A critical assessment of southern African 'early hominid bone tools'

Lucinda Ruth Backwell

Volume I

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DECLARATION

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

23rd day of DECEMBER 1999

ABSTRACT

The aim of this study is to assess the origin of the surface modifications on 69 fossil specimens from the early hominid sites of Swartkrans and Sterkfontein. These fossils have been interpreted by Brain & Shipman (1993) as digging tools used by hominids for the procurement of underground storage organs for food. The problem of natural processes mimicking anthropic traces is well documented (see for example Brain 1967a; d'Errico 1993; Villa & Bartram 1996; d'Errico & Villa 1997) and highlights the need for comparison of the modifications recorded on the purported bone tools to those produced by known taphonomic agents and processes.

Thirty-five comparative collections comprising 13 301 individual specimens of known taphonomic history were examined, including those modified by animals (hyaena, dog, leopard, cheetah, porcupine) and geological processes (river gravel, spring, flood plain, wind, trampling). Following a progressively more rigorous method of elimination, the collections were studied for pieces exhibiting morphological similarity to the Swartkrans and Sterkfontein purported bone tools. A detailed macro- and microscopic analysis of the comparative collections resulted in the retention of 24 bone tool mimics. Replicas of the tips of the Swartkrans and Sterkfontein specimens, and of the pseudotools found in the comparative collections were studied using optical and Scanning Electron Microscopy, and the similarities and dissimilarities assessed. The author then commented on the damage observed, discussing possible causative agents and processes associated with the modification of each collection.

The results of this research show that surface features observed on the Swartkrans and Sterkfontein purported bone tools are different from those recorded on bones modified by natural agents, and similar to those found on some experimental and archaeological specimens encountered in the course of research. According to the diagnostic criteria identified in the framework of this study, sixteen unpublished used bones have also been found among the Swartkrans faunal remains. This analysis confirms Brain and Shipman's (1993) diagnosis that the wear on many of the bone tips should be interpreted as resulting from use by early hominids.

Dedicated to my Mother
Maureen Eva Backwell

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Abbreviations Used in the Text

A.	*Australopithecus*
BP	before the present
cf.	*confer* compare
cm	centimetre
E	east
ESR	Electron Spin Resonance
kg	kilogram
kv	accelerating voltage
m	metre
mm	millimetre
MNI	minimum number of individuals
MnO_2	manganese dioxide
Mya	millions of years ago
n	sample size
N	north
ODK	osteodontokeratic culture
S	south
SEM	Scanning Electron Microscope
µm	microns
W	west
$\bar{x}$	mean

CONTENTS

CHAPTER 1 - INTRODUCTION

1.1 Introduction

Ever since Dart (1949) identified bones from the Makapansgat early hominid site as tools, scientific consensus has fluctuated as to whether certain modified bones from fossil sites are artefactual, or simply the result of modification by animals or non-biological agents. Dart's 'bone tool' hypothesis was challenged by the work of Brain (1967a, 1967b, 1976), Mills (1973), Mills & Mills (1977), Skinner (1976) and Klein (1975), and the taphonomic agent responsible for the damage identified as mammalian. More recently, Brain has partially recanted his vigorous refutation of a select few of the Makapansgat 'bone tools', and in addition has published on 68 purported 'bone tools' from the early hominid site of Swartkrans (Brain & Shipman 1993). Even more recently, Keyser and Kuman (pers. comm.) have tentatively identified 23 'bone tools' from the early hominid site of Drimolen. However, Villa and Bartram's (1996) discovery of bone pseudotools in an unequivocal hyaena den context in Europe has resurrected the debate over whether non-humans or humans have produced these purported bone tools, and highlighted the need for a systematic survey of the southern African 'bone tool' material. Based upon the conclusions of Villa and Bartram (1996), and working from the hypothesis that the modification of bone objects from southern African hominid-bearing sites that have been attributed to human utilisation are the result of non-human taphonomic processes, the author adopted a comparative approach in which the modification attributes on purported bone tools were micro- and macroscopically compared with those produced by known non-human agents. The similarities and dissimilarities were assessed.

The importance of this study is to gain a greater understanding of the tempo and mode of development of complex culture in the human lineage, and to demonstrate the necessity of a comprehensive understanding of taphonomy and its primacy in the inference of early hominid behaviour.

1.2 Background

A prerequisite to interpreting any faunal assemblage is a sound understanding of the complexities involved in the burial process (taphonomy), as well as a familiarity with diagnostic criteria relating to bone modification categories, and the contextual status of the site. The term 'taphonomy' was first introduced by the geologist Efremov

(1940: 85) to encompass studies in what he referred to as "the transition of animal remains from the biosphere into the lithosphere", with the word taphonomy deriving from the Greek *taphos*, meaning 'burial', and *nomos*, meaning 'law' (Brain 1981). The interval between death and fossilisation is a period in which a number of dynamic processes are at work, the understanding and recognition of which form the primary concern of taphonomists. Fossil assemblages may be studied to reconstruct the faunal composition of the original community; the environment in which the community lived; the process of community succession; the determination of the ages of different communities; and to infer early hominid behaviour (Brain 1981). Fundamental to the study of taphonomy is the concept of uniformitarianism, the principle formulated by the geologist James Hutton that states "the present is the key to the past". It postulates that the laws of nature now prevailing have always prevailed and that accordingly, the results of ocesses now active resemble the results of like processes in the past.

Dart's 1949 Osteodontokeratic (ODK) cultural hypothesis marked the first attempt within Africa to infer hominid behaviour from a fossil bone assemblage. Based on the bone damage, both in the form of fracture patterns and surface damage, and disproportionate skeletal part representation, Dart's interpretation of the Makapansgat faunal assemblage from the grey breccias led to the development of the hypothesis that *Australopithecus africanus (prometheus)* was a fire-using, weapon-yielding cannibal, who utilised a tool-kit compricing artefacts manufactured from animal bones, teeth and horns. Colleagues like Broom, Von Koeningswald and Oakley were sceptical, and continued to propound the idea that hyaenas and other carnivores were responsible for cavern bone accumulations. In order to gain a better understanding of hyaena foraging habits and the appearance of the resultant faunal assemblages, Dart instructed Hughes (1954) to embark on the first observational study of carnivore behaviour, investigating two southern African hyaena lairs. Although later studies showed that hyaenas *do* collect bones in some instances (Skinner *et al.* 1980; Skinner *et al.* 1986; Skinner & van Aarde 1991; Skinner *et al.* 1997; Lam 1992), those lairs were found to be devoid of any bone, a finding which Dart believed vindicated his hypothesis. In 1956 he published "The myth of the bone accumulating hyaena", and went on to describe and expound the use of tools by australopithecines in numerous other articles (Dart 1957, 1959a, 1959b, 1960, 1961a, 1961b, 1962). Dart's claims prompted a wide range of innovative research in fields as diverse as archaeology, primatology, and cave sedimentology. The seminal ethnographic, actualistic and palaeo-taphonomic studies of Brain were supplemented by the work of Bothma on hyraxes (1971); Mills (1973), Mills & Mills (1977) and Skinner (1976) on hyaenas; and Klein (1975, 1982, 1988) on skeletal part representation in fossil bone assemblages. Klein (1975) reports that the relative frequencies of different skeletal elements in the bone assemblage from the late Pleistocene site of Swartklip I closely resemble the composition of the Makapansgat faunal assemblage, and based on the conclusion that carnivores (probably hyaenas) were the accumulating agent at Swartklip I, Klein (1975) also proposes that carnivores, rather than hominids were responsible for the accumulation of bones at Makapansgat.

Dart's forceful advocacy of *A. africanus* as the first hunter in the line of man was unfortunate, especially at a time when the European scientific community was still sceptical about the validity of the Taung child as a human ancestor. His insistence resulted in the widespread dismissal of the 'bone tool' assemblage. Nonetheless, numerous long bone fragments and horn cores from the Makapansgat sample *do* exhibit anomalous localised wear-patterns, remarkably reminiscent of use as tools (Brain 1989).

Unusually modified bone fragments have also been found at the Swartkrans and Sterkfontein early hominid sites. In recognising that a similarity existed between the wear patterns on 68 fossils from Swartkrans and those produced on screwdrivers used as digging tools during the course of excavation, Brain commissioned digging experiments using bone flakes from a blue wildebeest kill worked over by spotted hyaenas. On the basis of palaeo-environmental reconstructions and on the wear patterns produced on the tips of the flakes after use, Brain & Shipman (1993) propose that the modifications recorded on the fossils are the result of digging activities conducted by hominids in the extraction of subterranean storage organs for food.

1.3 Taphonomy in theory and practice

No established conceptual framework exists for the study of human behavioural evolution (Blumenschine *et al.* 1994), although Quinney (1997) recognises two lines of inference. He divides models of early hominid behaviour into two broad classes:
1) socio-ecological models; and 2) palaeo-taphonomic models.

1.3.1 Socio-ecological (or behavioural) modelling encourages the use of naturalistic observations of living systems as a means of better understanding extinct ones, emphasising that the veracity of modern analogues is based on general principles relating to aspects of the environment in a wide range of species and conditions. The logic underlying this analogical approach suggests that because two cases share some features, they will also share other features not necessarily related to the common feature. An example of this may be combining the morphological features of fossil hominids (dentition, osteology and brain size) with modern ecologies and behaviours in an attempt to postulate prehistoric behaviour. Based on their common ancestry, researchers propound the link between extant primates and early hominids, using savannah baboons (Jolly 1970, Dunbar 1975) and chimpanzees (Goodall 1976, Zihlman *et al.* 1978, McGrew 1981) to better understand early hominid behaviour and physiology. Another approach entails observations of contemporary peoples like the aboriginal Australian and African Bushmen hunter-gatherer societies to elicit causal links between observed archaeological traces and the behaviours that produced them (Lee 1968, 1972). Such models are highly informative, but in the extreme may run the risk of being reductionist, glossing over the socio-biological distinctions that exist between taxa in both time and space (Gould 1980; Latimer *et al.* 1981; Luchterhand 1982; Shipman 1989).

1.3.2 Palaeo-taphonomic models are ultimately concerned with the burial and preservation processes, and use two approaches to problem solving. The first is called *palaeotaphonomy* and concerns the direct analysis and interpretation of fossils and their contexts. The second is called *actualism* (Lyman 1994). Also referred to as neotaphonomy (Gifford 1981), Middle Range research (Binford 1981), and functional analogies (Shipman 1989), actualism concerns the extrapolation of modern findings back into the past.

i. *Palaeotaphonomy* utilises palaeo-taphonomic data by examining the content and context of faunal assemblages, the skeletal part representation and patterns of bone modification (Behrensmeyer 1978, 1991; Bonnischen & Sorg 1989; Brain 1981; Hanson 1980; Klein 1975, 1982, 1988; Vrba 1980).

ii. *Actualistic research* is that in which knowledge of causal relationships in modern processes is used to establish diagnostic effects or signature criteria which are caused by particular processes or sequences of events. The presence of such effects on ancient material thus enables the occurrence of those events in the past to be deduced with considerable confidence. Two forms of actualistic research can be conducted, namely 'naturalistic' and 'experimental'. Naturalistic research involves behavioural studies of modern animals (ethology) and humans (ethnography) in an attempt to gauge the effects of their activities, and to extrapolate this back into the past. Because early hominids are extinct, naturalistic studies are essentially a 'best fit' method of evaluation. Naturalistic studies associated with pseudotool production include the effects of trampling (Brain 1967a, b; Behrensmeyer *et al.* 1986; Haynes 1986; Fiorillo 1989), hyaena scavenging (Shipman & Phillips-Conroy 1977), and modification by ungulates (Sutcliffe 1973, 1977; Brothwell 1976), chimpanzees (Pickering & Wallis 1997) and modern humans (Brain 1967a, b; Gifford 1977; Gifford-Gonzalez 1989).

While the 'cause and effect' correlations that have been gleaned from functional analogies have proved to be of great inferential value to researchers, the *experimental* manufacture of tools remains a contentious issue (Binford 1968, 1981; Collins 1975; Gould & Schiffer1981; Stanislawski 1977; Yellen 1977). For a summary of this debate see Wylie (1985). Sceptics argue that conscious and sub-conscious bias together with the great mimicry potentials of modern human's leads to the production of preconceived results. Cognisance of this problem is important, especially when replication studies are the only form of enquiry employed. However, experimental replication studies may be of great *supplementary* value to the task of problem solving in that they may for example support a hypothesis, clarify a range of variation, or highlight the impracticalities associated with theoretical issues. As the descendants of early hominids, anatomically modern humans are arguably the best models available for the study of prehistoric behaviours and the material cultures they produced.

In a move away from analogical thinking, Shipman (1981a: 12) argues that "the occurrence of a past event can be deduced only by demonstrating that its effects differed from other similar events". The strength in this sort of argument is that it is not based on analogies, but identifications. Klein & Cruz-Uribe (1996) have more recently echoed this sentiment in their adoption of a comparative approach for the analysis and interpretation of faunal remains from Middle and Later Stone Age sites in South Africa.

In critiquing the methodologies of Dart and Brain, it becomes evident that Dart, in the absence of lithics, interpreted the Makapansgat faunal assemblage as evidence of a pre-lithic stage in the evolution of material culture. To reinforce his argument that the bone assemblage was artefactual, Dart, with the assistance of Hughes, first included and then excluded hyaenas as the only other potential modifying/bone-accumulating agent at Makapansgat. Brain, working with the Swartkrans accumulation, felt that the association of 'bone tools' *with* lithics only substantiated his argument that the modifying agent was hominid. Recognising the flaw in limiting the range of potential modifying agents to hyaenas, Brain extended the field of research to include not only other carnivores, but also a wide range of non-biological agents.

In order *not* to make an anthropogenic assessment, and to reduce the high degree of inherent error, it was decided from the outset not to undertake experimental replication studies. Following the approach advocated by Shipman (1981a, 1989) and Klein and Cruz-Uribe (1984, 1996), this study adopted a comparative method for the analysis of the purported bone tools. Based on a set of predetermined criteria, a wide range of faunal assemblages of known taphonomic history was studied, their modification attributes identified and recorded, and their similarities and dissimilarities with the purported bone tools assessed. A systematic re-examination of the entire Swartkrans faunal collection was also undertaken to establish whether surface modifications interpreted as use-wear might represent the extreme limit of variation of a taphonomic process affecting a larger part of the assemblage.

CHAPTER 2 - MATERIALS

This study was based on an analysis of purported fossil bone tools from the early hominid sites of Swartkrans and Sterkfontein, as well as modern and fossil bone collections for which the accumulating and/or modifying agents are known. The purpose of this chapter is to list and describe all the materials used.

2.1 Purported bone tools (Table 1)

Excavations conducted at Swartkrans between 1979 and 1986 yielded sixty-eight fossil bones that Brain & Shipman (1993) interpreted as tools. Brain (1993) reports seventeen as coming from the Lower Bank of Member 1, eleven from Member 2 and forty from Member 3.

Only one purported bone tool has come from Sterkfontein. Described by Robinson (1959), this specimen was excavated in 1958 from the stony artefact-bearing Member 5 deposit (Partridge 1978), also known as the Extension Site (Robinson 1957) or Middle Breccia (Robinson 1962).

The format and descriptions used follow those of Brain & Shipman (1993). Note the use of centimetres for depth to conform to published data. An asterisk indicates that the specimen formed part of the template (see Chapter 3.3). A total of sixty-nine specimens are listed for Swartkrans because the two pieces designated SKX 1141/43 by Brain (1993) are considered here as two separate entities.

2.1.1 Swartkrans Member 1 Lower Bank

Horncore pieces

SKX 4228b

Grid square. E5/N5, SW quarter; depth: 560-570 cm.

Date found. 9 July 1980.

Description. A piece of bovid horncore.

SKX 7068

Grid square. E5/N4, SW quarter; depth 470-480 cm.

Date found. 19 March 1980.

Description. Parts of a fragmented bovid horncore.

SKX 5011*

Grid square. E3/N10; depth uncertain as the Member 1 sediment here had been disturbed by mining activities.

Date found. 25 March 1981.

Description. An almost complete horncore of *Damaliscus dorcas.*

Bone flakes

SKX 794

Grid square. E2/N3; depth: 350-400 cm.

Date found. 10 May 1979.

Description. A bone flake.

SKX 1429

Grid square. E4/N3; depth: 500-550 cm.

Date found. 17 May 1979.

Description. A symmetrical worn point.

SKX 3477/3478

Grid square. E4/N4, NE quarter; depth: 510-520 cm.

Date found. 28 February 1980.

Description. Two parts of a bone flake.

SKX 5000

Grid square. E3/N5, SW quarter; depth 620-630 cm.

Date found. 11 February 1981.

Description. Three pieces of a bone flake originally 130 mm long. The largest piece tapers to a smooth and symmetrical point.

SKX 5001

Grid square. E3/N4, NW quarter; depth: 610-620 cm.

Date found. 18 February 1981.

Description. A bone flake.

SKX 5003

Grid square. E4/N5, NW quarter; depth 660-670 cm.

Date found. 25 March 1981.

Description. A bone flake in four pieces which was at least 170 mm long when whole.

SKX 5005*

Grid square. E3/N5, SW quarter; depth: 610-620 cm.

Date found. 11 February 1981.

Description. A flat cortical fragment.

SKX 5006

Grid square. E3/N5, SE quarter; depth: 640-650 cm.

Date found. 18 March 1981.

Description. The tip of a bone flake.

SKX 5008

Grid square. E3/N5, SE quarter; depth: 580-590 cm.

Date found. 5 February 1981.

Description. A bone flake in three pieces that would have been at least 150 mm long.

SKX 5009

Grid square. E3/N5, NE quarter; depth: 750-760 cm.

Date found. 10 June 1981.

Description. A piece of the tip of a bone flake.

SKX 5010a*

Grid square. E4/N9; depth about 1000 cm, in Member 1 Lower Bank sediment disturbed by lime-mining operations.

Date found. 19 May 1981.

Description. A bovid radius fragment.

SKX 5010b*

Grid square. E4/N9; depth about 1000 cm, in Member 1 sediment disturbed by mining operations.

Date found 19 May 1981.

Description. A long bone fragment.

SKX 5012

Grid square. E4/N9; depth: 1230 cm.

Date found. 3 June 1981.

Description. A bone flake.

SKX 7062

Grid square. E5/N4, SW quarter; depth: 460-470 cm.

Date found. 19 March 1980.

Description. Part of a bone flake.

2.1.2 Swartkrans Member 2

Horncore pieces

SKX 12383

Grid square. E4/S6, SE quarter; depth 80-90 cm.

Date found. 26 May 1983.

Description. The distal end of a bovid horncore.

SKX 15536

Grid square. E6/S1; depth: 150-200 cm.

Date found. 6 June 1979.

Description. Two pieces of a broken horncore.

SKX 17211*

Grid square. E4/S3, NE quarter; depth: 160-170 cm, at the interface between Member 2 and the underlying Lower Bank of Member 1.

Date found. 22 June 1983.

Description. A horncore of a *Beatragus* antelope.

Bone flakes

SKX 105*

Grid square. E5/S2; depth: 180-190 cm.

Date found. 26 July 1979.

Description. The tip of a bone flake.

SKX 352*

Grid square. E5/N2; depth: 250-275 cm.

Date found. 21 June 1979.

Description. Part of the tip of a bone flake.

SKX 1141*

Grid square. E6/N1; depth: 175-200 cm.

Date found. 13 June 1979.

Description. A bone flake.

SKX 1142*

Grid square. E6/N1; depth: 175-200 cm.

Date found. 13 June 1979.

Description. A bone flake.

SKX 1143*

Grid square. E6/N1; depth: 175-200 cm.

Date found. 13 June 1979.

Description. A bone flake.

SKX 3227*

Grid square. E4/N4, SE quarter; depth: 460-470 cm.

Date found. 26 February 1980.

Description. A bone flake.

SKX 3287*

Grid square. E4/N4, NE quarter; depth: 490-500 cm.

Date found. 26 February 1980.

Description. A large bone flake.

SKX 10158/10159

Grid square. E1/S7, SE quarter; depth: 100-110 cm.

Date found. 2 March 1983.

Description. Two pieces of a bone flake that would have been at least 130 mm long.

SKX 16976*

Grid square. E4/N9; depth: 1200-1230 cm.

Date found. 3 June 1981.

Description. A bone flake.

2.1.3 Swartkrans Member 3

Horncore pieces

SKX 21790

Grid square. W3/S1, SW quarter; depth: 190-200 cm.

Date found. 15 March 1984.

Description. A complete left horncore.

SKX 23567

Grid square. W2/S4, NW quarter; depth: 200-210 cm.

Date found. 1 August 1984.

Description. A piece of horncore tip.

SKX 26234

Grid square. W2/S5, NE quarter; depth: 270-280 cm.

Date found. 11 January 1985.

Description. The distal end of a horncore.

SKX 28437

Grid square. W3/S3, NE quarter; depth: 280-290 cm.

Date found. 14 February 1985.

Description. The distal end of a large horncore.

SKX 28876B

Grid square. W3/S2, NE quarter; depth: 280-290 cm.

Date found. 14 February 1985.

Description. Four pieces of a curved horncore.

SKX 30214/5

Grid square. W3/S3, NE quarter; depth: 300-310 cm.

Date found. 27 February 1985.

Description. Two pieces of a horncore.

SKX 30246/9*

Grid square. W3/S3, SE quarter; depth: 320-330 cm.

Date found. 7 March 1985.

Description. An almost complete right horncore.

SKX 34570

Grid square. W4/S2, SE quarter; depth: 370-380 cm.

Date found. 24 July 1985.

Description. A small piece of horncore.

SKX 36485

Grid square. W5/S3; depth: 550-600 cm.

Date found. 24 May 1985.

Description. A small piece of horncore.

SKX 36861

Grid square. W5/S2; depth: 600-650 cm.

Date found. 27 September 1985.

Description. A piece of horncore tip.

Horse mandible

SKX 29388* + 22747-22750 + 29171

Grid square. W3/S2, NW & SE quarters, depth: 220-230 cm.

Date found. 20 February 1985.

Description. The left mandibular ramus of a *Hipparion lybicum steytleri.*

Bone pieces

SKX 10859

Grid square. W6/S4; depth: 0-100 cm, found in a hole in the south-western wall of the cave.

Date found. 17 November 1982.

Description. The end of a flake.

SKX 10978*

Grid square. W6/S4, depth: 0-100 cm.

Date found. 7 November 1982.

Description. The end of a flake.

SKX 20046*

Grid square. W2/S5, NE quarter; depth: 200-210 cm.

Date found. 17 November 1983.

Description. A bone flake.

SKX 20081

Grid square. W2/S5, SE quarter; depth: 210-220 cm.

Date found. 16 November 1983.

Description. The end of a bone flake.

SKX 21617

Grid square. W2/S5, NW quarter; depth: 220-230 cm.

Date found. 2 February 1984.

Description. Part of a thick bone flake.

SKX 22885

Grid square. W3/S1, SW quarter; depth: 210-220 cm.

Date found. 21 March 1984.

Description. The end of a bone flake.

SKX 22933a

Grid square. W3/S2, SE quarter; depth: 200-210 cm.

Date found. 21 March 1984.

Description. Part of the tip of a bone flake.

SKX 25678

Grid square. W2/S5, SW quarter; depth: 240-250 cm.

Date found. 11 January 1985.

Description. Part of the tip of a bone flake.

SKX 26112*

Grid square. W2/S3, SW quarter; depth: 170-180 cm.

Date found. 16 March 1984.

Description. Part of a bone flake.

SKX 26113

Grid square. W2/S3, SW quarter; depth: 170-180 cm.

Date found. 16 March 1984.

Description. Part of a bone flake.

SKX 26138*

Grid square. W3/S2, NE quarter; depth: 210-220 cm.

Date found. 21 March 1984.

Description. The end of a bone flake.

SKX 26139

Grid square. W3/S2, NE quarter; depth: 210-220 cm.

Date found. 21 March 1984.

Description. The end of a bone flake.

SKX 26149

Grid square. W3/S2, NE quarter; depth: 200-210 cm.

Date found. 21 March 1984.

Description. A bone flake.

SKX 26324/8

Grid square. W2/S5, SE quarter; dept: 300-310 cm.

Date found. 11 January 1985.

Description. A bone shaft.

