Faunal Exploitation and the Palaeoenvironment during the Middle Stone Age at Klasies River Cave 1B

by

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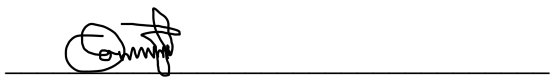
Declaration

I declare that this dissertation is my own, unaided work. It is being submitted for the Degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University



Signature of candidate

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Abstract

The general taphonomic signature and palaeoenvironment of MSA sites and layers dated to the Marine Isotopic Stage (MIS) 5e in the Eastern and Western Cape of South Africa is not well known; most of the focus has been on the younger MIS 5d-a and MIS 4 layers at Klasies River main site (KRM). At KRM, the first faunal material excavated by Singer and Wymer was at the centre of debates about the agents of accumulation and faunal use by humans; however, the mesh size used was large, and some of the faunal remains were not recovered. The faunal material studied here is from KRM Cave 1B RS sub-member, excavated by Deacon, where most of the faunal remains were retained. The results show fauna from the RS sub-member was primarily accumulated by humans, although there were some incidences of carnivore and natural intrusions, but their role in contributing to the faunal sample was insignificant. The subsistence strategies used by humans suggest that they were hunting a variety of taxa, including mammals, birds, tortoise and fish, using tool technology associated with the MSA I. The Klasies Pattern is present in the entire sample but not per individual layers. Based on the relative abundance of ungulates present from the oldest to the youngest RS layers, the palaeoenvironment was a mixture of open grassland and closed environments during the older layers with more open grassland environment in the younger layers. The ecological tolerance of certain taxa may have implications on these findings, and the results may also reflect a dating issue at KRM Cave 1B.

Keywords: Taphonomy, Palaeoenvironment, Marine Isotopic Stage 5, Klasies River main site, Subsistence strategies, Number of Individual Specimens

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Chapter 1. Introduction

The Middle Stone Age (MSA) is a significant period for understanding the origins of innovation and complex cognition of *Homo sapiens* (humans). The MSA is estimated to date between 300 Kya and 22/40 Kya (Wadley, 2015). During the MSA, humans were settling in cave shelters and open areas in small groups across southern Africa. In the southern Cape, evidence for their living conditions can be found at archaeological sites like Blombos Cave (BBC), Klasies River main site (KRM), Pinnacle Point (PP) and Die Kelders (DK1) (Henshilwood, 2012; Wadley, 2015). Evidence for active hunting is present at most archaeological sites like KRM and BBC (Hutson, 2018; Smith *et al*., 2019). One of the most significant MSA sites in South Africa is KRM. This site featured in many debates over the years, including deliberations about the role of scavenging and hunting behaviour (Klein, 1976; Binford, 1984; Milo, 1998; Bartram & Marean, 1999; Klein *et al*., 1999; Outram, 2001).

Zooarchaeological research over the past decade focussing on the MSA in South Africa has been primarily concerned with the hunting capabilities of humans, the components of their diet and interactions with the environment through the study of animal remains from archaeological sites (Thompson, 2020). Marginally more focus has been given to large mammals, although faunal assemblages also often contain fish, amphibians, reptilians, birds, rodents and other small mammals (Thompson, 2010; Thompson & Henshilwood, 2011; Badenhorst *et al.*, 2016; Van Pletzen *et al*., 2019; Reynard & Henshilwood, 2019; Badenhorst *et al*., 2021a). Using taphonomy, zooarchaeologists can obtain information about processes that affected faunal remains after death and infer the site formation processes. The most notable and common bone surface modifications on MSA faunal remains include butchery marks, burning, carnivore chew marks, gastric acid etching, weathering and rootlet etching (Brain, 1981; Lyman, 1994; Cain, 2006; Fernandez-Jalvo & Andrews, 2016; Reynard & Henshilwood, 2019). In addition, the use of information such as bone fragmentation, body-part representation and long bone breakage have proven to be an important tool for determining site formation processes and past lifeways (Marean *et al*., 2000; Klein & Cruz-Uribe, 2000; Henshilwood *et al.*, 2001; Reynard *et al.*, 2014).

Most rock shelters during the MSA were habitats for bone accumulators such as raptors, rodents, carnivores and humans. Therefore, it is important to determine the agent(s) of accumulation and the taphonomic history of a sample before any interpretations about subsistence strategies can be

made (Lyman, 1994; Cain, 2006; Thompson, 2010). This study aims to understand the subsistence patterns, site formation processes and palaeoenvironment at KRM Cave 1B, during an early part of the Marine Isotope Stage (MIS) 5.

1.1 Palaeoenvironment

KRM falls on the eastern end of the Greater Cape Floristic Region (GCFR). The GCFR is characterised by winter rainfall in the western parts, and a non-seasonal rainfall area in the far south-eastern part (Van Wijk *et al*., 2017). The Southern and South-Western Cape is currently dominated by fynbos vegetation. There are abundant food resources such as geophytes (Deacon, 1993; Larbey *et al*., 2019), shellfish (Thackeray, 1988; Langejans *et al*., 2012) and fauna present in the area (Klein, 1976; Van Pletzen *et al*., 2019). This has led researchers to suggest that the environment was critical in the development of human behaviour (Marean, 2010; Parkington, 2010; Compton, 2011). Although KRM falls within the GCFR, the climate and vegetation are different to the western parts of the GCFR, which is of great interest to botanists and biodiversity scientists because the floristic representation of a zone is strongly correlated to its climate (Reynard & Wurz, 2020). The MSA I layers at KRM is linked to the Last Interglacial, MIS 5e (Deacon & Geleijnse, 1988) although re-dating studies might change this temporal association. The MIS 5e period is dated to between 130 Kya and 115 Kya and is characterised by high sea levels and warm temperatures (Deacon & Geleijnse, 1988).

The basic assumption of palaeoecology is that the operations of ecological principles were the same through geological periods; the ecology of fossils can only be understood from an equivalent or relevant species present today (Faith & Lyman, 2019). While ungulate diversity is a good indicator of environmental productivity, some assumptions are made about their past ecological tolerance and diet preference, which are not always correct (Faith & Thompson, 2013). It is possible that MSA humans were hunting animals close to their habitation site, and therefore, it is conceivable that the faunal remains from archaeological sites reflect the local environment (Van Pletzen, 2000; Van Pletzen *et al*., 2019). However, this is subject to which fauna are preserved well-enough to be identified to taxa. This is because the absence of a taxon from an assemblage is not always evidence that it was not present in the past faunal community of the region, but could

be as a result of sampling, taphonomic or hunting biases (White, 1954; Bobe *et al*., 2002, Lyman, 2008; Discamps *et al*., 2011; Faith & Lyman, 2019).

1.2 Rationale

Since Klein's (1976) analyses of the fauna excavated by Singer and Wymer (S-W), much of the research from KRM have resulted in debates about the hunting ability of humans (Binford, 1984; Milo, 1998). The fauna has also provided information about MSA humans' subsistence behaviour, the site formation processes at the site, the agents of accumulation (Thackeray, 1990) and the palaeoenvironment (Klein, 1976; Van Pletzen *et al*., 2019; Reynard & Wurz, 2020). The general taphonomic patterns amongst MSA sites and layers dated to the MIS 5e in the Eastern and Western Cape of South Africa is not well-known. Most of the taphonomic studies done on MIS 5 layers at MSA sites in Southern Africa show that most of the faunal remains were accumulated primarily by humans (Henshilwood *et al*., 2001; 2011; Thompson, 2010; Thompson & Henshilwood, 2011, Van Pletzen *et al*., 2019; Reynard & Wurz, 2020; Lap, 2020). At KRM, the fauna from the younger layers MIS 5d-a and MIS 4 have been studied in greater depth more recently than the oldest MIS 5e layer (Achieng, 2019; Brenner *et al*., 2020; Pearson, 2021). The taphonomic and taxonomic part of this study will aim to address these aspects by providing information that can be used in future research and contribute to the existing knowledge about the palaeoenvironment, site formation processes and the subsistence behaviour during the early MIS 5 layers at KRM Cave 1B.

1.3 Research Question

- What information on the palaeoenvironment, site formation processes and subsistence behaviour can be inferred from the taxonomic and taphonomic analysis of MIS 5 fauna from Cave 1B at KRM?

1.4 Research Aim

- To investigate the palaeoenvironment, site formation processes and subsistence behaviour during the MIS 5 as reflected in the faunal remains from Cave 1B at KRM.

1.5 Objectives

- To carry out taxonomic identification on material excavated by Prof. HJ Deacon from KRM Cave 1B, RS sub-member (layers YS1T-GBS 2B) dated to between 115 Kya and possibly late MIS 6.
- To infer palaeoenvironmental conditions from the taxonomic analysis.
- To undertake a taphonomic study on the identified and unidentified sample.
- To infer site formation processes and subsistence behaviour from the taphonomic modifications.

Chapter 2. Background

2.1.1 Klasies River main site

Klasies River main site (KRM) (34.06ºS, 24.24ºE, Figure 1) is located on the Tsitsikamma coast in the Cacadu district in the western part of the Eastern Cape province, South Africa. The Klasies River is 500 metres (m) from the main site (Wurz, 2016). The Tsitsikamma coast consists of many cliffed sections and KRM is situated on such a cliff. KRM is located within the broad Fynbos Biome, but this cannot be described as a single biome because there are relatively few fynbos species. Rather, it has complex mosaic of thicket, forest and coastal vegetation (Van Wijk *et al.*, 2017). There are over 286 plant species from 196 genera within 78 families that are present around KRM (Van Wijk *et al.*, 2017). Birds such as cormorants and kelp gulls are present around the coastline (Deacon, 2001).

KRM has a long sequence of Late Pleistocene deposits preserved against a cliff within a number of caves (Deacon & Geleijnse, 1988). The main site consists of Caves 1, 1A, 1B and 2. The MSA layers at KRM are dated to between *ca*. 115 and 48 Kya (Wurz *et al*., 2018). There are also Holocene layers at the site within Cave 1. KRM represents one of the most prolonged MSA settlement sequences in South Africa and it is known to have some of the oldest occurrences of anatomically modern humans in South Africa, dated to MIS 5 (Singer & Wymer, 1982; Grine *et al*., 2017; 2020). This sequence provides archaeologists with an extensive series of transitions in environments and behaviours of MSA humans.

The faunal material found at KRM is associated with other cultural material such as stone artefacts and hearths (Klein 1976; Van Pletzen, 2000; Van Pletzen *et al.*, 2019; Reynard & Wurz 2020). The cultural materials provide evidence for complex behaviour (Wadley, 2015). These cultural materials are present throughout the layers at KRM, and they include bone tools, *Nassarius kraussianus* shell beads (Thackeray, 2019), evidence of cooked starchy foods (Larbey *et al*., 2019) and ochre (d'Errico *et al.*, 2012). Ochre use is similar between MSA and LSA people at KRM (Wurz, 2008).

The MSA cultural sequence at KRM is subdivided into the MSA I, MSA II, Howiesons Poort (HP), MSA III and MSA IV technocomplexes, occurring within a number of stratigraphic members. The MSA I layers, correlated with the fauna investigated here, are associated with the

production of regular quartzite blades and elongated points. The tool production during the MSA I technocomplex is characterised by blades and points, including very small blades, dorsal thinning and rubbing associated with small, diffused platforms (Wurz, 2002; Wurz, 2008). The MSA II blades and points are produced according to unipolar Levallois-like systems, and features are thick faceted platforms associated with prominent bulbs of percussion. The HP tools that succeed the MSA II are in some ways similar to that of the MSA I technocomplex. The HP is followed by the MSA III (Wurz, 2002; Wurz, 2008). The changes in the technocomplexes at KRM shows the adaptability of MSA humans to the resources that they were utilising (Wurz *et al*., 2018).

2.1.2 History of Excavations

Singer and Wymer (S-W) commenced the first set of excavations in 1967 and 1968 (Singer & Wymer, 1982). The extent and location of their excavations are shown in Figure 2. The material was excavated from Caves 1, 1A, 1B and 2. Klein (1976) analysed the large mammal fauna from the S-W excavations, and he provided data on palaeoenvironmental change through the sequence at KRM. The S-W excavations established the cultural stratigraphy at the main site. The layers excavated are, from the bottom, the MSA I layers in Cave 1 (layers 37-39) and Cave 1B (layers 1-15), although later investigation showed that the MSA l layers only occurs in layers 15 to 11 of Cave 1B (Wurz *et al*. 2018). The MSA II layers occur in Cave 1 (layers 14-17b) and Cave 1A (layers 22-36), and Cave 1B (layers 10-1). The HP layers occur in Cave 1A (layers 10-21) and Cave 2 (layers 1-5), whereas the MSA III layers occur in layers 1-9 of Cave 1A (Figure 4). The mesh size used by Wymer to sieve deposits was between 1 and 0.5 inches (in), and the excavators did not retain most of the smaller faunal specimens. Faunal remains that were not considered taxonomically identifiable were discarded at the time (Klein, 1976, p 76).

Hilary Deacon began the second phase of excavations in 1984 (Deacon, 1989). The Deacon (D) excavations used a mesh size of 3 millimetres (mm) by 2 mm stacked sieves, thereby retaining all faunal material excavated. One of the aims of the D excavations was to provide dates for the cultural sequence to allow for further palaeoenvironmental investigation. Deacon reconfigured the stratigraphy in a number of members, from the base to the top (Deacon & Geleijnse, 1988) as explained below.

The lowest member is the Light Brown Sand (LBS). The sand present in this member is similar to that on the beach. It was accumulated when sea levels were close to the current level. The LBS layers are equivalent to the S-W Layers 38-40 in Cave 1/1A and Layers 15 – 11 in Cave 1B (Figure 4). The Rubble Brown Sand (RBS) is the base of the overlying Shell and Sand (SAS) layer. The RBS member is equivalent to the S-W layer 37 (Figure 4), and it is made up of a carbonaceous layer showing plastic flow structures. The LBS and RBS member contain MSA l lithics (Deacon & Geleijnse, 1988; Deacon, 2001).

The SAS member is the overlying stratigraphic member on the LBS and RBS layers. The SAS member is 10 m in height and is the thickest member in the KRM stratigraphic sequence. The SAS is divided into four sub-members, namely the SAS Lower (SASL), SAS Upper (SASU), SAS Wedge (SASW) and SAS Rubble (SASR) (Figure 3). These sub-members occur in Cave 1. The lower set of deposits in Cave 1 referred to as the SAS member and is equivalent to S-W layers 36-23. The Rock Fall (RF) member is equivalent to the S-W layer 22 from Cave 1A and 2 (Figure 3), and it consists of yellow sands with flowstone blocks with minor carbonaceous partings. The lower section of the Upper member that follows the RF member is associated with the Howiesons Poort and is equivalent to S-W layers 10-21 (Deacon, 2001). In contrast, the top part of the upper member relates to the MSA III, equivalent to S-W's layers 9-1 (Figure 4). The Upper member is made up of distinctive multiple ash layers. All the layers at Klasies River contain shell middens and carbonised partings (Deacon & Geleijnse 1988).

Van Pletzen (2000) analysed the large mammal fauna from Deacon's excavations (Van Pletzen 2000; Van Pletzen *et al.*, 2019). She studied faunal material from the Upper, SAS and LBS members from Caves 1 and 1A. She assessed if the fauna followed the 'Klasies Pattern' and what palaeoenvironments were represented throughout the layers. Currently, there are ongoing excavations by Wurz (Wurz *et al.*, 2018; Brenner & Wurz, 2019) of the Witness Baulk (WB) layers where Deacon stopped. The excavation uses modern methods such as geoarchaeology, three-dimensional spatial recording and microstratigraphy. It uses the same stratigraphic system as Deacon and the same mesh size to sieve the finds (Wurz, 2016).

The LBS member, the topic of this study, falls within Marine Isotope Stage (MIS) 5d-e (Wurz *et al.*, 2018). The LBS member, associated with the MSA I technocomplex, and the layers in this member have been dated to 108.6 ± 3.4 Kya (Vogel, 2001) and 106.8 ± 12.6 Kya (Feathers, 2002).

The overlying SAS stratigraphic member with sub-members associated with the MSA II techno-complex is the thickest depositional unit; it dates to between 100.8 ± 2.1 and 85 ± 2.1 Kya (Vogel, 2001). Deacon *et al*. (1988) proposed a correlation with MIS 5c and 5b. The Upper member with the Howiesons Poort and MSA III techno-complexes, date to between 65.6 ± 5.3 (Vogel, 2001) and 48 Kya (Tribolo *et al.*, 2013).

2.2 Sample

The faunal sample analysed here comes from Cave 1B, where the LBS (named the RS member in the field notes, see Figure 4) and overlying SAS members (named DC in Cave 1B) occur (Figures 3 and 4). The correlation of the stratigraphic layers in Cave 1B and those in broad stratigraphic divisions in Cave 1B are represented in Figure 4. The focus of my study is the RS sub-member, dating to *ca*. 115 Kya, corresponding with the MSA I. The overlying DC sub-member has been dated to *ca*. 110 Kya and corresponds with the MSA II (Wurz, 2002). The layers from the RS member are characterised by the presence of mud in the oldest layer GBS 2B (Figure 4). The middle layers contain yellow sand, with some layers that have carbonised partings. The layers with carbonised partings include CP 1, CP 1T and CP 2 (Figure 4).

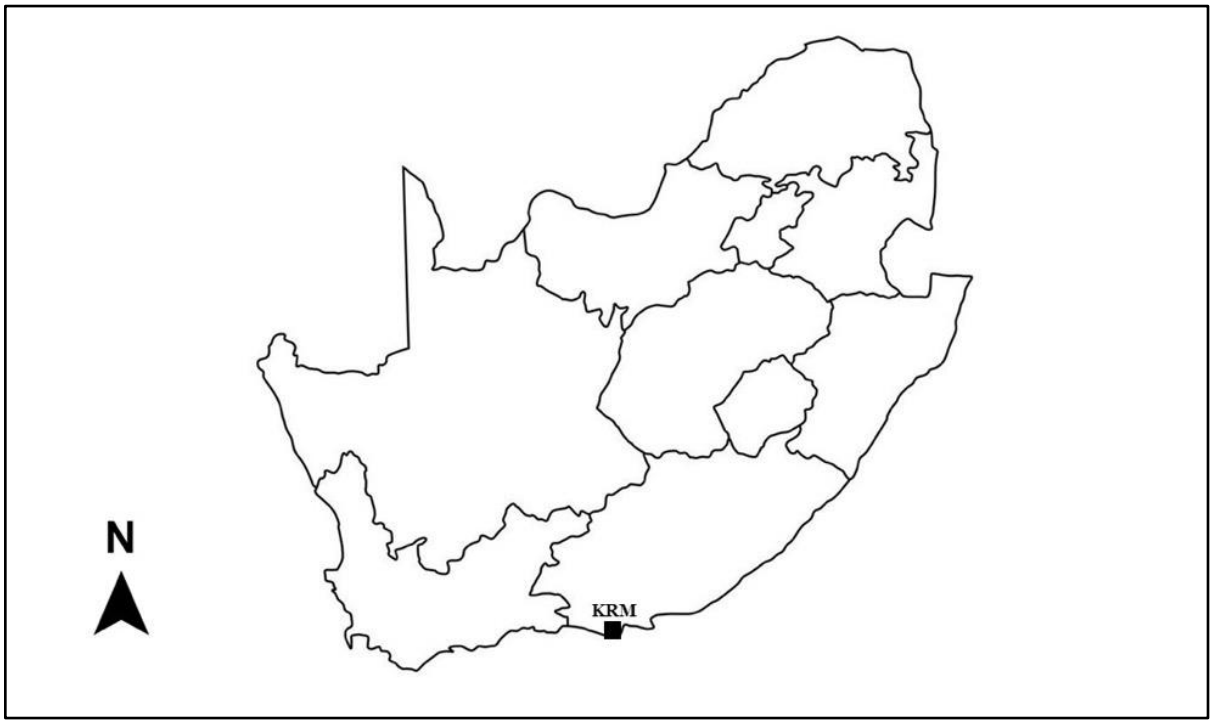

Figure 1. The geographical location of the Klasies River main site

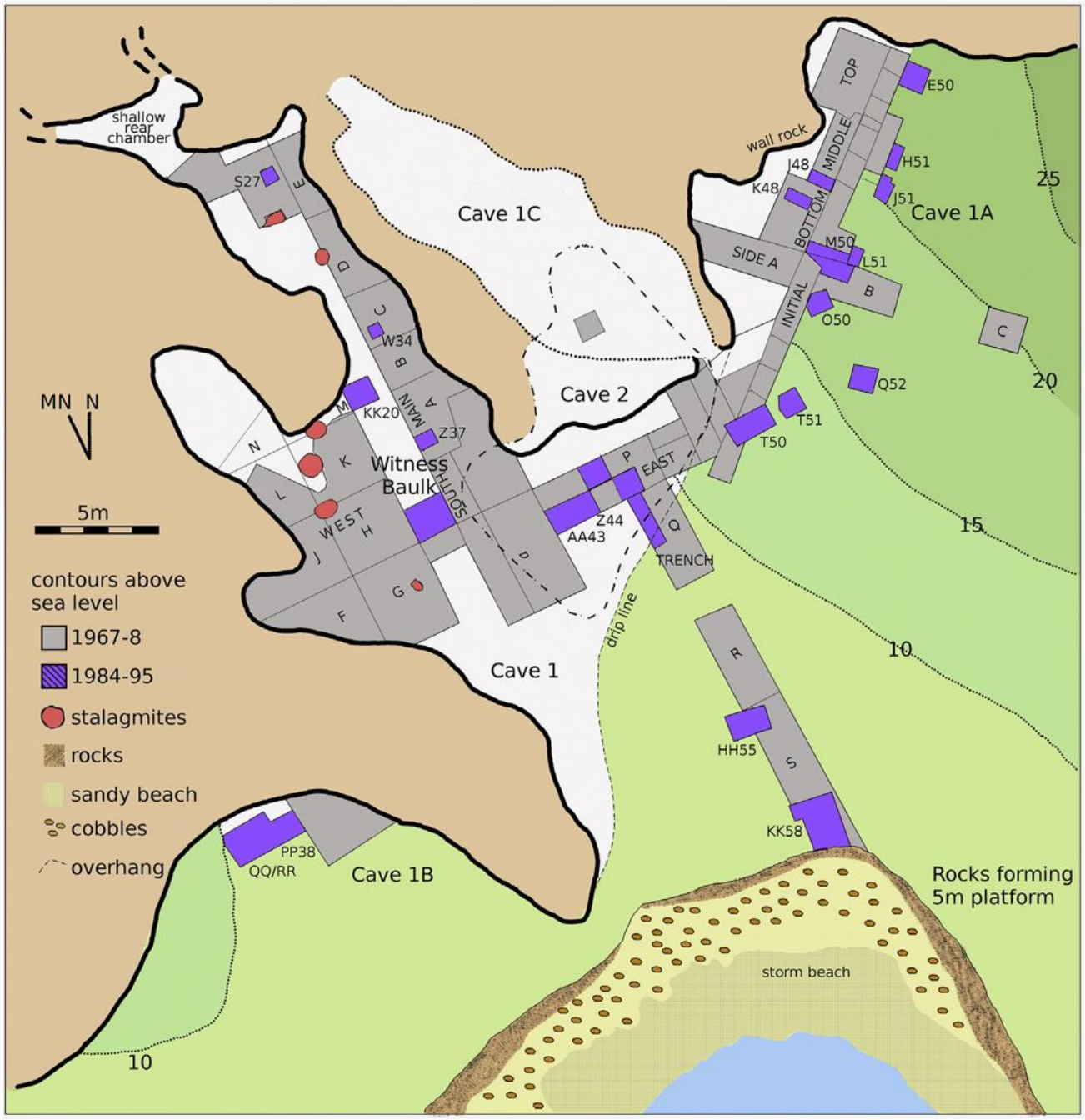

Figure 2. Plan of Singer and Wymer's (1967-8) and Deacon's (1984-95) excavation at KRM (Wurz *et al*., 2018)

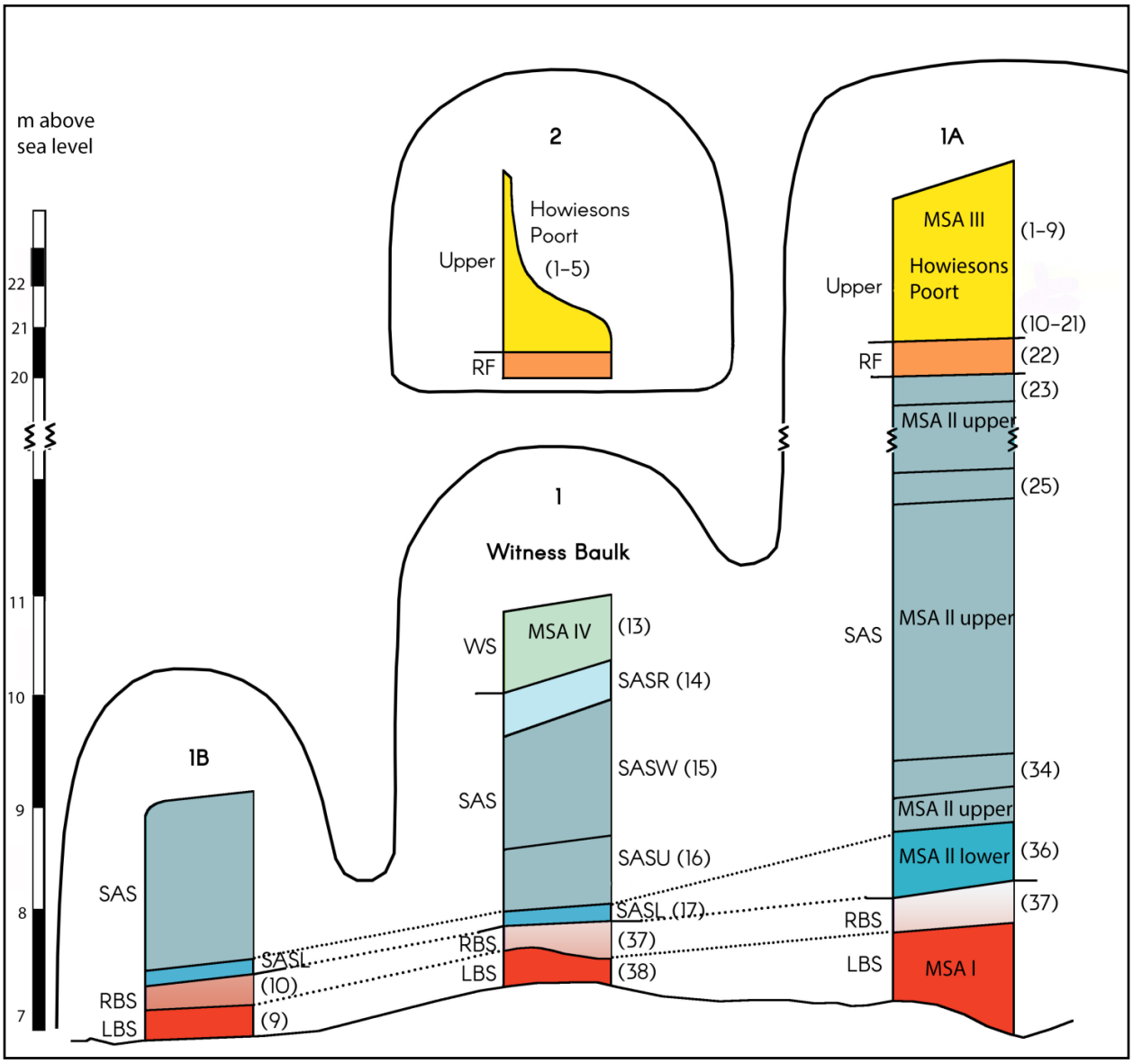

Figure 3. Stratigraphy of Cave 1, 1A, 1B and 2. Singer and Wymer layers are in the brackets (after Deacon & Geleijnse 1988)

