35.67	17.02	25.03
AZ 2595 / TM 38061	**M**	**A**	96.00	89.59	78.53	48.73	41.05	21.73	42.65	33.95	17.27	27.72
TM 41151	**M**	**A**	93.15	86.86	75.01	46.03	39.07	22.24	38.87	31.26	17.44	26.43
NMBF 848	**Not indicated**	**A**	87.99	81.98	71.12	44.38	36.92	17.56	38.35	29.71	16.35	24.66
NMBF 3005	**M**	**A**	87.77	82.52	71.58	43.68	37.53	19.83	34.57	28.96	16.22	25.34
NMBF 3008	**M**	**A**	83.13	78.53	67.29	41.47	35.66	20.30	34.70	28.42	15.88	23.40
NMBF 3009	**M**	**A**	96.21	88.57	77.17	48.71	43.06	20.86	40.02	33.63	18.45	27.37

Table C-4: Skull measurements 11 – 22 for *L. saxatilis*

Specimen Number	**Sex**	**Age**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
AZ 419	**F**	**A**	6.77	15.23	33.80	27.75	23.69	40.46	40.35	20.80	12.16	10.47	6.96	8.70
AZ 511	**M**	**SA**	6.16	13.52	B	28.69	28.71	36.23	39.10	20.18	11.78	10.48	7.09	8.61
AZ 2710 / TM 28444	**F**	**A**	7.56	14.48	B	B	22.25	39.19	B	21.16	11.50	10.35	7.68	9.51
AZ 2778 / TM 28456	**M**	**A**	6.76	14.87	37.60	30.64	24.85	41.49	43.43	24.37	12.33	12.40	9.15	10.65
TM 28471	**M**	**A**	6.06	15.41	35.31	30.77	26.02	40.70	43.27	20.43	11.75	10.52	7.50	9.76
AZ 657 / TM 28476	**F**	**SA**	6.67	14.05	32.62	28.41	23.97	36.97	40.69	16.88	11.75	11.55	7.42	9.07
TM 29605	**F**	**A**	5.11	13.20	30.65	27.60	21.59	35.06	38.50	18.30	11.33	12.58	8.35	10.06
TM 30036	**M**	**A**	6.37	14.81	31.58	28.18	22.74	37.61	39.38	18.02	10.50	11.34	8.38	9.75
TM 37972	**M**	**A**	6.18	14.28	33.31	29.49	23.34	39.09	41.40	18.70	11.35	9.67	7.17	9.05
AZ 2598 / TM 37978	**F**	**A**	6.95	14.98	36.02	32.36	26.69	42.91	44.92	22.09	13.16	11.21	7.49	9.07
AZ 2774 / TM 37979	**M**	**A**	6.35	16.11	39.30	32.29	30.85	43.03	B	25.21	12.98	11.48	8.48	10.37
TM 37981	**F**	**A**	6.19	17.28	40.07	31.28	24.78	45.05	43.99	22.49	13.90	12.04	9.09	9.56
TM 37987	**M**	**A**	6.37	15.74	35.83	30.53	25.31	42.87	42.79	22.75	12.62	11.87	7.86	10.32
AZ 2765 / TM 37991	**F**	**A**	8.01	15.93	37.01	31.15	24.23	43.11	43.65	22.05	12.78	11.07	7.48	8.88
TM 37996	**F**	**A**	7.74	15.53	39.02	31.52	25.15	44.37	46.06	21.59	13.41	11.64	9.18	10.35
AZ 2737 / TM 38000	**F**	**A**	7.06	16.94	38.49	31.16	26.31	44.74	43.46	21.59	12.99	11.75	9.46	10.35
AZ 655 / TM 38001	**F**	**A**	6.87	16.18	39.81	31.36	29.00	43.55	46.09	24.74	13.66	11.70	8.75	9.62
AZ671 / TM 38003	**M**	**A**	6.41	B	35.43	29.94	25.15	B	B	19.11	11.59	12.09	8.01	9.27
TM 38006	**F**	**A**	6.88	14.73	34.59	30.65	24.71	42.48	42.93	21.62	12.36	12.02	8.50	9.25
AZ 2740 / TM 38007	**F**	**A**	6.95	15.44	36.71	31.72	25.85	42.39	45.07	22.59	12.29	11.53	7.98	9.60
AZ 670 / TM 38013	**M**	**A**	7.33	16.16	B	30.68	24.25	43.04	44.04	22.00	13.17	11.32	7.73	9.93
AZ 2706 / TM 38021	**F**	**A**	8.10	16.31	38.55	33.81	27.88	44.31	46.96	18.92	12.59	12.39	9.41	11.13

AZ 656 / TM 38024	**F**	**A**	7.19	15.96	40.22	32.17	25.07	B	44.38	23.04	13.09	12.33	8.79	9.52
AZ 2773 / TM 38025	**M**	**A**	7.06	14.57	36.50	33.36	29.63	43.56	47.46	23.51	12.61	12.15	8.09	9.77
AZ 2714 / TM 38030	**F**	**A**	7.20	14.32	35.39	29.57	26.01	41.37	42.17	19.65	12.20	11.23	7.22	9.70
TM 38047	**F**	**A**	6.60	16.11	36.80	30.04	25.71	44.47	44.46	23.14	13.81	11.26	8.45	10.63
AZ 2379 / TM 38053	**M**	**A**	6.48	15.58	34.92	29.37	23.97	43.43	43.97	20.35	13.63	10.44	7.67	9.42
AZ 2595 / TM 38061	**M**	**A**	7.67	15.85	38.00	31.40	25.72	42.77	43.91	21.28	11.95	11.01	8.39	10.55
TM 41151	**M**	**A**	5.61	13.51	33.96	29.13	29.47	41.68	41.35	19.98	12.82	10.52	7.90	9.54
NMBF 848		**A**	6.29	14.86	34.96	29.38	24.88	39.75	42.17	20.01	13.00	11.62	8.12	9.60
NMBF 3005	**M**	**A**	6.88	13.56	33.82	28.95	23.34	37.47	40.65	19.70	10.62	11.62	8.26	9.93
NMBF 3008	**M**	**A**	5.37	14.28	31.75	27.84	23.06	38.18	38.38	17.24	11.13	11.20	7.30	9.11
NMBF 3009	**M**	**A**	7.35	15.11	35.49	31.23	26.98	42.50	43.30	23.72	12.93	10.28	7.85	10.07

Mandible

Table C-5: Mandible measurements for *L. capensis*

Specimen Number	Sex	Age	Side	1	2	3	4	5	5a	6	7
AZ 2922 / TM 27001	**F**	**A**	**L**	61.16	17.29	36.27	19.46	43.37	41.67	11.93	15.23
			R	B	17.06	36.34	19.88	B	B	12.19	15.34
AZ 684 / TM 28454	**M**	**A**	**L**	56.92	16.36	34.06	17.36	38.79	37.37	11.26	14.40
			R	56.73	16.35	33.96	17.65	38.54	37.23	11.39	14.70
AZ 678 / TM 28459	**F**	**A**	**L**	55.00	16.08	33.48	17.34	39.82	38.46	11.49	14.71
			R	54.79	16.10	33.67	17.49	39.87	38.85	11.51	15.07
AZ 681 / TM 28464	**F**	**A**	**L**	60.61	16.12	36.29	20.18	41.79	40.05	13.11	15.16
			R	60.40	16.17	36.01	20.06	41.63	40.17	13.18	15.11
AZ 2366 / TM 28976	**F**	**A**	**L**	B	15.13	31.87	16.83	35.89	34.82	9.90	12.26
			R	M	M	M	M	M	M	M	M
AZ 2367 / TM 28977	**M**	**A**	**L**	55.03	15.58	33.92	18.12	35.17	32.94	10.11	12.44
			R	55.24	15.33	34.15	18.15	35.49	33.02	10.37	12.34
AZ 2368 / TM 27979	**F**	**A**	**L**	B	16.42	33.92	17.75	39.39	37.32	11.44	14.29
			R	B	16.51	34.52	17.80	B	B	11.59	14.35
AZ 2369 / TM 28980	**M**	**A**	**L**	56.80	15.61	34.99	19.15	38.25	37.20	10.79	13.73
			R	55.98	15.43	34.68	18.99	38.34	37.17	10.58	13.80
AZ 680 / TM 38033	**F**	**A**	**L**	60.01	16.88	36.77	19.83	42.27	40.96	12.47	15.82
			R	60.52	16.82	37.23	20.10	42.07	40.91	12.59	15.89
AZ 2761 / TM 38035	**M**	**A**	**L**	B	B	B	19.16	B	B	B	B
			R	57.52	17.42	36.75	19.21	39.26	37.31	12.39	14.60
AZ 686 / TM 38039	**M**	**SA**	**L**	54.92	15.21	34.92	18.97	40.27	39.05	11.93	14.89
			R	54.86	15.18	34.29	19.02	40.24	38.84	12.13	14.46
TM 655	**F**	**A**	**L**	56.27	14.60	32.97	16.90	37.87	36.21	10.40	12.25
			R	B	14.61	33.10	17.30	37.88	36.37	10.77	12.53
TM 634	**Not indicated**	**A**	**L**	57.13	16.12	34.08	16.81	38.26	36.92	11.72	13.57
			R	56.68	15.97	34.16	17.03	39.05	37.74	11.71	13.40
TM 5545	**Not indicated**	**A**	**L**	B	17.60	35.15	17.74	39.61	36.75	11.34	15.55
			R	57.47	17.09	35.23	17.88	39.55	36.93	11.61	15.64
TM 6021	**Not indicated**	**A**	**L**	M	M	M	M	M	M	M	M
			R	60.77	16.56	36.44	20.37	39.91	37.45	11.77	14.89
TM 7821	**M**	**A**	**L**	60.22	16.61	36.16	18.87	41.20	38.83	12.32	14.99
			R	59.74	16.71	36.06	18.79	41.29	39.10	12.95	14.90
TM 12609	**Not indicated**	**A**	**L**	57.15	17.90	35.90	17.60	40.14	38.78	12.33	15.37
			R	56.66	17.28	35.70	17.73	40.23	38.73	13.22	15.52
TM 13719	**Not indicated**	**A**	**L**	B	16.92	34.13	16.95	42.46	41.37	12.27	15.04
			R	B	16.83	34.66	17.00	43.09	41.29	12.34	14.89
TM 19602	**F**	**A**	**L**	57.54	17.63	35.02	17.28	39.66	38.35	11.54	14.46
			R	55.93	17.01	34.43	16.84	39.21	37.38	12.23	14.29
TM 28187	**M**	**A**	**L**	55.93	17.01	34.43	16.84	39.21	37.38	12.23	14.29
			R	56.02	16.62	34.03	17.11	39.12	37.42	12.62	14.16
TM 28975	**F**	**A**	**L**	B	15.02	33.76	18.23	36.52	34.43	11.65	13.34
			R	B	15.08	B	B	36.65	35.46	B	13.59
TM 33802	**M**	**A**	**L**	B	15.03	33.71	19.02	B	B	11.51	13.82
			R	55.11	15.02	33.76	19.14	37.54	35.26	11.33	13.75
NMBF 9901	**F**	**A**	**L**	B	17.78	37.21	20.56	B	B	B	B
			R	60.16	17.25	37.06	20.37	39.85	38.11	B	B
NMBF 9881	**F**	**A**	**L**	62.61	17.16	36.30	19.25	38.24	36.85	B	B
			R	B	17.58	36.56	19.36	B	B	B	B
NMBF 9891	**F**	**A**	**L**	58.31	17.87	35.39	18.45	38.09	36.35	B	B
			R	57.85	17.70	35.58	18.17	38.12	36.52	B	B
NMBF 3004	**Not indicated**	**A**	**L**	B	15.58	33.63	18.97	B	B	B	B
			R	B	15.72	34.16	18.80	38.06	36.95	B	B

NMBF 3003	**M**	**A**	**L**	54.95	16.69	35.19	18.44	37.34	35.72	B	B
			R	55.31	16.44	34.19	18.09	37.08	35.55	B	B
NMBF 3012	**F**	**A**	**L**	55.11	16.73	34.22	17.34	38.55	37.46	B	B
			R	B	16.75	33.20	16.32	38.47	37.35	B	B
NMBF 9910	**Not indicated**	**A**	**L**	67.24	17.88	39.54	20.92	46.44	44.97	B	B
			R	B	18.06	39.30	21.53	B	B	B	B
NMBF 9893	**F**	**A**	**L**	65.43	18.76	38.12	19.55	45.93	44.15	B	B
			R	65.52	18.60	38.30	20.40	46.10	44.52	B	B
NMBF 9231	**Not indicated**	**A**	**L**	67.59	18.45	39.64	20.85	46.79	46.02	B	B
			R	67.69	18.41	39.65	21.27	46.99	45.62	B	B

Table C-6: Mandible measurements for *L. saxatilis*

Specimen Number	Sex	Age	Side	1	2	3	4	5	5a	6	7
AZ 419	**F**	**A**	**L**	61.44	16.69	36.20	19.38	44.42	42.88	12.74	15.08
			R	61.60	16.88	36.41	19.41	44.76	43.11	12.80	15.23
AZ 511	**M**	**A**	**L**	B	16.39	33.92	17.48	B	B	12.73	14.53
			R	54.35	16.52	34.05	18.15	36.67	35.05	13.16	14.63
AZ 657 / TM 28476	**F**	**SA**	**L**	54.89	16.08	33.57	17.50	41.16	39.37	11.98	15.33
			R	B	15.94	33.55	17.39	B	B	11.95	B
AZ 2778 / TM 28456	**M**	**A**	**L**	67.16	18.95	41.04	21.56	45.85	44.46	12.01	15.41
			R	M	M	M	M	M	M	M	M
TM 28471	**M**	**A**	**L**	B	18.22	B	B	45.17	43.40	13.62	15.88
			R	B	17.94	B	B	44.99	43.97	13.65	16.06
TM 29605	**F**	**A**	**L**	57.32	16.56	34.15	17.21	37.74	36.39	10.54	13.33
			R	57.59	16.22	34.26	17.42	37.36	36.31	11.06	13.37
TM 30036	**M**	**A**	**L**	54.31	15.96	32.25	16.00	40.74	38.89	12.75	14.66
			R	B	B	B	16.01	B	B	12.82	B
TM 37972	**M**	**A**	**L**	60.49	16.34	34.88	18.51	42.24	40.75	12.29	14.73
			R	58.97	16.27	34.60	18.49	42.26	40.70	12.45	14.62
AZ 2598 / TM 37978	**F**	**A**	**L**	64.06	18.32	38.23	20.09	46.66	44.28	13.68	17.36
			R	63.87	18.32	38.11	19.78	46.72	45.09	13.67	17.31
AZ 2774 / TM 37979	**M**	**A**	**L**	68.84	17.84	42.54	24.35	44.35	43.00	13.05	16.64
			R	68.00	18.00	42.14	24.16	44.54	43.56	13.05	16.48
TM 37981	**F**	**A**	**L**	B	21.49	43.00	21.95	B	B	13.31	16.92
			R	69.16	20.68	43.42	22.83	50.13	48.75	13.90	16.64
TM 37987	**M**	**A**	**L**	63.82	17.98	39.44	20.28	45.59	43.15	14.06	16.47
			R	63.57	18.25	39.22	20.67	48.85	43.80	14.00	16.42
AZ 2765 / TM 37991	**F**	**A**	**L**	66.47	19.79	40.93	20.84	46.28	43.58	14.57	18.27
			R	66.34	19.77	40.75	20.75	45.93	43.07	14.45	17.83
AZ 654 / TM 37996	**F**	**A**	**L**	71.77	19.33	42.20	22.94	48.25	45.57	12.43	16.58
			R	70.67	19.22	42.23	22.56	47.52	B	13.01	16.64
AZ 2737 / TM 38000	**F**	A	**L**	67.81	19.27	41.15	20.60	49.30	47.85	12.86	17.62
			R	67.54	20.15	41.20	21.08	49.65	47.91	13.31	17.20
AZ 655 / TM 38001	**F**	**A**	**L**	69.75	18.28	41.44	22.69	47.45	45.55	14.65	17.92
			R	69.33	18.14	41.72	22.46	46.87	44.36	14.86	17.75
AZ 671 / TM 38003	**M**	**A**	**L**	B	16.63	37.65	21.10	B	B	13.23	16.11
			R	62.68	16.40	37.11	20.96	41.44	40.21	13.251	15.29
TM 38006	**F**	**A**	**L**	66.21	19.13	40.83	21.11	B	B	13.15	16.03
			R	65.28	19.03	40.59	21.32	45.74	74.84	13.37	16.28
AZ 2740 / TM 38007	**F**	**A**	**L**	64.43	18.59	38.40	19.64	45.94	45.40	12.93	17.13
			R	64.16	18.81	38.47	19.29	46.51	45.78	13.34	17.24
AZ 670 / TM 38013	**M**	**A**	**L**	68.13	18.76	39.85	21.25	45.57	43.50	13.17	16.66
			R	68.31	18.34	39.49	21.18	45.26	43.79	13.36	16.86
AZ 2706 / TM 38021	**F**	**A**	**L**	69.23	19.48	42.36	21.78	48.40	46.28	14.27	17.37
			R	69.56	19.83	42.45	22.37	48.83	46.80	14.07	17.43
AZ 656 / TM 38024	**F**	**A**	**L**	69.98	19.17	42.58	22.79	47.59	46.72	13.20	16.71
			R	69.80	18.89	42.63	22.98	47.41	46.70	13.34	16.76
AZ 2773 / TM 38025	**M**	**A**	**L**	68.01	19.05	41.99	22.30	47.73	46.61	13.81	17.08
			R	68.04	18.91	41.71	22.97	41.22	46.30	13.97	16.93
AZ 2714/ TM 38030	**F**	**A**	**L**	62.60	17.21	37.15	19.60	46.62	45.72	14.00	16.74
			R	62.12	17.51	37.75	20.09	47.18	45.81	13.78	17.00
TM 38047	**F**	**A**	**L**	65.19	18.94	38.95	19.86	46.90	45.70	14.09	17.70
			R	64.60	18.88	38.64	19.43	B	B	14.12	17.28
AZ 2379 / TM 38053	**M**	**A**	**L**	63.20	19.17	38.64	18.85	44.82	44.34	13.62	17.04
			R	63.26	19.14	38.70	19.18	44.92	44.27	13.83	16.79
AZ 2595 / TM 38061	**M**	**A**	**L**	64.44	20.05	40.09	20.48	47.08	45.27	12.24	17.40
			R	65.70	B	40.51	21.09	46.63	44.48	12.30	17.69
TM 41151	**M**	**A**	**L**	63.49	18.85	39.68	21.77	40.31	38.59	13.44	15.31