SKX 26624

Grid square. W2/S5, NE quarter; depth: 280-290 cm.

Date found. 11 January 1985.

Description. The end of a bone flake.

SKX 28076

Grid square. W3/S4, NE quarter; depth: 230-240 cm.

Date found. 23 January 1985.

Description. A piece of bone flake.

SKX 28487

Grid square. W3/S3, NE quarter; depth: 290-300 cm.

Date found. 14 February 1985.

Description. The end of a bone flake.

SKX 28828

Grid square. W3/S3, NE quarter; depth: 270-280 cm.

Date found. 14 February 1985.

Description. A bone flake.

SKX 30052

Grid square. W3.S3, NW quarter; depth: 320-330 cm.

Date found. 7 March 1985.

Description. The tip of a bone flake.

SKX 30141

Grid square. W3/S3, NW quarter; depth: 300-310 cm.

Date found. 7 March 1985.

Description. The end of a bone flake.

SKX 32582

Grid square. W4/S2, NE quarter; depth: 230-240 cm.

Date found. 15 May 1985.

Description. A bone flake.

SKX 32897

Grid square. W4/S2, SE quarter; depth: 270-280 cm.

Date found. 21 May 1985.

Description. The end of a bone flake.

SKX 33654*

Grid square. W3/S2, SW quarter; depth: 420-430 cm.

Date found. 29 May 1985.

Description. A bone flake.

SKX 35196

Grid square. W4/S2; depth: 470-550 cm.

Date found. 8 August 1985.

Description. A bone flake.

SKX 37052*

Grid square. S3/W3; depth: 610-620 cm.

Date found. 26 September 1985.

Description. A bone flake.

SKX 37703*

Grid square. W3/S3; depth: 550-600 cm.

Date found. 28 September 1985.

Description. A bone flake.

SKX 38041

Grid square. W5/S4; depth: 660-700 cm.

Date found. 11 October 1985.

Description. The end of a bone flake.

SKX 38830*

Grid square. W4/S1; depth: 70 cm, on north wall of the Member 3 gully.

Date found. 23 October 1985.

Description. A bone flake.

SKX 45806

Grid square. W3/S2, SW quarter; depth: 260-270 cm.

Date found. 27 February 1985.

Description. The tip of a bone flake.

2.1.4 Sterkfontein Member 5

SE 612*

Grid square. Member 5 Breccia.

Date found. 5 June 1958.

Description. A bone flake.

2.2 Comparative collections (Table 2)

The comparative collections used in this study derive from both biological and non-biological contexts. Thirty-five collections, representing nine potential bone modifying agents were examined. The effects of these agencies were studied on material from twenty-four modern and eleven fossil contexts. See Table 3 for a list of the comparative collections and their source. All specimens in each collection were examined, except for reconnaissance collections where sampling was limited for the purposes of practicality. A blank defines a modern collection, while an asterisk indicates that the collection derived from a fossil context.

2.2.1 Biotic agents

Brown hyaena (*Hyaena brunnea*)

a. *Assemblage*: Botswana Den, Gemsbok National Parks, Botswana.
Reference: Mills & Mills (1977)
Institution: Transvaal Museum, Pretoria.
Number of bones studied: 27.

b. *Assemblage*: Kannaguass Den, Gemsbok National Parks, Botswana.

Reference: Mills & Mills (1977).

Institution: Transvaal Museum, Pretoria .

Number of bones studied: 54.

c. *Assemblage*: Kaspersdraai B Den, Gemsbok National Parks, Botswana.

Reference: Mills & Mills (1977).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 13.

d. *Assemblage*: Kwang Den, Gemsbok National Parks, Botswana.

Reference: Mills & Mills (1977).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 56.

e. *Assemblage*: Rooikop Den, Gemsbok National Parks, Botswana.

Reference: Mills & Mills (1977).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 17.

f. *Assemblage*: Two Central Namib Desert Dens, Namibia.

References: Skinner & van Aarde (1991); Skinner *et al.* (1997).

Institution: University of the Witwatersrand Medical School.

Number of bones studied: 7 023.

g. *Assemblage*: Deelpan A, Free State, South Africa.

Reference: Scott & Klein (1981).

Institution: Quaternary Research Department of the National Museum, Bloemfontein.

Number of bones studied: 220.

h. *Assemblage*: Uitkomst Cave, Gauteng Province, South Africa.

Reference: Brain (1981).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 234.

Spotted hyaena (*Crocuta crocuta*)

a. *Assemblage*: Kaspersdraai Den, Gemsbok National Parks, Botswana.
Reference: Mills & Mills (1977).
Institution: Transvaal Museum, Pretoria.
Number of bones studied: 15.

b. *Assemblage*: Satara, Kruger National Park, South Africa.
Reference: Brain (1981).
Institution: Transvaal Museum, Pretoria.
Number of bones studied: 12.

c. *Assemblage*: Urikaruus Den, Gemsbok National Parks, Botswana.
Reference: Mills & Mills (1977).
Institution: Transvaal Museum, Pretoria .
Number of bones studied: 69.

d. *Assemblage*: Bacon Hole Cave, South Wales, United Kingdom*.
References: Sutcliffe *et al.* (1987); Cook (1986).
Institution: British Museum of Natural History.
Number of bones studied: 199.

Mixed hyaena sp. and porcupine

a. *Assemblage*: Wright's Den, Gemsbok National Parks, Botswana.
Reference: Mills & Mills (1977).
Institution: Transvaal Museum, Pretoria.
Number of bones studied: 8.

Hyaena sp.

a. *Assemblage*: Randall's miscellaneous dens, Birmingham.
Reference: None.
Institution: Transvaal Museum, Pretoria.
Number of bones studied: 70.

b. *Assemblage*: Elandsfontein Bone Circle, south-western Cape Province, South Africa*.

Reference: Klein & Cruz-Uribe (1991).

Institution: South African Museum, Cape Town .

Number of bones studied: 196.

c. *Assemblage*: Ysterfontein, Cape Province, South Africa*.

Reference: None.

Institution: South African Museum, Cape Town.

Number of bones studied: 150.

Domestic dog (*Canis familiaris*)

a. *Assemblage*: Irene, Gauteng Province, South Africa.

Reference: None.

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 7.

b *Assemblage*: Johannesburg, Gauteng Province, South Africa.

Reference: None.

Institution: University of the Witwatersrand Medical School.

Number of bones studied: 4.

Leopard (*Panthera pardus*)

a. *Assemblage*: Portsmut lair, Namibia.

Reference: Brain (1981).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 184.

b. *Assemblage*: Hakos River lair, Namibia.

Reference: Brain (1981).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 318.

c. *Assemblage*: Kruger National Park, South Africa.

Reference: Brain (1981).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 174.

d. *Assemblage*: Quartzberg lair, Namibia.

Reference: Brain (1981).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 212.

e. *Assemblage*: Valencia Dam lair, Namibia.

Reference: Brain (1981).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 239.

Cheetah (*Acinonyx jubatis*)

a. *Assemblage*: Umfolosi, Kwazulu-Natal, South Africa.

Reference: Brain (1981).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 108.

b. *Assemblage*: Valencia Ranch, Namibia.

Reference: Brain (1981).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 291.

Porcupine (*Hystrix africaeaustralis*)

a. *Assemblage*: Wepener, Free State, South Africa.

Reference: None.

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 105.

2.2.2 Abiotic agents

Trampling

a. *Assemblage*: Elandsfontein Main (Saldanha/Hopefield), south-western Cape Province, South Africa*.

Reference: Klein (1978); Klein & Cruz-Uribe (1991).

Institution: South African Museum, Cape Town.

Number of bones studied: 1 116.

b. *Assemblage*: Homeb (Ossewater) water hole, Namibia.

Reference: Brain (1981).

Institution: Transvaal Museum, Pretoria.

Number of bones studied: 93.

Spring

a. *Assemblage*: Florisbad (Old collection), Free State, South Africa*.

Reference: Kuman & Clarke (1986); Brink (1987).

Institution: Quaternary Research Department of the National Museum, Bloemfontein.

Number of bones studied: 216.

b. *Assemblage*: Vlakkraal, Free State, South Africa*.

Reference: Wells *et al.* (1942).

Institution: Quaternary Research Department of the National Museum, Bloemfontein.

Number of bones studied: 42.

Flood plain

a. *Assemblage*: Erfkroon A, Free State, South Africa*.

Reference: None.

Institution: Quaternary Research Department of the National Museum, Bloemfontein..

Number of bones studied: 301.

Fluvial

a. *Assemblage*: Cornelia, Free State, South Africa*.

Reference: Butzer (1974).

Institution: Quaternary Research Department of the National Museum, Bloemfontein.

Number of bones studied: 974.

River gravel

a. *Assemblage*: Erfkroon B, Free State, South Africa*.

Reference: None.

Institution: Quaternary Research Department of the National Museum, Bloemfontein.

Number of bones studied: 263.

Wind

a. *Assemblage*: Duinefontein 2 (Melkbos), south-western Cape Province, South Africa*.

Reference: Hendey (1968); Klein (1976).

Institution: South African Museum, Cape Town.

Number of bones studied: 152.

b. *Assemblage*: Oyster Bay, south-eastern Cape Province, South Africa*.

Reference: None.

Institution: Quaternary Research Department of the National Museum, Bloemfontein.

Number of bones studied: 139.

2.3 Equipment

2.3.1 Photographic equipment

i. Nikon-F® camera and Micro-Nikkor® 55 mm lens.

ii. Ilford Pan-F Plus® film (50 ASA).

2.3.2 Moulding and casting materials

i. Plasticine® modelling clay.

ii Silicon rubber.

iii. Plaster of Paris.

iv. Araldite® SV 410 resin and HY 2404 hardener.

v. Araldite® M resin and HY 956 hardener.

2.3.3 Scanning Electron Microscopy

i. Coltene® PRESIDENT microSystem™ light body surface activated silicone paste for taking impressions.

ii. Araldite® M resin and HY 956 hardener for casting.

iii. JSM 840 Scanning Electron Microscope (SEM).

CHAPTER 3 - METHOD

This chapter is divided into five primary sections, the first of which deals with taphonomic terminology in order to familiarise the reader with terms used in this field of research, and to clarify the use of such terms in the context of this enquiry. The second section is an account of the method used to study the purported bone tool collection. Section three describes the template; a mobile reference sample of purported bone tools used in the study of comparative collections. The fourth section discusses the pilot study. Section five details the selection and sorting procedures used to study the comparative collections, and is itself sub-divided into four progressively more rigorous analytical phases of elimination.

3.1 Terminology

To enhance and facilitate unambiguous communication, the author has used the standardised descriptive vocabulary cited by researchers in the field of bone surface modification. Different authors sometimes offer slightly different definitions, and thus, where possible, the source of a particular definition is given. Unattributed definitions are my own, gleaned from the literature. The order of multiple definitions does not denote primary and secondary, or preferred and non-preferred definitions.

This section is divided into five subsections for easy reference, the first being a general glossary of terms used in the text. The second subsection lists and describes damage categories associated with the modification of bone. Subsection 3 defines terms specific to the first phase of faunal analysis, while subsection 4 explains the grouping of unidentifiable antelope bones into size classes. Subsection 5 lists and describes the criteria used to categorise weathering stages.

3.1.1 Glossary

See Figure 1 for a diagrammatic representation of a generalised bovid skeleton showing the locations of major skeletal elements mentioned in the text. See Figure 2 for directional terms used; Figure 3 for a diagram illustrating major bone structures; Figure 4 for schematic diagrams of fracture patterns, and Figure 5 for stages in the formation and modification of a bone assemblage.

Abiotic: (synonymous with non-biological). Any inanimate object or non-biological process capable of modifying a bone surface.

Agent: or actor refers to (1) "the general group to which the phenomenon causing change in the original state of the bone or a bone assemblage can be classed (for example biological, geological, hominid)" (Johnson 1985: 158); (2) the "immediate physical cause" of modification to bones (Gifford-Gonzalez 1991: 228).

Anterior: or front (synonymous with ventral) see Figure 2 (Seeley *et al.* 1992).

Artefact: any moveable object that has been used, modified or manufactured by humans (Bahn 1992), and extended here to include early hominids.

Assemblage: an accumulation of bones (modern or fossil) that occur at the same stratigraphic level.

Biotic: (synonymous with biological). Any micro- or macroscopic living organism capable of modifying a bone surface.

Bone flake: a fragment originating from the shaft of a long bone such as a femur, radius or metapouial. Such a piece lacks articular ends, and less than half the circumference of the long bone shaft is preserved (Brain 1981).

Bovid: antelope and cattle belonging to the family *Bovidae*. Bovids are ruminants (cudchewers), characterised by having even-toed hooves; horns; and selenodont teeth (longitudinal crescent-shaped ridges on the occlusal surfaces).

Calcrete: a limestone precipitated as surface or near-surface crusts and nodules by the evaporation of soil moisture in semi-arid climates; it may be combined with sand and gravel (Lapidus 1990). In the context of the Free State sites, calcrete occurs as calcium carbonate concretions on fossil collections from fluvial deposits.

Collection: a curated sample of an assemblage.

Configurational approach: refers to the study of multiple attributes as a means of determining what agents or processes were responsible for the modification of an assemblage. Criteria include the frequency of modified bone in an assemblage; number of marks per bone and their locations on the bone; their orientation (task related); their morphology and depth, and their association with polish or other features (Binford 1981; Bunn 1981; Potts

& Shipman 1981; Olsen & Shipman 1988; Capaldo & Blumenschine 1994; Blumenschine 1995).

Additional factors include sediment type, depositional context, matrix chemistry, rates of accumulation, the nutrient values of different bones, their survival and transport properties, the age groups of animals represented, species composition, the age of the assemblage and the weathering stages exhibited (Marshall 1989; Oliver 1989; Fisher 1995).

Diaphysis: or long bone shaft (see Figure 3).

Diagenesis: is (1) the study of post-burial taphonomic factors, that is between burial and recovery (Lawrence 1979); (2) chemical and physical changes that occur in animal remains as they alter from their original state and become fossilised (Behrensmeyer *et al.* 1989).

Distal: farther than another structure from the point of attachment to the trunk (see Figure 2) (Seeley *et al.* 1992).

Dorsal: or back (synonymous with posterior) see Figure 2 (Seeley *et al.* 1992).

Element: an anatomically complete bone or tooth (Lyman 1994).

Epiphysis: the growth end of a long bone (see Figure 3).

Geomorphology: the scientific discipline concerned with surface features of the Earth, including landforms and the chemical, physical and biological factors that act on them, for example weathering, groundwater, gravity and wind (Lapidus 1990).

Green bone: also termed wet or fresh bone (Johnson 1989) is that which (1) has recently had the flesh removed (Buikstra & Swegle 1989); (2) has not been exposed for more than two seasons (Irving *et al.* 1989).

Hominid: Any primate of the family Hominidae, which includes modern man (*Homo sapiens*) and the extinct precursors of man.

In situ: (Latin) for in the original position, or primary context.

Inferior: a structure lower than another (see Figure 2) (Seeley *et al.* 1992).

Lamellar bone: also called compact bone (see Figure 3), based on the structural characteristic of hard bone matrix arranged in concentric layers (lamellae) around Haversian canals (blood and nerve supply), oriented along the long axis of the bone (Marieb 1989).

Lateral: away from the middle or mid-line (see Figure 2) (Seeley *et al.* 1992).

Localised: in the context of surface area modification, refers to a delimited as opposed to entire surface area.

Medial: toward the mid-line or middle (see Figure 2) (Seeley *et al.* 1992).

Medulla: the inside or middle of a bone (see Figure 3).

Periosteum: a thick fibrous two-layered membrane covering the outer surfaces of bones (see Figure 3).

Postdeposition: refers to a taphonomic stage in which animal remains are buried in earth material that has been accumulated through the action of wind, water, ice or other agents (Lapidus 1990).

Posterior: or back (synonymous with dorsal) see Figure 2 (Seeley *et al.* 1992).

Predeposition: refers to the taphonomic stage after death, but prior to the burial of animal remains in earth material.

Proximal: closer than another structure to the point of attachment to the trunk (see Figure 2) (Seeley *et al.* 1992).

Sediment: refers here to the sand associated with faunal accumulations, or the matrix in which fossils are embedded whether in a loose or consolidated form (breccia).

Shaft piece: a bone piece which has more than half the circumference of the shaft preserved (Brain 1981). In the context of Appendix I (last column), the reader is alerted to the use of the term in reference to unidentifiable long bone pieces which have half or more of the circumference of the shaft preserved, irrespective of specimen length, size or taxon.

Spiral fracture: also termed radial or curvilinear, this type of fracture is (1) "curved in a helical, partially helical, or completely helical pattern around the circumference of the shaft" (Gifford-Gonzalez 1989: 188) (see Figure 4). The spiral pattern indicates bone breakage in a fresh state, but does not indicate the agency involved (Johnson 1985; Behrensmeyer *et al.* 1989; Hill 1989). A distinction is made here between spiral and oblique fractures, the latter of which is not helical in shape.

Step fractures: are characterised by irregular breakage patterns at the ends of bones (Binford 1981; Shipman *et al.* 1981) (Figure 4). Such fractures are largely a consequence of bone structure and condition (weathering stage) (Behrensmeyer *et al.* 1989), with pre-existing split lines determining the irregularity of the breakage pattern (Johnson 1985; Pickering & Wallis

1997). Step fractures may result from both pre- and postdepositional modification factors.

Striation: a general term used to describe various forms of linear damage on bone surfaces. In the context of this enquiry, striations refer to relatively fine linear markings for which the causal agent is not always known.

Superior: a structure higher than another (see Figure 2) (Seeley *et al.* 1992).

Syndiagenesis: used by Andrews & Cook (1985) to signify taphonomic processes that occur simultaneous with burial (Lyman 1994) (see Figure 5).

Tip: used here as the proximally oriented rounded or pointed worn end of a bone, or piece of bone.

Trabecular bone: also termed cancellous or spongy bone (see Figure 3).

Ventral: or front (synonymous with anterior) see Figure 2 (Seeley *et al.* 1992).

3.1.2 Damage categories

Damage categories are grouped according to the nature of the modifying agent, namely biotic, abiotic or a mixture of both. Biotic agents are subdivided into animal, insect and plant groups. As an aid to establishing a sequence of events for specimens exhibiting taphonomic overprinting, damage categories are chronologically classified into pre- and postdepositional stages. Damage categories associated with tool use are taken as predepositional. Figure 5 shows by means of a flow diagram the stages in the formation and modification of bone assemblages.

For the purpose of inter-assemblage comparison, the reader is alerted to the refined definitions of the terms 'polish', which in the context of this enquiry refers to a sheen or lustre (see below) as distinct from 'smoothing', which *need not* exhibit a sheen (see section 3.1.3).

3.1.2.1 Biotic agents

Animal

Porcupine gnawing: is characterised by incisor scrape marks which are relatively broad, shallow, and either flat-bottomed or slightly rounded in cross section (Newman 1993). They tend to overlap, and lie parallel to each other (Potts & Shipman 1981). Gnaw marks may be orientated perpendicular to the axis of the shaft, or longitudinally at extremities, where end chewing commonly results in a smoothly rounded or tapering tubular shaft pieces

(Maguire 1976; Brain 1981) (see Figure 6). Porcupine gnawing is a predepositional factor in the modification of bone.

Small rodent gnawing: produces marks similar to those made by porcupines, but on a smaller scale. Newman (1993: 223) describes individual marks as "resembling vertical-sided grooves, more than the shallow scoops of porcupine-gnawed bone". Small rodent gnaw marks lie parallel to each other and generally perpendicular to the axis of the shaft (Figure 7). Striations appear directional in the tapering of grooves from relatively deep and broad sites of tooth penetration to finer more linear lines of emergence. Small rodent gnawing is a predepositional factor in the modification of bone.

Tooth scores: are also referred to as scores (Binford 1981), striation/gouge marks (Maguire *et al.* 1980) and tooth scratches (Shipman 1981a), and are usually quite conspicuous and not easily confused with other marks. They are produced by mammal carnassials (scissor-like molars) pressing on green bone (Marshall 1989), and characterised by relatively shallow furrows (Marshall 1989; Blumenschine 1995, 1996) with smooth internal grooves (Figure 4) that vary from V-shaped to U-shaped in cross-section depending on the morphology of the tooth cusp (Haynes 1980; Bunn 1981; Potts & Shipman 1981; Shipman 1981a, 1989; Cook 1986; Newman 1993; Pickering & Wallace 1997) (Figure 8). Tooth scores may occur on bones singly, as sets of parallel and sub-parallel marks, or as clusters of marks differing widely in orientation (Haynes 1980; Shipman & Rose 1983a, b; Newman 1993), though orientation is commonly perpendicular to the axis of the shaft (Binford 1981). Unlike cutmarks, tooth scores tend to follow bone surface topography (Eickhoff & Herrmann 1985; Binford 1981), and commonly exhibit a sheen (Blumenschine & Marean 1993). Tooth scores represent predepositional modification of bone.

Tooth pits: are made by mammals (excluding rodents) and occur as discrete, roughly circular markings which scar the bone surface without any inward crushing of the bone cortex (Pickering & Wallis 1997) (Figure 9). Tooth pits tend to have a localised distribution (Maguire *et al.* 1980), typically adjacent to end chewing. They represent a predepositional stage in the modification of bone.

Tooth crushes: or punctate depressions (Maguire *et al.* 1980) are produced on green bone by the pointed tips of mammal canines and carnassials. They are characterised by roughly circular depressions of cortical bone nested in underlying cancellous bone in the vicinity of epiphyses (Binford 1981; Brain 1981; Haynes 1983; White 1992; Pickering & Wallis 1997) (Figure 10). Tooth crushes occur in the predepositional stage of bone modification.

Tooth punctures: are roughly circular holes produced by a mammal tooth cusp, often a canine, which travels through the entire thickness of a bone's cortex. The result is a hole with a depressed, roughly circular outline of bone showing inward crushing (Shipman 1981a; Cook 1986; Newman 1993; Pickering & Wallis 1997) (Figure 11). Tooth punctures generally occur on skulls and long bone shafts, and represent predepositional modification of bone.

Tooth notches: are also referred to as lunate fractures, and are semicircular- to arcuate-shaped indentations produced by mammal tooth loading (excluding rodent) along fractured or longitudinally split edges of bone (see Figure 12). Each notch usually displays two inflection points on the outer cortex, and negative flake scars on the medullary (internal) surface. Although similar in appearance, tooth notches occur characteristically less frequently than percussion notches, and in cortical view are narrower, deeper and smaller (Capaldo & Blumenschine 1994; Bunn 1981). Descriptions of this type of damage include those by Bonnichsen & Will (1980); Maguire *et al.* (1980); Brain (1981); Bunn (1989); Bunn *et al.* (1980) and Pickering & Wallis (1997).

Crenulated edges: or ragged edge chewing (Maguire *et al.* 1980), is characterised by irregular jagged edges which result from intense, sustained premolar/molar chewing by mammals other than rodents (Binford 1981; Brain 1981; Newman 1993; Pickering & Wallis 1997) (Figure 13). Crenulated edges are created during the predepositional stage of bone modification.

Shredded ends: are characterised by raw splayed fibres at the ends of bones. Shredded ends are commonly observed on mandibles modified by carnivore dental activity (see Figure 14), and therefore occur in the predepositional stage of bone modification.

Peeling: refers to the peeling back of cortical bone layers to produce bone pieces reminiscent of wood shavings. Pickering & Wallis (1997) report peeling back of cortical bone layers on specimens retrieved from controlled chimpanzee studies, where subjects were observed to grasp and pull ragged cortical bone edges using their upper and lower incisors. This type of damage has been attributed by Binford *et al.* (1988) to spotted hyaena (*Crocuta crocuta*), and by White (1992) to human modification of bone at the Mancos 5MTUMR-2346 site. Peeling occurs in the predepositional stage of bone modification.

