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Faunal Exploitation during Marine Isotope Stage 5c at Klasies River Main Site Cave 1B: Assessing Subsistence Behaviours, Occupational Activity, and Behavioural Complexity

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Declaration

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School of Geosciences……..

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Abstract

Klasies River Main Site (KRM) is a Middle Stone Age (MSA) site located on the Tsitsikamma coast of the Eastern Cape of South Africa. The majority of literature concerning the subsistence behaviours, occupational activity, and behavioural complexity of AMH that are associated with KRM comes from the Singer and Wymer (1982) samples, which are known to have a sampling bias. In this study, a faunal and taphonomic analyses of the samples excavated by Hillary Deacon from the DC sub-member of KRM Cave 1B is undertaken. This sample that does not have the sampling bias associated with the Singer and Wymer (1982) samples. There are 17 069 faunal specimens excavated from the DC sub-member, of these there are 1 291 identified faunal specimens. The taphonomic data suggest that AMHwere the primary source of the majority of taphonomic changes, this suggests that AMH werethe primary accumulators of the DC faunal sample. The faunal identification highlights that the accumulators of the DC faunal sample had a wide dietary breadth and exploited marine and terrestrial fauna at the site. Skeletal-part profilesand age estimations confirm that AMH favoured sub-adult and adult individuals and there was not selective transport of faunal skeletal-parts. All this suggests AMH that accumulated the DC faunal sample were accomplished hunter-gatherers.

Keywords

● Klasies River Main Site (KRM) ● Anatomically Modern Human (AMH)● DC sub-member ●Taphonomy ● Faunal specimens

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Chapter 1: Background

1.1. Introduction

Klasies River Main Site (KRM) is a collection of five caves excavated by Singer and Wymer (1982), namely Cave 1, Cave 1A, Cave 1B, Cave 1C And Cave 2 (Figure 1), Wurz subsequently excavated the Witness Baulk in Cave 1 (Wurz *et al*., 2018). KRM holds crucial evidence about the subsistence behaviours, and occupational activity of Anatomically Modern Humans (AMH) that occupied the site throughout MIS 5-3 (Klein, 1976; Rightmire and Deacon, 1991; Deacon, 2001). The primary goal of this project is to investigate AMH faunal exploitation at KRM Cave 1B during MIS 5c. This research will help determine which layers throughout MIS 5c have the highest faunal deposition, while also giving better insight into the dietary breadth of AMH as well as how successful these AMH were at exploiting different fauna. The research will also highlight the faunal exploitation of generations of AMH groups that occupied KRM at different periods of the MSA.

1.2. Research Questions

I will investigate five research questions of interest concerning the DC faunal sample excavated from Cave 1B . The research questions are as follows:

- Which DC sub-member layers have the highest faunal deposition?
- Are AMH the primary accumulators of the DC faunal sample?
- Is the Klasies Pattern visible in the Bovid specimens from the DC faunal sample?
- What subsistence strategies did AMH inhabiting KRM Cave 1B during MIS 5c employ?
- How prevalent are human and non-human taphonomic markers in the DC faunal sample?

These five research questions will provide comprehensive analyses of the extent of

faunal exploitation at KRM during MIS 5c, and highlight the subsistence behaviours, occupational activity, and behavioural complexity of AMH that occupied the Site during MIS 5c.

1.3. Objectives

This study is undertaken with the goal of fulfilling the follow research objectives:

- Perform a faunal analysis to categorise all the identified skeletal elements from the DC faunal sample by their taxa, sex, age, and side whenever possible.
- Perform a taphonomic analysis on the faunal remains from the DC faunal sample.
- Assess the skeletal-part-profiles of identified taxa in the DC faunal sample.
- Asses the sample size in each DC sub-member layer.

1.4. Aims

To address the research questions the research analysis will focus on fulfilling the following aims:

- Identify the identifiable faunal specimens in the DC faunal sample.
- Determine which DC sub-member layers have the highest Number of Identified Specimens (NISP) and the Number of Unidentified Specimens NUSP) values.
- Determine which taxa are most prevalent in the DC faunal sample.
- Determine the skeletal-part profiles of the identified taxa.
- Analyse the identified and unidentified faunal specimens for human and non-human taphonomic markers

These four aims listed above for a comprehensive analysis of the accumulators of the DC faunal sample and the fauna they exploited, as well as the diversity of the fauna and skeletal- parts they exploited.

1.5. Hypotheses

Four hypotheses that accompany the research questions are put forward; the hypotheses take into consideration prior established knowledge of faunal exploitation at KRM during the MSA. The hypotheses are as follows:

- AMH were the primary accumulators of the DC faunal sample.
- The Klasies Pattern is not visible in the faunal specimens from the DC faunal sample.
- AMH that occupied KRM were effective hunter-gatherers.
- Human taphonomic markers will be more prevalent than non-human taphonomic markers in the DC faunal sample.

Chapter 2: Literature Review

2.1. Introduction

The South African Cape coast has captivated anthropologists for decades due to its rich heritage of Middle Stone Age (MSA) sites and materials (Figure 1; Volman, 1981; Henshilwood *et al*., 2001; Jacobs *et al.*, 2008; Wadley, 2015). The MSA is a cultural period that occurred between 300 and 30 thousand years ago (ka) in Southern Africa (Jacobs *et al.*, 2008; Wadley, 2015). Klasies River Main site (KRM), Die Kelders Cave 1,Blombos Cave and Pinnacle Point Cave 13B are prominent early MSA sites (Deacon 1995; Marean *et al.*, 2000; Thompson *et al.*, 2010; Wadley, 2015). KRM is a Southern African MSAsite with evidence for the evolution of AMH subsistence behaviour and technological progress(Singer and Wymer, 1982; Deacon and Geleijnse, 1988; Wadley, 2015; Reynard and Wurz, 2020).

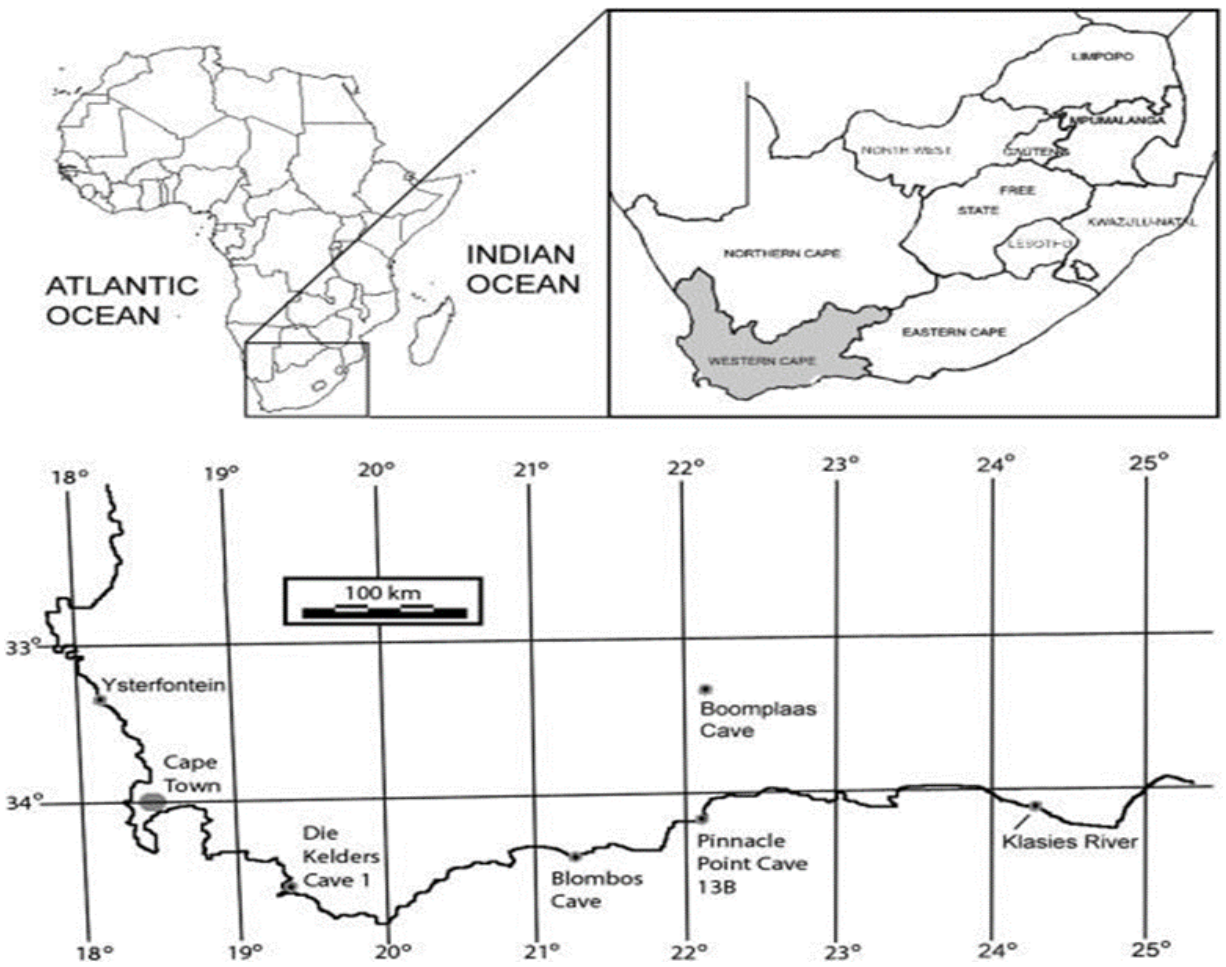


Figure 1. Location o Klasies River Main Site and other prominent MSA sites on the South African Cape coast, map extracted from Thompson (2010)

The Caves are situated along a two-point five (2.5) km stretch of the Tsitsikamma Coastal platform of the Eastern Cape of South Africa (Deacon and Geleijnse, 1988; Deacon and Wurz, 2005; Wurz *et al.*, 2018). The site has a complex depositional history due to the formation sequence of the region (Butzer, 1978; Deacon, 2001). KRM was an occupation site for AMH intermittently throughout the MSA (Rightmire and Deacon 1991). AMH are the earliest recorded *Homo sapiens* whose anatomical morphology is equivalent to modern-day humans (Rightmire and Deacon 1991; Lombard, 2012; Wadley, 2015; Hublin *et al.*, 2017). KRM holds diverse samples of organic and inorganic materials that AMH made, found, exploited and left behind (Singer and Wymer 1982; Deacon and Geleijnse, 1988; Wurz, 2013). KRM has undergone three mainexcavations (Figure 2); the discussions into the extent of these excavations are in the later chapters.

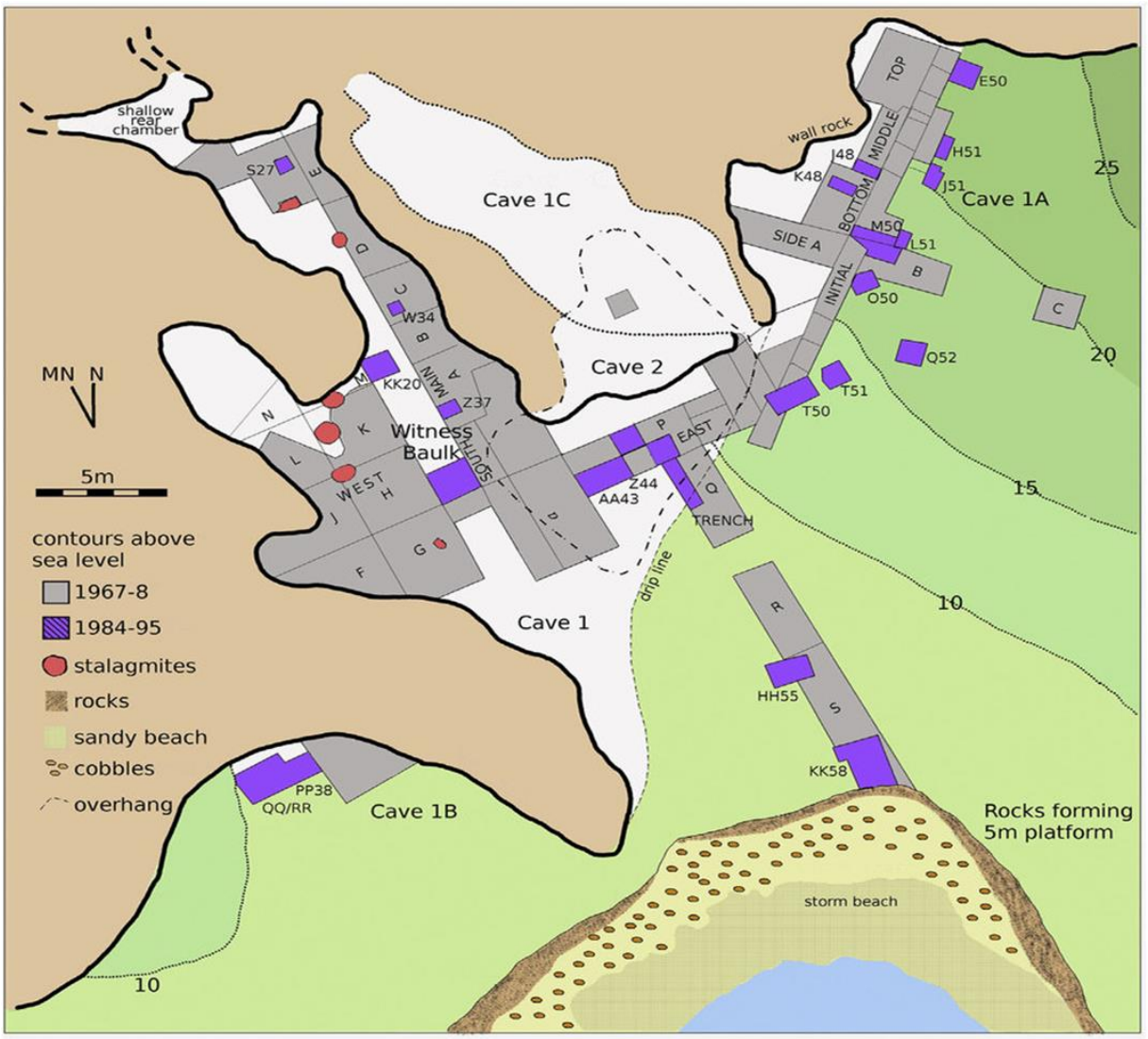


Figure 2. The layout plan of Klasies River Mouth Main Site (from Wurz *et al.*, 2018)

KRM preserves deposits that are 21 m deep indicating occupations of KRM throughout the MSA (Klein, 1976; Deacon, 1995, 2000; van Pletzen, 2001; Wurz *et al*., 2018). KRM sediments associated with the MSA represent a period between Marine Isotope Stages (MIS) 5 and 3. Stratigraphy and dating of these deposits indicate that AMH occupation occurred from MIS 5 to MIS 3 (Singer and Wymer, 1982; Deacon and Geleijnse, 1988). MIS are phases in the Earth's paleoclimate reflecting variations in warming and cooling periods, using oxygen isotope data extracted from core samples taken from the deep-sea sediments and ice cores (Wurz, 2012, 2013; Braun *et al.*, 2020; Morrissey *et al.*, 2020; Dupont *et al.*, 2021; Kris, 2021).

The South African Cape coast documents evidence of the earliest and longest record of marine resource use and coastal settlements established by AMH during the MSA (Volman, 1981; Wadley, 2015). MSA sites located on the South African Cape coastalong the Atlantic and the Indian Ocean are characterised by sediment deposits' that preserve shellfish and other marine resources (Volman, 1981; Henshilwood and Marean, 2003; Parkington, 2003; Marean, 2011). Anthropologist hypothesis that consumption of these marine resources aided the cognitive development and survival of AMH during the MSA (Volman, 1981; Henshilwood and Marean, 2003; Parkington, 2003; Marean, 2011).

KRM is a key MSA site due to almost complete Pleistocene deposits' spanning MIS 5-3 that have yielded large samples of archaeological remains and material (Singer and Wymer, 1982; Deacon and Geleijnse, 1988; Rightmire and Deacon, 1991). Analyses of the faunal samples and lithic technological sequence from KRM has been crucial to understandingearly AMH progression from MIS 5-3 (Singer and Wymer, 1982; Deacon and Geleijnse, 1988; Rightmire and Deacon, 1991; Reynard and Wurz, 2020).

The period between MIS 5 and 3 was a period of intense occupation of the Grater Cape Floristic Region (GCFR) by AMH and MSA sites with evidence of MIS 5 occupation have undergone extensive analysis as they hold some of the most in-depth evidence of early AMH behavioural complexity (Wurz, 2012, 2013; Braun *et al.*, 2020; Wadley, 2015; Morrissey *et al.*, 2020). AMH materials excavated from MIS 5 sites vary from coastal to interior sites

(Wadley, 2015; Kris, 2021). There are minimal recognisable spatial, chronological, and cultural patterns in the MSA before MIS 5 (Wurz, 2013).

The subsequent MIS 4 is characterised by environmental instability due to glacial activity and volcanic winter after the Toba volcanic eruption, which caused population stress in Sub-Saharan Africa (Ambrose, 1998; Williams *et al.*, 2009; Wadley, 2015). MIS 4 is characterised by two of the most diverse lithic technocomplexes namely the Still Bay and Howiesons Poort Technocomplexes, these technocomplexes are associated with the climax of AMH dietary breadth during the MSA (Clark and Kandel 2013; Ziegler *et al.*, 2013; Wadley, 2015). MIS 3 sites along the GCFR of the Southern Cape seem to lack extensiveoccupation between 50-25 ka, however, South Africa's interior holds extensive MIS 3 sites suggesting that AMH abandoned coastal sites for sites within the interior of South Africa (Mitchell, 2008; Wadley, 2015).

This research focuses on the progression of MIS 5 along the South African coast; as such, it delves into MIS 5 in detail in later chapters. The materials excavated from the DC sub-member have been utilised to make inferences of behaviour of AMH during the MSA (Klein, 1976; Singer and Wymer, 1982; Deacon and Geleijnse, 1988; van Pletzen, 2001; Deacon and Wurz, 2005; Ziegler *et al.*, 2013; Wadley, 2015). This chapter provides background information on KRM and highlights the significant material and dates of the KRM and other comparable MSA sites. This chapter also highlights previous faunal analyses and taphonomic studies of the faunal samples from KRM and other MSA sites dispersed across the coast of Southern Africa.

2.2. Klasies River Main Site Environment and Stratigraphy

2.2.1. KRM Environment

There are two dominant vegetation types in the region surrounding KRM namely, fynbos and forest (Avery, 1983, 1987; Deacon, 2001; Mucina and Rutherford, 2006; Reynard and Wurz, 2020). Theyboth occur on the Cape Fold Mountains and along with the Tsitsikamma

coastal platform (Avery, 1987; Deacon, 2001; Mucina and Rutherford, 2006; van Wijk, 2017; Reynard and Wurz, 2020). The Fynbos on the Tsitsikamma coastal platform is part of GCFR of the southernand southwestern Cape of South Africa (Avery, 1987; Deacon and Geleijnse, 1988; Reynard and Wurz, 2020). KRM sits on the eastern edge of the GCFR of the Southern and South Western Cape of South Africa (Avery, 1983, 1987; Larbey *et al.*, 2019; Reynard and Wurz, 2020).

The mosaic environment of the Tsitsikamma coast has remained unchanged for the most part since the MSA, making the region ideal hunting, scavenging and foraging ground for generations of AMH that occupied KRM throughout the MSA (Avery, 1983, 1987; Deacon, 2001; Mucina and Rutherford, 2006; Van Wijk *et al*., 2017; Reynard and Wurz, 2020). KRM is located approximately 0.5 km from the Klasies River; the Klasies River bank's indicate that the river was larger during the MSA, rising above current sea levels (Deacon and Geleijnse, 1988; Deacon, 2001). Assuming that the Klasies River had banks and slower running water and not rapids it likely functioned as a crucial source of various aquatic resources for the generations of AMH groups that occupied KRM during the Later Stone Age (LSA) and MSA (Deacon, 2001).

The KRM stratigraphic sequence is compacted and cemented on bedrock overlain by fine sands (Butzer, 1978; Singer and Wymer, 1982; Deacon and Geleijnse, 1988). Sedimentary layers with evidence of AMH occupation and those with the sands representing non-occupation periods are interspaced (Butzer, 1978; Singer and Wymer, 1982; Deacon and Geleijnse, 1988). The KRM sediments are comprised of five members (Figure 3) that sit truncated atop the underlying bedrock, the truncation of the sediments is due to multiple incidences of slumping caused by water saturation causing the plastic flow of the sediments (Deacon and Geleijnse, 1988).

From bottom to top, the KRM members are Light BrownSand (LBS), Rubble Brown Sand (RBS), Shell and Sand (SAS), Rock Fall (RF), Upper and White Sand (WS) members (Figure 3; Deacon and Geleijnse, 1988; Grine *et al.*, 1998; Grine *et al.*, 2017). Due to erosion,

none of the KRM Caves preserves all five sedimentary layers (Grine *et al.*, 1998; Grine *et al.*, 2017).

The LBS member is the oldest and lowermost member (Figure 3), and it is characterised by sands similar to those on the modern beach at the foot of KRM (Singer and Wymer, 1982; Deacon and Geleijnse, 1988). Accumulation of The LBS member was during the Last Interglacial (130—118 ka); the LBS sediments are rich in bone, shellartefacts, and hearths (Deacon, 1995; Pérez, *et al.*, 2017). Atop the LBS member is the RBS member (Figure 3) which is a carbonaceous layer partly infolded with the LBS member, the RBS member was initially categorised as part of the LBS member due to this infolding (Deacon, 2001; Wurz, 2000). The revaluation of KRM sediments led to reclassification of RBS (Wurz *et al.*, 2018).

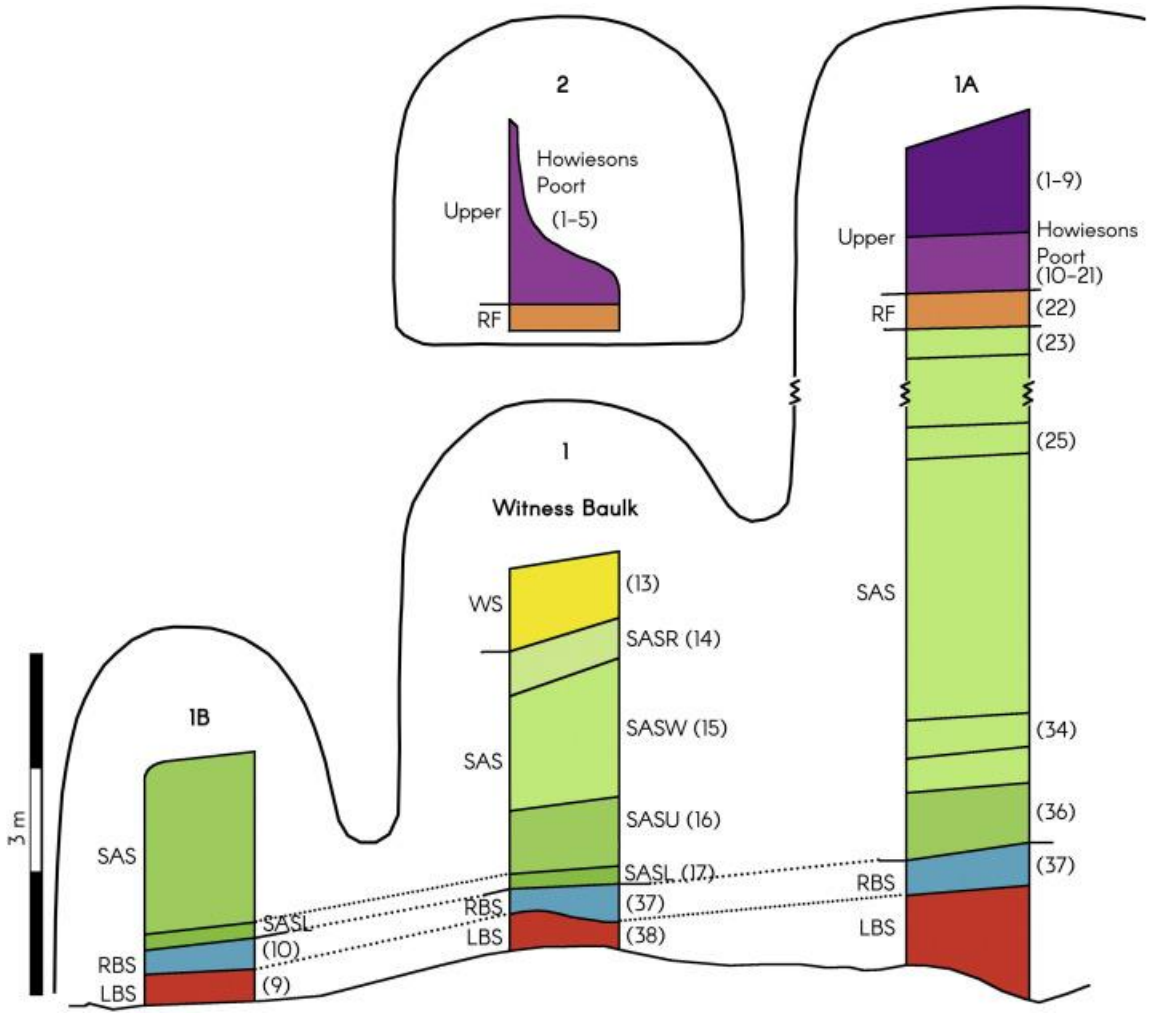


Figure 3. The generalized stratigraphy of Klasies River Main Site extracted from Wurz *et al.*, (2018)

The deposition of the SAS member was between 110-78 ka (Grine *et al.*, 2017). SAS

is divided into different sub-members at different KRM Caves, from top to bottom, the SAS Rubble (SASR), SAS Wedge (SAS-W) are sub-members in Cave 1 and the SAS Upper (SASU) and SAS Lower (SASL) are the sub-members presents in Caves 1, 1A and 1B (Figure 3; Singer and Wymer, 1982; Deacon and Geleijnse, 1988). The RF member is only present in Cave 1A and 2 (Figure3), the member was deposited between 78-70 ka it is characterised by red-brown sand withminor carb partings along with flowstone blocks (Singer and Wymer, 1982; Deacon and Geleijnse, 1988).

The Upper member is only present in Caves 1A and 2 (Figure 3) and was deposited between 70-50 ka and is dominated by microfauna sand beds along with multiple ash layers associated with the Howiesons Poort technocomplexes (Singer and Wymer, 1982; Deaconand Geleijnse, 1988). In the Cave 1A deposits, the Upper member has two sub-members (Figure3) whereby the top sub-member is a non-occupation deposit, and the bottom sub-member is rich in micro faunal deposits' (Singer and Wymer, 1982; Deacon and Geleijnse, 1988). The WS member is associated with the Late Pleistocene and is only present in Cave 1 (Figure 3); the member is a younger pulse of sands washed into the Cave but includes no features of primary AMH occupation (Deacon, 2008).

2.3. KRM Excavation History

2.3.1. Singer and Wymer Excavations

KRM has undergone three excavations from 1960 until present times; the excavations exposed multiple stratified layers of artefact rich deposits (Grine *et al.*, 1998; Grine *et al.*, 2017). Singer and Wymer (1982) performed the first excavations of KRM, their excavation aimed at understanding the progression of the MSA in South Africa. The Singer and Wymer (1967-1968) excavation allowed for the interpretations of the stratigraphy and dating of the KRM deposits. The data allowed researchers to make inferences about palaeoenvironment, paleoclimate and human subsistence strategies at the site (Klein, 1976; Singer and Wymer, 1982; Deacon and Geleijnse, 1988).

Singer and Wymer (1982) recognised a number of layers during their initial excavation . Singer and Wymer (1982) divided the KRM deposits into five cultural sequences called (from oldest to youngest) MSA I, MSA II, Howiesons Poort, MSA III and MSA IV (Singer and Wymer, 1982; Deacon, 2001). The five cultural subdivisions of KRM preserve sediments dating between 120-55 ka (MIS 5–3; Brenner *et al.*, 2020). The cultural material produced, palaeoclimatic and fauna and flora exploited by AMH at each cultural sequence distinguish the five cultural sequences (Singer and Wymer, 1982; Klein,1976; Deacon and Geleijnse, 1988; Deacon, 2001; Brenner *et al.*, 2020; Reynard and Wurz, 2020).

The KRM lithic history shows extensive variability in the lithic cultures due to changes in the dominant blade and point production traditions (Wurz, 2002). The KRM lithic sequence acts as a useful shorthand for inferring AMH complexity at various points in the MSA (Deacon and Geleijnse, 1988; Wurz, 2002; Deacon, 2008). According to Singer and Wymer (1982), the five KRM cultural sequences correlate with the KRM members as follows; MSA I is represented in the LBS member, MSA II is represented in the SAS, Howiesons Poort and MSA III are represented in the SAS Upper and MSA IV is represented in the WS member(Deacon and Geleijnse, 1988; Deacon, 2008). The MSA I cultural sequence is characterised bylong thin flake-blades retouched to form points made from locally sourced quartzite rocks (Singer and Wymer, 1982; Wurz, 2000, 2002). The platforms of the MSA I flake-blades bruised and worked back to allow for the detachment of the flake-blades (Wurz, 2000, 2002).

The MSA II cultural sequence has higher frequencies of convergent flake-blades and worked points (Wurz, 2002; McCall, 2006; Brenner and Wurz, 2019). MSA II blades were also manufactured using quartzite rocks, however, they are distinctively thicker and less regular in morphology when compared to MSA I blades (Wurz, 2002; Wurz *et al.*, 2003; McCall, 2006; Brenner and Wurz, 2019). The Howiesons Poort cultural sequence is characterised by various backed and truncated worked points made from silcrete (Wurz, 2002; Villa *et al.*, 2010; Brenner and Wurz, 2019). The Howiesons Poort cultural sequence also contains typical quartzite MSA flake-blades produced using methods similar to those used to make MSA I tools(Wurz, 2002;

Villa *et al.*, 2010; Brenner and Wurz, 2019).

The MSA III cultural sequence has a small sample size when compared to the previous sub-stages, it shows similarities with the Howiesons Poort cultural sequence and both cultural sequences are characterised by unifacial points and retouched flake-blades forms made from local quartzite and non-local silcrete (Klein, 1976; Singer and Wymer, 1982; Wurz, 2002; Villa *et al.*, 2010). The MSA IV cultural sequences has the smallest sample size of materials (Klein, 1976), however, the tools produced are characterised by irregular and underdeveloped single and double platform blades made with pebble chopper-cores and local quartzite (Singer and Wymer, 1982; Deacon, 2008). The blades from the MSA IV cultural sequence are unusually small and show minimal secondary working along their edges, which sets them apart (Singer and Wymer, 1982; Wurz, 2002; Deacon, 2008).

The lithic tools produced at different sub-stages of the MSA at KRM show some diversity in the methodology used to make the tools (Wurz, 2002; Brenner and Wurz, 2019). Each cultural sequence at KRM was accompanied by a unique technological reduction strategy and different typological characteristics, influenced by the availability of raw materials (Singer and Wymer, 1982; Wurz, 2002, 2005; Wurz *et al.*, 2003). The extensive faunal samples (Table 1) from Cave 1, 1A, 1B, 1C and 2, which show evidence of butchering display the complexity and effectiveness of the KRM lithic tools (Klein, 1976; Singer and Wymer, 1982). The faunal sample excavated from KRM by Singer and Wymer (1967-1968) has highlighted much of the debate on the effectiveness of lithic tools and subsistence strategies of AMH at KRM during the MSA (Klein, 1976; Singer and Wymer, 1982).

Preliminary sorting of faunal remains excavated by Singer and Wymer (1982) in the field led to all bones which were not regarded as taxonomically identifiable being discarded (Klein, 1976; Turner, 1989). Klein (1976) examined the potentially identifiable mammal bones from the Singer and Wymer (1982) samples (Table 1), making only a rough record of the relative abundance of bird, reptile, and fish specimens in the sample. Klein's (1976) analysis highlighted that bovid specimens are dominant mammal fauna amongst the KRM faunal

sample (Table 1); fluctuations in the frequencies of different bovid species suggest the vegetation around KRM fluctuated frequently with the progression of the MSA (Klein, 1976; Singer and Wymer, 1982; van Pletzen, 2000).