			R	63.47	18.39	39.51	21.20	39.67	38.68	13.99	15.34
NMBF 3008	**M**	**A**	**L**	59.03	17.67	35.55	18.69	42.03	40.96	B	B
			R	58.33	17.72	35.72	18.35	42.22	41.13	B	B
NMBF 3009	**M**	**A**	**L**	65.88	19.10	42.38	22.99	43.61	41.11	B	B
			R	65.97	19.05	41.28	22.20	43.66	40.94	B	B
NMBF 848	**Not indicated**	**A**	**L**	61.33	17.65	37.25	19.05	43.00	40.84	B	B
			R	B	17.74	37.29	19.20	B	38.59	B	B

Atlas

Table C-7: Atlas measurements for *L. capensis*

Specimen Number	Sex	Age	GB	GL	BFcr	BFcd	GLF	Lad Right	Ladt
AZ 678	**F**	**SA**	26.04	B	13.84	B	B	6.86	B
AZ 679	**F**	**A**	26.68	12.18	14.33	11.01	9.74	7.23	8.03
AZ 680	**F**	**A**	26.98	12.67	14.77	11.19	8.93	5.86	6.18
AZ 681	**F**	**A**	26.86	B	14.96	B	B	B	B
AZ 684	**F**	**A**	29.69	13.34	15.18	12.90	12.35	6.75	7.57
AZ 686	**M**	**SA**	37.39	12.39	14.53	12.01	11.53	6.51	7.68
AZ 2366	**F**	**SA**	25.34	B	14.39	B	B	B	B
AZ 2367	**M**	**A**	25.00	B	14.45	B	B	B	B
AZ 2368	**F**	**A**	26.72	B	13.98	B	B	B	B
AZ 2627	**F**	**A**	27.29	12.82	14.72	11.20	12.23	6.10	6.48
AZ 2756	**M**	**A**	27.23	12.28	14.43	11.43	12.46	7.26	6.74
AZ 2787	**F**	**A**	26.19	11.65	14.04	10.98	11.53	6.18	6.53
AZ 2922	**F**	**A**	27.89	12.70	14.23	11.09	10.31	6.94	7.18
AZ 2959	**F**	**A**	27.63	11.93	14.91	11.99	12.61	6.87	7.64
NMBF 9881	**F**	**A**	26.59	11.19	13.50	11.08	11.84	5.85	5.68
NMBF 9891	**F**	**A**	26.68	12.14	14.81	11.59	11.29	5.61	6.36
NMBF 9893	**F**	**A**	28.91	13.72	14.68	11.96	11.52	7.27	7.67
NBMF 9901	**F**	**A**	26.45	12.21	14.12	10.56	11.71	6.61	7.87
NMBF 9910	**Not indicated**	**A**	29.47	14.38	15.85	13.19	11.30	6.77	6.79
NMB 4713	**M**	**A**	26.57	13.39	13.82	11.59	11.64	7.54	7.95

Table C-8: Atlas measurements for *L. saxatilis*

Specimen Number	Sex	Age	GB	GL	BFcr	BFcd	GLF	Lad Right	Ladt
AZ 419	**F**	**SA**	27.32	12.86	15.49	12.16	13.03	6.79	7.35
AZ 511	**M**	**SA**	24.56	10.97	13.68	10.73	10.75	B	B
AZ 655	**F**	**A**	30.12	15.23	16.72	12.57	14.41	7.05	7.15
AZ 656	**F**	**A**	30.96	15.51	16.34	12.54	11.82	8.04	8.28
AZ 657	**F**	**SA**	25.00	B	14.29	10.82	11.09	6.89	6.65
AZ 658	**M**	**A**	27.89	13.07	16.09	11.76	12.75	7.38	7.39
AZ 659	**M**	**SA**	27.09	B	14.96	B	12.41	B	B
AZ 660	**M**	**A**	31.93	14.15	16.91	13.87	14.22	7.63	7.17
AZ 670	**M**	**A**	29.10	13.04	15.70	11.74	10.43	6.77	6.95
AZ 1791	**M**	**A**	27.23	13.74	15.04	11.59	12.60	7.47	7.32
AZ 2379	**M**	**A**	B	B	16.10	12.23	12.90	7.74	7.66
AZ 2598	**F**	**A**	29.83	13.92	14.83	11.09	13.22	7.17	7.42
AZ 2706	**F**	**A**	32.33	14.55	17.15	12.83	14.49	7.90	7.81
AZ 2716	**F**	**A**	27.92	12.64	15.98	12.74	13.20	7.17	6.75
AZ 2737	**F**	**A**	29.85	13.53	17.11	13.05	14.56	6.90	7.23
AZ 2740	**F**	**A**	30.53	14.72	13.95	16.15	12.19	7.84	7.56
AZ 2744	**F**	**A**	32.33	15.51	17.75	12.95	14.46	7.40	7.58
AZ 2765	**Not indicated**	**A**	28.78	12.52	15.69	12.67	12.91	7.60	7.54
AZ 2774	**M**	**A**	30.94	14.17	16.03	13.71	14.17	8.39	8.08
AZ 2778	**M**	**A**	27.92	13.30	15.02	11.83	13.40	7.79	8.09
TM 13509	**F**	**A**	28.32	12.91	15.28	11.46	12.95	7.24	7.00
TM 41151	**M**	**A**	26.59	12.43	14.56	11.44	11.87	B	4.85

Axis

Table C-9: Axis measurements for *L. capensis*

Specimen Number	Sex	Age	LCDe	LAPa	BFcr	BPacd	BPtr	SBV	BFcd	H
AZ 678	**F**	**SA**	15.74	12.37	B	8.37	10.27	9.90	B	B
AZ 679	**F**	**A**	16.71	13.36	10.22	9.13	11.08	9.68	5.61	14.81
AZ 680	**F**	**A**	17.70	13.57	10.24	9.97	12.51	10.10	B	15.55
AZ 681	**F**	**A**	19.34	14.83	B	8.79	11.51	9.95	B	B
AZ 684	**F**	**A**	18.71	14.82	11.24	9.82	12.39	11.59	B	14.49
AZ 686	**M**	**SA**	17.03	11.51	10.49	9.39	11.50	9.83	6.03	14.14
AZ 2366	**F**	**SA**	17.79	12.32	B	9.28	11.49	9.50	6.10	13.29
AZ 2367	**M**	**A**	16.40	12.40	B	8.30	10.22	9.77	B	B
AZ 2368	**F**	**A**	18.25	15.28	B	10.49	B	B	B	B
AZ 2368	**F**	**A**	18.25	15.28	B	10.49	B	B	B	B
AZ 2627	**F**	**A**	18.46	11.33	10.45	8.91	10.84	9.74	B	B
AZ 2756	**M**	**A**	18.64	13.99	10.49	9.51	12.08	9.96	5.91	14.31
AZ 2787	**F**	**A**	17.44	13.65	10.21	8.82	10.37	9.82	B	3.68
AZ 2922	**F**	**A**	17.97	13.41	10.27	8.90	11.66	10.19	5.98	13.26
AZ 2959	**F**	**A**	16.89	11.68	10.79	8.44	10.85	9.50	5.78	12.78
NMBF 9881	**F**	**A**	18.25	14.06	10.22	9.04	11.91	9.87	5.57	13.45
NMBF 9891	**F**	**A**	16.68	11.90	10.08	8.54	11.79	9.26	5.67	12.75
NMBF 9893	**F**	**A**	19.26	14.35	11.31	10.62	12.47	10.79	6.82	14.50
NMBF 9901	**F**	**A**	17.13	10.30	9.78	9.08	11.58	9.19	5.87	13.81
NMBF 9910	**Not indicated**	**A**	18.35	12.48	11.68	11.47	12.39	11.07	7.14	15.26
NMB 4713	**M**	**A**	18.66	12.66	10.38	8.69	11.93	9.75	6.04	12.99

Table C-10: Axis measurements for *L. saxatilis*

Specimen Number	Sex	Age	LCDe	LAPa	BFcr	BFacd	BFtr	SBV	BFcd	H
AZ 419	**F**	**SA**	17.95	B	10.63	B	B	10.53	6.35	14.68
AZ 511	**M**	**SA**	B	11.36	9.83	8.20	11.60	9.36	B	12.79
AZ 654	**F**	**A**	20.67	16.97	11.29	10.72	12.77	10.70	6.34	15.64
AZ 655	**F**	**A**	19.22	15.25	11.55	11.05	13.07	11.49	7.14	14.54
AZ 656	**F**	**A**	21.76	17.45	11.57	11.15	B	11.53	7.22	16.21
AZ 657	**F**	**SA**	17.43	13.35	9.714	8.52	11.12	9.95	5.93	12.54
AZ 658	**M**	**A**	20.18	14.29	11.18	10.56	13.44	11.01	6.09	13.67
AZ 659	**M**	**SA**	18.34	14.08	B	10.30	12.10	10.90	B	B
AZ 660	**M**	**A**	19.62	17.49	12.15	10.78	13.29	11.76	7.04	16.08
AZ 370	**M**	**A**	18.03	15.28	10.62	9.86	B	11.16	6.05	14.47
AZ 1791	**M**	**A**	18.48	13.88	10.10	9.54	11.58	9.95	6.77	B
AZ 2379	**M**	**A**	19.26	15.77	10.80	10.21	13.11	10.81	6.30	14.05
AZ 2598	**F**	**A**	18.45	14.16	10.09	9.51	B	11.36	6.16	14.54
AZ 2706	**F**	**A**	21.62	14.22	11.82	10.69	13.58	11.83	6.99	15.22
AZ 2714	**Not indicated**	**A**	18.07	14.41	11.16	B	B	10.42	7.07	13.66
AZ 2716	**F**	**A**	17.36	13.89	11.26	9.95	B	10.30	5.75	13.77
AZ 2737	**F**	**A**	21.92	15.00	12.01	10.60	13.13	11.80	7.12	15.02
AZ 2744	**F**	**A**	22.38	18.70	11.52	10.92	13.66	11.88	B	16.89
AZ 2765	**Not indicated**	**A**	19.34	17.68	11.91	10.42	13.02	10.46	6.64	14.79
AZ 2773	**Not indicated**	**A**	20.83	13.29	11.36	10.78	13.51	10.78	6.75	13.37
AZ 2778	**F**	**A**	18.58	15.55	11.52	10.19	12.06	11.08	6.45	14.61
TM 13509	**F**	**A**	18.46	12.46	10.28	10.03	11.47	10.04	6.22	13.74
TM 41151	**M**	**A**	17.04	14.45	10.93	10.62	11.69	9.62	6.09	14.38

Scapula

Table C-11: Scapula measurements for *L. capensis*

Specimen Number	Sex	Age	SIDE	HS	DHA	Ld	SLC	GLP	LG	BG
AZ 678	**F**	**SA**	**L**	63.26	61.62	33.98	5.36	10.33	9.09	9.40
			R	63.15	61.81	34.02	5.40	9.88	8.86	9.47
AZ 679	**F**	**A**	**L**	66.29	66.55	40.49	6.51	9.98	9.79	9.62
			R	66.67	66.08	B	6.34	10.02	9.77	9.51
AZ 680	**F**	**A**	**L**	71.62	70.11	41.96	6.84	10.41	9.84	9.19
			R	71.48	70.15	41.72	6.47	10.16	9.61	8.98
AZ 681	**F**	**A**	**L**	68.13	68.76	39.33	5.96	10.17	9.27	10.03
			R	68.14	67.89	37.80	6.22	10.08	8.96	9.84
AZ 684	**M**	**A**	**L**	71.62	71.67	40.66	6.47	11.87	10.12	10.48
			R	B	71.41	39.44	6.36	12.12	10.14	10.72
AZ 685	**M**	**A**	**L**	64.04	64.14	36.32	5.70	10.14	9.39	9.00
			R	64.26	64.42	36.94	5.69	10.25	9.27	9.08
AZ 686	**M**	**SA**	**L**	64.74	62.92	34.72	5.61	10.06	9.96	9.46
			R	64.67	62.86	34.73	5.69	10.38	9.76	9.51
AZ 2366	**F**	**SA**	**L**	61.57	61.60	35.66	5.38	9.96	9.82	9.13
			R	61.82	61.60	35.32	5.26	10.00	9.52	9.16
AZ 2367	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	68.83	67.78	40.71	6.30	10.37	10.09	9.44
AZ 2368	**F**	**A**	**L**	69.69	67.98	40.20	6.16	10.72	10.40	9.69
			R	70.33	68.36	40.25	6.11	11.00	10.22	10.24
AZ 2369	**M**	**A**	**L**	67.03	66.76	37.57	6.16	10.70	10.43	9.88
			R	M	M	M	M	M	M	M
AZ 2627	**F**	**A**	**L**	66.02	67.82	38.08	5.27	10.14	9.47	9.09
			R	66.25	67.57	37.48	5.34	10.09	9.24	8.89
AZ 2756	**M**	**A**	**L**	67.87	67.58	43.70	6.19	11.32	9.67	10.32
			R	68.01	69.39	44.68	6.39	11.68	10.18	10.44
AZ 2761	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	64.65	66.58	37.51	5.66	10.66	9.87	9.29
AZ 2787	**F**	**A**	**L**	62.52	61.33	41.35	6.25	9.86	9.52	9.06
			R	62.78	61.47	41.36	6.21	10.15	9.46	9.03
AZ 2791	**F**	**A**	**L**	69.51	68.02	36.66	6.19	9.70	9.92	9017
			R	69.58	76.45	37.45	6.11	9.74	10.06	8.97
AZ 2922	**F**	**A**	**L**	72.33	70.85	41.74	6.66	10.85	10.26	9.37
			R	71.78	71.01	41.68	6.64	11.17	10.34	9.38
AZ 2959	**F**	**A**	**L**	70.89	67.23	39.11	6.11	10.47	10.22	9.49
			R	M	M	M	M	M	M	M
TM 33082	**M**	**A**	**L**	59.34	60.13	37.77	5.76	9.56	9.54	8.77
			R	M	M	M	M	M	M	M
NMBF 9881	**F**	**A**	**L**	B	67.68	B	5.67	10.42	9.59	9.13
			R	66.17	67.31	39.03	5.75	10.16	9.47	9.26
NMBF 9891	**F**	**A**	**L**	63.68	63.11	35.04	5.91	10.30	9.36	9.28
			R	63.48	63.52	35.52	5.91	10.39	9.71	9.39
NMBF 9893	**F**	**A**	**L**	77.90	78.14	42.70	7.28	11.51	10.57	10.78
			R	76.74	76.92	42.23	7.22	11.32	10.53	11.09
NMBF 9901	**F**	**A**	**L**	M	M	M	M	M	M	M
			R	68.19	65.69	36.74	5.66	9.79	9.01	8.89
NMBF 9910	**Not indicated**	**A**	**L**	M	M	M	M	M	M	M
			R	75.84	74.60	38.72	6.53	11.28	10.40	10.74
NMB 4713	**M**	**A**	**L**	71.86	72.09	40.80	6.19	10.09	9.69	9.82
			R	71.69	71.75	40.85	6.22	10.51	10.08	10.02