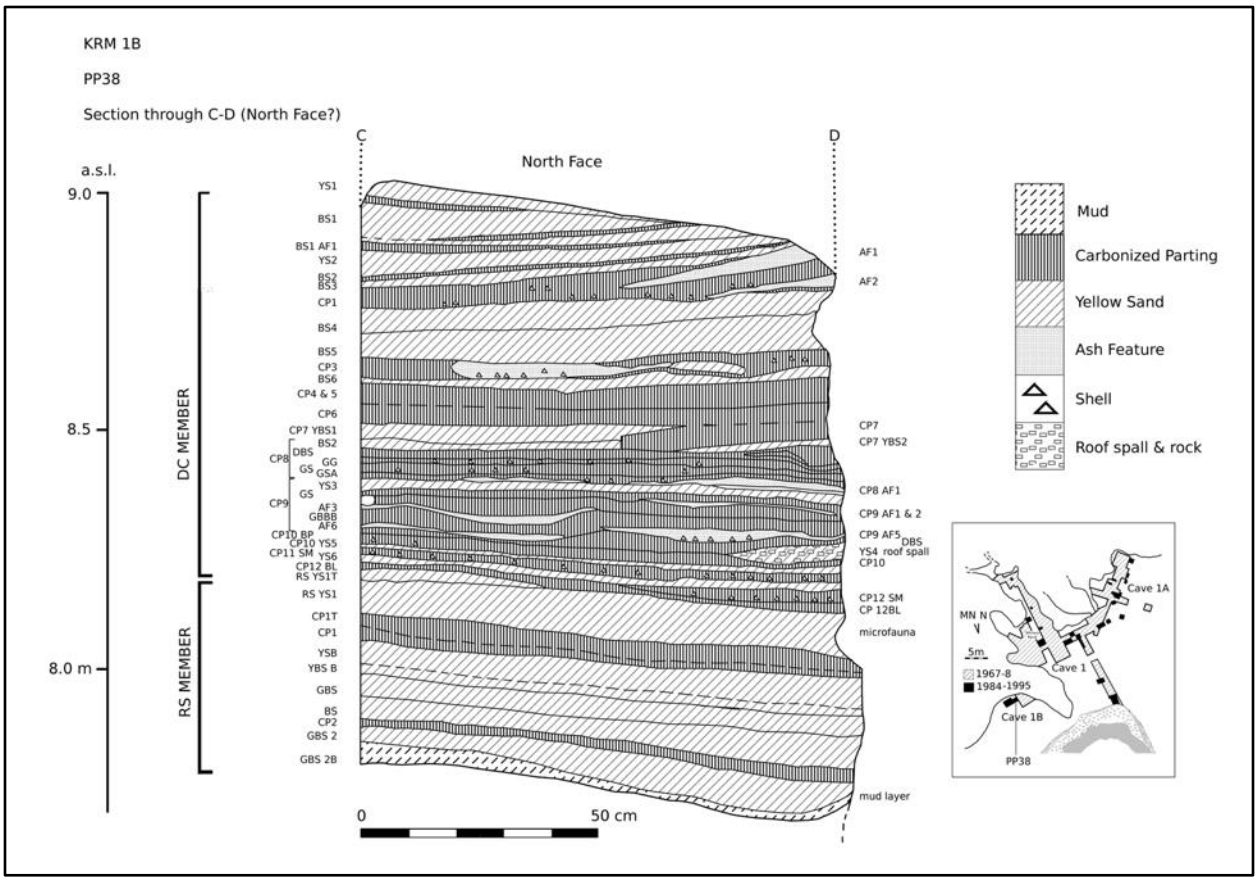

Figure 4. Sub-members and layers from KRM Cave 1B (stratigraphic drawing from the Deacon archive of field notes)

2.3 Faunal Research at Klasies River related to the MSA I

Both the Singer & Wymer and Deacon excavations at KRM have produced faunal remains that have been taxonomically analysed (Klein, 1976; Van Pletzen, 2000; Van Pletzen *et al*., 2019; Wurz *et al*., 2018; Reynard & Wurz, 2020). Limited taphonomic research has also been done on both samples (Milo, 1998). Recently, Lap (2020) undertook taphonomic analyses of MIS 5 fauna in Cave 1, and Pearson (2021) and Achieng (2019) analysed fauna from the HP and MSA III in Cave 1A from the Deacon excavations. Faunal analyses from the MSA I layers at KRM indicate a variety of taxa, including shellfish (Thackeray, 1988; Langejans *et al*. 2012, 2017), fish (Von den Driesch, 2004; Van Niekerk, 2011), birds (Klein, 1976; Avery, 1987b), micromammals (Nel *et al*., 2018) and large mammals (Klein, 1976; Van Pletzen *et al*., 2019; Reynard & Wurz, 2020).

For Cave 1 (S-W sample), Klein (1976) reported different small game taxa. Small game taxa include porcupines (*Hystrix africaeaustralis*), Cape hares (*Lepus capensis*) and rock hyraxes (*Procavia capensis*). Rock hyrax is the dominant small taxon in the MSA I layers in Cave 1 (Table 1, Klein, 1976). For the S-W sample, rock hyraxes are also the dominant small taxon and is the only small game present in the MSA I layers from Cave 1A from Van Pletzen's analyses (Table 2, Reynard & Wurz, 2020). In Cave 1B S-W sample, porcupines, Cape hares and rock hyraxes are present in the MSA I layers, with rock hyraxes also being the dominant taxon (Table 1, Klein, 1976).

At KRM, there are a variety of large game taxa reported from the MSA I layers in both samples. I discuss the large mammals in the following sequence: primates, bovids, equids, suids, hippopotamus (*Hippopotamus amphibius*), black rhinoceros (*Diceros bicornis*), elephant (*Loxodonta africana*), carnivores (Canids and Felids), including seals, as well as dolphins and whales. There are only two primate taxa identified from Caves 1 and 1B in the S-W sample (Klein, 1976). Humans (*Homo sapiens*) and baboons (*Papio ursinus*) were reported from the MSA I layers in Cave 1 and Cave 1B (Klein, 1976). Van Pletzen *et al*. (2019) did not analyse any of the human remains present in the MSA I layers in the D sample, but they were discussed by Deacon (2008) and Grine (Grine 2016; Grine *et al*. 2017, 2020).

Klein (1976) identified the following bovids from the MSA I layers of the S-W sample from Cave 1; Cape grysbok (*Raphicerus melanotis*), southern reedbuck (*Redunca arundinum*), mountain reedbuck (*Redunca fulvorufula*), blue antelope (*Hippotragus leucophaeus*), wildebeest (*Connochaetes gnou/taurinus*), bushbuck (*Tragelaphus scriptus*), greater kudu (*Tragelaphus strepsiceros*), eland (*Taurotragus oryx*), Cape buffalo (*Syncerus caffer*) and giant buffalo (*Pelorovis antiquus*) (Table 1).

In the S-W sample, Cape buffalo, giant buffalo, eland and blue antelope are the most abundant bovids in the MSA I layers in Cave 1, and eland is the most abundant in the MSA I layers in Cave 1B (Klein, 1976). For the D sample, Van Pletzen *et al*. (2019) report the presence of eland, greater kudu, Cape buffalo, giant buffalo, common duiker (*Sylvicapra grimmia*), hartebeest/wildebeest (*Alcelaphus/Connochaetes*), Cape grysbok/steenbok (*Raphicerus* sp.) and grey rhebok (*Pelea capreolus*) from the MSA I layers in Cave 1A (Table 2). Hartebeest/wildebeest, Cape buffalo and

giant buffalo were the most abundant from the MSA I layers from Cave 1/1A (Van Pletzen *et al*., 2019).

There is quagga (*Equus quagga*) and/or zebra (*Equus* sp.) in the MSA I layers (S-W excavation) in Cave 1 (Table 1, Klein, 1976). No equids were identified from Cave 1B (Klein, 1976). Bushpig (*Potamochoerus larvatus*) and warthog (*Phacochoerus africanus*) are the suid species identified from the MSA I layers in Cave 1 from the S-W and D excavations (Klein, 1976; Van Pletzen *et al*., 2019) (Table 1 and 2). In Cave 1B, bushpig was present at the MSA I layers (Klein, 1976).

Klein (1976) identified hippopotamus from MSA I layers in Cave 1 and 1B in the S-W sample (Table 1) and black rhinoceros from the MSA I layers in Cave 1. No other species of rhinoceros were reported from Caves 1A, 1B and 2 (Klein, 1976). The presence of hippopotamus suggests that a lake or wetland was nearby. These species are not found on the current landscape (Badenhorst *et al*., 2021b).

The following carnivore species were identified by Klein (1976) from MSA I layers in Cave 1 in the S-W sample; clawless otter (*Aonyx capensis*), marsh mongoose (*Atilax paludinosus*) and leopard (*Panthera pardus*) (Table 1, Klein, 1976). The much smaller D sample analysed by Van Pletzen *et al*. (2019) show indeterminate carnivores from the MSA I layers at Cave 1 (Table 2). In the S-W sample, black-backed jackal (*Canis mesomelas*) and marsh mongoose were identified from MSA I layers in Cave 1B (Table 1, Klein, 1976). The presence of such carnivores could indicate carnivore activity. There is a degree of carnivore activity reported in layers dated to around 110 Kya from the WB within KRM Cave 1, in the material excavated by Wurz (Lap, 2020). Klein (1976) recorded the occurrence of a fully articulated leopard (*Panthera pardus*) skeleton from the middle SAS layers (MSA II S-W 14-17b) in Cave 1, suggesting that these carnivores occasionally occupied the cave. Leopards usually revert to eating smaller fauna like baboons and rock hyraxes in the absence of impala (*Aepyceros melampus*) and reedbuck (Pienaar, 1969).

Cape fur seals (*Arctocephalus pusillus*) are present throughout the sequence, suggesting the sea was never far from the cave. According to the analyses of both Klein (1976) and Van Pletzen *et al*. (2019), Cape fur seals are abundant taxa in both samples (Tables 1 and 2). They are present throughout the MSA I in Cave 1, 1/1A and 1B. Van Pletzen *et al*. (2019) identified indeterminate Cetacea whale/dolphin from the D sample MSA I layers in Cave 1/1A, and dolphins (Delphinidae)

have been reported in S-W sample MSA I layers in Cave 1 (Klein, 1976). But none are present at Cave 1B (Klein, 1976).

Table 1. Minimum Number of Individuals of analysed fauna from MSA I layers of the Singer & Wymer sample in Klein (1976)

Taxa (common name)	**Cave 1 (37-39)**	**Cave 1B (1-15)**
Proboscidae		
Procavia capensis (rock hyrax)	4	14
Lagomorpha		
Lepus capensis (Cape hare)		1
Rodentia		
Hystrix africaeaustralis (porcupine)	3	1
Primates		
Papio ursinus (chacma baboon)	1	1
Homo sapiens (human)	2	1
Carnivora		
Panthera pardus (leopard)	1	
Atilax paludinosus (water mongoose)	1	1
Canis mesomelas (black-backed jackal)		1
Aonyx capensis (clawless otter)	1	
Arctocephalus pusillus (Cape fur seal)	11	21
Perissodactyla		
Diceros bicornis (black rhinoceros)	1	
Equus cf. quagga (zebra/quagga)	2	
Cetacean		
Delphinidae (dolphin)	3	
Cetacea (whale)	2	
Artiodactyla		
Potamochoerus larvatus (bushpig)	4	1
Phacochoerus africanus (warthog)	2	
Hippopotamus amphibius (hippopotamus)	6	2
Syncerus caffer (Cape buffalo)	11	1
Pelorovis antiquus (giant buffalo)	18	1
Tragelaphus strepsiceros (greater kudu)	3	
Tragelaphus scriptus (bushbuck)	3	1
Taurotragus oryx (eland)	21	9
Connochaetes sp. (wildebeest)	5	2
Alcelaphus buselaphus (hartebeest)	3	2

Hippotragus leucophaeus (blue antelope)	16	
Redunca arundinum (southern reedbuck)	4	
Redunca fulvorufula (mountain reedbuck)	4	1
Raphicerus melanotis (Cape grysbok)	4	
Total	**136**	**61**

Table 2. Number of Identified Specimen of analysed material from the AA43/Z44 square from the Cave 1/1A MSA I layers of the Deacon sample (Van Pletzen *et al.* 2019)

Taxa (common name)	**MSA I**
Proboscidae	
Procavia capensis (rock hyrax)	29
Carnivora	
Arctocephalus pusillus (Cape fur seal)	13
Indet. Carnivore	2
Perissodactyla	
Equus sp. (zebra/quagga)	2
Cetacean	
Indet. Cetacea (whale/dolphin)	1
Artiodactyla	
Suid sp. (bushpig/warthog)	1
Hippopotamus amphibius (hippopotamus)	5
Syncerus caffer (Cape buffalo)	3
Pelorovis antiquus (giant buffalo)	5
Tragelaphus strepsiceros (greater kudu)	1
Taurotragus oryx (eland)	5
Alcelaphus/Connochaetes (hartebeest/wildebeest)	3
Sylvicapra grimmia (common duiker)	2
Pelea capreolus (grey rhebok)	4
Raphicerus sp. (Cape grysbok/steenbok)	1
Bovid size classes	
Indet. Bovid	9
Large	34
Large medium	73
Small medium	48
Small	26
Indeterminate Mammals	
Indet. Mammal	24
Total	**289**

The micromammal fauna from KRM (D sample) has been analysed by Avery (1987) and Nel *et al*. (2018), including from the MSA l layers in Cave 1/1A. While numerous taxa are present, forest shrew (*Myosorex varius*), Duthie's golden mole (*Chlorotalapa duthiae*), striped mouse (*Rhabdomys pumilio*) and the South African vlei rat (*Otomys irroratus*) account for a significant fraction of the faunal assemblage from the MSA I layers. Most of the micromammals were most probably accumulated by avian taxa such as African barn owl (*Tyto alba*) and spotted eagle owl (*Bubo africanus*) (Avery, 1982; 1987). It is not clear if the spotted eagle owl had more of an influence in the accumulation of the micromammal fauna compared to the African barn owl (Andrews, 1990), since the assemblages of spotted eagles are known to contain relatively abundant micromammal fauna like *Rhabdomys* sp. and *Otomys* sp. (Matthew *et al*., 2011). Nel *et al*. (2018) concluded that spotted eagle owls were the main accumulators of the microfauna, although partial contribution was from the African barn owl. Avery (1987) has been able to highlight the rainfall, temperature and habitat (open or close vegetation) during MIS 5 by examining the relative abundance of different taxa and their relative change across the different layers (see below). Nel *et al.* (2018) analysed the micromammal fauna from the MSA I layers in Cave 1/1A. *Otomys* sp. Is the relatively most abundant taxa in the MSA I layers, and bats (*Chiroptera* sp.) were also recorded in the MSA I layers (Nel *et al*., 2018).

Micromammals have a specific environmental range and ecological needs, and they respond quickly to changes in the environment; and for these reasons, they make excellent palaeoenvironmental indicators (Faith *et al*., 2018; Matthews *et al*., 2011). The analyses by Nel *et al*. (2018) showed a greater diversity of micromammal species during the MSA I layers than MSA II layers at Cave 1, 1A and 1B, and this is a direct consequence of environmental change between MIS 5e and 5a. Thackeray (1988) indicated a decline in micromammal species diversity from the MSA I and II lower levels to the younger deposits at Cave 1A, which coincides with a decrease in temperature. *Otomys* sp. increased in relative abundance from the MSA I and MSA II lower to the MSA II upper layers in Cave 1A, and this indicates that there was an increase in seasonal rainfall pattern (Nel *et al*., 2018), as these species are known to require a moist environment (Thackeray, 1988). The MSA I period was much drier with little rainfall confined to the summer months. Based on the presence of forest shrew and golden mole (*Amblysomus hottentotus*) during the MSA I layers at KRM, the habitat reflects grassland, although there was an equal amount of shrubland present. The conditions were much drier than later in the MIS 5 (Nel *et al*., 2018).

There have been various species of birds reported at KRM from the S-W sample (Avery, 1990). They include great cormorants (*Phalacrocorax carbo*), African cormorants (*Phalacrocorax capensis*), gannet (*Morus capensis*), African barn owl, spotted eagle owl and flightless birds like penguins (*Spheniscus demersus*). Klein (1976) reported the presence of aquatic birds like penguin throughout the MSA layers from the S-W excavations. They are more abundant in the LSA levels at Cave 1. He concluded that MSA humans lacked the technological capability for fowling of airborne birds compared to their LSA counterparts (Klein, 1976). Penguins probably weren't on land throughout the year, as they are only present at the coast during the breeding season (Ksepka & Thomas, 2013).

Von den Driesch (2004) analysed the fish fauna from the D excavation at KRM. There are 82 species of fish from 47 different genera/family. The fish families present in the MSA I LBS layers are Clinidae, Sparidae, Gobiesocidae with the inclusion of Mugilidae, Carangidae, Teraponidae and Engraulidae found in the LBS layers at Cave 1B (Von den Driesch, 2004). Some of the fish material was regurgitated pellets of great cormorants or introduced through human activity (Von den Driesch, 2004; Deacon, 2001).

2.4 The Klasies Pattern

KRM has been central to faunal debates centred around the hunting proficiency of MSA relative to LSA humans (Klein, 1976; Binford, 1984; Thackeray, 1990; Milo, 1998, Outram, 2001; Outram *et al*., 2005; Faith, 2008; Dusseldorp, 2012; Clark & Kandel, 2013). The Klasies Pattern refers to the underrepresentation of proximal limb elements like femora and humeri of large bovids relative to more anatomically complete small bovids. The large bovid 4 have cranial and lower limb skeletal elements present (Klein, 1976, Bartram & Marean 1999). Klein (1976) identified this pattern in the bovids from the S-W assemblage at KRM. This pattern has implications for human behaviour during the MSA (Klein, 1976; 1978; 1983; 1989; Binford, 1984; Klein & Cruz-Uribe, 1991; Bartram & Marean, 1999). The Klasies Pattern is present at other sites (Binford, 1985; Chase, 1986; Klein, 1989; Stiner, 1991a; 1991b). The interpretations for the contributing factors to the Klasies Pattern include scavenging *versus* hunting (Binford, 1984), the '*schlepp*' effect (Klein, 1976), excavator's bias (Turner, 1989) and a combination of post-depositional damage, marrow extraction or agent of accumulation (Bartram & Marean, 1999).

Klein (1976) associated the Klasies Pattern as evidence of the '*schlepp*' effect. This effect is caused by distortion of the representation of skeletal parts due the difficulty associated with transport (Perkins & Daly, 1968). This means that for large bovids, only certain parts, such as the skull and lower limb portions, are carried back to the campsite, compared to smaller bovids, which weigh less and therefore, the whole individual can be easily transported back to campsites (Klein, 1989; Klein *et al*., 1999). Binford (1984) countered the reasons provided by Klein (1976) for the Klasies Pattern. He proposed that the '*schlepp*' effect had little theoretical support as applied to the Klasies Pattern. His reasons were that if MSA humans hunted and killed large prey, they would take portions back to campsites that provided enough economic returns and not parts containing less meat like the lower limbs and cranial parts. He suggested that smaller bovids were hunted and returned to camp, while larger bovids were most likely scavenged (Binford, 1984). He received criticisms for this proposal (Deacon, 1985; Thackeray & Binford, 1986; 1988; Klein, 1986; Turner, 1989).

Binford (1984) also argued that human scavengers were ignoring bone marrow from upper limb elements like the humerus and were only taking bones like radii, metapodia and phalanges because most of the upper limb elements and tibiae are areas with most of the meat that was already consumed by non-human scavengers (Outram, 2000). Blumenschine (1986) shows that there is no empirical evidence for human selection or avoidance of specific elements; he also mentions that different scavengers may favour different parts depending on the availability of particular skeletal elements on the carcass. There is no concrete explanation for why humans were scavenging lower limb proportions (Outram, 2000). For example, the modern Hadza people of Tanzania exploited marrow from all limb portions (O'Connell *et al*., 1988). Milo (1998) indicated that humans were responsible for most of the bone fragments at KRM, and only a few bones had porcupine or carnivore tooth marks on them. The issue of carnivores being responsible for the Klasies Pattern has lost support over the years. The S-W assemblage from KRM used a large mesh size of 1 in x 0.5 in and discarded unidentified specimens. This meant that smaller specimens were not considered and contribute to the faunal bias, which was a limitation to Milo's (1998) taphonomic study. Screen size plays an important role in determining faunal diversity, and previous faunal analyses with larger mesh sizes have been biased towards small fauna material like tortoises, birds and shellfish (Plug, 2000; Hutten, 2005).

Turner (1989) addressed the fact that both Klein (1976) and Binford (1984) ignored the discarding of unidentified specimens as an effect on their explanation for the cause of the Klasies Pattern. He, however, does not refute the Binford (1984) MSA human scavenging argument entirely. Turner (1989) showed that the '*schlepp*' effect is affected by post-excavation treatment. Turner (1989) admits that making any ethnographical inferences from the analysed fauna by Klein (1976) is flawed due to the discard of certain bone elements during excavations. However, the study by Klein (1976) is important for highlighting both pre- and immediate post-depositional processes that happen to animal remains. On the issue of unidentifiable bones, the non-identified component usually outnumbers the identified bones. Therefore, any skeletal part representation is based on a sub-sample only (Badenhorst & Plug, 2011).

Klein (1989) maintained that the Klasies Pattern was not a result of excavator's bias, incomplete recovery and discard of unidentified specimens. He also dismisses Binford's (1984) explanations for the Klasies Pattern due to its presence at other sites and in younger deposits (Turner, 1989). Moreover, only selected bone material was transported to the campsite (the *schlepp* effect), where they were subjected to *in situ* destruction. Research by Milo (1998) and Marean (1998) introduced the idea of selective transport, suggesting that long bones were excluded during analyses leading to cranial and foot dominant skeletal frequencies. Bartram and Marean (1999) proposed one or a combination of a series of taphonomic events that may be responsible for the skeletal incompleteness of bovid 2 (see chapter 3) specimens in the S-W assemblage. Bartram and Marean (1999) refitted the broken long bone shaft fragments from Die Kelders Cave 1 to solve the issue of long bone fragments that were unidentifiable due to heavy fragmentation, and they showed a significant difference in skeletal profiles when refitted long bone fragments were identified. They concluded that the pattern found was due to the processing of long bones for bone marrow by humans, leaving it highly fragmented and unidentifiable and systematically excluded from the following analyses.

Another contributing factor is that carnivores like hyenas are known to chew on epiphyseal ends on long bones (Bartram & Marean, 1999), causing them to be unidentifiable or absent. Marean *et al*. (2004) referred to refitting the long bone shaft as the 'shaft critique'. The long bone fragments are more difficult to identify to species level, causing them to have been excluded from the S-W sample (Marean & Frey, 1997; Bartram & Marean, 1999; Pickering *et al*., 2003; Marean *et al*.,

2004). Klein (1999) maintained that there was no carnivore damage from the S-W assemblage and that refitting the long bone shafts is impractical and time-consuming. Outram (2001) refuted Marean and Bartram's (1999) explanations of the Klasies Pattern. This is based on the lack of large bovid scapulae, which are denser than the scapulae of smaller bovids and therefore should survive pre- and post-depositional damage. He supports the notion that the Klasies Pattern is rather a process of selective transport (Klein, 1976).

In Deacon's and currently Wurz excavations, all the faunal remains were retained, which allows for a full evaluation of the Klasies Pattern in a complete assemblage. Unidentified faunal remains have an impact on the overall interpretation of an assemblage (Thackeray, 1979; Brain 1981; Reynard *et al*., 2014). Van Pletzen's (2000; *et al*., 2019) taxonomic analysis indicate that the skeletal part frequencies for bovids of all classes were evenly distributed, suggesting no evidence of the Klasies Pattern and that it was indeed a result of the S-W assemblage bias.

2.5 MSA Successful Hunter Debate

There have been arguments about the proficiency of MSA hunters compared to the LSA hunters. The debate arose due to explanations about the species representation from different MSA sites. Klein and Cruz-Uribe (1996) argued that MSA humans were not proficient at hunting large, dangerous game in comparison to Holocene humans. This was based on the large amount of docile prey like eland in MSA faunal assemblages at KRM, compared to the LSA deposits at Nelson Bay Cave (NBC). Klein (1976) also argued that a lack of flying birds and fish fauna in the S-W fauna assemblage from KRM reflects the technical insufficiencies of MSA hunters. The mortality profile of large game from MSA sites has also been used to argue about the hunting proficiency (Klein & Cruz-Uribe, 1996).