Table 1. The Minimum Number of Individuals (MNI) of the large mammals identified by Klein (1976: 77) from layers excavated by Singer and Wymer (1967-1968)

Taxa	**Cave 1**	**Cave 1A**	**Cave 1B**	**Cave 1C**	**Cave 2**
Primate					
Homo sapiens, Modern human	8	3	1	–	–
Papio ursinus, Chacma baboon	7	5	1	–	–
Carnivora					
Canis lupulella, Black-backed jackal	1	–	1	–	–
Mellivora capensis, Honey badger	2	–	–	–	–
Aonyx capensis, Clawless Otter	8	–	–	–	–
Genetta sp., Genet	–	–	–	–	–
Herpestes ichneumon, Egyptian mongoose	3	–	–	–	–
Herpestes pulverulentus, Cape grey mongoose	5	2	–	–	–
Atilax paludinosus, Water mongoose	1	1	1	–	–

Hyaena brunnea, Brown hyena	3	–	–	–	–
Felis libyca, African wildcat	1	3	–	–	–
Felis cf. caracal, Caracal	3	2	–	–	–
Panthera pardus, Leopard	10	1	–	–	–
Arctocephalus pusillus, Cape fur seal	64	43	21	6	–
Mirounga leonina, Southern elephant seal	1	–	–	–	–
Proboscidea					
Loxodonta africana, African bush elephant	3	1	–	–	–
Procavia capensis, Rock hyrax	51	33	14	–	–
Perissodactyla					
Diceros bicornis, Black rhinoceros	5	–	–	–	–
Equus cf. quagga, Quagga	4	14	–	–	–
Artiodactyla					
Potamochoerus larvatus,	6	–	1	–	–

Bushpig					
Phacochoerus africanus, Common warthog	3	–	2	–	–
Hippopotamus amphibius, Hippopotamus	16	4	–	–	–
Philantomba monticola, Blue duiker	5	–	–	–	–
Raphicerus melanotis, Cape grysbok	53	19	7	2	3
Ourebia ourebi, Oribi	2	–	–	–	1
Pelea capreolus, grey rhebok	7	5	1	–	–
Redunca cf. arundinum, Southern reedbuck	8	9	–	–	–
Redunca fulvorufula, Mountain reedbuck	7	–	–	–	–
Hippotragus leucophaeus, Blue antelope	52	23	3	–	–
Alcelaphus buselaphus, Hartebeest	5	–	2	1	–
Damaliscus sp., Bastard hartebeest	2	4	–	–	–

Connochaetes sp., Wildebeest	13	5	2	–	–
Antidorcas sp., Springbok	4	–	–	–	–
Tragelaphus scriptus, Bushbuck	24	1	1	–	2
Tragelaphus strepsiceros, Kudu	13	4	–	–	–
Taurotragus oryx, Common *e*land	104	37	9	2	1
Syncerus caffer, Cape buffalo	44	25	1	1	–
Syncerus antiquus, long-horned African buffalo	52	14	1	–	–
Delphinidae, Dolphins	11	1	–	1	–
Cetacea sp., Whales	3	–	–	–	–
Rodentia					
Hystrix africaeaustralis, Cape porcupine	22	4	1	–	–
Georychus capensis, Cape mole- rat	7	–	–	–	–
Lagomorpha					
Lepus capensis, Cape hare	1	–	1	–	–
Total	*644*	*262*	*71*	*13*	*7*

Klein (1976) observed that large bovid specimens are represented by distal elements (tibia, fibula, calcanea) whilst small bovids are represented by more anatomically complete

skeletons (Klein, 1976; Singer and Wymer, 1982; Bartram and Maren, 1999; van Pletzen, 2000). Klein (1976) termed this phenomenon as the “Klasies Pattern” (Klein, 1976; Turner, 1989; Bartram and Marean, 1999; van Pletzen, 2000).

Klein (1976) theorised that the differential skeletal-part representation is a consequence of selective transportation of whole carcasses of small bovids back to the site, whilst larger bovids were brought back in pieces with parts such as the feet attached to the skins and used as handles (Klein, 1976; Turner, 1989; Bartram and Marean, 1999; van Pletzen, 2000). This theory is referred to as the 'schlepp effect',however, this theory received significant push back (Klein, 1976; Turner, 1989; Bartram and Marean, 1999; van Pletzen, 2000). The main criticisms of Klein's (1976) 'schlepp effect' theoryare linked to Singer and Wymer's (1982) excavation team discarding all skeletal remains thought to be unidentifiable at the time of excavation (Turner, 1989; van Pletzen, 2000).

Attempting to explain, the 'Klasies Pattern' Binford (1985) proposed that the "Klasies Pattern" is the consequence of the interplay between scavenging and hunting by AMH(Binford, 1985). According to this theory, the Klasies Pattern observed at KRM is a consequence of the MSA hunting capabilities, whereby AMH selectively hunted and brought back whole carcasses of smaller bovids and scavenged larger bovids at carnivore kills (Binford,1985; van Pletzen, 2000). Binford (1985), argues that during the MSA AMH were behaviourally archaic and less competent hunters than their LSA counterparts and because of this the 'Klasies Pattern' is the result of the differential exploitation of different sized fauna.

The incomplete nature of Singer and Wymer's (1982) faunal samples due to them discarding unidentified skeletal remains suggests that the Klasies Pattern is merely a consequence of excavator/sampling bias (Turner, 1989). However, Blumenschine and Madrigal's (1993) research on marrow variability in ungulates in East Africa shows that lower limb bones are more marrow rich than upper limb bones, making it more cost-effective to exploit lower limb bones.

This suggests that the Klasies Pattern is not merely just a consequence of

excavator/sampling bias; instead, it is a taphonomic consequence of AMH and carnivores selecting long bones of large bovids due to the nutrient-rich marrow (Blumenschine and Madrigal, 1993; Bartram and Marean, 1999). Amongst smaller bovids, the marrow content in the long bone is lower making exploiting the entire carcass more energetically efficient (Blumenschine and Madrigal, 1993; Bartram and Marean,1999).

2.3.2. Deacon Excavations

The Deacon (1984-1995) excavations were on a more limited scale than the singer and Wymer excavations. The Deacon excavations aimed to provide more information from KRM to better contextualise the occupational history of the site rather than produce large samples of material (Deacon and Geleijnse, 1988; Deacon, 1995). The Deacon Excavation team excavated Caves 1, 1A, 1B and 2 along with the Witness Baulk (Deacon and Geleijnse, 1988; Deacon, 1995).

During the excavation of the KRMdeposits, the Deacon excavation team sieved the sediments through mesh sizes of 3 and 2 mm,during this process material >2 cm was assigned unique ID numbers before being bagged separately (Deacon and Geleijnse, 1988, van Pletzen, 2000). Deacon identified six members from the KRM deposits' these are, LBS, RBS, SAS, RF, Upper and WS members (Deacon andGeleijnse, 1988; Deacon, 1995). The Deacon excavations refined the dating of the deposits in Caves 1, 1A, 1B and 2, clarified the associations of the sediments, and identified new AMH remains (Deacon and Geleijnse, 1988; Rightmire and Deacon, 1991). The Deacon (1984-1995) excavations identified more layers in the sedimentation of KRM than the Singer and Wymer (1967-1968) excavation team (Deacon and Geleijnse, 1988;van Pletzen, 2000).

The findings from the Deacon (1984-1995) excavations highlighted that the KRM deposits represent multiple short-term AMH occupations interspaced by short-term non-occupation periods (Deacon and Geleijnse, 1988; Wurz, 2012). The occupation layers are rich in faunal material and AMH material, compacted sands with minimal faunal remains characterize the non-occupation periods (Deacon and Geleijnse, 1988; Rightmire andDeacon, 1991; Deacon, 1995). The Deacon Excavation team collected faunal samples (Table 2) from

occupation and non-occupations layers at KRM and the faunal analysis performed by van Pletzen (2000) is one of the most notable analyses of the Deacon (1984-1995) faunal sample (Table 2.

The MSA I occurs in the LBS and RBS members of Caves 1, 1A and 1B, the MSA II is sub-divided into MSA II Lower (101-90 ka) and MSA II Upper (85 ka) which comprises the entire SAS Member(Deacon and Geleijnse, 1988; Deacon, 1995; Rightmire *et al.*, 2006; Wurz, 2012). Howiesons Poort and MSA III occur in the Upper Member found in Cave 1A and 2; however, these two cultural sequences occur at different MIS (Deacon and Geleijnse, 1988; Deacon, 1995; Rightmire *et al.*, 2006; Wurz, 2012). Not much information exists about MSA IV, which only occurs in a small sample from the WS member in Cave 1 (Deacon and Geleijnse, 1988).

van Pletzen's (2000) analysis of the taphonomy and skeletal-part-frequencies of the faunal sample from the Deacon excavation highlighted the prominence of browsers from the SAS member, which encompasses the MSA II (Table 2; van Pletzen 2000). The findings of van Pletzen (2000) are in line with the palaeoenvironment distinctions highlighted by Klein (1984) from the Singer and Wymer samples indicating that the vegetation surrounding KRM fluctuated from open environment to closed environment and back to an open environment (Klein, 1984; van Pletzen, 2000).

Table 2. The Number of Identified Specimens (NISP) of the large mammals identified by van Pletzen (2000) from layers excavated by Deacon (1984-1995)

Taxa	**Cave 1**	**Cave 1A**	**Witness Baulk**
Primate			
Papio ursinus, Chacma baboon	2	–	–
Indeterminate primate, Primate	1	–	–

Carnivora			
Aonyx capensis, Clawless otter	2	1	–
Hyaena brunnea, Brown hyena	4	–	–
Arctocephalus pusillus, Cape fur seal	250	168	42
Indeterminate carnivore, Carnivore	15	37	2
Proboscidea			
Procavia capensis, Rock hyrax	339	194	62
Perissodactyla			
Equus sp., Quagga/zebra	2	3	5
Artiodactyla			
Suidae sp., Bushpig/warthog	2	3	1
Hippopotamus amphibius, Hippopotamus	6	2	5
Sylvicapra grimmia, Common duiker	2	3	2
Philantomba monticola, Blue duiker	1	–	–
Raphicerus melanotis, Cape grysbok	74	24	3
Pelea capreolus, Grey rhebok	1	5	4
Kobus sp., Waterbuck/lechwe	–	1	–

Redunca cf. Arundinum, Southern reedbuck	–	3	–
Redunca cf., Reedbuck	5	–	1
Hippotragus leucophaeus, Blue antelope	13	4	6
Hippotragus sp., Roan/sable/blue buck	–	3	4
Damaliscus pygargus,Bontebok/blesbok	–	3	–
cf. Alcelephine, Hartebeest/wildebeest	12	11	3
Megalotragus cf. Priscus, Giant *Alcelephine*	–	1	–
Antidorcas sp., Springbok	–	2	–
Tragelaphus scriptus, Bushbuck	23	–	–
Tragelaphus strepsiceros, kudu	16	5	2
cf. Tragelaphine, Bushbuck/kudu	2	–	–
Taurotragus oryx, Common eland	56	18	6
Syncerus caffer, Cape buffalo	26	14	3
Syncerus antiquus, Long-horned African buffalo	3	12	5
Cetacea sp., Whales/dolphin	1	–	1
Rodentia			
Hystrix	–	2	–

africaeaustralis, Cape porcupine			
Georychus capensis, Cape mole-rat	6	3	–
Lagomorpha			
Lepus capensis, Cape hare	1	5	–
Tubulidentata			
Orcyteropus afer, Aardvark	27	5	–
Bovid size class			
Small	608	438	39
Small-medium	299	210	76
Large medium	309	259	140
Large	–	188	54
Large/very large	225	–	–
Indeterminate bovid	192	4	21
Mammals			
Indeterminate mammal	603	22	57
Total	*3128*	*1653*	*544*

2.3.3. Wurz Excavations

Wurz resumed excavations of KRM in 2014/5 targeting the lowermost deposits within the Witness Baulk (Figure 2), the Witness Baulk extends for more than 12 m from the entrance to the back of Cave 1 (Wurz *et al.*, 2018; Brenner and Wurz 2019). The Deacon excavations removed the top-most deposits of the Witness Baulk, but the excavations halted before reaching the bedrock (Deacon and Geleijnse, 1988; Wurz *et al.*, 2018). The Deacon excavations excavated deposits' which encompasses the later periods of MSA II (Deacon and Geleijnse, 1988; Deacon, 1995), the Wurz excavation is targeting the deeper layers of the Witness Baulk which encompasses the MSA II lower (Brenner and Wurz 2019; Wurz *et al.*, 2018).

Currently, the Wurz excavations have excavated four layers from the Witness Baulk (Brenner and Wurz 2019; Wurz *et al.*, 2018). The uppermost layer is the Shell Midden One

(SMONE); the layer is 5 cm thick in the western part and thickens toward the east of the Witness Baulk (Brenner and Wurz, 2019). Below the SMONE layer is the Black Occupational Soils (BOS) layer, this layer is characterised by dark moist clay soils, which preserve evidence of AMH occupation (Brenner and Wurz 2019). The BOS layer is divided into three sub-layers namely, BOS One, Two and Three, there was combining of deposits from BOS One, Two are combined into one layer, and BOS Three encompasses a separate layer (Brenner and Wurz 2019). The lowermost layer is the Silty Black Soil (SBLS), this layer is characterised by dark silty soils, with clay patches that are non-occupation deposits' (Brenner and Wurz 2019).

The SMONE layer is between 106–93 ka and is associated with MIS 5c, the BOS and SBLS members are about 110 ka, which associates them with MIS 5d (Brenner and Wurz 2019). All of the layers contain lithic and faunal material, the SMONE and BOS layers have large patches of leached ash indicating use of hearths and the SBLS layer has hearths with ashes preserved (Brenner and Wurz, 2019). As with the Singer and Wymer (1967-1968) and Deacon (1984-1995) excavations, the Wurz excavations spotlight lithic and faunal material associated with AMH that occupied KRM (Brenner and Wurz 2019). The materials from the Wurz excavation will better contextualise the occupation and subsistence strategies of AMH during the MSA II.

2.4. Human Occupation of KRM during the MSA

AMH are the earliest known members of the species *Homo sapiens* and they appear in the fossil record approximately 300 ka (Lombard, 2012; Wadley, 2015; Hublin *et al.*, 2017). Throughout the MSA, AMH populations were interspersed across the South African landscape; AMH occupied coastal areas along the southern and western seaboards of South Africa to inland areas such as Rose Cottage and Border Cave (Fisher *et al*., 2013; Wadley, 2015). MSA sites located on the Southern African coast have provided evidence of AMH transitioning to become hunter-gatherers-fisher throughout the MSA (Wurz, 2013; Wadley, 2015, Will *et al*., 2016).

Along the South African Cape coast, faunal remains and material associated with AMH activity are primarily excavated from caves and overhangs such as Klasies River Main site (KRM), Blombos Cave, Die Kelders Cave, Boomplaas Cave, Ysterfontein Rock shelter and Pinnacle Point Cave 13B (Fisher *et al*., 2013; Wadley, 2015). Caves and overhangs are crucial to tracking changes in the cognitive complexity of AMH throughout the MSA (Dietl *et al*., 2005; Burns and Raber, 2010), according to Wadley (2015, p.g.156) "Cognitive complexity is defined here as a set of capabilities that includes abstract thought, analogical reasoning, multitasking and cognitive fluidity".

Cave shelters hold a wealth of organic and inorganic materials that AMH made and exploited and left behind that provide insights into the cognitive complexity of the individuals that made them (Dietl *et al*., 2005; Burns and Raber, 2010). Sedimentation and layering preserve well in caves and rock shelters because these structures protect them from erosive forces (Burns and Raber, 2010). This makes it easier to track changes over time within these sites by differentiating the unique layers and members in the site (Dietl *et al*., 2005; Burns and Raber, 2010; Wurz, 2013).

The Singer and Wymer (1967-1968) and Deacon (1984-1995) excavations unearthed rich samples of fragmentary AMH skeletal remains from KRM, these AMH remains have been crucial to understanding the morphology of early AMH (Singer and Wymer, 1982; Deacon and Geleijnse, 1988; Grine *et al.*, 2017). Dating of AMH remains excavated from KRM shows they are >100 ka making them some of the earliest AMH remains associated with the MSA (Singer and Wymer, 1982; Deacon and Geleijnse, 1988; Deacon, 1995; Rightmire *et al.*, 2006; Wurz, 2012).

In total fifty-six AMH specimens were recovered from Cave 1, 1A, 1B (Figure 3), these remains are characterised by a mosaic of modern and archaic morphological traits along with a pronounced degree of sexual dimorphism (Grine *et al.*, 1998;Deacon, 2001; Deacon and Wurz, 2005; Royer *et al.*, 2009; Grine *et al.*, 2017). The excavation of the vast majority of AMH remains is from the SAS member, with the Upper member and the LBS member bearing the

remaining AMH remains (Figure 3; Singer and Wymer, 1982; Deacon and Geleijnse, 1988; Deacon, 2001; Deacon and Wurz, 2005; Royer *et al*., 2009; Grine *et al*., 2017). The LBS layers of each of the three caves provided the oldest AMH remains (Singer and Wymer, 1982; Deacon and Geleijnse, 1988; Deacon, 2001; Deacon and Wurz, 2005; Royer *et al*., 2009; Grine *et al*., 2017).

Evidence from analysis of the KRM deposits suggests that KRM became an AMH habitation site during the Last glacial period approximately 125 ka (Singer and Wymer, 1982; Deacon and Geleijnse, 1988). The current consensus is that changes in habitat conditions due to climatic changes forced AMH to abandon KRM between 60-50 ka (Rightmire and Deacon, 1991; Deacon, 1995). The ~70 ka occupation of KRM by AMH shows episodes of occupation, during these episodes; AMH left extensive hearths, shell middens and other traces of activity (Rightmire and Deacon, 1991; Deacon, 1995; Pérez, *et al.*, 2017). KRM preserves an extensive record of AMH occupation throughout the MSA (Rightmire and Deacon, 1991; Deacon, 1995).

2.5. Marine Isotope Stage 5

Blombos Cave, Pinnacle Point Cave 13B, , Ysterfontein, Hoedjiespunt and KRM are prominent MIS 5 sites situated on the South African Cape coast that have undergone extensive analysis of human faunal exploitation throughout MIS 5 (Thompson, 2008; Marean, 2010, Wadley, 2015). The MIS 5 has five sub-stages (i.e., MIS 5a/e) which correlate with the MSA I and MSA II at KRM as follows: MSA I (MIS 5e/d), MSA II Lower (MIS 5c) and MSAII Upper (MIS 5b/a; Deacon and Geleijnse, 1988; Rightmire *et al*., 2006; Nel *et al.*, 2018). Howiesons Poort, from theUpper Member, is associated with MIS 5a and MIS 4, the MSA III from Upper Member,is associated with MIS 3 (Deacon and Geleijnse, 1988; Rightmire *et al*., 2006; Nel *et al.*, 2018). MSA I (MIS 5e-d) and MSA II (MIS 5c-a) sequences of KRM were the most intense periods of AMH occupation(Rightmire *et al*., 2006; Nel *et al.*, 2018). Sediments associated with MIS 5 are associated with the MSA I techno-complex and MSA II techno-complex (Brenner *et al.*, 2020). The MSA I technocomplex occurred during MIS 5e-d (Wurz, 2013; Nel *et al.*, 2018). Though there are distinct differencesbetween the MSA I and II technocomplexes, the

morphometric similarity of the stone tools produced during these two lithic industries suggests that there was sturdy continuous innovation of lithic tools by AMH (Wurz, 2012, 2013; Nel *et al.*, 2018).

The MSA II sediments excavated from KRM indicate that the Tsitsikamma coast was experiencing fluctuating environmental conditions during MIS 5c (Klein, 1982; Deacon, 1995; van Pletzen, 2000; Thackeray, 2018). This study will investigate the DC sub-member faunal sample excavated from Cave 1B,the DC sub-member is associated with the MSA II Lower (MIS 5c), and this sample is from the Deacon (1984-1995) excavations. Throughout MIS 5c, AMH occupying KRM had prime access to the species-rich terrestrial and aquatic biomes along the Tsitsikamma coast for foraging, scavenging, and hunting (Deacon and Geleijnse, 1988; Langejans *et al*., 2012). AMH behaviour and adaptations to coastal life during MIS 5c conferred unique evolutionary advantages that allowed AMH to exploit a large variety of fauna (Deacon and Geleijnse, 1988; van Pletzen, 2000; Will *et al.*, 2016).

2.6. Faunal Exploitation at KRM

Analysis of MSA faunal samples suggests that AMH that occupied the South African Cape coast were exploiting a variety of marine and terrestrial resources (Klein,1976; Binford, 1984; van Pletzen, 2000; Wadley, 2015; Smith *et al.*, 2019). Hunting behaviour is an adaptive skill amongst AMH and MSA sites with evidence ofAMH hunting to some degree preserve the lithic tools AMH were producing. Analytic studies conducted byLombard (2005), Pargeter (2007), and O'Driscoll and Thompson (2014) provide evidence that during the MSA AMH had a wide array of lithic tools that were effective at bringing down prey and butchering it (Rots, 2003; Lombard, 2005; Pargeter, 2007; O'Driscoll and Thompson, 2014; Wadley, 2015).

These lithic tools were effective as hand-held tools as well as projectile tools, this diversity made them more effective when exploiting different fauna (Rots,2003; Lombard, 2005; Pargeter, 2007; O'Driscoll and Thompson, 2014; Wadley, 2015). The analysisof these lithic tools also showed evidence of continuous use and accumulation of damage (Rots,2003;

Lombard, 2005; Pargeter, 2007; Wilkins *et al.*, 2012). These analyses highlight that AMH lithic tools had frequent use and were effective hunting tools, supporting the notion that AMH were effective hunters during the MSA (Rots,2003; Wilkins *et al.*, 2012).

Binford (1984) analysed the Singer and Wymer (1982) faunal sample from KRM to determine how crucial fauna such as rodents and carnivores were to the accumulation of the KRM fauna. Binford's (1984) analysis highlighted the low abundance of rodent-gnaw-marked specimens, and a low abundance of carnivore remains and carnivore-gnaw-marked specimens from KRM members. Binford's (1984) analysis led him to conclude that the accumulation of the Singer and Wymer (1982) faunal sample was primarily by AMH; rodents and carnivores had minimal input to the faunal sample.

Milo (1998) further analysed the Singer and Wymer (1982) faunal samples by performing a microscopic analysis of the faunal remains. The microscopic analysis indicated a significantly higher frequency of butchery marks on the specimens than those observed by Binford (1984). However, as in Binford's (1984) study, Milo (1998) observed minimal evidence of primary carnivore damage, suggesting that any traces of carnivore damage reflects carnivore scavenging of faunal remains discarded by AMH at the site (Milo, 1998). The bone surface modifications indicated that the carnivores ravaged the faunal remains discarded by AMH during periods when AMH were not occupying the site (Klein, 1976; Binford, 1984; Milo, 1998).

AMH are the primary accumulators of faunal sample excavated from KRM (Klein, 1976; Binford, 1984; Milo, 1998). The diversity of fauna identified from KRM sample is evidence of the dietary breadth of AMH and the diverse subsistence strategies they employed to be successful during the MSA (Binford, 1984; Milo, 1998; Van Pletzen, 2000). AMH foraged, gathered, scavenged, fished, and hunted for plants and animal products, which varied seasonally in their abundance on the Eastern Cape landscape during the MSA (Klein, 1976; Binford, 1984; Milo, 1998; Van Pletzen, 2000; Von den Driesch, 2004; Dusseldorp and Langejans, 2015). The presence of megafauna remains in KRM and other MSA sites are

evidence of scavenging and hunting (Singer and Wymer, 1982; Deacon and Geleijnse, 1988; Dusseldorp and Langejans, 2015).

There is extensive evidence of AMH hunting during the MSA (Klein, 1976; Binford, 1984; Milo, 1998; Wadley, 2015). The hunting, scavenging, butchery, and transport decisions of AMH that occupied KRM during the MSA have been highly investigated and debated, with the analysis by Klein (1976), Binford (1984), Milo (1998), Thackeray (1988) and van Pletzen (2000) having shaped much of the current debates central to understanding AMH fauna exploitation at KRM.

2.6.1. Fish and Shellfish Exploitation

Fish and shellfish were a part of the diet of AMH that occupied KRM during theMSA (Thackeray, 1988; Deacon and Wurz, 2005; Langejans *et al.*, 2012).Typically, large-mammal hunting provides higher protein returns than fish and shellfish, however, fish and shellfish are a more reliable food source due to the minimal risk of collection and the high protein and fat yield (Marlowe,2007). The South African shore is at the confluence of the Benguela and Agulhas currents, these two currents are responsible for regular upwelling events that boost the productivity of fish and shellfish communities along the coast (Walker, 1990; Sherman, 1994; Hutchings *et al.*, 2009).

Thackeray (1988) highlights the abundant shellfish exploitation at KRM (Langejans *et al.*, 2012). Thackeray (1988) identified forty-nine different molluscan taxa from KRMlayers, and the species vary significantly between members (Thackeray, 1988; Langejans *et al*., 2012). Most of the shellfish fauna excavated by Singer and Wymer (1982) is from the LBS and SAS members of KRM, these were deposited during MSA I and II (Voigt, 1982: Thackeray, 1988; Singer and Wymer, 1982).

Brown mussels are the dominant species, and the importance of brown mussels is most highlighted in SAS layers fromCave 1B, the SAS member is dominated by brown mussels which constitute 80% of marine molluscs identified (Thackeray, 1988; Langejans *et al*., 2012).

The variety and abundance of shellfish species at KRM at different periods of the MSA are not indicative of AMH dietary preferences. Instead, they maybe a consequence of climatic shifts and sea-level fluctuations along the KRM coast at different periods of the MSA causing Mollusca population fluctuations (Voigt, 1975, 1982; Thackeray, 1988; Langejans *et al*., 2012).

The Tsitsikamma coast has a large variety of fish species majority of which are endemic forms (Von den Driesch, 2004), some of the most prevalent fish species found along the coast are galjoen (*Coracinus capensis*), white mussel cracker (*Sparodon durbanensis*), Hottentot (*Pachymetopon grande*) to name a few (Bruton 1988: 451). Hilary Deacon (Deacon and Geleijnse, 1988; Brenner *et al*., 2020) excavated the majority of the ichthyo- archaeological faunal sample from KRM. Von den Driesch (2004) provided the most in-depth analysis of the ichthyo-archaeological faunal sample from KRM and identified eighty-two species of fish from forty-seven families from a limited number of fish skeletal elements (Vonden Driesch, 2004; Brenner *et al.*, 2020).

The vertebral skeletal elements constitute the majority of skeletal elements; however, identification to species level using vertebrae is complex as such the identification of the majority of the fauna is only to the level of the family (Deacon, 2001; Von den Driesch, 2004). Small-sized intertidal species (15-25cm long) dominate the ichthyo-archaeological faunal sample; the intertidal regions where these species are most prevalent are excellent for foraging at low tide (Von den Driesch, 2004; van Niekerk, 2011).

2.6.2. Marine Mammal Exploitation

The occurrence of marine mammal remains amongst the KRM caves suggests that these marine mammals were a recurrent part of AMH diets throughout the MSA (Klein and Cruz-Uribe, 1996; Deacon, 2001; Thompson and Henshilwood, 2011; Dusseldorp and Langejans, 2015). Marine mammals have high-fat yields compared to terrestrial mammals and the consumption of these long-chain polyunsaturated fatty acids afforded AMH selective advantages thatfacilitate improved brain development and maintenance (Smith, 1993; Leach *et al.*, 2003; Kyriacou *et al.*, 2014).

The most prolific marine mammal identified in the KRM faunal sample is the Cape fur seal (*Arctocephalus pusillus*) (Klein, 1976; Binford, 1984, 1985;Marean and Binford, 1986; van Pletzen, 2000; Loftus *et al*., 2019). Cape fur seals arecommon place off the southwestern coast of Africa (Smith, 1993) and numerous MSA sites preserve remains of Cape fur seal bones from MIS 5-3 (Marean and Binford, 1986). The availability ofseal carcass wash-ups on the South African Cape coast is seasonally punctuated (Marean and Binford, 1986; Loftus *et al*., 2019). The KRM faunal sample has patterns showing the exclusive grouping of old-seals and seal pups with limited co-grouping of older-seals and sealpups (Binford ,1984,1985; Marean and Binford, 1986; Klein and Cruz-Uribe, 1996).

Cetaceans (whales and dolphins) remains have been identified in the KRM faunal samples (Table 1, 2; Klein, 1976; van Pletzen, 2000). However, research of the mammalian fauna of KRM by Klein (1976) and van Pletzen (2000) does not identify any of the cetacean skeletal elements to any lower taxonomic classification namely, Family, genus, and species. The South Africa Eastern Cape coast has a varied cetacean population with thirty-seven species recorded from Southern African waters. Humpbacks (*Megaptera novaeangliae*), minke whales (*Balaenoptera acutorostrata*), killer whales (*Orcinus orca*) and bottlenose dolphins (*Tursiops truncatus*) are among the most common species in the region (Findlay, 1989; Smith, 1993; Jerardino and Parkington, 1993).

2.6.3. Avian Faunal Exploitation

For many MSA sites, the faunal remains of marine birds and other airborne birds lack detailed analysis due to the low occurrence of avian specimens in these sites (Clark and Kandel, 2013). Avian fauna has poor representation compare the aquatic fauna in the KRM faunal samples, the majority of the avian faunal remains identified in the KRM faunal samplesare from birds that roost and nest in and around the cave (Deacon, 2001). Analysis of the Singerand Wymer (1982) faunal samples identified African penguin (*Spheniscus demersus*) as the most prevalent avian species in the KRM samples (Klein, 1982; Deacon, 2001).

The African penguin has been the only breeding species of penguin on the South

African coastlines with AMH over the last 300 ka (Martínez, 1992; Deacon 1997; Von den Driesch, 2004; Thomas and Ksepka, 2013). The collection of fish specimens in the Upper member of KRM is likely by cormorants, which roosted on the cliffs above KRM (Deacon, 2001). It is unclear if AMH at KRM hunted these birds and if they did, it is unclear which tools they employed; it is more likely that AMH would opportunistically scavenge these birds when they died (Deacon, 2001)

2.6.4. Terrestrial Mammal Fauna Exploitation

The fauna from the KRM faunal samples is attributed to human collection because faunal analyses and taphonomic analysis by Klein (1976), Milo (1998) and van Pletzen (2000) indicated that AMH had exclusive first excess too much of the faunal remains. The prevalence of butchery marks on the meatiest faunal elements is evidence that AMH at KRM had early access to kills and were likely adept hunters (Milo, 1998; McBrearty and Brooks, 2000; Outram, 2001). The KRM faunal samples have a rich and diverse collection of terrestrial mammalian fauna associated with the open grassland, Fynbos, and closed forest environments around KRM (Klein, 1976, 1981, 1982, 1983; van Pletzen, 2000; Deacon and Wurz, 2005).

The dominant terrestrial mammalian group in the KRM sample is bovids, the KRM bovids range in size from very large antelopes such as Cape buffalo (*Syncerus caffe*r) to small antelope such as grysbok (*Raphicerus melanotis*; Klein, 1976, van Pletzen, 2000). Southern Africa boast the greatest diversity of extant bovids on Earth, eight of the nine bovid sub-families are endemic to Southern Africa and these eight sub-families represent thirty-five extant bovid species (Skinner and Chimimba, 2005; Janzen *et al.*, 2021). The frequencies of bovid species present in the South African Cape has fluctuated extensively throughout the MSA and LSA (Klein, 1976,1981, 1982, 1983; Klein and Cruz-Uribe, 1996; Milo, 1998; Janzen *et al.*, 2021).

The KRM bovid taxa encompass both extant and extinct specimens, the notable extinct bovid specimens from the KRM samples are the long-horned African buffalo (*Syncerus antiquus*) whichbecame extinct around 12 ka, and the blue antelope (*Hippotragus leucophaeus*) which became extinct in recent historic time (Klein, 1976; Milo, 1998; van Pletzen, 2000; Deacon

and Wurz, 2005). The analysis of bovid remains has yielded key details about the hunting, scavenging and subsequent transport of prey carcasses by AMH (Klein, 1976; Milo, 1998; Deacon and Wurz, 2005; van Pletzen-Vos *et al.*, 2019).

Analysis of KRM bovid samples shows that taxa such as the common eland (*Taurotragus oryx*) exhibit catastrophic mortality profiles, commonly associated with hunting methods such as driving animals off a cliff (Klein, 1976; Milo, 1998; Deacon and Wurz, 2005).The butchery patterns of these eland's mimic those carried out by Native Americans while butchering bison killed in mass drives (Frison, 1974; Milo, 1998). AMH that occupied KRM likely formed task groups within which they divided butchering tasks when dealing with numerous carcasses (Milo, 1998). The ability to form and organise such task groups is likely a by-product of AMH behavioural complexity (Reynolds, 1993; Milo, 1998; Wadley, 2010).