Table C-12: Scapula measurements for *L. saxatilis*

Specimen Number	Sex	Age	SIDE	HS	DHA	Ld	SLC	GLP	LG	BG
AZ 419	**F**	**SA**	**L**	67.38	67.46	31.29	6.19	10.64	9.38	9.83
			R	67.55	67.49	30.61	6.20	10.59	10.15	9.77
AZ 511	**F**	**SA**	**L**	B	61.87	B	5.32	8.58	8.70	8.70
			R	62.38	61.14	33.00	5.51	8.57	8.63	8.81
AZ 654	**F**	**A**	**L**	82.27	83.07	48.63	7.68	12.57	11.90	11.55
			R	82.62	84.58	47.96	7.41	12.61	11.33	11.46
AZ 655	**F**	**A**	**L**	76.63	75.08	42.00	7.26	11.67	10.98	10.40
			R	76.28	75.35	41.93	7.19	11.70	11.19	10.37
AZ 656	**F**	**A**	**L**	B	B	44.19	7.30	B	B	11.73
			R	83.79	84.22	45.29	7.22	12.75	11.47	11.64
AZ 657	**F**	**SA**	**L**	61.83	59.86	31.02	5.53	10.27	10.00	9.51
			R	61.75	61.91	30.43	5.49	10.18	9.60	9.53
AZ 658	**M**	**A**	**L**	72.10	73.86	44.97	6.73	11.83	11.58	11.06
			R	72.00	73.83	43.70	6.66	11.93	12.04	11.38
AZ 659	**M**	**SA**	**L**	68.44	67.39	36.88	5.98	10.43	9.66	10.14
			R	68.27	B	B	6.01	10.41	9.56	10.34
AZ 660	**M**	**A**	**L**	82.77	82.09	45.24	8.04	13.17	12.16	12.39
			R	83.02	82.10	45.73	7.96	13.14	12.45	12.35
AZ 670	**M**	**A**	**L**	B	74.44	73.70	6.94	11.41	10.53	11.21
			R	76.19	74.84	43.94	6.91	11.65	10.31	11.22
AZ 1791	**M**	**A**	**L**	70.45	70.41	38.53	6.41	10.73	9.87	9.97
			R	70.39	70.34	38.62	6.43	10.63	10.03	9.81
AZ 2379	**M**	**A**	**L**	72.22	73.70	38.70	6.81	11.33	10.22	9.97
			R	73.35	73.61	40.46	6.81	11.05	10.06	10.15
AZ 2598	**F**	**A**	**L**	77.31	75.47	46.03	7.24	11.43	10.73	10.72
			R	76.88	75.99	46.10	7.22	11.56	10.79	10.60
AZ 2706	**F**	**A**	**L**	80.18	81.96	47.42	7.35	12.48	12.06	12.00
			R	80.16	82.16	47.51	7.27	12.63	12.34	11.73
AZ 2710	**F**	**A**	**L**	73.97	73.22	41.50	6.19	10.80	9.90	9.64
			R	M	M	M	M	M	M	M
AZ 2716	**F**	**A**	**L**	72.02	71.58	41.93	6.97	11.01	10.46	10.16
			R	72.12	71.76	41.57	6.74	12.06	11.33	10.21
AZ 2737	**F**	**A**	**L**	81.61	80.46	41.83	7.45	13.27	12.19	11.27
			R	81.62	80.44	42.17	7.55	13.33	12.43	11.63
AZ 2740	**F**	**A**	**L**	73.81	75.91	42.57	6.56	10.92	9.52	10.50
			R	73.33	75.61	42.38	6.53	11.19	10.40	10.35
AZ 2744	**F**	**A**	**L**	78.62	80.70	46.68	7.65	13.15	12.46	11.91
			R	78.79	81.49	47.51	7.67	12.86	12.51	11.47
AZ 2774	**M**	**A**	**L**	84.77	86.42	50.27	8.41	14.35	13.05	12.56
			R	85.84	85.80	50.07	8.66	14.38	12.72	12.27
TM 13509	**F**	**A**	**L**	73.82	74.28	40.56	6.58	11.35	10.39	9.79
			R	74.04	74.57	41.19	6.44	11.74	10.53	9.81
TM 11454	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	69.92	69.64	40.16	6.02	10.48	9.83	9.99
NMB 4712	**M**	**A**	**L**	72.54	72.88	39.59	6.27	11.48	10.22	10.57
			R	72.26	72.02	39.70	6.24	11.38	10.37	10.51

Humerus

Table C-13: Humerus measurements for *L. capensis*

Specimen Number	Sex	Age	SIDE	GL	GLC	Dp	SD	Bd	DmTc	CL
AZ 678	**F**	**SA**	**L**	78.70	76.68	14.58	4.36	9.12	11.84	10.19
			R	78.59	76.52	14.60	4.36	9.15	12.00	10.20
AZ 679	**F**	**A**	**L**	78.43	76.03	15.27	4.77	9.54	12.85	11.03
			R	78.24	75.66	15.07	4.75	9.41	12.75	11.00
AZ 680	**F**	**A**	**L**	80.12	78.28	14.64	4.50	9.03	11.82	11.04
			R	79.95	78.05	14.57	4.52	9.01	11.74	10.86
AZ 681	**F**	**A**	**L**	85.28	81.83	15.19	4.84	9.51	11.97	10.93
			R	85.18	82.68	15.47	5.02	9.58	12.04	10.68
AZ 684	**M**	**A**	**L**	85.64	83.13	17.28	4.62	10.74	13.58	12.41
			R	86.05	85.15	17.25	4.67	10.71	13.73	12.87
AZ 685	**M**	**A**	**L**	78.70	77.22	15.10	4.68	9.36	12.23	10.59
			R	78.52	76.88	15.07	4.69	9.31	11.97	10.62
AZ 686	**M**	**SA**	**L**	78.47	76.60	15.60	4.73	9.43	12.32	12.00
			R	78.69	76.80	15.59	4.69	9.67	12.18	11.89
AZ 2366	**F**	**SA**	**L**	78.11	75.92	15.68	4.02	9.64	12.43	11.12
			R	77.82	76.15	15.63	4.08	9.42	12.31	11.00
AZ 2367	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	78.45	76.41	14.66	4.15	8.91	11.46	10.59
AZ 2368	**F**	**A**	**L**	81.62	79.79	16.18	4.84	9.46	12.46	11.56
			R	81.28	79.29	16.40	4.70	9.50	13.03	11.52
AZ 2369	**M**	**A**	**L**	83.11	80.69	16.13	4.72	10.29	12.69	11.47
			R	M	M	M	M	M	M	M
AZ 2627	**F**	**A**	**L**	79.61	77.35	14.58	4.36	8.82	12.14	10.35
			R	79.50	76.85	14.96	4.40	8.80	11.95	10.42
AZ 2756	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	84.37	82.24	16.52	5.13	10.20	13.15	12.44
AZ 2761	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	77.93	76.09	15.62	4.75	9.12	12.36	11.59
AZ 2787	**F**	**A**	**L**	M	M	M	M	M	M	M
			R	79.45	77.49	15.36	4.86	9.13	12.34	11.25
AZ 2791	**F**	**A**	**L**	81.73	79.11	14.60	4.62	9.89	11.73	10.67
			R	81.83	79.21	14.63	4.65	9.67	11.64	10.80
AZ 2922	**F**	**A**	**L**	83.50	81.60	15.69	4.88	10.00	12.59	11.24
			R	83.38	81.67	15.92	4.76	9.88	12.78	11.20
AZ 2959	**F**	**A**	**L**	B	B	15.42	4.79	9.77	11.95	11.00
			R	M	M	M	M	M	M	M
TM 33802	**M**	**A**	**L**	73.55	71.40	14.65	4.38	9.16	11.36	10.52
			R	M	M	M	M	M	M	M
NMBF 9881	**F**	**A**	**L**	80.44	78.20	15.14	4.39	9.56	11.79	11.33
			R	80.88	78.70	15.16	4.45	9.55	11.56	11.22
NMBF 9891	**F**	**A**	**L**	76.73	74.91	15.31	4.64	9.44	12.24	11.42
			R	76.80	74.82	15.28	4.84	9.39	12.33	11.63
NMBF 9893	**F**	**A**	**L**	89.09	87.22	17.32	5.69	11.40	13.89	12.50
			R	89.00	87.00	17.27	5.40	11.38	13.80	12.66
NMBF 9901	**F**	**A**	**L**	B	B	B	B	9.09	B	B
			R	78.90	77.26	14.64	4.59	8.90	11.35	10.40
NMBF 9910	**Not indicated**	**A**	**L**	89.25	87.79	17.41	5.18	11.28	13.22	12.11
			R	89.61	87.86	17.49	5.15	11.07	13.30	12.26
NMB 4713	**M**	**A**	**L**	87.46	85.62	16.07	5.12	9.79	B	B
			R	88.04	86.01	15.89	5.15	9.28	B	B

Table C-14: Humerus measurements for *L. saxatilis*

Specimen Number	**Sex**	**Age**	**SIDE**	**GL**	**GLC**	**Dp**	**SD**	**Bd**	**DmTc**	**CL**
AZ 419	**F**	**SA**	**L**	79.64	77.05	15.53	4.54	9.76	11.97	12.17
			R	80.30	77.62	15.44	4.59	9.82	11.92	12.14
AZ 511	**M**	**SA**	**L**	76.90	41.40	13.78	4.49	8.71	11.21	10.06
			R	75.82	73.94	13.77	4.38	8.52	11.36	9.89
AZ 654	**F**	**A**	**L**	99.13	98.08	18.65	6.46	11.70	14.78	13.27
			R	100.17	99.10	18.66	6.39	11.70	15.01	13.34
AZ 655	**F**	**A**	**L**	91.74	89.22	16.62	5.89	11.51	13.29	12.41
			R	91.81	88.70	16.39	5.72	11.47	13.22	12.44
AZ 656	**F**	**A**	**L**	97.59	96.02	18.23	6.03	11.53	14.49	13.55
			R	97.28	95.69	18.37	6.08	11.49	14.50	13.39
AZ 657	**F**	**SA**	**L**	76.06	73.62	15.17	4.76	10.38	12.20	11.35
			R	76.31	73.83	15.24	4.73	10.55	11.98	11.42
AZ 658	**M**	**A**	**L**	85.49	83.37	17.08	5.54	10.62	13.87	12.72
			R	84.75	82.76	17.14	5.63	10.36	14.28	12.45
AZ 659	**M**	**SA**	**L**	81.58	79.77	16.06	4.62	10.49	12.48	12.36
			R	81.07	79.48	15.78	4.71	10.39	12.42	12.40
AZ 660	**M**	**A**	**L**	98.73	96.87	19.04	6.28	12.80	15.92	14.09
			R	98.75	96.95	18.89	6.22	12.61	15.89	14.13
AZ 670	**M**	**A**	**L**	87.84	86.70	17.27	5.52	10.87	13.76	13.26
			R	87.85	86.72	17.00	5.51	11.09	13.68	13.21
AZ 2379	**M**	**A**	**L**	86.47	84.61	15.53	4.96	10.20	12.56	12.28
			R	86.54	84.50	15.51	4.94	10.18	12.53	12.28
AZ 1791	**M**	**A**	**L**	85.81	84.02	16.13	5.06	10.32	12.46	11.75
			R	86.28	84.48	16.27	4.93	10.59	12.64	11.91
AZ 2595	**F**	**A**	**L**	88.39	86.72	16.58	5.37	10.50	12.88	12.05
			R	M	M	M	M	M	M	M
AZ 2598	**F**	**A**	**L**	M	M	M	M	M	M	M
			R	88.55	86.43	16.47	5.12	10.63	13.73	12.27
AZ 2607	**F**	**A**	**L**	96.04	93.07	19.20	5.84	12.31	15.30	13.62
			R	96.75	94.16	19.22	5.73	12.23	15.18	13.89
AZ 2716	**F**	**A**	**L**	85.35	83.36	16.33	5.12	10.44	12.77	12.03
			R	86.32	84.14	16.38	4.93	10.68	13.58	12.94
AZ 2737	**F**	**A**	**L**	96.54	94.39	18.20	5.73	11.93	14.90	13.47
			R	96.75	94.98	18.31	5.75	11.88	15.22	14.14
AZ 2740	**F**	**A**	**L**	87.39	84.76	16.84	5.88	11.16	13.20	12.19
			R	87.55	85.06	16.71	5.73	10.95	13.29	12.44
AZ 2744	**F**	**A**	**L**	97.17	95.00	18.86	6.04	12.47	15.77	14.81
			R	96.94	94.55	18.63	5.91	12.36	15.52	14.71
AZ 2774	**M**	**A**	**L**	100.78	98.07	19.57	6.50	12.81	16.26	14.87
			R	100.49	98.10	19.47	6.42	13.11	15.93	14.82
AZ 2778	**M**	**A**	**L**	88.05	86.12	17.07	5.08	11.15	14.02	12.61
			R	87.64	85.76	16.91	5.07	11.13	13.78	12.50
TM 13509	**F**	**A**	**L**	88.79	87.09	15.55	5.33	10.27	12.59	11.45
			R	88.54	56.91	15.48	5.47	10.37	12.67	11.73
TM 11451	**M**	**A**	**L**	79.19	77.35	15.20	4.93	10.38	12.10	11.49
			R	78.79	77.62	15.17	5.16	10.01	12.22	11.43
NMB 7412	**M**	**A**	**L**	B	B	16.85	B	11.36	B	B
			R	B	B	16.81	B	11.00	B	B

Radius

Table C-15: Radius measurements for *L. capensis*

Specimen Number	Sex	Age	SIDE	GL	Bp	Bd	SD	WD
AZ 678	**F**	**SA**	**L**	88.65	6.84	8.40	4.09	5.07
			R	89.37	6.88	8.19	4.07	5.11
AZ 679	**F**	**A**	**L**	9.91	6.80	7.95	3.65	5.51
			R	91.09	6.87	7.8	3.69	5.52
AZ 680	**F**	**A**	**L**	93.70	7.0	7.12	3.68	5.31
			R	92.87	6.68	7.93	3.66	5.29
AZ 681	**F**	**A**	**L**	96.67	7.18	7.25	4.09	5.19
			R	96.45	7.17	8.37	4.05	5.05
AZ 684	**M**	**A**	**L**	95.66	7.87	8.77	4.30	5.44
			R	95.68	7.89	8.71	4.38	5.45
AZ 685	**M**	**A**	**L**	89.08	7.13	8.33	3.64	5.24
			R	88.81	7.14	8.26	3.72	5.22
AZ 686	**M**	**SA**	**L**	B	7.30	B	4.14	4.92
			R	B	7.54	B	4.33	4.92
AZ 2366	**F**	**SA**	**L**	92.36	7.01	8.81	3.51	4.98
			R	B	6.97	B	3.46	4.72
AZ 2367	**M**	**A**	**L**	M	M	M	M	M
			R	97.01	7.03	8.47	4.10	5.45
AZ 2368	**F**	**A**	**L**	93.36	7.03	7.75	3.90	5.24
			R	91.99	7.05	7.52	3.79	5.10
AZ 2369	**M**	**A**	**L**	94.56	7.52	8.52	3.80	5.07
			R	91.12	7.70	8.57	3.90	5.21
AZ 2627	**F**	**A**	**L**	90.29	6.95	7.86	3.81	4.74
			R	89.68	7.06	8.07	3.83	4.81
AZ 2756	**M**	**A**	**L**	M	M	M	M	M
			R	93.61	7.71	8.89	4.16	4.97
AZ 2761	**M**	**A**	**L**	89.56	6.89	7.84	3.66	5.05
			R	89.82	6.63	7.80	3.74	5.00
AZ 2787	**F**	**A**	**L**	88.29	6.83	7.81	3.92	5.11
			R	88.32	6.88	7.70	4.09	5.15
AZ 2791	**F**	**A**	**L**	92.09	7.01	8.12	3.94	5.16
			R	92.36	7.01	8.27	3.99	5.32
AZ 2922	**F**	**A**	**L**	B	7.76	7.89	4.39	5.37
			R	96.00	7.70	7.95	4.32	5.26
AZ 2959	**F**	**A**	**L**	97.17	7.41	7.99	4.25	5.50
			R	M	M	M	M	M
TM 33802	**M**	**A**	**L**	84.98	6.89	7.36	3.53	4.59
			R	M	M	M	M	M
NMBF 9881	**F**	**A**	**L**	90.92	7.07	8.33	3.73	5.02
			R	91.06	7.00	8.22	3.72	5.10
NMBF 9891	**F**	**A**	**L**	88.26	6.94	7.61	3.57	4.82
			R	88.22	6.87	7.42	3.60	4.81
NMBF 9893	**F**	**A**	**L**	101.93	8.46	9.41	4.48	5.70
			R	101.67	8.38	9.08	4.43	5.74
NMBF 9901	**F**	**A**	**L**	91.38	6.62	7.14	3.52	5.35
			R	B	B	7.11	B	B
NMBF 9910	**Not indicated**	**A**	**L**	97.60	8.47	8.87	4.37	5.74
			R	97.66	8.46	8.59	4.30	5.83
NMB 4713	**M**	**A**	**L**	B	7.29	B	4.14	B
			R	B	7.35	B	4.24	B