Osteophagia: Described by Sutcliffe (1973, 1977) and Brothwell (1976), osteophagia refers to the chewing of bones and antlers by ungulates suffering from a phosphorus deficiency. Phosphorus deficiency may be the result of a low phosphorus content in the parent rock on which food plants are growing, or an excess of calcium, aluminium or iron, which reduce the availability of phosphorus to plants. Knowing that an association exists between limestone areas and bone-chewing by ungulates is important for our understanding of the fossil record, and hence interpretations of anomalous bone modifications in these contexts. Because ungulates have no upper incisors, their dependence on their cheek teeth for chewing results in characteristic fork-like remnants or prongs at the ends of elements. These sometimes exhibit transverse tooth marks and recurrent wedge-shaped gouges the size of the diameter of the element, referred to by Sutcliffe (1977) as "zig-zags". Osteophagia occurs as a predepositinal taphonomic process.

Digested bone: attributes include widespread etching, erosion, perforation, smoothing, polish or thin edge termination (Maguire *et al.* 1980; Behrensmeyer *et al.* 1989; Hill 1989; Fisher 1995; Villa & Bartram 1996), and are most typically manifest as combinations of the above features on pieces less than 60 mm in length (d'Errico & Villa 1997). Regurgitated bone is generally presented in two forms: the corroded, grossly striated form with thin sharp edges and perforations (Figure 15); and the rounded, more dense form which is smooth, polished and finely pitted. Digested bone represents a predepositional stage of bone modification.

Insect

Beetle boring: is caused by some species of dermestid and carrion beetles, which in the larval stage burrow into bone to create pupation chambers manifest as circular holes and tubes. The pupation chambers penetrate the specimen either at right angles or obliquely to the surface (Kitching 1980; Newman 1993; Fisher 1995; d'Errico & Villa 1997) (Figure 16). They vary in diameter from two to ten millimetres (Kitching 1980; Newman 1993), with some reported as having a raised lip around the periphery of the hole. Beetle boring is a predepositional modification factor.

Larvae damage: is manifest as deep, broad transverse grooves which result from gnawing by larvae on both horncore and bone surfaces (Figure 17) (Kuman & Clarke 1986; Brink 1987; Newman 1993; Fisher 1995). Larvae damage is a predepositional modification factor.

Plant

Root etching: is caused by acids associated with plant roots (Behrensmeyer 1978; Binford 1981; Morlan 1984; Fisher 1995), though it is not clear whether these acids are emitted by the roots themselves or by fungi associated with decomposing roots (Lyman 1994). Root etching is typically manifest as multiple U-shaped channels imparted in a network of wavy configurations (Fisher 1995) (Figure 18). Microscopically, these channels may be distinguished from those produced by other agents by marked etching of the channel walls (Shipman 1981b; Cook 1986). Root etching may also produce discrete or clustered pits (Fisher 1995), which under extreme conditions develop into hollowing (see definition below). Root etching is both a pre- and postdepositional modification factor.

3.1.2.2 Abiotic agents

Trampling: refers to marks on bone surfaces produced by sand grains pressed against bones through animal hoof activity. Trampling is manifest as numerous superficial marks which are closely spaced, intersecting, and of variable curvature, length and breadth (Andrews & Cook 1985; Fisher 1995), though localised sets of shallow, subparallel scratches are a common feature (Fiorillo 1989) (see Figure 19). The orientation of the scratch marks varies, but marks on long bones and ribs show a preferred transverse orientation to the main axes, whilst on scapulae they are predominantly oblique. At a microscopic level, the morphology of trample marks is highly variable, including flat-bottomed troughs, strongly V-shaped incisions, grooves with multiple parallel internal striations, U-shaped scrape marks, and fine oblique striations (Andrews & Cook 1985; Behrensmeyer *et al.* 1986; Fiorillo 1989). With regard to frequency and distribution, the proportion of bones in an assemblage with trampling modification tends to be high, with great variability in the number of striations recorded on each bone. The distribution of striations is predominantly on bone shafts as opposed to proximal or distal ends (Andrews & Cook 1985; Fiorillo 1989). Trampling may occur pre- or postdepositionally, but as Fiorillo (1989) has observed on bones representing a cross section of weathering stages, striations are restricted to those with the least degree of weathering. Other features associated with trampling include conchoidal flake scars along fractured edges, and polish (Brain 1967a), which increases proportionally with grain size (Olsen & Shipman 1988).

Olsen & Shipman (1988) propose that transverse or oblique fracture patterns should not be considered as diagnostic of trampling or any other form of modification. This is firstly because breakage patterns are determined by properties of the bone itself, relating to the orientation of collagen fibres and the condition of the bone (wet, dry or weathered). Second, because different breakage patterns occur in response to different types of loading forces (Behrensmeyer *et al.* 1989; Brain 1989; Johnson 1989; Marshall 1989; Shipman 1989), and third because different processes or agents are known to produce the same or qualitatively similar patterns (Marshall 1989; Oliver 1989). In contrast, the presence of a spiral fracture (see 3.1.1) demonstrates only that a bone was broken when fresh (Irving *et al.* 1989; Johnson 1989; Marshall 1989), a condition that may have resulted from any of the following: trampling, rock fall, carnivore mastication, water transport, an accident during the life of an animal, low temperatures, diagenic movements, volcanic shock waves and marrow processing by hominids (Marshall 1989).

Hollowing: refers to relatively large depressions with no fixed geometrical pattern that occur on the surfaces of fossilised bones (Figure 20). Hollowing is the result of chemical dissolution or mechanical erosion caused by water action, and occurs as a post mineralization process (Brink 1987). Hollowing is thus a postdepositional factor in the modification of fossilised bone. *Etching*: is also termed corrosion and dissolution, and refers to changes in the chemical composition of skeletal tissue as a result of acid conditions (Lyman 1994). Acid contexts commonly include the digestive tracts of animals, hyaena lairs and sedimentary contexts. Etching is therefore classified as both a pre- and postdepositional modification factor. Etched bones tend to appear either grossly striated due to fine fissuring caused by the chemical alteration of bone fibres (Figure 15), or finely pitted due to the exposure of vascular canals originally hidden below the surface (Figure 16). Bones are typically brittle due to a loss of bone density.

Utilisation: This refers to the use of bones as implements. Features characteristic of utilisation include considerable rounding, smoothing, and loss of structural detail. Unless extensively used, wear is differential, with a clear distinction between used and unused areas, and on a microscopic level, between raised and low-lying areas of the same worked surface. Experimental utilisation studies conducted by Shipman (1989) and Shipman *et al.* (1984) on wood, bone, sediment, meat, hide, vegetable matter and ice, revealed that it is possible to distinguish between tools used on soft, hard and mixed hard-and-soft substances. For example, a glassy polish and loss of anatomical features is characteristic of use on soft tissue, whilst irregularly-spaced and -sized pits are associated with utilisation impact on hard substances.

Cutmarks: are imparted to bone by a sharp-edged implement. They consist of elongated, relatively narrow grooves, often strongly V-shaped in cross-section with flat sides (Marshall 1989) (see Figure 21). Potts and Shipman (1981) and Shipman & Rose (1983a, 1984) maintain that the most distinctive feature of cutmarks is the microscopic presence of multiple, fine, linear striations which cut into, and orient longitudinally within the main groove.

Experimental studies have shown that diagnostic features of cutmarks can be obliterated by relatively brief periods of sedimentary abrasion or root acid action (Shipman & Rose 1983b). In recognition of the morphological similarity that can occur between individual striations produced by different agencies, many analysts advocate assessment based on the "configurational" approach (Lyman 1987; Olsen & Shipman 1988; Behrensmeyer *et al.* 1989; Johnson 1989; Wh [illegible]), which expands the diagnostic criteria to include skeletal part representation and the distribution patterns of surface damage on specimens. In the case of cutmarks, damage distribution tends to occur on particular elements, in localised areas of ligament attachment (Fiorillo 1989; Marshall 1989).

Scrapemarks: are produced when the edge of a stone artefact is dragged across a bone surface. Scrapemarks occur as well defined bands of multiple fine, closely spaced, and parallel, or nearly parallel V-shaped striations that are elongate, linear, and relatively narrow (Potts & Shipman 1981; Cook 1986; Shipman 1988; Fisher 1995). They generally cover a broad area, and tend to continue uninterrupted for some length of the specimen.

Chopmarks: are produced by striking a bone surface with an artefact at a roughly perpendicular angle. Chopmarks are broad, relatively short linear depressions, generally V-shaped in cross section, with fragments of bone crushed inwards at the bottom of the grooves. They are often broader at the top than slicing marks and do not show fine parallel striations within their borders. Chopmarks have been similarly described by Binford (1981), Potts & Shipman (1981), Shipman (1981b), Cook (1986), Noe-Nygaard (1989) and Fisher (1995).

Percussion notches: are semicircular- to arcuate-shaped indentations along the fracture edges of long bones. They are produced by hammer-on-anvil breakage, and show impact points with corresponding negative flake-scars on the medullary surface. Although similar in appearance, percussion notches are characteristically more frequent, and, in cortical view broader and shallower than tooth notches (Bunn 1981; Capaldo & Blumenschine 1994).

Preparator's marks: vary from very fine scratches and grooves to pits, gouges and depressed fractures and tend to be obviously superimposed on older marks (Cook 1986). Shipman (1981b) describes them as very fine and barely visible without magnification. Although similar in shape to tooth scratches, preparator's marks have irregular and scalloped edges, and lack the internal striae peculiar to cutmarks (Potts & Shipman 1981). These marks will not contain any matrix and may be lighter in colour than the adjacent bone surface (Shipman 1981b).

3.1.2.3 Biotic and abiotic agents

Etching: is also termed corrosion and dissolution, and refers to changes in the chemical composition of skeletal tissue as a result of acid conditions (Lyman 1994) (see Figure 22 for examples of acid etched bone). Acid contexts commonly include the digestive tracts of animals, hyaena lairs and sedimentary contexts. Etching is therefore classified as both a pre- and postdepositional modification factor. Etched bones tend to appear either grossly striated due to fine fissuring caused by the chemical alteration of bone fibres, or finely pitted due to the exposure of vascular canals originally hidden below the surface. Bones are typically brittle due to a loss of bone density.

Pitting: refers here to patches of small circular depressions reminiscent of pin pricks (Figure 23), which on a microscopic scale appear as bowl-shaped microconcavities. Pitting is associated with both pre- and post-depositional processes, effected by both chemical and mechanical agents, including hyaena gastric acids (d'Errico & Villa 1997), chemical dissolution in aqueous environments (Brink 1987), sedimentary abrasion in water (Kuman & Clarke 1986) and on land (Shipman 1989), and post-burial compaction (Behrensmeyer *et al.* 1989).

Polish: refers to a very smooth light-reflecting surface that exhibits a sheen detectable *without magnification* (see Figure 24). Polish on bone may result from sedimentary abrasion caused by trampling (Brain 1981; Olsen & Shipman 1988), wind- and waterborne particles (Brink 1987); use as a tool (Runnings *et al.* 1989; Fisher 1995), especially on soft materials such as meat and hide (Shipman 1989; Shipman *et al.* 1984); mammalian dental activity (Blumenschine & Marean 1993); licking by carnivores (Haynes & Stanford 1984; Oliver 1994); wear resulting from contact between living broken limb bones (Oliver 1989), and an inherent sheen in bony tissue structures (d'Errico 1993). Polish is therefore both a pre- and postdepositional modification factor.

Abrasion: has been variously described as "loss of surface detail" (Behrensmeyer 1990: 234), rounded edges (Behrensmeyer 1988), "removal of external laminar bone" (Behrensmeyer 1982: 220), and "erosion of the bone surface through the application of force" (Bromage1984: 173) as opposed to chemical dissolution (Behrensmeyer *et al.* 1989). In the context of this paper, the term abrasion is understood to encompass all of the above.

The terms abrasion and polish are sometimes used interchangeably, resulting in ambiguity and confusion. Following Fisher (1995), use of the term abrasion applies here to specimens showing smoothing or rounding which *need not* exhibit a sheen. Abrasion of a bone can occur by processes acting before, during, or after burial (Bromage 1984), including the effects of wind and water action, collision of bones with rocks during hydraulic transport, soil movement, trampling, osteophagia, and handling.

Striation attributes resulting from sedimentary abrasion, in particular trampling, show a considerable range of variability in size, depth and orientation (Behrensmeyer *et al.* 1989; Fiorillo 1989). Shipman (1988) advocates that as a general rule, an excess of twenty-five striations on a single specimen is strongly suggestive of sedimentary abrasion, as distinct from the abrasion caused by wind- or waterborne particles which do not usually leave striation markings. With regard to frequency and distribution, sedimentary abrasion tends to be indiscriminate in terms of the elements it effects, and is found more or less throughout the affected assemblage on all regions of all elements. Abrasion also alters the entire surface of a specimen, unlike utilisation wear which is usually localised, and modifies elevated and recessed areas differentially. Microscopically, sedimentary abrasion (no matter how fine) creates a finely pitted surface texture (Shipman 1989).

Conchoidal flake scars: are also referred to as impact scars and flake scars, and occur mostly on medullary (internal) surfaces of bone as a consequence of impact or percussion caused by carnivore gnawing (Brain 1981), hammerstone-on-anvil breakage (White 1992; Capaldo & Blumenschine 1994), rockfall or trampling (Fisher 1995) (see Figure 25). The flake scars produced by hammer-stone blows are similar to those produced by carnivores, though the scars made by carnivores are much smaller (Bunn 1981). Because bone flakes and scars display the same attributes of percussion as knapped fine-grained stone, conchoidal flake scars exhibit a negative bulb of percussion (Fisher 1995). Conchoidal flake scars may be created both pre- and postdepositionally.

Scratch mark: is a general term used to describe linear, sharply defined grooves in bone surfaces usually less than 1 mm deep and 0.5 mm wide (Behrensmeyer *et al.* 1989) and *not* of anthropic origin. Possible causes of non-utilitarian scratch marks include trampling, transport, carnivore activity, bioturbation (disturbance by organisms, including churning, trampling, burrowing and root action), and physical movement against sharp-edged particles within the sediment after burial. Scratch marks may occur both pre- and postdepositionally.

Dimpling: refers here to the distortion but not rupture of the bone surface (Figure 26). Manifest as irregular impressions of no specific shape or orientation, the actual cause of damage is not always known. Potential effectors may include bioturbation (disturbance by churning, trampling, burrowing, root action), osteophagia, and various forms of abrasion. Dimpling may occur both pre- and postdepositionally.

3.1.3 Terms used in Phase 1 analysis

See section 3.5.1 for an explanation of this phase of analysis as the first in a series of selection and sorting procedures used to examine the comparative collections.

Smoothing: describes the loss of natural angularity that can occur on edges, protrusions and flat surfaces of bone. It is the result of an act of abrasion which need not result in a significant loss of bone mass. This does not include the results of non-relevant modifying agents such as decomposition of bone. Smoothed surfaces in the context of this enquiry *need not* exhibit a sheen or lustre.

Rounded and pointed ends: refers to the rounded or pointed shape at an extremity for which no identifiable agent is responsible.

Polish: refers to the glassy sheen observed around the worn extremity of a specimen.

Striations: are fine linear modifications in the vicinity of the worn tip. Striations are relatively fine and narrow when compared with the flat, broad modification patterns caused by small rodent or porcupine gnawing, and appear hair-like when compared with the broad and rounded impressions characteristic of mammal tooth scores. Striations do not include the fine fissuring of bone fibres which results from chemical alteration caused by etching.

Flake damage: refers to single or multiple flake scars caused by the removal of splinters, chips or flakes from a localised portion of the worn end of the specimen. This type of modification does not include the conchoidal flake scars found along the medial or lateral borders of some specimens.

Non-relevant modifying agents: are identifiable from the modification patterns observed, and are not considered as critical to the objectives of the study. Non-relevant modification damage commonly includes porcupine gnawing and the rounding of ends due to the disintegration of bone with a chalk-like structure.

3.1.4 Bovid size classes

Following Brain (1974), unidentified antelope species are divided into four size classes based on the liveweights of the animal:

Antelope class I: 0-23 kg, where the upper limit is represented by a large female duiker (*Silvicapra* sp.).

Antelope class II: 23-84 kg, where the upper limit is represented by a large male blesbok (*Damaliscus dorcas*).

Antelope class III: 84-296 kg, where the upper limit is represented by a blue wildebeest (*Connochaetes gnou*).

Antelope class IV: more than 296 kg, including very large animals such as eland (*Taurotragus oryx*) or buffalo (*Syncerus caffer*).

Antelope class V: fossil bovids greater than 296 kg.

3.1.5 Weathering stages

Weathering of bone results from a combination of physical and chemical processes which may result in cracking, splitting, exfoliation, disintegration and decomposition. Rate of bone weathering varies in response to regional, local and microenvironmental conditions such as moisture, temperature and shade (Behrensmeyer

1978; Brain 1981), with the result that bone weathering data provide an estimate of the relative length of time an assemblage remained exposed after death. Recognising the stage of weathering that a bone exhibits is important firstly for establishing a taphonomic sequence of events, and second for quantification of the incidence and numbers of surface modifications in an assemblage, as degradation of a bone's surface may result in the alteration or elimination of surface modifications (Fisher 1995).

The categorisation of weathering characteristics follows the descriptive criteria of Behrensmeyer (1978), who recognises six bone weathering stages (see Table 4).

Stage 0: The bone surface shows no signs of cracking or flaking due to weathering. The bone is usually still greasy; the marrow cavity contains tissue; and skin and muscle/ligament may cover part or all of the bone surface.

Stage 1: The bone shows cracking, normally parallel to the fibre structure (for example longitudinally in long bones). Articular surfaces may show mosaic cracking of covering tissue as well as in the bone itself. Fat, skin and other tissue may or may not be present. (See Figure 27).

Stage 2: The outermost concentric thin layers of bone show flaking, usually associated with cracks, in that the bone edges along the cracks tend to separate and flake first. Long thin flakes with one or more sides still attached to the bone are common in the initial part of Stage 2. Deeper and more extensive flaking follows, until most of the outermost bone is gone. Crack edges are usually angular in cross-section. Remnants of ligaments, cartilage, and skin may be present. (See Figure 28).

Stage 3: The bone surface is characterised by patches of rough, homogeneously weathered compact bone, resulting in a fibrous texture. In these patches all the external, concentrically layered bone has been removed. Gradually the patches extend to cover the entire bone surface. Weathering does not penetrate deeper than 1 - 1.5 mm at this stage, and bone fibres are still firmly attached to each other. Crack edges are usually rounded in cross-section, and tissue is rarely present at this stage. (See Figure 29).

Stage 4: The bone surface is coarsely fibrous and rough in texture. Large and small splinters occur and may be loose enough to fall away from the bone when it is moved. Weathering penetrates into inner cavities. Cracks are open and have splintered or rounded edges. (See Figure 30).

Stage 5: The bone is now fragile and easily broken if moved. It begins to fall apart *in situ*, and large splinters lie around what remains of the element. The original bone shape may be difficult to determine at this stage. Cancellous bone is usually exposed if present, and may outlast all traces of the former more compact outer parts of the bones. (See Figure 31).

3.2 The purported bone tool collection

Fossil 'bone tool' specimens are referred to by their catalogue numbers, with the prefix SKX assigned to Swartkrans material, and SE to the Sterkfontein piece. Expanding upon the format set out by Brain & Shipman (1993), the author recorded the provenience of each 'bone tool' specimen and the date on which it was found. This was followed by a comprehensive description of each specimen following the same technical summary used for the description of pseudotools found in comparative collections (see Appendix III). The technical summary was established to facilitate the systematic and uniform analysis of all specimens. Using harsh incandescent illumination to highlight topographical detail, the description began with an analysis of gross morphological features and proceeded with the aid of a stereoscopic microscope (4 to 16x magnification) to an investigation of micro-morphological features. Subjects of interest included the size and origin of the specimen; the stage of weathering it exhibited; the type of fracture patterns recorded; factors such as the presence and degree of polishing, pitting, or carnivore damage; and the current state of preservation. Weathering characteristics followed the six stages proposed by Behrensmeyer (1978), (see Chapter 3.1.5). Specimen dimensions were taken as the total length by the mid-width by the mid-thickness. All measurements were taken using standard Vernier callipers, with all quoted measurements given in millimetres. Striation attributes were described and their orientation and distribution on specimens recorded both diagrammatically and in written form. As in the case of specimens described in the comparative collections, the tips of all specimens were superiorly oriented. Where possible, four aspects were described, starting with the periosteal surface and rotating clockwise to the margin on the observer's right, followed by the posterior surface, and lastly the margin on the observer's left. The worn tips of all of the specimens were replicated using high resolution impression and casting materials, and observed under transmitted light and with the aid of a Scanning Electron Microscope.

3.3 Template

A mobile reference sample of purported bone tools was compiled to facilitate the comparative method of analysis. The template has two components:

First, nineteen specimens from Brain & Shipman's (1993) list of Swartkrans and Sterkfontein bone tools were chosen for features characteristic of the purported bone tool collection. Criteria for selection included (but were not restricted to) the presence of unipolar localised wear in combination with localised polish and striations. The sample was moulded and cast so as to record the gross morphology and overall appearance of the fossil tool assemblage.

The second component of the template consists of a collection of high resolution black and white prints of all sixty-nine purported bone tools. The contrasts in these images serve to record the distribution of breccia and manganese dioxide deposits, as well as features not readily visible on casts.

3.3.1 Photography

A Nikon-F® camera fitted with a Micro-Nikkor® 1:35 f 55 mm lens was used. Photographs were taken using Ilford Pan-F Plus® film (50 ASA), with the shutter speed set at a quarter of a second on f 5.6-8 and f 8-11. Both negatives were printable. The camera was attached to a vertical sliding wall tripod with two 500W lamps elevated on either side. The fossils were photographed on a horizontal plate glass surface over a white background at a depth of 150 mm from the glass.

3.3.2 Moulding and casting techniques

Moulding

i. The Base

The first stage in the moulding process is the construction of a base in order to secure the specimen. Plasticine® modelling clay served this purpose, starting as a platform on which the specimen was mounted, and developing into a casing that enveloped approximately half of the body of the specimen. Once the interface between the clay and the exposed bone was sufficiently compact and smooth, a set of impressions was made on the surface of the clay. These impressions would be moulded in conjunction with the specimen to form 'keys' that would assist in the joining of the two halves at a later stage. The base and the specimen were then liberally dusted with talcum powder to facilitate ease in separation.

ii. Silicon rubber application

The second stage entailed three silicon rubber/catalyst mixture applications with a gram ratio of 50 : 4. The properties of this mixture are such that warm ambient air temperatures encourage rapid setting, while cool environments retard it and thus offer more control in the application of the medium. The silicon rubber mixture was applied to the exposed surfaces of the specimen and base using a wooden spatula. The silicon rubber was then blown into finer crevices using compressed air. Specimens were left undisturbed for a minimum of three hours, in which time the silicon rubber solidified. Using the same proportions as for the first coat, a second coating of silicon rubber was applied. Once evenly distributed, single layers of gauze matting were added to the wet rubber surface for strength. After three hours the final coat of silicon rubber was applied and in turn allowed to set for a minimum of three hours.

iii. Plaster of Paris casing

The final step in the moulding of one half of the specimen was the application of a Plaster of Paris casing. Small amounts of mixture were repeatedly made and applied due to the rapidity with which the compound sets. The casing was briskly applied using the hands, and the top and bottom were flattened to provide a sturdy resting surface. The casing was allowed to set for half an hour.

Casting

The casting material used was Araldite® SV 410 resin and HY 2404 hardener at a ratio of 25 : 3g. These were mixed well and swiftly applied to the mould with a firm, short-bristle paint brush. Excess spillage was cleaned from the edges of the mould to ensure a close fit of the two parts. The resin was allowed to settle for half an hour, after which time a second coat was applied. After three hours a preparation of Araldite® M resin and HY 956 hardener was mixed in a ratio of 75 : 15g. Cotton flock was added until a suitably firm consistency was reached, and the mixture applied to the entire inner surface. A glue of Araldite® SV 410 resin and HY 2404 hardener in a ratio of 25 : 3g was immediately applied to the part line on one side of the mould. The two halves were then closed and left overnight to set. The completed casts were trimmed at the part line and then painted with oils to reproduce the colours and markings observed on the original fossils.

3.4 Pilot study

A pilot study was conducted on a large sample of fossil remains from the Cave of Hearths collection, which, although archaeological in nature, served to establish whether the criteria theoretically selected as markers for comparison were indeed satisfactory when applied in practice. Evidence of carnivore, porcupine, human and indeterminate modification of the bones proved valuable in assisting in the refining of criteria to be used in the selection process. Five standardised modification categories common to most specimens in the 'bone tool' assemblage were thus established for the first phase of analysis. Repeatability tests for intra-observer error and reliability proved one hundred percent favourable.