Klein and Cruz-Uribe (1991) stated that if the number of prime-aged bovid individuals proportions compared to older individuals were roughly equivalent, then the mortality was due to a catastrophic event. When the sample has relatively higher numbers of old aged individuals compared to prime-aged adults, then it is a result of attrition. MSA hunters were hunting young or older individuals of large bovids like the Cape buffalo. MSA hunters probably targeted them because they are more vulnerable or they were scavenged (Klein, 1978; 1983). This is evident at KRM since the age

distribution of Cape buffalo suggest that old or young individuals were targeted by MSA hunters (Klein, 1978). The mortality data on eland, and antelope from KRM are more evenly spread, with the presence of prime-aged individuals (Klein, 1978). The species mentioned above are susceptible to being driven into traps irrespective of a projectile weapon used. Recent research shows no correlation between specific tool technology and ungulate size classes present at Late Pleistocene deposits in South Africa (Smith *et al*., 2019).

The selection or avoidance of prey is based on fitness return, previous encounters with prey (Grayson, 2001) and migration patterns of prey (Faith & Thompson, 2013). If profitable species are unavailable, humans will resort to hunting less profitable species to decrease search time (Dusseldorp, 2010; 2012). Animals were also hunted based on the social value (Badenhorst & Plug, 2012). An animal can be considered as aggressive prey and is ranked as a low-ranked resource because they provide a less economic return for the risk associated with finding and capturing them and therefore is not a good indication of hunting success (Outram, 2000). While Klein (1976) had mentioned the lack of species like birds and fish as a lack of technological capability, recent research highlights that MSA people had a very broad diet breath (Clark & Kandel, 2013). An increase in dangerous prey is an indication of a wide diet breadth (Clark, 2009; 2011). According to Faith (2008), the presence of eland, buffaloes and suids are equally abundant during the MSA and LSA, and therefore, MSA hunters were as capable as LSA hunters. Weaver *et al*. (2011) however explains that there were inconsistencies used in the methods by Faith (2008). The inconsistencies were in the statistical method (log-transformation regression) used to compare the species frequencies between the MSA and LSA and the assumption that the environment at the sites such as DK1, BBC and Nelson Bay Cave (NBC) are the same as KRM (Weaver *et al*., 2011). Although there has been a lot of debates about the reasons for the difference, the frequencies of certain taxa like buffaloes, suids are also dependent on the environment (Weaver *et al*., 2011, Clark & Kandel, 2013).

2.6 Palaeoenvironment Trends based on Faunal Remains during the Early MIS 5 and 6

At KRM, the MSA I layers are linked to the Last Interglacial, MIS 5e (Deacon & Geleijnse, 1988), although re-dating studies might change this temporal association. This period is dated to between 130 Kya and 115 Kya and was characterised by high sea levels and relatively warm temperatures.

The global temperatures around during this period were drier and warmer than at present (Langejans *et al*., 2017; Loftus *et al*., 2019).

Faunal studies have used faunal composition and their shift in relative abundance across different layers to determine the changes in climate and vegetation at KRM (Klein, 1976; Avery, 1987; Thackeray, 1987; Thackeray, 1988; Avery, 1990; Langejans *et al*., 2017; Nel *et al*., 2018; Wurz *et al*., 2018, Van Pletzen *et al*., 2019; Reynard & Wurz, 2020). The ungulate diversity in an area has been shown to be affected by the amount rainfall the area receives, with winter and year-round rainfall zones have shown to be related to ungulate community richness (Faith, 2013a). This is because the amount of rainfall influences the forage ability and quality in an area (Thackeray, 1980; Olff *et al*., 2002). The use of fauna as proxies for environmental reconstruction can be problematic. This is because there are numerous variables, not just temperature, influencing the distribution of animals in an area (Shelford, 1931). Most species have a minimum, maximum and optimum range of environmental factors that they can tolerate. The combinations of these factors account for the success of a species in an ecozone. This is useful because species that may prefer a particular ecozone may inhabit an area where only a few environmental criteria for determining the species' success are present. Only when the conditions surpass a minimum or maximum threshold, there is a complete removal of species and taxa migrate from an area and then reflect a change in distribution (Shelford, 1931, Pörtner, 2001).

The presence or absence of specific ungulate taxa can be used to show changes or palaeoenvironmental trends. This can be done by assessing extant ungulates diets and preferred habitat based on current data (Skinner & Chimimba, 2005). However, a small sample size can influence confidence in palaeoenvironmental interpretations (Rector & Reed, 2010). Species like hares, hyraxes, eland, zebras, grysbok/steenbok and reedbuck occur across different habitats and ecozones and therefore are not very good indicators of the past environment. Rock hyraxes are adapted to many types of environments, provided there are rocky surfaces (Maswangye *et al*., 2017). Species like Cape grysbok can shift dietary habitats (Faith, 2011).

Despite these aspects, there is evidence that the palaeoenvironment and palaeoecology at KRM is reflected by the relative abundance of specific large mammals across the different layers (Klein, 1976; Van Pletzen, 2000; Van Pletzen *et al*., 2019, Reynard & Wurz, 2020). Klein (1976) compared the percentages of grassland species like equids and species that preferred a closed

habitat from LSA layers to the oldest MSA layers. The fluctuation in frequencies of different kinds of equids and bovids in layers indicate a change in the vegetation from closed to open grasslands in the MSA I layer dated to ~100 Kya.

There is a higher relative abundance of grazer species reported in the MSA I layers from Cave 1 at KRM (Reynard & Wurz, 2020). Klein's (1976) analysis also show the presence of large-bodied ungulates like Cape buffalo, giant buffalo and eland from the MSA I layers (S-W 37-39) at Cave 1, and these large species generally feed on low-quality forage like grass (Ryan *et al*., 2006). Analyses of large mammals from the MSA 1 layers from Cave 1B show eland and Cape grysbok as the more abundant ungulate taxa (Klein, 1976). Based on the faunal representation from the MSA I layers at KRM, the area to an extent was grassland, and temperatures were warmer with drier conditions compared to the MSA II (Reynard & Wurz, 2020).

2.7 Agents of Accumulation

Caves were occasionally occupied by humans, carnivores, rodents and raptors (Brain, 1981). This indicates that humans may not be entirely responsible for all MSA faunal assemblages (Grine & Klein, 1993). Taphonomy can be used to determine the agent(s) of accumulation of fauna (Brain, 1981; Binford, 1984; Milo, 1998, Achieng, 2019). Milo (1998) analysed the S-W faunal assemblage for cut marks, chop marks, rodent gnaw marks, burning and carnivore damage. There was minimal to no evidence of carnivore activity. This made him suggest that bones with carnivore modifications were scavenged parts discarded by humans.

In detailed taphonomic studies, carnivores may be partly responsible for the accumulation of smaller antelopes in MSA sites (Thompson, 2010, Faith, 2013b). Binford (1984) analysed the S-W fauna for porcupine, hyena and leopard activity. There were relatively low amounts of porcupine activity throughout the layers at KRM. There was a report of a fully articulated leopard by Singer and Wymer in layer 14 of Cave 1 at KRM (Singer & Wymer, 1982). Binford (1984) investigated the extent of leopard activity at these layers, and he reported no evidence that leopards accumulated the fauna from that layer. There was no incidence of hyena activity throughout the MSA I layers at KRM (Klein, 1976; Binford, 1984).

Binford (1984) used the ratios between grysbok and eland to determine the degree of hunting *versus* scavenging at the different layers. Humans and leopards are known to consume *Raphicerus* sp., therefore, leopards as well may be potential accumulators of assemblages with a relatively high abundance of *Raphicerus* sp. This is only in cases where leopard remains are also present. Thackeray (1990) suggested that the grysbok-eland ratio (Binford, 1984) is invalid for determining the hunting ability of humans. Thackeray (1990) calculated the indices of all the layers at KRM to determine the probability of carnivores as accumulators of the assemblages. S-W Layer 14 has a high probability of being accumulated by leopard according to the index values (Thackeray, 1990, p 102). There are no leopards remains in the MSA I layers at Cave 1B (Klein, 1976). This research aims to use both the indices and taphonomy to determine the extent of carnivore activity at the MSA 1 layers at KRM Cave 1B.

2.8 Conclusion

The information that can be obtained from the faunal material at KRM is beneficial to our current understanding of the evolution of MSA humans and their behaviour in the Southern Africa. The aim is to determine if there is a palaeoenvironmental changes that occurred during the MIS 6-5e, when the faunal material was accumulated. This period is known to have had brief periods of changes between glacial and interglacial periods (Helmens, 2013). The fauna can also show the interaction between MSA humans and the environment as well as the other taxa.

Chapter 3. Materials and Methods

3.1 Introduction

This chapter focuses on the materials used in this study it provides a description of the methods used to analyse the faunal remains.

3.2 Sample

Prof. H.J. Deacon excavated the faunal material used in this study in the 1980s (Deacon, 1989). The faunal remains are from the RS sub-member from Cave 1B, square PP38 (Figure 2). The excavation area was 1 x 1m in size and the material was sieved using a mesh size of 2 by 3mm. The faunal material retrieved includes mammals, birds, tortoise, toad/frogs, fish and shellfish as discussed in chapter 2, Section 2.1.2. For this study, I analysed the vertebrate remains. The faunal material also contained unidentifiable bone fragments.

3.3 Identification

I used the method suggested by Driver (2005) for taxonomic identification of the faunal material (Appendix 1). This method stipulates that specimens are identifiable when their element can be determined. This method has been used previously to analyse MSA faunas from South Africa (e.g., Reynard *et al*., 2016a; Badenhorst *et al*., 2016). Each bone specimen was identified first to the element and portion, and then to taxon. Specimens that could not be identified to an element were considered as unidentified bone material. Identified bone specimens were sided where possible. During analyses, epiphyseal fusion on long bones and vertebrae was recorded. Each specimen was given a double code, representing proximal – distal and anterior – posterior positions, based on their completeness or the part of the element present. The greatest length and cortical thickness of each specimen was measured using a caliper and were recorded according to a coding system. The cortical thickness was measured according to the method followed by Reynard *et al.* (2014), which states that the cortical thickness should be taken from the thickest part along the cortex. The analysis was done by comparing the faunal sample from Cave 1B, KRM, to the modern collections housed at the Evolutionary Studies Institute (ESI) of the University of the Witwatersrand and the

Ditsong National Museum of Natural History in Pretoria. The identified taxa were recorded on an Excel Spreadsheet (Appendix 2), including taphonomic details of each specimen.

The centrum shape of vertebrae can be used to differentiate between mammalian, avian or reptilian taxa (Linzey, 2012). I considered the cranial fragments, ribs, and vertebrae as either small, medium, or large mammals or birds, based on their size, according to Reynard *et al*. (2014). Identified long bone shaft fragments that could not be identified to species level were classified as either small, medium, or large mammals according to their cortical bone thickness (Reynard *et al.*, 2014; Reynard & Henshilwood, 2018; Table 3). Brain (1974) proposed a different analytical method than that used in this study, by considering vertebrae, enamel pieces and ribs as unidentifiable specimens. Previous faunal analyses from KRM did not consider ribs or vertebrae as identifiable specimens (Klein, 1976), and this affects the proportion of identifiable and unidentifiable specimens in the sample.

During analysis, some specimens could only be identified to a class, family or genus level. These specimens were then separated into different size classes. For this study, the indeterminate bovid specimens were assigned to four different bovid size classes, according to Brain (1974). These indeterminate bovid specimens were counted separately (Badenhorst & Plug, 2012). In contrast, Klein's analysis calculated the abundance of the bovid species/genera as an addition of both identified bovid taxa and indeterminate bovid specimens (Klein & Cruz-Uribe, 2000; Avery *et al.*, 2008; Steele & Klein, 2013; Grine & Klein, 1993, Table 3).

Table 3: The size class ranges for indeterminate fauna to taxa level

		Bovid Size Class			**Indeterminate Mammalian Size Class**	
Weight Range	**Cortical Thickness**	**Brain 1974**	**Klein 1976**	**This Study**	**Reynard & Henshilwood 2018**	**Example**
0-23 kg	0-1,9 mm	Bovid I	Small	Bovid I	Small	Grey Duiker

23-84 kg	2-3,9 mm	Bovid II	Small-Medium	Bovid II	Medium	Blesbok
84-296 kg	4-5,9 mm	Bovid III	Medium-Large	Bovid III	Medium	Black Wildebeest
>296 kg	6-7,9 mm	Bovid IV	Large	Bovid IV	Large	Eland
>296 kg	≥8 mm		Very Large	Bovid IV	Large	Giant Buffalo

3.4 Faunal Quantification

3.4.1 *Number of Identified Specimens (NISP)*

The NISP is the most commonly used method of quantification used by zooarchaeologists. Most zooarchaeologists conclude that NISP is the most reliable method to measure the relative abundance of taxa from archaeological and palaeo-anthropological sites (e.g. Grayson, 1984; Plug & Plug, 1990; Reitz & Wing, 1999; O'Connor, 2000). The NISP does not necessarily represent the actual, original taxonomic abundance of animals at the site (Grayson, 1984). For this study, I used NISP to quantify the different taxa. I considered teeth embedded in mandibles and maxillae as separate elements.

3.4.2 *Minimum Number of Individuals (MNI)*

The MNI is another method used to quantify faunal material. The MNI is the minimum number of individual animals required to completely represent all the faunal material in an accumulation unit. The MNI can be counted in different ways. The MNI is often calculated by considering aspects of an element such as age, side, and to an extent, sex of a specific taxon. The MNI is a highly problematic method of quantification and should be avoided (Plug & Plug, 1990; O'Connor, 2000).

3.4.3 *Statistics*

Zooarchaeologists often use statistical testing to answer questions about the faunal sample (Grayson, 1984). Statistical tests like the t-test (Badenhorst *et al*., 2021a) and chi-squared test (Klein, 1976) have been used to compare accumulations from southern African sites. Applying statistical testing to faunal remains can be problematic, unlike stone tools that are single units. All standard statistical tests assume that each observation is independent, and this means that the presence of an observation does not affect the presence of another observation. In a faunal assemblage, sample interdependence is impossible to prove in a fauna assemblage because each specimen is affected by the presence or absence of another taxa (Reitz & Wing, 1999). Larger game taxa have larger skeletal elements than smaller game taxa; therefore, they are more likely to be highly fragmented, while smaller game taxa have more complete bone specimens; therefore, the NISP of larger game in a faunal sample is inflated. Sample interdependence of faunal assemblages is affected because of the associated difficulty with proving that each NISP is from a single individual. Faunal remains are not random observations, and therefore they violate the basic principles of a statistical test. Since faunal studies do not have the same statistical test confidence as stone artefacts and pottery for example (Badenhorst, 2008), most studies use conservative statistical testing like ratios and %NISP (Badenhorst & Plug, 2012, Thackeray, 1990).

3.4.4 *Ratios*

Comparing NISPs or %NISPs of faunas from different sites or layers can be problematic. Several biological and taphonomic factors may result in biases when comparing NISPs of different sets of fauna. This is because NISPs are a function of factors like the original population of animals, human population density and length of human occupancy at a site, the location of excavations, the thickness of the layers excavated, preservation, taphonomy and fragmentation (Lyman, 2008; Fraser & Badenhorst, 2014). The solution to this is to use ratios. Ratios compare the relative abundance between particular taxa (Driver & Woiderski, 2008; Badenhorst, 2011). Such ratios provide cultural or ecological information (Driver & Woiderski, 2008; Badenhorst, 2011; Fraser & Badenhorst, 2014; Badenhorst, 2015).

For this study, I am using the ratios developed by Thackeray (1979, 1990) that can provide similar results to taphonomic studies in distinguishing between samples accumulated by carnivore and anthropogenic agents (Badenhorst *et al*., 2021a). The carnivore-ungulate ratio (C/U) is used to identify samples with high probabilities of hyena activity in accumulating faunas. It is calculated by dividing the total NISP of carnivores by that of the ungulates. The value is then represented as a percentage. The index value is higher for samples accumulated by hyenas. Samples with high numbers of carnivore remains such as hyenas, leopards and other terrestrial carnivores, are associated with probable hyena activities (Brain, 1981; Thackeray, 1990; Badenhorst *et al*., 2021a). Conversely, a high number of ungulates in a sample is primarily associated with human activity (Thackeray, 1990). The C/U is calculated without the inclusion of seals.

Often, the number of leopard and baboon remains in archaeological samples are small, hence the leopard index were formulated to identify samples with high probabilities of being accumulated at least in part by leopards (Thackeray, 1990). The leopard index (LI) measures the extent to which leopards contributed to the accumulation of faunal remains. The LI is the ratio between the NISP of leopards and baboons compared to that of ungulates. The LI is expressed as a percentage. A high number of baboons and leopards compared to ungulates indicate a site or layer with high probabilities of being accumulated by leopard activity. Leopards also often consume *Raphicerus* sp. and rock hyraxes, but measuring these taxa proved to be unreliable as indicators of leopard activities, as humans also often preyed on them (Badenhorst *et al*., 2021a). The leopard-brown hyena index is a combination of the C/U and LI. The ratios are calculated as;

$$\text{Carnivore} - \text{Ungulate Ratio} = \frac{\text{NISP (carnivores)}}{\text{NISP (ungulates)}} \text{ x } 100$$

$$\text{Leopard Index} = \frac{[\text{NISP (leopards)} + \text{NISP (baboons)}]}{\text{NISP (ungulates)}} \text{ x } 100$$

$$\text{Leopard} - \text{Hyeana Index} = \frac{[\text{NISP (leopards)} + \text{NISP (hyaenas)} + \text{NISP (carnivores)} + \text{NISP(baboons)}]}{\text{NISP (ungulates)}} \text{ x } 100$$

3.4.5 *Minimum Number of Elements (MNE)*

The Minimum Number of Elements (MNE) is the lowest number of elements for an individual taxon in a sample. To calculate the MNE, age, sex and side are ignored (Lyman, 2008). The MNE

is calculated using the number of single elements that had to be present from the fragmentary specimens (Marean *et al*., 2001). MNEs help quantify the relative abundance of certain skeletal parts in a faunal assemblage *versus* their relative frequency in the entire assemblage. The MNE faces a similar problem as the MNI, as the number is not a true representation of the skeletal abundance (Grayson, 1984). Nevertheless, I will calculate MNEs for the bovids.

3.4.6 *Minimum Animal Units (MAU)*

The MAU is calculated by dividing the MNE by the number of times a skeletal element appears in a complete skeleton (Binford, 1984). The MAU is similar to the MNE, however, bilaterally symmetrical specimens are considered. The MAU is the total number of all left and right elements, which is then divided by the total number of times the element appears in an individual. In the case of vertebrae, the total number of vertebrae is divided by the specific number of vertebrae type in a single individual (for example, 50 cervical vertebrae in a sample is divided by seven). Grayson (1984) suggested that this quantification method should not be used because if an analyst requires the specimen count, then the NISP or MNE would provide similar information. Nevertheless, I will use this calculation in my study for the bovids.

3.5 Taphonomy

Taphonomy is modifications and their effect on geological and cultural information (Lyman, 1994: 30). These modifications include burning, cut and chop marks (anthropogenic), carnivore tooth marks, rodent gnawing and digestion (zoogenic) and rootlet etching (natural). MSA faunal assemblages from caves and shelters could have been accumulated by humans or non-humans. The three main non-human accumulators of remains in caves or shelters are carnivores, porcupines and birds of prey (Brain, 1981; Lyman, 1994; Fisher, 1995).

3.5.1 *Anthropogenic Modifications*

It is important to determine the burning process when analysing burnt bone. The inference that sometimes can be made from burnt bones is the presence of fire in caves. The controlled use of

fire frequently indicates that humans cooked their food (Larbey *et al.*, 2019). Humans also use fire to provide warmth, chase away predators and it's possible that the temperature of fire was controlled for particular activities (Bentsen, 2013). Cooking is applying controlled heat to food such as meat or tubers for a specific amount of time. Burnt bones are a result of prolonged exposure to excessive heat. Burning can contribute to the fragmentation of bone specimens (Stiner *et al*., 1995, Reynard & Henshilwood, 2017). While acknowledging that bone can burn before burial, it is also possible to have burning occur after bone has been buried, such as underneath hearths (Grayson, 1988; Lyman, 1994).

Brain (1981) identified that the burning process occur in two stages. The first stage is the oxidisation state. This stage involves the periosteum on the bone being burnt, and this results in the black colouration formed on the bone. With continued heating, the bone becomes white, and this is the calcined state. Johnson (1989) distinguishes four burning stages, namely, unburned, scorched (superficial burning), charred (which is burnt black towards charcoal), and calcined blue-white colouration. The colouration is a practical way to categorise different burning stages (Taylor *et al*., 1995; Bennett, 1999; Clark & Ligouis, 2010). Colouration cannot indicate the precise temperature of burning. The amount of meat on the bone can also influence the colour and the duration of exposure to the fire/coals (Nicholson, 1993; Cain, 2005). For my study, the colouration of each burnt bone specimen will be recorded into four different colours to analyse the degree of heat that the bone specimen was exposed to, namely brown, black, grey, and white (Driver, 2005)

Cut marks on bones are produced by tools used during the skinning, dismemberment and removal of meat from the bone (Gifford-Gonzalez, 2018). Cut marks have behavioural significance. Cut marks show that MSA humans were using animals in multiple ways, namely skinning for production of the hide for clothing, reducing carcass to a smaller size and marrow and brain extraction (Binford, 1978; Brain, 1981; Lyman, 1995; 2005). Lyman (1995) shows that there is a lack of consistency with how cut marks are produced, and there are significant differences in the frequency of cut marks between archaeological sites from the same geographical location (Lyman, 1994; 2008).

Cut marks made with a stone tool are usually V-shaped. They include straight and deep striations and shoulder ridges which are small striae parallel to the main striations (Shipman, 1981; 1986). The location and direction of cut marks are used to differentiate them from other marks like those

produced by trampling (Binford, 1981). Cut marks can result from scraping the flesh off bone with stone tools (White, 2014), and scrape marks result from scraping the longitudinal axis of the bone with a stone tool, which results in parallel striations (Shipman, 1981). Slice marks are single extended grooves parallel to the working tool's longitudinal axis (Shipman, 1981).

Chop marks are produced when a bone is crushed or broken perpendicular to the bone surface by a percussive action with a tool (Lyman, 1994). Chop marks are not associated with striations (Shipman, 1981). Chop marks indicate humans reduced animal parts into smaller portions and broke a bone to extract marrow (Brain, 1981; Blumenschine & Selvaggio, 1988; Lyman, 1994). I observe most cut and chop marks with the naked eye. Some studies suggest that fauna should be subjected to magnification to increase the frequency of modifications observed (Thompson, 2010; Thompson & Henshilwood, 2011; Reynard & Henshilwood, 2019). However, the meaning of frequencies of modifications such as butchery is complex, and influenced by various factors such as butchering method, tenderness of meat as well as the age and sex of animals (Badenhorst, 2012; Badenhorst & Kimambo 2020) For this reason, the ratios developed by Thackeray (1990) will be used as they can provide information on the likelihood of hyaena and leopard contributions to the sample. Nevertheless, I randomly selected 100 unidentifiable bones from different layers and subjected them under a light microscope with 10X magnification to record additional modifications.

3.5.2 *Zoogenic Modifications*

Carnivore damage on bones show their interaction with species in an environment. Carnivores can destroy bone material in two ways: an original kill or scavenged prey from humans, or carnivore kills. Carnivore chew marks on bone are not fully indicative of hunting by carnivores and do not fully dismiss the possibility of hunting by humans (Yravedra *et al*., 2018). Carnivores like hyenas are known to be scavengers (Alam & Khan, 2015). The taphonomic relevance of carnivores are modification, destruction and transport (Gifford-Gonzalez, 2018). Here I describe damages inflicted by carnivore teeth.

Carnivores can inflict modifications such as teeth marks and gnaw marks. In South Africa, these modifications were first studied extensively by Brain (1981). Carnivore tooth marks can vary

because they are heterodonts. The frequency of carnivore teeth marks is also dependent on the bone element and surface (Binford, 1981; Blumenschine, 1995; Fisher, 1995; Domínguez-Rodrigo & Barba, 2006; Delany-Rivera *et al*., 2009; Gifford-Gonzalez, 2018). Tooth pits are often made by anterior premolars. They are small triangular shapes made on cortical bones (Binford, 1981). Tooth scores are grooves made when the anterior premolar is drawn across the cortical bone surface. Scores are U-shaped, and longer scores curve slightly (Maguire *et al*., 1980; Shipman, 1980). Scores can be a single groove or parallel grooves in any direction (Binford, 1981). Punctures are made by canines penetrating through cortical bone, creating a hole in the bone surface. They are circular or oval-shaped. Punctures are produced when the bone is not dense enough to withstand the pressure of carnivores' teeth (Binford 1981, Lyman 1994). Shipman (1981) suggests that puncture marks are due to a single tooth or cusp of a carnivore penetrating tooth at a perpendicular angle.

The spotted hyena is the most effective at flaking cortical bone, especially on long bone elements (Brain, 1981). Flaking is a result of pressure applied to the bone by two opposing teeth. This results in a flake being driven from the bone into the endosteal cavity of the bone. Furrowing is caused when damage is made to the cancellous bone by repeated scaping of carnivore canines or premolars. Furrowing results in grooves similar to the ones produced on the cortical surface.

A digested bone has lamellar and cortical bone loss, pitting on bone surface, rounding and thinning of the bone wall (Gifford-Gonzalez, 2018). This modification is caused by stomach acid and can only be observed if a bone is defecated or vomited before burial. The spotted hyena can digest bones up to the size of rhinoceros (Kruuk, 1972). Digested bone is indictive of carnivore presence at a site (Horwitz, 1990).

There are general taphonomic signatures that can differentiate between anthropogenic and carnivore accumulated assemblages. Leopards and/or hyenas are the main carnivore accumulators responsible for accumulating some of the faunal remains at many sites in southern Africa (Brain, 1981; Grine & Klein, 1993). The African leopard is known to carry carcasses of prey into trees to avoid other predators from scavenging. While feeding in the tree, the bone remains of the prey fall from the tree and gather below. African leopard also inhabited MSA caves (Brain, 1981, Cavallo & Blumenschine, 1989). Leopards leave less damage on bones compared to hyenas (Gifford-

Gonzalez, 2018). Striped hyenas are scavengers of large prey, even human burial remains (Kruuk, 1972). They also hunt smaller prey like porcupines (Kuhn *et al*., 2010).