Table C-16: Radius measurements for *L. saxatilis*

Specimen Number	**Sex**	**Age**	**SIDE**	**GL**	**Bp**	**Bd**	**SD**	**WD**
AZ 419	**F**	**SA**	**L**	91.75	7.36	8.86	4.81	5.12
			R	90.85	7.39	8.83	4.65	5.16
AZ 511	**M**	**SA**	**L**	87.01	6.26	6.74	3.80	5.23
			R	86.23	6.34	6.88	3.77	5.09
AZ 654	**F**	**A**	**L**	110.33	8.90	8.98	4.82	6.67
			R	110.07	8.85	9.03	4.74	6.61
AZ 655	**F**	**A**	**L**	101.04	7.90	9.09	4.88	6.10
			R	101.04	7.90	9.09	4.88	6.10
AZ 656	**F**	**A**	**L**	105.23	8.66	8.86	4.72	6.20
			R	105.16	8.68	8.75	4.67	6.31
AZ 657	**F**	**SA**	**L**	79.88	7.61	8.89	4.40	5.26
			R	B	7.58	B	4.47	5.15
AZ 658	**M**	**A**	**L**	95.49	8.02	8.80	4.78	5.66
			R	94.66	7.85	8.79	4.81	5.58
AZ 659	**M**	**SA**	**L**	88.23	7.38	B	4.51	5.47
			R	88.76	7.40	8.40	4.24	5.58
AZ 660	**M**	**A**	**L**	109.31	9.69	9.86	5.62	6.62
			R	109.20	9.71	9.91	5.72	6.65
AZ 670	**M**	**A**	**L**	B	8.11	B	4.47	5.61
			R	B	7.92	B	4.57	5.50
AZ 2379	**M**	**A**	**L**	93.89	7.72	7.94	4.30	5.52
			R	93.98	7.61	7.85	4.34	5.47
AZ 1791	**M**	**A**	**L**	95.43	7.66	8.46	4.77	5.70
			R	95.53	7.81	8.52	4.82	5.72
AZ 2595	**F**	**A**	**L**	99.13	7.95	8.80	4.58	6.04
			R	M	M	M	M	M
AZ 2598	**F**	**A**	**L**	99.82	8.18	8.14	4.95	5.64
			R	99.57	8.13	8.29	4.90	5.72
AZ 2607	**F**	**A**	**L**	103.30	8.90	10.52	4.94	6.76
			R	104.34	9.04	10.40	5.13	6.91
AZ 2716	**F**	**A**	**L**	93.53	7.70	8.87	4.59	5.41
			R	94.06	7.58	8.67	4.68	5.32
AZ 2737	**F**	**A**	**L**	M	M	M	M	M
			R	106.55	8.86	9.24	4.66	6.33
AZ 2740	**F**	**A**	**L**	99.05	8.11	9.35	4.54	6.55
			R	98.73	8.07	9.32	4.61	6.40
AZ 2744	**F**	**A**	**L**	104.69	9.01	10.40	4.69	6.12
			R	104.42	8.76	10.22	4.77	6.19
AZ 2774	**M**	**A**	**L**	106.13	9.57	10.36	5.41	6.80
			R	106.46	9.54	9.96	5.50	6.85
AZ 2778	**M**	**A**	**L**	99.19	8.01	9.62	4.33	5.59
			R	99.07	7.89	9.17	4.36	5.52
TM 13509	**F**	**A**	**L**	98.18	7.38	8.79	4.29	5.31
			R	97.64	7.36	8.80	4.39	5.36
TM 11451	**M**	**A**	**L**	92.21	7.39	8.10	4.31	5.18
			R	92.01	7.51	8.06	4.42	5.09
NMB 7412	**M**	**A**	**L**	B	8.18	B	4.55	5.92
			R	B	9.03	B	4.59	B

Ulna

Table C-17: Ulna measurements for *L. capensis*

Specimen Number	Sex	Age	SIDE	GL	DPA	SDO	BPC
AZ 678	**F**	**SA**	**L**	101.33	9.07	8.74	6.51
			R	102.31	8.95	8.97	6.53
AZ 679	**F**	**A**	**L**	104.02	9.64	9.28	6.69
			R	104.19	9.70	9.32	6.83
AZ 680	**F**	**A**	**L**	105.34	8.94	9.13	6.29
			R	104.88	8.86	9.16	6.22
AZ 681	**F**	**A**	**L**	110.07	8.74	9.40	6.84
			R	109.72	9.01	9.33	7.05
AZ 684	**M**	**A**	**L**	110.86	10.28	10.22	7.52
			R	110.81	10.24	10.22	7.58
AZ 685	**M**	**A**	**L**	101.52	9.63	9.40	6.65
			R	101.57	9.53	9.25	6.62
AZ 686	**M**	**SA**	**L**	B	9.01	8.93	6.98
			R	B	9.10	8.88	7.12
AZ 2366	**F**	**SA**	**L**	B	B	B	6.77
			R	B	9.37	9.21	6.84
AZ 2367	**M**	**A**	**L**	M	M	M	M
			R	109.65	9.11	9.21	6.48
AZ 2368	**F**	**A**	**L**	105.70	9.65	9.45	6.52
			R	105.38	9.57	9.39	6.59
AZ 2369	**M**	**A**	**L**	108.05	9.80	9.85	7.12
			R	108.41	10.07	10.29	7.12
AZ 2627	**F**	**A**	**L**	102.84	9.24	8.80	6.52
			R	103.52	9.32	8.72	6.43
AZ 2756	**M**	**A**	**L**	M	M	M	M
			R	106.80	10.14	9.65	6.73
AZ 2761	**M**	**A**	**L**	102.58	9.45	9.28	6.66
			R	102.35	9.64	9.16	6.48
AZ 2787	**F**	**A**	**L**	B	9.14	B	6.63
			R	99.33	9.11	8.95	6.63
AZ 2791	**F**	**A**	**L**	104.33	8.73	8.81	6.39
			R	104.63	8.99	8.89	6.45
AZ 2922	**F**	**A**	**L**	B	9.71	9.60	7.82
			R	107.53	9.74	9.65	7.95
AZ 2959	**F**	**A**	**L**	109.40	9.21	9.15	6.92
			R	M	M	M	M
TM 33802	**M**	**A**	**L**	96.02	8.84	8.62	6.36
			R	M	M	M	M
NMBF 9881	**F**	**A**	**L**	103.77	9.33	9.13	6.59
			R	B	B	B	6.57
NMBF 9891	**F**	**A**	**L**	99.58	9.20	8.92	6.44
			R	100.22	9.12	9.03	6.44
NMBF 9893	**F**	**A**	**L**	115.19	10.95	10.44	7.60
			R	115.53	10.73	10.41	7.52
NMBF 9901	**F**	**A**	**L**	B	8.70	8.66	6.56
			R	M	M	M	M
NMBF 9910	**Not indicated**	**A**	**L**	112.01	10.36	10.66	7.57
			R	112.27	10.43	10.63	7.68
NMB 4713	**M**	**A**	**L**	B	9.56	8.34	6.83
			R	B	9.49	8.40	6.78

Table C-18: Ulna measurements for *L. saxatilis*

Specimen Number	Sex	Age	SIDE	GL	DPA	SDO	BPC
AZ 419	**F**	**SA**	**L**	105.31	9.61	9.15	7.25
			R	105.02	9.53	9.05	7.14
AZ 511	**M**	**SA**	**L**	B	8.21	8.38	6.12
			R	B	8.16	8.17	6.35
AZ 654	**F**	**A**	**L**	127.09	11.66	11.55	7.87
			R	127.06	11.70	11.56	7.84
AZ 655	**F**	**A**	**L**	115.85	10.70	10.32	7.48
			R	116.08	10.55	10.07	7.42
AZ 656	**F**	**A**	**L**	120.46	11.73	11.07	8.02
			R	120.36	11.64	10.82	8.31
AZ 657	**F**	**SA**	**L**	93.44	9.49	9.09	7.07
			R	B	9.37	8.87	7.67
AZ 658	**M**	**A**	**L**	109.43	10.37	9.85	7.71
			R	109.02	10.34	9.73	7.65
AZ 659	**M**	**SA**	**L**	102.52	9.22	9.15	6.60
			R	102.55	8.93	9.05	6.79
AZ 660	**M**	**A**	**L**	125.38	12.13	11.78	8.47
			R	125.42	12.01	11.72	8.79
AZ 670	**M**	**A**	**L**	B	10.39	10.69	7.35
			R	B	10.59	10.60	7.47
AZ 2379	**M**	**A**	**L**	106.59	9.32	9.36	6.84
			R	107.20	9.45	9.53	6.86
AZ 1791	**M**	**A**	**L**	109.92	10.35	9.66	6.94
			R	109.44	10.42	9.84	7.17
AZ 2595	**F**	**A**	**L**	113.76	10.20	10.14	7.31
			R	M	M	M	M
AZ 2598	**F**	**A**	**L**	114.22	10.41	10.02	7.30
			R	114.23	10.32	10.04	7.30
AZ 2607	**F**	**A**	**L**	119.35	11.27	11.05	8.18
			R	120.24	11.31	11.06	8.38
AZ 2716	**F**	**A**	**L**	106.57	10.33	10.16	7.11
			R	107.34	10.14	9.97	6.90
AZ 2737	**F**	**A**	**L**	121.02	11.63	11.77	8.38
			R	120.87	11.52	11.87	8.35
AZ 2740	**F**	**A**	**L**	113.14	10.99	11.11	7.54
			R	112.55	11.55	11.19	7.43
AZ 2744	**F**	**A**	**L**	120.51	11.90	11.70	8.29
			R	120.27	11.73	11.46	8.27
AZ 2774	**M**	**A**	**L**	121.16	12.17	11.48	9.30
			R	121.25	12.08	11.86	9.64
AZ 2778	**M**	**A**	**L**	112.46	9.88	9.94	7.44
			R	112.80	10.00	9.91	7.36
TM 13509	**F**	**A**	**L**	111.57	9.56	9.80	6.75
			R	111.84	9.53	9.72	6.69
TM 11451	**M**	**A**	**L**	105.63	10.06	10.19	6.86
			R	104.80	9.68	9.84	6.93
NMB 7412	**M**	**A**	**L**	B	10.02	9.46	7.39
			R	B	10.02	9.58	7.33

Metacarpal

Table C-19: Metacarpal II measurements for *L. capensis*

Specimen Number	Sex	Age	METACARPAL	SIDE	GL	Bd	Dp	Bp
AZ 2922	**F**	**A**	**II**	**L**	28.08	3.61	4.78	3.88
				R	26.14	3.61	4.72	3.87
AZ 2959	**F**	**A**		**L**	24.38	3.41	5.03	3.75
				R	M	M	M	M
NMBF 9881	**F**	**A**		**L**	B	3.40	4.65	3.90
				R	M	M	M	M
NMBF 9891	**F**	**A**		**L**	B	3.39	4.58	3.65
				R	M	M	M	M
NMBF 9893	**F**	**A**		**L**	B	B	5.35	3.82
				R	B	B	5.14	3.61
NMBF 9901	**F**	**A**		**L**	22.13	3.17	4.29	3.66
				R	22.25	3.31	4.27	3.14
NMBF 9910	**Not indicated**	**A**		**L**	B	4.03	5.18	3.92
				R	25.22	4.07	5.24	3.95

Table C-20: Metacarpal III measurements for *L. capensis*

Specimen Number	Sex	Age	METACARPAL	SIDE	GL	Bd	Dp	Bp
AZ 2922	**F**	**A**	**III**	**L**	28.01	3.37	5.20	3.50
				R	27.99	3.44	3.38	3.13
AZ 2959	**F**	**A**		**L**	27.02	3.23	4.70	3.18
				R	M	M	M	M
NMBF 9881	**F**	**A**		**L**	26.17	3.13	4.72	3.12
				R	B	B	4.73	3.19
NMBF 9891	**F**	**A**		**L**	B	B	4.37	3.22
				R	23.05	3.08	B	B
NMBF 9893	**F**	**A**		**L**	28.23	3.97	5.28	3.64
				R	M	M	M	M
NMBF 9901	**F**	**A**		**L**	B	B	4.35	2.97
				R	24.57	2.98	4.33	2.96
NMBF 9910	**Not indicated**	**A**		**L**	27.80	3.72	5.30	3.72
				R	27.82	3.81	5.26	3.59

Table C-21: Metacarpal IV measurements for *L. capensis*

Specimen Number	Sex	Age	METACARPAL	SIDE	GL	Bd	Dp	Bp
AZ 2922	**F**	**A**	**IV**	**L**	21.93	3.36	4.09	3.19
				R	21.98	3.38	4.08	3.26
AZ 2959	**F**	**A**		**L**	20.96	3.27	4.16	3.01
				R	M	M	M	M
NMBF 9881	**F**	**A**		**L**	21.36	3.16	3.98	2.88
				R	21.33	3.20	3.98	2.83
NMBF 9891	**F**	**A**		**L**	18.69	3.12	3.80	2.88
				R	18.73	3.15	B	B
NMBF 9893	**F**	**A**		**L**	22.18	3.79	4.46	3.36
				R	M	M	M	M
NMBF 9901	**F**	**A**		**L**	19.20	3.08	3.87	2.76
				R	19.15	3.09	3.65	2.84
NMBF 9910	**Not indicated**	**A**		**L**	22.05	3.83	4.42	3.32
				R	22.22	3.83	4.52	3.37

Table C-22: Metacarpal V measurements for *L. capensis*

Specimen Number	Sex	Age	METACARPAL	SIDE	GL	Bd	Dp	Bp
AZ 2922	**F**	**A**	**V**	**L**	14.88	3.17	3.87	4.03
				R	15.04	3.13	4.01	4.09
AZ 2959	**F**	**A**		**L**	14.14	3.13	3.70	3.93
				R	M	M	M	M
NMBF 9881	**F**	**A**		**L**	15.04	3.14	3.42	3.74
				R	15.19	3.18	3.38	3.72
NMBF 9891	**F**	**A**		**L**	12.44	2.99	3.09	3.43
				R	13.06	3.06	B	B
NMBF 9893	**F**	**A**		**L**	15.25	3.52	4.28	4.00
				R	M	M	M	M
NMBF 9901	**F**	**A**		**L**	M	M	M	M
				R	13.13	3.01	3.24	3.51
NMBF 9910	**Not indicated**	**A**		**L**	15.75	3.63	4.02	4.04
				R	15.70	3.55	4.06	3.52

Table C-23: Metacarpal I measurements for *L. saxatilis*[1]

Specimen Number	Sex	Age	METACARPAL	SIDE	GL	Bd	Dp	Bp
AZ 419	**F**	**SA**	**I**	**L**	8.79	3.52	3.53	3.21
				R	M	M	M	M

Table C-24: Metacarpal II measurements for *L. saxatilis*

Specimen Number	Sex	Age	METACARPAL	SIDE	GL	Bd	Dp	Bp
AZ 419	**F**	**SA**	**II**	**L**	26.54	3.93	4.91	4.13
				R	26.39	3.82	4.84	4.12
AZ 511	**M**	**SA**		**L**	21.50	3.05	4.58	3.34
				R	21.73	2.99	4.34	3.47

Table C-25: Metacarpal III measurements for *L. saxatilis*

Specimen Number	Sex	Age	METACARPAL	SIDE	GL	Bd	Dp	Bp
AZ 419	**F**	**SA**	**III**	**L**	28.85	3.75	5.16	3.58
				R	28.89	3.64	5.11	3.52
AZ 511	**M**	**SA**		**L**	23.82	2.93	4.23	2.94
				R	23.72	2.78	4.16	2.98

Table C-26: Metacarpal IV measurements for *L. saxatilis*

Specimen Number	Sex	Age	METACARPAL	SIDE	GL	Bd	Dp	Bp
AZ 419	**F**	**SA**	**IV**	**L**	23.34	3.62	4.52	3.07
				R	23.48	3.65	4.53	3.04
AZ 511	**M**	**SA**		**L**	19.24	2.91	3.67	2.81
				R	19.31	2.88	3.61	2.77

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[1] *L. capensis* metacarpal I were not available for examination

Table C-27: Metacarpal V measurements for *L. saxatilis*

Specimen Number	Sex	Age	METACARPAL	SIDE	GL	Bd	Dp	Bp
AZ 419	**F**	**SA**	**V**	**L**	16.55	3.26	3.85	3.73
				R	16.77	3.27	3.98	3.99
AZ 511	**M**	**SA**		**L**	13.06	2.79	3.14	3.54
				R	13.26	2.83	3.09	3.32

Sacrum

Table C-30: Sacrum measurements for *L. capensis*

Specimen number	**Sex**	**Age**	**GL**	**PL**	**GB**	**BFcr**	**HFcr**
AZ 678	**F**	**SA**	B	B	29.47	B	B
AZ 679	**F**	**A**	39.97	35.79	35.96	14.56	4.72
AZ 680	**F**	**A**	B	B	31.76	B	B
AZ 681	**F**	**A**	B	B	33.53	B	B
AZ 684	**F**	**A**	41.51	39.77	B	12.41	6.80
AZ 685	**M**	**A**	39.43	36.12	31.02	12.31	4.82
AZ 686	**M**	**SA**	30.85	26.73	28.90	13.04	5.06
AZ 2922	**F**	**A**	42.95	38.53	35.44	13.40	4.58
AZ 2959	**F**	**A**	43.25	39.53	35.04	13.30	4.80
NMBF 9881	**F**	**A**	40.38	35.75	32.10	12.92	4.77
NMBF 9891	**F**	**A**	40.30	35.17	29.08	11.87	4.84
NMBF 9893	**F**	**A**	47.50	42.91	36.76	12.76	5.91
NMBF 9901	**F**	**A**	41.00	35.25	26.81	11.06	4.24
NMBF 9910	**Not indicated**	**A**	46.34	42.88	32.96	13.81	5.73
NMB 4713	**M**	**A**	40.39	34.43	34.35	B	B