3.5 Selection and sorting of comparative collections

3.5.1 Phase 1 analysis

In order to promote rigour and ensure that comparative analyses between collections were not distorted by the vagaries of noncomparable data, uniform procedures were adopted for the examination of all specimens. Each collection investigated was approached in an identical manner; with the 'bone tool' template at the observer's side, and using harsh incandescent illumination for highlighting topographical detail, every specimen was picked up for examination. Each specimen was counted to establish the frequency occurrence of damage types in the total number of specimens examined, and then the entirety of the bone's surface macroscopically analysed for its modification attributes. In the case of modern collections, mummified body parts and obscured articulated bones were considered as one specimen, while horn core sheaths and hooves were counted to conform with published data, but excluded from analysis as these do not preserve in the fossil record. Unidentifiable fragments under 20 mm in length and isolated teeth were not counted or analysed. No attempt was made to determine the minimum number of individuals (MNI) nor species represented in the collection. Analysis was purely at the level of the individual specimen and the surface modifications observed. The selection process looked for gross morphological similarity to the template, as well as the presence or absence of five critical criteria labelled "Critical Features" throughout the text.

The five Critical Features included:

1. *Smoothing*: which was retained unless a non-relevant modifying agent was identified, for example, the natural decomposition of bone.
2. *Rounded or pointed ends*: which were kept, unless the result of an identifiable non-human agent such as weathering or fracture. Bones with a naturally rounded or pointed morphology were excluded from this category, including the distal splint bones of equids, and the distal ulnae and ascending rami of some taxa.
3. *Polish*: which was always retained, unless the result of naturally smooth bone structure with an inherent shine as commonly observed on cranial fragments, in particular the acoustic meatus, most articular facets and some aves long bones; detectable periosteum remnants; adherent glistening sediments; or the insignificant abrasion of small elevated regions. Specimens coated with curating agents such as resin were eliminated from this selection category.
4. *Striations*: which were retained only if in conjunction with localised smoothing.
5. *Flake damage*: which was retained if at the tip and in conjunction with localised smoothing or polish.

In accordance with the selection criteria, specimens retained after the first phase of analysis did *not* necessarily mimic 'bone tools', but they did have to exhibit one or more of the Critical Features. The express purpose of selecting these Critical Features from assemblages of known taphonomic history was to elicit unperceived correlates between taphonomic agents and bone tool mimics. All specimens exhibiting the critical attributes were recorded on a data sheet, with a '0' or '1' value assigned to absent and present features so as to facilitate numerical analysis of the data. The skeletal part was also recorded, firstly to elucidate whether bone structure (as determined by body part) predetermined the ability of a specimen to be modified, second to gauge the effects of agents upon skeletal part modification and preservation in an assemblage, and third to aid identification of ambiguous features by way of the 'configurational' approach. (See Appendix I for the spreadsheet layout).

Those specimens clearly not comparable with the template were returned to the collection, while those bearing a resemblance to the template were placed in a holding box for further observation. This method allowed for the rapid and systematic sorting of large collections.

3.5.2 Phase 2 analysis

The selection process then proceeded to eliminate those specimens which exhibited the pertinent damage categories, but which clearly did not mimic the purported bone tools, thereby resulting in the retention of only truly close mimics. Only specimens with varying degrees of polish and those with smoothing or wear confined to one end were retained.

At this stage of analysis the author had to use discretion in the elimination of specimens which exhibited the relevant criteria, but which clearly did not mimic 'bone tool' points. This, the most critical phase of analysis, required close inspection and comparison of specimens on both a micro- and macroscopic level. For this reason, a stereoscopic microscope with 4x to 16x magnification was used to gauge the true similarities and dissimilarities between the comparative specimens and the template. Data was taken of the precise types of modification observed, including the percentage of surface area affected, plus specimen dimensions and weathering stages (see Appendix II). This facilitated comparative analysis of the various taphonomic agents and attributes, and determination of the frequencies of these in each collection. Those specimens categorised as 'non-mimics' were excluded from further investigation.

3.5.3 Phase 3 analysis

This, the final phase of reduction entailed the removal of all *entirely* worn material as caused by known agents, including hyaena gastric acids and water abrasion. Entirely worn pieces had to be retained thus far to account for the possibility that they once constituted the worn extremity of a now broken specimen.

3.5.4 Phase 4 analysis

Bone tool mimics which reached this stage were treated in the same manner as the Swartkrans and Sterkfontein fossil collection (section 3.2) with regard to descriptive analyses based on a list of predetermined criteria (see Appendix III); the use of linear diagrams to record modification distribution; and photography to capture the true image of specimens. The tips of bone tool mimics were replicated using high resolution impression and casting materials and observed using a Scanning Electron Microscope.

A detailed examination of both micro- and macroscopic morphology was made, and the similarities and dissimilarities with the purported bone tools assessed. The author then commented on the damage observed, discussing possible causative agents and processes associated with the modification of each collection.

3.5.5 Scanning Electron Microscopy

Offering a superior image of surface microtopography compared to the optical microscope, the Scanning Electron Microscope (SEM) attains superior resolution of three-dimensional structures, greater depth of field, the capability for higher magnification of specimens, and the facility of recording observed modifications by means of micrographic images. Shipman (1981b: 360) has noted that "inspection of the same specimen with a light microscope and the SEM has shown that the latter often reveals features that are unclear or invisible under the light microscope *even when the magnifications are the same*". The SEM also aids in resolving particular problems, such as determining which mark was laid down first, and hence the taphonomic history of a specimen. It also assists in ascertaining striation direction, which has important implications for the interpretation of wear patterns. Moreover, the SEM is very useful for studying striations on highly polished surfaces, as the light used with an optical microscope is reflected, causing glare that inhibits the examination of striae (Fisher 1995).

For the purposes of this study, a two-step replication technique was used. A negative impression was first made from a silicone-based high precision dental material, and then a cast made by pouring an epoxy resin into the mould. Coltene® PRESIDENT microSystem™ light body surface activated silicone paste constituted the moulding compound, and Araldite® M resin and HY 956 Hardener the casting agents.

Before commencing with moulding procedures, the surfaces of all bones and fossils were cleaned to remove any traces of grease, dirt, matrix or dust. To remove such contaminants, specimens were cleaned with mild hand soap and water using a very soft brush, and then placed under a lamp to encourage drying.

Specimens ready for moulding were first mounted in clay for stabilisation. Coltene® PRESIDENT microSystem™ light body surface activated paste, consisting of a silicone-based material and hardener, was then applied directly to the surface of the bone at temperatures between 22°C and 24°C in a relative humidity of 45% to 55% using a compound mixing syringe. After about one minute the compound was gently pressed onto the specimen surface to encourage the capture of all topographic details. After about three minutes setting time the mould was removed and stored in a zip-lock plastic bag to avoid contamination by dust. The assemblage name, specimen number and a diagrammatic representation were recorded on each bag using a permanent marker in order to avoid the use of dust-laden paper labels. A few days were set aside between moulding and casting to prevent the formation of bubbles, a feature common to newly made moulds.

Araldite®, the suggested epoxy, is also a two-part system, consisting of an epoxy resin and a catalyst. The Araldite® M resin and HY 956 Hardener were gently stirred in ratios of 100 : 20, and poured into the moulds. Air bubbles were brought to the surface using a blunt pin. When completely cured, the epoxy was removed from the mould and mounted on a stub using a colloidal graphite mixture. Specimens were rendered conductive by spanning the cement with silver paint, thereby connecting the replica and the stub. They were then sputter-coated with 200 angstroms of gold or gold/palladium.

All work done on the Scanning Electron Microscope was undertaken by the author. Casts were examined in a JSM 840 Scanning Electron Microscope, where resolutions of .1 to .25 μm (ie., accurate detail to x 1,500 to x 2,000) were anticipated. Magnifications were standardised to enable meaningful comparison between images. Two magnifications were used for micrograph reproductions; a relatively low magnification of 15x to situate the attributes in the vicinity of the tip, and a higher magnification of 30x to enhance these features. Some micrographs are marred by horizontal charge lines generated by a relatively high accelerating voltage of 15kv. With experience the author learned to rectify this problem by reducing the accelerating voltage to 10 kv.

CHAPTER 4 - ANALYSIS OF COMPARATIVE COLLECTIONS

The purpose of this study was to find bone tool mimics produced by agents other than hominid. Using a 'configurational' approach (see glossary Chapter 3.1.1), assemblages altered by known agents were studied for their modification attributes. Four stages of elimination based on progressively more rigorous analysis of bone tool mimics constituted the data collection, the results of which are presented here. The first phase of analysis looked for the presence of features broadly similar to those observed on the purported bone tools. Data collection was based on the presence of five Critical Features and the skeletal parts on which they occurred (see Appendix I). The second phase of analysis concentrated on the identification of damage categories and weathering stages, as well as measurement of specimens and the percentage of surface damage observed (see Appendix II). The third phase of analysis involved the elimination of entirely worn specimens, leaving only true bone tool mimics for the fourth and final phase of analysis and description (see Appendix III).

4.1 Description and summary of collections by type

Each collection is individually described and analysed, and the data on these collections pooled to elicit general trends and features characteristic of each agent at the assemblage level. A summary description of the modification caused by the various agents is given after the collections have been described in each category. See Table 5 for a summary of the most common elements recorded for each type in Phase 1 analysis of the comparative collections.

The description of each collection follows a generally standardised format; starting with the author's impressions of each collection with regard to characteristic features and preservation condition, and proceeding to accounts of specific information collected during the first two phases of analysis (see Appendices I and II for data collection criteria). Summary data presented here include weathering stages and the types and degree of modification observed in each collection. The description of bone tool mimics follows the considerations prescribed in Appendix III, with only observable features discussed. Attributes not mentioned are taken as absent. An asterisk indicates a fossil assemblage. Table 6 is a summary of the observed frequency (%) of specimens recorded in Phases 1 to 4 in the comparative collections.

Brown hyaena (*Hyaena brunnea*)

a. *Collection*: Botswana Den, Gemsbok National Parks, Botswana

Number of bones studied: 27

Number of pseudotools: 0

Description: As is the case with all of the Botswana-derived material in this study, this collection is characterised by a high frequency of complete elements and skulls in a good state of preservation, with no evidence of weathering. The bone structure is dense with a high fat content. The fat present in the bone produces a polish on the surface of 56% of the collection in the first phase of analysis (see Table 7). Polish confined to localised areas is the result of hyaena gnawing. Tooth scores, tooth pits and shredded ends are common. A red sediment adheres to the surface of all specimens. Flakes and fragments are few, and there is no evidence of gastric acid etching. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

b. *Collection*: Kannaguass Den, Gemsbok National Parks, Botswana

Number of bones studied: 54

Number of pseudotools: 0

Description: In keeping with the other Botswana-derived material, this collection is characterised by a high frequency of complete elements and skulls with no evidence of weathering. The bone structure is dense with a high fat content. The fat present in the bone produces a polish on the surface of 61% of the collection in the first phase of analysis (see Table 7). Polish is confined to localised areas and is the result of hyaena gnawing. Tooth scores, tooth pits and shredded ends are common. Evidence of gastric acid etching occurs on one entirely worn flake, specimen number PQ HK 116. Measuring 46 x 13 mm, it has rounded ends and a completely smooth and polished surface (see Table 7). A red sediment adheres to all specimens. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

c. *Collection*: Kaspersdraai B Den, Gemsbok National Parks, Botswana

Number of bones studied: 13

Number of pseudotools: 0

Description: In keeping with the other Botswana-derived material, this collection is characterised by a high frequency of complete elements and skulls with no evidence of weathering. The bone structure is dense with a high fat content. The fat present in the bone produces a polish on the surface of 62% of the collection in the first phase of analysis (see Table 7). Polish is confined to localised areas and is the result of hyaena gnawing. Tooth scores, tooth pits and shredded ends are common. A red sediment adheres to all of the specimens. Flakes and fragments are few, and there is no evidence of gastric acid etching. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

d. *Collection*: Kwang Den, Gemsbok National Parks, Botswana

Number of bones studied: 56

Number of pseudotools: 0

Description: In keeping with the other Botswana-derived material, this collection is characterised by a high frequency of complete elements and skulls with no evidence of weathering. The bone structure is dense with a high fat content. The fat present in the bone produces a polish on the surface of 43% of the collection in the first phase of analysis (see Table 7). Polish is confined to localised areas and is the result of hyaena gnawing. Tooth scores, tooth pits and shredded ends are common. Evidence of gastric acid etching occurs on one entirely worn flake, specimen number PQ HK 222. Measuring 37 x 11 mm, it has rounded edges and a smooth and polished surface (see Table 7). A red sediment adheres to all of the specimens. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

e. *Collection*: Rooikop Den, Gemsbok National Parks, Botswana

Number of bones studied: 17

Number of pseudotools: 0

Description: In keeping with the other Botswana-derived material, this collection is characterised by a high frequency of complete elements and skulls in a good state of preservation, with no evidence of weathering. The bone structure is dense with a high fat content. The fat present in the bone produces a polish on the surface of 71% of the collection in the first phase of analysis (see Table 7). Polish is confined to localised areas and is the result of hyaena gnawing. Tooth scores, tooth pits and shredded ends are common. A red sediment adheres to all specimens. Flakes and fragments are few, and there is no evidence of gastric acid etching. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

f. *Collection*: Two Central Namib Desert Dens, Namibia

Number of bones studied: 7023

Number of pseudotools: 0

Description: Bone accumulations from two maternity dens situated in close proximity to each other and to the Namibian coastline were pooled, and for the purposes of this study considered as one collection. The collection is characterised by a predominance of fur seal vertebrae, scapulae, appendages and skulls. These specimens exhibit a marked loss of bone density, and have an etched and friable structure. The outer cortical bone is absent from most specimens, exposing underlying bone structures to produce a finely pitted or grossly striated appearance. Long bone epiphyses are typically chewed off, resulting in an abundance of raw-ended shafts. Flakes and fragments are few. Less than 0.1% of the collection is polished or has rounded or pointed ends (see Table 7). Observed damage includes raw jagged edges, tooth scores, punctate depressions and punctures. Carnivores, ungulates and avifauna constitute only a small percentage of the collection, accurately reflecting the composition of the vertebrate fauna available to hyaenas in this region (Skinner & van Aarde 1991). In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

g. *Collection*: Deelpan A, Free State, South Africa

Number of bones studied: 220

Number of pseudotools: 0

Description: Bones in this collection are noted for the high degree of weathering they exhibit, with weathering stages ranging from 2 to 5, though stages 3 and 4 are most commonly represented. Prey species include small bovids as well as both small and large carnivores. Hyaena modification of bone is represented by tooth scores, tooth crushes and tooth punctures. Gnawed ends and edges are features commonly observed on long and compact bones, while ragged ends characterise the damage on pelvic processes and scapular blades. Gnawing out of cancellous bone is common, as is the presence of conchoidal flake scars on shaft pieces. There is an abundance of bone flakes, with 14% of the collection exhibiting rounded or pointed ends in the first phase of analysis. Polish is recorded on 38% of the collection, and striations on less than 1% (see Table 7). In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

h. *Collection*: Uitkomst Cave, Gauteng Province, South Africa*

Number of bones studied: 234

Number of pseudotools: 1

Description: The bones in this collection show a high degree of variation in the weathering attributes they exhibit, ranging from stages 0 to 3, though weathering stage 1 predominates. Porcupine gnawing noted on some specimens suggests that this secondary accumulating agent may be responsible for the more weathered material in the collection. Two distinct kinds of hyaena tooth score are recorded, namely a fine and relatively short type which glance over the surfaces of some bone shafts; and a second type, the classic tooth score manifest as broad grooves with rounded troughs. These tend to be discretely positioned and oriented perpendicular to the axes of shafts. Polish is recorded on 11% of the collection in the first phase of analysis, but occurs only as a function of mammalian dental activity. Five percent of the collection has rounded or pointed ends, while less than 1% records smoothing, striation or flaked tip attributes (see Table 7). A dark brown sand and a dry mud deposit adhere to the surfaces of most specimens.

From a sample of 234 bones, only two specimens proceeded to the second phase of analysis (see Table 7). Macroscopically, only one specimen truly mimicked a bone tool, qualifying it to reach the fourth phase of analysis in which it was studied and described in detail. Measuring 139 x 11.7 mm, this specimen was designated UIT 15 (see figure 32). Small rodent gnaw marks oriented transverse to the axis of the shaft extend for the length of the specimen on the left border. They occur at an oblique angle at the tip, as well as longitudinally for 23 mm from the superior end. Fractured edges evidence the same colour and degree of weathering as the rest of the specimen, indicating that breakage occurred prior to secondary modification. No weathering occurs on the periosteal surface, but stage 1 weathering is noted on the posterior aspect. A small amount of brown sediment adheres to both the inner and outer surfaces. Manganese dioxide staining is restricted to within 45 mm of the weathered inferior end. Smoothing at the superior end creates the illusion of an anthropically worn tip. Polish is pronounced on the worn superior and inferior ends, though the entire outer surface exhibits a sheen. Flake damage is present in a scalloped form around the perimeter of the rounded tip, as well as on the inferior end of the specimen. Mammal tooth scores oriented perpendicular to the axis of the shaft extend distally from 48.5 mm from the tip. SEM analysis of the tip reveals sets of flat, broad and parallel striations running longitudinal to the axis of the shaft (see Figure 33). These features, their dimensions and position are characteristic of rodent modification of bone. This specimen is therefore interpreted as a pseudotool resulting from porcupine gnawing.

Spotted hyaena (*Crocuta crocuta*)

a. *Collection*: Kaspersdraai Den, Gemsbok National Parks, Botswana
Number of bones studied: 15
Number of pseudotools: 0

Description: In keeping with the other Botswana-derived material, this collection is characterised by a high frequency of complete elements and skulls with no evidence of weathering. The bone structure is dense with a high fat content. The fat present in the bone produces a polish on the surface of 87% of the collection in the first phase of analysis (see Table 7). Polish confined to localised areas is the result of hyaena gnawing. Tooth scores, tooth pits and shredded ends are common. A light brown and muddy sediment adheres to the surface of the specimens. Flakes and fragments are few, and there is no evidence of gastric acid etching. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

b. *Collection*: Satara, Kruger National Park, South Africa

Number of bones studied: 12

Number of pseudotools: 0

Description: The most remarkable feature of this collection is its classic representation of hyaena den modification of bone, where leisurely feeding results in a high percentage of bone surface damage and characteristic markers. Eight of the twelve specimens illustrate typical mandible damage in that the ascending rami and incisor tooth row regions are absent. Tooth scores, tooth crushes and tooth notches occur in the tooth row region and are bracketed by shredded or jagged ends. Hyaena modification of long bones is exemplified in 'green' spiral fractures; tooth notches, tooth scores and gnaw marks on and around epiphyses; long bone shafts with one or both epiphyses chewed off; and the scooping out of cancellous bone from a humeral head. Weathering stages 0 and 1 are recorded on this material, and polish occurs on 17% of the collection in the first phase of analysis (see Table 7). In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

c. *Collection*: Urikaruus Den, Gemsbok National Parks, Botswana

Number of bones studied: 69

Number of pseudotools: 0

Description: In keeping with the other Botswana-derived material, this collection is characterised by a high frequency of complete elements and skulls with no evidence of weathering. The bone structure is dense with a high fat content. The fat present in the bone produces a polish on the surface of 71% of the collection in the first phase of analysis (see Table 7). Polish is confined to localised areas and is the result of hyaena gnawing. Tooth scores, tooth pits and shredded ends are common. A red sediment adheres to the specimens. Flakes and fragments are few, and there is no evidence of gastric acid etching. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

d. *Collection*: Bacon Hole Cave, South Wales, United Kingdom*

Number of bones studied: 199

Number of pseudotools: 10

Description: This Upper Pleistocene fossil collection is dominated by a large mammal long bone component with polished and rounded edges. An abundance of large carnivore tooth scores, and regurgitated flakes and fragments evidence hyaena modification of the bone. The material is highly fragmented, with many pieces having been refitted. Flakes are abundant and average 53 mm in length. Many of the bone surfaces appear dimpled, with polish on the elevated areas of dimpling. Microscopically, outer bone surfaces are corroded away, resulting in a finely pitted appearance. Establishing a weathering stage for the collection is difficult due to taphonomic processes having altered the bone chemistry and morphology. Weathering stage 0 is tentatively assigned to this collection. Manganese dioxide staining observed on virtually all specimens indicates a waterlogged context.

In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), fifteen specimens exhibited one or more of the critical features and proceeded to the second phase of analysis (see Table 8). Specimen dimensions were large, averaging 93 x 25 mm. Smoothing and polishing were the most frequently represented damage categories, with modification confined to a localised 28% of the surface area of specimens. Mammal tooth crushes, tooth scores and tooth pits are common, as are striations and grooves of indeterminate origin. Ten bone tool mimics reached the final phase of analysis, reiterating Stringer's (1977) original interpretation of the material as artefactual in nature. The ten pseudotool accession numbers as designated by the British Museum of Natural History are:

M43 447 (see figures 34 and 35)
M43 505 (see figures 36 and 37)
M 43 552 (see figures 38 and 39)
M43 559 (see figures 40 and 41)
M43 788 (see figure 42)
M43 476 (see figures 43 and 44)
M43 600 (see figures 45 and 46)
M43 551 (see figures 47 and 48)
M43 560 (see figures 49 and 50)
BH 74 (see figures 51 and 52).

SEM analysis of the tips revealed that not one of the marks resembles humanly produced types, nor the distinct striation modification observed on the tips of the 'bone tool' fossil material. All of the modified tip areas appear etched yet smooth on elevated areas, with occasional scratchmarks suggestive of geomorphological processes. Following Sutcliffe *et al.* (1987), it would appear that chemical alteration of the fauna was accentuated by biological agents, including hyaena faeces (represented by 63 coprolites), urine, and salivary enzymes. An acid environment would account for the corrosion observed on the bone surfaces, whilst a humid environment would have encouraged softening of the bone structure, making it susceptible to alteration. Hyaena trampling under these conditions best explains the etched yet smooth appearance of this pseudotool collection.

Mixed hyaena sp. and porcupine

a. *Collection*: <u>Wright's Den, Gemsbok National Parks, Botswana</u>
Number of bones studied: 8
Number of pseudotools: 0

Description: In keeping with the other Botswana-derived material, this collection is characterised by a high percentage of complete elements and skulls with no evidence of weathering. The bone structure is dense with a high fat content. The fat present in the bone produces a polish on the surface of 13% of the collection in the first phase of analysis (see Table 7). Polish is confined to localised areas and is the result of hyaena and porcupine gnawing. Tooth scores, tooth pits and shredded ends are common. A red sediment adheres to the specimens. Flakes and fragments are few, and there is no evidence of gastric acid etching. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

Hyaena sp.

a. *Collection*: Randall's miscellaneous dens, South Africa

Number of bones studied: 70

Number of pseudotools: 0

Description: This collection comprises specimens from three inland sites in southern Africa, namely Stella in the northern Cape Province, Morgenson in Gauteng Province and the unknown locality of Birmingham. Stage 1 weathering attributes have caused the partial erosion of some surface features. Hyaena involvement in the accumulation of this collection is evidenced by tooth scores and chewed epiphyses, as well as regurgitated pieces that are smoothly rounded and polished. Some small fragments are acid etched, with characteristically sharp and translucent edges. Porcupine gnawing is recorded on some specimens. In the first phase of analysis, polish and 'rounded or pointed end' damage categories were recorded on 3% of the collection, while smoothing was observed on only 1% of the material studied. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

b. *Collection*: Elandsfontein Bone Circle, south-western Cape Province, South Africa*

Number of bones studied: 196

Number of pseudotools: 0

Description: This fossil collection of Mid to Upper Pleistocene age (*c*. 200 000 - 30 000BP) (Klein & Cruz-Uribe 1991) exhibits weathering stages 2 to 4. Deep cracking and an absence of outer bone cortices is common. A complex taphonomic history makes it difficult to interpret the sequence of events, but the presence of coprolites and large carnivore dental markings evidence hyaena involvement in the accumulation of the assemblage. Averaging 30 mm in length, pointed and angular bone flakes constitute 17% of the collection in the first phase of analysis (Table 7). Unfortunately, investigator bias over a period of forty years favoured the removal of 'interesting pieces' (Klein & Cruz-Uribe 1991), thereby skewing the number of flakes, unidentified pieces and small bones in the sample. The collection is cream-coloured and smooth to the touch, with a talcum powder-like finish. Many of the bone surfaces have a 'bubbly' and dimpled appearance resulting from root and soil acid etching. In the first phase of analysis, 61% of the specimens were polished, while 52% were smooth (Table 7), resulting in a general blunting of all edges. Similar modification is noted on the Oyster Bay material, which has been designated an acid-etched assemblage with secondary wind modification (see this section under 'wind'). In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

c. *Collection*: Ysterfontein, Cape Province, South Africa*

Number of bones studied: 150

Number of pseudotools: 0

Description: This fossil collection of Middle to Upper Pleistocene age (*c*. 300 000 - 60 000BP) (Avery and Berger pers. comm.) exhibits stage 1 weathering attributes, and is a pale cream colour with chalky surface patches. The fossils are lightweight and friable, and many display a powdery decomposition of the bone structure. Nearly all specimens are marked with carnivore tooth scores and tooth pits. Porcupine gnawing is noted on two specimens. Plant root acid dissolution occurs in localised areas only. Manganese dioxide staining is observed on some specimens. In the first phase of analysis polish is recorded on 11% of the collection, while only 1% of the material is smoothed.