KRM faunal samples are rich in small-bodied terrestrial mammals (Table 1 and 2) such as Rock hyrax (*Procavia capensis*) which may have been exploited using remote capture methods such as snaring ornet hunting. (Dusseldorp and Langejans, 2015; Wadley, 2015). Micromammals excavated from act as Palaeoenvironmental indicators due to the correlation between the relative abundance of micromammals and vegetation composition of the Tsitsikamma coast(Nel *et al.*, 2018; Reynard and Wurz, 2020). The micromammals from KRM seem to decreasein availability as MIS 5 progressed; however, it is unlikely this decrease in abundance affected AMH much because birds of prey accumulated the majority of the micromammal specimens (Nel *et al.*, 2018; Reynard and Wurz, 2020).

Chapter 3: Material and Methods

3.1. Materials

3.1.1. Faunal Specimens

The faunal sample under investigation is from KRM Cave 1B. Cave 1B has two members, namely the LBS member and SAS member (Figure 3). There is division of these members into two sub-members known as the RS sub-member and the DC sub-member (Deacon and Geleijnse, 1988; Thackeray, 1989). Deacon (1984-1995) excavated three main squares from Cave1B, and these are the PP38, QQ38 and RR38 grids (Figure 1), the three squares encompass sediments from the RS and DC sub-members (Deacon and Geleijnse, 1988). Unlike the Singer and Wymer excavations, the Deacon excavations did not dispose of any skeletal remains that considered taxonomically unidentifiable during excavations (Deacon and Geleijnse, 1988). The approach ensures the retrieval of the complete faunal samples from the three squares.

The faunal sample under analysis in this research are from the DC sub-member section of the PP38 square. A three to two (3-2) mm mesh sieve sifted the sediments to retrieve any micro-skeletal elements missed upon preliminary inspections of the sediments (Deacon and Geleijnse, 1988; van Pletzen, 2000). (Deacon and Geleijnse, 1988; van Pletzen, 2000). The DC sub-member sits above the RS sub-member between 8.3 and 8.9 m above sea level (Figure 4). The DC sub-member sediments separate into forty-five layers and these layers are highly compressed on a sloping profile (Figure 4)

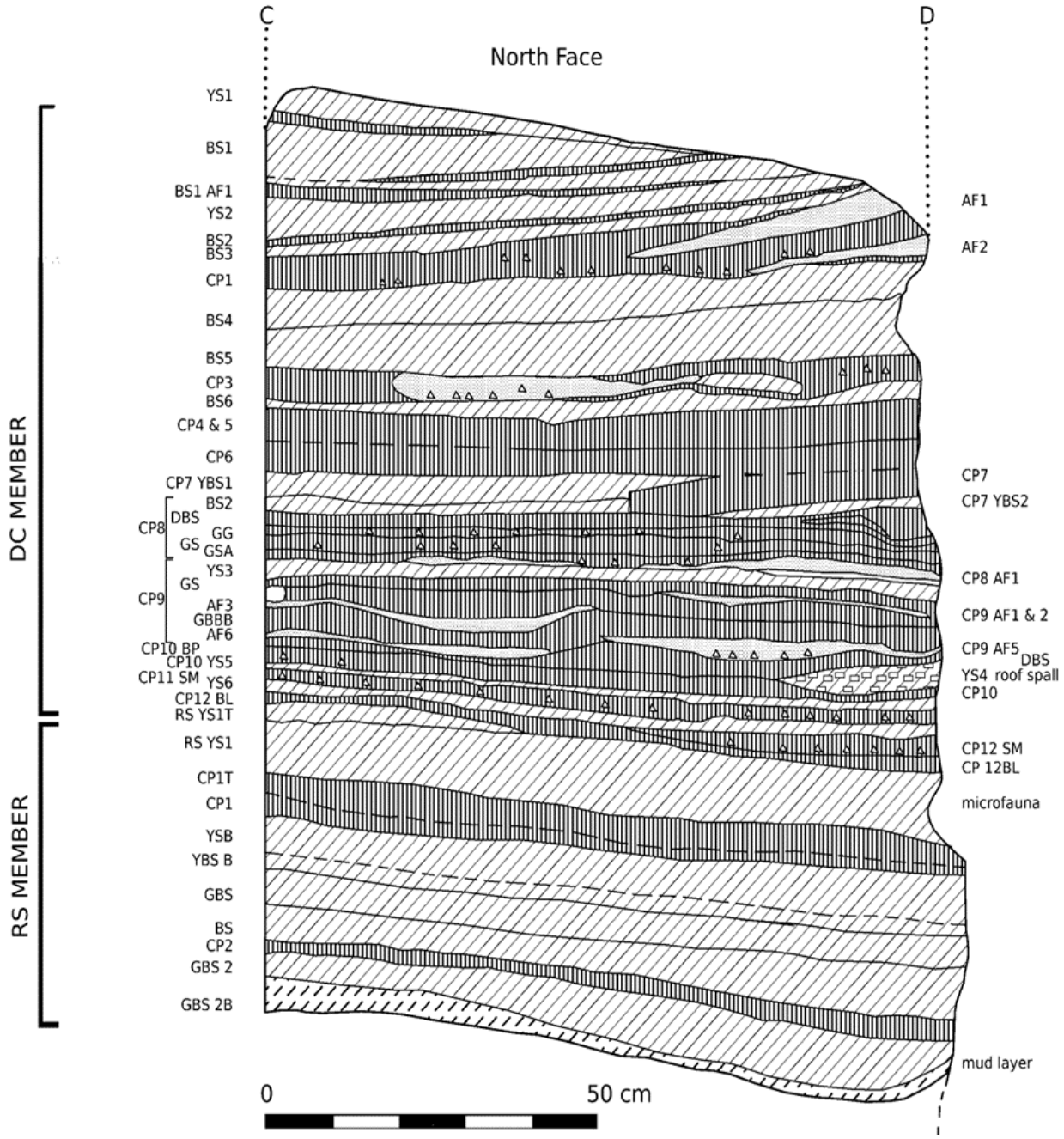


Figure 4. Section through Klasies River Main Site Cave 1B CD (North Face) displaying the DC and RS sub-members. Image courtesy of Professor Sarah Wurz, University of the Witwatersrand

3.2. Methods

3.2.1. Faunal Analysis

The fauna was analysed and identified following the guidelines detailed by Driver (1999, 2005, and 2011). Microsoft Excel spreadsheets recorded the identified and unidentified faunal remains using the codes detailed by Driver (1999, 2005). Driver (1999, 2005, and 2011)

emphasises the significance of three major attributes, these are element, taxon, and modification. The Driver (1999, 2005, and 2011) methodology is the refinement of previous faunal analysis methodologies; primarily it is an improvement of the Brain (1974) methodology. The most crucial of these three attributes is the element because specimen identification to any taxonomic group without knowing the element is impossible. As such, faunal specimens were analysed by first identifying the element and then identifying the taxonomic family of the specimen (Driver, 1999, 2005, 2011). Aside from these threemajor attributes, Driver (1999, 2005, 2011) also details the importance of recording provenience, side, modification, fusion, length, cortical thickness, and age of a faunal specimen (Davis, 1987; Reitz and Wing, 1999; O'Connor and O'Connor, 2008).

For each identified faunal specimen, the element and diagnostic zone (Davis, 1987; Reitz and Wing, 1999; O'Connor and O'Connor, 2008) that represents it were recorded using the coding system described by Driver (1999, 2005, 2011). The coding system assigns each element a two-letter code one for the proximal end and one for the distal end of the element. During identification faunal elements were sided and dental wear, dental eruptions, and the state of the epiphyseal fusion plates of long-bones and vertebrae (Davis, 1987; Reitz and Wing, 1999; O'Connor and O'Connor, 2008) were recorded using the coding system described by Driver (1999, 2005) and documented to make determinations of the ages of the specimens. Different taxa have unique variations in their skeletal morphology (Davis, 1987; Reitz and Wing, 1999; O'Connor and O'Connor, 2008). Due to this once there is identification of a specific skeletal element, the osteological landmarks on the element can identify the taxa, which the element may have come from (Davis, 1987;Reitz and Wing, 1999; O'Connor and O'Connor, 2008; Morin *et al.*, 2017).

The unique skeletal landmarks analysed on osteological remains are articulation surfaces, muscle attachment sites, bone spurs/processes, condyles, and tubercles (Klein and Cruz-Uribe, 1984). When analysing dental remains the key dental landmarks analysed are tooth cusps, tooth roots and dental crowns (Klein, 1984; Reitz and Wing, 1999; O'Connor and

O'Connor, 2008). The morphological landmarks on osteological and dental remains are uniform across taxon and by comparing landmarks on archaeological specimens to those of known comparative specimens of similar taxon; it is possible to identify osteological and dental remains (Klein, 1984; Driver, 2005, 2011; Morin *et al.*, 2017). For this study, there was comparison of skeletal remains that meet the guidelines of Driver (1999, 2005) with specimens from the University of the Witwatersrand Evolutionary Studies Institute in Johannesburg, South Africa and the Ditsong National Museum of Natural History in Pretoria, South Africa.

When analysing the faunal sample, specimens identified to be from the same order, class and family but not to a genus and species are put into various size classes together (Table 3; Brain, 1974; Klein, 1976). Indeterminate faunal specimens from the classes Mammalia, Aves, and Reptilia were grouped into size classes (Table 3) as was the casein Klein's (1976), Milo's (1998) and van Pletzen's (2000) analysis of KRM fauna.

Table 3. The size classes and weight ranges of indeterminate Mammal, Avian, Ungulate/Bovids and Reptilian faunal specimens

Size classes	**Mammalian faunal weight range (kg)**	**Avian faunal weight range (kg)**	**Reptilian faunal weight range (kg)**	**Ungulate weight range (kg)**	**Faunal examples**
Small	0-25	<1.5	<1	0-23	Cape mole-rat, Hadada ibis, Cape dwarf gecko, Duiker
Small-medium	25- 50	1.5-3	1-2	24-84	Leopard, Cape gannet, Brown house snake, Bontebok
Medium	50-250	3-6	2-6	85-300	Cape fur seal, African penguin, African helmeted turtle, Hartebeest
Medium-large	250-500	6-9	6-9	300-800	Mountain zebra; Cape vulture, rock monitor, Blue wildebeest

Large	500-1500	9-15	9-15	800-1000	Cape buffalo, Kori bustard, Leopard tortoise, Common eland
Very large mammal	>1500	>15kg	>15kg	1000>	Hippopotamus, Common ostrich, Nile monitor, long-horned African buffalo

When identification of faunal specimens from the family Bovidae to a lower taxonomic level is not possible, the identification of the specimens is to one of the five Bovidae size classes (Table 3) as in previous KRM faunal analyses. The five bovid size classes (Table 3) are from Brain's (1974) and Klein's (1976) bovid size classes. The identification of Bovid cranial elements, dentition, horn cores, vertebrae, and ribs beyond family is relatively inaccurate (Brain, 1974). As such these specimens are identified as indeterminate bovid specimens based on their size.

Skeletal remains unidentified as a specific skeletal element are categorised as unidentified. Unidentified faunal samples are characterised by highly fragmented and eroded specimens with damaged osteological landmarks hindering identification of the element (Badenhorst and Plug, 2011). The unidentified skeletal remains are crucial to understanding the post-depositional processes, faunal activity, and fragmentation at a site (Lyman and Lyman, 1994; Reitz and Wing, 1999; Badenhorst and Plug, 2011). As such, the unidentified faunal samples were included in the analysis to determine the taphonomic history of the site.

3.3. Age and Sex Estimation

Estimations of mortality profiles was by assessing the state of fusion of long bones and dental eruption patterns and categorising specimens as neonates, juveniles, sub-adult, and adults, and used the data to establish mortality profiles (Klein, 1982; Klein and Cruz-Uribe, 1984). The epiphysis and diaphysis steadily fuse as an animal reaches maturity, until they are one whole bone; this makes estimations of the age at death possible (Klein, 1982; Klein and Cruz-Uribe, 1983; Kausmally and Western, 2005; Steele, 2005, 2006). The recording of stages

of bone fusion using a two-letter code, the first letter details the proximal/anterior fusion, and the second letter details the distal/posterior fusion of a specimen.

The identification of every dental fragment still attached to a mandibula or loose tooth that could be reinserted was recorded as a mandibula or maxilla and assigned a two-letter aging according to Driver (1999, 2005, 2011). The first letter donates the type of tooth namely, incisor, canine, premolar, and molar and the second letter denotes the tooth type namely, deciduous and permanent (Driver, 1999, 2005, 2011). Dental eruption patterns and tooth-wear rates from the teeth associated with the mandibles and loose teeth were recorded whenever possible (Driver, 1999; Reitz and Wing, 1999).

Tooth-wear rates can often times lead to differences in age estimation because differences in the diet cause differential wear to the tooth enamel of individuals of the same age and species (Klein and Cruz-Uribe, 1983; Steele,2005, 2006). Dental eruption patterns are the better method for ageing fauna, however, there have not been many eruption pattern charts done for many taxon (Morris, 1978; Klein and Cruz-Uribe, 1983; Steele, 2005, 2006).

Mammals have marked sexual dimorphism highlighted in some skeletal elements (Klein, 1982; Klein and Cruz-Uribe 1984; Frayer and Wolpoff, 1985; Ruscillo, 2003). Skeletal elements often used to determine the sex of specimens are the pelvis and the sacrum; however, these elements are fragile and susceptible to post-depositional processes (Klein and Cruz-Uribe, 1984; Ruscillo, 2003). Other elements used to determine sex are the horns of bovids, female bovids often lack horns or their horns are smaller than male horns (Klein and Cruz-Uribe, 1996; Frayer and Wolpoff, 1985; Ruscillo, 2003). Mammal males often have larger bones than their females' counterparts do, osteometric measurements of skeletal specimens can estimate the sex of the specimen (Klein and Cruz-Uribe, 1984; Ruscillo, 2003). However, nutrition, season, and age affect long-bone densities and the size of horns significantly which hindered the determinations of sex profiles of the faunal sample (Klein and Cruz-Uribe, 1984; Ruscillo, 2003).

3.4. Taphonomy

Taphonomy refers to all the processes and modifications that faunal remains in a sample undergo from death until analysis and there are set taphonomic principles zooarchaeologist uses to study faunal specimens (Fernández-Jalvo and Andrews, 2016). The taphonomic historyof a faunal sample is dependent on the taphonomic agents (fauna, flora, and human activities) and processes (erosion, decomposition, and breakage) and analysing faunal samples for taphonomic traces can detail the processes the sample has undergone (Gifford-Gonzalez, 1991; Fernandez-Jalvo and Andrews, 2016). The taphonomy of a faunal sample is important to understandingtaxonomic abundances, sample fragmentation, and skeletal element frequencies in the sample (Lyman and Lyman, 1994).

The faunal samples from KRM have undergone few taphonomic studies since the first excavations by Singer and Wymer (1967-1968), with the analysis by Milo (1998) among the most significant taphonomic studies of the site. This research performs a taphonomic analysis of the faunal remains from the DC sub-member section of the PP38 grid. The analysis was by naked-eye observations. However, the research involved a microscopic analysis at fifty times magnification using a dissection microscope of one hundred individual faunal pieces. The specimens analysed are randomly selected faunal remains at least 2cm or longer for this microscopic analysis.

3.4.1. Butchery

The research saw the analysis of skeletal remains for cut and chop marks that are a result of AMH hunting and butchering processes. A bladed object hitting bone and lacerating it will leave cut and chop marks on the surface of the bone (O'Connor and Barrett, 2006). Cut marks are incisions that are transversely located on bone, and they are distinguishable by groves that have a V shape that is longer than they are wide (Blumenschine *et al*., 1996). Cut marks are characteristic of defleshing a carcass during the butchering process (Blumenschine, 1986, 1988; O'Connor and Barrett, 2006).

Chop marks are large lacerations of the bone often made by a heavy blade hitting the bone at a perpendicular angle causing bone fracturing and bone wastage (O'Connor and

O'Connor, 2008; Wedel and Galloway, 2013). Chop marks are often more prominent on large dense bones which may have been chopped through for the nutrient-rich marrow inside them (O'Connor and Barrett, 2006; Wedel and Galloway, 2013). The faunal specimens are analysed for cut and chop marks. The naked-eye observations were by rotating the specimen around its axis and recording any cut or chop marks observed. During the microscopic analysis, the specimen sits on the stage of a dissection microscope; the specimen is rotated around its axis to determine if there were any microscopic cuts on it.

3.4.2. Burning

There was investigation of burning in faunal sample because KRM layers are rich in ash and hearth deposits (Deacon and Geleijnse, 1988; Pérez *et al.*, 2017; Larbey *et al.*, 2019). Bones change colour based on how hot the heat source is, the moisture content of the bone, the amount of flesh on bones, the length of exposure to the heat source and the proximity to the heat source (Shipman *et al.*, 1984; Nicholson, 1993; Stiner *et al.*, 1995; Cain, 2005; Gonçalves, 2011). The hallmark colours for burning based on the increasing heat of the fire are yellow-brown, black, grey, and white.

Faunal remains burn by direct heat when deposited directly in a hearth and specimens buried in sediments at a depth of at least 30cm in and around a hearth can burn and experience fire deformation (Shipman *et al.*, 1984; Nicholson, 1993; Stiner *et al.*, 1995; Bennett, 1999; Cain, 2005, 2006; Gonçalves, 2011; Larbey *et al.*, 2019). A hearth operating sequentially in an isolated area will cause burn damage to bone similar to burning from deposition in a hearth (Bennett, 1999). Faunal remains buried deep below a hearth between 20-30 cm will be unaffected by the heat from a hearth, however, those buried between 10-20 cm show considerable charring causing the bones to turn brown (Bennett, 1999).

Faunal remains buried 2-4 cm below a hearth become baked and blackened by the hearth's fire, whilst there is calcination of faunal remains that are directly in and around a hearth after excessive burning (Bennett, 1999). The heat of a hearth may lead to fragmentation of the

faunal sample because bones fracture under high heat. However, factors such as the type of soil and the duration of the fire, make it difficult to determine if these changes are uniform from site to site (Shipman *et al*., 1984; Nicholson, 1993; Stiner *et al*., 1995; Bennett, 1999; Cain, 2005, 2006; Gonçalves, 2011; Pérez, *et al.*, 2017).

3.4.3. Fracture Patterns

The fracture patterns on the long-bone specimens were recorded with a two-letter code as detailed by Driver (1999, 2005). The first letter of the code distinguishes the type of fracture on the proximal end; the second letter distinguishes the type of fracture on the distal end of a long-bone specimen (Driver, 1999, 2005, 2011). Bone fractures because of force loading over an area on the bone which results in fractures if the force is strong enough (Johnson, 1985; Driver, 2005). The fracture patterns that faunal samples display are contingent on the type of force and the direction at which the force acts on the bone (Driver, 2005). Fracture patterns are categorised as either intact, irregular, spiral or transverse fracture patterns (Driver, 1999, 2005).

Irregular fracture patterns are bone breaks characterised by a series of curving, splintered and stepped fractures known as scallops along the edge of the bone (Johnson, 1985; Driver, 2005). An irregular fracture pattern occurs when bones are broken during the dry phase of their taphonomic history (Johnson, 1985; Gifford-Gonzalez, 1989; Driver, 1999). A faunal sample dominated by specimens with irregular fractures is likely a sample that was broken post-mortem, suggesting the sample underwent fracturing after deposition like due to sediment compaction. Spiral fractures are characterised by oblique, curved and corkscrew-like fracture lines that wrap around the circumference of the shaft of a long-bone specimen (Haynes, 1980).

High-energy rotational forces cause spiral fractures and fracturing of recently deceased long specimen tend to result in bone being broken into splintered pieces (Haynes, 1980; Driver, 1999). Spiral fractures are associated with AMH activity and hyena activity, to excess bone marrow. These fauna apply rotational force to long bone specimens causing spiral fractures (Haynes, 1980). A faunal sample dominated by spiral fractures is one primarily accumulated by AMH and hyena (Bunn, 1986). Transverse fractures occur when bone breaks at a right angle

to the long axis of the bone due to perpendicular force loading on the long axis of bone (Pickering *et al*., 2005). Transverse fractures are associated with carnivore and human activity (Pickering *et al.,* 2005).

3.4.4. Gnaw Marks

Gnawing is characterised by crunching, chewing and tooth-marks depending on the agent that was gnawing on the bone (Cruz-Uribe and Klein, 1994; Lyman and Lyman, 1994; O'Connor and O'Connor, 2008). Rodent gnawing is characterised by a unique pattern of close wide striations on the bone that vary in length often with a smooth texture (Andrews, 1995). Rodent gnaw-marks are often oriented perpendicular or transverse to the long axis of long bones (Andrews, 1995). Felid and canid gnawing is characterised by canine pits and puncture marks on the bone surface, these carnivore pits and punctures differ in depth based on the size of the animals' canines (Blumenschine, 1988; Bunn, 1986; Njau and Blumenschine, 2006). Punctures are characterised by deep depressions that penetrate the thickness of compact cortical bone and pits are characterised by shallow depressions in the bone that do not penetrate all layers of the cortical bone (Blumenschine, 1988; Njau and Blumenschine, 2006).

Different agents gnaw on the bone to get to the bone marrow, which is a nutritional source of calcium, potassium and phosphorous (Lyman and Lyman, 1994; Andrews, 1995). Rodents primarily gnaw on the bone to wear down their continuously growing incisors (Andrews, 1995; Pokines, 2014). The modifications made by faunal agents gnawing on bone can resemble human modifications as the striations, punctures and lacerations caused by teeth marks can resemble those made by bladed and pointed stone tools (Andrews, 1995). Carnivores may ingest skeletal elements and these skeletal elements will undergo gastric erosion to their surfaces, skeletal elements were analysed for the presence or absence of gastric erosion (Lyman and Lyman, 1994; Reitz and Wing, 1999).

3.4.5. Weathering, Root Etching and Staining

Weathering is a taphonomic modification associated with site formation processes. Recording of weathering on faunal specimens was only if the weathering was greater than 2

cm in length (Behrensmeyer, 1978). Behrensmeyer's (1978) stages of weathering are adapted to analyse the DC sub-member faunal samples that exhibit the most weathering.

Root-etchings are multidirectional randomly orientated patterns on the surface of the bone (Bar-Oz and Munro, 2004). Root-etchings are a result of plant roots adhering to the bone surface and leaching minerals from it at some point in the taphonomic history of the bone (Lyman and Lyman, 1994). A faunal sample dominated by specimens with root-etching is one that underwent a prolonged period without disturbance allowing plant roots to adhere to bone and leach nutrients (Johnson, 1985; Lyman and Lyman, 1994; Bar-Oz and Munro, 2004). Recording of the presence/absence of root etching on the faunal specimen occurs during analysis of the DC faunal sample.

Bones deposited in a site may experience colour changes due to staining. Staining differs based on the environment where a specimen is deposited, manganese dioxide rich environments stain bone black, iron oxide rich environments are responsible for orange-yellow staining and iron phosphate rich environments may stain skeletal elements blue (Nicholson, 1993). Organic compounds and acids tend to be the major causes of staining, and the majority of staining colour changes resemble the colour changes from burning (Nicholson, 1993). Staining depends on the extent of exposure to these organic compounds and acids.

3.5. Data Quantification

3.5.1. Number of Identified Specimens

NISP is the key quantification method for estimating the number of identifiable skeletal specimens in an archaeological faunal sample (Grayson, 1973; Ringrose, 1993; Lyman, 2008). The calculation of NISP is by counting each identifiable specimen in the faunal sample as an individual unit, and this allows for estimations of the taxonomic abundance and diversity of the taxa in a sample (Grayson, 1973, 1984; Ringrose, 1993). NISP estimates taxonomic abundance of skeletal remains in different sites by designating each identified specimen as an independent observation (Grayson, 1973, 1984; Ringrose, 1993). This results in some degree of overestimation because some skeletal elements occur more frequently than others; for example

ribs, vertebrae, phalanges, and long bones, which can fragment into multiple pieces, and still be identifiable as independent specimens(Morin *et al*., 2017).

This is the major criticism of the NISP as it affects the observations of abundance. This is not the only criticism of the NISP, and Reitz and Wing (1999) and Lyman (2008) highlight the other minor criticisms of the NISP. NISP is the chosen method of analysing archaeological faunal remains because it can derive other skeletal count measures discussed below.

3.5.2. Normed Number of Identified Specimens

To ensure the skeletal element consistency in the DC faunal samples there was calculation of normed Number of Identifiable Specimen (nNISP), nNISP is the number of elements recordedas NISP values divided by the number of times each element occurs in an organism's skeleton(Grayson and Frey, 2004; van Pletzen-Vos *et al.*, 2019). The nNISP method produces values that are similar to the values from measures of element abundance such as the Minimum Number of Elements (MNE) and Minimum Animal Units (MAU). The sum of the nNISP for each skeletal region; skull, forelimbs, hind limbs, proximal elements and distal limbs will be used to calculate the skeletal-part profile of the sample. However, the nNISP lacks the aggregation effects, which necessitates the use of the MNE and MAU (Grayson and Frey,2004).

3.5.3. Minimum Number of Elements and Minimum Animal Units

The NISP derives measures of skeletal element abundance specifically the MNE and MAU. The MNE is a modification of the NISP method that estimates how many skeletal elements are in a faunal sample by determining the minimum number of complete skeletal elements necessary to account for all observed specimens (Bunn, 1986; Lyman and Lyman, 1994; Morlan, 1994). The estimation of MNE is by calculating the minimum number of skeletal elements by assessing the landmark features on skeletal remains in a faunal sample (Binford, 1984, 1985; Bunn, 1986; Ringrose, 1993).

The two most common methods of determining the MNE are the fraction summation and the overlap approach (Bunn and Kroll, 1986). The fraction summation and the overlap approach are both

effective methods of estimating the MNE (Bunn and Kroll, 1986), for this analyses the fraction summation method of calculating the MNE was selected (Watson, 1979; Klein and Cruz-Uribe, 1984). The fraction summation method is the estimation of the fraction of defined zones.

The MNE can provide biased values as such there is calculation of NISP: MNE ratios to measures skeletal abundance; however, as the intensity of fragmentation increases at a site, the variation between NISP and MNE becomes larger (White 1953; Binford; 1984; Klein and Cruz-Uribe, 1984; Bunn and Kroll, 1986; Marean and Spencer 1991; Morlan 1994; Marean *et al*., 2001). Fragmentation makes it harder to differentiate small skeletal elements as independent from one another (Lyman and Lyman, 1994), thus limiting this approach. The derivation of MNE can further provide the Minimum Number of Animal Units (MAU). The MAU considers that some skeletal elements occur in the skeleton more or less frequently than others e.g., humans have one sternum compared to twenty-four vertebrae in the same skeleton. The calculation of MAU is by dividing the MNE by the number of times the relevant skeletal element appears in a complete skeleton (Binford, 1984; Lyman and Lyman, 1994).

3.5.4. Indices

Indices reflect the ecological and cultural history of a faunal sample (Badenhorst *et al.*, 2021); usually indices are for faunal samples larger than that of the DC sub-member. However, they are useful tools for assessing the prevalence of hyenas, leopards or human activity in a faunal sample. Furthermore, these indices along with faunal taphonomy markers and faunal composition data to give the best assessment of carnivore activity at the site.

A faunal sample with a high ratio of carnivores indicates hyenas were the primary accumulators (Brain, 1983; Thackeray, 1990); however, humans do exploit small carnivores for their skins. Leopards were accumulators of some fauna at KRM and tend to focus on hunting a variety of prey such as baboons, rock hyraxes or small antelopes such as those from the genus *Raphicerus* (Brain, 1983; Thackeray, 1990). AMH do not often eat baboons and their presence in the faunal samples would be a result of leopard accumulation (Thackeray, 1990).

Indices act as proxies to investigate the impact of carnivore activity at KRM in this study. Only terrestrial carnivores were included in the carnivore indices, the two carnivore

indices analysed are the carnivore–ungulate and the leopard index. Calculation of the indices follows methods of Badenhorst *et al.* (2021) as follows:

Carnivore−Ungulate Ratio = (Carnivores NISP/Ungulates NISP) × 100

Leopard Index = [(Leopards + Baboons NISP)/Ungulates NISP] × 100

3.6. Osteometry

There was measuring of select groups of indeterminate *Raphicerus sp.* specimens using specific reference points established by Von den Driesch (1976). These reference points are dependent on the type of bone namely, long bone, flat bone, irregular bone (Von den Driesch, 1976; Boessneck and von Den Driesch, 1978). All measurements of the reference points are on phalanges using a Vernier caliper and measured in millimeters. For identification, there is comparisons of the reference point measurements or indeterminate faunal specimens with those of known taxa from the comparative collections from the University of the Witwatersrand Evolutionary Studies Institute in Johannesburg, South Africa and Ditsong National Museum of Natural History in Pretoria, South Africa. Osteometric measurements can estimate the sex and size of the fauna analysed.

Individually these measurements are not a good enough estimator of Faunal size and age, however, they can be used in conjuncture with dental remains and eruption patterns and long bone fusion patterns to give more precise estimates of age at death and size of specimens in the faunal sample.

3.6.1. Cortical Thickness and Bone Length

There was measuring of the cortical thickness of the long bones because morphometric measurements of cortical thickness can approximate the size of the specimen it is from (Currey and Alexander, 1985; Reynard *et al*., 2014). The measuring of cortical thickness was by Vernier caliper. Based on the cortical thickness measurements, the long-bone elements are identified according to the cortical thickness' codes determined by Driver (1999, 2005) and Reynard *et al*. (2014; Table 4). Where possible, there was measurement of cortical thickness

of proximal and distal fragments approximately 2 cm above and below the epiphyseal fusion line. These measurements were along the long-bone shaft fragments on the widest portion of the shaft.

Table 4. Cortical thickness size categories derived from Driver (1999) and Reynard *et al*., (2014) shaft.

Cortical thickness codes	**Cortical thickness (mm)**	**Indeterminate mammalian size classes**	**Bovid size classes**	**Faunal example**
1	<2	Small mammals	Bov1	Cape mole-rat, Cape grysbok
2	2-3.99	Small-medium mammals	Bov2	Leopard, Impala
3	4-5.99	Medium mammals	Bov3	Cape fur seal, Hartebeest
4	6-7.99	Medium/large mammals	Bov4	Mountain zebra; Blue wildebeest
5	8-9.99	Large mammals	Bov5	Cape buffalo, Common eland

6	>10.00	Very large mammal	_	Hippopotamus, long-horned African buffalo

There was measuring of the length of each identified skeletal element to the nearest millimeter using a Vernier caliper, and a standardised ruler. Longitudinal measurements from the most proximal part to the most distal part of each long bone measure, the maximum length of the element. The recording of the length is according to a coding scale. The length of each element gives further insight into the fragmentation of the faunal sample from the DC sub-member.

Chapter 4: Results

4.1. Faunal Sample

4.1.1. DC Sub-Member layers

There are forty-five layers from the DC sub-member, 17 069 specimens were excavated from these layers. Of the 17 069 specimens, 1 291 (8%) specimens were identified and 15 778 (92%) remains were unidentified (Table 5). Of the forty-five DC sub-member layers, there are five layers with over one-thousand faunal samples (Table 5). These five layers constitute the majority (n=7110, 42%) of the DC faunal sample.

Nine of the layers have between five hundred and one-thousand faunal specimens (Table 5). DC sub- member layers with between five hundred and one-thousand total faunal specimens constitute another majority (n=6087, 36%) of the DC faunal sample. These fourteen layers produced 13 197 (77%) of the total DC faunal sample, indicating high faunal deposition when these layers accumulated. There are thirty-one layers with less than five hundred faunal remains and these layers produced 3 872 (23%) of the total faunal sample, indicating low faunal deposition when these layers accumulated.

The layer with the highest NISP value is CP8; this is the only layer with more than one hundred identified specimens (Table 5). Eight layers namely CP2, CP8 AF, CP3, CP6, CP7 AF, YS6, AF1, CP12 BL all have NISP values between fifty and one hundred (Table 5), these layers have varying sample sizes suggesting identification of taxa was not strictly dependent on sample size. The layers YS1, AF1, BS1AF1, YS2, BS2, BS3, AF2, BS4, CP2, BS5, BS6 and CP7YBS2 lack unidentified specimens (NUSP=0; Table 5). The layers YS1, BS1 AF1, BS2, CP9 AF1, CP9 AF2 and CP9 AF6 lack identified specimens (Table 5). The layers YS1, BS1 AF1 and BS2 lack any faunal specimens (Table 5).