Hyaena activity is also indicated by the presence of carnivore remains in the faunal assemblage, especially young individuals and the destruction of epiphyseal ends of long bones (Brain, 1981, Cain, 1995; Hutson & Cain, 2008). Spotted hyenas are known to chew off epiphyseal ends of long bones (Maguire *et al.*, 1980; Binford, 1981). Leopard accumulation usually has gnawed marks on the ends of long bones. Leopards' diets include small bovids (Bovid 1 and 2) like *Raphicerus,* baboons and small mammals like rock hyraxes (Brain, 1981). Fauna recovered from carnivore assemblages have low proportions of phalanges, carpals and tarsals (Klein, 1975; *et al.*, 1991). Ribs and vertebrae are destroyed, and the epiphyses of long bones are destroyed with only midshaft fragments (Marean *et al.*, 1992). This aspect of skeletal remains and proportions will be tested (Reynard, 2021). I investigate the differences in accumulation by comparing the frequencies of specific anthropogenic modifications and carnivore modifications to the entire faunal assemblage.

The identification of samples accumulated by raptors or owls usually has the presence of complete elements of species of prey birds with surface damage (Brain, 1981; Lyman, 1994; Marean *et al.*, 2000). Fauna assemblages contain prey species like rodents and other micromammals.

3.5.3 *Natural Modifications*

Root etching on bones is caused by the humic acid excreted from plants. They are randomly oriented in multiple directions (Lyman, 1994). The marks reflect individual roots that were in contact with a bone surface at some point in its taphonomic history. Root etching show plant growth in the environment the bone was buried. Rootlet etching can contribute to bone fragmentation (Thompson & Henshilwood, 2011; Reynard & Henshilwood, 2018). In this study, I recorded the occurrence of root etching on a bone. This will enable me to reconstruct the burial taphonomy of the specimens as a contributing factor to bone fragmentation.

Polishing is the smoothing and rounding that can occur on edges and flat surfaces of bone (Fisher, 1995). Humans can cause a bone to be polished intentionally or unintentionally. Polished bone

signifies that the bone was handled by humans for a long period during its taphonomic history before being buried (Shipman & Rose, 1988). Carnivores can also polish bones by repeatedly licking compact bone or grinding the bone surface with their teeth (Fisher, 1995; Gifford-Gonzalez, 2018). Other reasons include trampling by animals and humans, although this is not the typical case for every site (Brain, 1969; Madgwick, 2014); bones that were worked by humans usually have an abrasive surface. In other cases, hydraulic pressure from flowing water over the bone surface can become smooth (Brain, 1981; Fernandez-Jalvo & Andrews, 2016).

3.6 Fracture Patterns

Fracture patterns have been studied experimentally, and this is because long bones fracture in particular ways (Johnson, 1985, Villa & Mahieu, 1991). There are different types of fracture patterns. They include spiral, transverse and irregular breaks. Spiral fractures are produced when long bones are still fresh. They are usually V-shaped, curved or diagonal to the longitudinal section of a bone (Shipman, 1981; Villa & Mahieu, 1991). Spiral fractures can be caused by both humans and carnivores (Haynes, 1983). Transverse fractures are perpendicular to the long axis of long bones. They are produced when a bone is dry (Villa & Mahieu, 1991; Lyman, 1994). Transverse fracture can be caused by post depositional damages as well as carnivore activity (Lyman, 1994). Irregular breakage is an uneven pattern perpendicular to the long bone axis. Irregular breakage is noted when there is no clear distinction on the other fracture typologies mentioned prior.

The fracture ends of long bones were recorded using a two-letter coding system. The codes were noted for fracture patterns found on the proximal end following the distal end of long bones. Long bones include humeri, radii, ulnae, femora, tibiae, fibulae, metacarpals, metatarsals and phalanges.

3.7 Osteometry

Osteometry refers to measurements taken of bones or teeth. Measuring bones are an essential method for zooarchaeologists to be objective about the size or form of animals and have comparable traits between individual bones. Osteometry can also be used to determine the sex and age of certain taxa such as bovids and rock hyraxes (Von den Driesch, 1976; Peters, 1986, Munro

& Badenhorst, in press). Bone and teeth measurements also give an understanding of the animals' evolutionary history, and it allows for the comparison of modern to pre-existing forms of a species (Von den Driesch, 1976). Although it is generally accepted that bone measurements should only be taken on adult individuals, bone measurements can also be used to determine age groups (Von den Driesch, 1976). The data provided by the measurements is comparable if analyst make use of the same points landmarks on specific bone elements.

In my analyses, I took the specific measurements using a caliper on cranial and long bones following Von den Driesch (1976). I also took measurements on bovid carpals and tarsals (Von den Driesch, 1976; Peters, 1986). While morphology is used for determining the taxa of an element, bone measurements were used for elements that are very similar between species in the same family. For example, phalanges are morphologically very similar between bovid taxa, however, there is variation in specific measurements between taxa (Peters & Brink, 1992).

The method of osteometry is necessary for identifying postcranial elements of endemic bovids like springbok and grey rhebok in a fauna sample (Peters & Brink, 1992). These bovid taxa help establish ecological and environmental information about MSA assemblages. Osteometry can also be used to separate between bovid size class (Swanepoel *et al*., 2008). In some cases, separating elements between taxa like *Raphicerus campestris* (steenbok) and *Raphicerus melanotis* (Cape grysbok) is very difficult (Klein & Cruz-Uribe, 1991; Plug, 2014).

3.8 Ageing and Sexing

Sexual dimorphism is a noticeable trait in many species. Physical competition for mates may result in differences in size between males and females. Males are larger than females due to sexual selection favouring larger body size (Gifford-Gonzalez, 2018). Zooarchaeologists can use differences in bone structures and size to observe sexual dimorphism in archaeological fauna, however, it is dependent on which skeletal elements are preserved. Elements such as the innominate bones, skull and horns can often distinguish females and males of the same species. Differences can be noted in cranial size and shape (Skinner & Chimimba, 2005). In bovids, one of the distinguishing characters between males and females is a horn; for example, female impalas

do not have horns. In cases where both males and females have horns, there are differences in the structure, shape or texture (Skinner & Chimimba, 2005; Klein, 1978). In females, the pelvic cavity (birth canal) is larger than males (Estévez Campo *et al.*, 2018). In mammals that have multiple births at once, such as suids and carnivores, the individual foetus is much smaller than the pelvic cavity and the pelvic cavity does not change sure, but the pelvic cavity rarely preserves. (Reitz & Wings, 1999; O'Connor, 2000; Plug, 2014).

Tooth eruption is a way of determining age in species; this is because teeth erupt in a predictable sequence in most mammals. The presence of a certain mixture of deciduous and permanent teeth and the timing of permanent teeth eruption can give information about age. Wear patterns and the number of centrum layers on a tooth are accurate indicators of age, although the latter is rather destructive to teeth. While wear patterns can indicate the relative age of an individual, it is heavily influenced by the diet of the individual (Klein & Cruz-Uribe, 1984). The presence of fused and unfused epiphyses of a bone is also a good indicator of age. Other signs of ageing such as exostosis, ossification of cartilage and the arthritic lesion can differentiate adults from juveniles. For this study, I consider the endochondral fusion pattern on long bones. I also observe wear patterns on teeth, and although this is arbitrary, I use it to determine if an individual is a juvenile, sub-adult, adult or old age. The fusions pattern on proximal and distal ends of elements are coded according to Driver (2005).

Previous studies have tried to shed light on the rock hyrax assemblages accumulated by different predators (Klein & Cruz-Uribe, 1996; Cruz-Uribe & Klein, 1998), and other studies have shown their seasonality and their subsistent use during the MSA (Parkington & Poggenpoel, 1971; Parkington, 1972, Badenhorst *et al*., 2014). In the Eastern Cape, male rock hyraxes are known to have a peak in spermatogenic activity around February and March, and then it decreases for the remainder of the year. Females have a gestation period of 230 days; therefore, there is a marked seasonality of birth. This is between September and October for the Western Cape and between October and November for Eastern Cape (Skinner & Chimimba, 2005).

Fisher and Parkington (2014) recorded stages of teeth eruption for rock hyraxes. They used October as the first month of each year, considering it is the peak of birthing in the Eastern Cape. This is not the case in other places like Zimbabwe where parturition period is between March and April (Skinner & Chimimba, 2005). They found that certain eruption stages, such as replacing

deciduous incisors and premolars with their permanent counterparts, occur within a short period. Permanent incisors are already erupted by July (nine months after birth) in the first year. The permanent premolars (P2-P4) are erupted during December and replace the deciduous teeth by January in the second year. The permanent molars (M1-M3) are partially erupted from January to July in the first year after birth. The first molar (M1) fully erupts in October in the second year after birth. The second (M2) and third (M3) molars remain partially erupted from July in the second year through to October in the third year after birth (Fisher & Parkington, 2014). The eruption pattern is used to identify the month of death (MOD). This information helps estimate the season of hyrax accumulation, and I will utilise this aging system for rock hyraxes in my sample. The aging data based on tooth eruption patterns data already provided by Steyn & Hanks (1983, Table 1, p 250).

In rock hyraxes, sex difference is not very noticeable in living individuals. Males generally weigh 10% more than females. One difference is in the incisor shape (Klein and Cruz-Uribe, 1996). The males have a triangular-shaped incisor, while females have a flatter rectangular shape. Here I note the differences in specimen identified as rock hyraxes to determine both sex and age by using tooth eruption pattern and body measurements of the individual specimens (Peters, 1986; Von den Driesch, 1976).

3.9 Palaeoenvironment

Zooarchaeologists have used large mammal remains for palaeoenvironmental reconstructions (Klein, 1976; Faith, 2013b; Van Pletzen, 2000; Faith, 2018; Faith & Lyman, 2019; Van Pletzen *et al*., 2019). The diversity of ungulates in an area is linked to the primary environmental productivity and precipitation (Thackeray, 1980; Faith, 2013a). Ungulate diversity increases with an increase in amount of rainfall (Olff *et al*., 2002). Faith (2011) argues that the decrease in ungulate diversity in the southern Cape results from the decline in grassland areas during the MIS 5.

When using a faunal list to reconstruct the palaeoenvironment, the first step to take is to draw from published material about species geographical distribution and ecological tolerance. Certain species are habitat-specific, however, the ecological tolerance of extinct forms of particular species may differ from those present. The relative abundance and absence of taxa can be informative and

conspicuous about the palaeoenvironment (Faith & Lyman, 2019). Overhunting has affected the distribution of present-day species compared to the past forms (Ogutu *et al.*, 2010) and therefore, the distribution of species today is not always a good reflection of their historical distribution (Faith & Lyman; 2019; Avery, 2019).

Regardless of the quantification methods used, such as MNI and NISP, ratios are good to compare the relative abundance of species (Grayson, 1984; Lyman, 2008). Here I compare the relative abundance of grazing species such as blue antelope, roan or sable, giant buffalo or Cape buffalo *versus* browsing species such as blue or common duiker (Klein, 1976) to determine if the palaeoenvironment had a degree of forestation or an open grassland area.

Other methods such as the degree of vegetative cover (DVC) index is used by Thackeray (1990). It is calculated by adding the number of kudus, eland, bushbuck and *Raphicerus* sp. and expressing the value as a percentage of the total number of ungulates in an assemblage (Thackeray, 1990; Lebatla *et al.*, 2020). A high DVC index value indicates more likely fynbos than grassland environment, although the values can be affected by behaviour (Klein, 1972).

3.10 Conclusion

The above-mentioned zooarchaeological methodologies are used to assess the fauna to examine the taphonomic signatures caused by possible site formation processes from the KRM Cave 1B RS faunal sample and to determine the palaeoenvironment at KRM during the MIS 5e. The analysis of the data from the material is provided in the following chapter 4 and the findings are discussed in chapter 5.

Chapter 4. Results

4.1 Sample

The faunal sample consists of 19 468 specimens from 26 layers, of which 1 239 (6%) are identifiable (Table 4). The YBS and YS1M layers have the most specimens (n=157, 8% and n=177, 5% respectively). Layer BYS1 has the highest percentage of identifiable bone (n=4, 67%), but this is most likely due to the small sample size.

Table 4. The Number of Identified Specimens (NISP), unidentified specimens and percentage of identified specimens per layer of the RS sub-member in KRM Cave 1B

Layer	Identified Specimens	Unidentified Specimens	Total	% Identified Specimens
GBS 2B	100	1066	1166	9%
GBS 2	101	1267	1368	7%
CP2	20	413	433	5%
CP2T	42	1460	1502	3%
BCH	89	712	801	11%
BR	14	20	34	41%
BRAF	3	33	36	8%
BRU	9	158	167	5%
BS	66	1376	1442	5%
BSH1	32	116	148	22%
BSH2	68	164	232	29%
BSH2 BH	15	66	81	19%
BYS1	4	2	6	67%
GBS	28	487	515	5%
YBS B	57	689	746	8%
YBS	157	1858	2015	8%

YRU	75	966	1041	7%
CP1	17	1511	1528	1%
CP1T	8	194	202	4%
YS1	22	88	110	20%
YS1T	46	1134	1180	4%
YS1M	177	3455	3632	5%
Y/SH	37	262	299	12%
CP3	17	196	213	8%
DRU	35	536	571	6%
Total	**1239**	**18229**	**19468**	**6%**

The collectors' curve shows that the sample size I analysed is a good representation of the total number of taxa potentially represented at KRM Cave 1B (Figure 5). However, after the sample size reached approximately 800 specimens, the curve starts to flatten, indicating that few more additional taxa will be added through additional analyses (Badenhorst *et al*., 2021a).

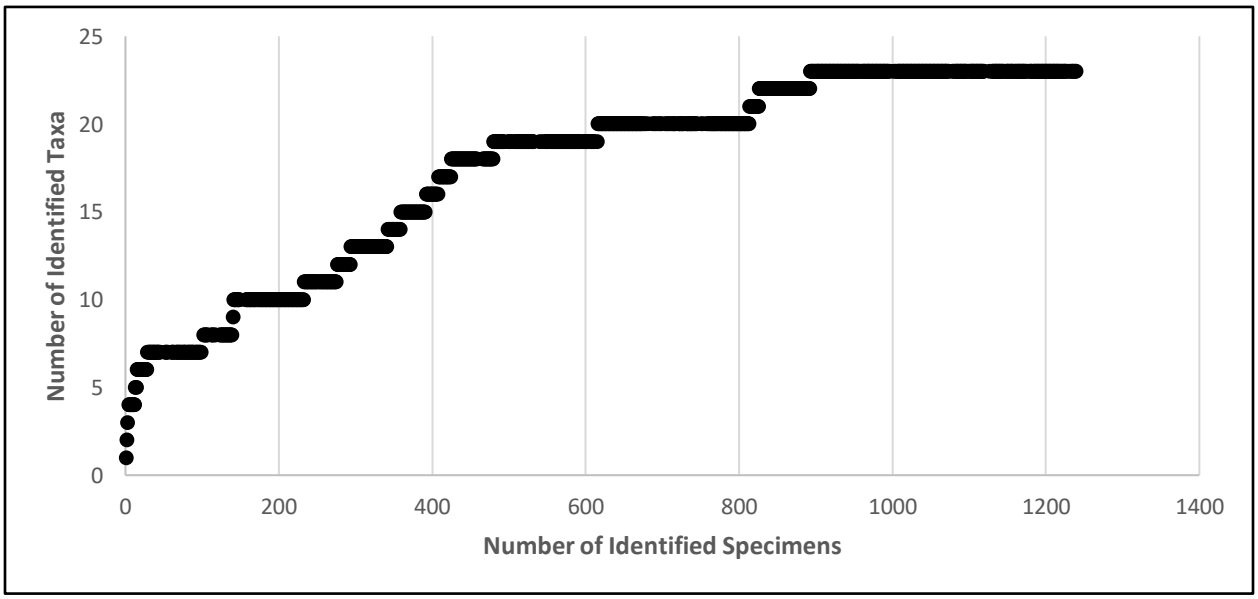

Figure 5. The collectors' curve of taxa identified from the RS sub-member layers at Klasies Cave 1B

4.2 Taxa Representation

The sample contains mammals, birds, reptiles, amphibians and fish (Table 5, Appendix 2). The most common taxa identified from the sample are the rock hyrax (*Procavia capensis*) and Cape fur seal (*Arctocephalus pusillus*) (n=133, 11%, n=58, 5% respectively). The indeterminate small rodent remains were found in various layers. However, the only rodent taxa identified is the vlei rat (*Otomys* sp.), and it is likely that many of the indeterminate small rodent remains are from this taxon. It is also possible that additional taxa may be present in the sample. Rock hyraxes are relatively common and present in many layers. The highest number of rock hyraxes are present in layer YBS (n=29, 22%), which is a middle layer in the RS sub-member. Most of the indeterminate small mammal specimens are likely rock hyraxes. Only one baboon (*Papio ursinus*) specimen is present. This is a first phalanx from layer YBS. The only identified carnivore remains are the Cape fur seal (n=58, 5%). Cape fur seals are present in most layers, with the highest number of seals from layer YBS (n=17, 29%). Many of the indeterminate medium carnivore specimen are probably seal. However, there is a distal humerus fragment identified as an indeterminate small carnivore from layer YBS. This specimen does not appear to be from a seal. There are three vertebrae remain from the GBS 2B layer that are potentially from dolphins or whales. The remains of the Cape grysbok/steenbok (*Raphicerus* sp.) are present in most layers, and they are also the most common ungulate (n=27, 2%). While present in many layers, the highest NISP is from layer YBS (n=4, 15%). Other bovid taxa identified from the assemblage include mountain (*Redunca fulvorufula*) and southern reedbuck (*Redunca arundinum*), oribi (*Ourebia ourebia*), grey rhebok (*Pelea capreolus*), roan/sable/blue antelope (*Hippotragus* sp.), wildebeest/hartebeest (Alcelaphaline sp.), eland (*Taurotragus oryx*), Cape buffalo (*Syncerus caffer*) and giant buffalo (*Pelorovis antiquus*) (Appendix 2). Many of these bovid taxa consist mainly of isolated specimens from a variety of layers. From the indeterminate bovids, size class 1 are most numerous (n=65, 40%), and many of these are likely Cape grysbok/steenbok.

Bird remains are present in most layers (Table 5). The African penguin (*Spheniscus demersus*) is the most prevalent bird taxon (n=38, 3%), and it occurs in most layers. The Cape seagull (*Phalacrocorax capensis*) and the eagle owl (*Bubo* sp.) are the other identified avian taxa. Most of

the eagle owl specimens are from layer GBS 2 (n=9, 50%). Many of the indeterminate medium birds (n=260, 21%) are most likely the African penguins.

There are some tortoise/turtle (Testudinidae sp.) specimens present in most layers (Table 5), and the most are present in the GBS 2B layer (n=6, 22%). There are relatively high numbers of tortoise remains in the BCH and YRU layers (n=5, 19% and n=4, 15%, respectively). There is a urostyle fragment from a toad or a frog present in the GBS 2 layer. There are seven fish specimens present in a few layers, but they were not identified to species level, with most from layer YS1M (n=3, 43%).

Table 5. The total NISP and percentage of the total sample of identified taxa from the RS layers at KRM Cave 1B. The species follow the order listed by Skinner and Chimimba (2005) for the mammals and Maclean (1985) for the birds

	Taxa (Common Name)	**Total NISP**	**% NISP**
Rodentia	*Otomys* sp. (vlei rat)	8	1%
	Small rodent	43	4%
Proboscidae	*Procavia capensis* (rock hyrax)	133	11%
	cf. Procavia capensis (possibly rock hyrax)	3	<1%
Primate	*Papio ursinus* (chacma baboon)	1	<1%
Carnivora	*Arctocephalus pusillus* (Cape fur seal)	58	5%
	Small carnivore	1	<1%
Cetacea	Cetacea (dolphin/whale)	3	<1%
Artiodactyla	*Syncerus caffer* (Cape buffalo)	3	<1%
	cf. Syncerus caffer (possibly Cape buffalo)	1	<1%
	Pelorovis antiquus (giant buffalo)	2	<1%

	Taurotragus oryx (eland)	3	<1%
	Alcelaphaline sp. (hartebeest/wildebeest)	4	<1%
	Pelea capreolus (grey rhebok)	1	<1%
	Hippotragus sp. (roan/sable/blue antelope)	8	1%
	Redunca arundinum (southern reedbuck)	1	<1%
	Redunca fulvorufula (mountain reedbuck)	8	1%
	Redunca sp. (southern/mountain reedbuck)	10	1%
	cf. Redunca sp. possibly southern/mountain reedbuck)	1	<1%
	Ourebia ourebia (oribi)	1	<1%
	Raphicerus sp. (Cape grysbok/steenbok)	27	2%
	cf. Raphicerus sp. (possibly Cape grysbok/steenbok)	1	<1%
	Bovid 1	65	5%
	Bovid 2	43	4%
	Bovid 2/3	2	<1%
	Bovid 3	50	4%
	Bovid 3/4	2	<1%
	Bovid 4	1	<1%
Indeterminate Mammal	Small mammal	156	13%
	Small/medium mammal	2	<1%
	Medium mammal	120	10%
	Large mammal	34	3%

Avian	*Bubo* sp. (eagle owl)	18	2%
	Phalacrocorax capensis (Cape sea gull)	5	<1%
	Spheniscus demersus (African penguin)	38	3%
	Small bird	71	6%
	Small/medium bird	13	1%
	Medium bird	260	21%
Reptilia	Testudinidae sp. (tortoise/turtle)	27	2%
Amphibia	Amphibian sp. (frog/toad)	1	<1%
Fish	Fish	7	1%
Total		**1239**	

4.3 Palaeoenvironment

There are some grazing taxa in the faunal assemblage. They include the Cape buffalo (n=3, <1%), possibly Cape buffalo (n=1, <1%) giant buffalo (n=2, <1%), wildebeest/hartebeest (n=4, <1%), roan/sable/blue antelope (n=8, 1%), southern reedbuck (n=1, <1%), mountain reedbuck (n=8, 1%) and southern/mountain reedbuck (n=10, 1%). The taxa that prefer a mixed grassland and forested environment are eland (n=3, <1%), oribi (n=1, <1%), grey rhebok (n=1, <1%), Cape grysbok/steenbok (n=27, 2%) and *cf. Raphicerus* sp. (n=1, <1%). There are no browsing taxa present. Grazers are more common in the younger deposits from layers CP1T. In the CP1T layer, only grazing taxa occur and the layers younger than CP1T all have a higher representation of grazers than mixed feeders. The YS1 layer also has only grazing species present. The older deposits (Layers GBS-BS) have better representation of mixed-feeding and grazing taxa compared to the younger layers. In layers GBS 2 and YBS B, only mixed-feeding taxa are present although in both cases the NISPs are small (Figure 6).

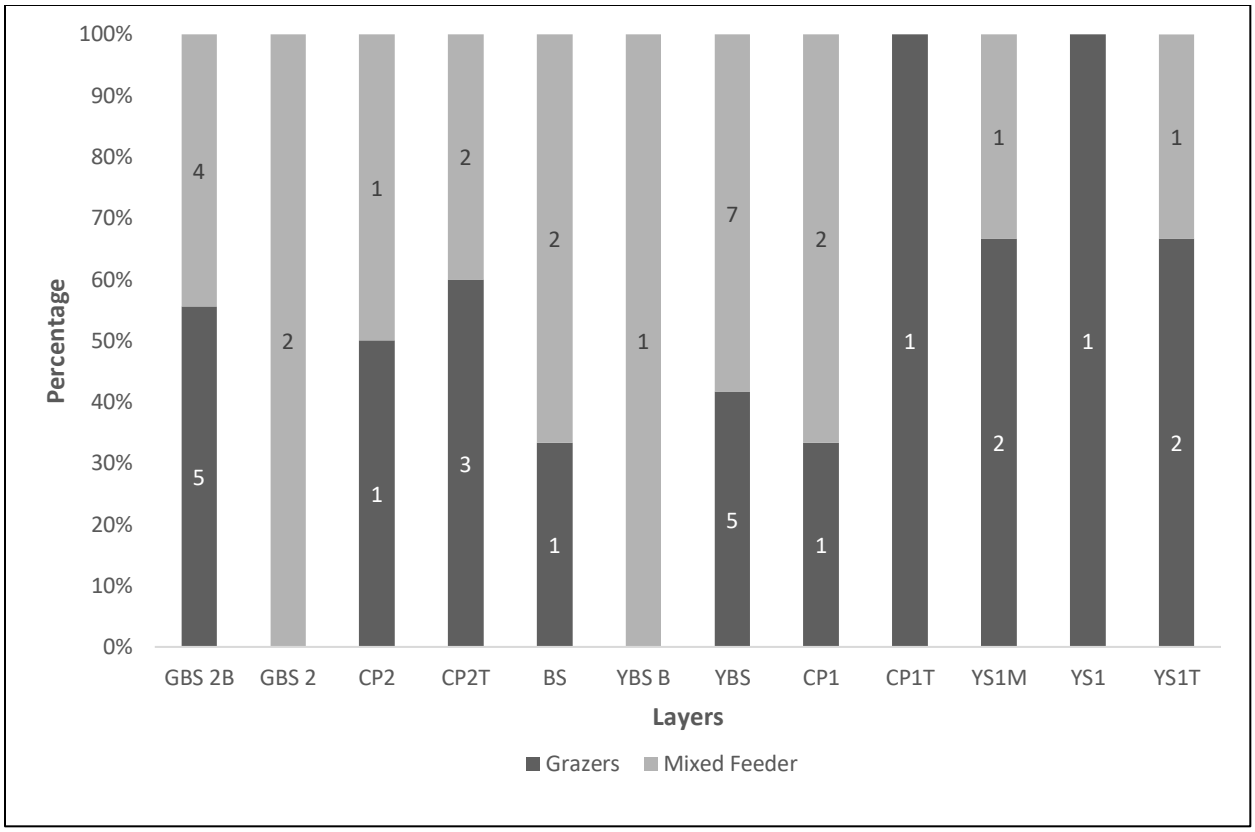

Figure 6: A clustered bar chart of the relative abundance of grazers and mixed feeders per layer from the oldest (on the left) to youngest layers at the RS sub-member in KRM Cave 1B. The identified ungulate species are divided into groups based on their environmental preferences according to Skinner & Chimimba (2005). NISP values are presented within the bars

4.4 Skeletal Part Representation

The identified bovids were combined with the indeterminate bovid size classes. The skeletal element representation (Table 6) of bovid size classes shows that the majority of the skeletal elements preserved are lower limb skeletal element (n=171, 73%). The bovid 1 and 2 elements represented are mostly phalanges (n=36, 45% n=17, 39%, respectively). 15% of the identified bovid specimens are cranial skeletal elements. There were no upper limb skeletal elements for bovid 4 size classes. This overall sample correspondents with the Klasies Pattern. Bovid 1, 2 and 3 size classes all have relatively complete skeletal element representation compared to the bovid

4s, which only have cranial and lower limb element present (see Klein, 1976). However, the sample size of bovid 4s is low.