Specimens with rounded or pointed ends constitute 11% of the collection (see Table 7). In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

Summary description

In the collections studied, hyaena modification of bone is characterised by elements that have been chewed on one end, resulting in long bones with gnawed and ragged ends, and flat bones with shredded ends. Damage to mandibles is characterised by removal of the ascending rami and incisor tooth row regions to produce shredded and jagged ends. Gnawing out of cancellous bone is commonly observed on epiphyses. Tooth scores are generally broad and deep and have rounded troughs, they tend to be discretely positioned, and for the most part are oriented perpendicular to the axes of shafts. Tooth scores and tooth pits may be positioned anywhere on an element, but are most commonly observed on shafts, as are tooth punctures, tooth notches and conchoidal flake scars. Tooth crushes occur on and around epiphyses. Most collections have a few smoothly rounded regurgitated pieces, as well as a few sharp and flat acid etched pieces. A high fat content in fresh bones accounts for the deceptively high percentage of polish recorded. Flakes and long bone pieces constitute the majority of the collection, while vertebrae are the most common identifiable element, followed by mandibles, distal tibiae and distal humeri (see Table 5).

Domestic dog (*Canis familiaris*)

a. *Collection:* Irene, Gauteng Province, South Africa

Number of bones studied: 7

Number of pseudotools: 0

Description: This collection has no evidence of weathering. Gouge marks, tooth pits and tooth scores are common. Long bone pieces are either shredded at their ends or gnawed to produce irregular and untidy edges. In the first phase of analysis, smoothing, polish, and 'rounded or pointed ends' constituted 29% of the collection (see Table 7). Only one flake resembled a bone tool and proceeded to the second phase of analysis (Table 8). The modification of this specimen was clearly the result of carnivore gnawing, so the specimen was eliminated from further investigation.

b. *Collection*: Johannesburg, Gauteng Province, South Africa

Number of bones studied: 4

Number of pseudotools: 0

Description: This collection resulted from actualistic research conducted by the author. A cow humerus was obtained from a butcher and broken with the aid of a heavy rock to produce flakes and pieces suitable for a feeding experiment. Four specimens were given to two large dog pups living on a substrate of fine compact sand and dry grass. Two of the flakes were removed for analysis after one week. Both specimens had tooth scores and gnaw marks and appeared heavily striated. After the second week the other two specimens were removed. They too bore evidence of tooth scores and gnaw marks, but only one was striated (see Table 7). In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

Summary description

In the collections studied, dog modification of bone is characterised by elements that have gnawed or shredded ends. Gnawing out of cancellous bone is common. Tooth scores are relatively deep and well defined and may be U or V-shaped in cross section. Tooth scores are abundant, and together with tooth pits and gouge marks are distributed over the entire surfaces of specimens. Because these collections are the result of actualistic feeding experiments, data relating to skeletal part representation are not relevant.

Leopard (*Panthera pardus*)

a. *Collection*: Portsmut lair, Namibia

Number of bones studied: 184

Number of pseudotools: 0

Description: This collection exhibits stage 1 and 2 weathering attributes. The bones are generally brittle with a marked loss of bone mass. Black oxide staining and porcupine gnawing is noted on some pieces. Many elements remain completely unmodified. Damage observed tends to be in the form of chewing, either on the ends of long bones or around the edges of flat bones.

The portions of elements commonly affected include the ends of ribs and limb bones, mandibular ascending rami, scapular blades, and vertebral processes. This damage distribution pattern appears to be repeated throughout the collection irrespective of the taxon or size class represented. Though relatively few in number, tooth scores are fine, only glazing the surface of the bone at an angle generally perpendicular to the longitudinal axis of the shaft.

b. *Collection*: Hakos River lair, Namibia

Number of bones studied: 318

Number of pseudotools: 0

Description: This collection exhibits a wide range of weathering stages, ranging from stage 0 to 3. Evidence of leopard activity includes multiple parallel tooth grazes oriented perpendicular to the axes of shafts; tooth pits randomly interspersed between shallow tooth scores; tooth crushes on epiphyses; and chewed off ends, notably the olecranon processes of ulnae. Ones first impression of the collection is that leopard modification of bone is not unlike that of hyaenas. However, closer inspection reveals that leopards do not damage elements and their surfaces with as much force as hyaenas; they favour smaller bovid size classes; and they consume different body parts as seen in skeletal part representation (Table 5). Polish is recorded on 12% of the collection in the first phase of analysis (see Table 7), but it is a function of dental activity, and the presence of a reflective micaceous mineral in the adhering sediment. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

c. *Collection*: Kruger National Park, South Africa

Number of bones studied: 174

Number of pseudotools: 0

Description: This collection is not weathered. The bones are an orange colour with a high fat content, giving 9% of the collection a polished appearance in the first phase of analysis (see Table 7). Except for tooth crushes recorded on the tuber calcis of a calcaneum, there is very little surface damage observed on the bones. Epiphyses are characteristically absent, and there are few flakes. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

d. *Collection*: Quartzberg lair, Namibia

Number of bones studied: 212

Number of pseudotools: 0

Description: The weathering stages in this collection range from stages 0 to 2, with weathering obscuring some of the surface damage recorded. No fat is observed, and the specimens exhibit a loss of bone mass. Leopard damage to bones includes the reduction of flat bones through gnawing; the removal of epiphyses; long tooth scores which tend to hug the bone uninterrupted for half the circumference of the shaft; and a few tooth crushes located near epiphyses. Nearly all of the material is porcupine-gnawed which gives a polished appearance to 15% of the collection in the first phase of analysis. Speckled brown oxide staining is observed on some elements. Fragments are few, and less than 1% of the collection exhibits rounded or pointed ends. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

e. *Collection*: Valencia Dam lair, Namibia

Number of bones studied: 239

Number of pseudotools: 0

Description: This collection is not weathered. The bones have a high fat content and as a result give a polish to 33% of the collection in the first phase of analysis (see Table 7). Except for a few tooth scores, there is notably very little surface modification on long bone shafts. Epiphyses are typically absent or reduced through gnawing, and may have a few tooth crushes. Vertebrae have a high incidence of gnaw and bite marks, with most processes absent or reduced. Rib damage is associated with a high incidence of tooth crushes and shredded ends. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

Summary description

In the collections studied, leopard modification is characterised by long bones and flat bones with gnawed and shredded ends. Leopards modify elements with considerably less force than hyaenas, as demonstrated by tooth scores that are shallow and fine and graze the surfaces of long bones. Except for a few tooth scores and pits, long bone shafts show little modification, but their ends record a high incidence of gnaw marks and tooth crushes. Polish on specimens is associated with dental activity. Ribs are the most commonly represented element in the collections studied (see Table 5).

Cheetah (*Acinonyx jubatis*)

a. *Collection*: Umfolosi, Kwazulu-Natal, South Africa

Number of bones studied: 108

Number of pseudotools: 0

Description: No evidence of weathering is recorded in this collection. A high fat content in the bone produces a polish on 18% of specimens in the first phase of analysis. Tooth scores are generally fine and shallow, though some are V-shaped and linear and reminiscent of cutmarks. Gnawing on the ends of flat bones is common. There is a high incidence of vertebral modification. Vertebral processes are reduced through chewing, and the remaining parts are covered in tooth scores. Tooth scores are curvilinear, and tend to extend for the length of the specimen. Tooth scores are noted to straddle the processes of three articulated vertebrae. Flakes and fragments are few. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

b. *Collection*: Valencia Ranch, Namibia

Number of bones studied: 291

Number of pseudotools: 0

Description: This collection is not weathered. The bones have a high fat content and the periosteum remains intact, producing a polish on 4% of the specimens in the first phase of analysis (see Table 7). The collection is characterised by complete elements, many of which are unmodified. Surface damage on long bone shafts is not easily detectable, with only a few fine tooth grazes recorded. These are curvilinear and their orientation is multidirectional. Tooth crushes, tooth punctures and gnawing are recorded on and near epiphyses. End chewing is noted on flat bones and some long bones, resulting in shredded and ragged ends. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

Summary description

In the collections studied, cheetah modification is characterised by long bones and flat bones with gnawed and shredded ends. Like leopards, cheetahs modify elements with considerably less force than hyaenas, as illustrated by fine curvilinear tooth grazes on the surfaces of long bones. Tooth scores are manifest either as grazes, or fine V-shaped striations of multidirectional orientation. Except for a few tooth scores and pits, long bone shafts show little modification, but their ends record a high incidence of gnaw marks and tooth crushes. Ribs are the most commonly represented element (see Table 5).

Porcupine (*Hystrix africaeaustralis*)

a. *Collection*: Wepener, Free State, South Africa

Number of bones studied: 105

Number of pseudotools: 0

Description: This collection exhibits weathering stages 0 and 1, though weathering stage 0 predominates. Variability is also noted in bone density. In this collection, gnawing is observed more commonly on ends than on shafts. Porcupine gnaw-marks are characteristically broad and flat with finer longitudinal striae within the width of each incisor. Gnaw marks on long bones extend for the length of the specimen at an angle perpendicular to the axis of the shaft. Ends, however, are reduced through gnawing at an angle longitudinal to the axis of the shaft to produce a 'serviette ring' effect. Intense gnawing gives the bone an oleaginous quality. In exceedingly smooth and rounded areas where it may be difficult to grip, porcupine tooth scores are shallow, glancing the surface and resembling superficial cutmarks. Polish resulting from smoothing and dental activity is recorded on 96% of the collection in the first phase of analysis (see Table 7). Only one specimen in the collection mimicked a bone tool and proceeded to the second phase of analysis (See Table 8). Modification to this piece was clearly the result of porcupine gnawing, so it was eliminated from further investigation.

Summary description

In the collection studied, porcupine modification is characterised by multiple broad and flat gnaw marks with finer longitudinal striae within the width of each incisor. Gnaw marks on long bones extend for the length of the specimen at an angle perpendicular to the axis of the shaft. Ends are reduced through gnawing at an angle longitudinal to the axis of the shaft to produce a 'serviette ring' effect. Intense gnawing gives the bone an oleaginous quality with a high sheen. Long bones are the most commonly represented elements, followed by mandibles and distal metapodials (see Table 5).

Trampling

a. *Collection*: Elandsfontein Main (Saldanha/Hopefield), south-western Cape Province, South Africa*

Number of bones studied: 1116

Number of pseudotools: 0

Description: This Middle Pleistocene fossil collection dated to between 700 000 and 400 000 years ago (Klein & Cruz-Uribe 1991) exhibits weathering stages 2 to 4, though weathering stage 2 predominates. Multiple taphonomic agents are recorded as having contributed to the modification of this collection, which is characterised by large sized bovid limb bones in a good state of preservation. Investigator bias has resulted in a skewed skeletal part representation, biased against small bones, ribs and flakes. All surfaces are extremely smooth, with smoothing observed on 100% of the collection in the first phase of analysis (see Table 7). The general smoothing of all specimen surfaces and edges is reminiscent of the spring-modified Florisbad and wind-abraded Oyster Bay collections. Wind is considered as a major modifier of this collection, and may account for the lack of striation attributes recorded in the first phase of analysis (see Table 7). Two types of polish are recorded on 99% of the collection in the first phase of analysis (see Table 7). The first is associated with a smooth talcum powder-like finish recorded on most specimens, while the second has the appearance of a wet varnish and occurs in conjunction with localised orange coloured areas of iron mineralisation. All specimens show signs of root acid etching manifest as fine pitting, micro-grooves, or hollowing with secondary abrasion caused by water or wind. Less common types of damage include beetle boring, porcupine gnawing and large carnivore tooth scores. Spiral 'green' fractures are few, with rounded or pointed ends recorded on only 4% of the collection in the first phase of analysis (see Table 7). Most breaks have irregular edges, and are oriented perpendicular to the axis of the shaft, suggesting that breakage occurred after some degree of weathering. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

b. *Collection*: Homeb (Ossewater) water hole, Namibia

Number of bones studied: 93

Number of pseudotools: 6

Description: This collection exhibits weathering stages 0 to 2, though weathering stage 1 predominates. Striae and grooves recorded on 73% of the collection in the first phase of analysis (see Table 7) tend to be sub-parallel and unidirectional, oriented most often at an angle perpendicular to the axis of the shaft. Scratchmarks on large elements are localised in their distribution, occurring on shafts as opposed to epiphyses, and following the contours of the bone. Smaller specimens are entirely scratched. Macroscopically, there are two types of scratchmarks. The first type is broad, U-shaped, and with the naked eye is indistinguishable from carnivore tooth scores. The second type comprises multiple parallel scratches that are fine and linear. Smoothing is recorded on 68% of the collection in the first phase of analysis. It is confined to elevated regions and edges and produces an effect of localised wear. Polish is associated with smooth areas, and is recorded on 75% of the collection in the first phase of analysis (see Table 7). A relatively coarse-grained sediment with a highly reflective mineral component is found in the recesses and microfissures of the bone structures, and adds to the polished appearance of bone surfaces. Modified bones have an oleaginous appearance irrespective of their weathering stage. Seventy three percent of the collection exhibited one or more of the critical features and continued to the second phase of analysis (see Table 8). Of the sixty-eight specimens in Phase 2, only six truly mimicked bone tools and continued to Phase 4. For the purposes of description the six pseudotools are designated alphabetical letters a to f.

Specimen (a) is a bovid size class III proximal radius and ulna complex measuring 140 x 40 mm, with stage 2 weathering attributes (see Figure 53). The longitudinally fractured edge is weathered to the same degree as the rest of the specimen, indicating that this is not a fresh break. Isolating striae for the purposes of description is difficult as linear or sub-linear damage is manifest as elongated indentations as opposed to distinct scratch- type marks that incise the outer surface. These indentations are generally perpendicular to the axis of the shaft. Discrete patches of well-defined parallel and sub-parallel striae overlie these, but are confined to very small surface areas (for example 3.8 x 1.5 mm). Microscopically, the scratchmarks show cutting of the outer surface, and longitudinal microstriae within the margins of the scratches. Along the left border and periosteal surface of the specimen, broad grooves oriented perpendicular to the axis of the shaft extend distally for 65 mm. Smoothing occurs on the entire outer surface of the bone, though is most distinct on the rounded tip and elevated regions of the specimen. Polish intensity is concordant with the distribution of smoothing. Flake damage is noted on the most superior part of the specimen. Pitting is observed in the medullary cavity. Although localised smoothing at the tip mimics utilisation as a tool, SEM analysis shows an absence of striation attributes (see Figure 54).

Specimen (l_1) is a juvenile large bovid radius measuring 133 x 28 mm, with stage 1 weathering attributes (see Figure 55). The fractured edge is weathered to the same degree as the rest of the specimen, indicating an old break. Sub-parallel scratches and grooves oriented generally perpendicular to the axis of the shaft extend distally for the length of the specimen along the posterior and periosteal surfaces. Microscopically, broader scratches are seen to have fine striae running longitudinally within their borders, unlike groove-like scratches which are U-shaped in cross section, and which depress the surface as opposed to cutting it. With increased magnification, the orientation of scratches is found to be random and multi-directional. Smoothing tends to be concentrated at the fractured edge, but extends distally on the periosteal surface for approximately 20 mm; on the posterior surface for 11 mm; and in the medullary cavity for 13 mm. Polish occurs on the entire shaft, with a particularly high sheen at the worn tip. SEM analysis reveals smoothing and rounding in the vicinity of the tip, with a few relatively broad striations at angles approximately transverse to the axis of the shaft (see Figure 56).

Specimen (f_1) is a bovid size class III proximal tibia piece, measuring 144 x 41 mm, which exhibits weathering stage 1 attributes (see Figure 57). The fractured edge is weathered to the same degree as the rest of the specimen, indicating an old break. Two distinct types of striation are recorded; a fine linear type, and a broad U-shaped groove. The broader scratches appear to depress the surface, while the finer scratches incise it, and exhibit microstriae within their borders. Macroscopically, all the striations are oriented perpendicular to the axis of the shaft, and follow the contours of the bone, but microscopically their orientation is multidirectional. Overwriting and smoothing at the tip has resulted in the distortion of striae to produce a generally dimpled and depressed surface. Smoothing is most distinct on the longitudinally fractured piece and elevated areas. Polish is concordant with the areas of smoothing, and within the margins of all scratches. SEM analysis of the tip highlights the dimpled and crushed appearance of the surface. The tip is smooth and rounded with a few relatively broad and randomly oriented striations (see Figure 58).

Specimen (j) is a bovid size class III pelvic piece, including the acetabulum, ilium shaft and ischial spine. Although this piece does not conform to the dimensions and shape characteristic of bone tool points, it was necessary to include it because it met all the criteria of a pseudotool. Measuring 133 x 64 mm, it has weathering stage 1 attributes (see Figure 59). The fractured edge is weathered to the same degree as the rest of the specimen, indicating an old break. Striations occur on the flattest and most recessed portions of the specimen, and are generally oriented perpendicular to the axis of the bone. Broader groove-like scratches that depress the surface occur at the extremities, and are overlain by smoothing and polish. The surfaces of worn areas appear dimpled and distorted. Fine and well-defined scratches on the body of the specimen have microstriae within their borders. Smoothing occurs at the extremities. Polish is concordant with the smoothing, but extends to cover 90% of the bone surface. SEM analysis of the tip area shows smoothing and rounding of the highly weathered surface. At high magnification sets of extremely fine parallel striations may be seen at an angle oblique to the main axis of the shaft (see Figure 60).

Specimen (h_1) is a bovid size class III distal metatarsal. Measuring 167 x 25 mm, it has weathering stage 2 attributes (see Figure 61). The fractured edge is weathered to the same degree as the rest of the specimen, indicating an old break. Multiple parallel and sub-parallel striations and grooves oriented diagonally to the axis of the shaft tend to concentrate in the vicinity of the worn tip. On the right border they extend inferiorly for 32 mm. These scratches occur as elongated depressions (as opposed to the finer scratches that cut the surface and are multidirectional). Abrasion occurs over the entire surface of the specimen, but smoothing is confined to the area of the tip. Fracture edges also exhibit smoothing. Polish is concordant with smoothing. Flake damage is recorded at the tip. SEM analysis of the tip shows smoothing and rounding of the weathered surface, and a few relatively broad curvilinear striations at an oblique angle to the main axis of the piece (see Figure 61).

Specimen (p) is a juvenile bovid size class III medial metacarpal. Measuring 163 x 22 mm, it has weathering stage 1 attributes (see Figure 62). Striations occur generally perpendicular or oblique to the axis of the shaft, especially at the superior and inferior ends. Mimicking tooth scores, they are broad and U-shaped, and in the vicinity of the tip depress the surface to create a dimpled effect. Striations in the medullary cavity also dimple the surface, but have finer resolution, showing microstriae within the margins of each scratchmark. The orientation of the scratches is multidirectional. The entire specimen is abraded, but smoothing is confined to the rounded tip, especially in the medullary cavity and on the outer surface of the left border. Polish is concordant with smoothed areas, and extends over the entire surface of the specimen, except for in patches where the outermost layers of cortical bone have exfoliated. Pitting is observed in the medullary cavity. SEM analysis of the tip shows dimpling of the surface, with overall smoothing and rounding. No striations are recorded (see Figure 63).

Summary description

In the collections studied, trampling modification is characterised by extremely smooth surfaces, most of which are polished. Striations observed on the modern collection occur as unidirectional sub-parallel scratches, oriented most often at angles perpendicular or oblique to the axis of the shaft. Scratch marks on large elements are localised in their distribution, occurring on shafts as opposed to epiphyses. Smaller pieces are entirely scratched. Secondary wind abrasion is thought to account for the lack of striae observed in the fossil collection. Flake damage at the tip occurs in 9% of the collection Flakes and fragments constitute the majority of the collection, with horncores the most common identifiable element (see Table 5).

Spring

a. *Collection*: Florisbad (Old collection), Free State, South Africa*

Number of bones studied: 216

Number of pseudotools: 0

Description: This collection of late Middle-Upper Pleistocene age (*c.* 400 000 - 100 000BP) (Kuman & Clarke 1986; Brink 1987; Klein 1989) is dominated by bovid size class III fossil material. Weathering stage attributes range from 0 to 2, though weathering stage 1 predominates. All specimens have a white and chalky internal structure, but the outer surfaces vary from matt, to partially or entirely polished. The colours range from predominantly white, through hues of yellow, brown and grey to black. Virtually all of the specimens have been entirely modified through water abrasion, resulting in a collection of bones with amorphous structures (see Figure 64). This smoothing effect may be likened to the appearance, weight and friability of Plaster of Paris casts. Microscopically, elevations look like soft peaks on whipped cream. Some areas are exceedingly smooth and highly polished, taking on a wax-like quality. Smoothing is recorded on 99.5% of the collection in the first phase of analysis, while polish is recorded on 92% of the material (see Table 7). Pieces with rounded ends constitute 28% of the collection in the first phase of analysis (see Table 7). Fine pitting and hollowing of surfaces is common, and mammal tooth scores are surprisingly clear even after exposure to water abrasion. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), entirely worn specimens had to be retained until the third phase of analysis. The entire Florisbad collection was thus studied for Phase 2 damage attributes (see Table 8 for percentage occurrences of the attributes already discussed). The presence of a manganese dioxide deposit was not recognised at the time of data collection because it was not classically presented. Having subsequently studied the very similar Vlakkraal collection which is 100% manganese dioxide stained, the author is now of the opinion that the gradations of different colours observed on the Florisbad material are the result of water modification of manganese dioxide staining. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens mimicked a bone tool so did not proceed to the final phase of analysis and description.

b. *Collection*: Vlakkraal, Free State, South Africa*

Number of bones studied: 42

Number of pseudotools: 0

Description: This collection of late middle-Quaternary age (*c*. 400 000 - 100 000BP) (Brink pers. comm.) is dominated by bovid size class III fossil material, and shares all the characteristics observed in the Florisbad collection. Weathering stage attributes range from 0 to 2, though weathering stage 1 predominates. All specimens have a white and chalky internal structure, but the outer surfaces vary from matt, to partially or entirely polished. The colours range from predominantly white, through hues of yellow, brown and grey to black. Virtually all of the specimens have been water abraded, resulting in amorphous bone structures. This smoothing effect may be likened to the appearance, weight and friability of Plaster of Paris casts. Fine abrasion and polish is recorded on 100% of the collection in the first phase of analysis (see Table 7). Pieces with rounded ends constitute only 2% of the collection in the first phase of analysis (see Table 7). In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), entirely worn specimens had to be retained until the third phase of analysis. The whole collection was thus studied for Phase 2 damage attributes, of which fine pitting and manganese dioxide deposition are the most common (see Table 8 for percentage occurrences of the various attributes). None of the specimens truly mimicked a bone tool, so did not proceed to the final phase of analysis and description.