Table C-31: Sacrum measurements for *L. saxatilis*

Specimen Number	**Sex**	**Age**	**GL**	**PL**	**GB**	**BFcr**	**HFcr**
AZ 673	**F**	**A**	44.91	40.17	37.40	14.41	6.22
AZ 511	**M**	**SA**	37.49	33.68	24.74	11.57	4.05
AZ 654	**F**	**A**	50.78	48.36	43.76	15.02	6.91
AZ 655	**F**	**A**	49.06	43.57	37.20	13.3	5.99
AZ 656	**F**	**A**	49.54	42.10	38.17	B	B
AZ 657	**F**	**SA**	B	B	25.08	B	B
AZ 658	**M**	**A**	46.26	41.23	32.71	14.14	6.01
AZ 659	**M**	**SA**	B	35.59	B	B	B
AZ 660	**M**	**A**	58.03	53.06	36.13	15.52	6.79
AZ 670	**M**	**A**	36.18	31.23	30.85	12.79	5.63
AZ 1791	**M**	**A**	40.12	37.00	30.09	B	B
AZ 2598	**F**	**A**	46.03	41.83	35.18	14.75	5.47
AZ 2737	**F**	**A**	48.76	44.72	42.19	14.82	6.25
AZ 2706	**F**	**A**	49.79	44.30	40.69	14.33	6.42
AZ 2778	**M**	**A**	48.77	40.64	31.09	13.69	5.39
TM 41151	**M**	**A**	42.02	37.11	28.36	13.46	B
NMB 4712	**M**	**A**	44.37	39.22	29.06	11.70	5.92

Pelvis

Table C-28: Pelvis measurements for *L. capensis*

Specimen Number	**Sex**	**Age**	**SIDE**	**GL**	**LAR**	**SH**	**SB**	**Lfo**	**LAIIL**	**GBTc**	**GBA**	**GBTi**	**SBI**
AZ 678	**F**	**SA**	**L**	72.63	8.97	8.28	5.28	15.66	9.19	I	I	I	I
			R	72.80	9.07	8.32	5.30	15.53	9.16	I	I	I	I
AZ 679	**F**	**A**	**L**	78.97	9.33	9.00	5.15	17.38	9.58	I	I	I	I
			R	79.25	9.52	9.06	4.98	17.26	9.58	I	I	I	I
AZ 680	**F**	**A**	**L**	79.69	8.93	8.56	5.41	17.13	9.27	I	I	I	I
			R	79.55	9.23	8.72	5.62	16.83	9.28	I	I	I	I
AZ 681	**F**	**A**	**L**	81.24	9.20	9.16	5.82	16.66	10.02	I	I	I	I
			R	79.28	9.35	9.24	5.93	16.76	9.92	I	I	I	I
AZ 684	**M**	**A**	**L**	B	10.04	8.56	5.52	B	9.81	I	I	I	I
			R	B	10.01	8.92	5.23	B	10.05	I	I	I	I
AZ 685	**M**	**A**	**L**	76.71	9.23	7.97	4.85	16.39	8.85	I	I	I	I
			R	76.52	9.10	7.77	4.90	16.07	8.78	51.35	41.39	41.14	31.09
AZ 686	**M**	**SA**	**L**	B	9.39	8.26	5.15	16.74	8.95	I	I	I	I
			R	B	9.16	8.15	5.19	16.69	9.01	51.10	41.40	41.04	31.17
AZ 2366	**F**	**SA**	**L**	72.12	9.28	8.11	5.11	15.39	9.40	I	I	I	I
			R	72.35	9.29	7.93	4.97	15.48	9.35	I	I	I	I
AZ 2367	**M**	**A**	**L**	76.83	8.53	7.59	4.59	15.66	9.07	I	I	I	I
			R	76.77	8.55	7.80	4.61	15.56	9.11	I	I	I	I
AZ 2368	**F**	**A**	**L**	80.99	8.78	9.68	5.18	14.67	9.14	I	I	I	I
			R	81.28	8.67	9.45	5.13	14.86	9.25	55.22	48.79	50.83	40.03
AZ 2369	**M**	**A**	**L**	80.42	9.65	8.82	5.20	16.50	9.19	I	I	I	I
			R	80.89	9.47	8.72	5.35	B	9.47	I	I	I	I
AZ 2627	**F**	**A**	**L**	79.10	9.16	7.95	5.17	16.71	9.24	I	I	I	I
			R	80.11	8.82	8.09	5.20	16.63	9.28	I	I	I	I
AZ 2756	**M**	**A**	**L**	82.97	9.94	9.31	6.11	17.37	10.21	I	I	I	I
			R	82.74	9.78	9.30	6.00	17.18	10.15	I	I	I	I
AZ 2761	**M**	**A**	**L**	73.94	9.03	8.06	5.26	15.18	9.22	I	I	I	I
			R	75.78	876.	8.12	5.17	15.14	9.34	I	I	I	I
AZ 2787	**F**	**A**	**L**	78.28	9.03	8.30	5.23	16.33	9.57	I	I	I	I
			R	78.71	9.01	8.44	5.27	16.25	9.44	I	I	I	I
AZ 2791	**F**	**A**	**L**	79.61	8.70	8.35	4.59	17.55	8.58	I	I	I	I
			R	79.25	8.91	8.40	4.61	17.69	8.72	I	I	I	I

AZ 2922	**F**	**A**	**L**	82.91	9.17	9.41	5.65	15.16	9.53	I	I	I	I
			R	82.84	9.17	9.51	5.97	15.18	9.55	I	I	I	I
AZ 2959	**F**	**A**	**L**	72.12	9.97	8.95	5.84	15.82	10.23	I	I	I	I
			R	76.32	9.86	8.81	6.04	15.39	10.10	I	I	I	I
NMBF 9881	**F**	**A**	**L**	76.65	9.24	8.06	4.62	16.00	9.54	I	I	I	I
			R	76.88	9.33	8.12	4.81	15.88	9.33	I	I	I	I
NMBF 9891	**F**	**A**	**L**	72.43	8.87	7.91	5.05	16.02	9.17	I	I	I	I
			R	73.33	9.22	8.01	5.11	15.62	8.98	I	I	I	I
NMBF 9893	**F**	**A**	**L**	91.69	10.02	9.38	5.59	18.20	10.22	I	I	I	I
			R	90.86	10.00	9.42	5.61	18.43	10.33	I	I	I	I
NMBF 9901	**F**	**A**	**L**	74.52	8.37	7.62	4.44	15.77	8.54	I	I	I	I
			R	74.83	8.46	7.60	4.68	15.79	8.59	46.73	42.35	41.08	31.98
NMBF 9910	**Not indicated**	**A**	**L**	89.95	9.96	8.92	5.65	17.98	10.24	I	I	I	I
			R	89.38	10.24	9.10	5.70	18.36	10.58	I	I	I	I
NMB 4713	**M**	**A**	**L**	81.18	9.24	7.88	5.35	17.16	B	I	I	I	I
			R	80.69	9.37	7.86	5.43	17.51	B	57.97	45.54	47.17	35.47

Table C-29: Pelvis measurements for *L. saxatilis*

Specimen Number	Sex	Age	SIDE	GL	LAR	SH	SB	Lfo	LAIIL	GBTc	GBA	GBTi	SBI
AZ 419	**F**	**SA**	**L**	79.10	10.16	7.63	5.03	16.89	9.89	I	I	I	I
			R	79.15	9.97	8.12	5.21	17.03	9.91	I	I	I	I
AZ 511	**M**	**SA**	**L**	71.72	8.94	7.97	5.08	14.88	8.78	I	I	I	I
			R	71.49	8.69	7.98	4.95	14.73	8.67	I	I	I	I
AZ 654	**F**	**A**	**L**	99.57	11.13	9.94	6.60	20.52	11.04	I	I	I	I
			R	100.00	11.05	10.30	6.75	20.00	10.98	I	I	I	I
AZ 655	**F**	**A**	**L**	92.11	10.74	9.86	6.43	16.54	10.84	I	I	I	I
			R	81.72	10.83	10.12	6.66	16.57	10.96	I	I	I	I
AZ 656	**F**	**A**	**L**	91.71	10.79	10.54	5.93	19.60	11.88	I	I	I	I
			R	100.78	10.82	10.43	6.07	19.44	11.71	I	I	I	I
AZ 657	**F**	**SA**	**L**	73.31	9.48	7.65	5.66	15.18	9.92	I	I	I	I
			R	73.44	9.41	7.64	5.72	14.90	10.11	I	I	I	I
AZ 658	**M**	**A**	**L**	89.37	10.79	9.82	5.98	17.12	10.88	I	I	I	I
			R	88.28	10.81	9.73	6.06	17.55	10.92	I	I	I	I
AZ 659	**M**	**SA**	**L**	79.70	9.41	7.96	5.78	15.77	9.57	I	I	I	I
			R	80.13	9.39	8.10	5.85	16.04	9.60	I	I	I	I
AZ 660	**M**	**A**	**L**	98.29	12.68	10.20	6.70	20.11	12.79	I	I	I	I
			R	98.37	12.79	10.24	6.71	20.27	12.80	I	I	I	I
AZ 670	**M**	**A**	**L**	88.69	10.63	9.54	5.59	18.46	11.26	I	I	I	I
			R	89.19	10.74	9.62	5.72	18.57	11.11	I	I	I	I
AZ 2379	**M**	**A**	**L**	87.43	8.88	9.03	5.01	18.11	10.23	I	I	I	I
			R	86.72	8.82	9.08	5.11	18.05	10.25	I	I	I	I
AZ 1791	**M**	**A**	**L**	87.93	10.31	9.16	5.30	18.90	9.84	I	I	I	I
			R	87.48	9.93	9.00	5.58	18.95	9.97	54.20	44.55	43.91	34.65
AZ 2595	**F**	**A**	**L**	91.69	10.15	9.38	5.79	16.66	10.69	I	I	I	I
			R	91.09	10.14	9.20	5.99	16.59	10.63	I	I	I	I
AZ 2598	**F**	**A**	**L**	88.50	9.98	9.35	5.45	19.32	10.45	I	I	I	I

			R	88.81	9.99	9.45	5.43	18.98	10.32	I	I	I	I
AZ 2607	**F**	**A**	**L**	96.93	10.81	9.85	6.19	19.32	11.17	I	I	I	I
			R	96.95	10.67	9.86	6.08	19.46	11.06	65.39	58.33	59.03	46.53
AZ 2716	**F**	**A**	**L**	85.25	9.25	8.58	5.85	17.38	9.83	I	I	I	I
			R	86.70	9.56	8.73	5.85	17.46	9.97	I	I	I	I
AZ 2737	**F**	**A**	**L**	95.80	10.53	10.06	6.45	19.47	11.59	I	I	I	I
			R	96.27	11.04	9.53	6.71	19.18	11.75	66.18	58.84	52.63	43.07
AZ 2740	**F**	**A**	**L**	92.31	10.13	9.10	5.28	18.39	9.89	I	I	I	I
			R	92.07	9.71	9.06	5.22	18.34	9.95	I	I	I	I
AZ 2744	**F**	**A**	**L**	100.22	10.90	10.49	6.60	18.95	11.56	I	I	I	I
			R	99.49	11.44	10.47	6.60	18.95	11.56	I	I	I	I
AZ 2774	**M**	**A**	**L**	102.33	11.60	10.85	7.33	21.66	11.85	I	I	I	I
			R	102.18	11.62	10.89	7.15	21.25	11.75	63.45	54.29	55.56	43.16
AZ 2778	**M**	**A**	**L**	88.53	9.68	8.43	5.49	17.76	10.18	I	I	I	I
			R	89.05	9.87	8.41	5.47	17.81	10.39	50.90	46.53	50.38	36.77
TM 13509	**F**	**A**	**L**	89.23	9.26	8.70	5.59	17.74	9.45	I	I	I	I
			R	89.88	9.35	8.98	5.54	17.35	9.50	59.31	49.86	44.61	37.55
TM 11451	**M**	**A**	**L**	82.59	8.79	8.35	5.23	15.60	9.46	I	I	I	I
			R	82.17	9.80	8.31	5.13	15.54	9.56	48.55	40.89	42.56	33.13
NMB 7412	**M**	**A**	**L**	89.23	10.12	8.62	5.72	17.50	B	I	I	I	I
			R	88.68	10.13	8.64	5.89	17.40	B	58.24	47.37	46.65	36.23

Femur

Table C-32: Femur measurements for *L. capensis*

Specimen Number	Sex	Age	SIDE	GL	GLC	Bp	BTr	DC	SD	Bd	CB	CONM	CONL
AZ 678	**F**	**SA**	**L**	99.98	94.60	19.37	16.19	7.58	7.59	14.92	8.42	14.77	13.94
			R	99.74	94.53	19.21	B	8.02	7.70	14.76	8.44	14.88	13.82
AZ 679	**F**	**A**	**L**	100.03	93.75	19.92	20.06	8.07	7.63	15.26	9.07	15.55	14.26
			R	100.77	93.71	20.06	19.87	8.02	7.58	15.81	8.99	15.48	14.24
AZ 680	**F**	**A**	**L**	101.50	95.30	20.17	19.45	8.33	7.85	15.15	8.73	15.77	14.43
			R	101.67	94.82	19.78	19.23	8.08	7.83	15.12	8.77	15.73	14.50
AZ 681	**F**	**A**	**L**	108.72	102.18	18.94	19.24	8.25	7.98	15.42	8.81	15.17	14.35
			R	108.91	102.15	18.93	19.75	8.23	7.88	15.33	8.85	15.15	14.43
AZ 684	**M**	**A**	**L**	107.29	101.05	21.13	19.93	8.55	8.01	17.72	9.71	17.44	16.59
			R	107.13	101.27	21.42	19.83	8.56	7.93	17.66	9.67	17.68	16.48
AZ 685	**M**	**A**	**L**	B	93.37	20.54	18.81	7.38	7.80	15.05	8.47	14.74	13.96
			R	99.09	93.21	20.86	19.20	7.48	7.72	15.09	8.49	15.22	13.93
AZ 686	**M**	**SA**	**L**	98.81	95.10	19.50	18.97	7.83	7.86	15.24	8.57	15.58	14.58
			R	98.70	94.66	19.80	19.17	7.54	7.53	15.59	8.54	15.48	14.42
AZ 2366	**F**	**SA**	**L**	B	94.57	19.21	18.40	8.36	7.00	15.44	8.75	18.93	15.06
			R	100.18	94.88	19.59	18.51	8.30	7.04	15.00	8.65	15.98	14.90
AZ 2367	**M**	**A**	**L**	98.59	93.33	19.11	B	7.95	7.03	14.53	8.56	14.63	13.54
			R	98.95	93.91	19.54	B	7.77	7.04	14.39	8.69	14.39	13.59
AZ 2368	**F**	**A**	**L**	M	M	M	M	M	M	M	M	M	M
			R	102.03	97.18	20.50	18.88	8.12	8.11	15.68	8.81	15.33	14.66
AZ 2369	**M**	**A**	**L**	103.03	97.99	21.00	20.03	8.17	7.54	17.13	9.15	16.56	14.90
			R	102.63	91.34	20.63	20.56	8.28	7.61	17.26	9.20	16.40	15.07
AZ 2627	**F**	**A**	**L**	98.25	93.84	20.79	19.13	7.90	7.76	15.35	8.76	14.45	14.56
			R	98.37	94.41	20.37	19.10	7.78	7.84	15.43	8.70	14.82	14.38
AZ 2756	**M**	**A**	**L**	105.87	100.41	20.64	20.54	8.84	8.22	15.90	9.58	15.87	15.40
			R	105.87	100.34	20.89	19.91	8.82	8.14	16.12	9.38	16.24	15.37
AZ 2761	**M**	**A**	**L**	M	M	M	M	M	M	M	M	M	M
			R	97.44	91.88	19.88	18.72	8.30	7.13	15.05	8.95	14.86	13.58
AZ 2787	**F**	**A**	**L**	M	M	M	M	M	M	M	M	M	M
			R	101.87	97.20	20.77	19.83	8.02	7.95	15.46	8.88	14.48	14.08
AZ 2791	**F**	**A**	**L**	100.51	95.53	19.56	18.38	7.60	7.71	14.90	8.23	15.85	14.10
			R	M	M	M	M	M	M	M	M	M	M
AZ 2922	**F**	**A**	**L**	103.13	98.56	20.68	20.55	8.17	7.88	15.56	8.59	16.31	15.12
			R	103.51	95.30	20.63	20.76	7.97	7.70	15.57	8.50	16.38	15.08
AZ 2959	**F**	**A**	**L**	102.79	97.17	20.55	20.15	8.79	7.37	14.98	9.28	15.71	15.30
			R	M	M	M	M	M	M	M	M	M	M
TM 33802	**M**	**A**	**L**	92.45	86.40	17.80	17.21	7.39	6.89	13.61	7.94	14.03	13.03
			R	M	M	M	M	M	M	M	M	M	M
NMBF 9881	**F**	**A**	**L**	99.95	95.01	20.15	18.93	7.92	7.47	15.05	8.63	16.17	15.72
			R	100.18	94.75	19.94	19.31	7.98	7.28	15.02	8.52	16.18	15.32
NMBF 9891	**F**	**A**	**L**	96.36	91.38	20.10	19.21	7.93	7.42	15.30	8.39	16.49	15.33
			R	96.70	91.86	20.12	18.91	8.01	7.36	15.33	8.58	16.56	15.42