The Klasies Pattern however could not be observed in the layers with the highest number of identified taxa, YS1M (n=177) and YBS (n=157) (Tables 7 – 8.3). In the YS1M layer, there are only lower limb elements present for bovid 1, 2 and 3 size classes (Table 7). The YBS layer however has cranial, upper, and lower limb skeletal elements for bovid 1, 2 and 3 but only lower limb elements are present for bovid 4 (Tables 8.1-8.3). While the overall sample may reflect the Klasies Pattern this may not be the case per individual layer.

Table 6.1. The total NISP of cranial skeletal elements identified from the different bovid taxa. The identified bovids are included in the bovid size classes. (The percentage row is calculated per the total NISP of the different bovid size classes)

Elements	**Bovid 1**	**Bovid 2**	**Bovid 3**	**Bovid 3/4**	**Bovid 4**	**Total**	**%**
Horn Core	0	0	2	2	0	4	2%
Occipital	1	0	0	0	0	1	0%
Maxilla	0	2	0	0	0	2	1%
Mandible	1	2	5	0	0	8	3%
Premolar	2	2	8	0	1	13	6%
Molar	0	0	3	0	2	5	2%
Tooth Fragment	1	1	1	0	0	3	1%
Total Cranial	**5**	**7**	**19**	**2**	**3**	**36**	**15%**
Percentage	**5%**	**11%**	**31%**	**100%**	**30%**		

Table 6.2. The total NISP of upper limb skeletal elements identified from the different bovid taxa. The identified bovids are included in the bovid size classes. (The percentage row is calculated per the total NISP of the different bovid size classes)

Elements	**Bovid 1**	**Bovid 2**	**Bovid 3**	**Total**	**%**
Scapula	0	1	1	2	1%
Humerus	2	3	2	7	3%
Innominate	0	4	0	4	2%
Femur	4	6	2	12	5%
Patella	2		0	2	1%
Total Upper Limbs	**8**	**14**	**5**	**27**	**12%**
Percentage	**9%**	**22%**	**8%**		

Table 6.3. The total NISP of lower limb skeletal elements identified from the different bovid taxa. The identified bovids are included in the bovid size classes. (The percentage row is calculated per the total NISP of the different bovid size classes)

Elements	**Bovid 1**	**Bovid 2**	**Bovid 2/3**	**Bovid 3**	**Bovid 4**	**Total**	**%**
Radius	8	0	1	2	0	11	5%
Ulna	1	2	0	1	0	4	2%
Carpal	1	5	0	2	3	11	5%
Metacarpal	1	2	0	0	0	3	1%
Tibia	3	4	0	0	0	7	3%
Metatarsal	2	1	0	2	1	6	3%
Metapodial	10	9	0	9	0	28	12%
Tarsal	4	2	0	3	0	9	4%
Astragalus	6	0	0	1	0	7	3%
Calcaneus	3	1	0	1	0	5	2%
Sesamoid	5	1	1	7	0	14	6%

First Phalanx	8	8	0	5	1	22	9%
Second Phalanx	14	6	0	4	1	25	11%
Third Phalanx	14	3	0	1	1	19	8%
Total Lower Limbs	**80**	**44**	**2**	**38**	**7**	**171**	**73%**
Percentage	**86%**	**68%**	**100%**	**61%**	**70%**		

Table 7. The total NISP of lower limb skeletal elements identified as bovid taxa from layer YS1M. The identified bovid taxa were included in the bovid size classes. (The percentage row is calculated per the total NISP of the different bovid size classes)

Elements	**Bovid 1**	**Bovid 2**	**Bovid 3**
Radius	1	0	0
Tibia	0	1	0
Metapodial	5	2	1
Tarsal	0	0	2
Astragalus	1	0	1
Calcaneus	1	0	0
Sesamoid	0	1	0
First Phalanx	3	0	0
Second Phalanx	4	0	1
Third Phalanx	2	1	0
Total Lower Limbs	**17**	**5**	**4**
Percentage	**100%**	**100%**	**100%**

Table 8.1. The total NISP of cranial skeletal elements identified as bovid taxa from layer YBS. The identified bovid taxa were included in the bovid size classes. (The percentage row is calculated per the total NISP of the different bovid size classes)

Elements	**Bovid 1**	**Bovid 2**	**Bovid 3**

Horn Core	0	0	1
Maxilla	0	2	0
Mandible	1	2	0
Premolar	2	0	0
Total Cranial	**3**	**4**	**1**
Percentage	**21%**	**44%**	**14%**

Table 8.2. The total NISP of upper limb skeletal elements identified as bovid taxa from layer YBS. The identified bovid taxa were included in the bovid size classes. (The percentage row is calculated per the total NISP of the different bovid size classes)

Elements	**Bovid 1**	**Bovid 2**	**Bovid 3**
Scapula	0	0	0
Humerus	1	0	0
Innominate	0	0	0
Femur	1	1	1
Patella	0	0	0
Total Upper Limbs	**2**	**1**	**1**
Percentage	**14%**	**11%**	**14%**

Table 8.3. The total NISP of lower limb skeletal elements identified as bovid taxa from layer YBS. The identified bovid taxa were included in the bovid size classes. (The percentage row is calculated per the total NISP of the different bovid size classes)

Elements	**Bovid 1**	**Bovid 2**	**Bovid 2/3**	**Bovid 3**	**Bovid 4**
Radius	2	0	1	0	0
Ulna	0	1	0	0	0
Carpal	0	0	0	0	3
Metacarpal	0	0	0	0	0

Tibia	1	0	0	0	0
Metatarsal	0	0	0	0	0
Metapodial	1	2	0	0	0
Tarsal	0	1	0	0	0
Astragalus	1	0	0	0	0
Calcaneus	0	0	0	1	0
Sesamoid	1	0	1	1	0
First Phalanx	1	0	0	2	0
Second Phalanx	0	0	0	1	0
Third Phalanx	2	0	0	0	0
Total Lower Limbs	**9**	**4**	**2**	**5**	**3**
Percentage	**64%**	**44%**	**100%**	**71%**	**100%**

The larger bovids, namely bovid 3 and 4, have more proximal portions of long bones present (41%, 50%, respectively) than the smaller bovids 1 and 2, that have more distal portions (50%, 44%, respectively, Table 9). There are a few long bone shafts present for bovid 1, 2, 3 and 4 (Figure 7).

Table 9. The number of skeletal parts of identified long bone specimens. Long bone in bovids include humeri, radii, ulnae, metacarpals, femora, tibiae, fibulae, metatarsals and phalanges. The identified bovids are included in the bovid size classes

		Bovid 1	**Bovid 2**	**Bovid 2/3**	**Bovid 3**	**Bovid 4**
Proximal	n	22	14	0	12	2
	Percentage	39%	34%	0%	41%	50%
Shaft	n	6	9	0	9	1
	Percentage	11%	22%	0%	31%	25%
Distal	n	28	18	1	8	1
	Percentage	50%	44%	100%	28%	25%

	Total	**56**	**41**	**1**	**29**	**4**

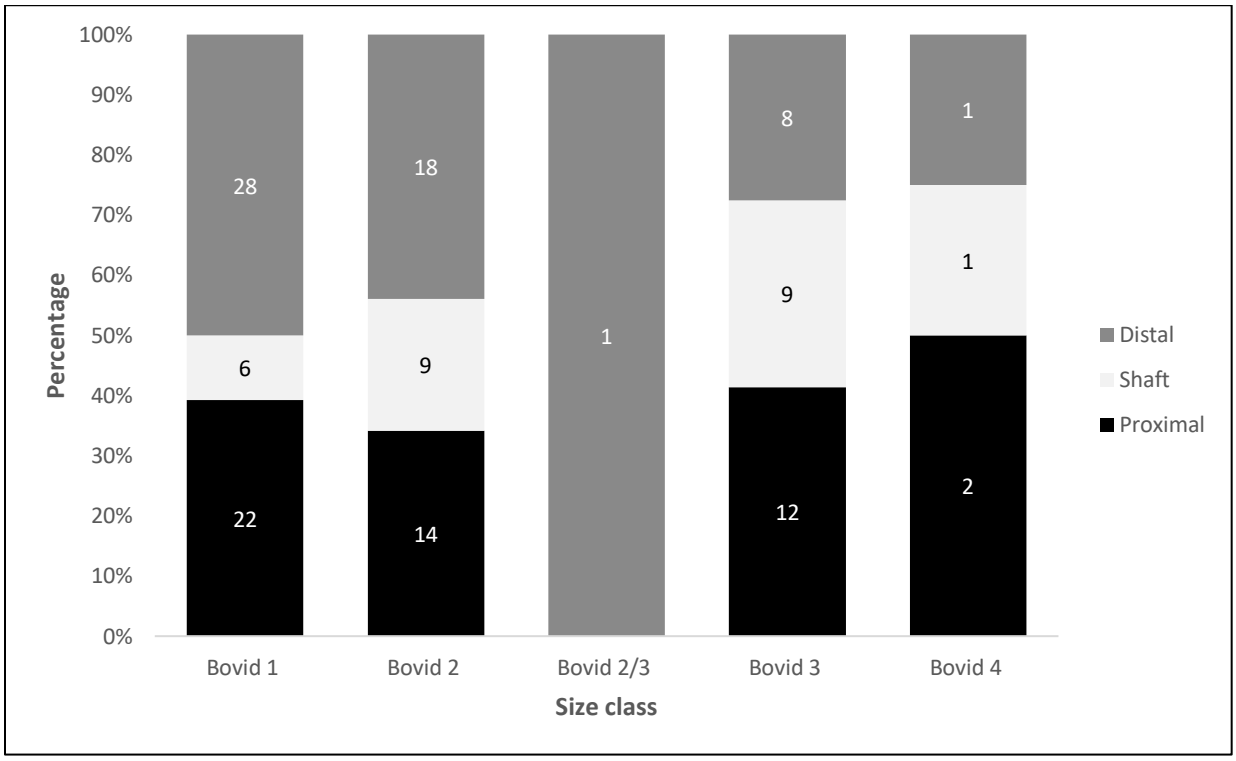

Figure 7: A clustered bar graph representing the skeletal portions of bovid long bones. The identified bovids are included in the bovid size classes. The NISP values are inserted in the bars

The data suggest that there is a potential that the pattern of preserved skeletal parts for bovids in this sample is as a result of bone density (Brain, 1981, Table 10). The are no proximal ends of humeri present in the sample. Premolars are the best represented cranial element (n=13). They have a high preservation rate. The most preserved skeletal fragments are metapodia (n=28), and according to Brain's (1981) density categories, this element has a high chance of being well preserved because they are dense. There are several carpals and sesamoid elements (n=11, n=14, respectively), and they are very dense and preserve well, thereby increasing the lower limb skeletal portions. There is a high number of phalanges in a bovid skeleton, they are highly dense and therefore are well preserved (n=66, Table 10).

Table 10. The skeletal part representation of identified bovids and the NISP of identified bone. Bone density categories are from Brain (1981)

	Skeletal Part	**Total NISP**	**Density Categories**
Skull	Horn Core	4	Intermediate
	Occipital	1	Low to High
	Maxilla	2	High
	Mandible	8	High
	Premolar	13	High
	Molar	5	High
	Tooth Fragment	3	High
Scapula	Head	2	Low to High
	Other fragment	0	-
Humerus	Proximal ends	0	Low
	Distal ends	2	Low to High
	Shaft fragment	5	Low to High
Innominate	Acetabular portion	3	Intermediate to High
	Other fragments	1	Intermediate
Femur	Proximal ends	2	Low
	Distal ends	7	Low to High
	Shaft fragment	3	Low to High
Patella		2	-
Radius and Ulna	Complete	0	Low
	Proximal ends	7	Intermediate to High
	Distal ends	5	Intermediate to High
	Shaft fragment	3	Intermediate to High
Carpal		11	High
Metacarpal	Complete	0	Low

	Proximal ends	2	High
	Distal ends	0	High
	Shaft fragment	1	High
Tibia	Proximal ends	0	Low
	Distal ends	7	Low to High
	Shaft fragment	0	Low to High
Metatarsal	Complete	0	Low
	Proximal ends	4	High
	Distal ends	1	High
	Shaft fragment	1	High
Metapodial		28	High
Tarsal		9	High
Astragalus		7	-
Calcaneus		5	-
Sesamoid		14	High
First Phalanx		22	High
Second Phalanx		25	High
Third Phalanx		19	Intermediate

There is a possibility that most of the indeterminate medium and large mammals bone specimens are bovids and/or Cape fur seals. Most of the indeterminate medium mammal bone specimens are vertebra and ribs (n=39, 33% n=42, 35%, respectively, Table 11). The indeterminate large mammals mostly have tooth fragments present, suggesting that the skulls of large game was returned to Cave 1B. There are also several petrosa (n=11, 7%) which are most probably bovid remains, but they are difficult to differentiate between mammal species.

Table 11. The NISP of the skeletal elements represented as indeterminate medium and large mammals

Elements	**Medium Mammal**	**Large Mammal**	**Total**	**%**
Cranial	1	3	4	3%
Occipital condyle	1	0	1	1%
Petrosa	7	4	11	7%
Mandible	2	0	2	1%
Tooth fragment	8	11	19	12%
Vertebra	39	4	43	28%
Cervical vertebra	2	1	3	2%
Thoracic vertebra	6	0	6	4%
Ribs	42	6	48	31%
Ossified costal cartilage	0	2	2	1%
Lumbar vertebra	1	1	2	1%
Caudal vertebra	1	0	1	1%
Scapula	1	0	1	1%
Humerus	2	0	2	1%
Innominate	1	0	1	1%
Femur	4	1	5	3%
Fibula	1	0	1	1%
Sesamoid	1	1	2	1%
Total	**120**	**34**	**154**	

4.4.1 *MNEs and MAUs*

The MNE and MAU values are very low for all the bovid size classes (Table 12). The highest MNEs for bovid 1s are the third phalanges (n=7). Bovid 4s do not have enough elements to make a complete animal unit, but the most number of elements are carpals, identified as eland (n=3).

Table 12. The MNE and MAU values of the different bovid size classes. The identified bovids are also included in the bovid size classes

Elements	**Bovid 1**		**Bovid 2**		**Bovid 2/3**		**Bovid 3**		**Bovid 4**	
	MNE	**MAU**	**MNE**	**MAU**	**MNE**	**MAU**	**MNE**	**MAU**	**MNE**	**MAU**
Premolar	-	-	2	-	-	-	-	-	-	-
Patella	1	0,5	-	-	-	-	-	-	-	-
Radius	1	0,5	-	-	-	-	-	-	-	-
Carpal	1	-	2	-	-	-	1	-	3	-
Metacarpal	1	0,3	-	-	-	-	-	-	-	-
Tarsal	3	-	1	-	-	-	2	-	-	-
Astragalus	3	1,5	-	-	-	-	-	-	-	-
Calcaneus	1	0,5	-	-	-	-	-	-	-	-
Sesamoid	3	-	1	-	1	-	6	-	-	-
First Phalanx	3	0,4	3	0,4	-	-	1	0,1	-	-
Second Phalanx	4	0,5	2	0,3	-	-	-	-	-	-
Third Phalanx	7	0,9	2	0,3	-	-	-	-	-	-
Total	**28**	**-**	**13**	**-**	**1**	**-**	**10**	**-**	**3**	**-**

The most common taxon in the sample are rock hyraxes. Rock hyraxes have a nearly complete representation of their skeletal elements, except that there are no phalanges (Table 13.1) because of the difficulty involved in differentiating phalanges amongst small mammalian taxa (Hillson, 2016). Several skeletal elements identified as rock hyrax were mandibles (n=43), and there is also a high number of maxillae (n=28). The maxillae and mandibles that were identified had sets of premolars and molars embedded. There were also isolated teeth and several incisors, premolars, and molars present. Most of the indeterminate small mammals are likely rock hyraxes, and these

are dominated by vertebrae. The indeterminate small and medium mammals have more cranial, upper limb and lower limb skeletal elements compared to the large mammals (Table 13.1). It is important to note that there are many vertebrates and ribs for the indeterminate small and medium mammals.

Table 13.1. The NISP of the skeletal element represented as indeterminate small mammal taxa, rock hyraxes and possibly rock hyraxes

Elements	**Rock Hyrax**	**Possibly Rock Hyrax**	**Small Mammal**	**Small/ Medium Mammal**	**Total**	**%**
Cranial	0	0	4	0	4	1%
Petrosa	0	0	9	0	9	3%
Maxilla	28	0	3	0	31	11%
Mandible	43	0	3	0	46	16%
Incisor	4	1	0	0	5	2%
Premolar	4	0	0	0	4	1%
Tooth fragment	6	0	3	0	9	3%
Vertebra	0	0	69	1	70	24%
Axis	1	0	1	0	2	1%
Thoracic vertebra	0	0	2	1	3	1%
Ossified costal cartilage	0	0	1	0	1	1%
Caudal vertebra	0	0	2	0	2	7%
Rib	0	0	20	0	20	<1%
Scapula	7	0	3	0	10	4%

Humerus	9	0	4	0	13	2%
Femur	8	0	3	0	11	3%
Patella	4	0	1	0	5	2%
Ulna	7	1	0	0	8	<1%
Carpal	2	0	4	0	6	2%
Metatarsal	0	0	1	0	1	1%
Metapodial	3	0	2	0	5	3%
Astragalus	3	0	0	0	3	3%
Calcaneus	4	1	3	0	8	2%
Sesamoid	0	0	8	0	8	<1%
First Phalanx	0	0	6	0	6	<1%
Second Phalanx	0	0	1	0	1	1%
Third Phalanx	0	0	1	0	1	1%
Phalanx	0	0	2	0	2	3%
Total	**133**	**3**	**156**	**2**	**294**	

There is a higher number of cranial elements present compared to postcranial elements for rock hyraxes (n=86, 63%, Table 13.2). The proportion of forelimb skeletal elements to hindlimb skeletal elements are very similar (Figure 8). There are only just three more forelimb bone specimens (n=26, Table 13.3).

Table 13.2. The NISP of cranial *versus* post cranial skeletal elements identified as rock hyraxes and possibly rock hyraxes

Elements	**Rock hyrax**
Maxilla	28

Mandible	43
Incisor	4
Premolar	5
Tooth fragment	6
Total	**86**
Percentage	**63%**
Axis	1
Scapula	7
Humerus	9
Femur	8
Patella	4
Ulna	8
Carpal	2
Metapodial	3
Astragalus	3
Calcaneus	5
Total	**50**
Percentage	**37%**

Table 13.3. The NISP of forelimb *versus* hindlimb skeletal elements identified as rock hyraxes and possibly rock hyraxes

Elements	**Rock hyrax**
Scapula	7
Humerus	9
Ulna	8
Carpal	2
Total	**26**

Percentage	**54%**
Femur	8
Patella	4
Metapodial	3
Astragalus	3
Calcaneus	5
Total	**23**
Percentage	**46%**

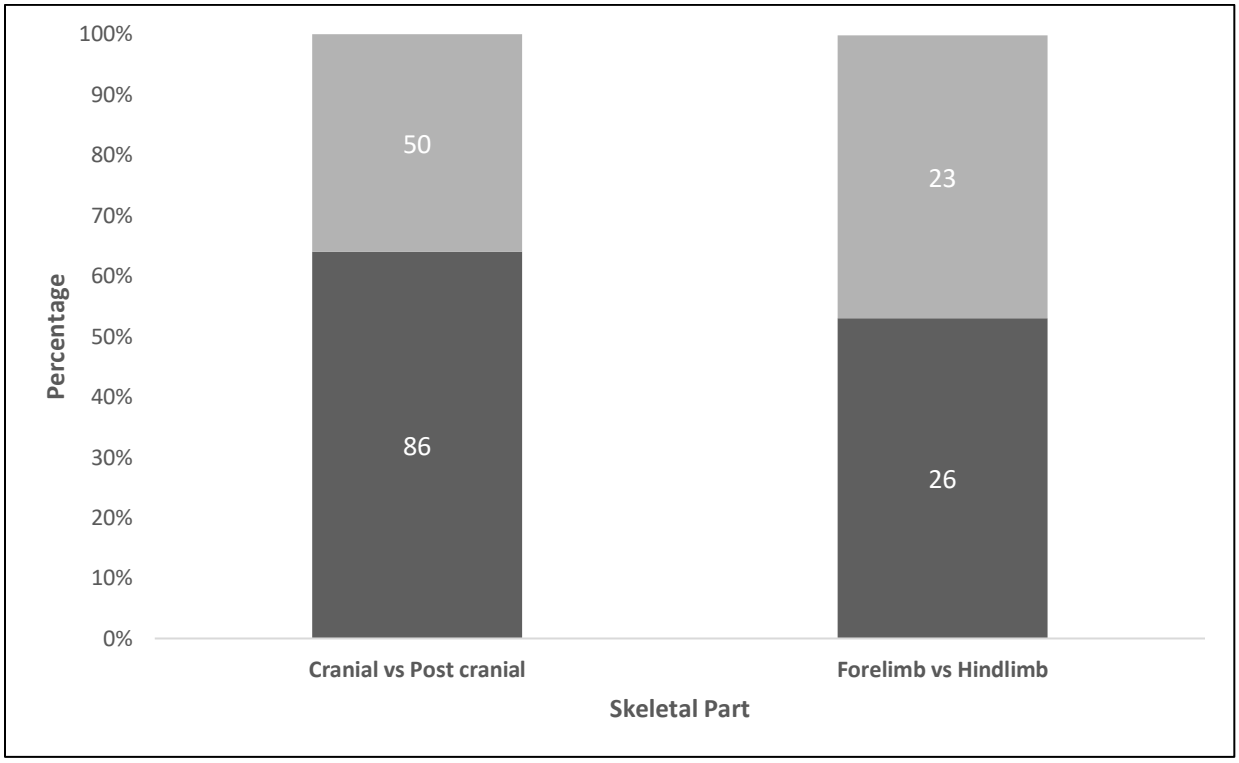

Figure 8: A stacked bar graph representing the relative proportions of cranial *vs* post cranial skeletal elements and forelimbs *vs* hindlimbs skeletal elements of rock hyraxes and possibly rock hyraxes. The NISP values are within the bars. Cranial and forelimbs are the darker bars and post cranial and hindlimbs are lighter bars

Cape fur seals (*Arctocephalus pusillus*) have cranial elements present, particularly molars and isolated tooth fragments, and lower limb skeletal elements including carpals, metacarpals, tarsals, metatarsals, and phalanges (Table 14). Cape fur seals have no other upper limb skeletal elements, apart from innominate bones present. There are also three indeterminate medium carnivore skeletal elements that are most likely from carnivores smaller than the Cape fur seal.

Table 14. The NISP of the skeletal element represented Cape fur seal and medium carnivore

Elements	**Cape Fur Seal**	**Medium Carnivore**	**Total**	**%**
Premolar	2	0	2	3%
Tooth fragment	1	0	1	2%
Humerus	0	1	1	2%
Innominate	2	0	2	3%
Femur	0	1	1	2%
Radius	4	0	4	7%
Ulna	0	1	1	2%
Carpal	3	0	3	5%
Metacarpal	2	0	2	3%
Tarsal	2	0	2	3%
Metatarsal	2	0	2	3%
First Phalanx	17	0	17	28%
Second Phalanx	8	0	8	13%
Third Phalanx	14	0	14	23%
Phalanx	1	0	1	2%
Total	**58**	**3**	**61**	

There is a high number of vertebrates and phalanges identified as either indeterminate small or medium birds (Table 15). The African penguins have a relatively complete skeletal element

representation. The highest number of skeletal elements for the African penguin and indeterminate medium birds are tarsometatarsus (n=11, n=25 respectively). While there were other birds identified, it is most likely that most of the indeterminate medium bird skeletal elements are African penguins.

Table 15. The NISP of the skeletal element represented as African penguin and indeterminate small and medium bird size classes

Elements	**African Penguin**	**Small Bird**	**Small/ Medium Bird**	**Medium Bird**	**Total**	**%**
Quadrate	0	0	0	8	8	2%
Mandible	1	0	0	1	3	1%
Vertebra	0	36	8	83	127	32%
Atlas	0	0	1	2	3	1%
Sacral	0	1	0	4	5	1%
Pygostyle	0	1	0	0	2	1%
Rib	0	0	0	4	4	1%
Sternum	2	2	0	0	4	1%
Furculum	0	1	0	0	1	<1%
Scapula	0	0	0	1	1	<1%
Coracoid	4	1	0	8	16	4%
Humerus	4	3	1	7	23	6%
Radius	3	0	0	2	5	1%
Ulna	3	0	0	4	10	3%
Carpal	1	4	1	14	19	5%
Carpometacarpus	3	1	0	2	7	2%

Wing phalanx	0	0	1	1	2	2%
Femur	1	1	0	5	10	3%
Tibiotarsus	2	1	0	5	9	2%
Tarsal	2	0	0	0	2	1%
Tarsometatarsus	11	2	1	25	41	10%
First phalanx	0	0	0	3	3	<1%
Third phalanx	0	0	0	1	1	3%
Fourth phalanx	0	4	0	9	13	20%
Phalanx	1	13	0	71	80	1%
Total	**38**	**71**	**13**	**260**	**405**	

4.5 Ageing and Sexing

Most of the bone specimens from bovid 1, 2, 3 and 4 are from adult individuals (n=34, 67%; n=26, 76%; n=11, 69%; n=2, 100% respectively, Table 16). However, some bovid 1, 2 and 3 (n=14, 27%; n=7, 21%; n=3, 19%) unfused ends also indicate that juvenile and sub-adult individuals are present. There are some neonatal bovid 1 (n=3, 6%) bovid 2 (n=1, 3%) and (n=2, 13%) bovid 3 individuals (Figure 9).