Summary description

In the collections studied, spring modification is characterised by amorphous bone structures that evidence a high degree of smoothing and polishing. Smoothing and polish modify entire specimens to produce exceptionally smooth and rounded pieces reminiscent of Plaster of Paris casts, not only in appearance but also in weight and friability. The majority of specimens are white, and hollowing and pitting of surfaces is common. Ribs are the most common element in the collection, followed by flakes and horncores (see Table 5).

Flood plain

a. *Collection*: <u>Erfkroon A, Free State, South Africa*</u>

Number of bones studied: 301

Number of pseudotools: 1

Description: This fossil collection of mid to late Pleistocene age (*c.* 120 000BP) (Brink pers. comm.) is covered with a calcrete deposit which unfortunately obscures most surface features. The fossil material is highly fragmented, comprising mostly long bone flakes <90 mm in length, half of which have rounded or pointed ends (see Table 7). Porcupine or small rodent gnawing is recorded on most specimens, and in most instances accounts for localised polish and rounding of tips. Weathering stage 2 is assigned to this collection on the basis of deep cracking. Manganese dioxide growth on some pieces highlights mosaic cracking of the surface. Microscopically, the outer cortical layers appear crushed and broken, with contiguous fibres and structures at differing heights and depths, and on different planes. This damage may be the result of calcretisation, localised weathering conditions, or mechanical action in a fluvial context. On a macroscopic scale, the overall effect of roughness has subsequently been reduced through abrasion. Five specimens continued to the second phase of analysis (see Table 8), and only one to the fourth phase.

Specimen EK 555 is a long bone piece measuring 117 x 24 mm (see Figure 65). It is almost entirely covered with an abraded calcrete deposit. Fractures along the right and left borders show the same degree of weathering and calcretisation as the rest of specimen, indicating no post-fossilisation reduction in size. Smoothing is observed on the right facet of the tip, as well as along the posterior aspect of the specimen. Polish is concordant with smoothing, but is marked in elevated areas. Pitting is associated with smoothing and polish, and extends inferiorly on the posterior aspect of the tip for 7 mm. Flake damage is noted on the posterior and periosteal aspects at the tip. Manganese dioxide staining is present on all exposed areas of the specimen. Dimpling modification of the tip appears to be the result of acid etching. Porcupine gnawing has created a scalloped effect along the length of the left margin, as well as mediolaterally in the medullary cavity. This specimen is interpreted as a piece of porcupine-gnawed bone with evidence of secondary plant root acid and flood plain modification. SEM analysis of the tip shows an etched surface with evidence of smoothing and rounding. There are no striation attributes (see Figure 66).

Fluvial

a. *Collection*: Cornelia, Free State, South Africa*

Number of bones studied: 974

Number of pseudotools: 0

Description: This fossil collection, between 600 000 and 800 000 years old (Butzer *et al.* 1974; Brink pers. comm.), is dominated by bovid size class IV material in a virtually complete state of preservation. Abrasion of the outer surfaces has caused a general rounding of elevations and raw edges, leaving most of the material in a friable and chalky condition. The abrasion is of a coarse type, with less than 1% of the collection smoothed in the first phase of analysis (see Table 7). Surface features and polish are for the most part eliminated, leaving a matt and rough surface texture. Microscopically, surfaces appear etched, and exhibit micro-crushing and mosaic cracking. In the first phase of analysis, polish (at a low 8%) was the most frequently observed attribute in the collection (see Table 7). Hollowing (also associated with spring site contexts) was noted on some specimens. Of the ten modification attributes recorded in Phase 2, manganese dioxide was the most frequently observed; represented on only 1% of the collection (see Table 8). Abrasion of the surface, and a thin calcrete deposit on many specimens makes determining a weathering stage difficult, though stage 3 weathering features appear to be most commonly represented in this sample. In accordance with the selection and sorting procedures stipulated in the method (Chapter 3.5), none of the specimens exhibited one or more of the critical features, so did not proceed past the first phase of analysis.

River gravel

a. *Collection*: Erfkroon B, Free State, South Africa*

Number of bones studied: 263

Number of pseudotools: 1

Description: This collection of late Middle-Upper Pleistocene age (*c.* 400 000 - 300 000BP) (Brink pers. comm.) exhibits weathering stage 3 attributes. In the first phase of analysis, 27% of the collection had rounded or pointed ends, 19% was smoothed, and 8% was polished to some degree (see Table 7). Manganese dioxide staining, root acid etching and fine pitting occur on many specimens, though these attributes are represented by relatively low frequencies as shown in the second phase of analysis (see Table 8). Microscopically, elevations and raw edges are rounded and polished, surfaces look etched, and areas with calcrete deposits appear dimpled.

Only one specimen proceeded to the fourth phase of analysis. Designated ERF B2, this possible horncore specimen measures 21 x 15 mm (see Figure 67) and is of an indeterminate weathering stage. Three groove-like striations are recorded on the periosteal, right, and posterior surfaces of the specimen. All three occur at an angle oblique to the axis of the shaft, and may be the result of carnivore dental activity. Mottled manganese dioxide staining covers the entire specimen, with thicker deposition in recessed areas Smoothing extends inferiorly for 11 mm on the periosteal surface, and 8 mm on the posterior side. Polish is contiguous with the smoothing, and is pronounced in areas with heavy manganese dioxide staining. SEM analysis of the tip shows a dimpled but extremely smooth surface with no striation attributes (Figure 67).

Summary description

In the various collections studied, riverine contexts produce highly fragmented pieces, which tend to have pointed ends. The surface of the material is matt and rough due to micro crushing and mosaic cracking of the outer surfaces. Calcrete deposits were observed on all three fossil collections studied. Flakes are most commonly represented in the collection, while horncores are the most common identifiable element.

Wind

a. *Collection*: Duinefontein 2 (Melkbos), south-western Cape Province, South Africa*

Number of bones studied: 152

Number of pseudotools: 5

Description: This fossil collection of later Middle Pleistocene age (in excess of 125 000 years) (Klein 1976), exhibits weathering stage 1 attributes. Bovid size classes III and IV predominate. The fossils are generally smooth to the touch and have well-rounded edges. Sand abrasion and polishing tend to modify only one aspect of specimens, producing a talcum powder-like finish. Polish is recorded on 55% of the collection in the first phase of analysis, though its distribution is variable. Some specimens are matt with only elevated regions and sharp edges showing polishing, while others are completely and highly polished, as if varnished. They are ochre-coloured with some evidence of manganese dioxide staining and root acid etching. Pointed flakes and fragments constitute 16% of the collection in the first phase of analysis (see Table 7). In accordance with the selection and sorting criteria prescribed in the method (Chapter 3.5), six specimens proceeded to the second phase of analysis (see Table 8), and five to the fourth phase. For the purposes of description, four of the five bone tool mimics have been assigned the prefix D.

Specimen (D_1) is a flake which measures 43 x 14 mm, and has weathering stage 1 attributes (see Figure 68). The fractured edge is weathered to the same degree as the rest of the specimen, indicating an old break. The entire periosteal surface is defaced by parallel and sub-parallel striations that occur in clusters oriented at angles perpendicular or oblique to the axis of the shaft. Each batch is approximately 13 mm wide, and individual striae are 10 mm long. The batches (which are randomly bisected by isolated striations) are interpreted as trampling marks. Relatively deep and broad grooves on the periosteal surface of the specimen are interpreted as tooth scores. Smoothing is observed on the left margin and periosteal surface, while all aspects show polishing, but only superiorly. SEM analysis of the tip shows a set of fine sub-parallel striations at an angle transverse to the main axis of the piece. Smoothing is noted on elevated areas and along edges (see Figure 69).

Specimen (D_2) is a long bone piece which measures 37 x 13 mm, and has weathering stage 1 attributes (Figure 70). The fractured edge is weathered to the same degree as the rest of the specimen, indicating an old break. Fine parallel striations oriented at an angle oblique to the axis of the shaft occur on all aspects of the specimen. A pair of 24 mm long curvilinear striations of unknown origin extend distally from the superior left border. A groove on the inferior end of the periosteal surface is interpreted as a carnivore tooth score. A manganese dioxide deposit is noted in the recessed and flaked areas of the tip, as well as in the medullary cavity. Smoothing and polish is observed on all elevated areas, along the right border of the posterior surface and at the tip. Dimpling and smoothing noted along the right border is interpreted as the result of carnivore chewing. SEM analysis of the tip shows an etched surface with subsequent smoothing and rounding of elevated areas and edges (see Figure 71).

Specimen (D_3) is a long bone flake which measures 62 x 21 mm and exhibits weathering stage 1 attributes (Figure 72). Fractures appear evenly worn since the original break. The entire periosteal surface is defaced by parallel striations that occur in clusters oriented at an angle oblique to the axis of the shaft. Interpreted as trample marks, each batch is approximately 7 mm wide, with individual striae up to 13 mm long where flatness of the surface permits. The batches are bisected by multi-directional isolated striations. Grooves along the left border of the periosteal surface are interpreted as carnivore tooth scores. The entire specimen is smoothed and polished, especially in elevated regions. A small conchoidal flake scar is recorded at the tip. Fine pitting is noted on both the periosteal and posterior surfaces. SEM analysis of the tip shows smoothing and rounding of a finely pitted and highly weathered surface. A set of parallel striations oriented transverse to the main axis may be seen distal to the tip (Figure 73).

Specimen (D_4) is a cancellous bone flake which measures 56 x 15 mm, and exhibits weathering stage 1 attributes (Figure 74). Fractures are evenly worn, suggesting an old break. The periosteal surface of this specimen is not scratched in the same manner as the other wind-abraded pseudotools in the collection, but is instead covered with grooves oriented at an angle oblique to the axis of the shaft. These are interpreted as carnivore tooth scores due to their association with carnivore tooth crushes, and the end gnawing recorded at the tip. Manganese dioxide staining is noted in small quantities on the same surface. Smoothing is observed on all aspects of the specimen, especially the superior 1/3 of the flake. Polish also occurs superiorly, but is confined to the periosteal, right and left surfaces. SEM analysis of the tip shows an etched and highly weathered surface with smoothing and rounding of elevated areas and edges (see Figure 75).

Specimen A15-11 (111) OC2 is a long bone flake that measures 90 x 12 mm, and exhibits stage 1 weathering attributes (Figure 76). Fractures are evenly weathered, indicating old breakage. A network of grooves caused by root acid etching covers the entire specimen, and obscures other forms of modification, except for fine pitting in the medullary cavity, and flake damage at the tip. Smoothing and polish is observed on all elevated areas, but is most pronounced at the tip. SEM analysis of the tip shows an etched surface with subsequent smoothing of elevated areas (see Figure 76). There are no striation attributes.

b. *Collection*: Oyster Bay, south-eastern Cape Province, South Africa*

Number of bones studied: 139

Number of pseudotools: 0

Description: This material originates from a fossil dune ridge that was exposed by wind. The material dates to between 70 000 and 80 000BP (Brink pers. comm.). Smoothing of the entire collection (see Table 7) makes identification of weathering stages difficult, though weathering stage 1 appears to be most common. Root acid etching is present on nearly all specimens, but wind modification of the grooves and pits has created a 'bubbly' effect. All elevations and raw edges are rounded, and all surfaces are extremely smooth, as if covered by a layer of talcum powder. Polish is recorded on 53% of the collection in the first phase of analysis (see Table 7). Highly polished surfaces feel waxy to the touch, and reminiscent of spring-eroded material which has an oleaginous quality. Manganese dioxide staining is observed on most specimens. In accordance with the selection and sorting criteria prescribed in the method (Chapter 3.5), sixteen specimens proceeded to the second phase of analysis (see Table 8). None of these truly mimicked bone tools, so were eliminated from further investigation.

Summary description

In the collections studied, wind modification is characterised by material with extremely smooth surfaces that have a talcum powder-like finish. Elevations and raw edges are smoothed and rounded. Varying degrees of polish are recorded on half of the specimens. Vertebrae are the most commonly represented elements, followed by flakes and ribs (see Table 5).

CHAPTER 5 - DESCRIPTION OF FOSSILS

This chapter is divided into two sections. In the first section the fossils are described individually, and in the second section they are summarised collectively.

5.1 Fossil descriptions

Purely descriptive, the purpose of this section is to enhance the existing fossil descriptions of Brain & Shipman (1993) and to re-describe the fossil specimens from Swartkrans and Sterkfontein. The same technical summary as used for the description of pseudotools was followed to facilitate the systematic and standardised analysis of all material studied (see section 3.2 for a detailed description of the method, and Appendix III for the data sheet layout). Variables not mentioned in the text are taken as absent. The narrow range of features common to all of the fossil specimens studied served to reduce the descriptive format to a set of criteria which focused primarily on the skeletal origin of pieces; fracture patterns; wear in the vicinity of the tip; striation data, and the state of preservation. Weathering stages are not given for horncores.

The fossil specimens are described in a uniform manner, with the worn tip always superiorly oriented. Unless otherwise stated, the modifications discussed under the sub-heading 'striations' refer exclusively to those found in the localised area of the worn tip. Where possible, four aspects are described, starting with the periosteal surface and rotating clockwise to the margin on the observer's right, followed by the posterior surface, and lastly the margin on the observer's left. Because many of the pieces are fragmented and therefore difficult to identify and orientate, the generic term 'posterior' refers to the back surface of the specimen, opposite the periosteum. The size of the specimen is given in millimetres (mm), with the total length (L) preceding the mid-width (W) and mid-thickness (T) respectively. Following Brain (1974), unidentified antelope species are divided into four size classes based on the liveweights of the animal (see 3.1.4). An asterisk denotes a new tool, identified during re-examination of the Swartkrans faunal collection. New tools are grouped together at the end of the Swartkrans section. See Table 9 for a list of these specimens.

Definitions used to describe the conservation of specimens are specific to this section of the enquiry. The term 'broken' refers here to fracture damage which has occurred subsequent to wear observed at the tip and on the edges of the object, while the term 'unbroken' is used for specimens with worn edges, *albeit* if the blank is a bone fragment showing original fracture surfaces. 'Unbroken' edges are sub-divided into two types, namely 'weathered' or 'spiral'. Weathered fractures are typically longitudinal or transverse to the main axis of the bone, while spiral fractures have a helical breakage pattern as described by Gifford-Gonzalez (1989) (see Glossary, Chapter 3.1.1).

A 'fresh break' refers to one that happened relatively recently, commonly occurring during the excavation or preparation of a specimen. In this section, a 'fresh break' does *not* refer to the helical fracture pattern associated with green fractures in the stricter sense of the term. Although distinctly fresh with regard to unmodified surface structure and colour, some fresh breaks may bear the traces of manganese dioxide or breccia deposits.

An 'ancient break' is one that occurred in prehistory, either simultaneous with wear at the tip, or post-depositionally, usually as a result of geological processes. Ancient breaks are those which have a manganese dioxide deposit on the unworn break edge, and are clearly discoloured to the same degree as the rest of the specimen.

The term 'flake damage' refers to single or multiple flake scars caused by the removal of splinters, chips or flakes from a localised portion of the worn end of the specimen.

5.1.1 Swartkrans Member 1 Lower Bank

Horncore pieces

SKX 4228b, Figures 77 and 78.

Grid square: E5/N5, SW quarter; depth: 560-570 cm.

Date found: 9 July 1980 (Brain & Shipman 1993).

Size: 42 (L) x 15 (W) 12 mm (T).

Origin: The distal portion of a bovid horncore.

Conservation: Ancient breaks are noted at the tip and along the left margin. A fresh break is noted at the inferior end. The right margin and what remains of the left side appear worn.

Worn tip: The shape of the tip is indeterminate due to breakage. However, the wear pattern extends inferiorly for 25 mm, and flake damage is recorded on the periosteal surface.

Striations: Longitudinal and oblique striations are recorded on all aspects with the addition of transverse striae on the posterior surface.

Preservation: Manganese dioxide and an orange breccia deposit are recorded on all of the ancient surfaces. A residual moulding agent may be seen in recessed areas. The preservation of striation detail is excellent.

SKX 7068, Figures 79 and 80.

Grid square: E5/N4, SW quarter; depth 470-480 cm.

Date found: 19 March 1980 (Brain & Shipman 1993).

Size: 38 (L) x 16.5 (W) x 15 mm (T).

Origin: A bovid distal horncore.

Conservation: A fresh break is noted on the inferior end. Both the left and the right margins are worn.

Worn tip: The shape of the tip is pointed and the wear pattern extends inferiorly for 19 mm. There is no evidence of flake damage.

Striations: Longitudinal and oblique striations are recorded on all aspects.

Preservation: The fresh break has reduced the length of the piece to the remnant tip. A diffuse manganese dioxide deposit grows over the extent of the ancient surface. An orange breccia residue may be seen in recessed areas. Residual moulding materials adhere to the inferior end of the piece. Surface modifications are well preserved.

SKX 5011, Figure 81.

Grid square: E3/N10; depth uncertain as the Member 1 sediment here had been disturbed by mining activities.

Date found: 25 March 1981 (Brain & Shipman 1993).

Size: 144 (L) x 29.5 (W) x 21 mm (T).

Origin: A complete *Damaliscus dorcas* horncore.

Conservation: The left and right margins appear worn, as does the inferior end of the specimen, which has a weathered breakage pattern.

Worn tip: The shape of the tip is pointed, and the wear pattern extends inferiorly for 33 mm.

Striations: Longitudinal and oblique striations are recorded on all aspects of the piece.

Preservation: A manganese dioxide deposit covers most of the surface area. An orange breccia is noted in recesses, particularly on the left border and inferior end of the specimen. The preservation of surface detail is excellent.

Bone flakes

SKX 794, Figures 82 and 83.

Grid square: E2/N3; depth: 350-400 cm.

Date found: 10 May 1979 (Brain & Shipman 1993).

Size: 27.5 (L) x 20.5 (W) x 9 mm (T).

Origin: A mammal bone flake.

Conservation: Ancient breaks are noted on the left side and inferior end of the piece. The right margin appears worn.

Worn tip: The shape of the tip is linear and wear extends inferiorly for 26.35 mm. Flake damage overlain by wear is noted on the periosteal and posterior surfaces.

Striations: No striations are observed.

Preservation: A light manganese dioxide deposit is noted on all aspects. An orange breccia may be seen in recessed areas. The piece appears to be well preserved, but does not record a definitive wear pattern.

Weathering stage: 1.

SKX 1429, Figure 84.

Grid square: E4/N3; depth: 500-550 cm.

Date found: 17 May 1979 (Brain & Shipman 1993).

Size: 18.5 (L) x 9 (W) x 6 mm (T).

Origin: A possible mammal rib flake.

Conservation: A fresh break is noted on the inferior end. Both the left and right margins are worn.

Worn tip: The shape of the tip is pointed and the wear pattern extends inferiorly for the length of the piece, that is a distance of 18.55 mm. There is no evidence of flake damage.

Striations: Longitudinal, oblique and transverse striations are recorded on all aspects.

Preservation: Small patches of manganese dioxide may be seen on the posterior aspect. Orange breccia is recorded in recessed areas. Surface preservation of the wear pattern is very good.

Weathering stage: 0.

SKX 3477/3478, Figures 85 and 86.

Grid square: E4/N4, NE quarter; depth: 510-520 cm.

Date found: 28 February 1980 (Brain & Shipman 1993).

Size: 64 (L) x 19 (W) x 13.5 mm (T).

Origin: A large mammal bone flake.

Conservation: A fresh break is noted on the left, and an ancient break on the inferior end of the piece. The unbroken right side is worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 35 mm. There is flake damage on the periosteal side of the tip.

Striations: Longitudinal striations are recorded on all aspects, with the addition of oblique and transverse striae on the periosteal surface.

Preservation: There is very little manganese dioxide on this piece. An orange breccia is recorded in recessed areas. Glue has been used to mend a break inferior to the tip. Although highly worn on all aspects, the wear pattern is well preserved in a recess along the right margin.

Weathering stage: 2.

SKX 5000, Figures 87 and 88.

Grid square: E3/N5, SW quarter; depth 620-630 cm.

Date found: 11 February 1981 (Brain & Shipman 1993).

Size: 63 (L) x 23 (W) x 12 mm (T).

Origin: A possible large mammal rib fragment.

Breakage: Ancient breaks are recorded inferiorly along the left margin and at the distal end of the specimen. Both the left and right margins are weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 42 mm. There is no evidence of flake damage.

Striations: Longitudinal striations are recorded on the periosteal and posterior surfaces. Oblique striations are noted on the left and right margins.

Preservation: Manganese dioxide and a residual orange breccia deposit are present on all aspects. Glue has been used to repair a longitudinal fracture. Moulding materials may be seen on all aspects, especially inferiorly. The wear pattern is well preserved.

Weathering stage: 1.

SKX 5001, Figures 89 and 90.

Grid square: E3/N4, NW quarter; depth: 610-620 cm.

Date found: 18 February 1981 (Brain & Shipman 1993).

Size: 52.5 (L) x 15 (W) x 9 mm (T).

Origin: A medial metapodial fragment.

Conservation: Ancient breaks are noted along the left margin and inferior end of the piece. The unbroken right side is worn and weathered.

Worn tip: The shape of the tip is rounded and wear extends inferiorly for 42 mm.

Striations: Longitudinal striations are recorded on all aspects, with the addition of oblique striae on the periosteal and endosteal surfaces.

Preservation: A diffuse manganese dioxide deposit covers the fossil. Orange breccia is noted in recessed areas and inferiorly along the right margin. A white moulding material adheres to the surface on the inferior end. Th preservation of surface detail is excellent.

Weathering stage: 1.

SKX 5003, Figure 91.

Grid square: E4/N5, NW quarter; depth 660-670 cm.

Date found: 25 March 1981 (Brain & Shipman 1993).

Size: 59 (L) x 16 (W) x 10 mm (T).

Origin: A mammal bone flake.

Conservation: Fresh breaks are noted along the left margin below the tip, and at the inferior end of the piece.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 20 mm. There is no evidence of flake damage.

Striations: Longitudinal striations are recorded on the periosteal, endosteal and right surfaces. Oblique striations may be seen on the posterior, left and right sides of the piece.

Preservation: Manganese dioxide and an orange breccia deposit are recorded on all of the ancient surfaces. Residual moulding materials may be seen on all aspects, especially on the inferior half. Glue has been used to mend a transverse break midway down the length of the specimen. Striation modifications at the tip are well preserved.

Weathering stage: 1.

SKX 5005, Figure 92.

Grid square: E3/N5, SW quarter; depth: 610-620 cm.

Date found: 11 February 1981 (Brain & Shipman 1993).

Size: 100 (L) x 19.5 (W) x 7.5 mm (T).

Origin: A rib fragment from a size class III-IV mammal.

Conservation: An ancient break is noted on the inferior end only. Both the left and the right margins appear worn and weathered.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 40 mm. There is no evidence of flake damage at the tip.

Striations: Longitudinal striations are recorded on all aspects, with the addition of transverse striae on the periosteal surface.

Preservation: Glue is noted on a transverse break half way down the length of the specimen. A manganese dioxide deposit covers all aspects, and is most dense on the superior half of the piece. A relatively thick orange breccia deposit may be seen in recessed areas, especially in the hollow spongy bone structures on the posterior surface. Residual moulding materials are noted along the left and right margins. Preservation of surface detail is excellent.

Weathering stage: 0.

SKX 5006, Figures 93 and 94.

Grid square: E3/N5, SE quarter; depth: 640-650 cm.

Date found: 18 March 1981 (Brain & Shipman 1993).

Size: 36 (L) x 15 (W) x 6.5 mm (T).

Origin: A mammal bone flake.

Conservation: An ancient break is noted on the inferior end of the piece. Both the left and right margins are weathered and worn.

Worn tip: The shape of the tip is pointed, and wear extends inferiorly for 22 mm.

Striations: Longitudinal striations are recorded on all aspects. Oblique striae are recorded on all aspects except for the posterior surface. Transverse striae are noted on the periosteal surface.

Preservation: A diffuse manganese dioxide deposit is recorded on all aspects. An orange breccia residue discolours the fossil surface and may be seen on the inferior break edge. A white moulding material adheres to the surface on the inferior end of the piece. Preservation of surface detail is very good.

Weathering stage: 1.

SKX 5008, Figure 95.

Grid square: E3/N5, SE quarter; depth: 580-590 cm.

Date found: 5 February 1981 (Brain & Shipman 1993).

Size: 146.5 (L) x 16 (W) x 15 mm (T).