NMBF 9893	**F**	**A**	**L**	112.06	105.29	23.19	22.54	8.72	8.50	17.58	10.19	17.76	16.88
			R	112.38	106.09	22.68	22.40	8.73	8.15	17.23	10.08	17.70	16.56
NMBF 9901	**F**	**A**	**L**	99.09	93.61	17.72	18.84	7.28	7.29	14.27	7.85	14.34	13.49
			R	99.17	94.18	17.52	19.11	7.49	7.49	14.32	7.74	14.34	13.33
NMBF 9910	**Not indicated**	**A**	**L**	99.09	107.11	22.08	21.58	8.73	8.52	17.60	9.80	17.64	16.88
			R	112.08	107.30	22.61	22.32	8.87	8.52	17.78	9.85	17.75	16.90
NMB 4713	**M**	**A**	**L**	108.47	102.32	20.58	19.42	7.95	7.48	15.49	B	B	B
			R	107.68	102.17	21.06	19.65	8.04	7.19	15.59	B	B	B

Table C-33: Femur measurements for *L. saxatilis*

Specimen Number	Sex	Age	SIDE	GL	GLC	Bp	BTr	DC	SD	Bd	CB	CONM	CONL
AZ 419	**F**	**SA**	**L**	103.00	96.89	18.61	17.45	8.31	7.24	16.02	9.13	15.80	15.46
			R	103.11	97.23	19.14	17.61	8.20	7.29	15.96	9.21	15.89	15.64
AZ 511	**M**	**SA**	**L**	94.37	90.48	17.29	16.76	7.21	7.39	14.62	8.11	14.30	13.57
			R	95.00	91.17	17.36	16.54	7.22	7.52	14.58	8.02	14.46	13.65
AZ 654	**F**	**A**	**L**	130.32	124.24	23.60	22.29	9.41	8.84	19.07	10.96	18.83	18.37
			R	B	122.65	24.78	23.36	9.69	9.24	19.43	10.92	19.29	18.32
AZ 655	**F**	**A**	**L**	113.38	107.20	22.64	21.39	9.25	9.23	18.28	10.24	17.30	16.62
			R	113.63	107.92	22.66	21.38	9.30	9.16	18.22	10.65	17.32	16.45
AZ 656	**F**	**A**	**L**	117.75	111.58	23.70	22.38	9.43	9.12	18.23	11.10	19.06	17.81
			R	118.05	112.19	23.55	21.90	9.46	9.11	18.11	11.08	18.76	18.06
AZ 657	**F**	**SA**	**L**	95.49	91.47	18.99	15.44	8.29	7.03	16.55	8.72	16.23	15.92
			R	95.43	91.49	19.04	15.96	8.32	7.02	16.37	8.70	16.46	B
AZ 658	**M**	**A**	**L**	108.41	102.50	22.67	21.00	9.23	9.26	17.57	10.61	16.66	16.48
			R	108.25	102.83	22.90	20.71	9.31	9.27	17.62	10.63	16.57	16.35
AZ 659	**M**	**SA**	**L**	101.04	96.36	19.31	18.18	8.11	8.36	16.65	8.50	16.49	15.50
			R	101.22	96.20	19.23	17.84	8.09	8.35	16.57	8.81	16.87	15.42
AZ 660	**M**	**A**	**L**	128.97	121.74	24.20	21.68	10.68	8.89	21.18	12.43	20.43	19.85
			R	129.15	122.09	23.62	21.18	10.77	8.98	21.13	12.28	20.89	19.98
AZ 670	**M**	**A**	**L**	110.40	104.34	22.18	19.95	9.19	8.91	17.34	10.48	17.76	16.94
			R	B	104.64	22.56	20.59	8.16	8.94	17.36	10.47	17.80	17.01
AZ 2379	**M**	**A**	**L**	B	B	20.76	19.08	8.24	8.50	16.79	9.71	17.05	16.92
			R	B	B	20.53	18.69	8.22	8.13	16.43	9.66	16.96	16.95
AZ 1791	**M**	**A**	**L**	113.48	107.03	21.24	19.87	8.90	8.55	17.47	9.15	16.28	15.47
			R	112.53	106.54	21.29	19.44	8.72	8.05	16.92	9.23	16.19	15.36
AZ 2595	**F**	**A**	**L**	115.99	109.95	20.84	20.44	9.02	8.68	17.60	10.01	17.83	17.44
			R	115.12	109.45	21.07	20.03	9.10	8.73	17.35	9.99	17.99	17.51
AZ 2598	**F**	**A**	**L**	111.42	106.53	21.77	20.45	8.64	8.44	17.02	10.00	17.41	16.47
			R	111.86	106.87	21.49	20.24	8.63	8.21	17.13	9.77	17.24	16.62
AZ 2607	**F**	**A**	**L**	119.76	112.52	24.40	21.98	9.50	9.46	20.24	10.95	19.24	18.30
			R	119.14	112.46	24.52	22.18	9.36	9.45	20.19	10.60	19.29	18.55
AZ 2716	**F**	**A**	**L**	109.49	103.50	20.63	19.37	8.34	8.34	16.93	9.53	16.96	16.00
			R	109.44	103.62	30.93	19.35	8.38	8.27	17.08	9.48	17.03	16.15
AZ 2737	**F**	**A**	**L**	121.31	114.30	23.86	22.58	9.71	9.14	18.31	10.77	19.72	18.56
			R	121.76	115.24	23.14	22.23	9.61	8.86	22.03	10.44	19.73	18.22
AZ 2740	**F**	**A**	**L**	M	M	M	M	M	M	M	M	M	M
			R	109.32	102.27	21.66	20.17	8.52	8.66	17.43	9.35	18.11	17.33
AZ 2744	**F**	**A**	**L**	124.71	118.62	24.83	21.43	9.94	8.31	20.24	11.04	19.80	19.17
			R	124.10	118.10	24.98	21.76	9.92	8.32	20.19	10.96	19.62	19.13
AZ 2774	**M**	**A**	**L**	M	M	M	M	M	M	M	M	M	M
			R	127.51	120.81	26.93	24.07	10.50	9.40	21.13	11.91	20.41	18.80
AZ 2778	**M**	**A**	**L**	M	M	M	M	M	M	M	M	M	M
			R	108.53	103.71	22.72	21.02	8.85	7.76	17.36	10.28	17.28	B
TM 13509	**F**	**A**	**L**	112.02	104.90	20.77	19.56	8.18	8.41	16.74	9.14	16.35	15.42
			R	111.63	105.09	20.77	19.56	8.18	8.46	16.67	9.10	16.42	15.66
TM 11451	**M**	**A**	**L**	B	B	20.49	19.02	7.91	B	15.71	8.97	15.53	15.01
			R	103.13	97.78	20.40	19.43	8.31	8.62	16.10	9.14	15.65	15.05
NMB 7412	**M**	**A**	**L**	111.80	106.07	21.94	20.36	8.63	8.51	16.89	B	B	B
			R	112.00	106.50	22.12	20.28	8.64	8.58	16.95	B	B	B

Tibia

Table C-36: Tibia measurements for *L. capensis*

Specimen Number	Sex	Age	SIDE	GL	Bp	SD	Bd	Dd	DP	DDL
AZ 678	**F**	**SA**	**L**	113.81	14.97	5.96	11.98	8.18	15.88	5.56
			R	114.32	15.42	6.07	12.16	8.25	15.97	5.77
AZ 679	**F**	**A**	**L**	116.41	15.35	5.88	13.72	8.08	16.48	5.83
			R	117.01	16.03	5.74	13.48	8.20	16.99	5.88
AZ 680	**F**	**A**	**L**	115.88	15.26	8.72	11.34	7.56	16.66	5.30
			R	115.39	15.12	5.54	11.20	7.55	16.58	5.56
AZ 681	**F**	**A**	**L**	121.18	15.72	6.19	12.81	8.21	17.61	6.19
			R	122.09	15.84	6.05	12.57	8.23	17.63	5.84
AZ 684	**M**	**A**	**L**	127.00	18.18	6.53	14.04	8.35	18.63	6.71
			R	127.83	18.06	6.65	14.05	8.38	18.75	6.78
AZ 685	**M**	**A**	**L**	B	15.51	5.90	12.14	7.66	16.53	6.16
			R	113.43	15.40	6.03	11.86	7.57	16.51	5.86
AZ 686	**M**	**SA**	**L**	110.58	16.06	5.92	12.26	7.38	16.77	5.72
			R	110.74	15.92	5.95	12.29	7.37	16.74	5.68
AZ 2366	**F**	**SA**	**L**	M	M	M	M	M	M	M
			R	114.38	16.03	5.67	12.44	8.12	17.53	5.61
AZ 2367	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	114.80	14.77	5.58	11.26	7.28	15.86	5.60
AZ 2368	**F**	**A**	**L**	118.27	16.16	6.23	12.18	7.64	17.31	6.13
			R	119.02	16.80	6.92	11.75	7.64	17.52	6.02
AZ 2369	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	117.59	16.99	6.40	13.41	8.28	17.96	6.49
AZ 2627	**F**	**A**	**L**	116.07	15.22	5.79	12.35	7.34	16.07	6.04
			R	116.69	15.21	5.63	12.53	7.25	16.06	5.83
AZ 2756	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	119.13	16.31	6.69	13.38	8.27	18.09	6.09
AZ 2761	**M**	**A**	**L**	114.09	15.29	6.18	11.83	7.36	17.05	5.84
			R	113.60	15.28	6.11	11.90	7.41	16.64	5.91
AZ 2787	**F**	**A**	**L**	115.83	15.79	5.98	11.89	7.45	16.40	5.84
			R	116.05	15.40	5.83	11.51	7.65	15.84	5.65
AZ 2791	**F**	**A**	**L**	115.59	15.39	6.51	12.23	7.68	16.90	5.95
			R	115.95	15.22	6.30	12.74	7.77	16.38	5.96
AZ 2922	**F**	**A**	**L**	116.40	16.14	6.72	13.07	7.62	17.10	5.79
			R	116.57	16.18	6.74	13.10	7.84	17.17	5.65
AZ 2959	**F**	**A**	**L**	118.66	15.49	6.26	12.24	7.64	16.80	5.75
			R	M	M	M	M	M	M	M
TM 33802	**M**	**A**	**L**	109.11	13.81	5.56	11.39	6.65	15.20	5.11
			R	M	M	M	M	M	M	M
NMBF 9881	**F**	**A**	**L**	113.45	15.73	5.83	12.64	7.59	16.57	6.03
			R	113.35	15.75	5.88	12.74	7.63	16.70	6.16
NMBF 9891	**F**	**A**	**L**	109.56	15.30	5.98	12.04	7.31	16.48	6.20
			R	109.74	15.42	5.85	12.00	7.45	16.13	6.30
NMBF 9893	**F**	**A**	**L**	129.70	17.63	7.21	14.25	8.83	18.48	6.87
			R	129.58	17.68	6.98	14.21	8.90	18.26	6.78
NMBF 9901	**F**	**A**	**L**	112.34	14.24	6.22	11.07	7.15	16.25	5.76
			R	112.30	14.47	6.15	11.28	7.41	16.32	5.88
NMBF 9910	**Not indicated**	**A**	**L**	128.29	17.72	6.68	14.75	9.04	18.34	7.02
			R	128.88	17.73	7.08	14.69	9.54	18.06	7.00
NMB 4713	**M**	**A**	**L**	B	15.58	B	B	B	B	B
			R	B	15.53	B	B	B	B	B

Table C-37: Tibia measurements for *L. saxatilis*

Specimen Number	Sex	Age	SIDE	GL	Bp	SD	Bd	Dd	DP	DDL
AZ 419	**F**	**SA**	**L**	117.53	16.63	6.16	13.06	7.91	16.91	6.20
			R	117.05	16.82	6.13	13.28	8.09	16.82	6.11
AZ 511	**M**	**SA**	**L**	108.40	14.27	5.28	11.46	6.85	15.11	5.74
			R	108.42	14.38	5.39	11.41	6.88	15.09	5.71
AZ 654	**F**	**A**	**L**	145.07	20.00	7.69	15.08	9.62	19.91	7.55
			R	146.22	20.07	7.93	15.14	9.66	20.01	7.40
AZ 655	**F**	**A**	**L**	133.62	18.76	7.18	14.32	8.87	19.34	6.77
			R	133.79	18.69	7.08	14.53	9.16	19.18	6.68
AZ 656	**F**	**A**	**L**	136.78	18.97	7.43	14.74	9.12	19.73	6.93
			R	136.98	19.19	7.48	14.86	9.09	19.90	6.85
AZ 657	**F**	**SA**	**L**	108.61	16.96	5.85	12.69	8.73	17.02	6.40
			R	108.64	17.02	5.87	12.76	9.00	17.17	6.24
AZ 658	**M**	**A**	**L**	125.40	18.01	7.17	14.24	8.50	19.59	6.65
			R	125.19	18.04	7.11	14.22	9.00	18.47	6.90
AZ 659	**M**	**SA**	**L**	117.84	17.27	6.66	13.18	8.03	18.17	6.44
			R	117.50	17.13	6.55	13.39	7.93	18.00	6.47
AZ 660	**M**	**A**	**L**	146.41	21.20	8.13	16.76	9.76	21.40	8.08
			R	146.35	21.38	8.16	16.72	9.85	21.55	8.26
AZ 670	**M**	**A**	**L**	129.03	17.87	6.70	14.58	9.08	18.84	6.78
			R	128.80	18.01	6.67	13.96	8.72	18.96	6.76
AZ 2379	**M**	**A**	**L**	124.35	16.54	6.90	13.03	7.64	19.28	6.35
			R	124.34	16.66	6.21	12.94	7.87	19.04	6.28
AZ 1791	**M**	**A**	**L**	127.66	18.51	6.42	14.09	8.82	17.14	5.93
			R	126.76	18.48	6.32	14.18	8.74	17.05	5.80
AZ 2595	**F**	**A**	**L**	133.03	17.87	7.29	14.55	9.09	19.37	6.89
			R	133.02	17.93	7.26	14.37	9.10	19.11	6.78
AZ 2598	**F**	**A**	**L**	130.64	17.65	6.58	13.95	8.60	17.66	6.50
			R	131.29	17.88	6.54	13.73	8.58	17.62	6.50
AZ 2607	**F**	**A**	**L**	138.88	20.59	7.23	15.44	9.62	21.31	6.93
			R	138.72	20.40	7.18	14.29	9.61	21.40	6.83
AZ 2716	**F**	**A**	**L**	125.50	17.57	6.31	13.80	8.77	18.40	6.70
			R	126.19	17.58	6.47	14.30	9.91	18.56	6.87
AZ 2737	**F**	**A**	**L**	139.43	19.00	7.80	15.44	9.59	20.79	7.21
			R	119.16	23.06	7.70	15.46	9.35	20.87	7.17
AZ 2740	**F**	**A**	**L**	M	M	M	M	M	M	M
			R	129.50	18.07	7.21	14.04	8.31	19.03	6.94
AZ 2744	**F**	**A**	**L**	142.92	20.64	7.31	16.40	9.52	21.65	7.95
			R	143.21	21.09	7.26	16.64	9.61	21.64	7.92
AZ 2774	**M**	**A**	**L**	M	M	M	M	M	M	M
			R	144.53	21.10	7.77	16.65	10.60	22.40	7.81
AZ 2778	**M**	**A**	**L**	128.86	17.62	6.54	14.10	8.77	17.48	6.47
			R	129.47	17.87	6.76	13.83	9.06	17.88	6.37
TM 13509	**F**	**A**	**L**	129.62	16.73	6.55	13.18	8.49	17.43	6.35
			R	129.21	16.93	6.50	3.33	8.28	17.60	6.43
TM 11451	**M**	**A**	**L**	122.92	16.51	6.08	13.10	8.28	16.80	6.14
			R	123.32	16.56	6.16	13.25	8.21	16.79	6.10
NMB 7412	**M**	**A**	**L**	B	17.56	B	B	B	B	B
			R	B	17.48	B	B	B	B	B

Patella

Table C-34: Patella measurements for *L. capensis*

Specimen Number	Sex	Age	SIDE	GL	GL
AZ 678	**F**	**SA**	**L**	5.70	9.85
AZ 2757	**M**	**A**	**L**	7.10	11.92
AZ 2922	**F**	**A**	**L**	5.91	9.36
			R	5.92	9.30
AZ 2959	**F**	**A**	**L**	5.86	10.47
TM 33802	**M**	**A**	**L**	5.13	9.05
NMBF 9881	**F**	**A**	**R**	5.94	10.68
NMBF 9891	**F**	**A**	**L**	5.89	10.03
			R	5.88	10.03
NMBF 9893	**F**	**A**	**L**	6.65	11.75
			R	6.75	11.59
NMBF 9901	**F**	**A**	**R**	5.74	8.92
NMBF 9910	**Not indicated**	**A**	**R**	6.84	11.69