Table 5. NISP and NUSP values and percentages of each of the forty-five DC sub-member layers

DC sub-member layers	**NISP**	**NUSP**	***Total***	**NISP%**	**NUSP%**
YS1	0	0	*0*	0	0
BS1	4	3	*7*	57	43
AF1	58	0	*58*	100	0
BS1 AF1	0	0	*0*	0	0
YS2	8	0	*8*	100	0
BS2	0	0	*0*	0	0
BS3	2	0	*2*	100	0
AF2	3	0	*3*	100	0
CP1	9	2	*11*	82	18
BS4	24	0	*24*	100	0
CP2	92	0	*92*	100	0
BS5	14	0	*14*	100	0
CP3	86	162	*248*	35	65
BS6	8	0	*8*	100	0
CP4	8	25	*33*	24	76
CP5	49	861	*910*	5	95
CP6	79	1245	*1324*	6	94
CP7 (AF)	64	1090	*1154*	6	94
CP7 YBS1	9	80	*89*	10	90
CP7 YBS2	3	0	*3*	100	0
CP8	156	1197	*1353*	12	88
CP8 BS2	18	300	*318*	6	94
CP8 DBS	45	498	*543*	8	92
CP8 GG	23	396	*419*	5	95

CP8 GS	18	326	*344*	5	95
CP8 GSA	36	532	*568*	6	94
CP8 AF	90	1621	*1711*	5	95
YS3 (U)	29	585	*614*	5	95
CP9 GSB	23	608	*631*	4	96
CP9 AF1	0	53	*53*	0	100
CP9 AF2	0	46	*46*	0	100
CP9 AF3 (UB)	5	239	*244*	2	98
CP9 AF4	1	102	*103*	1	99
CP9 AF5	11	117	*128*	9	91
CP9 AF6	0	118	*118*	0	100
CP9 DBS	12	1556	*1568*	1	99
CP10 BP	41	590	*631*	6	94
CP10 (AF)	8	361	*369*	2	98
YS4 Roof spall	8	349	*357*	2	98
YS5	48	602	*650*	7	93
CP11 (AF)	14	293	*307*	5	95
CP11 SM	32	373	*405*	8	92
YS6	62	676	*738*	8	92
CP12 BL	51	751	*802*	6	94
CP12 SM	40	21	*61*	66	34
Total	*1291*	*15778*	*17069*	*8*	*92*

4.1.2. Faunal Identification

There are 1291 identified faunal specimens, amongst the DC faunal sample. There is identification of taxa from the Classes Mammalia, Aves, Reptilia, Actinopterygii, Amphibia, and

Mollusca (Table 6). Mammals (n=935, 72%) are the most prevalent class in the DC faunal sample, there are five identified mammal orders in the sample namely Primates (n=2), Carnivora (n=71), Rodentia (n=45), Procaviidae (n=23) and Artiodactyla (n=295; Table 6). The majority of the identified mammal specimens are indeterminate mammalian specimens (n=747, 58%) that could not be confidently identified to a specific family or species (Table 6). There is fragmentation of the majority of the DC faunal sample into short faunal specimens (Figure 14) which hinders faunal identification. This fragmentation implies that the NISP severely underestimate the identifiable fauna in the sample

Table 6. Identified taxa list and NISP values from the DC faunal sample

Taxa	**NISP**	**NISP%**
Primate		
Papio ursinus, Chacma baboon	2	0.2
Carnivora		
Aonyx capensis, Clawless otter	4	0.3
Arctocephalus pusillus, Cape fur seal	61	4.7
Indeterminate small carnivore, Carnivore	3	0.2
Indeterminate small-medium carnivore, Carnivore	3	0.2
Rodentia		
Otomys irroratus, Southern African vlei rat	10	0.8
Indeterminate rodent, Rodent	35	2.7
Procaviidae		
Procavia capensis, Rock hyrax	23	1.8
Artiodactyla		
Sylvicapra grimmia, Common duiker	4	0.3
Philantomba monticola, Blue duiker	3	0.2
Raphicerus melanotis, Cape grysbok	3	0.2

Raphicerus campestris, Steenbok	6	0.5
Raphicerus sp., Cape grysbok/steenbok	36	2.8
Redunca fulvorufula, Mountain reedbuck	6	0.5
Oreotragus oreotragus, Klipspringer	6	0.5
Ourebia ourebi, Oribi	2	0.2
Alcelaphus buselaphus, Hartebeest	3	0.2
Connochaetes taurinus, Blue wildebeest	3	0.2
Tragelaphus scriptus, Bushbuck	5	0.4
Tragelaphine, Bushbuck/greater kudu	8	0.6
Taurotragus oryx, Eland	3	0.2
Syncerus caffer, Cape buffalo	2	0.2
Syncerus antiquus, Long-horned African buffalo	1	0.1
Bovid size class		
Indeterminate Bov1	64	5.0
Indeterminate Bov2	73	5.7
Indeterminate Bov3	50	3.9
Indeterminate Bov4	17	1.3
Indeterminate Mammals		
Indeterminate small mammal	165	12.8
Indeterminate small-medium mammal	46	3.6
Indeterminate medium mammal	243	18.8
Indeterminate medium-large mammal	21	1.6
Indeterminate large mammal	27	2.1
Aves		
Phalacrocorax cf. capensis, Cape cormorant	4	0.3

Spheniscus demersus, African penguin	33	2.6
Indeterminate small bird	76	5.9
Indeterminate small-medium bird	23	1.8
Indeterminate medium bird	61	4.7
Indeterminate large bird	3	0.2
Reptilia		
Testudines, Angulate tortoise	107	8.3
Indeterminate small reptile	21	1.6
Amphibia		
Indeterminate frog, Frog	4	0.3
Actinopterygii		
Cymatoceps nasutus, Black mussel cracker	6	0.5
Indeterminate small fish	11	0.9
Indeterminate medium fish	3	0.2
Mollusca		
Indeterminate marine invertebrate, Mussel	1	0.1
Total	*1291*	*100*

There is identification of thirteen bovid taxa (Table 6) from the DC faunal sample, Klein (1978) identified sixteen bovid taxa and van Pletzen (2000) identified thirteen from the KRM samples they analysed. This suggests intensive exploitation of a variety of bovid taxa at KRM. Despite there being high numbers of indeterminate bovid samples, the diversity of identified bovid taxa in the sample suggest that the indeterminate specimens in the sample are not leading to underrepresentation of the bovid taxa.

Avian faunal specimens (n=203, 16%) are the second most prevalent faunal class in the DC faunal sample, two taxa from the class Aves (Table 6) are identified in the sample namely, Cape cormorant (n=7, 1%) and African penguin (n=33, 3%; Table 6). However, majority of

the avian fauna in the sample is from indeterminate avian groups (n=163, 13%). The class Reptilia (n=128, 10%) is only represented by one taxon in the DC faunal sample namely, angulate tortoise (n=107, 8%) and this taxon encompass the majority of reptilian faunal specimens (Table 6). Small unknown reptilian specimens in the sample were grouped as indeterminate small reptiles (n=21, 2%; Table 6).

There was identification of only one taxon from the class Actinopterygii in the sample this is the Black mussel cracker (n=6, 1%), but majority of the identified Actinopterygii specimens could not be confidently assigned to a specific taxon (Table 6). The classes Amphibia and Mollusca are only represented by indeterminate faunal specimens namely, indeterminate frog (n=4, 0.3%) and indeterminate marine invertebrate (n=1, 0.1%; Table 6). This is due to the relatively low number of identified specimens from these two classes making it harder to identify specific taxa from these two classes.

The indeterminate mammal groups identified are indeterminate small mammals (n=165, 13%), indeterminate small-medium mammals (n=46, 4%), indeterminate medium mammals (n=243, 19%). Along with indeterminate medium-large mammals (n=21, 2%), indeterminate large mammals (n=27, 2%), indeterminate small carnivores (n=3, 0.2%), indeterminate small- medium carnivores (n=3, 0.2%), indeterminate rodents (n=35, 3%), indeterminate Bov1 (n=64, 5%), indeterminate Bov2 (n=73, 6%), indeterminate Bov3 (n=50, 4%) and indeterminate Bov4 (n=17, 1%; Table 6). These indeterminate groups may be from some of the known mammalian taxa, for example, majority of indeterminate rodent specimens are likely from the Southern African vlei rat (*Otomys irroratus*) specimens as this is the only identified rodent species in the DC faunal sample (Table 6).

The indeterminate avian groups identified are indeterminate small bird (n=76, 6%), indeterminate small-medium bird (n=23, 2%), indeterminate medium bird (n=61, 5%) and indeterminate large bird (n=3, 0.2%; Table 6). The indeterminate Actinopterygii specimens (n=14, 1%) are grouped into indeterminate small fish (n=11, 1%) and indeterminate small-medium fish (n=3, 0.2%).

4.1.3. Taxon Accumulation Curve

The taxa identification rate of the sample is in the taxon accumulation curve (Figure 5). The taxon accumulation curve is technique to determine if NISP of faunal assemblages are adequate. The curve shows sampling until the line graph tends towards the asymptote. As identification of taxa in the sample increases the total number of specimens also increases, which produces a graph that rises sharply initially as the NISP increases and flattens out, as new fauna become less prevalent (Figure 5). The taxon accumulation curve tests for redundancies in the faunal sample by plotting the number of taxa identified against the size of the sample (Colwell and Coddington, 1994; Reitz and Wing, 1999; Badenhorst *et al.*, 2022).

The taxon accumulation curve has three steep regions where there was increased identification of new taxa in the DC faunal sample (Figure 5). The steepest of these regions is between zero and two hundred identified specimens where there is identification of ten of the twenty-four identified taxa from the sample. The second steep region of the curve comes between four hundred and six hundred identified specimens where there is addition of seven additional taxa to the sample (Figure 5). The last steep portion of the collector's curve is between eight hundred and one thousand identified specimens where there is addition of a further seven taxa to the sample (Figure 5).

The separation of the three steep phases in the taxon accumulation curve is by three plateaus, where the NISP increases but no identification of new taxa to the sample occurs (Figure 5). Taxa that shows up before the graph starts to plateau will tend to be the most ubiquitous fauna in the faunal sample, whereas taxa that appear after the graph plateaus is rarer in the sample (Lepofsky and Lertzman, 2005).

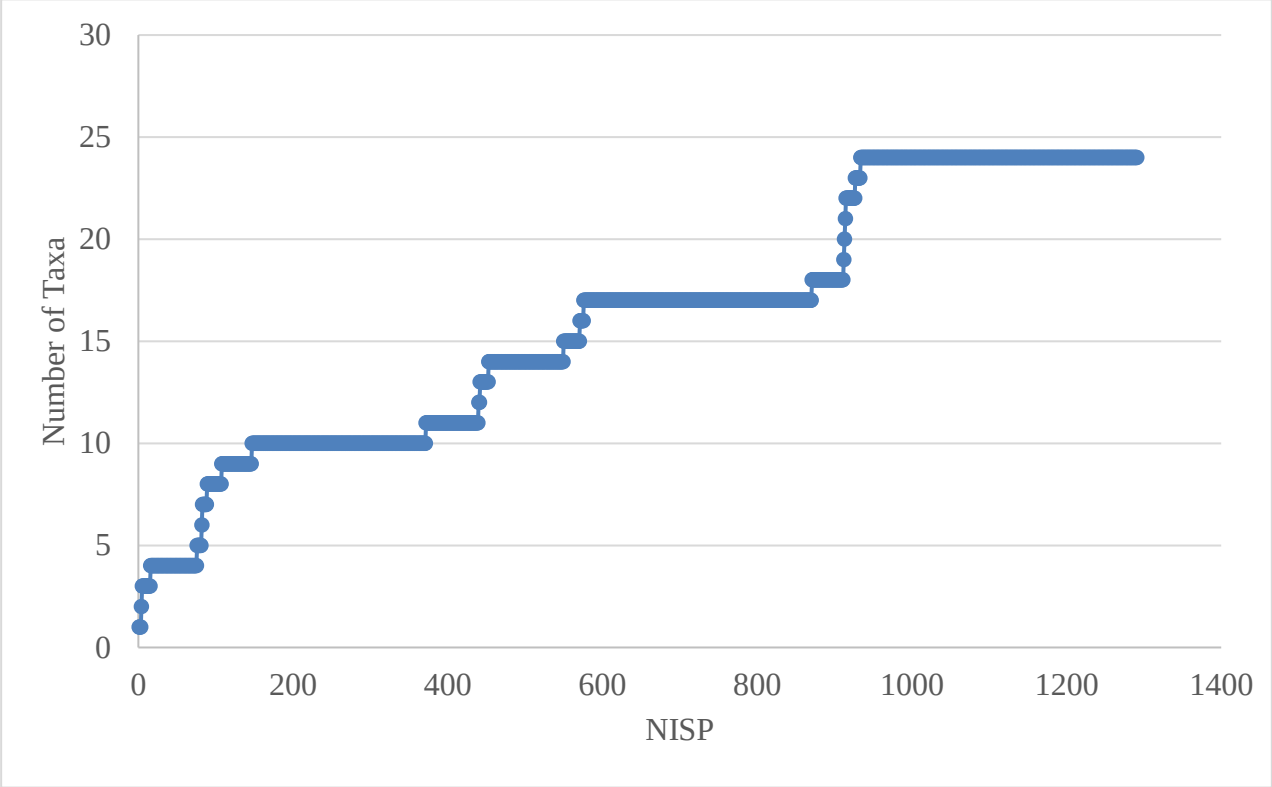


Figure 5. Taxon accumulation curve based on NISP

4.1.4. Dental Element Representation

The sample contained one hundred and two dental remains (Table 7). These dental remains consist of loose teeth, not attached to any mandibulae or maxillae. These dental fragments were identified to ten identified taxa and nine indeterminate faunal specimen groups (Table 7). The majority of the dental remains are unknown tooth fragments of unknown age (n=63, 62%).

Of the known tooth fragments permanent incisors (n=13, 13%) and permanent molars (n=13, 13%) are the most abundant specimens (Table 7). The indeterminate faunal specimen groups with the most identified loose teeth are indeterminate Bov3 (n=19, 19%), indeterminate Bov2 (n=17, 17%), and indeterminate medium mammals (n=13, 13%). There were no neonate and juvenile dental specimens identified indicating an absence of young individuals in the DC faunal sample.

Table 7. Faunal dental remains from the DC faunal remains (Dental codes: YP=Permanent incisor, XP=Permanent premolar, XN= Premolar of unknown age, ZP=Permanent molar, ZN=Molar of unknown age, TP= Unknown permanent tooth fragment, TN= Unknown tooth fragment of unknown age

Taxa	**YP**	**XP**	**XN**	**ZP**	**ZN**	**TP**	**TN**	***Total***
Carnivora								
Arctocephalus pusillus, Cape fur seal	1	1		3			1	*6*
Rodentia								
Otomys irroratus, Southern African vlei rat	3							*3*
Indeterminate Rodent					1		1	*2*
Procaviidae								
Procavia capensis, Rock hyrax	1		1	2				*4*
Artiodactyla								

Raphicerus cf. campestris, Steenbok								*0*
Raphicerus sp., Cape grysbok/steenbok		1		1			2	*4*
Redunca fulvorufula, Mountain reedbuck		2						*2*
Connochaetes taurinus, Blue Wildebeest				1				*1*
Tragelaphine, Bushbuck/kudu				3				*3*
Taurotragus oryx, Eland				1				*1*
Bovid size class								
Indeterminate Bov1		1					7	*8*
Indeterminate Bov2		1		2			14	*17*
Indeterminate Bov3	3	1				1	14	*19*
Indeterminate Bov4	3	1						*4*

Indeterminate Mammals								
Indeterminate small mammal							7	*7*
Indeterminate small/medium mammal						1	2	*3*
Indeterminate medium mammal	1		1				11	*13*
Indeterminate large mammal	1						1	*2*
Actinopterygii								
Cymatoceps nasutus, Black mussel cracker							3	*3*
Total	*13*	*8*	*2*	*13*	*1*	*2*	*63*	*102*

4.2. Skeletal-Part Profiles

4.2.1. Mammal Skeletal-Part Profiles

There are 935 mammal specimens in the DC faunal sample; the skeletal-part profiles display the frequencies of each body part in the faunal sample. Medium mammals (n=364, 39%) and small mammals (n=350, 37%) are the two most prevalent mammal size classes. Small- medium mammals (n=117, 13%), medium-large mammals (n=44, 5%), and large mammals (n=28, 3%) represent a smaller percentage of the mammal specimens.

The skeletal-part profile of large mammals does not show evidence of cranial skeletal

parts. However, cranial skeletal parts are moderately prevalent amongst the other mammal size classes (Figure 6). All the mammal size classes have representation of the proximal elements in their skeletal-part profiles. However, small mammals and small-medium mammals have a low prevalence of proximal elements in their skeletal-part profiles whereas the larger mammal size classes have a high prevalence of proximal elements in their skeletal-part profiles (Figure 6).

The hind limb and forelimb have similar moderate representation amongst small and medium mammals, whereas amongst medium-large and large mammals there is a high prevalence of hind limb specimens compared to limited fore limb specimens (Figure 6). Amongst the small-medium specimens, the forelimb is prevalent whereas the hind limb has poor representation (Figure 6). Amongst small, small-medium, medium, and medium-large mammal specimens the distal element skeletal parts constitute at least twenty per cent of the specimens identified; large mammals have a poor representation of distal skeletal parts compared to the other mammal size classes (Figure 6).

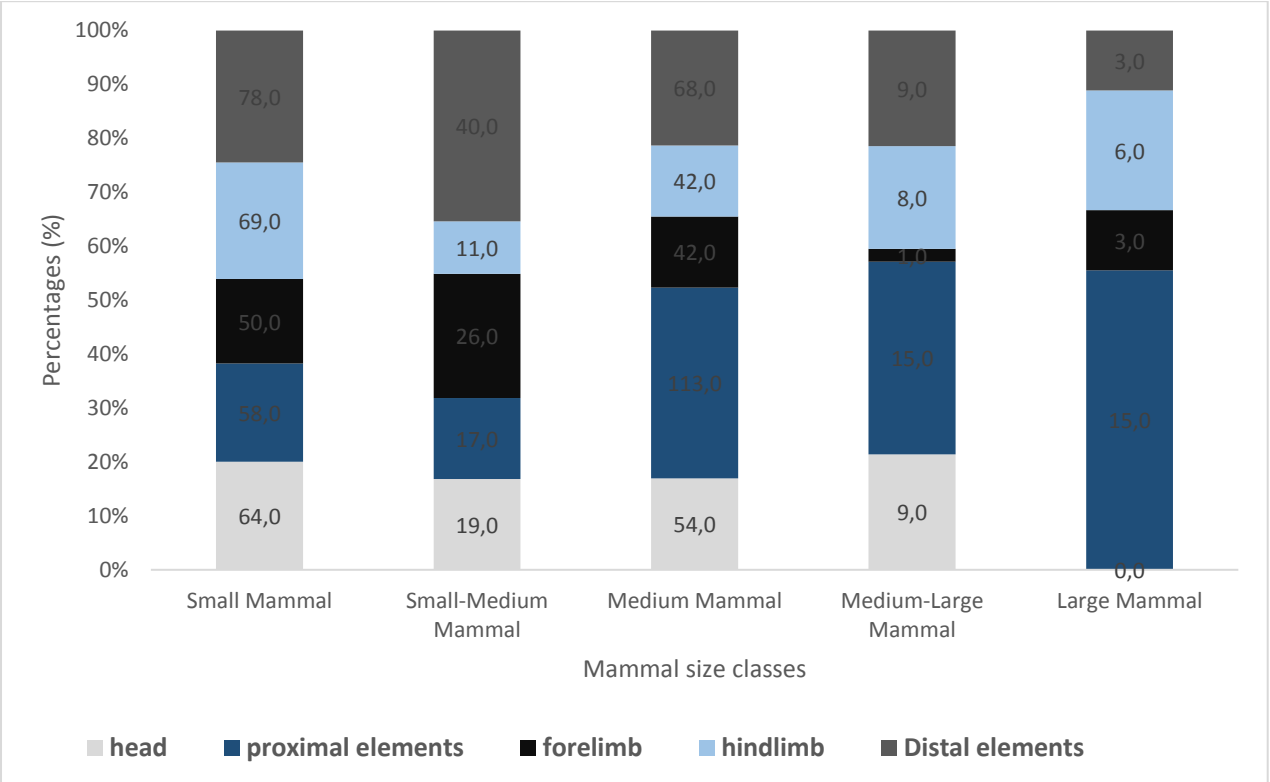


Figure 6. The skeletal-part profiles of indeterminate mammal size classes using MNE values

4.2.2. Bovid Skeletal Part Profiles

4.2.2.1. Bovid nNISP

There are 292 bovid specimens in the DC faunal sample, of these Bov1 (n=123, 42%), Bov2 (n=83, 28%), and Bov3 (n=63, 22%) are the most abundant identified bovid specimens, Bov1-2 specimens are considered small bovids, Bov3 are considered medium sized bovids. Bov4 (n=22, 8%) and Bov5 (n=1, 0.3%) which are considered large and very larger bovids respectively are far less prevalent amongst the bovid specimens. the NISP is used to derive the nNISP for the Bovid specimens (Figure 7).

Cranial elements have relatively good representation amongst Bov1-4 taxa; however, Bov5 has no representation of cranial skeletal parts (Figure 7). Bov1, 3, 4 and 5 have poor representation of the proximal elements in their skeletal-part profiles, however, Bov2 have a high prevalence of proximal elements in their skeletal-part profile (Figure 7). Bov1 and Bov4 have relatively moderate representation of distal elements in their skeletal-part profiles.

whereas Bov2 and Bov3 have poor representation of the distal elements in the skeletal-part profiles (Figure 7). The skeletal- part profile of Bov5 specimens only has evidence of distal elements with an incredibly low prevalence. Bov1-3 have a good representation of front-limb and hind limb in their skeletal- part profiles, however, Bov4 specimens are dominated by hind limb skeletal parts whereas the front-limb skeletal parts are relatively scarce (Figure 7).

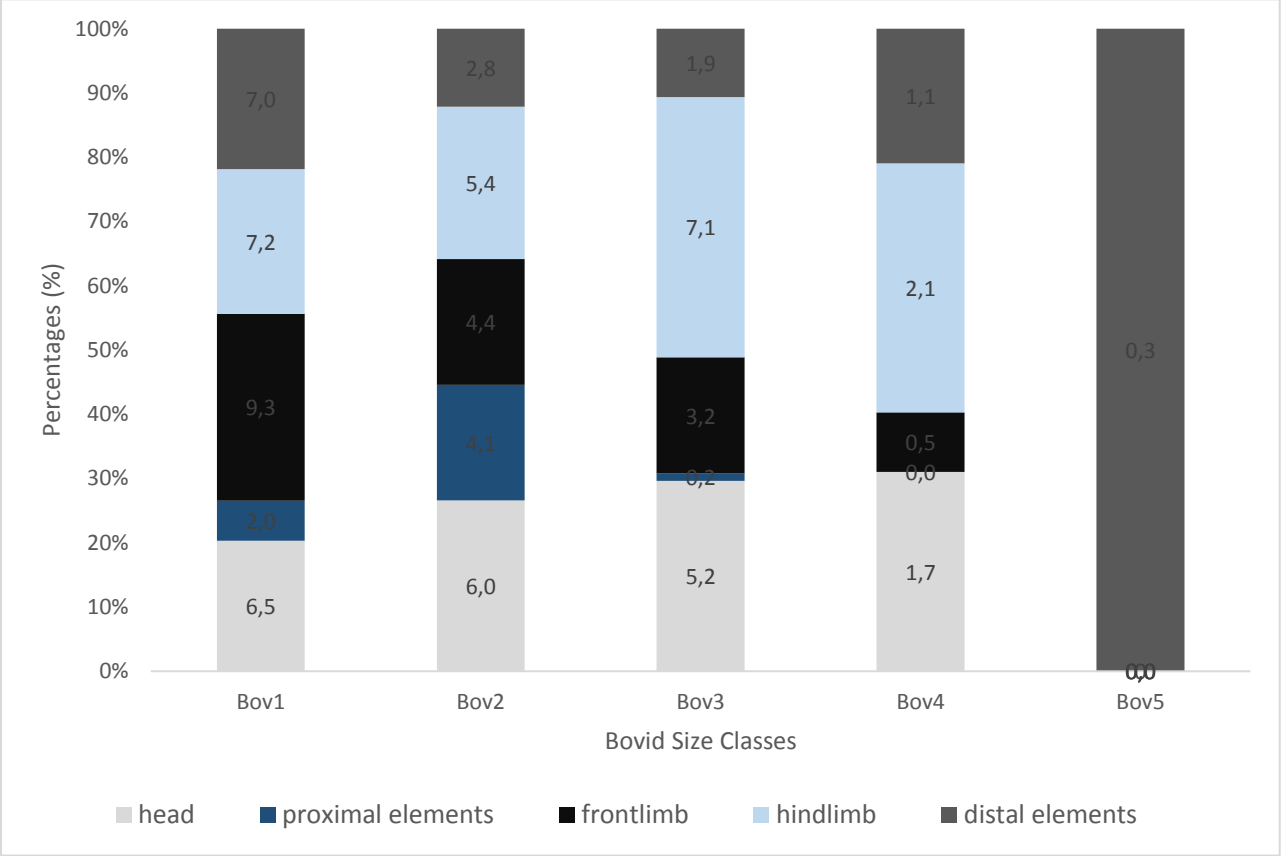


Figure 7. The skeletal-part profiles of indeterminate bovid size-classes using nNISP values

4.2.2.2. Bovid MNE

The bovid NISP values derive the MNE values for the Bovid skeletal parts (Figure 8). The MNE values for each bovid size classes are as follows, Bov1 (n=110), Bov2 (n=74), Bov3 (n=61), Bov4 (n=22), and Bov5 (n=1). Each bovid size class aside from Bov5 has representation of head, proximal elements, front limb, hind limb and distal elements, whereas Bov5 only has representation of distal elements (Figure 8).

The cranial skeletal parts have relatively good representation amongst Bov1-4; however, Bov5 has no identified cranial skeletal parts (Figure 8). Amongst the Bovid size classes, there is a poor representation of the proximal elements; however, distal elements have good representation in the MNE percentages (Figure 8). The bovid fore limbs have a high prevalence amongst Bov1, Bov2 and Bov3 specimens; however, Bov4 and Bov5 have poor representation of the forelimb (Figure 8). The prevalence of the hind limb is similar to that of the forelimb amongst Bov1, Bov2 and Bov3 specimens. However, this is not the case amongst Bov4 specimens where the hind limb is five times more prevalent than the forelimb (Figure 8).

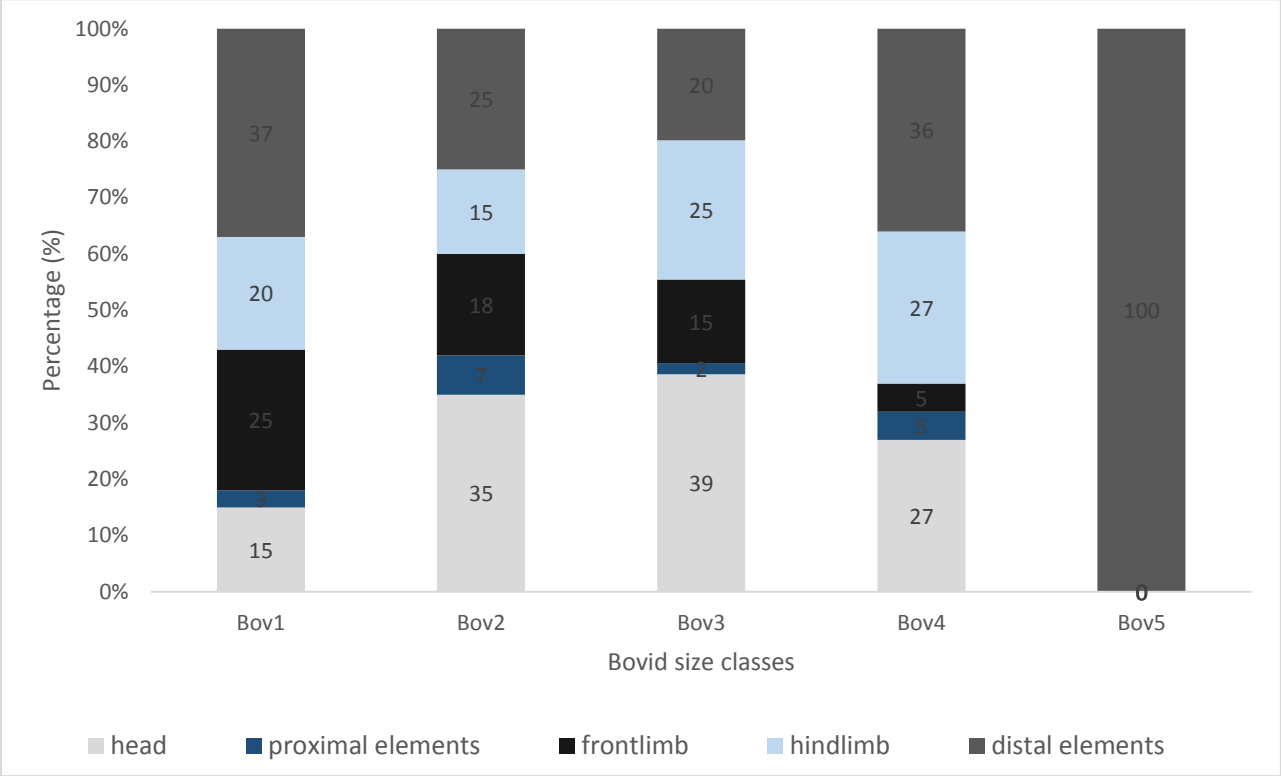


Figure 8. The skeletal-part profiles of indeterminate bovid size-classes using MNE values

4.2.2.3. Bovid MAU

The Bovid MNE values derived the MAU values for each skeletal element identified (Figure 9). The MAU values for bovid size classes are as follows, Bov1 (MAU=28.1), Bov2 (MAU=22.0), Bov3 (MAU=16.8), Bov4 (MAU=6.8) and Bov5 (MAU=0.3). The Bovid MAU values are comparable to the nNISP values observed in (Figure 9) due to this; the distribution of skeletal parts amongst the bovid size classes in the MAU is a mirror image of the distribution of skeletal elements in the nNISP .

Bov1-4 have a good representation of cranial skeletal parts, however, Bov5 has no representation of cranial skeletal parts (Figure 9). Bov1, 3, 4 and 5 have relatively poor representation of the proximal elements in their skeletal-part profiles, whereas proximal elements are the second most prevalent specimens amongst Bov2 skeletal-part profiles (Figure 9). Bov1-4 have a poor representation of distal elements in their skeletal-part profiles, Bov5 has representation by distal elements only.

However, there is an exceptionally low prevalence of these specimens (Figure 9). Bov1-

3 have a good representation of front-limb and hind limb in their skeletal-part profiles. This is not the case amongst Bov4 specimens where the hind limb is the second most prevalent skeletal part whereas the front limb is the second least prevalent skeletal part (Figure 9).