Origin: A bone piece possibly originating from an ulna.

Conservation: The piece is complete, with weathering and wear recorded on the left and right margins as well as the inferior end.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 32 mm.

Striations: Longitudinal and oblique striations are noted on all aspects, with the addition of transverse striae on the right side.

Preservation: A diffuse manganese dioxide deposit covers all of the ancient surfaces. An orange breccia is noted in recessed areas. Glue has been used to mend three transverse breaks on the body of the piece. Preservation of surface detail is excellent.

Weathering stage: 2.

SKX 5009, Figures 96 and 97.

Grid square: E3/N5, NE quarter; depth: 750-760 cm.

Date found: 10 June 1981 (Brain & Shipman 1993).

Size: 36.5 (L) x 7 (W) x 6.5 mm (T).

Origin: A mammal bone flake.

Conservation: Fresh breaks are noted on the left side and inferior end of the piece. The unbroken right side is worn.

Worn tip: A longitudinal fracture on the left makes the shape of the tip indeterminate. Wear extends inferiorly for 27 mm.

Striations: Longitudinal striations are recorded on all of the ancient surfaces.

Preservation: A thick manganese dioxide deposit covers the worn surfaces. Orange breccia is recorded in recessed areas. Even though the piece is greatly reduced in size through breakage, surface detail is well preserved on the remnant tip.

Weathering stage: 1.

SKX 5010a, Figure 98.

Grid square: E4/N9; depth about 1 000 cm in Member 1 Lower Bank sediment disturbed by lime-mining operations.

Date found: 19 May 1981 (Brain & Shipman 1993).

Size: 114 (L) x 21.5 (W) x 14.5 mm (T).

Origin: A right inner mediodistal radius fragment from a bovid size class II-III animal.

Conservation: A fresh break is noted only at the distal end of the specimen. Both the left and right sides are unbroken, weathered and worn.

Worn tip: The shape of the tip is rounded, with wear extending distally for 54 mm. Both the periosteal and endosteal surfaces evidence flake damage overlain with wear.

Striations: Both longitudinal and oblique striations are observed on the periosteal surface and left margin of the specimen, while only longitudinal striations are recorded on the right margin and in the medullary cavity.

Preservation: A manganese dioxide deposit is noted on all surfaces of the specimen, while an orange breccia deposit may be seen in recesses along the left and right edges, as well as on the unworn periosteal surface. Casting materials adhere to rough surfaces, and impression materials are trapped in surface fissures. Preparator's marks are noted in the medullary cavity, and glue is recorded on the superior right margin where flake damage has been curated.

Weathering stage: 2.

SKX 5010b, Figure 99.

Grid square: E4/N9; depth about 1000 cm in Member 1 sediment disturbed by mining operations.

Date found: 19 May 1981 (Brain & Shipman 1993).

Size: 84.5 (L) x 12 (W) x 13 mm (T).

Origin: A mammal long bone flake.

Conservation: An ancient break is noted on the left and inferior end of the specimen. The right margin is worn and weathered.

Worn tip: The shape of the tip is pointed and the wear pattern extends inferiorly for 33 mm. Flake damage on the periosteal surface is overlain with wear.

Striations: Longitudinal striations are noted on all of the ancient surfaces.

Preservation: The periosteal surface of the specimen exhibits mosaic cracking and longitudinal split lines associated with Behrensmeyer's (1978) stage 1 weathering characteristics. The weathered surface does not detract from the well-preserved wear pattern. Manganese dioxide and an orange breccia deposit are present on all surfaces. Moulding materials may be seen on all surfaces, particularly on the spongy bone on the posterior aspect.

Weathering stage: 2.

SKX 5012, Figures 100 and 101.

Grid square: E4/N9; depth: 1230 cm.

Date found: 3 June 1981 (Brain & Shipman 1993).

Size: 117 (L) x 25 (W) x 21 mm (T).

Origin: A bone flake from a very large mammal.

Conservation: Ancient breaks are noted on the left and at the inferior end of the piece. The right margin is weathered and worn.

Worn tip: The shape of the tip is linear, and wear extends for 20 mm inferiorly. Flake damage overlain with wear is observed on the posterior surface.

Striations: Longitudinal and oblique striations are recorded on the periosteal and posterior surfaces, as well as along the right hand margin. Transverse striae are noted on the right border only.

Preservation: A diffuse manganese dioxide de[illegible] [illegible]urs on all aspects. A residual orange breccia deposit discolours the fossil [illegible] most noticeable on the inferior posterior surface. Preservation of surface detail is excellent, recording the wear pattern in detail and with high resolution.

Weathering stage: 2.

SKX 7062, Figure 102.

Grid square: E5/N4, SW quarter; depth: 460-470 cm.

Date found: 19 March 1980 (Brain & Shipman 1993).

Size: 80 (L) x 11.5 (W) x 11 mm (T).

Origin: A mammal long bone segment.

Conservation: Ancient breaks are noted on the left margin and inferior end of the piece. The unbroken right side is weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 28 mm.

Striations: Longitudinal and oblique striations are noted on the periosteal surface and left margin.

Preservation: A diffuse manganese dioxide deposit extends over the ancient surfaces. Orange breccia may be seen in recessed areas. Glue has been used to mend two transverse breaks in the middle section of the fossil. White moulding material adheres to the posterior surface. A high degree of wear is recorded at the tip.

Weathering stage: 2.

5.1.2 Swartkrans Member 2

Horncore pieces

SKX 12383, Figure 103.

Grid square: E4/S6, SE quarter; depth 80-90 cm.

Date found: 26 May 1983 (Brain & Shipman 1993).

Size: 50.5 (L) x 24 (W) x 20 mm (T).

Origin: A large bovid horncore piece.

Conservation: A fresh break is noted on the inferior end. The left and right margins are worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 20 mm.

Striations: Longitudinal striations are noted on all aspects.

Preservation: Breakage at the inferior end has restricted the size of the specimen to the region of the tip. Most of the surface is covered with a manganese dioxide deposit. An orange breccia residue may be seen in recesses on all aspects. Residual moulding material adheres to the inferior surface area as well as the wear facet at the tip of the specimen. A few broad striations along the right margin run approximately transverse to the axis of the shaft.

Weathering stage: 1.

SKX 15536, Figures 104 and 105.

Grid square: E6/S1; depth: 150-200 cm.

Date found: 6 June 1979 (Brain & Shipman 1993).

Size: 56.5 (L) x 23 (W) x 17 mm (T).

Origin: The distal part of a large mammal horncore.

Conservation: Fresh breaks are noted along the left margin behind the tip, and on the inferior end of the specimen. The right and remnant left margin are worn.

Worn tip: The shape of the tip is rounded and wear extends inferiorly for 20 mm. Unworn flake damage is noted on both the periosteal and endosteal surfaces.

Striations: Striations are recorded on the facet on the right in the vicinity of the tip.

Preservation: Fresh breaks along the left border and inferior end of the piece have greatly reduced the size of the fossil, exposing its friable inner structure. As a consequence, the fractured surfaces have been consolidated with a Paraloid® glue wash. An orange breccia overlain by a brown deposit is noted on the inferior half. A diffuse manganese dioxide deposit grows on top of the breccias and on the remnant surface of the bone. Five deep and broad indentations reminiscent of hyaena tooth scores run perpendicular to the main axis on the periosteal surface. Although damaged, the preservation of surface detail is excellent, especially on and around the worn facet on the right hand side of the tip.

SKX 17211, Figure 106.

Grid square: E4/S3, NE quarter; depth: 160-170 cm, at the interface between Member 2 and the underlying Lower Bank of Member 1.

Date found: 22 June 1983 (Brain & Shipman 1993).

Size: 285 (L) x 55 (W) x 47 mm (T).

Origin: The compete horncore of an Alcelaphine antelope, cf. *Beatragus.*

Conservation: The specimen appears worn on the left side.

Worn tip: The shape of the tip is rounded and wear extends inferiorly for 10 mm.

Striations: Transverse striations are noted on the right margin only.

Preservation: A manganese dioxide deposit covers much of the surface area. An orange breccia is recorded in recessed areas. Putty and glue have been used to mend breaks on the superior half of the piece. Residual moulding materials are seen on all aspects. General preservation of the fossil is good, and though the tip appears worn, no distinctive wear pattern is observed.

Bone flakes

SKX 105, Figures 107 and 108.

Grid square: E5/S2; depth: 180-190 cm.

Date found: 26 July 1979 (Brain & Shipman 1993).

Size: 38 (L) x 12.5 (W) x 12 mm (T).

Origin: A size class II mammal long bone.

Conservation: A fresh break is noted on the inferior end. The left and right sides appear weathered and worn.

Worn tip: The shape of the tip is pointed and the wear pattern extends for 29 mm inferiorly.

Striations: Longitudinal, transverse and oblique striations are recorded on the periosteal surface and right margin of the piece. Longitudinal and oblique striae may be seen on the posterior aspect, and longitudinal and transverse striae occur on the left side.

Preservation: Manganese dioxide deposition is confined to the tip and right border of the piece. Orange breccia discolours the surface of the fossil, and may be seen as a deposit on the inferior periosteal surface. Preservation of surface detail is very good.

Weathering stage: 1.

SKX 352, Figure 109.

Grid square: E5/N2; depth: 250-275 cm.

Date found: 21 June 1979 (Brain & Shipman 1993).

Size: 41 (L) x 13 (W) x 11 mm (T).

Origin: A long bone cortical fragment from a size class III-IV mammal.

Conservation: Ancient breaks are noted on the right margin and inferior end of the specimen. The left margin of the fossil is weathered and worn.

Worn tip: The shape of the tip is linear, with wear extending inferiorly for 25 mm. Flake damage on the periosteal surface is overlain with wear.

Striations: Longitudinal and oblique striae are recorded on the periosteal surface, while only longitudinal striae occur on the posterior and left aspects of the piece.

Preservation: The condition of the worn tip is good, preserving well defined longitudinal striations on the periosteal surface. A diffuse manganese dioxide deposit covers the entire surface of the specimen. An orange breccia is noted, particularly in recessed areas of the posterior surface.

Weathering stage: 1.

SKX 1141, Figures 110 and 111.

Grid square: E6/N1, SW quarter; depth: 175-200 cm.

Date found: 13 June 1979 (Brain & Shipman 1993).

Size: 9.5 (L) x 14 mm (T). Width indeterminate.

Origin: A cortical fragment from a large mammal long bone.

Conservation: An ancient fracture is noted along the right margin and inferior end of the specimen. A fresh break at the superior end of the piece has resulted in the loss of the worn tip. The left margin appears worn and weathered.

Worn tip: Morphometric analysis of the tip is indeterminate due to a fresh break at the superior end of the piece.

Striations: Longitudinal and oblique striations are recorded on the periosteal surface, while longitudinal striations alone may be seen on the left border.

Preservation: A light and diffuse manganese dioxide deposit may be seen on all of the ancient surfaces. An orange breccia deposit may be seen on the left and right margins as well as the posterior aspect of the piece. Although greatly reduced through breakage, a clearly defined wear pattern is preserved on the periosteal surface of the specimen.

Weathering stage: 1.

SKX 1142, Figure 112.

Grid square: E6/N1; depth: 175-200 cm.

Date found: 13 June 1979 (Brain & Shipman 1993).

Size: 60.5 (L) x 20.5 (W) x 11 (T) mm.

Origin: A long bone flake from a size class II –III mammal.

Conservation: There is a fresh break on the left of the flake that leaves only the tip section of the left border intact. An ancient break is noted at the inferior end of the fossil. The unbroken right margin and remaining left margin appear weathered and worn.

Worn tip: The shape of the tip is rounded with wear extending inferiorly for 40 mm. There is no evidence of flake damage.

Striations: Longitudinal striations may be seen in the medullary cavity and along the left margin of the piece. Both longitudinal and oblique striations are noted on the periosteal surface and along the right margin.

Preservation: The superior region of the specimen is in good condition with a well-preserved wear pattern. A manganese dioxide deposit is noted on all of the ancient surfaces of the specimen. An orange breccia may be seen in recesses and on unworn surface areas. Glue and remnants of casting and moulding agents are recorded in the midline fracture.

Weathering stage: 1.

SKX 1143, Figure 113.

Grid square: E6/N1; depth: 175-200 cm.

Date found: 13 June 1979 (Brain & Shipman 1993).

Size: 52 (L) x 13 (W) x 8.5 mm (T).

Origin: A long bone cortical fragment from a class size III-IV mammal.

Conservation: Ancient breakage is noted along the right margin and inferior end of the specimen. The left side is worn and weathered.

Worn tip: The shape of the tip is pointed with wear extending inferiorly for 32 mm. Flake damage on the periosteal surface is overlain with wear.

Striations: Longitudinal striations are recorded on the periosteal and posterior surfaces, as well as along the left margin.

Preservation: A diffuse manganese dioxide deposit covers all aspects of the specimen. An orange breccia deposit is noted on the inferior half of the piece, particularly on the posterior surface and in the angular recesses of the inferior broken end. Although reduced in size through breakage, the specimen is in good condition with excellent preservation of surface detail.

Weathering stage: 2.

SKX 3227, Figures 114 and 115.

Grid square: E4/N4, SE quarter; depth: 460-470 cm.

Date found: 26 February 1980 (Brain & Shipman 1993).

Size: 42 (L) x 16.5 (W) x 10 mm (T).

Origin: The medial part of a size class II-III mammal bone.

Conservation: Ancient breaks are noted on the left margin and inferior end of the piece. The unbroken right margin is worn and weathered.

Worn tip: The shape of the tip is rounded and wear extends inferiorly for 33 mm. There is no flake damage.

Striations: Longitudinal striae are noted on all aspects, with the addition of oblique striae on the periosteal surface.

Preservation: Manganese dioxide and orange breccia deposits are noted on all aspects. Residual moulding materials remain trapped in recessed areas. The preservation of striations is excellent.

Weathering stage: 1.

SKX 3287, Figure 116.

Grid square: E4/N4, NE quarter; depth: 490-500 cm.

Date found: 26 February 1980 (Brain & Shipman 1993).

Size: 131 (L) x 24 (W) x 15 mm (T).

Origin: A size class III-IV mammal tibia.

Conservation: A complete piece with all aspects weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 37 mm.

Striations: Longitudinal striations are noted on the left, right and periosteal surfaces. Oblique striae are recorded on the left side only.

Preservation: A diffuse manganese dioxide deposit extends over the entire piece. An orange breccia deposit may be seen in recessed areas. Glue has been used to mend three transverse breaks. Moulding materials may be seen in cracks and on the surface of the fossil.

Weathering stage: 1.

SKX 10158/10159, Figures 117 and 118.

Grid square: E1/S7, SE quarter; depth: 100-110 cm.

Date found: 2 March 1983 (Brain & Shipman 1993).

Size: 60 (L) x 20 (W) x 15 (T) mm.

Origin: A large mammal bone flake.

Conservation: An ancient break is noted on the inferior end. Both the left and right sides appear weathered and worn.

Worn tip: The shape of the tip is pointed and the wear pattern extends inferiorly for 23 mm. There is no evidence of flake damage.

Striations: Longitudinal striations are noted on all aspects.

Preservation: A light manganese dioxide deposit extends over the entire surface of the fossil, particularly along the right margin. An orange breccia deposit may be seen in recessed areas, especially on the posterior surface. Residual moulding materials may be seen on all aspects. Preservation of surface detail is good.

Weathering stage: 1.

SKX 16976, Figure 119.

Grid square: E4/N9; depth: 1200-1230 cm.

Date found: 3 June 1981 (Brain & Shipman 1993).

Size: 68 (L) x 21 (W) x 13 mm (T).

Origin: The medial portion of a size class III mammal femoral flake.

Conservation: Fresh breaks are noted on the left margin and inferior end of the specimen. The right margin appears worn and weathered.

Worn tip: The shape of the tip is rounded, with wear extending inferiorly for 24 mm.

Striations: Longitudinal and oblique striations are noted on both the periosteal and posterior surfaces. Microscopic analysis shows that the fine longitudinal striae emanating from the tip *overlie* the broad and approximately transversely oriented tooth scores recorded on the periosteal and endosteal surfaces.

Preservation: A diffuse and polished manganese dioxide deposit covers all aspects of the specimen. A residual orange breccia deposit may be seen in surface cracks and recesses, as well as on the inferior break edge of the piece. Moulding materials are noted in indentations and surface irregularities. Although weathering and carnivore damage have imposed a high degree of post-mortem modification on the specimen, the surface preservation is excellent, with well-defined striations recorded on the worn surfaces.

Weathering stage: 0.

5.1.3 Swartkrans Member 3

Horncore pieces

SKX 21790, Figure 120 and 121.

Grid square: W3/S1, SW quarter; depth: 190-200 cm.

Date found: 15 March 1984 (Brain & Shipman 1993).

Size: 42 (L) x 15 (W) x 11.5 mm (T).

Origin: An antelope horncore.

Conservation: The specimen is complete and has wear on the left margin.

Worn tip: The shape of the tip is rounded with wear extending inferiorly for 14 mm.

Striations: Longitudinal striations are observed on the broad and flat facets designated the periosteal and posterior surfaces.

Preservation: Manganese dioxide covers most of the surface of the specimen. An orange breccia is noted in recesses. Glue has been used to curate a transverse fracture 47 mm from the tip. Moulding materials adhere to irregularities on the periosteal surface inferior to the tip. The fossil is in a good state of preservation.

SKX 23567, Figures 122 and 123.

Grid square: W2/S4, NW quarter; depth: 200-210 cm.

Date found: 1 August 1984 (Brain & Shipman 1993).

Size: 32 (L) x 14 (W) x 11 mm (T).

Origin: The distal part of a mammal horncore.

Conservation: Ancient breaks are noted along the right margin and inferior end. The unbroken left side and remnant right margin are weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 25.30 mm. There is no evidence of flake damage at the tip.

Striations: Longitudinal striations are recorded on all aspects.

Preservation: Manganese dioxide and an orange breccia deposit occur on all surfaces. Residual moulding materials may be seen in recessed areas. Although the surface of the specimen appears rough and is greatly reduced in size through breakage, the preservation of striation detail remains excellent.

SKX 26234, Figures 124 and 125.

Grid square: W2/S5, NE quarter; depth: 270-280 cm.

Date found: 11 January 1985 (Brain & Shipman 1993).

Size: 46 (L) x 13 (W) x 12 mm (T).

Origin: The distal horncore of a steenbuck-like antelope.

Conservation: An ancient break is noted on the inferior end only. The left and right sides appear worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 28 mm. Flake damage overlain by wear is noted on the posterior aspect.

Striations: Longitudinal striations are recorded on all aspects.

Preservation: A relatively thick manganese dioxide deposit covers most of the surface area of the fossil. A residual orange breccia deposit may be seen in recessed areas. Three different moulding agents are observed adhering to the surface of the piece. Attempts at their removal are detrimental to the excellent preservation of surface details.

SKX 28437, Figures 126 and 127.

Grid square: W3/S3, NE quarter; depth: 280-290 cm.

Date found: 14 February 1985 (Brain & Shipman 1993).

Size: 52.5 (L) x 22.5 (W) x 18.5 mm (T).

Origin: The distal part of a large mammal horncore, species indeterminate.

Conservation: An ancient break is noted on the tip, while a fresh break is recorded on the inferior end. The left and right sides (narrow facets) appear worn.

Worn tip: The shape of the tip is pointed, with wear extending inferiorly for 15 mm.

Striations: Oblique striations are noted on the left and right margins. Flake damage on the right margin is overlain with wear.

Preservation: A sparse manganese dioxide deposit may be seen on the posterior surface and right margin of the piece. An orange breccia is recorded in recesses on all aspects of the specimen. Coarse sediment granules are lodged in the tip.

SKX 28876B, Figures 128 and 129.

Grid square: W3/S2, NE quarter; depth: 280-290 cm.

Date found: 14 February 1985 (Brain & Shipman 1993).

Size: 140 (L) x 32 (W) x 23 mm (T).

Origin: A distal horncore, possibly from an Alcelaphine antelope species.

Conservation: There is a fresh break on the left and an ancient break on the inferior end of the piece.

Worn tip: The shape of the tip is round and wear extends inferiorly for 5 mm.

Striations: A few multi-directional striations associated with polish may be seen on the right side at the inferior end.

Preservation: The piece is greatly reduced through breakage, and the surface is poorly preserved. A diffuse manganese dioxide deposit grows on the ancient surface inferiorly. An orange breccia deposit may be seen in recessed areas, and is commonly overlaid by an adherent moulding material.

SKX 30214/5, Figures 130 and 131.

Grid square: W3/S3, NE quarter; depth: 300-310 cm.

Date found: 27 February 1985 (Brain & Shipman 1993).

Size: 20 (L) x 12 (W) x 11 mm (T).

Origin: The distal part of a bovid horncore.

Conservation: A fresh break is noted on the inferior end. All of the surfaces are worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 16 mm. There is no evidence of flake damage.

Striations: The striations are multi-directional, with longitudinal, oblique and transverse striae recorded on all aspects.

Preservation: The specimen is greatly reduced in size due to breakage. Manganese dioxide and breccia deposits are present on the ancient surface, and together with the catalogue number obscure a great deal of the wear pattern. The surface preservation of modifications is good.

SKX 30246/9, Figure 132.

Grid square: W3/S3, SE quarter; depth: 320-330 cm.

Date found: 7 March 1985 (Brain & Shipman 1993).

Size: 123 (L) x 29.5 (W) x 23 mm (T).

Origin: An entire horncore of the genus *Antidorcas*.

Conservation: A fresh break is noted on the inferior end only.

Worn tip: The shape of the tip is rounded, and wear extends inferiorly for 20 mm.

Striations: Longitudinal striations occur along the right margin only.

Preservation: A diffuse manganese dioxide deposit covers all aspects of the specimen. An orange breccia deposit may be seen in recessed areas, particularly inferiorly on the irregular break edge. Residual moulding material defaces the entire surface of the specimen. Glue has been used in the refitting of three transverse breaks approximately 24 mm, 89 mm and 112 mm from the tip. The specimen is in a relatively good state of preservation.

SKX 34570, Figure 133 and 134.

Grid square: W4/S2, SE quarter; depth: 370-380 cm.

Date found: 24 July 1985 (Brain & Shipman 1993).

Size: 26 (L) x 11 (W) x 10 mm (T).

Origin: The distal part of a bovid horncore.

Conservation: Fresh breaks are noted on the left and inferior end of the piece. There is an ancient break along the right margin.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 20 mm.

Striations: Longitudinal and oblique striations are recorded on the periosteal and posterior surfaces.

Preservation: The piece has been greatly reduced in size through breakage. A diffuse manganese dioxide deposit covers all the ancient surfaces of the remnant tip. Orange breccia is observable in recessed areas. Striation modifications are relatively well preserved considering that very little remains of the original highly weathered surface.

SKX 36485, Figures 135 and 136.

Grid square: W5/S3; depth: 550-600 cm.

Date found: 24 May 1985 (Brain & Shipman 1993).

Size: 30 (L) x 10 (W) x 9 mm (T).

Origin: A possible horncore fragment.

Conservation: Ancient breaks are noted on the left and right sides, as well as the inferior end of the piece. Both the left and right margins are weathered and worn.

Worn tip: The shape of the tip is pointed, and the wear pattern extends inferiorly for 30 mm. There is no flake damage.

Striations: Longitudinal and oblique striations are recorded on all of the worn surfaces.

Preservation: The piece is greatly reduced in size through breakage. Manganese dioxide and an orange breccia deposit are noted on the ancient surfaces. Moulding materials may be seen in recessed areas. The wear pattern covers a very small area of the remnant tip.

SKX 36861, Figures 137 and 138.

Grid square: W5/S2; depth: 600-650 cm.

Date found: 27 September 1985 (Brain & Shipman 1993).

Size: 25 (L) x 13 (W) x 7 mm (T).

Origin: The distal portion of a mammal horncore.

Conservation: Ancient breaks are noted along the left margin and inferior end of the specimen.

Worn tip: The shape of the tip is pointed, and worn to such a degree that no definitive measurements can be taken.

Striations: Very few are discernible, and not characteristic of the type seen on other specimens.

Preservation: Only the highly worn remnant tip of this piece remains. The periosteal surface is totally covered by manganese dioxide and breccia deposits, while the fractured internal surface is obscured by a residual moulding material.