Table C-35: Patella measurements for *L. saxatilis*

Specimen Number	Sex	Age	SIDE	GL	GL
AZ 511	**M**	**SA**	**R**	5.45	8.95
AZ 670	**M**	**A**	**R**	7.25	11.92
AZ 1791	**M**	**A**	**R**	5.56	9.78
AZ 2598	**F**	**A**	**L**	6.47	10.90
			R	6.30	10.09
AZ 2774	**M**	**A**	**L**	7.96	13.80
TM 13509	**F**	**A**	**L**	6.08	11.08
			R	6.03	10.91

Calcaneus

Table C-38: Calcaneus measurements for *L. capensis*

Specimen Number	Sex	Age	SIDE	GB	GL
AZ 2922	**F**	**A**	**L**	9.06	28.06
			R	9.03	28.27
AZ 2959	**F**	**A**	**L**	8.67	26.80
TM 33802	**M**	**A**	**L**	7.76	23.80
NMBF 9881	**F**	**A**	**L**	8.28	26.58
NMBF 9891	**F**	**A**	**L**	8.37	26.43
			R	8.52	26.86
NMBF 9893	**F**	**A**	**L**	9.68	29.79
			R	9.66	29.81
NMBF 9901	**F**	**A**	**L**	8.36	25.43
			R	9.59	30.02
NMBF 9910	**Not indicated**	**A**	**L**	9.59	30.02
			R	9.34	29.84

Table C-39: Calcaneus measurements for *L. saxatilis*

Specimen Number	Sex	Age	SIDE	GB	GL
AZ 419	**F**	**SA**	**L**	9.90	27.68
			R	10.00	27.61
AZ 511	**M**	**SA**	**L**	8.31	23.72
			R	8.44	23.17
AZ 1791	**M**	**A**	**L**	8.61	26.83
			R	8.65	26.72
TM 11451	**M**	**A**	**L**	9.64	27.01
			R	9.61	26.90

Talus

Table C-40: Talus measurements for *L. capensis*

Specimen Number	Sex	Age	SIDE	GL	DC
AZ 2922	**F**	**A**	**L**	13.79	7.27
			R	13.58	6.80
AZ 2959	**F**	**A**	**L**	12.88	6.75
TM 33802	**M**	**A**	**L**	11.27	5.76
NMBF 9891	**F**	**A**	**L**	12.61	6.98
			R	12.50	7.02
Incorrectly numbered specimens			**L (EXTRA)**	12.76	6.46
			R (EXTRA)	12.63	6.14
NMBF 9893	**F**	**A**	**L**	14.41	7.05
			R	14.49	7.14
NMBF 9901	**F**	**A**	**L**	11.89	6.08
			R	11.85	6.08
NMBF 9910	**Not indicated**	**A**	**L**	14.85	7.34
			R	14.86	7.46

Table C-41: Talus measurements for *L. saxatilis*

Specimen Number	Sex	Age	SIDE	GL	DC
AZ 419	**F**	**SA**	**L**	13.68	6.19
			R	13.77	6.25
AZ 511	**M**	**SA**	**L**	10.95	6.16
			R	11.18	6.27
AZ 1791	**M**	**A**	**L**	12.43	6.22
			R	12.59	6.45
TM 11451	**M**	**A**	**L**	12.86	6.27
			R	13.02	6.35
AZ 2710	**F**	**A**	**L**	13.58	6.48

Metatarsals

Table C-42: Metatarsal I measurements for *L. capensis*

Specimen Number	Sex	Age	METATARSAL	SIDE	GL	Bd	Dp	Bp
TM 33802	**F**	**A**	**I**	**L**	38.73	4.59	6.21	3.62
				R	M	M	M	M
AZ 2922	**F**	**A**		**L**	46.63	4.59	6.94	4.20
				R	45.98	4.39	7.00	3.91
AZ 2959	**F**	**A**		**L**	45.10	4.55	6.44	3.90
				R	M	M	M	M
NMBF 9881	**F**	**A**		**L**	43.47	4.37	6.11	3.82
				R	43.73	4.39	6.07	3.80
NMBF 9891	**F**	**A**		**L**	M	M	M	M
				R	40.90	4.24	6.50	3.99
NMBF 9893	**F**	**A**		**L**	45.03	5.60	7.58	4.43
				R	44.99	5.58	7.48	4.69
NMBF 9901	**F**	**A**		**L**	39.91	4.32	6.29	3.58
				R	M	M	M	M
NMBF 9910	**Not indicated**	**A**		**L**	44.53	5.54	7.58	4.69
				R	43.94	5.52	7.64	4.65

Table C-43: Metatarsal II measurements for *L. capensis*

Specimen Number	Sex	Age	METATARSAL	SIDE	GL	Bd	Dp	Bp
TM 33802	**F**	**A**	**II**	**L**	6.58	4.13	6.65	4.04
				R	M	M	M	M
AZ 2922	**F**	**A**		**L**	46.37	4.52	7.58	4.31
				R	46.40	4.51	7.45	4.50
AZ 2959	**F**	**A**		**L**	45.73	4.49	7.22	4.38
				R	M	M	M	M
NMBF 9881	**F**	**A**		**L**	44.84	4.20	6.76	4.18
				R	44.41	4.24	6.48	4.18
NMBF 9891	**F**	**A**		**L**	M	M	M	M
				R	42.56	4.27	6.66	3.93
NMBF 9893	**F**	**A**		**L**	46.64	5.65	7.40	4.96
				R	46.19	5.62	7.45	4.91
NMBF 9901	**F**	**A**		**L**	41.83	4.19	6.51	3.86
				R	42.00	4.29	6.51	3.92
NMBF 9910	**Not indicated**	**A**		**L**	45.11	5.25	7.96	5.13
				R	44.98	5.28	7.79	4.73

Table C-44: Metatarsal III measurements for *L. capensis*

Specimen Number	**Sex**	**Age**	**METATARSAL**	**SIDE**	**GL**	**Bd**	**Dp**	**Bp**
TM 33802	**F**	**A**	**III**	**L**	38.42	4.01	5.88	3.80
				R	M	M	M	M
AZ 2922	**F**	**A**		**L**	44.10	4.30	6.72	5.03
				R	44.11	4.26	6.68	5.01
AZ 2959	**F**	**A**		**L**	43.21	4.24	6.37	4.81
				R	M	M	M	M
NMBF 9881	**F**	**A**		**L**	42.88	3.69	6.25	4.15
				R	42.81	4.05	6.33	4.77
NMBF 9891	**F**	**A**		**L**	M	M	M	M
				R	40.57	4.09	6.31	4.07
NMBF 9893	**F**	**A**		**L**	45.01	5.39	6.64	5.05
				R	44.84	5.33	6.82	4.97
NMBF 9901	**F**	**A**		**L**	40.27	4.18	5.97	4.18
				R	40.29	4.16	6.10	4.11
NMBF 9910	**Not indicated**	**A**		**L**	43.18	5.18	6.77	5.55
				R	43.26	5.17	6.91	5.60

Table C-45: Metatarsal IV measurements for *L. capensis*

Specimen Number	**Sex**	**Age**	**METATARSAL**	**SIDE**	**GL**	**Bd**	**Dp**	**Bp**
TM 33802	**F**	**A**	**IV**	**L**	34.65	3.48	5.31	5.70
				R	M	M	M	M
AZ 2922	**F**	**A**		**L**	39.27	3.81	5.95	5.92
				R	39.17	3.92	5.70	5.91
AZ 2959	**F**	**A**		**L**	38.74	3.78	5.45	5.85
				R	M	M	M	M
NMBF 9881	**F**	**A**		**L**	39.33	3.70	5.26	6.02
				R	38.38	3.60	5.73	6.02
NMBF 9891	**F**	**A**		**L**	M	M	M	M
				R	36.22	3.61	5.07	4.82
NMBF 9893	**F**	**A**		**L**	40.06	4.41	6.72	6.73
				R	40.11	4.43	6.68	6.55
NMBF 9901	**F**	**A**		**L**	35.49	3.56	5.25	5.48
				R	35.56	6.65	5.28	5.47
NMBF 9910	**Not indicated**	**A**		**L**	B	B	6.49	6.76
				R	39.47	4.69	6.70	6.86

Table C-46: Metatarsal I measurements for *L. saxatilis*

Specimen Number	**Sex**	**Age**	**METATARSAL**	**SIDE**	**GL**	**Bd**	**Dp**	**Bp**
AZ 419	**F**	**SA**	**I**	**L**	45.24	5.00	7.17	4.28
				R	45.09	5.02	7.40	4.27
AZ 511	**M**	**SA**		**L**	39.39	3.99	3.76	6.18
				R	39.50	4.10	3.71	6.15

Table C-47: Metatarsal II measurements for *L. saxatilis*

Specimen Number	Sex	Age	METATARSAL	SIDE	GL	Bd	Dp	Bp
AZ 419	**F**	**SA**	**II**	**L**	46.86	5.06	7.52	4.13
				R	46.48	5.20	7.66	4.21
AZ 511	**M**	**SA**		**L**	40.53	3.94	6.05	4.00
				R	40.62	3.92	6.00	3.95

Table C-48: Metatarsal III measurements for *L. saxatilis*

Specimen Number	Sex	Age	METATARSAL	SIDE	GL	Bd	Dp	Bp
AZ 419	**F**	**SA**	**III**	**L**	45.04	4.89	6.45	4.50
				R	44.72	4.85	6.47	4.65
AZ 511	**M**	**SA**		**L**	39.52	3.93	5.51	4.30
				R	39.38	3.87	5.47	4.44

Table C-49: Metatarsal IV measurements for *L. saxatilis*

Specimen Number	Sex	Age	METATARSAL	SIDE	GL	Bd	Dp	Bp
AZ 419	**F**	**SA**	**IV**	**L**	40.30	4.33	5.98	6.55
				R	40.10	4.36	6.08	6.48
AZ 511	**M**	**SA**		**L**	34.61	3.33	4.91	4.98
				R	34.83	3.38	4.70	5.02

APPENDIX D

PUBLISHED ARCHAEOLOGICAL LAGOMORPHA DATA

Explanatory notes

- In this Appendix I use the time period organisation as in Plug and Badenhorst (2001).
- The references provided in this Appendix only list those publications that report Lagomorpha material that are not listed in Plug and Badenhorst (2001: 229).
- The values (NISP and/or MNI) given are the combined totals for Lagomorpha remains recovered from excavations with occupation levels that fall within the applicable time period.
- Appendix D is not meant to be an exhaustive list but it serves as an indication of the frequency of Lagomorpha remains in published archaeological faunal lists. It further gives an indication of group vs species level identification.

Legend for tables:

- ***** = The presence of the remains on a site where no NISP and/or MNI amounts were provided but where the remains were reported as part of the faunal compliment.
- **NISP** (Number of Identified Specimens) and/or **MNI** (Minimum Number of Individuals) = There is little consistency among authors for reporting values. The values reported are those provided in the publications.
- **Dates** = are provided only were the publication lists specific dates for the level(s) in question.
- **cf.** = *confer* - The identification is used when the archaeological specimen compares well with the modern specimen but a firm identification is not possible.
- **QSP:** Quantifiable Specimens present

The classification of the Order Lagomorpha (Chapter 2, **Table 2.1)**

<table>
<tr><td colspan="3">Order
Lagomorpha</td></tr>
<tr><td colspan="3">Family
Leporidae</td></tr>
<tr><td>Genus
<i>Lepus</i></td><td>Genus
<i>Pronolagus</i></td><td>Genus
<i>Bunolagus</i></td></tr>
<tr><td>Species
<i>capensis</i> (Cape hare)
<i>saxatilis</i> (scrub hare)</td><td>Species
<i>rupestris</i> (Smith’s red rock rabbit)
<i>crassicaudatus</i> (Natal red rock rabbit)
<i>randensis</i> (Jameson’s red rock rabbit)</td><td>Species
<i>monticularis</i> (riverine rabbit)</td></tr>
</table>

1. Lagomorpha
2. Leporidae
3. *Lepus* sp.
4. *Lepus capensis*
5. *Lepus saxatilis*
6. *Pronolagus* sp.
7. *Pronolagus rupestris*
8. *Pronolagus crassicaudatus*
9. *Pronolagus randensis*
10. *Bunolagus monticularis*
11. *Oryctolagus cuniculus*

APPENDIX D

Table D-1: >30 000 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Pokkenbank	**> 45k BP**							5														
Aar 1 & 2	**33 260 BP**							4														
Border Cave		**MSA 1 Formerly full MSA or Pietersburg**								cf 7												
		MSA 2 Formerly Final MSA or epi-Pietersburg								cf 5												
		MSA 3 Formerly post-Final MSA >49 000 BP								cf 9												
		Early LSA Formerly Pre-Early LSA ca 38 000 – 36 000 BP								cf 12												
Redcliff Cave	**40 000 - 25 650 BP**	**Bambata and Tshangula Industries**	52 small 8 large																			
Klasies Rivier	**80 000 - 70 000 BP**	**1**						cf 1														
Ysterfontein 1	**MSA**						22	7														
Sibudu		**Howieson's Poort**											3				2					

Table D-2: 30 000 – 25 000 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Shongweni South Cave	**22 990 BP**						5															

Table D-3: 25 000 – 18 000 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Sehonghong Shelter	**20 000 BP**	**MOS (Mottled Orange Sand)**	1	1																		
Heuningneskrans Shelter	**23 000 - 12 500 BP**	**3B - 3H**					12	2														

Table D-4: 18 000 – 12 000 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Elands Bay Cave	**18 000 - 13 000 BP**	**18 - 20**					7	3														
Tloutle Shelter	**18 000 - 14 000 BP**	**BS, BC**	1	1																		
Pokkenbank	**14 000 - 10 000 BP**						4															
Faraoskop Rock Shelter	**16 500 BP**	**4 - 5**					2	2														
Sehonghong Shelter	**15 700 BP**	**Robberg: BAS (Brown ashy sand)**	12	2																		
	12 410 BP	**Robberg: RBL (Red Brown Loam)**	9	1																		
Byeneskranskop Shelter	**12 730 BP**	**19**				1																
Umhlatuzana Rock Shelter	**13 400 BP**	**5**					2	1														
Nelsons Bay Cave	**18 500 BP**	**Robberg**								cf 3												
Heuningneskrans Shelter	**12 500 BP**	**Intermediate layers 2A, 2B**					1	1														

Table D-5: 12 000 – 8000 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Sehonghong Shelter		**Oakhurst SA**	58	1			1				26	3										
	12 000 BP	**RF**	12	2							3	1										
	11 090 BP	**BARF**	1								1	1										
Ntloana Tsoana			38	3																		
Ha Makotoko			92	2																		
Sikhanyusweni					49	10																
			4		29	6																
Boomplaas Cave		**Albany**				12																
Umhlatuzana Rock Shelter					29	6																
Tloutle	**8680 BP**	**GS**	10	1																		
Elands Bay Cave		**10 - 17**					114	11														
Jubilee Shelter	**8500 BP**	**0 - Oakhurst**					3	3														
Byeneskranskop Shelter		**13 - 18**				8																
Umhlatuzana Rock Shelter	**9 000 BP**	**4**					29	6														
Faraoskop Rock Shelter		**4**					1	1														
Rose Cottage Cave		**Ja - H**	19				4	1			1	1										
Bushman Rock Shelter	**9570 - 12 950 BP**	**2 - 18**										2		2								
Heuningneskrans Shelter	**9 000 BP**	**Oakhurst 1A, 1B**					3	1														

Table D-6: 8000 – 6000 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Mgede Shelter	**6550 BP**	**4 - 5**					3	1														
Tloutle	**6140, 6910, 7230 BP**	**CCL, CSL-UP, CSL-LR**	37	5			1	1														
Good Hope Shelter	**7670 BP**	**3 - 4**				1																
Tortoise Cave	**7700 BP**	**14**					2															
Sehonghong Shelter		**Oakhurst SA**	58	1			1				26	3										
		Oakhurst ALP	77	5							23	4										
	5950 BP	**Classic Wilton, GWA**	15	2			5	1			35	2	5	1	1	1						
Byeneskranskop Shelter	**6500 BP**	**9 - 11**				4																
Wilton Shelter	**8000 - 10 000 BP**	**3G**						cf 1														
Rose Cottage Cave		**P / P2**	12	2			1	1														
		Pt	13																			
Tshisiku Shelter	**6330 BP**	**8,9**	1						cf 1													

Table D-7: 6000 – 4000 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Gehle Shelter	**5690 BP**	**2 - 3**			9	2																
Maqonqo Shelter	**9000 - 3500 BP**		315	30			23	4			46	18			23	7	32	13				
Buffelskloof Shelter	**10 000 - 8000 BP**	**HE**							cf 1	1												
Highlands Rock Shelter	**4500 BP**	**IV**								cf 2												
Jubilee Shelter	**3100 - 6890 BP**	**W - Wilton**					17	10														
Tortoise Cave	**4190 - 4330 BP**	**9 - 11, 13a**					34	8														
Byeneskranskop Shelter		**6, 8**				2 (?1)																
Wilton Shelter	**4900 BP**	**2, 3B, 3C, 3E, 3F**						cf 6														
Mzinyashana	**4010 - 4170 BP**	**10 - 11**	20	2			5	2			34	5				1	1					
Tshisiku Shelter	**4220 BP**	**5**	1						cf 1													