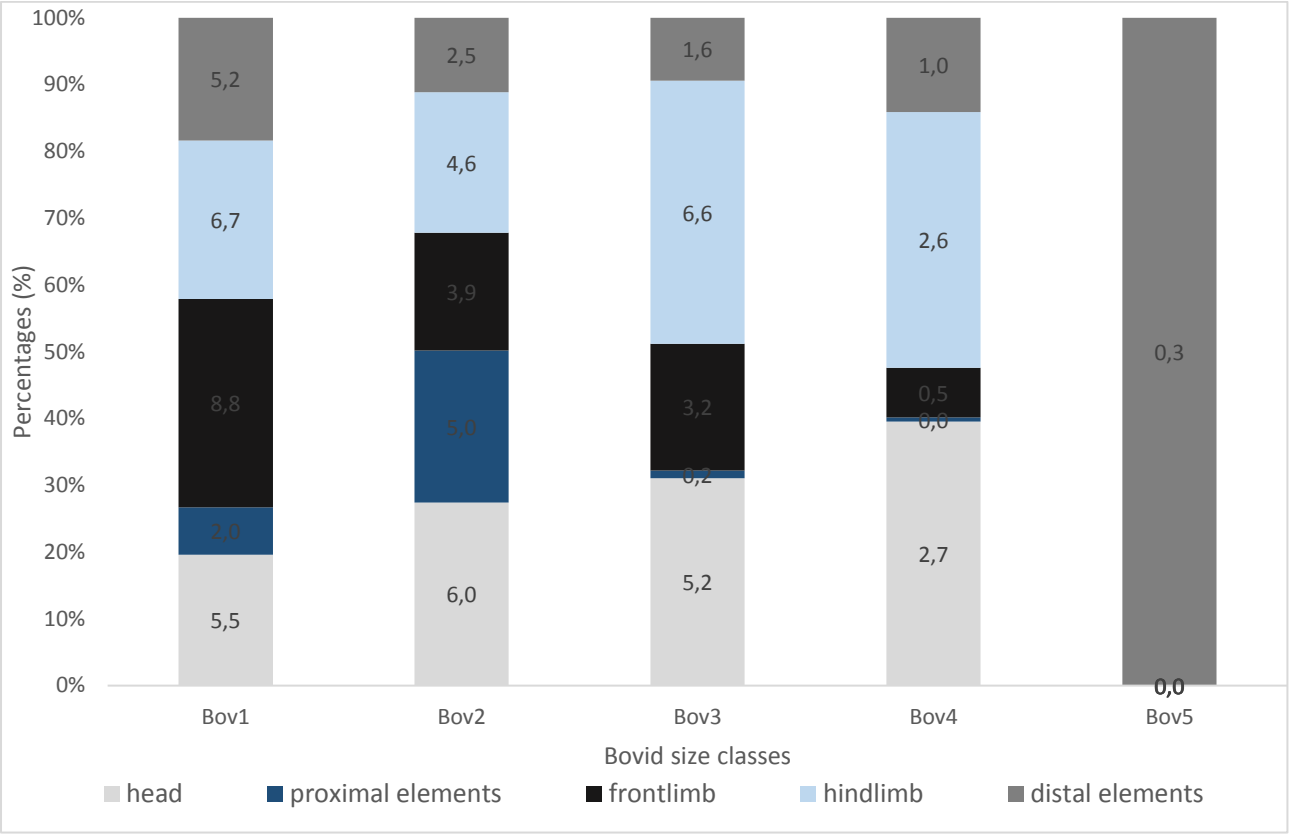


Figure 9. The skeletal-part profiles of indeterminate bovid size-class using MAU values

4.2.2.4. Avian Skeletal-Part Profiles

Avian specimens (n=203, 16%) are the second most prolific class in the DC faunal sample. Amongst the avian fauna, small birds (n=83, 41%), small-medium birds (n=25, 12%) and medium birds (n= 92, 45%) are the most prolific in the sample. Large birds (n=3, 2%) have minimal representation at the site, far less than their small counterparts do. the NISP values are used to derive the MNE values of the Avian size classes, and the values are as follows, small birds (n=74), small-medium birds (n=20), medium birds (n= 86) and large birds (n=3; Figure 10). The Avian faunal orders namely, Sphenisciformes and Suliformes are only represented by completely fused specimens (Figure 11), suggesting they are from sub-adult and adult specimens.

Small birds and small-medium birds have similar skeletal-part profiles dominated by proximal elements and distal elements, whereas cranial, forelimb and hind limb skeletal parts represent a smaller portion of specimens (Figure 10). Medium birds have a much more balanced skeletal-part profile with adequate representation of the proximal element, fore limb, hind limb, and distal element skeletal parts (Figure 10). However, there is a poor representation of cranial skeletal parts amongst the medium bird specimens (Figure 10). Large birds have equal representation of cranial, proximal, and fore limb skeletal parts, but the large birds have no representation of the hind limb or distal elements in their skeletal-part profiles (Figure 10).

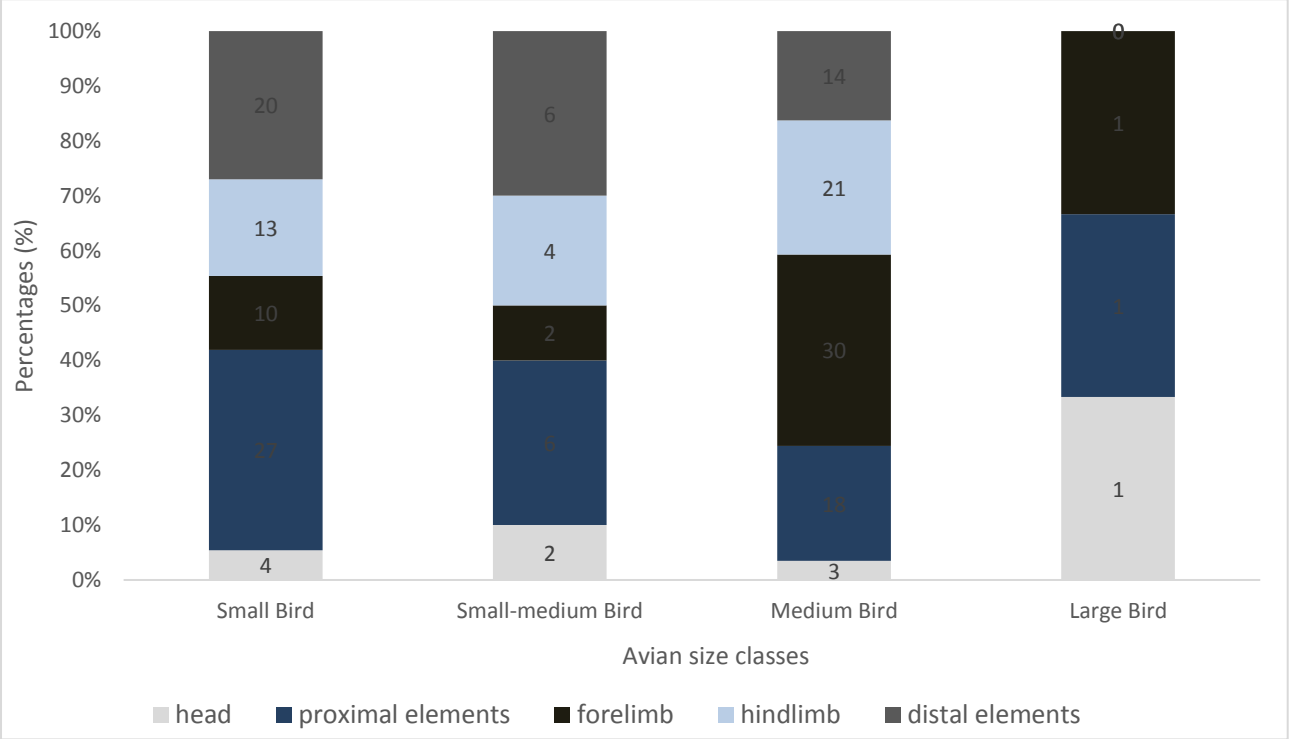


Figure 10. The skeletal-part profiles of indeterminate avian size-classes using MNE values

4.3. Aging

4.3.1. Dental Eruption Patterns and Tooth Wear Rates

There was identification of three maxillae fragments and fifteen mandibulae fragments in the DC faunal sample (Table 8). Eleven of the specimens are from prime-age adults and show some partial wearing, six of these specimens belong to the family Rodentia, three belong

to the family Bovidae and two of specimens are indeterminate mammal specimens (Table 8). Six of the specimens are from sub-adult individuals, the sub-adults are a possible steenbok individual, a mountain reedbuck and four sub-adult rock hyrax specimens. The youngest of these hyrax specimens indicates the individual died between the ages of seventeen and nineteen months (Table 8; Badenhorst *et al*., 2014). One of the specimens is from an old hyrax individual that died with molar teeth fully erupted and worn. None of the specimens is from neonate and juvenile individuals, which is in line with the age profile observed from the loose teeth specimens (Table 7).

Table 8. Analysis of dental eruption patterns and tooth wear rates of mandibulae and maxilla remains

Taxa	**Element**	**Side**	**Driver code**	**Description**	**Ageing**
Indeterminate Mammals					
Small mammal	MN	I	35	Fully erupted M1 and M2 teeth partially worn	Adult
Small-medium carnivore	MN	I	30	P1, P2 and M1 partially worn and fully erupted	Adult
Small rodent	MX	U	42	One upper M1 tooth fully erupted and worn	Adult
Rodentia					
Otomys irroratus	MX	R	35	One upper incisor tooth that is partially worn	Adult

Otomys irroratus	MN	R	30	M1 and M2 with extensive wearing and fully erupted	Adult
Otomys irroratus	MN	L	30	M1 with partial wearing and fully erupted	Adult
Otomys irroratus	MN	R	35	Two lower incisors with extensive wearing	Adult
Otomys irroratus	MN	R	32	One M1 fully erupted and partially worn	Adult
Procaviidae					
Procavia capensis	MN	R	32	P3, P4 and M1 teeth fully erupted	17-19 months
Procavia capensis	MN	R	30	One M1 tooth fully erupted	20-22 months sub-adult
Procavia capensis	MN	U	30	P4, M1 and M2 teeth fully erupted	23-27 months
Procavia capensis	MN	R	33	M2 and M3 teeth fully erupted and worn	Old
Procavia capensis	MN	L	40	P2, P3, P4 and M1 teeth fully erupted	20-22 months, sub-adult
Artiodactyla					

Raphicerus cf. campestris	MN	U	30	M1 and M2 partially erupted with minimal wear	Sub-adult
Redunca cf. fulvorufula	MN	L	34	P1 and P2 fully erupted and worn	Adult
Redunca fulvorufula	MN	R	30	P2, P3 and M2 teeth with minimal wear	Sub-adult
Bovid size class					
Bov1	MN	U	30	One broken M1 tooth fully erupted with minimal wear	Adult
Bov2	MX	R	30	P1 and P2 teeth which are fully erupted and worn down	Adult

4.3.2. Long Bone Fusion

Fusion states of long bone specimens (Table 9) were recorded from Primate (n=2), Carnivora (n=64), Rodentia (n=30), Hyracoidean (n=18), Artiodactyla (n=243), Sphenisciformes (n=40) and Suliformes (n=4) faunal orders. In each faunal order, completely fused long bones represent at least 60% of specimens (Table 9). There is relatively poor representation of unfused specimens and partially fused specimens amongst the long bone specimens (Table 9).

Table 9. Fusion amongst long bone specimens from the DC faunal sample

Taxa	**Fused**	**Partially fused**	**Unfused**	***Total***	**Fused (%)**	**Partially fused (%)**	**Unfused (%)**	***Total***
Primate	2	0	0	*2*	100	0	0	*100*
Carnivora	42	7	15	*64*	66	11	23	*100*
Rodentia	20	1	9	*30*	67	3	30	*100*
Hyracoidea	11	2	5	*18*	61	11	28	*100*
Artiodactyla	203	11	29	*243*	84	5	12	*100*
Sphenisciformes	40	0	0	*40*	100	0	0	*100*
Suliformes	4	0	0	*4*	100	0	0	*100*
Total	322	21	58	*401*	80	5	14	*100*

Partially fused long bone specimens are by far the least well represented amongst the mammalian orders (Figure 11). Primates are the only mammalian order with no evidence of partially fused specimens. The other four mammalian orders also have a relatively low representation of partially fused long bone specimens (Figure 11). Unfused long bone specimens have relatively better representation amongst the mammal orders than the partially fused specimens but are relatively less prevalent than the completely fused specimens.

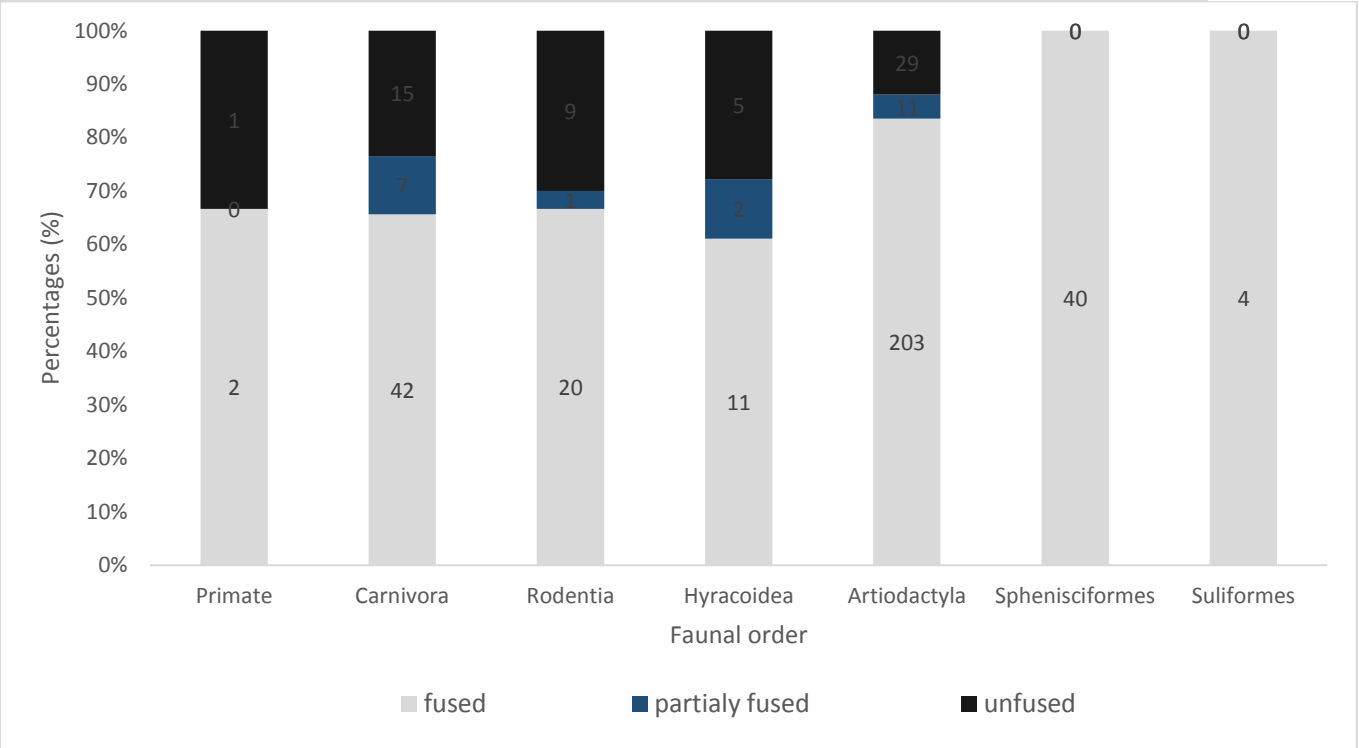


Figure 11. The long-bone fusion states of identified faunal orders from the DC faunal sample

There was recording of fusion states of long bones from indeterminate specimens. The specimens are from the classes Mammalia, Aves, Reptilia and Amphibia (Figure 12). Indeterminate Mammal specimens (n=229) are dominated by fused specimens (n=111, 49%) and unfused specimens (n=90, 39%), however, representation of partially fused specimens is poor (n=28, 12%; Figure 12). Amongst the indeterminate Avian specimens (n=200), fused specimens (n=192, 96%) are the most prevalent with unfused specimens (n=7, 3.5%) and partially fused specimens (n=1, 0.5%) being less prevalent in the faunal sample (Figure 12). The amphibians (n=3) and Reptilia (n=33) are characterised by long bones that are completely fused (Figure 12).

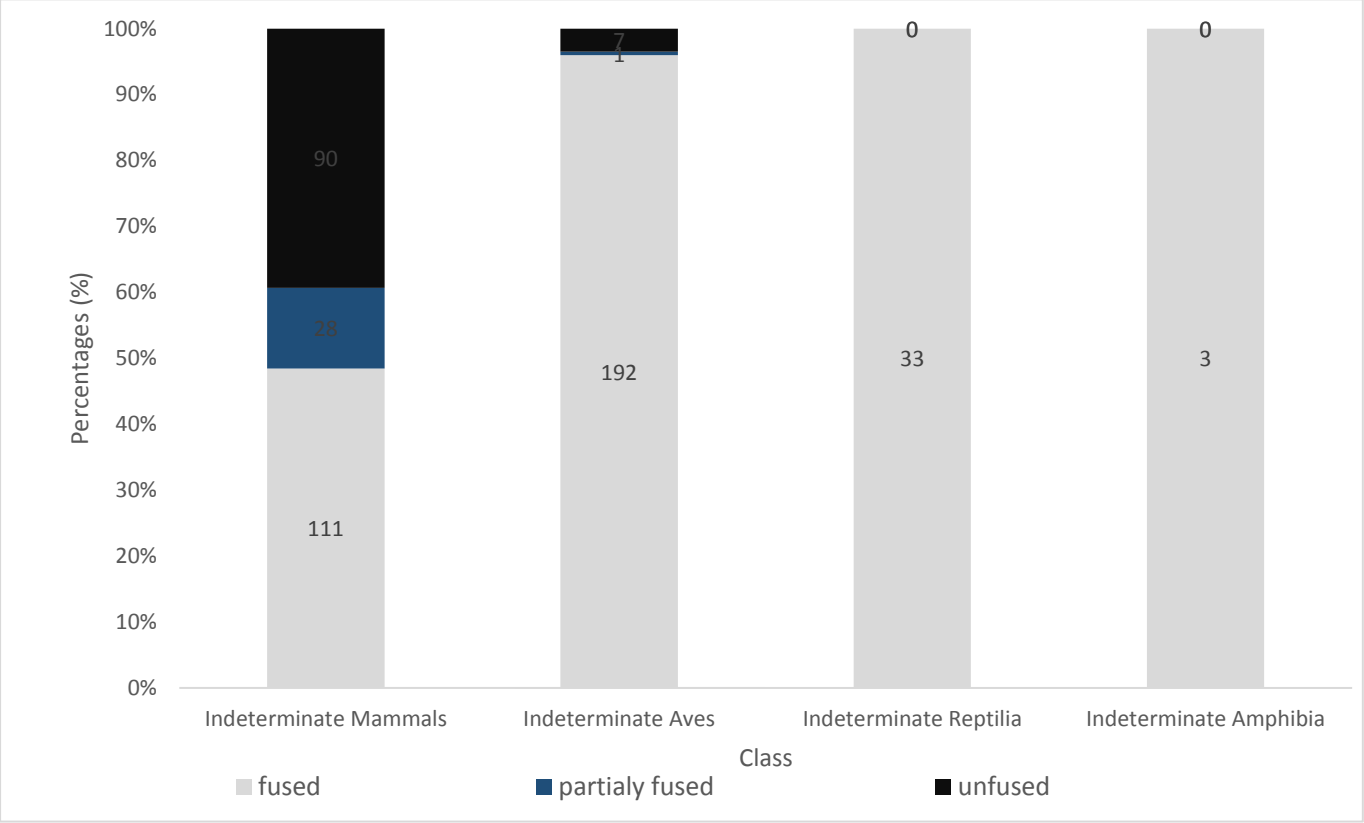


Figure 12. The fusion states of indeterminate faunal specimens from the DC faunal sample

4.4. Taphonomy

4.4.1. Burning

Colour changes due to burning are analysed and recorded for the faunal specimens and in the DC sample (Table 10). 14 413 (84%) of the DC faunal sample displays evidence of burning. Six of the DC sub-member layers have no evidence of faunal specimens being burnt (Table 10), these layers have low faunal samples (Table 5) suggesting minimal deposition and fire activity when these layers accumulated. The layers CP6, CP7 AF, CP8, CP8 AF, and CP9 DBS are the only layers with over one thousand burnt specimens. Twenty-two of the layers have specimens with all four-colour changes associated with burning.

Much of the DC faunal sample is burnt brown (n=6385; 44%) and burnt black (n-5810; 40%). Only four layers from the DC sub-member have no specimens burnt brown, whereas ten of the layers have no specimens with evidence of specimens burnt black (Table 10). Faunal specimens burnt grey (n=1249; 9%) and those burnt white (n=944; 7%) are far less prevalent amongst the DC faunal sample (Table 10). Sixteen of the DC sub-member layers lack evidence

of specimens burnt grey, whereas the are only thirteen layers without evidence of specimens burnt white (Table 10).

Table 10. DC faunal Specimens burnt brown, burnt black, burnt grey and burnt white in each of the forty-five DC sub-member layers

DC sub-member layers	**Burnt brown**	**Burnt black**	**Burnt grey**	**Burnt white**	***Total***	**Burnt brown (%)**	**Burnt black (%)**	**Burnt grey (%)**	**Burnt white (%)**	***Total***
YS1	0	0	0	0	*0*	0	0	0	0	0
BS1	7	0	0	0	*7*	100	0	0	0	*100*
AF1	36	21	0	1	*58*	62	36	0	2	*100*
BS1 AF1	0	0	0	0	*0*	0	0	0	0	0
YS2	8	0	0	0	*8*	100	0	0	0	*100*
BS2	0	0	0	0	*0*	0	0	0	0	0
BS3	2	0	0	0	*2*	100	0	0	0	*100*
AF2	1	1	0	1	*3*	33	33	0	33	*100*
CP1	9	1	0	1	*11*	82	9	0	9	*100*
BS4	20	4	0	0	*24*	83	17	0	0	*100*
CP2	65	22	4	1	*92*	71	24	4	1	*100*
BS5	12	2	0	0	*14*	86	14	0	0	*100*
CP3	106	105	27	9	*247*	43	43	11	4	*100*
BS6	8	0	0	0	*8*	100	0	0	0	*100*
CP4	28	4	0	0	*32*	88	13	0	0	*100*
CP5	613	128	79	63	*883*	69	14	9	7	*100*
CP6	756	345	115	90	*1306*	58	26	9	7	*100*
CP7 (AF)	314	545	160	92	*1111*	28	49	14	8	*100*
CP7 YBS1	52	17	1	10	*80*	65	21	1	13	*100*
CP7 YBS2	0	3	0	0	*3*	0	100	0	0	*100*
CP8	402	621	134	64	*1221*	33	51	11	5	*100*
CP8 BS2	259	53	2	2	*316*	82	17	1	1	*100*
CP8 DBS	249	219	10	3	*481*	52	46	2	1	*100*
CP8 GG	160	209	13	3	*385*	42	54	3	1	*100*
CP8 GS	139	128	17	15	*299*	46	43	6	5	*100*
CP8 GSA	183	220	21	11	*435*	42	51	5	3	*100*
CP8 AF	674	668	205	81	*1628*	41	41	13	5	*100*

YS3 (U)	270	213	48	33	*564*	48	38	9	6	*100*
CP9 GSB	82	277	47	34	*440*	19	63	11	8	*100*
CP9 AF1	21	0	0	32	*53*	40	0	0	60	*100*
CP9 AF2	29	0	0	17	*46*	63	0	0	37	*100*
CP9 AF3 (UB)	135	2	17	81	*235*	57	1	7	34	*100*
CP9 AF4	54	0	16	31	*101*	53	0	16	31	*100*
CP9 AF5	103	5	19	1	*128*	80	4	15	1	*100*
CP9 AF6	41	23	37	17	*118*	35	19	31	14	*100*
CP9 DBS	313	644	69	48	*1074*	29	60	6	4	*100*
CP10 BP	135	273	9	7	*424*	32	64	2	2	*100*
CP10 (AF)	109	26	89	97	*321*	34	8	28	30	*100*
YS4 ROOF SPALL	92	132	19	13	*256*	36	52	7	5	*100*
YS5	155	199	38	21	*413*	38	48	9	5	*100*
CP11 (AF)	141	119	16	27	*303*	47	39	5	9	*100*
CP11 SM	137	136	32	23	*328*	42	41	10	7	*100*
YS6	272	182	4	0	*458*	59	40	1	0	*100*
CP12 BL	152	246	23	15	*436*	35	56	5	3	*100*
CP12 SM	41	17	3	0	*61*	67	28	5	0	*100*
Total	***6385***	***5810***	***1274***	***944***	***14413***	***44***	***40***	***9***	***7***	***100***

4.4.2. Cut Marks and Chop Marks

There are 317 specimens with evidence of striations. Cut marks (n=258; 82%) are the most prevalent type of striation in the DC faunal sample. The fifteen topmost layers of the DC sub-member (i.e., YS1-CP4) have minimal presence of specimens with cut marks, the majority of the cut marks sit between layers CP5 and CP12 BL (Table 11).

Chop marks (n=56; 18%) are less prevalent in the DC faunal sample in comparison to cut marks. As with the cut marks the fifteen topmost layers of the DC sub-member (i.e., YS1-CP4) have minimal presence of specimens with chop marks, the majority of the chop marks sit between layers CP5 and CP12 BL (Table 11). The cut marks are for more prevalent than the chop marks, however, their pattern of occurrence in the DC sub-member layers is almost

identical.

Table 11. The prevalence of DC faunal specimens with cut marks and chop marks in each of the forty-five DC sub-member layers

DC sub-member layers	**Cut marks**	**Chop marks**	***Total***	**Cut marks (%)**	**Chop marks (%)**	***Total***
YS1	0	0	*0*	0	0	*0*
BS1	0	0	*0*	0	0	*0*
AF1	1	0	*1*	100	0	*100*
BS1 AF1	0	0	*0*	0	0	*0*
YS2	0	0	*0*	0	0	*0*
BS2	0	0	*0*	0	0	*0*
BS3	0	0	*0*	0	0	*0*
AF2	0	0	*0*	0	0	*0*
CP1	0	0	*0*	0	0	*0*
BS4	0	0	*0*	0	0	*0*
CP2	0	1	*1*	0	100	*100*
BS5	0	0	*0*	0	0	*0*
CP3	0	0	*0*	0	0	*0*
BS6	0	0	*0*	0	0	*0*
CP4	0	0	*0*	0	0	*0*
CP5	20	5	*25*	80	20	*100*
CP6	14	4	*18*	78	22	*100*
CP7 (AF)	15	4	*19*	79	21	*100*
CP7 YBS1	4	1	*5*	80	20	*100*
CP7 YBS2	0	0	*0*	0	0	*0*
CP8	14	2	*16*	88	13	*100*
CP8 BS2	0	2	*2*	0	100	*100*
CP8 DBS	5	5	*10*	50	50	*100*
CP8 GG	9	6	*15*	60	40	*100*
CP8 GS	15	2	*17*	88	12	*100*
CP8 GSA	13	2	*15*	87	13	*100*
CP8 AF	27	2	*29*	93	7	*100*
YS3 (U)	14	1	*15*	93	7	*100*
CP9 GSB	7	0	*7*	100	0	*100*

CP9 AF1	0	0	*0*	0	0	*0*
CP9 AF2	0	0	*0*	0	0	*0*
CP9 AF3 (UB)	3	0	*3*	100	0	*100*
CP9 AF4	3	0	*3*	100	0	*100*
CP9 AF5	0	0	*0*	0	0	*0*
CP9 AF6	0	0	*0*	0	0	*0*
CP9 DBS	23	3	*26*	88	12	*100*
CP10 BP	14	3	*17*	82	18	*100*
CP10 (AF)	7	1	*8*	88	13	*100*
YS4 ROOF SPALL	9	2	*11*	82	18	*100*
YS5	16	6	*22*	73	27	*100*
CP11 (AF)	4	0	*4*	100	0	*100*
CP11 SM	16	2	*18*	89	11	*100*
YS6	0	0	*0*	0	0	*0*
CP12 BL	5	1	*6*	83	17	*100*
CP12 SM	0	1	*1*	0	100	*100*
Total	***258***	***56***	***314***	***82***	***18***	***100***

4.4.3. Faunal Taphonomy

Evidence of gnawing is visible in 42 (0.2%) faunal specimens from the DC sub-member. Carnivore gnawing (n=19, 45%) and rodent gnawing (n=23, 55%) are the only two faunal taphonomy indicators observed from the sample (Table 12). Thirty-three of the DC sub-member layers have no evidence of faunal specimens with carnivore gnaw marks, and thirty-four of the layers have no evidence of rodent gnawing (Table 12).

Table 12. The prevalence of DC faunal specimens with carnivore chew marks and

Dc sub-member layers	**Carnivore chew marks**	**Rodent gnaw marks**	***Total***	**Carnivore chew marks (%)**	**Rodent gnaw marks (%)**	***Total***
YS1	0	0	*0*	0	0	*0*

BS1	0	0	*0*	0	0	*0*
AF1	0	0	*0*	0	0	*0*
BS1 AF1	0	0	*0*	0	0	*0*
YS2	0	0	*0*	0	0	*0*
BS2	0	0	*0*	0	0	*0*
BS3	0	0	*0*	0	0	*0*
AF2	0	0	*0*	0	0	*0*
CP1	0	0	*0*	0	0	*0*
BS4	0	0	*0*	0	0	*0*
CP2	1	2	*3*	33	67	*100*
BS5	0	0	*0*	0	0	*0*
CP3	0	0	*0*	0	0	*0*
BS6	0	0	*0*	0	0	*0*
CP4	0	0	*0*	0	0	*0*
CP5	1	0	*1*	100	0	*100*
CP6	3	2	*5*	60	40	*100*
CP7 (AF)	4	5	*9*	44	56	*100*
CP7 YBS1	1	1	*2*	50	50	*100*
CP7 YBS2	0	0	*0*	0	0	*0*
CP8	0	1	*1*	0	100	*100*
CP8 BS2	0	0	*0*	0	0	*0*
CP8 DBS	2	2	*4*	50	50	*100*
CP8 GG	0	0	*0*	0	0	*0*
CP8 GS	1	0	*1*	100	0	*100*
CP8 GSA	0	0	*0*	0	0	*0*
CP8 AF	1	0	*1*	100	0	*100*
YS3 (U)	0	0	*0*	0	0	*0*

CP9 GSB	0	0	*0*	0	0	*0*
CP9 AF1	0	0	*0*	0	0	*0*
CP9 AF2	0	0	*0*	0	0	*0*
CP9 AF3 (UB)	0	0	*0*	0	0	*0*
CP9 AF4	0	0	*0*	0	0	*0*
CP9 AF5	0	0	*0*	0	0	*0*
CP9 AF6	0	0	*0*	0	0	*0*
CP9 DBS	1	3	*4*	25	75	*100*
CP10 BP	0	1	*1*	0	100	*100*
CP10 (AF)	0	0	*0*	0	0	*0*
YS4 ROOF SPALL	1	0	*1*	100	0	*100*
YS5	1	3	*4*	25	75	*100*
CP11 (AF)	0	0	*0*	0	0	*0*
CP11 SM	0	1	*1*	0	100	*100*
YS6	0	0	*0*	0	0	*0*
CP12 BL	2	2	*4*	50	50	*100*
CP12 SM	0	0	*0*	0	0	*0*
Total	***19***	***23***	***42***	***45***	***55***	***100***

4.4.4. Weathering, Root Etching and Staining

Weathering (n=198, 9%), root etching (n=91, 4%) and staining (n=2032, 88%) which are natural modifications associated with site formation processes are analysed and recorded (Table 13). Weathering and root etching are not prevalent amongst the faunal specimens from the DC sub-member layers (Table 13). The majority of the specimens with evidence of weathering and root etching cluster in between layers CP8 DBS and CP12 BL (Table 13).

Twenty-six of the DC sub-member layers have no specimens with evidence of weathering or root etching (Table 13). Seventeen of the DC sub-member layers have evidence of both weathering and root etching. This implies fluctuations in there prevalence of these site formation processes.

Staining is the most prevalent natural modification that occurred amongst the specimens. The majority of the DC faunal specimens with evidence of staining cluster between the layers CP8 DBS and CP9 GSB, as well as layers CP9 DBS and CP12 BL (Table 13). Aside from these two clusters, there is poor prevalence of stained specimens in the other DC sub-member layers. The prevalence of weathering, root etching and staining in the DC sub member layers has strong correlation to the faunal distribution (Table 5) in each layer.

Table 13. The prevalence of DC faunal Specimens with weathering, root etching and staining in each of the forty-five DC sub-member layers

Dc sub-member layers	**Weathering**	**Root etching**	**Staining**	***Total***
YS1	0	0	0	*0*
BS1	0	0	0	*0*
AF1	0	0	0	*0*
BS1 AF1	0	0	0	*0*
YS2	0	0	0	*0*
BS2	0	0	0	*0*
BS3	0	0	0	*0*
AF2	0	0	0	*0*
CP1	0	0	0	*0*
BS4	0	0	0	*0*
CP2	0	0	0	*0*
BS5	0	0	0	*0*
CP3	0	0	0	*0*

BS6	0	0	0	*0*
CP4	0	0	0	*0*
CP5	0	0	0	*0*
CP6	0	0	0	*0*
CP7 (AF)	5	1	16	*22*
CP7 YBS1	0	0	0	*0*
CP7 YBS2	0	0	0	*0*
CP8	13	7	99	*119*
CP8 BS2	0	0	0	*0*
CP8 DBS	4	3	41	*48*
CP8 GG	1	1	17	*19*
CP8 GS	2	4	22	*28*
CP8 GSA	12	4	102	*118*
CP8 AF	3	2	48	*53*
YS3 (U)	4	3	32	*39*
CP9 GSB	15	6	159	*180*
CP9 AF1	0	0	0	*0*
CP9 AF2	0	0	0	*0*
CP9 AF3 (UB)	2	0	6	*8*
CP9 AF4	0	0	0	*0*
CP9 AF5	0	0	0	*0*
CP9 AF6	0	0	0	*0*
CP9 DBS	38	11	419	*468*
CP10 BP	15	8	158	*181*
CP10 (AF)	3	3	33	*39*
YS4 ROOF SPALL	9	4	76	*89*

YS5	19	8	189	*216*
CP11 (AF)	0	0	0	*0*
CP11 SM	7	1	53	*61*
YS6	21	13	242	*276*
CP12 BL	25	12	320	*357*
CP12 SM	0	0	0	*0*
Total	*198*	*91*	*2032*	*2321*

4.4.5. Microscopic Analysis

There was a microscopic analysis of one hundred randomly selected faunal specimens (Figure 13). The microscopic analysis indicates that burning (n=46) is the dominant taphonomic damage sustained by the specimens (Figure 13). This is in line with the naked eye observation. Striations (n=30) are more prominent in the microscopic analysis than in the naked eye observations (Figure 13).