Table 16. The number of fusion patterns on bone bovid specimens

	Neonatal		**Unfused**		**Fused**	
	n	%	n	%	n	%
Bovid 1	3	6%	14	27%	34	67%
Bovid 2	1	3%	7	21%	26	76%

Bovid 3	2	13%	3	19%	11	69%
Bovid 4	0	0%	0	0%	2	100%
Total	**6**		**24**		**73**	

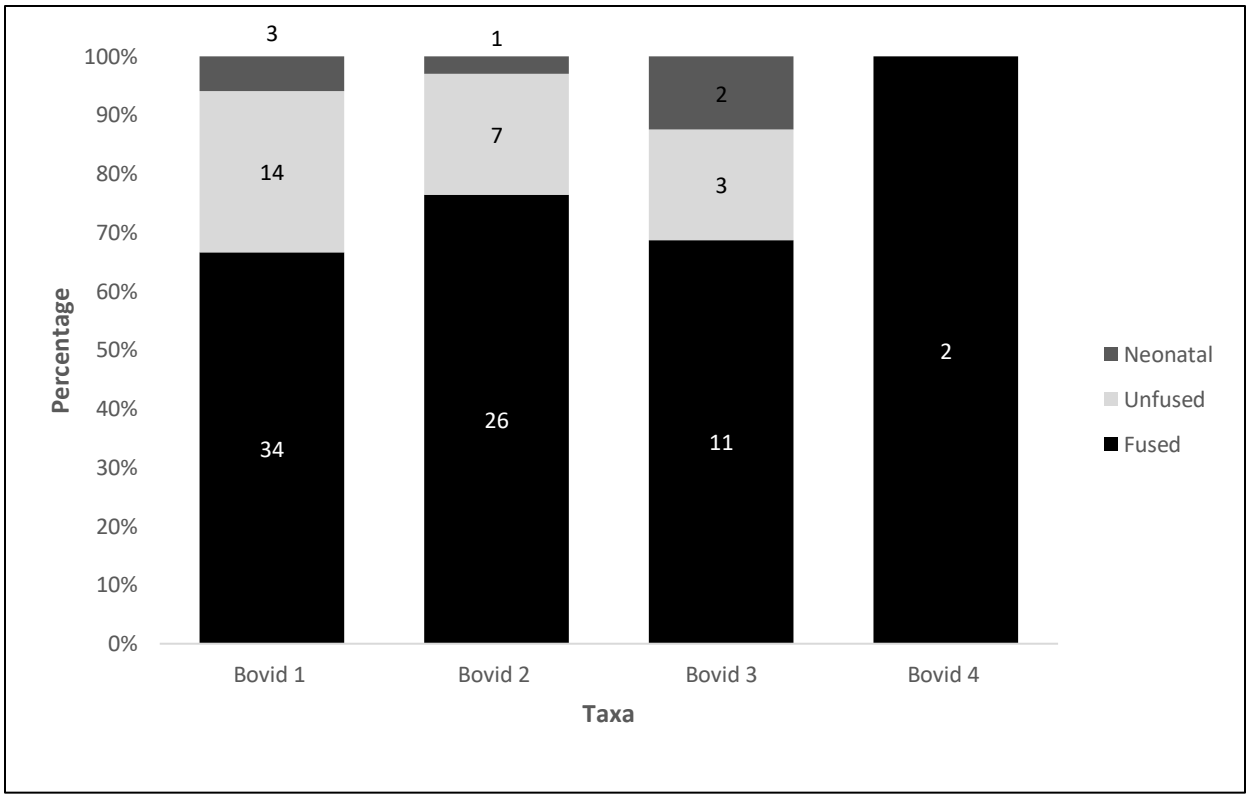

Figure 9: A clustered bar graph representing the percentage of the different fusion pattern on specimens identified as bovids

The long bone specimens of indeterminate large mammals show that there are more adults than juvenile individuals (n=4, 80%, Table 17). The indeterminate medium mammals show that there are equal representation of adult and sub-adult individual bone specimens (n=22, 50%).

Table 17. The number of fusion patterns on the bone specimens identified as indeterminate medium and large mammals

	Unfused		**Fused**	
	n	%	n	%
Medium Mammal	22	50%	22	50%
Large Mammal	1	20%	4	80%
Total	**23**		**26**	

The aging data on Cape fur seals show that the majority of the individuals are adult individuals (n=24, 50%, Table 18). There are also several sub-adults (n=2, 5%) and juvenile (n=18, 41%) individuals.

Table 18. The number of fusion patterns on the bone specimens identified as Cape fur seals

	Unfused		**Just Fused**		**Fused**	
	n	%	n	%	n	%
Cape fur seal	18	41%	2	5%	24	55%

There are both female and male rock hyraxes present in the fauna sample (Table 19). The table below shows that there is a variety in the ages and sex of individuals hunted. There were also two very old individuals with very worn premolars and molars embedded in the maxilla and mandible. Their age range of the two individuals span across 15 months and therefore I did not use them in the interpretation of seasonality. Based on the age ranges of rock hyraxes with a maximum age of 27 months or lower, the accumulation of rock hyraxes is most present between the months of March and January. Most of the rock hyraxes are estimated to have been accumulated in the month of June, however, there is a possibility that the accumulation of rock hyraxes occurred throughout the year.

Table 19. The month of accumulation based on the measurements taken on the maxilla and mandible specimens of rock hyraxes embedded with tooth are length, breadth, (CH) crown height, based on these measurements and tooth morphology the age and sex of the specimens were determined where possible. The minimum age was used to calculate the range of months for accumulation

***Procavia capensis* (rock hyrax) Element**	**Layer**	**Sex**	**Age Range (months)**	**Crown Height (mm)**	**Month of Accumulation**
Maxilla	GBS 2	-	17-19	-	March-May
Maxilla	GBS 2	Male	44-59	-	June-September of the following year
Maxilla	GBS	-	23-27	-	September-January
Maxilla	YS1M	-	-	4.8	-
Mandible	BCH	-	76-91	4.2	June-September of the following year
Mandible	GBS 2B	-	23-27	-	September-January
Mandible	GBS 2B	-	76-91	4.6	June-September of the following year
Mandible	YBS	-	8-10	-	June-August
Mandible	YBS	Female	0-4	-	October-February
Mandible	YS1T	-	20-22	-	June-August

The post cranial remains of rock hyraxes show that there are mostly adult individuals present (n=27, 56%, Table 20). However, there are also some juvenile and sub-adult individuals present (n=12, 25%, n=9, 19%). Many of the indeterminate small mammal remains are also from adults (n=57, 75%) with some juvenile and sub-adults present in the sample.

Table 20. The number of fusion patterns on rock hyraxes, possibly rock hyraxes and indeterminate small mammal bone specimens

	Unfused		**Just Fused**		**Fused**	
	n	%	n	%	n	%
Rock hyrax	12	25%	9	19%	27	56%
Possibly rock hyrax	1	100%	0	0%	0	0%
Small Mammal	18	24%	1	1%	57	75%
Total	**31**		**10**		**84**	

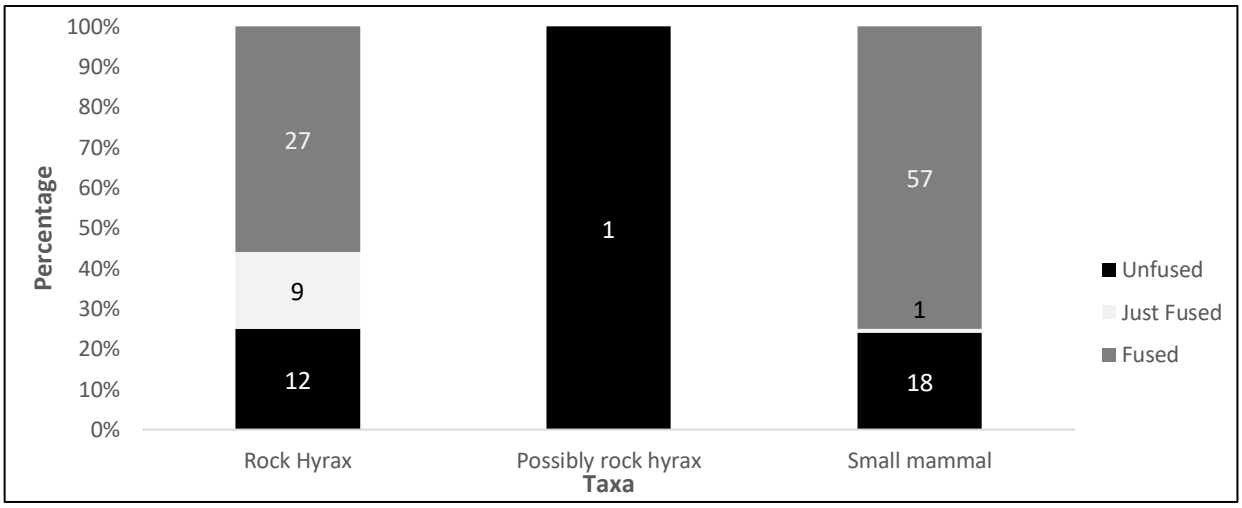

Figure 10. A stacked bar graph of the different fusion patterns on rock hyraxes, possibly rock hyraxes and indeterminate small mammal size class. NISP values are at the top of the

4. 6 Taphonomy

4.6.1 *Long Bone Breakage*

Most of the long bones have irregular breakage (71%, Figure 12). This suggest that bones were dry when broken. Fewer specimens display spiral and transverse fractures. The presence of spiral fractures indicates that at least some specimens were broken when fresh. One specimen resulted from the damage caused during excavation (n=1, 0.2%, Table 21). There are only two specimens with carnivore damage, and they are on the ends of bird phalanges, particularly from layer YBS B.

Table 21. The number different breakage patterns on ends of identified long bones skeletal element

Elements	**Spiral**	**Transverse**	**Irregular**	**Carnivore**	**Excavation**
Coracoid	2	0	4	0	0
Humerus	17	9	49	0	0
Radius	4	0	18	0	0
Ulna	5	1	15	0	1
Carpal	0	3	1	0	0
Metacarpal	3	1	8	0	0
Femur	7	5	45	0	0
Tibia	3	5	12	0	0
Metatarsal	8	8	39	0	0
Metapodial	6	1	20	0	0
Calcaneus	0	0	1	0	0
Tarsals	0	0	1	0	0
First Phalanx	8	3	25	0	0
Second Phalanx	6	4	22	0	0
Third Phalanx	1	1	10	0	0
Phalanx	1	1	18	2	0

Total	**71**	**42**	**288**	**2**	**1**
Percentage	**18%**	**10%**	**71%**	**<1%**	**<1%**

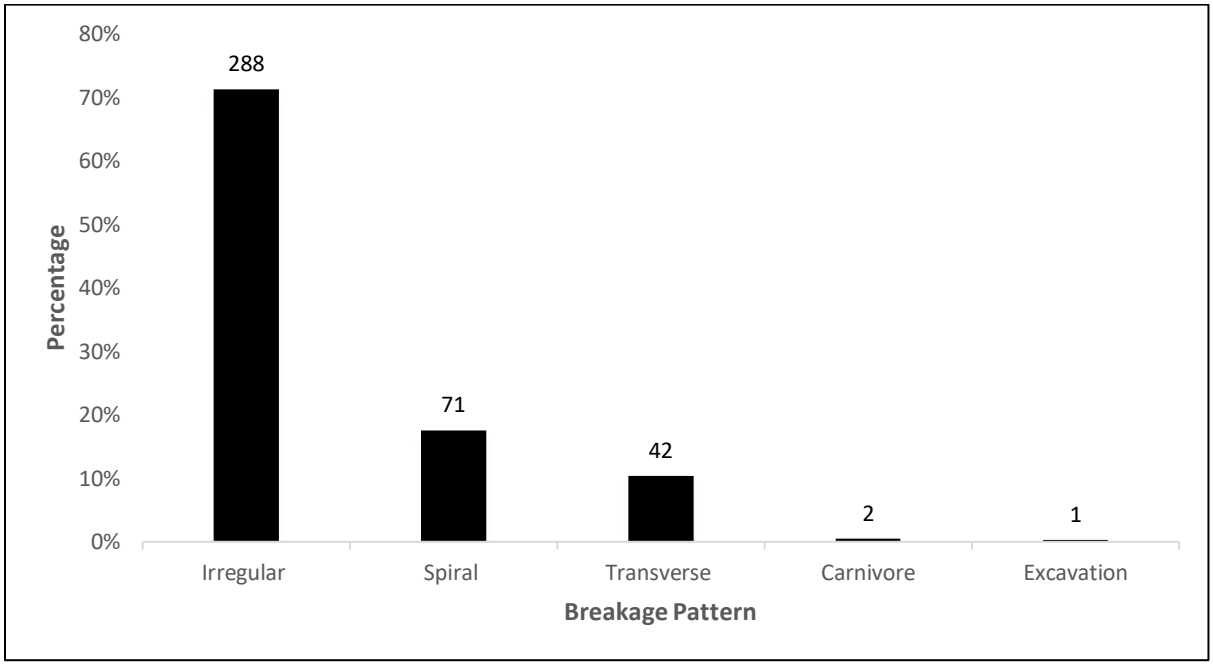

Figure 11. A column chart of the total percentage of breakage patterns found on identified long bone remains. The NISP values are on top of the bars

4.6.2 *Anthropogenic Modifications*

Most layers contain burnt bone (n=2520, 13%). Layers GBS 2B, GBS 2 and the YS1M have the most burnt specimens (Table 22). The overall sample has more burnt black bones than the other colouration types (40%). The CP1T and CP3 layers have the highest percentage of burnt bones (49%, 37%, respectively). There are several bird elements with burning, as well as a burnt fish fin.

Table 22. The number of specimens of the different colouration of burnt bone specimens per layer. The number of specimens include identified and unidentified bone specimens

Taphonomy	Burnt Brown	Burnt Black	Burnt Grey	Burnt White	Total	Total Sample	% Burnt
GBS 2B	0	22	296	28	346	1166	30%
GBS 2	0	356	0	2	358	1368	26%
CP2	1	11	69	11	92	433	21%
CP2T	41	51	92	3	187	1502	12%
BCH	26	55	11	12	104	801	13%
BR	0	2	3	1	6	34	18%
BRAF	0	0	9	2	11	36	31%
BRU	1	21	9	2	33	167	20%
BS	0	60	0	0	60	1442	4%
BSH1	5	8	4	11	28	148	19%
BSH2	0	29	8	9	46	232	20%
BSH 2 BH	0	16	1	3	20	81	25%
YBS B	38	30	6	10	84	746	11%
YBS	120	27	48	12	207	2015	10%
YRU	15	60	12	50	137	1041	13%
CP1	0	5	0	1	6	1528	<1%
CP1T	16	27	47	8	98	202	49%
YS1	0	3	1	4	8	110	7%
YS1T	92	8	0	7	107	1180	9%
YS1M	126	68	83	27	304	3632	8%
Y/SH	12	28	2	7	49	299	16%
CP3	25	39	7	8	79	213	37%
DRU	42	77	8	23	150	571	26%

Total	**560**	**1003**	**716**	**241**	**2520**	**19468**	
Percentage	**22%**	**40%**	**<1%**	**10%**			

There are 65 specimens with butchery modifications, which is less than 1% of the total sample. The BCH layer recorded the highest number of cut marks (n=6) although it is less than 1% of its total sample. Layer CP3 has the highest number of chop marks (n=6) and the second highest percentage of butchery marks (3%). The highest percentage of butchery mark is from BYS1 layer (17%), but this is due to the sample from that layer being low. Using a microscope on a random sample of 100 unidentified bone specimens, I found an additional 16 bone specimens with cut marks and five bone specimens with chop marks.

Table 23. The number of butchery marks observed on bone specimens per layer. The table includes the number of additional butchery marks observed using a microscope. Layers without butchering marks were not included in the table. The number of specimens include identified and unidentified specimens

Taphonomy	**Cut Marks**	**Added Cut Marks**	**Chop Marks**	**Added Chop Mark**	**Total Butchery**	**Total Sample**	**%**
GBS 2B	4	2	1	1	8	1166	1%
GBS 2	1	1	0	0	2	1368	<1%
CP2	0	1	2	0	3	433	1%
BCH	6	1	4	0	11	801	1%
BRU	1	0	1	0	2	167	1%
BS	2	1	1	2	6	1442	<1%
BSH2	1	0	2	0	3	232	1%
BYS1	1	0	0	0	1	6	17%
GBS	1	3	0	0	4	515	1%
YBS B	0	1	0	0	1	746	<1%

YBS	0	1	2	0	3	2015	<1%
YRU	2	0	1	0	3	1041	<1%
CP1	0	1	0	0	1	1528	<1%
CP1T	0	1	0	0	1	202	<1%
YS1	0	1	0	0	1	110	1%
YS1M	2	1	0	2	5	3632	<1%
Y/SH	0	0	1	0	1	299	<1%
CP3	0	0	6	0	6	213	3%
DRU	0	1	2	0	3	571	1%
Total	**21**	**16**	**23**	**5**	**65**	**19468**	
Percentage	**32%**	**25%**	**35%**	**8%**			

Overall, there were three specimens that had a polished surface. Here they have been measured and described (Table 27). The polishing is caused by bone being handled by humans (Appendix 4.1).

Table 24. The length of bone specimens which have a polished cortical surface identified from different layers at KRM Cave 1B RS sub-member

Layer	**Length**	**Description**
CP2T	16.28 mm	Triangular-shaped bone flake
DRU	17.10 mm	Bone point used for arrow
YS1M	104.46 mm	Thin bone flake

4.6.3 *Zoogenic Modifications*

There are several layers with incidence of carnivore damage to bone (n=5, <1%, Table 24). There are more digested bone specimens recorded than carnivore marks (n=34, <1%). Some of these digested bone specimens were elements identified as *Raphicerus* sp. The YBS layer had the highest

number of digested bone specimens (n=8). Layer YS1 had the highest percentage of bone specimens with carnivore and digested damage (n=2, 2%); however, this is due to a low sample number in the layer (n=110). There was no additional carnivore damage noted after the bone specimens were subjected to a microscopic analysis.

Table 25. The number of carnivore tooth marks and gastric acid etching on bone specimens. Layers without carnivore were not included in the table. The number of specimens include identified and unidentified bone specimens

Taphonomy	**Carnivore**	**Digested**	**Total**	**Total Sample**	**%**
GBS 2B	0	1	1	1166	<1%
GBS 2	0	1	1	1368	<1%
CP2T	1	0	1	1502	<1%
BCH	1	1	2	801	<1%
BS	0	1	1	1442	<1%
BSH2	0	2	2	232	1%
YBS B	0	1	1	746	<1%
YBS	0	8	8	2015	<1%
YRU	1	4	5	1041	<1%
CP1	1	0	1	1528	<1%
YS1	0	2	2	110	2%
YS1T	1	2	3	1180	<1%
YS1M	0	6	6	3632	<1%
Y/SH	0	3	3	299	1%
DRU	0	2	2	571	<1%
Total	**5**	**34**	**39**	**19468**	
Percentage	**13%**	**87%**			

There are rodent's gnaw marks and scratch marks identified on a few bone specimens (n=4, <1%, n=3, <1%, respectively, Table 25), particularly on the baboon phalanx recovered from the YBS layer. Layer YBS has the highest number of the rodent marks (n=2). The YRU layer has the most number of scratch marks.

Table 26. The number of rodent's gnaw marks and rodent's scratch marks. Layers without the above-mentioned modifications were excluded. The number of specimens include identified and unidentified specimens

Taphonomy	**Rodent Gnaw Marks**	**Rodent Scratch Marks**	**Total**	**Total Sample**	**%**
BCH	0	1	1	801	<1%
BSH2	1	0	1	232	<1%
YBS B	1	0	1	746	<1%
YBS	2	0	2	2015	<1%
YRU	0	2	2	1041	<1%
Total	**4**	**3**	**7**	**19468**	
Percentage	**57%**	**43%**			

4.6.5 *Natural Modifications*

There are a few specimens that are encrusted in ash (n=45, 68%, Table 26). Most of these bone specimens are from the YBS layer. This makes it difficult to observe taphonomic signatures. Rootlet etching is present on 16 bone specimens, mostly in layers GBS 2 and YS1T (n=4, 25%). After subjecting about 100 specimens under a light microscope, rootlet etching was observed on an additional five specimens.

Table 27. The number of rootlet etching, and ash covered specimens. The table include additional rootlet etching modification observed using a microscope. Layers without the above-mentioned modifications were excluded. The number of specimens include identified and unidentified specimens

Taphonomy	**Rootlet Etching**	**Added Rootlet Etching**	**Ash**	**Total**	**Total Sample**	**%**
GBS 2	4	0	1	5	1368	<1%
CP2T	1	0	3	4	1502	<1%
BCH	0	0	4	4	801	1%
BS	0	1	4	5	1442	<1%
BSH1	0	0	2	2	148	1%
BSH2	0	0	5	5	232	2%
BYS1	0	0	2	2	6	33%
GBS	1	1	1	3	515	1%
YBS B	0	1	1	2	746	<1%
YBS	3	0	7	10	2015	<1%
YRU	1	0	6	7	1041	1%
CP1T	0	0	1	1	202	<1%
YS1T	4	2	0	6	1180	1%
YS1M	1	0	1	2	3632	<1%
Y/SH	1	0	1	2	299	1%
CP3	0	0	4	4	213	2%
DRU	0	0	2	2	571	<1%
Total	**16**	**5**	**45**	**66**	**19468**	
Percentage	**24%**	**8%**	**68%**	**<1%**		

4.6.5 *Carnivore Indices*

Layer YBS has a low index value (C/U=2,86, Table 28). Layer YBS layer is also associated with some digested bone (n=8, Table 24). The YS1 layer has the highest carnivore and leopard/brown hyena index. However, the small sample size suggest that this pattern may not indicate hyena or leopard activity. Overall, the indices value at layer YBS indicate very low probabilities of carnivore activity despite the presence of baboon remains in the layer. Layer BSH a carnivore index of 11.11, and a leopard/brown hyena index of 11.11, however, both indices are quite low, and the sample sizes are small.

Table 28. The carnivore-ungulate indices calculated for each layer of the RS sub-member of KRM Cave 1B. The NISP of the identified bone specimens required to calculate the indices are included in the table

Layers	**Carnivore NISP**	**Baboon NISP**	**Leopard NISP**	**Hyena NISP**	**Ungulate NISP**	**Carnivore-Ungulate Index**	**Leopard Index**
GBS 2B	0	0	0	0	25	0,00	0,00
GBS 2	0	0	0	0	10	0,00	0,00
CP2	0	0	0	0	4	0,00	0,00
CP2T	0	0	0	0	9	0,00	0,00
BCH	0	0	0	0	21	0,00	0,00
BR	0	0	0	0	1	0,00	0,00
BRAF	0	0	0	0	0	0,00	0,00
BRU	0	0	0	0	2	0,00	0,00
BS	0	0	0	0	7	0,00	0,00
BSH1	0	0	0	0	11	0,00	0,00
BSH2	1	0	0	0	9	**11,11**	0,00
BSH 2 BH	0	0	0	0	0	0,00	0,00

BYS1	0	0	0	0	2	0,00	0,00
GBS	0	0	0	0	5	0,00	0,00
YBS B	0	0	0	0	9	0,00	0,00
YBS	1	1	0	0	35	**2,86**	**2,86**
YRU	0	0	0	0	17	0,00	0,00
CP1	0	0	0	0	6	0,00	0,00
CP1T	0	0	0	0	3	0,00	0,00
YS1	2	0	0	0	4	**50,00**	0,00
YS1T	0	0	0	0	8	0,00	0,00
YS1M	0	0	0	0	27	0,00	0,00
Y/SH	0	0	0	0	6	0,00	0,00
CP3	0	0	0	0	5	0,00	0,00
DRU	0	0	0	0	8	0,00	0,00

4.7 Measurements

4.7.1 *Lengths*

Most of the identified specimens (n=571) were between 1 cm - 1.99 cm in length (Figure 11). the second highest number of identified specimens fall within the 0 cm – 0.99 cm (n=242) and 2 cm – 2.99 cm (n=203) categories. This indicates that the sample is generally highly fragmented. However, the sample does contain a few larger specimens.

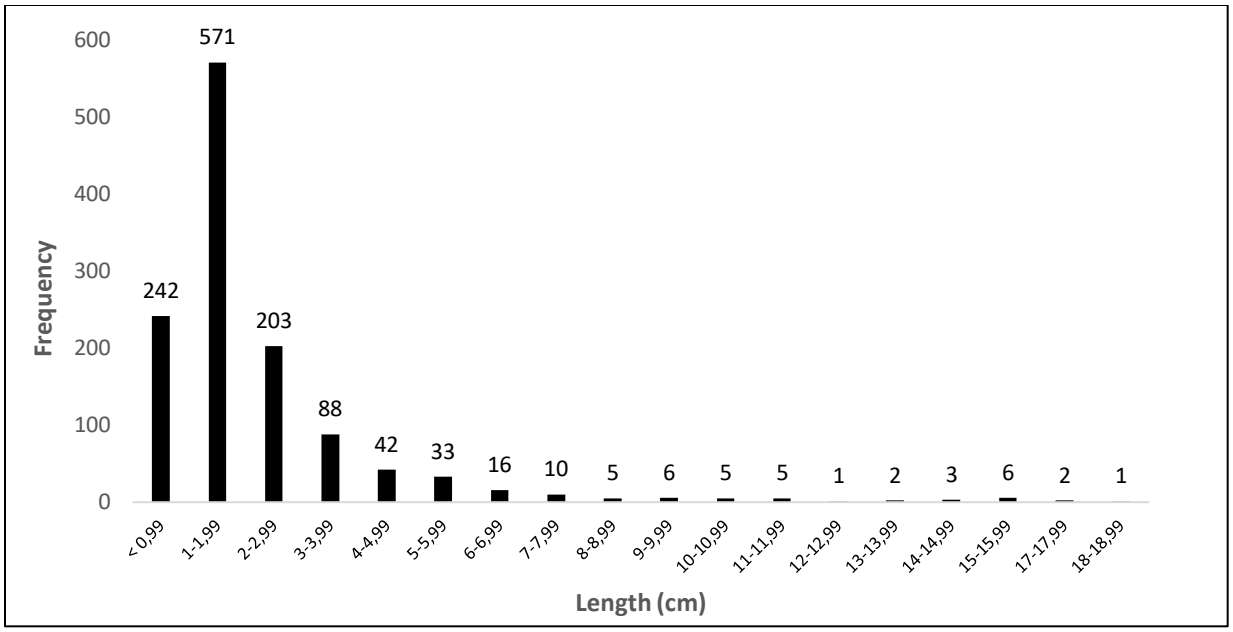

Figure 12. The total number of identified specimens within length ranges of 1cm. The NISP values are added on the top of the bars

4.7.2 *Cortical Thickness*

The smaller taxa and birds in the faunal sample have thin cortical thicknesses. The smaller bovids, namely bovid 1 and 2 have thinner cortical thickness ranging between 0 mm - 2 mm and 2 mm – 3.99 mm. The size of the cortical thickness is also dependent on the element. Most of the large bovids, namely bovid 3 and 4 have larger cortical thickness (Table 29).