Table D-8: 4000 – 2000 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Geduld Rock Shelter	**2090 BP**	**9**	1																			
Steenbokfontein Cave	**4000 - 2000 BP**	**1 - 40**					15	4														
Clarke's Shelter	**2380 - 1580 BP**				7	4																
Mhlwazini Cave	**2280 - 2665 BP**	**5 - 6**					14	2														
KwaThwaleyakhe Shelter	**3810 - 1290 BP**	**4 - 8**			52	6																
Highlands Rock Shelter	**2500 - 3500 BP**	**II and III**								cf 3						5						
Elands Bay Cave	**3500 BP**	**8 - 9**							12	2												
	2100 BP	**SK5b**							*													
Mgede Shelter	**4390 BP**	**3**					5	1														
Good Hope Shelter	**2160 BP**	**2**				4																
Pancho's Kitchen Midden	**2940 - 3570 BP**	**5 - 7**							1	1					2	2						
Faraoskop Rock Shelter		**2**					3	1														
Tortoise Cave	**3500 - 4000 BP**	**3, 5A, 6 -8**					16	5														
Byeneskranskop Shelter	**3400 BP**	**2**				1																
Wilton Shelter	**2270 BP**	**3A**						cf 1														
Umhlatuzana Rock Shelter		**1 - 3**					27	5														
Sikhanyusweni Shelter		**1 - 2**			32	5																
Maqonqo Shelter		**1 - 2**			33	2																
Dikbosch Shelter		**1 - 2**						2														

Diamond Shelter 1		**1 - 2**			2	1																
Liphofung Shelter			3	1																		
Blydefontein Shelter						11																
Zaayfontein Shelter						2																
Riversmead Shelter						12																
iNkolimahashi	**2520 - 3130 BP**	**8 - 9**					1				9	2					1	1				
Makgabeng Plateau	**2130 & 2160 BP**	**4 - 8**					8															
Mhlwazini Cave							18	4														
Rooiwalbaai	**2505 BP**						4	3														
Mzinyashana	**2260 - 2930 BP**	**6 - 9**	2	1							18	8			7	3						
Rose Cottage Cave	**2240 BP**	**A2**	54																			

Table D-9: 2000 – 1500 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Apollo II Cave								7														
Tiras Shelter								2														
Namtib Shelter								3												2		
Twyfelpoort Shelter							2															
Collingham Shelter			71	5													33	3				
Driel Shelter						5																
Happy Rest	**350 - 470 BCE**							1														
Klein Kliphuis	**1990 BP**	**B, C**									1	1										
Spoegrivier Cave		**PAT - FBS, 6-surface**	35				52	10			20											
Broederstroom	**1600 - 1350 BP**							2														
Jubilee Shelter	**1350 - 1840 BP**	**P-W Post Wilton**					22	20														
Spring Cave		**2 - 3**					5	2														
Tortoise Cave		**2B**					17	2														
Geduld Rock Shelter	**1980 BP**	**7**	1																			
			cf 2																			
	1970 BP	**8**	cf 1																			
	1200 BP	**3**	1																			
iNkolimahashi	**1580 - 1990 BP**	**5 - 7**					49				42 cf 2	7					4	2				
Kasteelberg	**1430 - 1734 BP**	**3**						3														

Table D-10: 1500 – 1000 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Limerock 1	**1620 BP**	**3**		3																		
Limerock 2	**1720 BP**	**4**		1																		
	1430 BP	**5**		1																		
KNP MA 38	**470 BCE**												1	1								
KNP TSH 1	**510 BCE**												12	2								
KNP MO 8	**300 - 600 BCE**										cf 1	1	1	1								
KNP LE 7a													5	1								
KNP SK 17	**121 BP**												3	1								
KNP LE 6																						
KNP LE7b							2	1														
KNP OI 20	**1100 BP**						122	5														
KNP PH9	**800 BCE**												3	1								
KNP MA 4													2	1								
Nanada	**1150 - 1450 BP**		2	2																		
Magogo	**590 BCE**			2																		
Ntshekana								3														
Msuluzi Confluence	**640 BCE**			1																		
Mbabane	**420 - 700 BCE**	**4, 5**					25	2														
Elandsbay Cave		**6**					3	1														
eSinhlonhloweni	**1550 - 1250 BP**						26	2														
Kasteelberg	**1300, 1000 BP**	**KBB, KBA**					5	2														
Kadzi River			9																			

KwaGandaganda			1				4				4											
Schroda				41																		
Pontdrift	**1140 - 840 BP**	**All**		30																		
Commando Kop	**980 - 1115 BP**	**All**		1				4														
Ficus Cave	**550 - 1350 BP**		3	3				1														
Doornfontein	**1120 BP**	**All**					9															
Mamba Confluence			1	1																		
Wosi	**1350 - 1150 BP**	**All**	6	4																		
Renbaan Cave	**1150 BP**	**BU**					2	1														
Klein Kliphuis	**1230 BP**	**Bed**	1	1																		
Eiland Salt Works	**1350 - 1050 BP**		11								11	4	21	5								
Langdraai			3	1																		
Spoegrivier Cave	**1390 BP**	**SURF, UN1, TWIG, BS1, BS2, CORP**					46	7														
Ndondondwane	**1190 BC**		2																			
KwaThwaleyahkhe		**1 - 3**					58	7														
K2				24				13				2		1						1		
Klipspruit			3																			
Tortoise Cave		**2A**					26	2														
Drie Susters	**1050 BP**								3	1												
White Painting Rock Shelter	**1080 - 3700 BP**						3	2														
Smitswinkelbaai Cave	**1420 - 1175 BP**	**2**					*	1														
Geduld Rock Shelter	**1000 BP**		cf 7																			
Bosutswe	**1250 - 1150 BP**	**Taukoma**	1	1																		

Gehle Shelter	**750 - 1280 BP**	**1**	5	1																		
Wilton Shelter	**735 BP**	**1, 2A**						cf 2														
iNkolimahashi	**1170 BP**	**4**					13				24	3					1	1				
Mzinyashana	**1520 - 1750 BP**	**4 - 5**					1				28	4										

D-11: 1000 – 500 BP

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Hail Stone Midden	**990 – 910 BP**	**SS**					2	1			1	1										
		GB									1	1										
Muela Shelter			7				1	1					3	1								
Tandjiesberg Shelter			*																			
Twyfelpoort								2														
Mapungubwe		**K2/TS1**						3														
		K2/TS2						3														
		K2/TS3						18														
		K2/TS4																		3		
		MST/K8						6														
		MK1						9														
Elandsbay Cave		**3 - 4**					5	2														
Limerock 2		**2**						2														
Limerock 2		**2 - 3**						4														
Mgede Shelter	**820 BP**	**2**					7	1														
Kasteelberg	**900 BP**	**KBB**					27	2														
Taukome				8																		
Faraoskop Rock Shelter	**670 BP**	**1**					3	1						1								
Connie's Limpet Bar	**300 - 1000 BP**						1	1														
Tortoise Cave		**1A - 1B**					35															
Gehle Shelter		**Surface**	1	1																		
Bosutswe	**1150 - 750 BP**	**Toutswe**									2	1										

Bosutswe	**750 - 560 BP**	**Mapungubwe**									5	1										
Rose Cottage Cave		**Mn - A**					39				25	*										
Icon	**620 BP**	**1 M. ind, Test Trench M. Ind**		2																		
Honingklip Shelter1	**Late holocene**	**HKLP 1**									7	2										
Scott's Cave	**360 - 1 190 BP**	**Spits 1, 2, 5**								cf 3												
Border Cave	**800 - 200 BP**	**1BSUPA**								cf 7												
Harleigh Farm	**750 BP**	**Ruin 2**						1														
Umuab 28																			1			
Wilton Shelter																						
Goergap		**2 - 6**	233				12		5		4											
iNkolimahashi	**550 BP**	**3**					1	1			19 cf 1	2					5	3				
Mzinyashana	**660 - 970 BP**	**1 - 3**	2								18	5										

D-12: 500 BP – recent

Site	Age	Levels	1		2		3		4		5		6		7		8		9		10		11	
			NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Winburg or Doornpoort	**90 - 240 BP**						12		cf 12	2	63	5												
											cf 1	1												
Melrose Huis			5	2																				
KNP		**LE2**					2				15	2												
		PR34					4	1																
		SH16	5	1																				
Ondini	**150 BP**	**OM1**	1	1																				
		OM2	48	4																				
		OM3	36	3																				
		OM6	2	1																				
		OM8	7	2																				
		OM9	2	1																				
		OM10	10	1																				
		OM14	60	4																				
uMgungundlovu	**1829 - 1838**						1	1																
Vumba							1	1																
Bole Hill							1	1			1	1												
Selolwe							*				*													
Thulamela			9								6													
Colwinton Rock Shelter				2																				
eSinhlonhloweni		**1 - 3**					110	11																
Mbabane Shelter		**1 - 3**					8	2																
Vredefort Dome				1																				

Buffelshoek								1																
Robbertsdrift								1																
Mgede		**1**					11	1																
Twyfelpoort		**H**						3																
Bekkersberg								3																
Radiepolong							2																	
Selonskraal			1	1																				
Pilansberg							1																	
Olifantspoort							3																	
Swartkoppies			*																					
Mmatshetshele							4																	
Tshirululuni											*													
Tavhatshena											*													
Ndebele Sites	**230 - 75 BP**	**2329 CD 9 (B)**	2																					
		2329 CD 12	1																					
		2329 CD 15	1																					
Tshitseme			1								1								5					
Schoemansdal			1																					
Kami Hill								15																
Kliprivierberg							2																	
Blinkklipkop SP?								5																
Burchells Shelter				1																				
Westbury			2	1																				
Rooikrans		**1 - 2**	2				2																	
Toutle Shelter		**SS - BGL**	1	1																				
Toutle Shelter		**Interior Excavation**	1	1																				
Mpanbanyoni		**Midden A & B**						3																

Burchells Shelter		**1 - 2**							*															
Umbeli Belli Shelter		**1 - 2**								2														
Highlands Rock Shelter		**I - Surface**								cf 4						cf 5								
Elands Bay Cave	**315 BP**	**1**					7	1																
Kekane	**50 – 10 BP**						1	1																
Riekertsdam	**1666 - 1818**		1	1																				
Magozastad	**400 BP**		1	1																				
Kleinfontein	**268 - 147 BP**		1	1																				
Limerock 2	**500 BP**	**1**					1																	
Mgede Shelter	**120 BP**	**1**					11	1																
Good Hope Shelter		**1**				1																		
Mhlwazini Cave		**1 - 4**					4	2																
Abbot' s Cave	**500 - 200 BP**	**A & B**		401				76				97				17								
Lame Sheep Shelter	**500 - 200 BP**	**A & B**		27																				
Driekoppen	**500 - 200 BP**	**A & B**		2												1								
Van Zyl's Rus Shelter		**A & B**						1				37				5								
Boundry Shelter		**A & B**		3								3				9								
Volstruisfontein		**A & B**		48				16																
Leeuhoek		**A & B**		5												1								
Bloubos		**A & B**														2								
Haaskraal		**A & B (QSP published)**		227				44				15				1								
Kasteelberg	**800 - 300 BP**	**KBB**					4	1																
Oudepost 1	**218 - 281 BP**	**All**			399	16																		
Paradise	**350 - 250 BP**	**All**																						1 (2?)

Tortoise Cave	**760 BP**	**1A, 1B**					35	4																
Sehonghong Shelter	**500 - 100 BP**	**Dung Crust with Pottery**	10				6	1			14	1												
Byeneskranskop Shelter	**255 BP**	**1**				1																		
Dzata											18	2												
Sebatini											5													
Serotwe			4								40													
Sonkoanini									37															
Hill X									43															
Selongwe											9													
Marupale			2						1															
Steinaecker's Horse											6	1												
Droegrond	**120 BP**	**B1 0 - 10**																			cf 1	1		
		B7 10 - 20																			cf 4	2		
Lekkerwater	**150 - 50 BP**	**Fase III A E**					1	1																
		VIB(1)					1	1																
		VIB (2)					4	2																
		Group D VIC					2	1																
Melora Hill	**250 BP**										6	1												
Goergap	**250 - 380 BP**	**1 - Surface**	56	5																				
Randjies	**220 - 350 BP**	**TR 1/1**	28	8			6	3			5	1												
		TR 1/4	6	2			8	1			2	1												
		TR 1/3	2	1																				
Qwa-Qwa Museum Site		**M**							cf 5	1														
iNkolimahashi	**360 BP**	**2**					7				22	1					1	1						
Makgabeng Plateau	**210 & 290 BP**	**1 - 3**					8																	

APPENDIX D

Historic Cave													*											
Connies Limpet Bar	**390 BP**						1	1																
KwaMaza B			1	1																				
Esikhunjini											1	1												
UmKlaarmaak							1	1																
Mmatshethsele	**200 - 120 BP**						4	1																
Boitsemagano			1	1			1	1																
Molokwane			1	1																				
Mabjanamatshwana			4	3																				
Mauermanshoek Shelter	**200 BP**	**S1, S2, L Ash**					2																	

BIBLIOGRAPHY

Avery, G., Halkett, D., Orto, J., Steele, T., Madelon, T. and Klein, R., 2008. The Ysterfontein 1 Middle Stone Age rock shelter and the evolution of coastal foraging. *South African Society Goodwin Series* 10, p.66-89.

Badenhorst, S., 2003. The archaeofauna from iNkolimahashi Shelter, a later Stone Age shelter in the Thukela Basin, KwaZulu-Natal, South Africa. *Southern African Humanities* 15, p.45-57.

Badenhorst, S., Plug, I., Pelser, A.J. and van Vollenhoven, A.C., 2002. Faunal analysis from Steinaecker's Horse, the northernmost British military outpost in the Kruger National Park during the South African war. *Annals of the Transvaal Museum* 39, p.57-63.

Bradfield, J., Holt, S. and Sadr, K., 2009. The last of the LSA on the Makgabeng plateau, Limpopo Province. *South African Archaeological Bulletin* 64(190), p.176-183.

Esterhuysen, A., 2010. Excavation at Historic Cave. Makapan's Valley, Limpopo: 2001-2005. *South African Archaeological Bulletin* 65(101), p.67-83.

Jerardino, A., 2003. Pre-colonial settlement and subsistence along Sandy Shores South of Elands Bay, West coast, South Africa. *South African Archaeological Bulletin* 58(178), p.53-62.

Jerardino, A., Horwitz, L.K., Mazel, A. and Navarro, R., 2009. Just before van Riebeeck: Glimpses into terminal LSA lifestyle at Connie Limpet Bar, West coast of South Africa. *South African Archaeological Bulletin* 64(189), p.75-86.

Mazel, A., 1990. Mhlwazini Cave: the excavation of Late Holocene deposits in the northern Natal Drankensberg, Natal, South Africa. *Natal Museum Journal of Humanities* 2, p.95-133.

Nelson, C., 2009. An archaeozoology of the Ndzundza Ndebele in the Steelpoort River Valley, Mpumalanga, South Africa, *c*. 1700 AD – 1883 AD. *South African Archaeological Bulletin* 64(190), p.184-192.

Orton, J., Hart, T. and Halkett, D., 2005. Shell middens in Namaqualand: Two later Stone Age sites at Rooiwalbaai, Northern Cape Province, South Africa. *South African Archaeological Bulletin* 60(181), p.24-32.

Pistorius, J.C.C., Badenhorst, S. and Plug, I., 2001. Later Iron Age sites on Mmatshetshele Mountain in the Central Bankeveld of the North West Province, South Africa. S*outh African Archaeological Bulletin* 56(173/174), p.46-56.

Plug, I., 2002. Faunal remains from Mzinyashana, a Late Stone Age site in KwaZulu-Natal, South Africa. *Southern African Humanities* 14, p51-63.

Plug, I. and Badenhorst, S., 2006. Notes on the fauna from three Late Iron Age mega-sites, Boitsemagano, Molokwane and Mabjanamatshwana, North West Province, South Africa. *South African Archaeological Bulletin* 61(183), p.57-67.

Sadr, K., 2007. Early first millennium pastoralists on Kasteelberg? The UB/UCT excavation at KBA. *South African Archaeological Bulletin* 62(186), p.154-161.

Van Doornum, B., 2007. Tshisiku Shelter and the Shashe-Limpopo confluence area hunter-gatherer sequence. *Southern African Humanities* 19, p.17-67.

Wadley, L., 2000. The Wilton and Pre-Ceramic Post-Classical Wilton Industries at Rose Cottage Cave and their context in the South African sequence. *South African Archaeological Bulletin* 55(172), p.90-106

Wadley, L., 2001. Who lived in Mauermanshoek Shelter, Korannaberg, South Africa? *African Archaeological Review* 18(3), p.153–179.

Wadley, L., 2008. The Howieson’s Poort Industry of Sibudu Cave. *South African Archaeological Society Goodwin Series* 10, p.122-132.