The microscopic analysis revealed a prominence of root etching (n=21) not observed in the naked eye observations (Figure 13). The microscopic analysis showed a low presence of faunal specimens with evidence of carnivore gnawing (n=1) in addition to rodent gnawing (n=2; Figure 13). This mirrors the relatively low prevalence of specimens with evidence of these taphonomic signatures in the naked-eye observations.

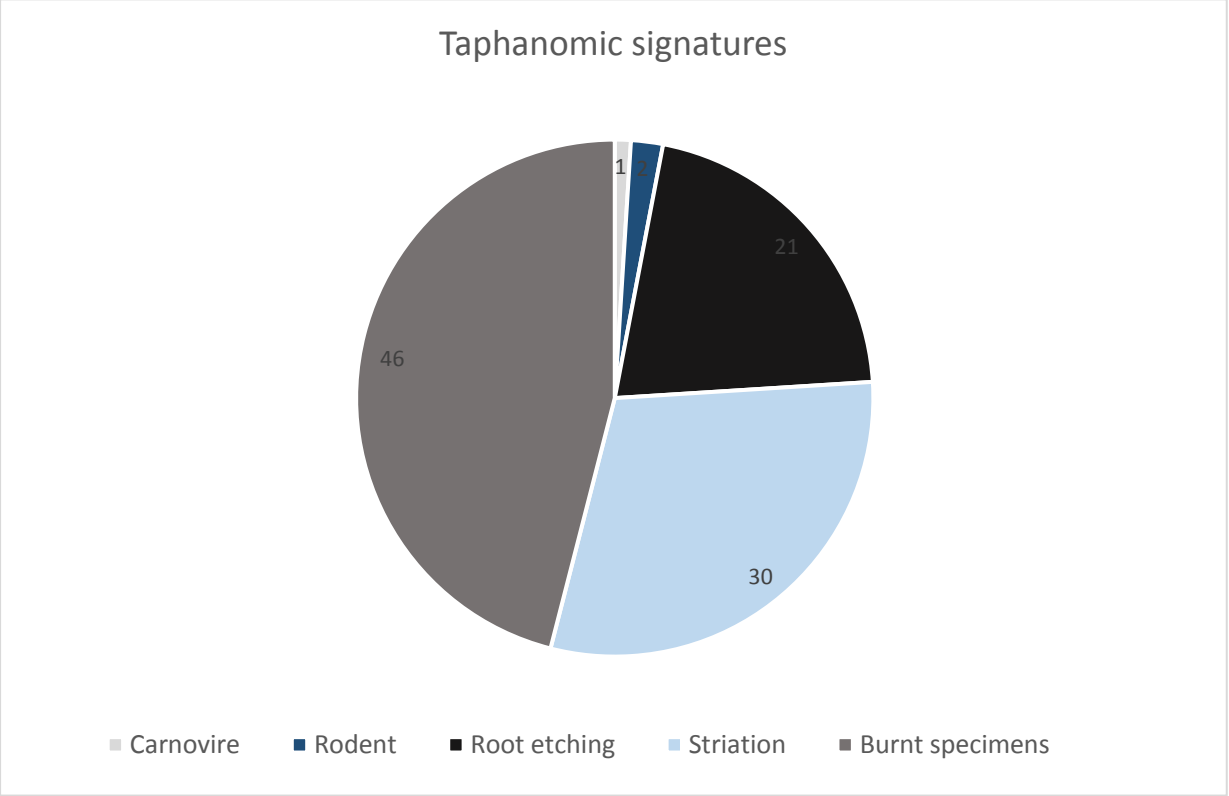


Figure 13. A pie chart of the taphonomic changes observed from a microscopic analysis of one hundred random identified specimens

4.4.6. Breakage Patterns

Amongst the long-bone specimens, the most prevalent fracture patterns are irregular fractures (n=131, 62%), the front-limb long bones are the only long bone specimens where irregular fractures represent less than fifty per cent of the fracture patterns (Table 14). In contrast, the hind limb long bones and distal long bones are dominated by irregular fractures (>50% of the specimens; Table 14). Spiral fractures (n=60, 29%) are moderately represented amongst the long bone specimens (Table 14). The ulnae and distal long bones are the only long bone specimens where the spiral fractures do not constitute at least thirty per cent of the fracture patterns (Table 14), suggesting these specimens had minimal rotational forces applied to them.

The femur and fibulae are the only long-bone specimens whereby over fifty per cent of the fractures are spiral fractures (Table 14) indicating extensive rotational forces applied to them. Transverse fractures (n=20, 9%) are less prevalent compared to irregular and spiral fractures, the radii and ulnae are the only long-bone specimens wherein transverse fractures are more prevalent than irregular and spiral fractures (Table 14). The other long-bone elements

have poor representation of transverse fractures, with the fibulae having no specimens with irregular fractures (Table 14).

Table 14. Distribution of long-bone fracture patterns amongst identified specimens from the DC faunal sample

Element	**Irregular**	**Spiral**	**Transverse**	***Total***	**Irregular (%)**	**Spiral (%)**	**Transverse (%)**
Humeri	8	8	3	*19*	43	43	14
Radii	1	3	3	*7*	15	38	46
Ulnae	3	1	4	*8*	38	13	50
Femora	7	9	1	*16*	44	53	3
Tibiae	20	12	2	*34*	60	36	4
Fibulae	1	1	0	*1*	50	50	0
Metapodia	37	12	5	*53*	70	22	8
Phalanges	55	16	4	*74*	74	22	5
Total	*131*	*60*	*20*	*211*	*62*	*29*	*9*

4.5. Faunal Specimen Measurements

4.5.1. Faunal Specimen Length

1 182 (92%) of all identified specimens are between 0-4cm in length (figure 14). The shortest specimens are between 0.1-1 cm (n=222, 17.2) and the longest specimen is 18.1-19 cm (n=1, 0.1). The majority of identified faunal specimens (n=1 182; 92%) from the DC faunal sample are between 0-4cm in length (Figure 14). Between 1.1-2 cm the faunal specimens are (n=561, 44%) are most prevalent (Figure 14).

The following specimen length ranges 2.1-3 cm (n=273, 21%), 0.1-1 cm (n=222, 17%), and 3.1-4 cm (n=126, 10%) encompasses the remaining majority of the identified specimens. Eighty-nine (6.9%) specimens are between 4.1- 8cm in length, and twenty (1.5%) specimens have a length 8.1-20cm (Figure 14). Consequently, only 109 (8%) of all identified specimens are between 4.1-19 cm in length (Figure 14).

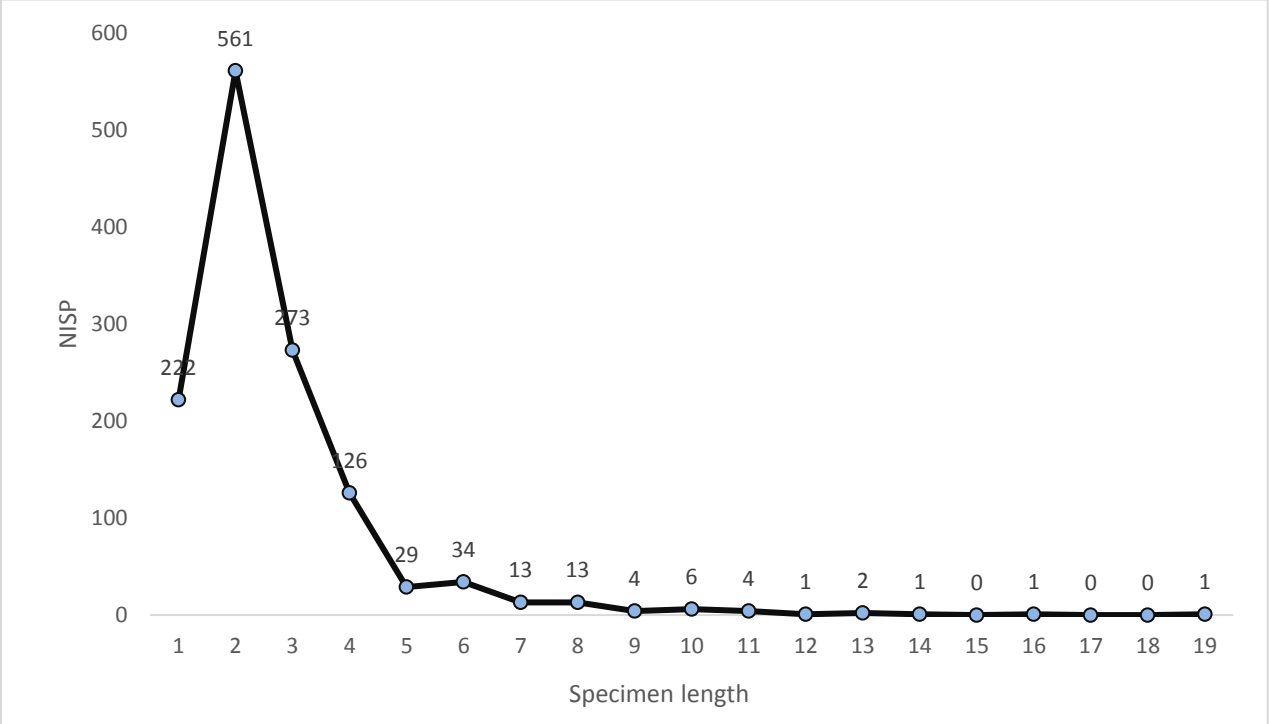


Figure 14. The bone length measured from the identified specimens

4.5.2. Cortical Thickness

The cortices of 449 identified specimens (Table 15) are measured. The DC faunal sample has a distinct absence of neonates and juveniles suggesting the majority of the cortical thickness measurements are from sub-adult and adult specimens. Small mammals generally have thinner cortical thickness measurements as compared to their larger mammalian

counterparts, for example, all rodent specimens are associated with cortical thickness code 1 (Table 15). Indeterminate Bov1 specimens, which are also small mammals, are represented by specimens that correspond with cortical thickness codes 1, 2 and 3 (Table 15).

Medium mammalian fauna has a diversity of cortical thickness measurements, for example, indeterminate Bov3 specimens correspond with cortical thickness codes between code 2 and code 7 (Table 15). Larger Mammalian fauna such as indeterminate Bov4 shows the greatest diversity of cortical thickness measurements between cortical thickness code 3 and code 9 (Table 15). All the Avian, amphibian and Reptilian specimens identified have thin cortices; the specimens from these faunal Classes all have a cortical thickness code of one (Table 15).

Table 15. Cortical thickness measurements of identified faunal specimens (*FE = Femur; HU = Humerus; MC = Metacarpal; MP = Metapodia; MT = Metatarsal; PH = Phalange; RA = Radius; TI = Tibia; UL = Ulna)

Driver Code	**NISP**	**Taxa**	**Element**
1	3	*Aonyx capensis*, Clawless otter	PH
	4	*Arctocephalus pusillus*, Cape fur seal	PH
	9	*Procavia capensis*, Rock hyrax	FE, HU, RA, UL
	22	Indeterminate small rodent	FE, TI, HU
	1	*Otomys irroratus*, Southern African vlei rat	FE
	1	Indeterminate Bov1	PH
	13	Indeterminate small mammal	PH
	4	Indeterminate small-medium mammal	PH
	5	Indeterminate medium mammal	PH
	1	Indeterminate medium-large mammal	PH
	4	*Phalacrocorax capensis*, Cape cormorant	HU, MT
	32	*Spheniscus demersus*, penguin	MT, UL, RA, MC, HU, TI
	39	Indeterminate small bird	MT, MC, RA, HU, FE, PH
	14	Indeterminate small-medium bird	PH, MT, FE
	37	Indeterminate medium bird	PH, FI, TI, MC, MT
	1	Indeterminate large bird	HU

	5	*Testudines*, Angulate tortoise	HU, PH
	4	Indeterminate small Reptile	HU, FE, TI
	2	Indeterminate small Amphibian	HU
2	22	*Arctocephalus pusillus*, Cape fur seal	PH
	3	*Papio ursinus*, Chacma baboon	MC, PH
	2	*Philantomba monticola,* Blue duiker	PH
	12	*Raphicerus sp.*, Indeterminate *Raphicerus*	PH
	1	*Redunca fulvorufula*, Mountain reedbuck	PH
	2	*Ourebia ourebi*, Oribi	PH
	3	*Alcelaphus buselaphus*, Hartebeest	PH
	6	Indeterminate Bov1	PH
	10	Indeterminate Bov2	PH
	4	Indeterminate Bov3	PH
	25	Indeterminate small mammal	HU, TI, FI, FE, RA, MP
	5	Indeterminate small-medium mammal	MC, FE, UL
	2	Indeterminate medium mammal	TI
3	4	*Arctocephalus pusillus*, Cape fur seal	PH, MC, PH
	1	*Philantomba monticola,* blue duiker	PH
	2	*Sylvicapra grimmia*, Common duiker	MC, RA
	5	*Raphicerus Sp.*, Indeterminate *Raphicerus*	MC, MT, TI, HU
	1	*Oreotragus oreotragus*, Klipspringer	HU
	19	*Raphicerus sp.*, Indeterminate Raphicerus	MC, RA, PH
	1	*Redunca fulvorufula*, Mountain reedbuck	PH
	1	*Ourebia ourebi*, Oribi	PH
	2	*Alcelaphus buselaphus*, Hartebeest	PH
	1	*Connochaetes taurinus*, Blue wildebeest	PH
	1	*Taurotragus oryx*, Common eland	PH
	20	Indeterminate Bov1	MC, MT, UL, TI
	6	Indeterminate Bov2	PH, UL
	2	Indeterminate Bov4	PH
	4	Indeterminate medium mammal	UL, FE
4	6	*Arctocephalus pusillus*, Cape fur seal	MC, MT
	2	*Syncerus caffer*, Cape buffalo	PH
	7	Indeterminate Bov2	FE, TI, MC, MT, UL
	3	Indeterminate Bov3	RA, MT

	2	Indeterminate Bov4	PH
	4	Indeterminate medium mammal	FE, TI
5	9	*Arctocephalus pusillus*, Cape fur seal	MC, TI, MT, UL, HU
	3	*Tragelaphine Sp.*, Bushbuck/kudu	UL, TI, MP
	4	Indeterminate Bov2	HU, TI, MP
	4	Indeterminate Bov3	MT, MC, UL
	7	Indeterminate medium mammal	MT, FE, MC, TI
	2	Indeterminate large mammal	TI
6	1	*Arctocephalus pusillus*, Cape fur seal	MT
	1	*Raphicerus Sp.*, Indeterminate *Raphicerus*	HU
	3	Indeterminate Bov2	MC, MT, FE
	10	Indeterminate Bov3	MC, MT, TI, FE, HU
7	2	*Tragelaphus scriptus*, Bushbuck	MP
	1	Indeterminate Bov3	TI
	3	Indeterminate Bov4	HU, TI
	3	Indeterminate large mammal	TI, MC
8	3	Indeterminate Bov4	TI, MP
9	1	*Syncerus antiquus*, Long-horn African buffalo	MP

4.5.3. Indeterminate *Raphicerus* Phalanges

Landmarks from eight indeterminate *Raphicerus sp*. phalanges (Table 16) are analysed and recorded. Two incomplete specimens namely Specimen 1 and Specimen 2 represent the first phalanges, and the only landmark measurable from these two specimens was BP.

Three specimens namely Specimen 3, Specimen 4, and Specimen 5 represent the second phalanges. Specimen 3 is the most incomplete of the second phalange specimens. The only landmark measurable from Specimen 3 is BP and identified the specimen as an adult Cape grysbok from the measurements (Table 16). Specimen 4 is the most complete of the second phalange specimens and measurements of four of the landmarks namely BP, BD, SD, and GL, identify the specimen as an adult Cape grysbok (Table 16). Measurements of BP and BD from Specimen 5, the measurements characterised the specimen as an adult Cape grysbok

(Table 16).

Three partially complete specimens namely Specimen 6, Specimen 7, and Specimen 8 represent the third phalanges. Measurements of five landmarks from the three specimens, namely HP, BFP, LD, DLS and MBS characterised Specimen 6 as an adult steenbok and Specimen 7 and Specimen 8 are both adult steenbok (Table 16).

Table 16. Morphometric measurements of Indeterminate *Raphicerus sp.* phalanges from the DC faunal sample

Element	**Specimens**	**Landmarks**	**Measured values**	**Average**	**SD**	**Variance**	**Max**	**Min**
First Phalange	Specimen 1	BP	9.2	9.175	0.05	0.0025	9.2	9.1
			9.2					
			9.2					
			9.1					
	Specimen 2	BP	8.15	8.1675	0.015	0.000225	8.18	8.15
			8.18					
			8.18					
			8.16					
Second Phalange	Specimen 3	BP	7.8	7.81	0.02708	0.000733	7.85	7.79
			7.85					
			7.79					
			7.8					
	Specimen 4	BP	6.9	6.905	0.020817	0.000433	6.93	6.88
			6.93					
			6.88					
			6.91					
		DP	5.2	5.21	0.018257	0.000333	5.23	5.19
			5.23					
			5.19					
			5.22					

		SD	5.1	5.075	0.050662	0.002567	5.11	5
			5					
			5.11					
			5.09					
		GL	17.65	17.6175	0.027538	0.000758	17.65	17.59
			17.59					
			17.6					
			17.63					
	Specimen 5	BP	6.69	6.7	0.008165	6.67E-05	6.71	6.69
			6.7					
			6.7					
			6.71					
		DP	5	4.9675	0.04717	0.002225	5	4.9
			5					
			4.9					
			4.97					
Third Phalange	Specimen 6	HP	10.5	10.4975	0.009574	9.17E-05	10.51	10.49
			10.49					
			10.49					
			10.51					
		LD	18.1	18.1375	0.047871	0.002292	18.2	18.1
			18.1					
			18.2					
			18.15					
		BFP	6.9	6.88	0.021602	0.000467	6.9	6.85
			6.85					
			6.88					
			6.89					

		DLS	20.2	20.1925	0.017078	0.000292	20.21	20.17
			20.17					
			20.21					
			20.19					
		MBS	4.2	4.22	0.021602	0.000467	4.25	4.2
			4.22					
			4.25					
			4.21					
	Specimen 7	HP	9.1	9.105	0.01291	0.000167	9.12	9.09
			9.11					
			9.09					
			9.12					
		LD	16.7	16.74	0.029439	0.000867	16.77	16.7
			16.77					
			16.74					
			16.75					
		BFP	6.1	6.0875	0.022174	0.000492	6.11	6.06
			6.08					
			6.11					
			6.06					
		DLS	20.2	20.215	0.01291	0.000167	20.23	20.2
			20.22					
			20.23					
			20.21					
		MBS	5.2	5.2125	0.015	0.000225	5.23	5.2
			5.23					
			5.22					
			5.2					
	Specimen 8	HP	10.1	10.0875	0.060759	0.003692	10.14	10

			10					
			10.11					
			10.14					
		LD	19.1	19.1325	0.027538	0.000758	19.16	19.1
			19.15					
			19.12					
			19.16					
		BFP	6.1	6.1375	0.029861	0.000892	6.17	6.1
			6.17					
			6.15					
			6.13					
		DLS	21.9	21.89	0.021602	0.000467	21.91	21.86
			21.89					
			21.91					
			21.86					
		MBS	4.5	4.545	0.042032	0.001767	4.59	4.5
			4.57					
			4.59					
			4.52					

4.6. Faunal Indices

4.6.1. Carnivore–Ungulate Index

There are only four DC sub-member layers with terrestrial carnivore remains and the carnivore–ungulate indices in each of these layers is calculated (Table 17). The carnivore–ungulate indices are moderately high in layers CP3 (i=25.0) and CP11 SM (i=50.0), the high carnivore–ungulate indices in layers CP3 and CP 11 SM may be a consequence of the sparse number of ungulate specimens in these two layers (Table 17). The carnivore–ungulate indices are low for CP8 AF (i=9.5) and YS6 (i=6.3; Table 17). These two layers have a higher

occurrence of ungulate specimens (n=45) which is more in line with other layers resulting in the lower carnivore–ungulate indices calculated (Table 17).

Table 17. Carnivore-ungulate ratios of faunal specimens from the DC sub-member layers

DC sub-member layers	**Carnivore NISP**	**Ungulate NISP**	**Carnivore-ungulate indices (i)**
CP3	1	4	25.0
CP8 AF	2	21	9.5
CP11 SM	2	4	50.0
YS6	1	16	6.3

4.6.2. Leopard Index

The leopard indices for layers CP5 and CP6 (Table 18) are calculated. The leopard indices values are low at layers CP5 (i=6.7) and CP6 (i=5.6; Table 18). The low leopard indices values are a consequence of the low leopard (n=1) and baboon (n=1) NISP values. The scarcity of leopard and baboon specimens suggest that leopards had minor impact on the accumulation of the faunal specimens in these two layers.

Table 18. Leopard index of faunal sample from layers CP5 and CP6 of the DC sub-member

Layers	**Leopard and baboon NISP**	**Ungulate NISP**	**Leopard indices (i)**

CP5	1	15	6.7
CP6	1	18	5.6

Chapter 5: Discussion

5.1. Site Occupation and Intensity of Faunal Deposition

The faunal deposition at KRM is sporadic, and it points to the accumulators of the DC faunal sample occupying the site repeatedly (Figure 15). Primarily during accumulation of the fifteen top-most layers, there was minimal occupation of the site. The DC sub-member was accumulated During MIS 5c approximately 99-91 ka (Brenner *et al*., 2020). During the early MIS 5c, there was rapid lowering of sea levels causing coastal retreat during the transition from MIS 5d to MIS 5c (Marean, 2010; Brenner *et al*., 2020).

The coast steadily retreated with the progression of MIS 5c getting further away from KRM (Marean, 2010; Brenner *et al*., 2020). There was likely less intense occupation of the site as the coast retreated leading to less intense faunal accumulation and this may be the cause of low faunal numbers in the layers towards the top of the sample. This is because the region could not support larger groups of people due to the coast and its resources being outside the sites foraging radius (Marean, 2010). However, this explanation does not give reasoning to the low fauna deposition between layers CP9 AF1-CP9 AF6 (Figure 15). This pulse of low faunal deposition sits between layers of relatively intense faunal deposition at the site (Figure 15).

This drop in faunal deposition may point to the primary accumulators of DC faunal sample visiting the site less frequently or to the accumulators of the sample occupying the site with less intensity for generations. This may have been due to reduced environmental productivity in the sites foraging radius or just shifting frequency in habitation site of the accumulators.

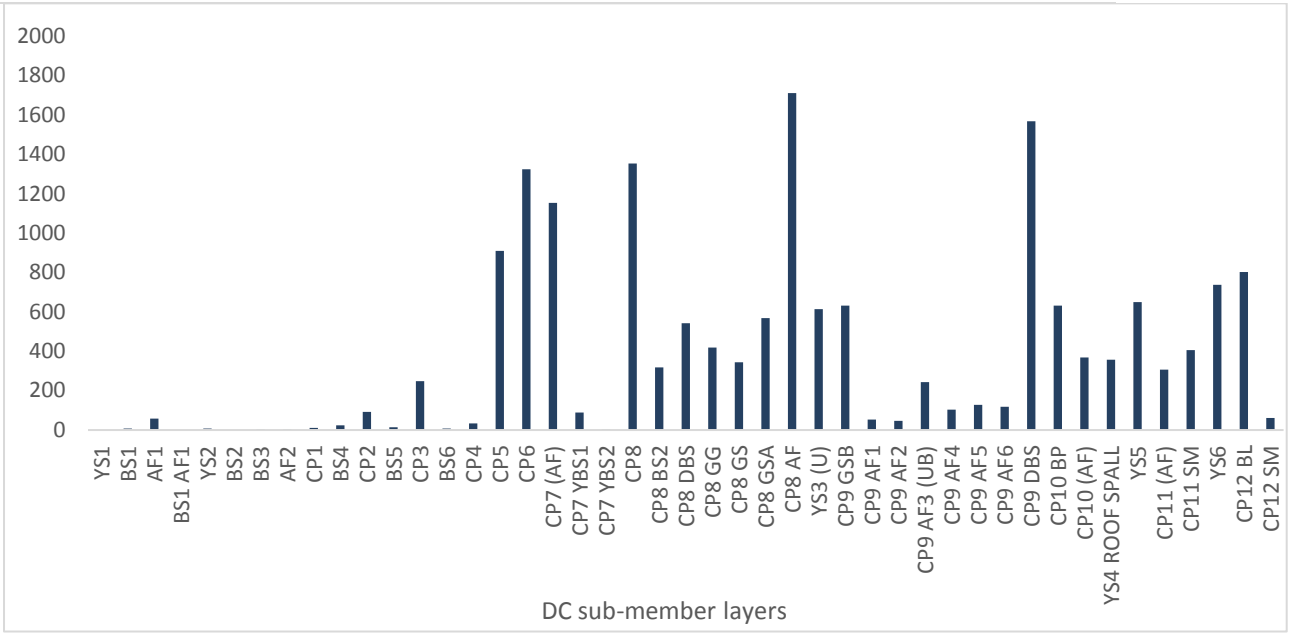


Figure 15. The distribution of faunal remains amongst the DC sub-member layers

5.2. Faunal Exploitation

The DC faunal sample produces a unique taxon accumulation curve (Figure 5). Zooarchaeological samples tend to have a few common taxa that were favoured targets of exploitation by the accumulators of the sample, whilst taxa that is less desirable occur in sparse numbers in these samples (Lepofsky and Lertzman, 2005).

The accumulation of the DC faunal sample is by multiple generations of various accumulators. During this time the KRM region underwent shifting faunal composition and shifting access to different taxa, which is responsible for the heterogeneity in the taxa identified in the sample (Avery, 1983, 1987; Deacon, 2001; Langejans *et al*., 2017; Van Wijk *et al.*, 2017; Nel *et al*., 2018; Reynard and Wurz, 2020).

Mammals are the dominant taxa identified in the DC faunal sample (Table 6). The majority of the long bone specimens from these taxa are completely fused (Figure 11 and 12). The prevalence of completely fused long bone specimens implies that the majority of the mammal samples are from adult specimens. This implies that exploitation of juveniles and neonates was less frequent than that of adult individuals by the accumulators of the DC faunal sample. There are no neonate and juvenile dental specimens identified amongst the lose teeth,

mandibulae and maxillary specimens.

The skeletal-part profiles of mammals and bovids from the DC faunal sample indicates very uniform exploitation of all skeletal-parts from all size classes except the largest mammals, birds and bovids (Figure 6, 7, 8, 9, 10). These mammals and bovid skeletal-part profiles are vastly different from those observed from the Singer and Wymer faunal sample assessed by Klein (1976). Klein (1976) found that the representation of smaller bovids was by relatively complete skeletal profiles whereas representation of the Bov3-5 is mainly by cranial and foot bones.

Klein (1976) hypothesised that this phenomenon was a result of selective transportation skeletal parts of different bovid classes (schlepp effect). The findings show that the representation of Bov1-4 is by relatively complete skeletal profile, but Bov5 has poor abundance leading to a sparse skeletal part profile (Figure 7, 8, 9). This implies that the Klasies Pattern observed from the Klein's (1978) KRM sample was likely a consequence of the sampling bias of the Singer and Wymer excavation team (Blumenschine, 1986; Bartram and Marean, 1999).

The bovid faunal remains from the DC sub-member further add more evidence against the existence of the Klasies Pattern (van Pletzen, 2000). van Pletzen (2000) analysed the mammalian skeletal part profiles of this analysis revealed that the skeletal part profiles of different sized bovids were more or less evenly distributed the same was seen by van Pletzen-Vos *et al.* (2019). This suggests that the Klasies Pattern is not present in the Deacon samples. Interestingly the skeletal-part profiles of avian fauna show the same pattern as in the mammals and bovids (Figure 10). This pattern of skeletal-part profiles suggest that the accumulators of the DC faunal sample exploited whole carcasses of all but the largest mammal, bovid and avian taxa (Figure 6, 7, 8, 9, 10). The KRM region hosted large mammal, bovid and avian taxa during MIS 5c (Klein, 1976; van Pletzen, 2000). The underrepresentation of the largest taxa suggests that there was minimal exploitation of large taxa throughout MIS 5c.

The skeletal-part profiles suggest that the accumulators of the DC faunal sample had access to whole carcass in order to produce the observed skeletal-part profiles. Dental remains

(Table 7 and 8), fusion patterns (Figure 11) and skeletal measurements (Table 15) show that the majority of these faunal specimens are sub-adult and adult individuals. This would imply that accumulators of the faunal sample might have targeted the individuals with the highest meat yield in the group to maximise their energy expenditure.

The DC faunal sample has a high prevalence of small-bodied bovids, hyrax, rodents, and small carnivores (Table 6). The prevalence of these type of fauna may point to extensive carnivore activity in the site, as faunal samples primarily accumulated by carnivores are likely to produce similar distribution of taxa (Brain, 1983; Skinner and Chimimba, 2005; Badenhorst *et al*, 2021). For AMH to acquire these fast-moving prey they likely needed considerable technological investment in snares, bow and arrow and nets (Lupo and Schmitt 2005; Wadley, 2010; Masele and Willoughby, 2021). Circumstantial evidence from different MSA studies suggest that AMH utilised traps and other remote capture techniques to acquire taxa that prefer forested environments and small elusive taxa (Lupo and Schmitt 2005; Wadley, 2010; Masele and Willoughby, 2021).

Artiodactyl specifically bovids are the dominant taxa in the sample (Table 6). Adult ungulates are the most prevalent mammalian fauna in the sample. *Raphicerus sp.* (Cape grysbok and steenbok) are the most prolific bovid taxa in the DC faunal sample (Table 6), they are timed small bovids that are quick to flee when startled. Analysis of indeterminate *Raphicerus sp* phalanges measurements that the specimens are all adult *Raphicerus sp* (Table 16).

Amongst the DC faunal sample, the only hype-aggressive bovid taxa are the Cape buffalo (n=2) and extinct long-horned African buffalo (n=1) which are both underrepresented (Table 6). Furthermore, the sample has no suids, though they are smaller, suids are aggressive and possess tusks that can cause deep wounds (Klein, 1976; van Pletzen, 2000). The prominence of small-bodied timed and docile bovid taxa (Table 6) suggests that the accumulators of the DC faunal sample primarily exploited small-bodied bovids that presented the least threat. Skeletal part frequencies (Figure 7, 8, 9, 10) and taphonomic analysis discussed below give further insight into the extent of exploitation of these bovids.

There is a relatively high prevalence of specimens from the order Carnivora (n=71). The majority of these are Cape fur seal (n=61; 86%) specimens (Table 6), Seals seem to be slow and clumsy on land (Orr, 2020) which makes them relatively easy targets for exploitation when they come to shore. However, there is no evidence that there was ever a seal rookery on land anywhere near KRM, so it is unlikely they were hunting the specimens. Instead, they likely washed-up from offshore islands rookery's (Marean and Binford, 1986).

All Cape fur seal specimens from the DC sample are either sub-adult or adult specimens, suggesting a bias for these individuals by the accumulators of the DC faunal sample. If the accumulation of seals was by opportunistic scavenging occasional during seasonally unfocused visits the representation of the seal specimens would of individuals of various age ranges (Marean and Binford, 1986). The prevalence of adult specimens without evidence of a nearby rookery implies scavenging of individuals that washed up from offshore rookeries.

Similarly, all African Penguins specimens from the DC sample are either sub-adult or adult specimens; also, penguins do not nest on shore. Despite this, they are the most prevalent avian taxa in the sample. Exploitation was likely by scavenging of individuals that washed up from offshore colonies. The exclusive sub adult and adult specimens implies strict exploitation of these individuals. Admittedly, the DC faunal sample is very small and the observed bias for sub-adult and adult specimens may just a perceived pattern of occurrence.

AMH likely supplemented hunting with scavenging. The vast majority of scavenging vertebrates are facultative/opportunistic scavengers (Selva and Fortuna, 2007). Facultative scavengers are organisms that supplement their primary food acquisition method (hunting/foraging/grazing/browsing) with scavenged food whenever possible (DeVault *et al*., 2003; Selva and Fortuna, 2007; Wilson and Wolkovich, 2011). AMH likely employed facultative scavenging to acquire these marine fauna, and this practice continued for thousands of years (Blumenschine, 1986; Kandel and Conard, 2003).