Table 29. The cortical thickness ranges and the taxa of the bone specimens that fall within these ranges

Category (mm)	**Taxa**
< 2	Small rodent, *Procavia capensis*, *Arctocephalus pusillus*, Small carnivore, *Pelea capreolus*, *Raphicerus* sp., Bovid 1, Bovid 2, Small mammal, Medium mammals, *Bubo* sp., *Phalacrocorax capensis*, *Spheniscus demersus*, Small bird, Medium bird, Testudinidae sp.

2 – 3.99	*Procavia capensis*, *Arctocephalus pusillus*, Alcephaline sp. *Redunca arundinum*, *Redunca fulvorufula*, *Redunca* sp. *Raphicerus* sp., Bovid 1, Bovid 2, Bovid 3, Medium mammal, Large mammal, *Bubo* sp., *Phalacrocorax capensis*, *Spheniscus demersus*, Medium bird
4 – 5.99	*Raphicerus* sp., Bovid 2, Bovid 3
6 – 7.99	Bovid 2
8 – 9.99	Bovid 3
10 – 11.99	Bovid 3
12 – 13.99	Bovid 4

4.8 Osteometry

The measurements of specimens were taken and have been listed in Appendix 3 (Von den Driesch, 1976; Von den Driesch, 2004; Peters, 1986). All the measurements are in millimetres (mm).

4.9 Conclusion

The result from the zooarchaeological analyses of KRM Cave 1B fauna material excavated from the PP38 square include identification, taphonomy and the palaeoenvironmental reconstruction. The sample contains anthropogenic, zoogenic and natural taphonomy. Using simple comparisons of the percentages of taphonomic signatures, long bone fracture patterns and percentage NISPs, the majorly of the sample was accumulated by humans. There are some layers with very little incidence of carnivore activity. The palaeoenvironment for most of the older layers is a mixture of open grassland and mixed environment. The palaeoenvironment shifts to a more open grassland area in the younger layers. The results will be discussed in the following chapter 5.

Chapter 5. Discussion and Conclusion

5.1 Sample Size

Recent research by Badenhorst *et al.* (2021) on faunal assemblages sizes for making inferences suggests that for samples with only large mammals, a NISP nearing 1000 was sufficient, and for samples with a full range of vertebrates, 2000 NISPs are required. The RS faunal sample containing a full range of vertebrates, yielded 1239 identified specimens. While not close to 2000 NISPs, it is substantial enough to provide information about the agents of accumulation, subsistence patterns and the palaeoenvironment. Unfortunately, MSA faunas in southern Africa are usually very fragmented (Marean *et al*., 2000; Plug, 2004, Reynard *et al*., 2016b). It is nearly impossible to identify all fragmented bone specimens to taxon, therefore, the sample size of identified taxa is usually small for MSA sites.

The proportion of identified to unidentified bone can indicate the level of fragmentation in an assemblage (Badenhorst & Plug, 2011), and it can be used to infer occupational intensity at layers at archaeological sites (Reynard *et al*., 2014; Reynard & Henshilwood, 2018; Reynard, 2021). The RS faunal sample suggest that human occupational intensity at KRM Cave 1B was high in some layers, such as YBS (n=2015, 8%) and YS1M (n=3632, 5%). Klein's (1976) analyses of KRM, did not list the number of unidentified specimens per layer, and at the time, mentioned that the total NISP is not the actual representation of animals present as it is affected by the number of unidentified specimens and bones that were not carried to the camp sites.

Other zooarchaeological studies from the MIS 5 layers at KRM Cave 1 also show that the fauna is fragmented (Lap, 2020). In Lap's study (2020), only 5,6% of the fauna from the C1 and B2 squares of the WB were identifiable. Van Pletzen's *et al.*, (2019) analyses from the Witness Baulk at KRM Cave 1 yielded a high percentage of identified specimens (n= 3128, 43%) of which 28% of NISP were identified to genus level from faunal material analysed. Most of the specimens identified were unidentified bovids and indeterminate mammals. There are number of possible reasons for fragmentation in the RS faunal sample, they include trampling, carnivore ravaging and burning. Trampling marks on bone can be used to infer occupational intensity at caves by humans and/or animals (Reynard *et al.*, 2016b, Reynard & Henshilwood, 2018). Trampling marks can be associated with other bone surface modifications, such as cut marks. Although there is a negative but significant relationship between trampling marks and bone surfaces with rounding and abrasive

surfaces on bone specimens (Reynard, 2014), this effect was only observed on three bone specimens in the RS faunal. Therefore, trampling is not a possible reason for bone fragmentation in the KRM Cave 1B RS faunal sample.

The reason for the high level of fragmentation in the RS sample is more likely due to burning (Stiner *et al.*, 1995); more than 13% of bone fragments in the RS sample are burnt. Moreover, the fragmentation levels from the PP38 square in KRM Cave 1B is possibly as a result of a combination of additional factors caused by humans, such as marrow attrition and butchery.

5.2 Agents of Accumulation

The number of burnt specimens and bones with butchery marks are evidence that MSA humans accumulated a substantial portion of the faunal sample from the MIS 5e layers at KRM Cave 1B. Moreover, there are human remains and cultural artefacts found throughout the deposit in other areas of the site, and also shellfish remains, which support the notion that humans accumulated fauna at KRM Cave 1B (Thackeray, 1988; 2019). Other samples from KRM MIS 5 layers in Cave 1A also show that humans were the primary accumulators of the fauna (Van Pletzen *et al.*, 2019; Reynard & Wurz, 2020; Lap, 2020). The MIS 5 layers at other caves, notably Blombos Cave, also show that humans were the main accumulator of the fauna (Henshilwood *et al.*, 2001; Thompson & Henshilwood, 2011; 2014; Badenhorst *et al.*, 2014; 2016; Reynard & Henshilwood, 2017). The results from Pinnacle Point 13B show an increase in human activity with a decrease in carnivore activity from the MIS 6 to MIS 5 (Thompson, 2010). Another evidence of human activity in the RS faunal sample is there are a greater number of spiral fractures on long bone specimens compared to transverse breakage (Lyman, 1994).

Thompson and Henshilwood (2011) found that while most of the large mammals at BBC were accumulated by humans, carnivores occasionally accumulated some smaller ungulate taxa. However, the carnivore-ungulate and leopard indices and the few surface modification caused by carnivores from the RS faunal sample indicate that the sample was mainly accumulated by humans (Badenhorst *et al.*, 2021). For example, Sea Harvest (SH) and Pinnacle Point 30 are known hyena accumulated assemblages. These assemblages are characterised by a high carnivore to ungulate ratio. There high number of bovid phalanges, carpal and tarsals and majority of the identified

indeterminate medium and large mammals are ribs and vertebrae remains, which is not common in known carnivore sites like Kalkbank that has relatively few bovid phalanges, ribs and vertebrates (Haynes, 1983; Hutson & Cain, 2008).

A few digested Cape grysbok/steenbok phalanges are present in the RS faunal sample indicated that there is some carnivore activity (Brain, 1981; Thackeray, 1990; Mitchell, 2002; Lyman, 2008). Cape grysbok/steenbok is a common taxa in all anthropogenic accumulations in the Eastern and Western Cape (Klein, 1976; Henshilwood *et al*., 2001; Faith, 2011; Badenhorst *et al*., 2016), but they are also present in hyena accumulations (Grine & Klein, 1993) and those of leopards (Klein, 1978; Faith, 2013b). Leopard activity was reported in layer 17 from KRM Cave 1 (Klein, 1976; Lap, 2020), however, leopard remains are not present in the RS faunal sample. However, the animals they prefer as prey, like baboons, rock hyraxes and small antelope like the Cape grysbok/steenbok (Brain, 1981; Thackeray, 1990), were identified in the RS faunal sample. There are more cranial than postcranial rock hyrax elements (Figure 8), and this is another line of evidence indicating that there are low probabilities of leopard activity in the RS sample. Humans accumulated the rock hyraxes in the KRM Cave 1B fauna, this is evident in burning found on rock hyrax specimens and their skeletal element representation, also the material is found alongside Cape fur seal, tortoises and other large mammals (Cruz-Uribe & Klein, 1988; Badenhorst *et al*., 2014). Cape grysbok/steenbok in the RS faunal sample were accumulated by humans. Leopard accumulated assemblages, for example, at Boomplaas in layers LOH and OCH, dating to MIS 3, lack the presence of anthropogenic signatures on small mammals including bovid 1 and have the presence of baboon remains (Thackeray, 1990; Faith, 2013b). Baboon remains are typical is leopard accumulated assemblages (Badenhorst *et al*., 2021). All of the evidence provided above shows that the RS sample has low probabilities of carnivore activity.

The taphonomy in this study shows that the role of raptors such as the eagle owl in accumulating the RS sub-member fauna sample is of no significance. Bone specimens introduced by raptors would have beak damage on the bone surface (Brain 1981), and this was not recorded in any bone specimens from the RS faunal sample. In raptor accumulations, the hindlimb skeletal elements of rock hyraxes (pelvis, femur, tibia) outnumber the forelimb skeletal elements (scapula, humerus, radius, ulna); in the RS faunal sample, this is not the case. Humans may not be responsible for the inclusion of the eagle owl remains in the sample, as humans seldom eat raptors (Badenhorst &

Plug, 2012). The raptors in the RS faunal sample may have been introduced through natural deaths as their nest are sometimes above rock shelters (Taylor, 2003) and burning was probably due to post-depositional damage. Irregular and transverse breakages are indication of post-depositional damage in the RS faunal sample. These damages are a result of bone density-mediated attrition and possibly burning (Badenhorst & Plug, 2012; Badenhorst *et al*., 2014).

At Blombos Cave, Nel *et al*. (2018) proposed that spotted eagle owls (*Bubo africanus*) and the African barn owls (*Tyto alba*) accumulated the micromammals from the MIS 5 layers at KRM (Matthews *et al*., 2009; 2011; Nel & Henshilwood, 2021) based on the frequency of digested bones. Modern spotted eagle owl samples have 20-25% digested incisors of small mammal and rodents (Matthews *et al*., 2011). Digestion on rock hyraxes and small rodent fauna in the RS sub-member is very low. The inclusion of vlei rats in the RS faunal assemblage is most probably due to natural deaths from burrowing in caves (Andrews, 1990).

Human accumulated tortoises are heavily fragmented and contain 30-40% charring (Sampson, 2000). The KRM Cave 1B RS faunal sample only has three tortoise shell specimens with burning on it, and this represents 11% of the total NISP of tortoise remains. However, the tortoise remains were most probably accumulated by humans. Based on the evidence provided, the majority of the KRM Cave 1B RS faunal sample was accumulated by human activity.

5.3 Palaeoenvironment

In general, the ungulate diversity at KRM Cave 1B shows the presence of mixed feeders and grazing taxa. This indicates that for most parts of the older deposits, namely GBS2B – CP1, the palaeoenvironment was an open grassland area mixed with other types of closed environment such as thickets and forests (Reynard & Wurz, 2020). Furthermore, the environment at KRM Cave 1B was within a winter (WRZ) or an aseasonal rainfall zone for the older deposits dated to *ca*. ~ 115 Kya (Wurz *et al*., 2018).

The change in the palaeoenvironment at KRM 1B between *ca*. ~ 115 Kya and the younger MIS 5 layers could have been due to climate changes. The climate during the MIS 5e was drier and warmer (see Chapter 2 section 2.6), with limited rainfall, causing the environment to be much drier (Langejans *et al*., 2017; Loftus *et al*., 2019; Reynard & Wurz, 2020). The change from a glacial

period between the MIS 6 to the interglacial period during the MIS 5e is another factor that would have caused an environmental change (Helmens, 2013). Based on the faunal composition from MSA I layers at KRM, there is an abundance of grazing taxa (Van Pletzen *et al*., 2019; Reynard & Wurz, 2020), suggesting that the environment was dominated by open grassland. This is also supported and evident in Cave 1B as grazers are present, particularly large-bodied grazers like the Cape buffalo and giant buffalo in the MIS 5 layers (Figure 6).

At KRM, the microfauna from MSA I layers (MIS 5e) indicates that the palaeoenvironment was a mosaic of vegetation habitats with an abundance of grasses. There was more shrubland indicating the environment was much drier (Nel *et al*., 2018). This is supported by shellfish faunal data highlighting the decreased summer rainfall due to reduced summer upwellings in the Agulhas system during the MIS 5. Shellfish data also shows that the sea surface temperature is equal for MSA I and MSA II (Loftus *et al.*, 2017; 2019). Although there was an expansion of grassland areas on the western part of the GCFR due to low sea levels which extended Palaeo Agulhas Plain (PAP) during the interglacial period, BBC, a coastal site, was more of an inland site during the MIS 5 (Cawthra *et al*., 2020). The fauna from the M3 phase at BBC is dominated by small game such as rock hyraxes, hares (*Lepus capensis*) and small bovids like Cape grysbok/steenbok and micromammals (Badenhorst *et al*., 2016; Nel & Henshilwood, 2021), and the presence of rock hyraxes show that there are rocky surfaces around the site. Based on the MSA fauna from BBC, the palaeoenvironment during the MIS 5 was grassland and moister than the evergreen shrubland and fynbos type environment presently covering most of Western Cape (Henshilwood *et al*., 2001, Reynard & Henshilwood, 2018; 2019). At Pinnacle Point, the faunal composition of the layer that corresponds to the MIS 5 (PP13B) is reflective of a denser vegetation that the MIS 6 (Matthews *et al*., 2009). This is also similar to the conditions at Nelson Bay Cave (Rector & Reed, 2010). The presence of frog/toad remains in the RS faunal sample indicates there was a still body of water close to the campsite.

The result from the above-mentioned all shows that, while palaeoenvironment at KRM more of grassland environment, the environment was a mosaic of different fynbos type vegetation (Reynard & Wurz, 2020). The increase in grazing species suggests an expansion of grassland and a drier environment supported by the shrubland taxa indicating a drier environment (Avery, 1982; 1987; Nel *et al*., 2018). The sea surface temperatures at KRM and most parts of the Western Cape

also indicate drier summers and warmer conditions during the MIS 5 (Loftus *et al.*, 2017). The palaeoenvironment during the MIS 5 in the Western Cape suggests that the area was predominantly grassland environment (Rector & Reed, 2010; Faith, 2011; Mathews *et al*., 2011; Nel *et al*., 2018).

When reconstructing palaeoenvironments based on the ungulates present at a layer or site, there are uncertainties about the dietary preference of extinct ungulates; for example, the diet of blue antelope (*Hippotragus leucophaeus*) cannot be observed, and inference on its dietary preference is based on tooth morphology or relative species like the roan and sable, which suggests that it is a grazing species (Faith, 2011; Faith & Thompson, 2013). Extant ungulates' dietary preferences may differ from the present (Lyman & Faith, 2018). The taxa present today in the Western and Eastern Cape of South Africa may have adapted to the current conditions, which may not be the same as those present over 100 Kya.

5.4 Seasonality

MSA humans used rock shelters seasonally, based on the favourable environmental conditions and available resources present around the site (Jacobs *et al*., 2008). The ageing data on bovid 3 may suggest that there was human occupation at KRM Cave 1B between the months of September to January, which are spring and summer months. The only bovid 1 taxa present in the sample are steenbok/Cape grysbok. Female Cape grysbok generally gives birth to single lambs most months throughout the year, but the birthing peak is between September and December (Novellie *et al.*, 1984; Skinner & Chimimba, 2005). The birthing month of steenbok from data collected in Zimbabwe and Botswana shows that the birth peak was during November/December (Smithers, 1971; Skinner & Chimimba, 2005). Based on the presence of neonate indeterminate bovid 1, which are most probably Cape Grysbok/steenbok, this would suggest that death and human occupancy at KRM Cave 1B were at least during the spring and summer months between September and December.

Rock hyraxes ageing data for younger individuals below the ages of 27 months, mandibles showed that most individuals' month of death was between June and January. This highlights the occupation of caves during the winter, spring, and summer months. During the winter, the region of KRM during the MIS 5 was in a winter rainfall zone. Therefore, the environment was most

probably very productive (Reynard & Wurz, 2020), allowing MSA humans to have abundant plant and animal resources available (Dusseldorp, 2010; 2012). However, based on the age ranges of some individuals, it possible that people were visiting the site during other times of the year.

Most of the Cape fur seals present in the RS faunal sample are adults, although some sub-adult and juvenile individuals are present. The presence of the Cape fur seal remains throughout the RS layers indicates that the sea was close to the campsite. During the breeding season, the male Cape fur seals establish harems on land in October/November, and they stay in these territories for six to eight weeks surviving on their fat reserves. This offers hunting opportunities for MSA humans. In November, the female Cape fur seals are only present at the coastline to deliver their pups (Kirkman, 2010). Juvenile Cape fur seals mortality rates are high during this time because of predation, trampling, starvation and drowning (De Villiers & Roux, 1992). Predation may have been done at this time by MSA humans. The data from bovids, rock hyraxes and Cape fur seals suggest human occupancy at KRM Cave 1B at least in the winter, spring and summer months (June to December) during the MIS 5.

Other studies on seasonality at KRM have shown the shellfish seasonal acquisition patterns by humans. At KRM and Pinnacle Point 5-6, there are distinct seasonal patterns in the acquisition of shellfish between the MIS 5 and MIS 4 (~ 72 Kya) (Loftus *et al.*, 2019). The human population at KRM were using mobility strategies between habitats on a seasonal basis (Liberman *et al.*, 1993; Haaland *et al*., 2021; Reynard, 2021). These strategies were necessary for avoiding resource depletion (Mannino & Thomas, 2002). A number of recent research has been done about the mobility of humans around the Southern Cape (Reynard & Henshilwood, 2019, Reynard, 2021). Future research on seasonal use of caves can provide more information the MSA human population sizes, frequency of their visits at cave sites and the duration of their stay at cave sites (Haaland *et al*., 2021; Reynard, 2021).

5.5 The Klasies Pattern

The Klasies Pattern is present for the entire RS sub-member faunal assemblage. However, when the Klasies Pattern was calculated on the individual layers with the highest number of bone specimens, YS1M and YBS layers, the Klasies Pattern was not present. Van Pletzen *et al.*, (2019)

highlighted that the bovid skeletal-part profiles are equal for the Deacon excavation than the S-W samples (Reynard & Wurz, 2020). This is also supported by most recent faunal studies from KRM (Achieng, 2019; Lap, 2020; Pearson, 2021), however, the Klasies Pattern was not calculated per individual layer. In the RS faunal sample, there are several lower limb skeletal elements, particularly phalanges, which are not desirable portions. The bone density of these elements makes their survival chances higher (Brain, 1969). The ethnographical material from the Kua foragers of the Eastern Kalahari Central District, Botswana, provides a comparative data set for possible human behavioural patterns that may have led to the Klasies Pattern (Bartram & Marean, 1999). Based on the MNE data of bovids in the RS sample, there are differences in skeletal remains between small and large bovids. The majority of the large bovid long bones present in the RS faunal sample are shaft remains. The Klasies Pattern in the entire sample of Cave 1B is most probably a result of fragmentation of the long bone from large bovids resulting in many shafts remains that could not be identified (Bartram & Marean, 1999). The Klasies Pattern remains a debate in Southern African archaeology, but this study has highlighted that the pattern resulted from unidentifiable long bone fragments that were discarded during the S-W excavations (Turner, 1989; Bartram & Marean, 1999, Van Pletzen *et al.*, 2019; Reynard & Wurz, 2020). Moreover, it is important to recognize that a large portion of the RS sample are unidentified specimens, and that the skeletal part representation is based only on identified specimens (Badenhorst & Plug 2011).

5.6 Subsistence Behaviour

5.6.1 *Hunting Techniques*

Klein and Cruz-Uribe (1996) argued that MSA humans had limited technological ability compared to their LSA counterparts. However, the diverse range of taxa in the RS sub-member suggests that MSA humans present at KRM Cave 1B had a diverse range of hunting methods to acquire animals (Thompson, 2010; Thompson & Henshilwood, 2011; Dusseldorp, 2010; Clark & Kandel, 2013; Dusseldorp & Reynard, 2021). Recent research has shown that MSA humans in the Western and Eastern Cape of South Africa were possibly using several hunting techniques such as hafted points, projectile weapons, ambush, pits and tactical hunting to obtain very large ungulates like Cape buffalo and giant buffalo (Milo, 1998; Lombard, 2005; 2008, Clark & Plug, 2008; Faith, 2008; Dusseldorp, 2010; Clark & Kandel, 2013; Armstrong, 2016; Jenkins *et al.*, 2017). Hunting very

large ungulates from a close distance can be dangerous, so a projectile weapon like spears may have been used. Intentional hunting of large bovids stems from the invention of spears (Smith, 2000). Driving docile bovids like elands over cliff edges is another hunting strategy that could have been used by MSA I hunters at KRM (Klein, 1978).

Binford's (1984) argument was that most of the large bovid 4 remains are very old individuals at KRM. The age profile of bovids from the RS sub-member study indicates that MSA humans were hunting adult individuals from bovid 1, 2, 3 and 4. There are also more adult specimens represented for indeterminate large and medium mammals, and most of these are likely bovids. Hunting buffaloes, which are aggressive game, shows hunting proficiency and cognitive research has shown that MSA hunters could hunt bovids of all sizes, both dangerous and docile (Milo, 1998; Marean, 1998; Dusseldorp, 2012; 2021).

At KRM, changes in the tool production from the MSA I to the MSA II layers reflect adaptive hunting strategies and technology imposed by environmental changes and other factors, and these changes are not chronologically or geographically defined (Klein, 1974; also see Lombard, 2007; Wurz, 2008; Orbach & Yeshurun, 2019). The use of projectile technology is well documented in the later MSA layers dated to the MIS 4 at Sibudu Cave (Wadley, 2008). The bony points and small quartz artifacts found in the RS sample show that they were used as arrow tips (Lombard, 2011; Williams *et al*., 2014; Rots *et al*., 2017). The Cape fur seal would have been speared from a close distance or clubbed to death (Klein & Cruz-Uribe, 1996). The skeletal elements of Cape fur seals in the RS faunal sample show that favourable meat portions were obtained. It is also possible that the meat was buried on the beach and preserved for later use (Richardson, 2020).

Wadley (2010) suggested the use of snares or trapping technology was used to obtain small mammals, however, this technology was hypothesized as an explanation for the large amount of small mammal remains in most southern Cape MSA sites. Small mammals like rock hyraxes at KRM Cave 1B were hunted with weapons like stone points (Wurz, 2000; Dusseldorp, 2012). Humans at KRM Cave 1B could have also hunted small mammals by spearing them while they were on rock cliff surfaces or between cracks in the rock cliff.

The San Bushmen used projectile weapons such as bows and poisoned arrows tips. The Bushmen had to skillfully follow prey to come within a decent shooting distance. The arrow tips were made from stones, wood and even bones before using metal in the Iron Age (McGranaghan & Challis,

2016; Smith, 2000). MSA humans at KRM during the RS sub-member may have used ambush hunting techniques to obtain large bovids like Cape buffalo and giant buffalo. Studies on the Kalahari Basarwa Bushmen people of Botswana use ambush hunting from blinds, where animals were injured or poisoned from arrow tips and followed by the trail they leave behind until the animal is found either severely injured or dead (Parris, 1971; Crowell & Hithcock, 2009).

By studying the specific tool types at sites and during specific periods in relationship with the taxa present, zooarchaeologists can gain more resolute information about tool use by MSA humans (Lombard, 2007; 2011; Gärdenfors & Lombard, 2018). For example, at KRM MSA I layers, there is some evidence for the use of hafting technology (Klein, 1974; Wurz, 2000). However, there are three bone specimens shaped like bone points (Appendix 4.1) which may have been used for this purpose.

There is burning on three tortoise shell pieces indicates that they were gathered and eaten by humans. It is possible that the whole organism was placed over the fire and cooked by humans in KRM Cave 1B, as was recorded in various ethnographic studies (Speth & Tchernov, 2002). Tortoise remains are also present at other MIS 5 layers at sites such as BBC and PP Cave 13B (Thompson & Henshilwood, 2011; Thompson & Henshilwood, 2014). Tortoise can be obtained with little to no risk by humans. Tortoises are small and slow. They a can be obtained by women and children, and this has been documented in modern hunter-gatherer groups like the Ache hunter group in Paraguay and also in central African foragers (Hurtado *et al*., 1985; Lupo & Schmitt, 2000). It is possible that these species were opportunistically or conditionally foraged by women or children and potentially men within MSA human populations (Lupo & Schmitt, 2000; Henshilwood *et al*., 2001, Thompson & Henshilwood, 2014).

5.6.2 *Fowling*

The acquisition of the African penguin may not have required any form of projectile weapon as they are flightless birds (Ksepka & Thomas, 2012). It is unlikely that eagle owls were a component of the MSA diet. People would unlikely have eaten a raptor like eagle owls (Badenhorst & Plug, 2012) because carnivores like eagle owls are often not considered as desirable meats because of their diet (Taylor, 2003). MSA humans from the RS sub-member at KRM hunted the Cape sea

gull. Evidence for this in the RS sub-member is found in bone specimens identified as Cape sea gull with burning and cut marks. The use of birds by San Bushman has been associated with a magical context as they are linked with healing (Low, 2011). The Kua people of Botswana and the Hadza people of Tanzania are known to hunt birds with special arrows, and they were used in the human diet alongside other animals (Bartram, 1997). Humans at KRM would have hunted the Cape sea gull with a projectile weapon like bows and arrows.