Hyrax tooth eruption sequences (Cruz-Uribe and Klein, 1998; Badenhorst *et al*., 2014) indicate that four out of the five hyrax mandibulae and maxilla specimens in the DC faunal sample are from sub-adult individuals between nineteen and twenty-four months old (Table 8).

The prominence of sub-adult hyrax specimens in a faunal sample suggests a late spring to late summer (November to March) deposition of specimens (Cruz-Uribe and Klein, 1998; Badenhorst *et al*., 2014). This suggest that the hyrax were being deposited there by an accumulator targeting sub-adults and this points to the hyrax sample not being a natural death sample.

Angulate tortoise (n=107, 8%) are the most prevalent species amongst the identified specimens (Table 6). This prevalence of angulate tortoise is likely due to them having stable population densities around KRM (Branch, 1984). The prevalence of tortoise in the DC faunal samples suggest that it was a preferred prey for the accumulators of the DC faunal sample. Mongoose and jackals hunt tortoise primarily in their natural habitats (Branch, 2012). However, indices indicate carnivores have minimal association with the DC faunal sample (Table 17 and 18), suggesting these tortoise specimens were primary accumulated by AMH.

Hyrax and tortoise are fall prey to leopards, hyenas, mongoose and jackals; however, indices (Table 17, 18) and faunal taphonomic markers (Table 12) show that these carnivores had minimal association with the fauna from the DC faunal sample, suggesting these tortoise specimens were primary accumulated by AMH. The prevalence of hyrax and tortoise in a faunal sample primarily accumulated by AMH hints to foraging/gathering behaviour (Dusseldorp and Langejans, 2015). However, the data implies the exploitation of hyrax and tortoise was highly sporadic.

5.3. Taphonomy

5.3.1. Burning

The DC faunal specimens show a deficit of specimens burnt grey (n=1274, 9%) and those burnt white (n=886, 6%). Specimens burnt grey and white present with the most heat damage and cortical deformation (Shipman *et al*., 1984; Stiner *et al*., 1995; Cain, 2005, 2006). The scarcity of faunal remains burnt grey and those burnt white suggest that fauna did not undergo prolonged exposure to high heat. Due to this, the current hypothesis is that the majority of the faunal remains in the DC sub-member underwent burning during cooking and after the

specimens were discarded within caves due to routine intermittent use of hearths during occupations.

If the remains were discarded directly within the hearth there would be a higher prevalence of specimens burnt grey and white (Cain, 2005, 2006; Pérez, *et al.*, 2017). The relative absence of these specimens suggest the majority of the faunal sample was never exposed to heat damage that was intense and prolonged enough to cause the majority of specimens to be burnt grey or white (Cain, 2005, 2006; Pérez, *et al.*, 2017). The few specimens burnt grey or white are the few bones AMH discarded directly into the hearth and the faunal remains directly below the hearth, these specimens are most likely to turn grey and subsequently white (Shipman *et al*., 1984; Stiner *et al*., 1995; Cain, 2005).

Intermittent use of a hearths can cause fire damage to faunal specimens buried at least 30 cm deep (Bennett, 1999; Pérez, *et al.*, 2017), however, the extent of the fire damage in the DC faunal sample is too widespread and intensive to be just a result of intermittent use of a hearths. The extensiveness of the heat damage (Cain, 2005, 2006; Pérez, *et al.*, 2017) on the DC faunal sample is evidence that AMH were burning the majority of the sample. The high degree of burning at KRM points to intensive AMH activity at the sight throughout.

5.3.2. Butchery

The DC faunal sample shows minimal evidence of butchery. The overall scarcity of cut and chop marks amongst the DC faunal sample would suggest that AMH had minimal access to the samples (Table 11; Steele and Klein, 2013). However, the microscopic analysis (Figure 13) found that thirty per cent of the faunal specimens showed evidence of striations. These striations were not as visible because burning and abrasion from sediments have deformed and weathered much of the surface cortical bone (Fernandez-Jalvo and Andrews, 2003, 2016), obscuring the visibility of these taphonomic markers. The low frequency of striations upon naked eye observation compared to microscopic analysis suggests there are extensive striations obscured from the naked eye by fire damage and other surface abrasions.

The lack of visibility of the striations may also be a consequence of the sharpness and

sturdiness of the lithic tool, the amount of flesh on the sample and the proficiency of the AMH individual that made the striation (Thompson, 2010). The frequency of AMH striations on skeletal elements is an efficient quantitative method of inferring if AMH were the main accumulators of the DC faunal sample (Blumenschine *et al*., 1996; Marean *et al*., 2000; Steele and Klein, 2013). The DC faunal sample has a scarcity of faunal remains bearing evidence of chop marks, chop marks are large lacerations to bone associated with hunting and bone breakage for marrow extraction (Noe-Nygaard, 1989; Marean, 1991).

The microscopic analysis did not highlight any missed chop marks; it merely highlighted the prevalence of striations, which may be due to a host of post-depositional processes acting on the faunal remains. Since the naked eye, observation clearly underrepresents the extent of cuts on the skeletal elements, the microscopic results are from the limited sample, any inferences about the extent of the perceived trapping, and butchery that was occurring in the DC faunal sample is limited. A microscopic analysis of the entire DC faunal sample would show much more evidence of butchery, fragmentation and abrasion then the naked eye observation and allow a clear description of the intensity of faunal processing.

5.3.3. Human and Faunal Taphonomy

The microscopic analysis and naked-eye analysis indicate evidence of minimal faunal taphonomy (Figure 13; Table 11). The distribution of faunal taphonomic signatures is highly sporadic between the DC sub-member layers (Table 11). Similarly, carnivore–ungulate indices (Table 17) and leopard indices (Table 18) show carnivores have minimal association with the DC faunal sample. The lack of evidence for faunal taphonomy at the site implies minimal primary and secondary access to faunal remains deposited in the DC sub-member.

Human taphonomic signatures are far more prevalent in the DC faunal sample (table 10, 11). Cut marks, chop marks and burning imply that AMH where the most prolific taphonomic agents of the DC faunal sample (Cain, 2005, 2006; Steele and Klein, 2013; Pérez, *et al.*, 2017). This implies to AMH being the main accumulators of the majority of the taxa in the DC faunal sample. The skeletal-part profiles indicate that AMH had primary access to

whole carcass of the fauna they exploited which is most probable through either hunting or trapping or scavenging.

This lack of faunal taphonomic markers is admittedly odd considering a leopard skeleton was excavated (van Pletzen, 2000) from KRM indicating that the site supports these other taxa. In addition, the prevalence of avian predators roosting at the side should predispose the site to higher incidences of faunal taphonomy. This information points to the AMH at KRM being accomplished hunter-gatherers. The individuals had a wide dietary breadth, as seen by the faunal diversity in the faunal sample and caused variable damage to faunal remains.

5.3.4. Breakage Patterns

The long bone specimens (n=211) from the DC faunal sample are dominated by irregular breakage patterns (Table 4). The dominance of irregular fractures in the sample points to excessive secondary breakage, because irregular fractures occur during the dry phase of a skeletal elements taphonomic history (Johnson, 1985). This suggest that the majority of the faunal specimens in the DC faunal sample were broken post deposition. This implies that most of the fragmentation observed in the sight is due abiotic post-depositional factors. This implies minimal interaction of the faunal specimens with fauna and flora post deposition

Spiral fractures occur very rarely under natural conditions (Miller, 1975), these type of fractures are mostly associated with anthropogenic activity, trampling, and hyena activity (Miller, 1975; Lyman and Lyman, 1994; Drivers, 1999). The prominence of spiral fractures suggest that a considerable portion of the long bone specimens were broken not long after the individual died (Haynes, 1980; Lyman and Lyman, 1994; Driver, 1999). AMH and hyenas usually exert rotational forces to skeletal elements to access the nutrient rich marrow within; these rotational forces produce spiral fractures that other fauna cannot readily replicate (Haynes, 1980; Lyman and Lyman, 1994; Driver, 1999). Trampling is not very likely to have been a cause of the spiral fracture due to the location of the DC sub-member in an elevated cave.

The ulna, metapodia and phalanges display the least spiral fractures (Table 4), these

faunal samples are marrow poor compared to the other long bone specimens (Blumenschine and Madrigal, 1993). The femora, tibia and humeri exhibit extensive spiral damage moreover, they are marrow rich (Table 4). The prominence of spiral fractures on marrow rich long bones suggest that there was targeting of specific elements for breakage (Blumenschine and Madrigal, 1993). Marrow rich faunal remains indicate greater spiral fractures due to marrow extraction behaviour. Most organisms that break bone for marrow are scavengers and this may imply that there was extensive scavenging at the site.

Transverse fractures are the least prominent breakage pattern observed from the DC faunal sample. Transverse fractures occur on bone when carnivores chew and break bone or when dry bone experiences transverse loading (Johnson, 1985; Gifford- Gonzalez, 1989; Lyman and Lyman, 1994; Driver, 1999). The DC faunal sample displays minimal evidence of carnivore activity. This suggest that the majority of the transverse fractures are caused by secondary breakage, if carnivore activity was responsible for such extensive transverse fractures, logically the prominence of carnivore gnaw marks would be higher in the sequence (Johnson, 1985; Gifford-Gonzalez, 1989; Lyman and Lyman, 1994).

Overall, the DC faunal sample displays extensive breakage (Figure 13) caused by the compaction of the DC sub-member as evidenced by the prominence of irregular and transverse breakages. However, prevalence of spiral fractures may point to AMH and other carnivores being significant contributors to the fragmentation of the sample. However, data from these analyses points to minimal non-human faunal activity at KRM.

The fragmentation of the DC faunal sample minimises the accuracy of the NISP, fractures damage a specimen's diagnostic features, which prevents identification in many instances (Marshall and Pilgram, 1993). Due to this, the assumption is that NISP from the DC faunal sample significantly underestimates the identifiable fauna in the sample. Smaller taxa namely rodents, amphibians and reptiles are most likely to suffer from this underrepresentation as they have thin cortices (Table 14) which makes them susceptible to fracturing in such compacted sediments

5.3.5. Weathering, Root Etching and Staining

Weathering and root etching are not prevalent amongst the faunal specimens from the DC sub-member layers (Table 13). A low prevalence of weathering and root etching in a faunal sample suggest minimal post depositional process occurred and limited vegetation activity at the site (Bar-Oz and Munro, 2004). The low incidence of weathering and root etching on suggests the DC faunal sample underwent relatively minimal changes when the site was unoccupied (Bar-Oz and Munro, 2004). The microscopic analysis (Figure 13) shows that root etching is present on some specimens, but it is not extensive.

Staining is by far the most prevalent natural modification that occurred amongst the specimens (Table 13). However, specimens that have undergone colour change from burning may exhibit staining. Distinguishing staining from a burnt specimen is difficult. This suggest that incidences of staining amongst the DC faunal sample may be higher than recorded but the microscopic analysis (Figure 13) did not identify any stained specimens suggesting staining was not underrepresented by the naked eye observation.

The prevalence of weathering, root etching and staining in the DC sub member layers has strong correlation to the faunal distribution (Table 5) in each layer. This means that these natural modifications were most prevalent when AMH faunal deposition was highest. However, the low prevalence of these modifications amongst the sample suggest that these modifications never act on the sample for long. During periods of intense occupation AMH would stay at the site intermittently, the periods when they abandoned the site allowed these natural modifications to take hold. However, AMH were not abandoning the site long enough for natural modifications to affect the majority of the sample.

The reason for the low prevalence of these natural modifications amongst the DC sub-member layers with low faunal sample is unclear. These samples with low faunal specimens were likely periods of AMH occupational intensity, which would have allowed these natural modifications to affect a larger portion of the sample. However, this is not the case in the KRM sample, which suggest that these natural modifications were not major factors in the taphonomic

history of the site. However, the faunal specimen length (Figure 14) indicates fragmentation of the majority of the DC faunal sample, which make it hard to discern these taphonomic markers. The burning and cortical surface abrasions also obscure the visibility of these taphonomic markers

The microscopic analysis indicates that that weathering may be far more prevalent in the DC faunal sample then in the naked-eye observation. This is mainly due to burning, fragmentation and surface abrasions hampering analysis of these markers. A microscopic analysis of the entire DC faunal sample would likely find that the sample has a larger incidence of weathering and other taphonomic markers.

Chapter 6: Conclusions

6.1. Research Conclusions

This research was undertaken to test four hypothesis related to subsistence behaviours, occupational activity of AMH, and taphonomic indicators at KRM. The hypotheses are discussed below:

AMH were the primary accumulators of the DC faunal sample:

The DC faunal sample is a diverse collection of extant and extinct taxa known to the area (Table 6). The majority of the faunal sample is burnt (Table 10), burning is a taphonomic change associated with archaeological samples accumulated by AMH if there was extensive hearth use in a sample (Cain, 2006). KRM has a rich deposit of hearths, which may suggest repeated occupations of the site by AMH (Cain, 2006; Pérez, *et al.*, 2017). Burnt specimens are prevalent amongst the majority of the DC sub-member layers, this implies extensive human activity amongst the DC faunal sample. Furthermore, the faunal sample has a high incidence of cut marks and chop marks (Table 11) compared to carnivore and rodent gnaw marks (Table 12) suggesting AMH had greater access to these specimens then non-human taxa (Cruz-Uribe and Klein, 1994).

The DC faunal sample also has a moderate prevalence of spiral fractures (Table 14) which are associated with human and carnivore brakages. Carnivore-ungulate indices (Table 17) and leopard indices (Table 18) indicate that carnivores had minimal access to the DC faunal sample. This may suggest AMH caused the spiral fractures, in attempts to reach the nutrient rich marrow within (Haynes, 1980; Bunn, 1986). All this evidence points to AMH being the primary accumulators of the DC faunal sample, the faunal and taphonomic analysis affirm the hypothesis that the accumulation of faunal samples in the DC layers was primarily by AMH at different intensities throughout MIS 5c.

The Klasies Pattern is not visible in the faunal specimens from the DC faunal sample:

Bovids are the most abundant faunal specimens in the sample. Small-bodied bovids

(duiker, and grysbok) are more prevalent then large bodied bovids (long-horned African buffalo, African buffalo). The skeletal-part profiles of bovid fauna from the DC faunal sample indicate uniform exploitation of all skeletal-parts from all size classes except the largest bovids (i.e. long-horned African buffalo; Figure 7, 8, 9).

The indeterminate mammal and avian skeletal part profiles resemble those of the bovids (Figure 6, 10). The prevalence of complete skeletal part profiles among the smaller fauna is a consequence of the higher number of samples. Overall, the size classes with adequate faunal specimens affirm the hypothesis that the Klasies Pattern is not visible amongst the faunal specimens from the DC faunal sample. The differences observed in Skeletal- part representation of the largest mammal, bovid and avian size classes are likely a consequence of a lack of prevalence of these large taxa in the KRM region.

AMH that accumulated the DC faunal sample were accomplished hunter-gatherers:

AMH accumulated a diverse faunal sample, which suggest they had a wide dietary breadth. There are sixteen bovid taxa ranging from Bov1 (Steenbok) to Bov5 (longhorn buffalo; Table 6). Dental specimens (Table 7, 8), fusion patterns (Figure 12; Table 8), and osteometric measurements (Table 16) indicate that the majority of the specimens are adult or sub adult specimens. This implies that AMH selected for individuals closest to adult prime, this individuals are often the hardest to capture.

Angulate tortoise and rock hyrax are prevalent in the DC faunal sample; these taxa commonly accumulated via foraging and trapping activity by AMH (Dusseldorp, and Langejans, 2015). Foraging and trapping activity requires a familiarity with the environment and prey activity patterns, because AMH foragers search their foraging radius until they encounter prey to pursue and kill it (Dusseldorp, and Langejans, 2015). These small fauna pose less risk to accumulators, which likely made them a target.

There is a high prevalence of marine fauna (i.e., seals and penguins) in the DC fauna sample. AMH opportunistically scavenged seals and penguins when these specimens washed up on shore. The seal and penguin specimens are represents by adult and sub-adult specimens. Adult specimens are provide higher meat and fat yields making it more energetically efficient

to hunt them (Klein and Cruz-Uribe 1996; 2000). Seal wash-up are seasonally punctuated and the select grouping of adults suggest that the accumulators occupied the site when these wash up of adults where most prolific (Marean and Binford., 1986).

The skeletal-part profiles indicate that the faunal samples have good representation of all the skeletal parts and taphonomic data indicates that human taphonomic markers are the most prevalent markers in the sample. To exploit this diversity of fauna AMH must have utilized complex subsistence strategies to yield a them the necessary daily caloric requirements and diverse taxa for exploitation (Dusseldorp, 2012. Dusseldorp, and Langejans, 2015, Wadley; 2010, 2015). This implies that the AMH that accumulated the faunal sample were successful hunter-gatherers

Human taphonomic markers will be more prevalent than non-human taphonomic markers in the DC faunal sample:

As previously stated the majority of the DC faunal sample is burnt from human activity (Table 10), burning is the most prevalent taphonomic signature identified in the DC faunal sample. Cut marks and chop marks associated with AMH butchery are far more prevalent than carnivore gnaw marks and rodent gnaw marks amongst the DC sub-member layers (Table 17, 18) suggesting that AMH butchery was far more extensive than faunal gnawing in the sample (Steele and Klein, 2013). A small portion of the DC faunal sample exhibits weathering and root etching (Table 13) suggesting that the samples hardly underwent these taphonomic changes. All this affirms the hypothesis that AMH taphonomic markers are more prevalent than non-human taphonomic markers in the DC faunal sample.

6.2. Research Challenges

This study's limitations are due to a lack of research time, the facility lockdowns due to the Covid-19 pandemic made for sporadic accesses to the faunal samples and laboratory tools to perform required analyses of the study. Due of this there was minimal time to perform a microscopic analysis on the faunal remains. Another major issue was the fragmentation of the DC faunal sample. The fragmentation of the DC faunal sample is extensive, and this may

lead to underrepresentation of identified faunal specimens. Finally due to time constraints the study did not adopt a critical approach to the metrics and observations used as support for the stated hypotheses.

6.3. Future Studies

The restricted microscopic analysis performed on the DC faunal sample suggests that there is extensive taphonomic markers not visible to the naked eye, as such future studies of the DC faunal sample should include microscopic analysis of identified and unidentified specimens. This would give a more comprehensive understanding of the taphonomic history of the DC sub-member. Knowing the extent of anthropogenic and non-anthropogenic taphonomic changes allows for precise inferences about the subsistence behaviours, occupational activity, and behavioural complexity of AMH at KRM during the MSA.

Future studies should also aim to give age ranges to the forty-five layers of the DC sub-member; it is unclear how old each DC sub-member layer isbecause there are no definitions of the age-ranges of each layer. The lack of clarity on the age-ranges of the layers makes assessing occupational intensity at each layer difficult. Assessing the dates when each layer accumulated will allow the faunal remains from each layer to be used act asa proxy for inferring local climate conditions and vegetation cover along the Tsitsikamma coastal platform during MIS 5c. The ages of the layers and the faunal samples from each layerwill provide further insight into the intensity of occupation at various stages of MIS 5c.

The Deacon excavations excavated three squares from Cave 1B namely PP38, QQ38, RR38. Each of these grids holds faunal samples associated with the DC sub-member and subsequently MIS 5c. As such, this research of the PP38 faunal samples is not a comprehensive analysis of the subsistence behaviours, occupational activity, and behavioural complexity of AMH at Cave 1B of KRM during MIS 5c. It is imperative that there be faunal analyses and taphonomicanalyses of the faunal samples from the QQ38 and PP38 grids to determine if the patterns observed in the PP38 sample are in line with observations in these other Cave1B grids.

References

Avery, D.M., 1983. Palaeoenvironmental implications of the small Quaternary mammalsof the fynbos region. *Fynbos palaeoecology: a preliminary synthesis, South African National Scientific Progress Report*, (75), pp.139-155.

Avery, D.M., 1987. Late Pleistocene coastal environment of the Southern Cape province of provinceof South Africa: Micromammals from Klasies River Mouth. *Journal of Archaeological Science*, *14*(4), pp.405-421.

Avery, D.M., 1995. Physical environment and site choice in South Africa. *Journal of Archaeological Science*, *22*(3), pp.343-353.

Badenhorst, S and Plug, I., 2011. Unidentified specimens in zooarchaeology. *Palaeontologica Africana*, *46*, pp.89-92.

Badenhorst, S., Ezeimo, J., van Niekerk, K.L. and Henshilwood, C.S., 2021. Differentialaccumulation of large mammal remains by carnivores and humans during the Middle Stone Age in the Eastern and Western Cape, South Africa. *Journal of Archaeological Science: Reports*, *35*, p.102752.

Badenhorst, S., Mthombothi, N., Niekerk, K.L.V. and Henshilwood, C.S., 2022. An initial assessment of zooarchaeological assemblage sizes from South Africa. *Revue de Paléobiologie, Genève (janvier 2022) 41* (1), pp.1-10

Badenhorst, S., van Niekerk, K.L. and Henshilwood, C.S., 2014. Rock Hyraxes (Procaviacapensis) from Middle Stone Age Levels at Blombos Cave, South Africa. *African Archaeological Review*, *31*(1), pp.25-43.

Bar-Oz, G. and Munro, N.D., 2004. Beyond cautionary tales: a multivariate taphonomic approach for resolving equifinality in zooarchaeological studies. *Journal of Taphonomy*, *2*(4), pp.201-220.

Bartram Jr, L.E. and Marean, C.W., 1999. Explaining the “Klasies Pattern”: Kua

ethnoarchaeology, the Die Kelders Middle Stone Age archaeofauna, long bone fragmentation and carnivore ravaging. *Journal of Archaeological Science, 26*(1), pp.9-29.

Binford, L.R., 1984. *Faunal remains from Klasies River mouth*. Academic Press.

Binford, L.R., 1985. Human ancestors: changing views of their behavior. *Journal of Anthropological Archaeology, 4*(4), pp.292-327.

Blumenschine, R.J., 1986. Carcass consumption sequences and the archaeological distinction of scavenging and hunting. *Journal of Human Evolution, 15*(8), pp.639-659.

Blumenschine, R.J., 1988. An experimental model of the timing of hominid and carnivoreinfluence on archaeological bone assemblages. *Journal of Archaeological Science, 15*(5),pp.483-502.

Blumenschine, R.J., and Madrigal, T.C., 1993. Variability in long bone marrow yields ofEast African ungulates and its zooarchaeological implications. *Journal of ArchaeologicalScience, 20*(5), pp.555-587.

Blumenschine, R.J., Marean, C.W. and Capaldo, S.D., 1996. Blind tests of inter-analyst correspondence and accuracy in the identification of cut marks, percussion marks, and carnivore tooth marks on bone surfaces. *Journal of archaeological science, 23*(4), pp.493-507.

Boessneck, J. and von Den Driesch, A., 1978. Preliminary analysis of the animal bones from Tell Hesban. *Andrews University Seminary Studies, 16*(1), pp.259-87.

Brain, C.K., 1974. Some suggested procedures in the analysis of bone accumulations fromSouthern African Quaternary sites. *Annals of the Transvaal Museum, 29*(1), pp.1-8.

Brain, C.K., 1983. *The hunters or the hunted?: an introduction to African cave taphonomy*. University of Chicago Press, Chicago.

Branch, B., 2012. *Tortoises, terrapins & turtles of Africa*. Penguin Random House South Africa.

Branch, W.R., 1984. Preliminary observations on the ecology of the angulate tortoise (Chersina angulata) in the Eastern Cape Province, South Africa. *Amphibia-reptilia*, *5*(1), pp.43-55.

Braun, K., Bar-Matthews, M., Matthews, A., Ayalon, A., Zilberman, T., Cowling, R.M.,Fisher, E.C., Herries, A.I., Brink, J.S. and Marean, C.W., 2020. Comparison of climate and environment on the edge of the Palaeo-Agulhas Plain to the Little Karoo (South Africa) in Marine Isotope Stages 5–3 as indicated by speleothems. *Quaternary Science Reviews*, *235*, p.105803.

Brenner, M.J. and Wurz, S., 2019. A high-resolution perspective on MIS 5c-d lithic assemblages from Klasies River main site Cave 1. *Journal of Archaeological Science: Reports*, *26*, p.101891.

Brenner, M.J., Ryano, K.P. and Wurz, S., 2020. Coastal adaptation at Klasies River mainsite during MIS 5c-d (93,000–110,000 years ago) from a southern Cape perspective. *TheJournal of Island and Coastal Archaeology*, pp.1-28.

Bunn, H.T. and Ezzo, J.A., 1993. Hunting and scavenging by Plio-Pleistocene hominids:nutritional constraints, archaeological patterns, and behavioural implications. *Journal of Archaeological Science*, *20*(4), pp.365-398.Bunn, H. T., and Kroll, E. M. 1986 Systematic Butchery by Plio-Pleistocene Hominids at Olduvai Gorge, Tanzania. *Current Anthropology* 27: 431–452

Bunn, H.T., 1986. Patterns of skeletal representation and hominid subsistence activities at Olduvai Gorge, Tanzania, and Koobi Fora, Kenya. *Journal of Human Evolution*, *15*(8), pp.673-690.

Burns, J.A. and Raber, P.A., 2010. Rockshelters in Behavioral Context: Archaeological Perspectives from Eastern North America. *North American Archaeologist*, *31*(3), pp.257-285.

Butzer, K.W., 1978. Sediment stratigraphy of the Middle Stone Age sequence at Klasies River mouth, tsitsikama coast, South Africa. *The South African Archaeological Bulletin*,*33*(128), pp.141-151.

Cain, C.R., 2005. Using burned animal bone to look at Middle Stone Age occupation andbehavior. *Journal of Archaeological Science*, *32*(6), pp.873-884.

Cain, C.R., 2006. Human activity suggested by the taphonomy of 60 ka and 50 ka faunal remains from Sibudu Cave. *Southern African Humanities*, *18*(1), pp.241-260.

Clark, J.L. and Kandel, A.W., 2013. The evolutionary implications of variation in humanhunting strategies and diet breadth during the Middle Stone Age of southern Africa. *Current Anthropology*, *54*(S8), pp.S269-S287.

Colwell, R.K. and Coddington, J.A., 1994. Estimating terrestrial biodiversity through extrapolation. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *345*(1311), pp.101-118.

Cruz-Uribe, K. and Klein, R.G., 1994. Chew marks and cut marks on animal bones from the Kasteelberg B and Dune Field Midden later Stone Age sites, western Cape Province, South Africa. *Journal of Archaeological Science*, *21*(1), pp.35-49.

Cruz-Uribe, K. and Klein, R.G., 1998. Hyrax and hare bones from modern South African eagle roosts and the detection of eagle involvement in fossil bone assemblages. *Journal of Archaeological Science*, *25*(2), pp.135-147.

Davis, S.J., 1987. *The archaeology of animals*. Psychology Press.

Deacon, H.J. and Wurz, S., 2005. A Late Pleistocene archive of life at the coast, Klasies River. *African Archaeology. Blackwell Publishing, Oxford*, pp.130-149.

De Vynck, J.C., Cowling, R.M., Potts, A.J. and Marean, C.W., 2016. Seasonal availabilityof edible underground and aboveground carbohydrate resources to human foragers on theCape south coast, South Africa. *PeerJ*, *4*, p.e1679.

Deacon, H.J. and Geleijnse, V.B., 1988. The stratigraphy and sedimentology of the mainsite sequence, Klasies River, South Africa. *The South African Archaeological*

Bulletin, pp.5-14.

Deacon, H.J., 1995. Two late Pleistocene-Holocene archaeological depositories from thesouthern Cape, South Africa. *The South African Archaeological Bulletin*, pp.121-131.

Deacon, H.J., 2001. Guide to Klasies River 2001. *Unpublished Manuscript. Retrieved from: http://www. sun. ac. za/internet/academic/arts/archaeology/KRguide2001*.

Deacon, H.J., 2008. The context of the 1967-8 sample of human remains from Cave 1 Klasies River Main Site. *Goodwin Series*, pp.143-149.

DeVault, T.L., Rhodes, Jr, O.E. and Shivik, J.A., 2003. Scavenging by vertebrates: behavioral, ecological, and evolutionary perspectives on an important energy transfer pathway in terrestrial ecosystems. *Oikos*, *102*(2), pp.225-234.

Development of Middle Stone Age innovation linked to rapid climate change. *Naturecommunications*, *4*(1), pp.1-9.

Dietl, H., Kandel, A.W. and Conard, N.J., 2005. Middle Stone Age settlement and land use at the open-air sites of Geelbek and Anyskop, South Africa. *Journal of African Archaeology*, *3*(2), pp.231-242.

Driver, J.C., 1999. *Crow Canyon Archaeological Center Manual for Description of Vertebrate Remains*. Crow Canyon Archaeological Center, Cortez.

Driver, J.C., 2005. *Manual for description of vertebrate remains*. Unpublished manual. Crow Canyon Archaeological Center, Cortez.

Driver, J.C., Bovy, K., Butler, V.L., Lupo, K.D., Lyman, R.L. and Otaola, C., 2011. Identification, classification and zooarchaeology. *Ethnobiology letters*, *2*, pp.19-39.

Dupont, L.M., Zhao, X., Charles, C., Faith, J.T. and Braun, D., 2021. Continuous vegetation record of the Greater Cape Floristic Region (South Africa) covering the past 300 thousand years (IODP U1479). *Climate of the Past Discussions*, *2021*, pp.1-32.

Dusseldorp, G.L. and Langejans, G.H., 2015. 'Trapping the past'? Hunting for

remote capture techniques and planned coastal exploitation during MIS 5 at Blombos Cave and Klasies River, South Africa. *Analecta Praehistorica Leidensia*, *45*, pp.15-27.

Dusseldorp, G.L., 2010. Prey choice during the South African Middle Stone Age: avoiding dangerous prey or maximising returns?. *African Archaeological Review*, *27*(2), pp.107-133.

Dusseldorp, G.L., 2012. Studying prehistoric hunting proficiency: applying optimalforaging theory to the Middle Palaeolithic and Middle Stone Age. *Quaternary International*, *252*, pp.3-15.

Dusseldorp, G.L., 2012. Tracking the influence of technological change on Middle StoneAge hunting strategies in South Africa. *Quaternary International*, *270*, pp.70-79.

Faith, J.T., 2008. Eland, buffalo, and wild pigs: were Middle Stone Age human's ineffective hunters?. *Journal of Human Evolution, 55*(1), pp.24-36.

Fernández-Jalvo, Y. and Andrews, P., 2003. Experimental effects of water abrasion on bone fragments. *Journal of taphonomy*, *1*(3), pp.147-163.

Fernandez-Jalvo, Y. and Andrews, P., 2016. *Atlas of taphonomic identifications: 1001+ images of fossil and recent mammal bone modification*. Springer.

Findlay, K.P., 1989. *The distribution of cetaceans off the coast of South Africa and Southwest Africa/Namibia* (Doctoral dissertation, University of Pretoria).

Fisher, E.C., Albert, R.M., Botha, G., Cawthra, H.C., Esteban, I., Harris, J., Jacobs, Z., Jerardino, A., Marean, C.W., Neumann, F.H. and Pargeter, J., 2013. Archaeological reconnaissance for Mmiddle stone ageStone Age sites along the Pondoland Coast, SouthAfrica. *PaleoAnthropology*, *2013*, pp.104-137.

Frayer, D.W. and Wolpoff, M.H., 1985. Sexual dimorphism. *Annual Review of Anthropology*, *14*(1), pp.429-473.

Gifford-Gonzalez, D., 1989. Ethnographic analogues for interpreting modified bones: some cases from East Africa. *Bone modification*, pp.179-246.

Goodwin, A.J.H., 1928. An introduction to the Middle Stone Age of South Africa.

SouthAfrican Journal of Science, 25, pp.410-418.

Grayson, D.K. and Frey, C.J., 2004. Measuring skeletal part representation in archaeological faunas. *Journal of Taphonomy*, *2*(1), pp.27-42.

Grine, F.E., Pearson, O.M., Klein, R.G. and Rightmire, G.P., 1998. Additional human fossils from Klasies River Mouth, South Africa. *Journal of Human Evolution*, *35*(1), pp.95-107.

Grine, F.E., Wurz, S. and Marean, C.W., 2017. The middle stone age human fossil recordfrom Klasies River main site. *Journal of human evolution*, 103, pp.53-78.

H.

Haynes, G., 1980. Evidence of carnivore gnawing on Pleistocene and Recent mammalian bones. *Paleobiology*, *6*(3), pp.341-351.

Henshilwood, C.S. and Marean, C.W., 2003. The origin of modern human behavior: critique of the models and their test implications. *Current anthropology*, *44*(5), pp.627- 651.

Henshilwood, C.S., d'Errico, F., Marean, C.W., Milo, R.G. and Yates, R., 2001. An earlybone tool industry from the Middle Stone Age at Blombos Cave, South Africa: implications for the origins of modern human behaviour, symbolism, and language. *Journal of human evolution*, *41*(6), pp.631-678.

Hine, P.J., 2008. *Stone-walled tidal fish traps: an archaeological and archival investigation* (Master's thesis, University of Cape Town).

Hublin, J.J., Ben-Ncer, A., Bailey, S.E., Freidline, S.E., Neubauer, S., Skinner, M.M., Bergmann, I., Le Cabec, A., Benazzi, S., Harvati, K. and Gunz, P., 2017. New fossils from Jebel Irhoud, Morocco, and the pan-African origin of Homo sapiens. *Nature*, 546(7657), pp.289-292.

Hutchings, L., Van der Lingen, C.D., Shannon, L.J., Crawford, R.J.M., Verheye, H.M.S.,Bartholomae, C.H., Van der Plas, A.K., Louw, D., Kreiner, A., Ostrowski, M. and Fidel,Q., 2009. The Benguela Current: An ecosystem of four components. *Progress*

in Oceanography, *83*(1-4), pp.15-32.

Jacobs, Z., Roberts, R.G., Galbraith, R.F., Deacon, H.J., Grün, R., Mackay, A., Mitchell,P., Vogelsang, R. and Wadley, L., 2008. Ages for the Middle Stone Age of Southern Africa: implications for human behavior and dispersal. *Science, 322*(5902), pp.733-735.

Janzen, A., Richter, K.K., Mwebi, O., Brown, S., Onduso, V., Gatwiri, F., Ndiema, E., Katongo, M., Goldstein, S.T., Douka, K. and Boivin, N., 2021. Distinguishing African bovids using Zooarchaeology by Mass Spectrometry (ZooMS): New peptide markers andinsights into Iron Age economies in Zambia. *PloS one, 16*(5), p.e0251061.

Jerardino, A. and Parkington, J., 1993. New evidence for whales on archaeological sites in the south-western Cape. *South African Journal of Science, 89*(1), pp.06-07.

Johnson, E., 1985. Current developments in bone technology. I*n Advances in archaeological method and theory (pp. 157-235)*. Academic Press.

Kandel, A.W. and Conard, N.J., 2003. Scavenging and processing of whale meat and blubber by Later Stone Age people of the Geelbek Dunes, Western Cape Province, SouthAfrica. *South African Archaeological Bulletin, 58*(178), pp.91-93.

Kausmally, T. and Western, A.G., 2005. *The Excavation of Faunal Skeletal Remains from Archaeological Sites*. British Archaeological Jobs Resource: OssaFreelance.

Klein, R.G. and Cruz-Uribe, K., 1984. *The analysis of animal bones from archeological sites*. University of Chicago press.

Klein, R.G. and Cruz-Uribe, K., 1996. Exploitation of large bovids and seals at Middle and Later Stone Age sites in South Africa. *Journal of Human Evolution, 31*(4), pp.315- 334.

Klein, R.G., 1976. The mammalian fauna of the Klasies River mouth sites,

southern CapeProvince, South Africa. *The South African Archaeological Bulletin, 31(123/124)*, pp.75-98.

Klein, R.G., 1981. Stone Age predation on small African bovids. *The South African Archaeological Bulletin*, pp.55-65.

Klein, R.G., 1982. Age (mortality) profiles as a means of distinguishing hunted species from scavenged ones in Stone Age archeological sites. *Paleobiology*, *8*(2), pp.151-158.

Klein, R.G., Cruz-Uribe, K., 1983. The computation of ungulate age (mortality)profiles) profiles from dental crown heights. *Paleobiology 9*, pp.70–78.

Kris Kris, H., 2021. 'Marine Isotope Stages'. *How do Scientists Know about 1 Million Years of Climate Change?*. ThoughtCo. Available at: <https://www.thoughtco.com/marine- isotope-stages-climate-world-171568> [Accessed 16 February 2021].

Kyriacou, K., Parkington, J.E., Marais, A.D., and Braun, D.R., 2014. Nutrition, modernity, and the archaeological record: Coastal resources and nutrition among Middle Stone Middle

Langejans, G.H., Dusseldorp, G.L. and Thackeray, J.F., 2017. Pleistocene molluscs fromKlasies River (South Africa): reconstructing the local coastal environment. *Quaternary International*, *427*, pp.59-84.

Langejans, G.H., van Niekerk, K.L., Dusseldorp, G.L. and Thackeray, J.F., 2012. MiddleStone Age shellfish exploitation: Potential indications for mass collecting and resource intensification at Blombos Cave and Klasies River, South Africa. *Quaternary International*, *270*, pp.80-94.

Larbey, C., Mentzer, S.M., Ligouis, B., Wurz, S. and Jones, M.K., 2019. Cooked starchy food in hearths ca. 120 kya and 65 kya (MIS 5e and MIS 4) from Klasies River Cave, South Africa. *Journal of Human Evolution*, *131*, pp.210-227.

Leach, F., Quinn, C., Morrison, J. and Lyon, G., 2003. The use of multiple isotope

signatures in reconstructing prehistoric human diet from archaeological bone from the Pacific and New Zealand. *New Zealand Journal of Archaeology*, *23*, pp.31-98.

Lepofsky, D. and Lertzman, K., 2005. More on sampling for richness and diversity in archaeobiological assemblages. *Journal of Ethnobiology*, *25*(2), pp.175-188.

Lombard, M., 2005. Evidence of hunting and hafting during the Middle Stone Age at Sibudu Cave, KwaZulu-Natal, South Africa: a multianalytical approach. *Journal ofhuman evolution*, *48*(3), pp.279-300.

Lombard, M., 2012. Thinking through the Middle Stone Age of sub-Saharan Africa. *Quaternary International*, *270*, pp.140-155.

Lombard, M., Parsons, I. and Van der Ryst, M.M., 2004. Middle Stone Age lithic point experimentation for macro-fracture and residue analyses: the process and preliminary results with reference to Sibudu Cave points: Sibudu Cave. *South African Journal of Science*, *100*(3), pp.159-166M.

Lupo, K.D. and Schmitt, D.N., 2005. Small prey hunting technology and zooarchaeological measures of taxonomic diversity and abundance: ethnoarchaeological evidence from Central African forest foragers. *Journal of Anthropological Archaeology*, *24*(4), pp.335-353.

Lyman, R.L. and Lyman, C., 1994. *Vertebrate taphonomy*. Cambridge University Press.

Lyman, R.L., 2008. *Quantitative paleozoology*. Cambridge University Press.

Marean, C. and Binford, L., 1986. On the Seal Remains from Klasies River Mouth: An Evaluation of Binford's Interpretations. *Current Anthropology*, 27(4), pp.365-368.

Marean, C.W. 2011. Coastal South Africa and the coevolution of the modern human lineage and the coastal adaptation, in: Bicho, N.F., Haws, J.A., and Davis, L.G.

(eds.), *Trekking the Shore*. Springer New York, p. 421–440.

Marean, C.W., 1991. Measuring the post-depositional destruction of bone in archaeological assemblages. *Journal of Archaeological Science*, *18*(6), pp.677-694.

Marean, C.W., 2010. Pinnacle Point Cave 13B (Western Cape Province, South Africa) in context: the Cape floral kingdom, shellfish, and modern human origins. *Journal of Human Evolution*, *59*(3-4), pp.425-443.

Marean, C.W., Abe, Y., Nilssen, P.J. and Stone, E.C., 2001. Estimating the minimum number of skeletal elements (MNE) in zooarchaeology: a review and a new image-analysis GIS approach. *American Antiquity*, *66*(2), pp.333-348.

Marean, C.W., P. Goldberg, G. Avery, F.E. Grine and Klein, R.G., 2000. "Middle StoneAge stratigraphy and excavations at Die Kelders Cave 1 (Western Cape Province, SouthAfrica): the 1992, 1993, and 1995 field seasons." *Journal of Human Evolution 38*: pp. 7–42.

Marshall, F. and Pilgram, T., 1993. NISP vs. MNI in quantification of body-part representation. *American Antiquity*, *58*(2), pp.261-269.

Masele, F. and Willoughby, P.R., 2021. Zooarchaeology of the Middle Stone Age in Magubike rockshelter, Iringa region, Tanzania. *African Archaeological Review*, *38*(2), pp.275-295.

McCall, G.S., 2006. Multivariate perspectives on change and continuity in the Middle Stone Age lithics from Klasies River Mouth, South Africa. *Journal of Human Evolution*, *51*(4), pp.429-439.

Miller, G.J., 1975. Weathering cracks, fractures, splinters, and other similar natural phenomena. *Lithic Technol Mak Using Stone Tools*, *79*, pp.211-226.

Morrissey, P., Knight, J., and Stratford, D.J., 2020. Early Marine Isotope Stage 5 sea levels, coastal dune palaeoenvironments, and human occupation on the southeast coast ofSouth Africa. *Quaternary Science Reviews*, *245*, p.106504.

Mucina, L., Rutherford, C.M., 2006. The vegetation of South Africa, Lesotho and

Swaziland. *South African National Biodiversity Institute*, Pretoria.

Nel, T.H., Wurz, S. and Henshilwood, C.S., 2018. Small mammals from marine isotope stage 5 at Klasies River, South Africa–reconstructing the local palaeoenvironment. *Quaternary International*, *471*, pp.6-20.

Nicholson, R.A., 1993. A morphological investigation of burnt animal bone and an evaluation of its utility in archaeology. *Journal of Archaeological Science*, *20*(4), pp.411-428.

Noe-Nygaard, N., 1989. Man-made trace fossils on bones. *Human Evolution*, *4*(6), pp.461-491.

O'Connor, T. and Barrett, J., 2006. Animal bones. *Archaeology in Practice*, p.260 O260.

O'Connor, T.P. and O'Connor, T., 2008. *The archaeology of animal bones* (No. 4). TexasA and M University Press.

Orr, R.T., 2020. Seals and sea lions. In *Marine Mammals of California* (pp. 43-600. U). *Palaeontologia africana*, *27*, pp.101-109.

Pargeter, J., 2007. Howiesons Poort segments as hunting weapons: experiments with replicated projectiles. *The South African Archaeological Bulletin*, *62*(186), pp.147-153.

Parkington, J. and Poggenpoel, C., 1971. Excavations at de Hangen, 1968. *The South African Archaeological Bulletin*, *26*(101/102), pp.3-36.

Parkington, J., 2003. Middens and moderns: Shell fishing and the Middle Stone Age of the Western Cape, South Africa: Reviews of current issues and research findings: Humanorigins research in South Africa. *South African Journal of Science*, *99*(5), pp.243-247.

Parsons, I. and Badenhorst, S., 2004. Analysis of lesions generated by replicated MiddleStone Age lithic points on selected skeletal elements. *South African Journal of*

Science, *100*(7), pp.384-387.

Plug, I and Badenhorst, S., 2001. The distribution of macromammals in Southern Africaover the past 30 000 Years: as reflected in animal remains from archaeological sites. Present and historical distributions of macromammals in southern Africa. Order-Artiodactyla. *Transvaal Museum Monographs*, *12*(1).

Plug, I., 2004. Resource exploitation: animal use during the Middle Stone Age at Sibuducave, KwaZulu-Natal: Sibudu cave. *South African Journal of Science*, *100*(3), pp.151- 158.

Pérez, L., Sanchis, A., Hernández, C.M., Galván, B., Sala, R. and Mallol, C., 2017. Hearths and bones: An experimental study to explore temporality in archaeological contexts based on taphonomical changes in burnt bones. *Journal of Archaeological Science: Reports*, *11*, pp.287-309.

Quick, L.J., Chase, B.M., Wuendsch, M., Kirsten, K.L., Chevalier, M., Maeusbacher, R., Meadows, M.E. and Haberzettl, T., 2018. A high-resolution record of Holocene climate and vegetation dynamics from the southern Cape coast of South Africa: pollen and microcharcoal evidence from Eilandvlei. *Journal of Quaternary Science*, *33*(5), pp.487-500.

Reitz, E.J. and Wing, E.S., 1999. *Zooarchaeology*. Cambridge University Press.

Reynard, J.P. and Henshilwood, C.S., 2018. Using trampling modification to infer occupational intensity during the Still Bay at Blombos Cave, southern Cape, South Africa.*African Archaeological Review*, *35*(1), pp.1-19.

Reynard, J.P. and Wurz, S., 2020. The palaeoecology of Klasies River, South Africa: Ananalysis of the large mammal remains from the 1984–1995 excavations of Cave 1 and 1A. *Quaternary Science Reviews*, *237*, p.106301.

Reynard, J.P., Henshilwood, C.S. and Badenhorst, S., 2014. Inferring animal size from the unidentified long bones from the Middle Stone Age layers at Blombos Cave,

South Africa. *Annals of the Ditsong National Museum of Natural History*, *4*(1), pp.9-25.

Rightmire, G.P. and Deacon, H.J., 1991. Comparative studies of late Pleistocene human remains from Klasies River mouth, South Africa. *Journal of Human Evolution*, *20*(2), pp.131-156.

Rightmire, G.P., Deacon, H.J., Schwartz, J.H. and Tattersall, I., 2006. Human foot bones from Klasies River main site, South Africa. *Journal of Human Evolution, 50*(1), pp.96-103.

Roberts, P., Henshilwood, C.S., van Niekerk, K.L., Keene, P., Gledhill, A., Reynard, J., Badenhorst, S. and Lee-Thorp, J., 2016. Climate, environment, and early human innovation: stable isotope and faunal proxy evidence from archaeological sites (98-59ka)in the southern Cape, South Africa. *PLoS One*, *11*(7), p.e0157408.

Rots, V., 2003. Towards an understanding of hafting: the macro-and microscopic evidence. *Antiquity*, *77*(298), pp.805-815.

Ruscillo, D., 2003. Alternative methods for identifying sex from archaeological animal bone. *British School at Athens Studies*, pp.37-44.

Selva, N. and Fortuna, M.A., 2007. The nested structure of a scavenger community. *Proceedings of the Royal Society B: Biological Sciences*, *274*(1613), pp.1101-1108.

Sherman, K., 1994. Sustainability, biomass yields, and health of coastal ecosystems: an ecological perspective. *Marine ecology progress series. Oldendorf*, *112*(3), pp.277-301.

Shipman, P., Foster, G. and Schoeninger, M., 1984. Burnt bones and teeth: an experimental study of colour, morphology, crystal structure and shrinkage. *Journal of archaeological science*, *11*(4), pp.307-325.

Singer, R. and Wymer, J., 1982. *The middle stone age at Klasies riverRiver Mouth in South Africa*. University of Chicago Press.

Smith, A.B., 1993. Exploitation of marine mammals by prehistoric Cape herders. *South African Journal of Science*, *89*(4), pp.162-165.

Smith, G.M., Ruebens, K., Gaudzinski-Windheuser, S. and Steele, T.E., 2019. Subsistence strategies throughout the African Middle Pleistocene: Faunal evidence for behavioral change and continuity across the Earlier to Middle Stone Age transition. *Journal of Human Evolution*, *127*, pp.1-20.

Steele, T.E. and Klein, R.G., 2013. The Middle and Later Stone Age faunal remains from Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of Archaeological Science*, *40*(9), pp.3453-3462.

Steele, T.E., 2005. Comparing methods for analysing mortality profiles in zooarchaeological and palaeontological samples. *International Journal of Osteoarchaeology 15*, pp.404–420. (Klein and Cruz-Uribe, 1983;Steele, 2006)

Steele, T.E., 2006. *Accuracy of age determinations from tooth crown heights: a test usingan expanded sample of known age red deer (Cervus elaphus).* In: Ruscillo, D. (Ed.), Recent Advances in Ageing and Sexing Animal Bones. Oxbow, Oxford, pp. 119–128.

Stone Age hunter-gatherers on the Western Cape coast of South Africa. *Journal of HumanEvolution*, *77*, pp.64-73.

Thackeray, A.I., 1989. Changing fashions in the Middle Stone Age: the stone artefact sequence from Klasies River main site, South Africa. *African Archaeological Review*, *7*(1), pp.33-57.

Thackeray, F., 2018. Oxygen isotope ratios of Turbo sarmaticus molluscan opercula fromlate Pleistocene Archaeological deposits, Klasies River, South Africa. The *South African Archaeological Bulletin*, *73*(208), pp.143-146.

Thackeray, J.F., 1988. Molluscan fauna from Klasies River, South Africa. *The South African Archaeological Bulletin*, pp.27-32.

Thackeray, J.F., 1990. Carnivore activity at Klasies River Mouth: a response to Binford.

Thom, H.B., 1952. *Journal of Jan van Riebeeck (Vol. 1)*. A.A. Balkema for the Van Riebeeck Society, Cape Town.

Thomas, D.B. and Ksepka, D.T., 2013. A history of shifting fortunes for African penguins. *Zoological Journal of the Linnean Society*, *168*(1), pp.207-219.

Thompson, E., H.M. Williams, and T. Minichillo. 2010. "Middle and Late PleistoceneMiddle Stone Age lithic technology from Pinnacle Point 13B (Mossel Bay, Western CapeProvince, South Africa)." *Journal of Human Evolution 59*: pp.358–377.

Thompson, J.C. and Henshilwood, C.S., 2011. Taphonomic analysis of the Middle Stone Age larger mammal faunal assemblage from Blombos Cave, southern Cape, SouthAfrica. *Journal of Human Evolution*, *60*(6), pp.746-767.

Thompson, J.C., 2008. *Zooarchaeological tests for modern human behavior at Blombos Cave and Pinnacle Point Cave 13B, southwestern Cape, South Africa*. Arizona State University.

Thompson, J.C., 2010. Taphonomic analysis of the middle stone age faunal assemblagefrom Pinnacle Point Cave 13B, Western Cape, South Africa. *Journal of Human Evolution*, *59*(3-4), pp.321-339.

Turner, A., 1989. Sample selection, schlepp effects and scavenging: the implications ofpartial recovery for interpretations of the terrestrial mammal assemblage from Klasies River Mouth. *Journal of Archaeological Science*, *16*(1), pp.1-11.

University of California Press.

Van Niekerk, K.L., 2011. *Marine fish exploitation during the Middle and Later Stone Age of South Africa* (Doctoral dissertation, University of Cape Town).

Van Pletzen, L., 2000. *The large mammal fauna from Klasies River* (Doctoral dissertation, Stellenbosch: Stellenbosch University).

van Pletzen-Vos, L., Brink, J., Reynard, J.P. and Wurz, S., 2019. Revisiting Klasies River. *The South African Archaeological Bulletin*, *74*(211), pp.127-137.

van Wijk, Y., 2017. Plants, people, and place: co-evolving global patterns through time. *Pretoria: University of Pretoria*.

Villa, P., Soriano, S., Teyssandier, N. and Wurz, S., 2010. The Howiesons Poort and MSA III at Klasies River main site, cave 1A. *Journal of Archaeological Science*, *37*(3), pp.630-655.

Voigt, E. A. 1982. *The molluscan fauna. In: Singer R. and Wymer, J. The Middle StoneAge at Klasies River Mouth in South Africa: 155-186*. Chicago: University of Chicago Press.

Voigt, E.A., 1975. Studies of marine mollusca from archaeological sites: dietarypreferences, environmental reconstructions, and ethnological parallels. Archaeozoological studies, pp.87-98.

Volman, T.P., 1981. *The middle stone age in the Southern Cape* (Doctoral dissertation,The University of Chicago).

Von den Driesch, A. 1976. *A guide to the measurement of animal bones from archaeological sites*. Peabody Museum Bulletin 1, Harvard University

Von den Driesch, A., 1976. *A guide to the measurement of animal bones from archaeological sites* (Vol. 1). Peabody Museum Press.

Von den Driesch, A., 2004. The Middle Stone Age fish fauna from the Klasies river main site, South Africa. *Anthropozoologica*, *39*(2), pp.33-59.

Wadley, L., 2010. Were snares and traps used in the Middle Stone Age and does it matter? A review and a case study from Sibudu, South Africa. *Journal of Human Evolution*, *58*(2), pp.179-192.

Wadley, L., 2015. Those marvellous millennia: The Middle Stone Age of Southern Africa. *Azania: Archaeological Research in Africa*, *50*(2), pp.155-226.

Walker, N.D., 1990. Links between South African summer rainfall and temperature variability of the Agulhas and Benguela Current systems. *Journal of Geophysical Research: Oceans*, *95*(C3), pp.3297-3319.

Wilkins, J., Schoville, B.J., Brown, K.S. and Chazan, M., 2012. Evidence for early hafted hunting technology. *Science*, *338*(6109), pp.942-946.

Will, M., Kandel, A.W., Kyriacou, K. and Conard, N.J., 2016. An evolutionary perspective on coastal adaptations by modern humans during the Middle Stone Age of Africa. *Quaternary International*, *404*, pp.68-86.

Williams, M.A., Ambrose, S.H., van der Kaars, S., Ruehlemann, C., Chattopadhyaya, U., Pal, J. and Chauhan, P.R., 2009. Environmental impact of the 73 ka Toba super- eruption in South Asia. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *284*(3-4),pp.295-314.

Wilson, E.E. and Wolkovich, E.M., 2011. Scavenging: how carnivores and carrion structure communities. *Trends in Ecology & Evolution*, *26*(3), pp.129-135.

Wurz, S., 2000. *The Middle Stone Age at Klasies River, South Africa* (Doctoral dissertation, Stellenbosch: Stellenbosch University).

Wurz, S., 2002. Variability in the middle stone age lithic sequence, 115,000–60,000 years ago at Klasies river, South Africa. *Journal of Archaeological Science*, *29*(9), pp.1001-1015.

Wurz, S., 2005. Exploring and quantifying technological differences between the MSA I, MSA II and Howieson's Poort at Klasies River. *From tools to symbols: from early hominids to modern humans*, pp.418-440.

Wurz, S., 2012. The significance of MIS 5 shell middens on the Cape coast: A lithic perspective from Klasies River and Ysterfontein 1. *Quaternary International*, *270*, pp.61-69.

Wurz, S., 2012. The significance of MIS 5 shell middens on the Cape coast: A lithic perspective from Klasies River and Ysterfontein 1. *Quaternary International*, *270*, pp.61-69.

Wurz, S., 2013. Technological trends in the Middle Stone Age of South Africa betweenMIS 7 and MIS 3. *Current Anthropology*, *54*(S8), pp.S305-S319.

Wurz, S., Bentsen, S.E., Reynard, J., Van Pletzen-Vos, L., Brenner, M., Mentzer, S., Pickering, R. and Green, H., 2018. Connections, culture, and environments around 100 000 years ago at Klasies River main site. *Quaternary international*, *495*, pp.102-115.

Wurz, S., Le Roux, N.J., Gardner, S. and Deacon, H.J., 2003. Discriminating between the end products of the earlier Middle Stone Age sub-stages at Klasies River using biplotmethodology. *Journal of Archaeological Science*, *30*(9), pp.1107-1126.

Ziegler, M., Simon, M.H., Hall, I.R., Barker, S., Stringer, C. and Zahn, R., 2013. Development of Middle Stone Age innovation linked to rapid climate change. *Nature communications*, *4*(1), pp.1-9.

Appendix

Table A. 1. The normed Number of Identified Specimen (nNISP) for identified mammal specimens

Skeletal -parts	**Small mammal**		**Small-medium mammal**		**Medium mammal**		**Medium-large mammal**		**Large mammal**	
Cranial elements	NISP	nNISP	NISP	nNISP	NISP	nNISP	NISP	nNISP	NISP	nNISP
Cranium	8	8.0	3	3.0	14	14.0	3	3.0		
Maxilla										
Mandibulae	2	2.0			1	1.0				
Proximal elements										
Atlas	2	2								
Axis	1	1			3	3				

Cervical vertebrae					1	0.2				
Thoracic vertebrae	4	0.3333			4	0.333			1	0.083
Sacral vertebra e	2	0.3333							1	0.167
Caudal vertebrae	4	1	3	0.75	7	1.75	1	0.25	1	0.25
Indeterminate vertebrae	35	1.0606	7	0.212	64	1.939	3	0.091	5	0.152
Ribs	27	2.25	4	0.333	54	4.5	8	0.667	9	0.75
Sternum					4	4	1	1		
Front limb										
Scapulae	1	0.5	1	0.5	2	1				
Humeri	2	1								

Radii	1	0.5								
Ulnae			3	1.5	1	0.5				
Carpals	9	1.125	5	0.625	17	2.125			1	0.125
Metacarpals	1	0.1	1	0.1	2	0.2			1	0.1
Hind limb										
Innominate	7	7			3	3				
Femora	10	5	1	0.5	7	3.5				
Patellae	2	1	1	0.5	2	1				
Tibiae	9	4.5			6	3			5	2.5
Fibulae	1	0.5								

Tarsals	2	0.3333			9	1.5	1	0.167	1	0.167
Sesamoids	5	0.3571	10	0.714	23	1.643	1	0.071	1	0.071
Calcanea	1	0.5								
Distal element s										
Indetermin ate metapodia	1	0.025								
First phalanges	3	0.3			1	0.1				
Second phalanges	2	0.2			2	0.2	1	0.1		
Third phalanges	3	0.375								
Indetermin ate phalanges	10	0.3571	3	0.107	1	0.036				
Total	157	41.95	42	8.842	230	48.83	21	5.746	27	4.565

Table A. 2. The normed Number of Identified Specimen (nNISP) for identified bovid specimens

Skeletal elements	**Bov1**		**Bov2**		**Bov3**		**Bov4**		**Bov5**	
Cranial element s	NISP	nNISP	NISP	nNISP	NISP	nNISP	NISP	nNISP	NISP	nNISP
Crania	2	2.0	1	1.0	1	1.0	1	1.0		
Maxilla e		0.0	1	1.0		0.0				
Mandibulae	4	4.0	3	3.0	3	3.0				
Indetermina te permanent teeth	8	0.3	14	0.4	15	0.5				
Permanent incisor					3	0.5	3	0.5		

Permanent premolars	2	0.2	3	0.3	1	0.1	1	0.1		
Permanent molars	1	0.1	4	0.3	2	0.2	1	0.1		
Proximal elements										
Atlas	2	2.0	3	3.0						
Axis			1	1.0						
Thoracic			1	0.1						
Lumber					1	0.2				
Ribs							1			

Front limb										
Scapulae	3	1.5	2	1.0	1	0.5				
Humeri	5	2.5	1	0.5	1	0.5	1	0.5		
Radii	2	1.0			1	0.5				
Ulnae	1	0.5	3	1.5	2	1.0				
Metacarpals	6	3.0	2	1.0	1	0.5				
Carpals	13	0.8	7	0.4	3	0.2				
Hind limb										

Femora			2	1.0	2	1.0				
Patella			2	1.0	2	1.0				
Tibiae	6	3.0	2	1.0	5	2.5	4	2.0		
Fibulae							1			
Metatarsals	6	3.0	3	1.5	4	2.0				
Tarsals	5	0.4	1	0.1	1	0.1	1	0.1		
Calcanea	1	0.5	1	0.5	1	0.5				
Sesamoids	7	0.3	7	0.3	1	0.0				

Distal elements										
Indeterminate metapodia	7	1.8	3	0.8	3	0.8	1	0.3	1	0.3
First phalanges	21	2.6	7	0.9	4	0.5	6	0.8		
Second phalanges	12	1.5	5	0.6	5	0.6	1	0.1		
Third phalanges	9	1.1	4	0.5						
Total	123	32.0	83	22.7	63	17.6	22	5.4	1	0.3

Table A. 3. The Minimum Number of Elements (MNE) for identified bovid specimens

Skeletal elements	**Bov1**		**Bov2**		**Bov3**		**Bov4**		**Bov5**	
Cranial elements	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE	NISP	MNE
Cranium	2	1	1	1	1	1	1	1		

Maxillae			1	1						
Mandibulae	4	4	3	3	3	2				
Indeterminate permanent teeth	8	8	14	14	15	15				
Permanent incisor					3	3	3	3		
Permanent premolars	2	2	3	3	1	1	1	1		
Permanent molars	1	1	4	4	2	2	1	1		
Proximal elements										
Atlas	2	2	3	3						
Axis			1	1						
Thoracic			1	1						
Lumber					1	1				
Ribs							1	1		
Front limb										
Scapulae	3	3	2	2	1	1				
Humeri	5	5	1	1	1	1	1	1		
Radii	2	2			1	1				
Ulnae	1	1	3	3	2	2				
Metacarpals	6	5	2	1	1	1				

Carpals	13	12	7	6	3	3				
Hind limb										
Femora			2	1	2	2				
Patella			2	2	2	2				
Tibiae	6	5	2	2	5	4	4	4		
Fibulae							1	1		
Metatarsals	6	6	3	3	4	4				
Tarsals	5	5	1	1	1	1	1	1		
Calcanea	1	1	1	1	1	1				
Sesamoids	7	6	7	1	1	1				
Distal elements										
Indeterminate metapodia	7	6	3	3	3	3	1	1	1	1
Indeterminate phalanges	1	1			1	1				
First phalanges	20		7	7	3	3	6	6		
Second phalanges	12	10	5	5	5	5	1	1		
Third phalanges	9	9	4	4						
Total	*123*	*95*	*83*	*74*	*63*	*61*	*22*	*22*	*1*	*1*

Table A. 4. The Minimum Animal Units (MAU) for identified bovid specimens

Skeletal elements	**Bov1**		**Bov2**		**Bov3**		**Bov4**		**Bov5**	
Crania l elements	MNE	MAU	MNE	MAU	MNE	MAU	MNE	MAU	MNE	MAU
Cranium	1	1.0	1	1.0	1	1.0	1	1.0		
Maxillae			1	1.0						
Mandibula e	4	4.0	3	3.0	2	2.0				
Indetermin ate permanent teeth	8	0.3	14	0.4	15	0.5				
Permanent incisor					3	1.5	3	1.5		
Permanent premolars	2	0.2	3	0.3	1	0.1	1	0.1		
Permanent molars	1	0.1	4	0.3	2	0.2	1	0.1		
Proximal elements										
Atlas	2	2.0	3	3.0						
Axis			1	1.0						
Thoracic			1	1.0						
Lumber					1	0.2				
Ribs							1	0.0		
Front limb										
Scapulae	3	1.5	2	1.0	1	0.5				

Humeri	5	2.5	1	0.5	1	0.5	1	0.5		
Radii	2	1.0			1	0.5				
Ulnae	1	0.5	3	1.5	2	1.0				
Metacarpals	5	2.5	1	0.5	1	0.5				
Carpals	12	0.8	6	0.4	3	0.2				
Hind limb										
Femora			1	0.5	2	1.0				
Patella			2	1.0	2	1.0				
Tibiae	5	2.5	2	1.0	4	2.0	4	2.0		
Fibulae							1	0.5		
Metatarsals	6	3.0	3	1.5	4	2.0				
Tarsals	5	0.4	1	0.1	1	0.1	1	0.1		
Calcanea	1	0.5	1	0.5	1	0.5				
Sesamoids	6	0.3	1	0.0	1	0.0				
Distal elements										
Indeterminate metapodia	6	1.5	3	0.8	3	0.8	1	0.3	1	0.3
Indeterminate phalanges	1	0.0		0.0	1	0.0				
First phalanges	15	1.5	7	0.7	3	0.3	6	0.6		

Second phalanges	10	1.0	5	0.5	5	0.5	1	0.1		
Third phalanges	9	1.1	4	0.5						
Total	*110*	*28.1*	*74*	*22.0*	*61*	*16.8*	*22*	*6.7*	*1*	*0.3*

Table A. 5. The normed Number of Identified Specimen (nNISP) for identified avian specimens

Skeletal elements	**Small bird**		**Small-mediumbird**		**Medium-bird**		**Large-bird**	
Cranial elements	**NISP**	**MNE**	**NISP**	**MNE**	**NISP**	**MNE**	**NISP**	**MNE**
Crania			1	1	1	1		
Quadrate	5	4	1	1	2	2	1	1
Proximal elements								
Cervical vertebrae	21	19	3	2	9	9		
Thoracic vertebrae	6	5	2	2	7	6		
Caudal vertebrae	1	1	1	1	3	2		

Sacral vertebrae								
Indeterminate vertebrae	4	2	2	1	2	1		
Sternum							1	1
Forelimb								
Scapulae	1	1						
Coracoids	1	1	2	2				
Humeri	5	5			10	10	1	1
Radii	1	1			6	6		
Ulnae					6	6		
Carpometacarpal	2	2			9	8		
Hind limb								

Innominate	1	1						
Femora	2	2	1	1				
Tibiotarsi	9	9			7	7		
Tarsometatarsi	1	1	5	3	15	14		
Fibulae								
Distal elements								
First phalanges	5	3	5	4	8	8		
Second phalanges	7	7	1	1	4	4		
Third phalanges	4	3			1	1		
Fourth phalanges	1	1	1	1				
Indeterminate phalanges	6	6			2	1		

Total	83	74	25	20	92	86	3	3