5.6.3 *Fishing*

The coastal MSA sites in the Western Cape of southern Africa such as BBC, PP Cave and Die Kelders occupied during the Last Interglacial, rarely contain fish and flying bird fauna (Thackeray, 1992). One fishbone specimen present in the RS sample contains burning (Appendix 2). Burnt fish bone specimens suggest they were caught and eaten (Badenhorst & Plug, 2012). Burning can also be a result of post-depositional damage, already buried bones can show burning modifications (Lyman, 1994). Humans that occupied KRM during the MSA I layers could have obtained fish using spears or hooks (Van Niekerk, 2011). They also could have been killed by cold water upwelling events (Hartline, 1980).

5.7 Conclusion

To determine the palaeoenvironment, site formation processes and subsistence behaviour from the KRM Cave 1B faunal sample, taxonomic and taphonomic analyses were carried out. Faunal assemblages may reflect biases in prey selection in human accumulated sites, with human prey selection affected by several factors, namely hunting strategies, preferences and technological capabilities. The KRM Cave 1B fauna sample consists of mammals, birds, reptiles, amphibians and fish, and the total sample was large enough to produce significant results. The general taphonomic signature shows that most of the fauna was accumulated by humans. Humans during ~ 115 Kya to MI5 5e were actively hunting large, medium and small mammals. They also added to their diets with other animals such as birds, tortoises and fish. The presence of juveniles bovids, seals and rock hyraxes from the faunal sample suggest that human occupation in KRM Cave 1B

was during the winter, spring and summer months, however, it is possible that humans made use of the KRM Cave IB during other times of the year.

The ungulate data from KRM Cave 1B is dominated by Cape grysbok/steenbok which are not very good palaeoenvironmental indicators. The palaeoenvironment in KRM during the older layers ~ 115 kya was a mixture of open grassland and other closed forest environment, this changed in the younger RS layers to a grassland environment. The palaeoenvironment of the RS sub-member might reflect the dating issue at KRM Cave 1B, but it is also possible that the ecological tolerance of Cape grysbok/steenbok at KRM meant they could occupy an open grassland environment during the MIS 5e.

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Appendix

Appendix 1

Driver 2005

Appendix 2

Appendix 2.1. Number of Identified Specimen (NISP) per RS Layers at KRM Cave 1B

Taxa (common name)	**GBS2B**	**GBS 2**	**CP2**	**CP2T**	**BCH**
Rodentia					
Otomys sp. (vlei rat)	3	0	0	0	0
Small rodent	5	2	0	1	2
Proboscidae					
Procavia capensis (rock hyrax)	11	21	0	1	9
cf. Procavia capensis (possibly rock hyrax)	0	0	0	0	1
Primate					
Papio ursinus (chacma baboon)	0	0	0	0	0
Carnivora					
Arctocephalus pusillus (Cape fur seal)	1	2	4	2	2
Small carnivore	0	0	0	0	0
Cetacea					
Cetacea (dolphin/whale)	3	0	0	0	0
Artiodactyla					
Syncerus caffer (Cape buffalo)	0	0	0	0	0
cf. Syncerus caffer (possibly Cape buffalo)	0	0	0	0	0
Pelorovis antiquus (giant buffalo)	0	0	0	0	2
Taurotragux oryx (eland)	0	0	0	0	0
Alcelaphaline sp. (hartebeest/wildebeest)	0	0	0	3	0
Pelea capreolus (grey rhebok)	1	0	0	0	0
Hippotragus sp. (roan/sable/blue antelope)	0	0	0	0	3
Redunca arundinum (southern reedbuck)	0	0	0	0	0

Redunca fulvorufula (mountain reedbuck)	1	0	1	0	0
Redunca sp. (southern/mountain reedbuck)	4	0	0	0	0
cf. Redunca sp. (possibly southern/mountain reedbuck)	0	0	0	0	0
Ourebia ourebia (oribi)	0	0	0	0	0
Raphicerus sp. (Cape grysbok/steenbok)	3	2	1	2	1
cf. Raphicerus sp. (possibly Cape grysbok/steenbok)	0	0	0	0	0
Bovid size classes					
Bovid 1	6	2	1	1	1
Bovid 2	6	4	0	1	4
Bovid 2/3	0	0	0	0	0
Bovid 3	4	2	1	2	9
Bovid 3/4	0	0	0	0	1
Bovid 4	0	0	0	0	0
Indeterminate Mammal					
Small mammal	8	19	3	4	9
Small/medium mammal	2	0	0	0	0
Medium mammal	18	6	5	12	8
Large Mammal	1	0	2	7	4
Avian					
Bubo sp. (eagle owl)	0	9	0	0	1
Phalacrocorax capensis (Cape sea gull)	1	0	0	0	0
Spheniscus demersus (African penguin)	2	1	0	0	2
Small bird	0	2	0	0	7
Small/medium bird	7	0	0	3	0
Medium bird	6	25	2	3	18
Reptilia					
Testudinidae sp. (tortoise)	6	2	0	0	5
Amphibia					

Amphibian sp. (frog/toad)	0	1	0	0	0
Fish					
Fish	1	1	0	0	0
Total	**100**	**101**	**20**	**42**	**89**

Appendix 2.1 cont.

Taxa (common name)	**BR**	**BRAF**	**BRU**	**BS**	**BSH1**
Rodentia					
Otomys sp. (vlei rat)	0	0	0	0	0
Small rodent	0	1	1	1	0
Proboscidae					
Procavia capensis (rock hyrax)	0	0	0	11	0
cf. Procavia capensis (possibly rock hyrax)	0	0	0	0	0
Primate					
Papio ursinus (chacma baboon)	0	0	0	0	0
Carnivora					
Arctocephalus pusillus (Cape fur seal)	0	0	0	7	1
Small carnivore	0	0	0	0	0
Cetacea					
Cetacea (dolphin/whale)	0	0	0	0	0
Artiodactyla					
Syncerus caffer (Cape buffalo)	0	0	0	0	3
cf. Syncerus caffer (possibly Cape buffalo)	0	0	0	0	1
Pelorovis antiquus (giant buffalo)	0	0	0	0	0
Taurotragux oryx (eland)	0	0	0	0	0
Alcelaphaline sp. (hartebeest/wildebeest)	0	0	0	0	0
Pelea capreolus (grey rhebok)	0	0	0	0	0
Hippotragus sp. (roan/sable/blue antelope)	0	0	0	1	4
Redunca arundinum (southern reedbuck)	0	0	0	0	0
Redunca fulvorufula (mountain reedbuck)	0	0	0	0	0

Redunca sp. (southern/mountain reedbuck)	0	0	0	0	0
cf. Redunca sp. (possibly southern/mountain reedbuck)	0	0	0	0	0
Ourebia ourebia (oribi)	0	0	0	0	0
Raphicerus sp. (Cape grysbok/steenbok)	0	0	0	2	0
cf. Raphicerus sp. (possibly Cape grysbok/steenbok)	0	0	0	0	0
Bovid size classes					
Bovid 1	0	0	1	3	1
Bovid 2	0	0	1	0	1
Bovid 2/3	0	0	0	0	0
Bovid 3	1	0	0	1	1
Bovid 3/4	0	0	0	0	0
Bovid 4	0	0	0	0	0
Indeterminate Mammal					
Small mammal	0	0	2	4	1
Small/medium mammal	0	0	0	0	0
Medium mammal	3	0	0	5	5
Large Mammal	1	0	3	1	1
Avian					
Bubo sp. (eagle owl)	0	0	0	0	0
Phalacrocorax capensis (Cape sea gull)	0	0	0	0	1
Spheniscus demersus (African penguin)	1	0	0	1	1
Small bird	0	1	1	2	2
Small/medium bird	0	0	0	1	0
Medium bird	8	1	0	26	9
Reptilia					
Testudinidae sp. (tortoise)	0	0	0	0	0
Amphibia					
Amphibian sp. (frog/toad)	0	0	0	0	0

Fish					
Fish	0	0	0	0	0
Total	**14**	**3**	**9**	**66**	**32**

Appendix 2.1 cont.

Taxa (common name)	**BSH2**	**BSH 2BH**	**BYS1**	**GBS**	**YBS B**
Rodentia					
Otomys sp. (vlei rat)	0	0	0	0	0
Small rodent	0	0	0	0	1
Proboscidae					
Procavia capensis (rock hyrax)	1	0	0	4	5
cf. Procavia capensis (possibly rock hyrax)	0	0	0	0	1
Primate					
Papio ursinus (chacma baboon)	0	0	0	0	0
Carnivora					
Arctocephalus pusillus (Cape fur seal)	6	0	0	0	1
Small carnivore	1	0	0	0	0
Cetacea					
Cetacea (dolphin/whale)	0	0	0	0	0
Artiodactyla					
Syncerus caffer (Cape buffalo)	0	0	0	0	0
cf. Syncerus caffer (possibly Cape buffalo)	0	0	0	0	0
Pelorovis antiquus (giant buffalo)	0	0	0	0	0
Taurotragux oryx (eland)	0	0	0	0	0
Alcelaphaline sp. (hartebeest/wildebeest)	0	0	0	0	0
Pelea capreolus (grey rhebok)	0	0	0	0	0
Hippotragus sp. (roan/sable/blue antelope)	0	0	0	0	0
Redunca arundinum (southern reedbuck)	0	0	0	0	0
Redunca fulvorufula (mountain reedbuck)	1	0	0	0	0
Redunca sp. (southern/mountain reedbuck)	2	0	0	0	0

cf. Redunca sp. (possibly southern/mountain reedbuck)	0	0	0	0	0
Ourebia ourebia (oribi)	0	0	0	0	0
Raphicerus sp. (Cape grysbok/steenbok)	0	0	0	0	1
cf. Raphicerus sp. (possibly grysbok/steenbok)	0	0	0	0	0
Bovid size classes					
Bovid 1	4	0	0	2	1
Bovid 2	0	0	1	1	3
Bovid 2/3	0	0	0	0	0
Bovid 3	2	0	1	1	4
Bovid 3/4	0	0	0	0	0
Bovid 4	0	0	0	1	0
Indeterminate Mammal					
Small mammal	10	0	0	8	16
Small/medium mammal	0	0	0	0	0
Medium mammal	7	0	0	1	3
Large Mammal	3	0	0	1	0
Avian					
Bubo sp. (eagle owl)	0	0	0	0	1
Phalacrocorax capensis (Cape sea gull)	1	0	1	0	0
Spheniscus demersus (African penguin)	12	2	0	0	3
Small bird	4	6	0	0	0
Small/medium bird	0	0	0	0	0
Medium bird	13	7	1	9	17
Reptilia					
Testudinidae sp. (tortoise)	1	0	0	0	0
Amphibia					
Amphibian sp. (frog/toad)	0	0	0	0	0
Fish					

Fish	0	0	0	0	0
Total	**68**	**15**	**4**	**28**	**57**

Appendix 2.1 cont.

Taxa (common name)	**YBS**	**YRU**	**CP1**	**CP1T**	**YS1**
Rodentia					
Otomys sp. (vlei rat)	1	0	0	0	0
Small rodent	3	6	0	0	2
Proboscidae					
Procavia capensis (rock hyrax)	29	6	0	1	2
cf. Procavia capensis (possibly rock hyrax)	0	0	0	0	0
Primate					
Papio ursinus (chacma baboon)	1	0	0	0	0
Carnivora					
Arctocephalus pusillus (Cape fur seal)	17	2	1	0	0
Small carnivore	1	0	0	0	2
Cetacea					
Cetacea (dolphin/whale)	0	0	0	0	0
Artiodactyla					
Syncerus caffer (Cape buffalo)	0	0	0	0	0
cf. Syncerus caffer (possibly Cape buffalo)	0	0	0	0	0
Pelorovis antiquus (giant buffalo)	0	0	0	0	0
Taurotragux oryx (eland)	3	0	0	0	0
Alcelaphaline sp. (hartebeest/wildebeest)	1	0	0	0	0
Pelea capreolus (grey rhebok)	0	0	0	0	0
Hippotragus sp. (roan/sable/blue antelope)	0	0	0	0	0
Redunca arundinum (southern reedbuck)	1	0	0	0	0
Redunca fulvorufula (mountain reedbuck)	0	1	1	0	1
Redunca sp. (southern/mountain reedbuck)	2	1	0	0	0
cf. Redunca sp. (possibly	1	0	0	0	0

southern/mountain reedbuck)					
Ourebia ourebia (oribi)	0	0	0	0	0
Raphicerus sp. (Cape grysbok/steenbok)	4	0	2	1	0
cf. Raphicerus sp. (possibly Cape grysbok/steenbok)	0	0	0	0	0
Bovid size classes					
Bovid 1	10	7	0	1	2
Bovid 2	5	5	0	0	1
Bovid 2/3	2	0	0	0	0
Bovid 3	6	3	2	1	0
Bovid 3/4	0	0	1	0	0
Bovid 4	0	0	0	0	0
Indeterminate Mammal					
Small mammal	14	5	1	1	3
Small/medium mammal	0	0	0	0	0
Medium mammal	17	8	5	1	0
Large Mammal	3	2	0	0	1
Avian					
Bubo sp. (eagle owl)	3	3	0	0	0
Phalacrocorax capensis (Cape sea gull)	0	0	0	0	0
Spheniscus demersus (African penguin)	6	1	0	0	0
Small bird	3	7	0	0	0
Small/medium bird	0	0	0	0	0
Medium bird	24	14	4	1	6
Reptilian					
Testudinidae sp. (tortoise)	0	4	0	0	2
Amphibian					
Amphibian sp. (frog/toad)	0	0	0	0	0
Fish					
Fish	0	0	0	1	0

Total	**157**	**75**	**17**	**8**	**22**

Appendix 2.1 cont.

Taxa (common name)	**YS1T**	**YS1M**	**Y/SH**	**CP3**	**DRU**	**Total**
Rodentia						
Otomys sp. (vlei rat)	2	0	0	0	2	**8**
Small rodent	0	15	0	0	3	**43**
Proboscidae						
Procavia capensis (rock hyrax)	13	10	3	0	6	**133**
cf. Procavia capensis (possibly rock hyrax)	0	1	0	0	0	**3**
Primate						
Papio ursinus (chacma baboon)	0	0	0	0	0	**1**
Carnivora						
Arctocephalus pusillus (Cape fur seal)	2	8	1	1	0	**58**
Small carnivore	0	0	0	0	0	**4**
Cetacea						
Cetacea (dolphin/whale)	0	0	0	0	0	**3**
Artiodactyla						
Syncerus caffer (Cape buffalo)	0	0	0	0	0	**3**
cf. Syncerus caffer (possibly Cape buffalo)	0	0	0	0	0	**1**
Pelorovis antiquus (giant buffalo)	0	0	0	0	0	**2**
Taurotragux oryx (eland)	0	0	0	0	0	**3**
Alcelaphaline sp. (hartebeest/wildebeest)	0	0	0	0	0	**4**
Pelea capreolus (grey rhebok)	0	0	0	0	0	**1**
Hippotragus sp. (roan/sable/blue antelope)	0	0	0	0	0	**8**
Redunca arundinum (southern reedbuck)	0	0	0	0	0	**1**
Redunca fulvorufula (mountain reedbuck)	0	1	0	1	0	**8**
Redunca sp. (southern/mountain reedbuck)	0	0	0	1	0	**10**
cf. Redunca sp. (possibly southern/mountain reedbuck)	0	0	0	0	0	**1**

Ourebia ourebia (oribi)	1	0	0	0	0	**1**
Raphicerus sp. (Cape grysbok/steenbok)	2	2	1	0	3	**27**
cf. Raphicerus sp. (possibly Cape grysbok/steenbok)	0	0	1	0	0	**1**
Bovid size classes						
Bovid 1	1	15	1	1	4	**65**
Bovid 2	3	4	0	2	1	**43**
Bovid 2/3	0	0	0	0	0	**2**
Bovid 3	1	5	3	0	0	**50**
Bovid 3/4	0	0	0	0	0	**2**
Bovid 4	0	0	0	0	0	**1**
Indeterminate Mammal						
Small mammal	8	26	6	4	4	**156**
Small/medium mammal	0	0	0	0	0	**2**
Medium mammal	1	10	1	4	0	**120**
Large Mammal	0	3	1	0	0	**34**
Avian						
Bubo sp. (eagle owl)	0	0	0	1	0	**18**
Phalacrocorax capensis (Cape sea gull)	0	0	0	0	1	**5**
Spheniscus demersus (African penguin)	0	5	0	0	1	**38**
Small bird	1	24	8	0	3	**71**
Small/medium bird	0	2	0	0	0	**13**
Medium bird	9	41	9	2	5	**260**
Reptilian						
Testudinidae sp. (tortoise)	1	2	2	0	2	**27**
Amphibian						
Amphibian sp. (frog/toad)	0	0	0	0	0	**1**
Fish						
Fish	1	3	0	0	0	**7**
Total	**46**	**177**	**37**	**17**	**35**	**1239**

Appendix 3

Appendix 3.1. The measurements of *Procavia capensis*

***Procavia capensis* (rock hyrax) Elements**	**Layer**	**GLP**	**SLC**	**BG**	
Scapula	YBS	15.5	7.66	8.24	
Scapula	YBS B	15.2	7.56	9.36	
		GL	**SD**	**BP**	**BD**
Humerus	YRU	-	-	-	11.2
Femur	YBS	78.24	6.72	17.92	16.5
		BPC	**SDO**		
Ulna	GBS	8.68	9.18		
Ulna	GBS	8.66	-		
Ulna	YBS	6.78	8.76		
Ulna	YBS B	8.62	5.7		

Appendix 3.2. The measurement of *Syncerus caffer*

***Syncerus caffer* (Cape buffalo) Element**	**Layer**	**Length**	**Breadth**	**Description**
Upper Second Molar	BSH1	31.8	30.0	Upper left side molar, Very worn. Old individual

Appendix 3.3. The measurement of *Pelorovis antiquus*

***Pelorovis antiquus* (giant buffalo) Element**	**Layer**	**BP**
Third phalanx	BCH	32.3

Appendix 3.4. The measurements of *Taurotragus oryx*

***Taurotragus oryx* (eland) Elements**	**Layer**	**GH**	**GD**	**BFp**
Radial Carpal	YBS	37.2	48.3	-
Ulnar Carpal	YBS	-	-	29.52
Intermediate Carpal	YBS	-	49.2	-

Appendix 3.5. The measurement of Alcelaphaline sp.

Alcelaphaline sp. (hartebeest/wildebeest) Element	**Layer**	**SD**
Second Phalanx	YBS	15.2

Appendix 3.6. The measurements of *Hippotragus* sp.

Hippotragus sp. (roan/sable/blue buck) Elements	**Layer**	**Circumference**	**Length**	**Breadth**
Horn core	BS	138.6	-	-
Upper Second Premolar	BSH1	-	21.56	13.1
Upper Second Premolar	BSH1	-	14.38	20.2
Upper Second Molar	BSH1	-	21.8	18.2
Lower Third Molar	BSH1	-	29.8	11.9

Appendix 3.7. The measurement of *Palea capreolus*

***Palea capreolus* (grey rhebok) Element**	**Layer**	**BP**
Second phalanx	GBS 2B	11.38

Appendix 3.8. The measurement of *Ourebia ourebia*

***Ourebia ourebia* (oribi) Element**	**Layer**	**HP**	**DLS**	**MBS**	**LD**	**BFP**
Third phalanx	YS1T	11.38	20.2	4.88	18.1	6.3

Appendix 3.9. The measurements of *Redunca arundinum*

***Redunca arundinum* (southern reedbuck) Element**	**Layer**	**LO**	**SDO**
Ulna	YBS	45.4	21.68

Appendix 3.10. The measurements of *Redunca fulvorufula*

***Redunca fulvorufula* (mountain reedbuck) Elements**	**Layer**	**GL**	**BP**	**BD**		
First phalanx	BSH2	-	9.6	-		
First phalanx	CP1	-	12.4	-		

First phalanx	CP3	-	-	11.1		
First phalanx	YRU	-	-	10.8		
Second phalanx	GBS 2B	22.98	10.04	-		
Second phalanx	YS1	-	9.1	-		
		DLS	**LD**	**MBS**	**BFp**	**HP**
Third phalanx	CP2	18.0	16.9	5.5	6.1	11.48
Third phalanx	YS1M	23.0	20.1	5.4	6.2	12.6

Appendix 3.11. The measurements of *Redunca* sp.

***Redunca sp.* (southern/mountain reedbuck) Elements**	**Layer**	**Length**	**Breath**	
Premolar	GBS 2B	10.3	10.6	
Premolar	GBS 2B	11.1	7.64	
		GH	**GD**	**HMD**
Intermediate Carpal	BSH2	13.8	17.0	-
Ulnar Carpal	BSH2	-	-	13.1
Navicular Cuboid Tarsal	GBS 2B	25.3	29.4	-
		SD	**BP**	**BD**
First phalanx	GBS 2B	-	10.08	-
First phalanx	YRU	9.84	11.9	-
Second phalanx	CP3	-	-	7.78

Appendix 3.12. The measurements of *Raphicerus* sp.

***Raphicerus* (Cape grysbok/steenbok) Elements**	**Layer**	**GL**	**SD**	**BP**	**BD**	**DP**
Radius	YBS	-	-	-	16.1	-
		GD				
Intermediate Carpal	CP1T	10.2				
		GL	**SD**	**BP**	**BD**	**DP**
Tibia	GBS 2	-	-	-	17.8	-
Navicular Cuboid Tarsal	GBS 2B	-	-	-	16.9	-
		GLi	**GLm**	**DL**	**DM**	
Astragalus	GBS 2B	21.6	19.1	-	10.8	
Astragalus	YBS	-	-	11.8	12.14	
		GL	**SD**	**BP**	**BD**	**DP**
First phalanx	BCH	27.3	-	6.4	-	-
First phalanx	CP2	27.4	6.3	7.36	6.6	-
First phalanx	DRU	29.1	5.5	8.3	-	-
First phalanx	YBS	-	-	8.3	-	-
First phalanx	YS1M	-	-	-	7.9	-
Second phalanx	BS	16.68	5.2	6.0	5.2	-
Second phalanx	CP1	13.42	-	5.9	4.82	-
Second phalanx	Y/SH	19.7	-	7.7	-	9.8
Second phalanx	YBS B	-	-	7.3	-	-
Second phalanx	YS1M	19.2	-	8.0	-	-
Second phalanx	YS1T	21.2	5.8	8.1	6.0	-
		DLS	**LD**	**MBS**	**BFP**	**HP**
Third phalanx	BS	20.86	19.0	4.56	6.1	12.2
Third phalanx	CP1	-	-	4.66	6.0	11.18

Third phalanx	CP2T	20.0	17.46	4.1	5.3	10.5
Third phalanx	DRU	20.4	18.6	4.68	5.3	11.6
Third phalanx	DRU	-	-	4.0	6.12	11.4
Third phalanx	YBS	-	-	4.2	5.3	10.0
Third phalanx	YS1T	17.3	14.76	4.52	6.0	11.0

Appendix 3.13. The measurements for *Bubo* sp.

***Bubo* sp. (eagle owl) Elements**	**Layer**	**SD**	**DD**	**GL**	**BP**	**BD**
Coracoid	GBS 2	9.72	-	52.0	-	-
Coracoid	GBS 2	5.02	-	50.0	-	-
Humerus	GBS 2	7.74	-	-	-	17.84
Humerus	GBS 2	13.42	-	92.1	24.52	13.1
Humerus	YBS	8.2	-	-	-	19.62
Ulna	BCH	4.48	-	116.1	12.8	10.9
Ulna	GBS 2	6.3	-	103.91	-	-
Ulna	YRU	6.48	-	-	12.8	-
Femur	GBS 2	7.1	-	-	-	14.9
Femur	GBS 2	12.28	-	62.36	-	14.72
Femur	YRU	6.4	-	-	-	14.92
Tarsometatarsus	GBS 2	-	5.82	-	-	10.08
Tibiotarsus	GBS 2	11.6	11.00	120.5	14.42	-

Appendix 3.14. The measurements of *Phalacrocorax capensis*

***Phalacrocorax capensis* (Cape gull) Elements**	**Layer**	**SD**	**BP**	**Cr-Gov**
Mandible	DRU	-	-	6.42
Coracoid	GBS 2B	5.1	-	-

Carpometacarpus	BSH1	4.12	10.8	-

Appendix 3.15. The measurements of *Spheniscus demersus*

***Spheniscus demersus* (penguin) Elements**	**Layer**	**Cr-Gov**				
Mandible	BCH	7.8				
		LC				
Sternum	GBS 2	6.23				
Sternum	GBS 2B	6.09				
		GL	**SD**	**BP**	**BD**	**Wpg**
Coracoid	BSH2	-	-	-	20.4	-
Coracoid	BSH2	67.1	-	11.5	20.48	-
Coracoid	GBS 2B	-	7.56	10.0	-	-
Coracoid	YRU	-	-	-	-	18.0
Humerus	BR	63.22	13.1	22.0	19.3	-
Humerus	BSH2	64.9	11.6	21.18	16.8	-
Humerus	BSH2	-	-	-	17.56	-
Radius	YS1M	-	-	6.4	-	-
Ulna	BSH 2 BH	50.4	7.36	7.48	7.7	-
Ulna	DRU	-	-	-	6.8	-
Ulna	YS1M	25.5	7.6	5.2	7.1	-
Tibia	BSH 2 BH	-	-	-	13.64	-
Tibia	YBS B	-	-	-	12.36	-
Metatarsal	YBS	-	-	13.48	-	-

Appendix 3.16. The measurement of Amphibian sp.

Amphibian sp. (toad/frog) Element	**Layer**	**GL**
Innominate	GBS 2	28.38

Appendix 3.17. The measurements of fish sp.

Fish Elements	**Layer**	**GL**	**Circumference**
Vertebra	CP1T	13.2	-
Vertebra	GBS 2	7.1	-
Vertebra	GBS 2B	5.0	-
Vertebra	YS1M	-	5.1
Vertebra	YS1M	-	9.1
Vertebra	YS1T	-	12.1
Fin	YS1M	13.2	-

Appendix 4

Appendix 4.1. Image of bones with polished/abrasive surface, the bone on top was shaped into a pointy tool

Appendix 4.2. Image of the different colouration pattern observed on burnt bone specimens