Horse mandible

SKX 29388 + 22747-22750+29171, Figures 139 and 140.

Grid square: W3/S2, NW & SE quarters, depth: 220-230 cm.

Date found: 20 February 1985 (Brain & Shipman 1993).

Size: 186 (L) x 54 (W) x 24 mm (T).

Origin: A *Hipparion lybicum steytleri* left mandible.

Conservation: The mandible is almost complete, and exhibits signs of weathering and wear in the vicinity of the mandibular ramus.

Worn tip: The worn region of the mandibular ramus is rounded in shape, with wear extending inferiorly for 20 mm. Flake damage overlain by wear is noted on the periosteal and posterior surfaces.

Striations: Longitudinal striations are observed on all aspects.

Preservation: A diffuse manganese dioxide deposit extends over most of the fossil. An orange breccia residue is noted in recessed areas and on the bone surface where it has coloured the fossil a pale orange. Plaster of Paris and glue have been used to repair and reinforce the specimen. Preservation of surface detail is excellent, especially in the vicinity of the worn tip.

Weathering stage: 2.

Bone pieces

SKX 10859, Figures 141 and 142.

Grid square: W6/S4; depth: 0-100 cm, found in a hole in the south-western wall of the cave.

Date found: 17 November 1982 (Brain & Shipman 1993).

Size: 42.5 (L) x 11 (W) x 18.5 mm (T).

Origin: A bone flake from a very large mammal.

Conservation: Ancients breaks are noted on the left and inferior end of the piece. The unbroken right margin is weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 25 mm. Flake damage overlain by wear may be seen on the posterior surface.

Striations: Longitudinal striations are noted on the periosteal and right surfaces. Oblique striae may be seen on the posterior aspect of the piece.

Preservation: Manganese dioxide and orange breccia deposition is relatively dense, especially along the fractured edge on the left. Residual moulding materials may be seen on all aspects. Surface preservation is relatively good, but because the tip is highly worn, individual striations are not well recorded.

Weathering stage: 1.

SKX 10978, Figure 143.

Grid square: W6/S4, depth: 0-100 cm.

Date found: 7 November 1982 (Brain & Shipman 1993).

Size: 63.5 (L) x 14 (W) x 13 (T) mm.

Origin: A long bone flake from a size class III-IV mammal.

Conservation: An ancient break is noted on the inferior end of the specimen. Both the left and right margins appear worn and weathered.

Worn tip: The shape of the tip is pointed, and wear extends inferiorly for 33 mm. Flake damage overlain with wear is noted on the periosteal and posterior aspects of the tip.

Striations: Longitudinal striations are recorded on all surfaces, with the addition of oblique striations on the periosteal surface and right margin. Transverse striae are limited to only the periosteal surface.

Preservation: Manganese dioxide and an orange breccia deposit are diffusely distributed over all aspects of the piece. Residual casting and moulding materials may be seen in the fracture lines on the periosteal surface and the right margin of the specimen. The condition of the fossil is good with excellent preservation of surface details.

Weathering stage: 1.

SKX 20046, Figure 144.

Grid square: W2/S5, NE quarter; depth: 200-210 cm.

Date found: 17 November 1983 (Brain & Shipman 1993).

Size: 87.5 (L) x 28.5 (W) x 19.5 mm (T).

Origin: The distolateral end of an equid metacarpal.

Conservation: The inferior portions of both the left and right margins are freshly broken. However, the remaining superior region of the right margin evidences a spiral breakage pattern overlain with wear. An ancient break is noted at the most inferior part of the specimen.

Worn tip: The tip is rounded, with wear extending inferiorly for 33 mm. Unworn flake damage is recorded on the endosteal surface.

Striations: Longitudinal striations are confined to all aspects of the tip, with additional oblique striations recorded on the endosteal surface.

Preservation: The condition of the fossil is good with excellent preservation of surface modifications. Unfortunately, a manganese dioxide deposit covers the entire periosteal surface as well as most of the endosteal cavity, and in so doing slightly obscures the wear pattern. A brown sediment adheres to the surface of the medullary cavity, while the residue of an orange breccia may be seen on the periosteal surface. Remnants of a moulding material adhere to the fresh break edges and unworn surface of the medullary cavity.

Weathering stage: 1.

SKX 20081, Figure 145.

Grid square: W2/S5, SE quarter; depth: 210-220 cm.

Date found: 16 November 1983 (Brain & Shipman 1993).

Size: 62 (L) x 20.5 (W) x 12.5 mm (T).

Origin: A mammal bone flake.

Conservation: An ancient break is noted on the inferior end. Both the left and right sides appear weathered and worn.

Worn tip: The shape of the tip is rounded and wear extends inferiorly for 40 mm. Flake damage overlain with wear is noted on the posterior surface.

Striations: Longitudinal striations are noted on all aspects, with the addition of oblique and transverse striae on the periosteal surface only.

Preservation: A thick manganese dioxide deposit covers most of the surface area of the fossil. An orange breccia is observed in recessed areas. Glue has been used to mend transverse and longitudinal fractures at the inferior end of the piece. Preservation of the wear pattern is excellent.

Weathering stage: 1.

SKX 21617, Figures 146 and 147.

Grid square: W2/S5, NW quarter; depth: 220-230 cm.

Date found: 2 February 1984 (Brain & Shipman 1993).

Size: 49.5 (L) x 14 (W) x 18.5 mm (T).

Origin: A flake from a large mammal bone.

Conservation: Ancient breaks are noted along the right margin and at the inferior end of the piece.

Worn tip: The shape of the tip is linear and wear extends inferiorly for 10 mm. There is no flake damage.

Striations: Longitudinal striations are recorded on the posterior surface only.

Preservation: Manganese dioxide and orange breccia deposition is relatively thick on all aspects. The ancient surfaces are highly weathered and appear to have been consolidated with a glue wash.

Weathering stage: 2.

SKX 22885, Figures 148 and 149.

Grid square: W3/S1, SW quarter; depth: 210-220 cm.

Date found: 21 March 1984 (Brain & Shipman 1993).

Size: 35.5 (L) x 17 (W) x 8 mm (T).

Origin: A mammal bone fragment.

Conservation: An ancient break is noted on the inferior end only. The left and right sides are worn and weathered.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 20 mm. There is no evidence of flake damage.

Striations: Longitudinal and oblique striations are noted on the periosteal surface, while only longitudinal striae are recorded on the left and right margins.

Preservation: Manganese dioxide and an orange breccia deposit are observed on all aspects. Residual moulding materials may be seen in the endosteal cavity. Surface preservation of striation detail is excellent.

Weathering stage: 1.

SKX 22933a, Figures 150 and 151.

Grid square: W3/S2, SE quarter; depth: 200-210 cm.

Date found: 21 March 1984 (Brain & Shipman 1993).

Size: 25.35 (L) x 8.40 (W) x 9.50 mm (T).

Origin: A bone flake from a medium sized mammal.

Conservation: A fresh break is noted on the right, and an ancient break on the inferior end of the specimen. The left unbroken margin appears worn and weathered.

Worn tip: The shape of the tip is indeterminate due to the longitudinal fracture on the right. However, wear extends inferiorly for 25.35 mm.

Striations: Longitudinal and oblique striations may be observed on the periosteal and posterior surfaces, but only longitudinal striations are recorded on the left.

Preservation: Breakage has greatly reduced the size of the piece to only a relic of the tip. However, good surface preservation records the striation damage observed on the three ancient facets of the tip. A light manganese dioxide deposit may be seen on the ancient surfaces. An orange breccia residue may be seen in recessed areas and on the inferior end of the specimen. Moulding material adheres to the breccia-covered inferior end.

Weathering stage: 1.

SKX 25678, Figures 152 and 153.

Grid square: W2/S5, SW quarter; depth: 240-250 cm.

Date found: 11 January 1985 (Brain & Shipman 1993).

Size: 30.50 (L) x n/a (W) x 6.70 mm (T).

Origin: A mammal bone flake.

Conservation: Fresh breaks are noted on the right side and inferior end of the piece. The unbroken left side is worn.

Worn tip: The shape of the tip is rounded and the wear pattern extends 30.50 mm inferiorly.

Striations: Longitudinal striations are recorded on the left side, periosteal and posterior surfaces, with the addition of oblique striae on the posterior surface.

Preservation: A heavy manganese dioxide deposit covers the ancient surfaces, partly obscuring the wear pattern. An orange breccia deposit is observed on all aspects. Surface preservation of striations is particularly good on the posterior surface of the piece.

Weathering stage: 1.

SKX 26112, Figure 154.

Grid square: W2/S3, SW quarter; depth: 1 /0-180 cm.

Date found: 16 March 1984 (Brain & Shipman 1993).

Size: 92.35 (L) x 20 (W) x 17.50 mm (T).

Origin: A mammal size class III-IV long bone shaft fragment.

Conservation: An ancient break is noted on the inferior end only. The unbroken left and right sides are weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 35 mm.

Striations: Longitudinal striations are recorded on the periosteal and endosteal surfaces, as well as long the right margin.

Preservation: A very thick manganese dioxide deposit extends over the entire surface of the specimen, greatly obscuring the wear pattern in places. Orange breccia is recorded in recessed areas, especially on the endosteal surface. Glue has been used to mend multiple fractures. Surface preservation is good, particularly in the vicinity of the tip. Moulding materials are noted in cracks and recesses and may be seen on all aspects.

Weathering stage: 2.

SKX 26113, Figures 155 and 156.

Grid square: W2/S3, SW quarter; depth: 170-180 cm.

Date found: 16 March 1984 (Brain & Shipman 1993).

Size: 49.5 (L) x 14 (W) x 12 mm (T).

Origin: A large mammal long bone flake.

Conservation: An ancient break is noted on the inferior end of the specimen. Both the left and right sides have spiral fractures overlain with wear.

Worn tip: The shape of the tip is pointed, and wear extends inferiorly for 26 mm. Flake damage overlain with wear is observed on the posterior surface.

Striations: Very fine longitudinal and oblique striations are recorded on both the left and right margins. Only longitudinal straie are observed on the posterior surface of the specimen.

Preservation: An extensive manganese dioxide deposit obscures most of the periosteal surface, as well as the left and right margins of the specimen. On the posterior surface the manganese dioxide deposit appears to have been reduced by postdepositional abrasion. In general, the specimen is characterised by poor surface detail and striations are not well defined. An orange breccia residue is clearly visible in all recessed areas. Residual moulding material adheres to all surfaces on the inferior half of the fossil.

Weathering stage: 2.

SKX 26138, Figures 157 and 158.

Grid square: W3/S2, NE quarter; depth: 210-220 cm.

Date found: 21 March 1984 (Brain & Shipman 1993).

Size: 47 (L) x 11 (W) x 8 mm (T).

Origin: A long bone shaft fragment from a size class I-II mammal.

Conservation: A fresh break is noted on the left side, and an ancient break on the inferior end. Both the left and right margins appear weathered and worn.

Worn tip: The shape of the tip is pointed and the wear pattern extends inferiorly for 28 mm. There is no evidence of flake damage at the tip.

Striations: No definitive striation marks are recorded on the heavily worn tip.

Preservation: A thick manganese dioxide deposit covers all aspects and obscures the already feint wear pattern. An orange breccia deposit may be seen on all surfaces. Residual moulding materials are noted, especially in the medullary cavity.

Weathering stage: 0.

SKX 26139, Figures 159 and 160.

Grid square: W3/S2, NE quarter; depth: 210-220 cm.

Date found: 21 March 1984 (Brain & Shipman 1993).

Size: 27.5 (L) x 7.5 (T) mm. Width not applicable.

Origin: A large mammal rib fragment.

Conservation: Ancient breaks are noted on the right side and inferior end of the specimen. The left side is worn and weathered.

Worn tip: The shape of the tip is indeterminate due to the longitudinal fracture on the right. Wear extends inferiorly for 25 mm.

Striations: Longitudinal striations are noted on the periosteal and posterior surfaces.

Preservation: All surfaces of the specimen are covered by manganese dioxide and breccia deposits which together slightly obscure the wear pattern. Although greatly reduced in size through breakage, the tip relic is well preserved and records good surface detail.

Weathering stage: 0.

SKX 26149, Figures 161 and 162.

Grid square: W3/S2, NE quarter; depth: 200-210 cm.

Date found: 21 March 1984 (Brain & Shipman 1993).

Size: 46 (L) x 13.5 (W) x 6 mm (T).

Origin: A compact bone piece of unknown origin.

Conservation: An ancient break is noted on the inferior end. Both the left and right sides are worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 46 mm. Flake damage overlain by wear is noted on the periosteal surface.

Striations: Longitudinal striations are noted on all aspects.

Preservation: A thick manganese dioxide deposit covers all aspects, except for the medial section on the posterior surface. This and a residual orange breccia deposit obscure much of the wear pattern. The inferior half of the posterior surface evidences crushing and scratching of the bone, resulting in irregular split line fractures and distortion of the surface.

Weathering stage: 1.

SKX 26324/8, Figures 163 and 164.

Grid square: W2/S5, SE quarter; dept: 300-310 cm.

Date found: 11 January 1985 (Brain & Shipman 1993).

Size: 94.5 (L) x 26 (W) x 26 (T) mm.

Origin: The almost complete medial portion of a large mammal tibia shaft.

Conservation: Only the inferior part of the shaft exhibits an ancient fracture. Wear is noted on both of the spirally fractured left and right margins.

Worn tip: The shape of the tip is rounded, with wear extending inferiorly for a distance of 40 mm. Both the periosteal and endosteal surfaces evidence flake damage overlain with wear.

Striations: Longitudinal, oblique and transverse striations are noted on the periosteal surface. The left margin records both longitudinal and oblique striae, whereas only longitudinal striations are observed on the right. A few longitudinal striations may be seen in the medullary cavity.

Preservation: A patchy manganese dioxide deposit lightly covers all aspects of the specimen. Remnants of an orange breccia may be seen in recesses and on inferior unworn surfaces. Glue is noted in and around the recesses of two recent fractures on the periosteal surface. Pitting caused by fine abrasion is noted on the inferior periosteal surface.

Weathering stage: 3.

SKX 26624, Figures 165 and 166.

Grid squar: W2/S5, NE quarter; depth: 280-290 cm.

Date found: 11 January 1985 (Brain & Shipman 1993).

Size: 46 (L) x 22 (W) x 15.5 mm (T).

Origin: A large mammal bone flake.

Conservation: An ancient break is recorded on the inferior end. Both the left and right sides show evidence of wear on spirally fractured edges.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 18 mm. There is no evidence of flake damage.

Striations: Longitudinal striations are recorded on all aspects.

Preservation: Manganese dioxide and breccia deposits are recorded on all aspects. Residual moulding materials may be seen adhering to all of the surfaces. Preservation of surface detail is good.

Weathering stage: 0.

SKX 28076, Figures 167 and 168.

Grid square: W3/S4, NE quarter; depth: 230-240 cm.

Date found: 23 January 1985 (Brain & Shipman 1993).

Size: 51 (L) x 10 (W) x 10 mm (T).

Origin: A bone flake from a medium sized mammal.

Conservation: A fresh break is noted on the inferior end of the flake. Both the left and right margins appear worn and weathered. A deep midline fracture on the periosteal surface of the fossil highlights its precarious state of completeness.

Worn tip: The shape of the tip is pointed, and wear extends inferiorly for 23 mm.

Striations: Longitudinal striations are recorded on all aspects of the flake.

Preservation: Manganese dioxide and an orange breccia encrustation obscure most of the wear modification.

Weathering stage: 2.

SKX 28487, Figures 169 and 170.

Grid square: W3/S3, NE quarter; depth: 290-300 cm.

Date found: 14 February 1985 (Brain & Shipman 1993).

Size: 35.5 (L) x 11 (W) x 8 mm (T).

Origin: A compact bone flake of mammalian origin.

Conservation: Fresh breaks are noted on the left and right margins of the inferior half of the piece. These two fractures terminate in a v-shaped point, and in so doing constitute the freshly broken inferior end of the specimen.

Worn tip: The shape of the tip is pointed, and striations extend inferiorly for 35.5 mm. Flake damage overlain with wear may be seen on the posterior surface of the piece.

Striations: Longitudinal striations occur on all aspects of the specimen, with the addition of transversal striae on the periosteal and posterior surfaces. Transverse striae may be seen on the periosteal surface only.

Preservation: A diffuse manganese dioxide deposit covers all the ancient surfaces of the specimen. An orange breccia may be seen adhering to the worn surfaces, as well as the break edge on the left side of the piece. A residual casting material is observed in the midline fracture on the posterior surface, as well as the surface of the fracture on the left.

Weathering stage: 1.

SKX 28828, Figures 171 and 172.

Grid square: W3/S3, NE quarter; depth: 270-280 cm.

Date found: 14 February 1985 (Brain & Shipman 1993).

Size: 43 (L) x 15 (W) x 8 mm (T).

Origin: A bone flake from a small to medium sized mammal.

Conservation: Ancient breaks are recorded along the left margin distal to the tip, and at the inferior end of the piece. Both the left and right sides are worn, with apparent weathering on the right margin.

Worn tip: The shape of the tip is linear with wear extending inferiorly for 30 mm. Flake damage overlain with wear is noted on the posterior surface.

Striations: Longitudinal striations are recorded on all aspects.

Preservation: A diffuse manganese dioxide deposit covers all aspects. An orange breccia residue may be seen in recessed areas. Residual moulding materials are noted on all aspects, particularly inferiorly and in the medullary cavity.

Weathering stage: 1.

SKX 30052, Figures 173 and 174.

Grid square: W3.S3, NW quarter; depth: 320-330 cm.

Date found:. 7 March 1985 (Brain & Shipman 1993).

Size: 26 (L) x 20 (W) x 9 mm (T).

Origin: A long bone flake from a medium to large sized mammal.

Conservation: An ancient break is noted on the inferior end of the specimen. Both the left and right margins are worn.

Worn tip: The shape of the tip is rounded and the surface is smoothly worn. A barely discernible wear pattern extends inferiorly for the short length of the specimen.

Striations: A few exceedingly fine longitudinal striae are noted on the periosteal surface.

Preservation: A manganese dioxide deposit covers all aspects of the specimen. An orange breccia deposit is observed on the inferior break edge. Moulding material obscures much of what remains of the endosteal surface, and may be seen in recessed areas on the periosteal surface. The specimen is greatly reduced in length through breakage, and there is poor preservation of surface detail. The longitudinal wear pattern is discernible only under high magnification.

Weathering stage: 0.

SKX 30141, Figures 175 and 176.

Grid square: W3/S3, NW quarter; depth: 300-310 cm.

Date found: 7 March 1985 (Brain & Shipman 1993).

Size: 40 (L) x 11 (W) x 9 mm (T).

Origin: A mammal bone flake.

Conservation: Fresh breaks are noted on the right hand side and inferior end of the piece. The unbroken left side appears weathered and worn.

Worn tip: The shape of the tip is pointed and the wear pattern extends inferiorly for 18 mm. There is no evidence of flake damage.

Striations: Longitudinal striations are noted on the left side, periosteal and posterior surfaces.

Preservation: A relatively thick manganese dioxide deposit is observed on the ancient surfaces. An orange breccia residue may be seen in recessed areas. Although striations in the region of the tip are well defined, surface preservation of the fossil is not good.

Weathering stage: 1.

SKX 32582, Figures 177 and 178.

Grid square: W4/S2, NE quarter; depth: 230-240 cm.

Date found: 15 May 1985 (Brain & Shipman 1993).

Size: 25 (L) x 5.5 (W) x 4 mm (T).

Origin: A piece of ivory, most probably of the genus *Phacocoerus*.

Conservation: An ancient break is noted on the left, and a fresh break on the inferior end. The unbroken surface appears worn and weathered.

Worn tip: The shape of the tip is indeterminate due to the longitudinal break on the left. The wear pattern extends inferiorly for the length of the piece for a distance of 25.35 mm. Flake damage overlain by wear is noted on the periosteal surface.

Striations: Longitudinal striations are noted on the periosteal surface and right margin.

Preservation: The ancient break on the left has greatly reduced the size of the piece. Light manganese dioxide and breccia deposits are recorded on all surfaces. The catalogue number obscures much of the remnant wear pattern.

Weathering stage: 1.

SKX 32897, Figures 179 and 180.

Grid square: W4/S2, SE quarter; depth: 270-280 cm.

Date found: 21 May 1985 (Brain & Shipman 1993).

Size: 49 (L) x 7.5 (W) x 8.5 mm (T).

Origin: A possible mammal rib fragment.

Conservation: A fresh break is noted on the inferior end of the piece. Both the left and right margins appear worn and weathered.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 28 mm.

Striations: Longitudinal striae are recorded on all aspects

Preservation: A relatively thick manganese dioxide deposit may be seen on all aspects, whilst an orange breccia is noted in recesses, especially inferiorly and in the structures associated with spongy bone. Longitudinal fracture lines cover the periosteal surface, but at this stage do not detract from the well-preserved wear pattern in the vicinity of the tip.

Weathering stage: 2.

SKX 33654, Figures 181 and 182.

Grid square: W3/S2, SW quarter; depth: 420-430 cm.

Date found: 29 May 1985 (Brain & Shipman 1993).

Size: 71.5 (L) x 13.5 (W) x 11 mm (T).

Origin: A bone flake from the medial portion of a large mammal long bone.

Conservation: An ancient break is noted on the inferior end of the specimen. Both the left and right margins are worn and weathered.

Worn tip: The shape of the tip is pointed, and wear extends inferiorly for 30 mm. There is no evidence of flake damage.

Striations: Longitudinal striations are recorded on all aspects of the specimen, with the addition of oblique striations along the right margin.

Preservation: A thick manganese dioxide deposit obscures all aspects of the tip, particularly the periosteal surface. This deposit and a high incidence of smoothing render the identification of striations difficult. An orange breccia deposit may be observed inferiorly, especially on the posterior, left and right aspects of the piece. Glue is noted in the longitudinal fracture line on the periosteal surface. Residual moulding material may be seen in surface cracks.

Weathering stage: 1.

SKX 35196, Figures 183, 184 and 185.

Grid square: W4/S2; depth: 470-550 cm.

Date found: 8 August 1985 (Brain & Shipman 1993).

Size: 56 (L) x 15.5 (W) x 7 mm (T).

Origin: A mammal rib fragment.

Conservation: An ancient break is noted on the inferior end of the piece. Both the left and right margins are worn and weathered.

Worn tip: The shape of the tip is rounded and the wear pattern extends inferiorly for 25 mm. Flake damage overlain with wear is noted on the periosteal and posterior surfaces of the piece.

Striations: Longitudinal striations are observed on all facets.

Preservation: A diffuse manganese dioxide deposit is noted on all aspects. An orange breccia may be seen in recessed areas, particularly in the structures associated with the spongy bone on the posterior surface. Residual moulding material may be seen on the inferior end. Surface preservation of the wear pattern is excellent, especially on the posterior surface.

Weathering stage: 1.

SKX 37703, Figures 186 and 187.

Grid square: W3/S3; depth: 550-600 cm.

Date found: 28 September 1985 (Brain & Shipman 1993).

Size: 131 (L) x 21 (W) x 13.5 mm (T).

Origin: A possible rib fragment from a large mammal.

Conservation: An ancient break is noted on the inferior end. Both the left and right margins appear weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 25 mm.

Striations: Longitudinal striations are recorded on all aspects. Transverse striae are noted on the periosteal surface only.

Preservation: A light manganese dioxide deposit is noted on all aspects. Orange breccia discolours the periosteal surface and is particularly noticeable in recessed areas. The residual traces of three different moulding materials may be seen, especially on the posterior spongy bone surface. Surface modifications on the periosteal surface are well preserved.

Weathering stage: 1.

SKX 38041, Figures 188, 189 and 190.

Grid square: W5/S4; depth: 660-700 cm.

Date found: 11 October 1985 (Brain & Shipman 1993).

Size: 44 (L) x 16 (W) x 10 mm (T).

Origin: A compact bone flake.

Conservation: A fresh break is noted on the inferior end only. The unbroken left and right sides are weathered and worn.

Worn tip: The shape of the tip is pointed and the wear pattern extends for 20 mm inferiorly.

Striations: Longitudinal and transverse striae are noted on the periosteal and endosteal surfaces, while oblique striae may be seen on the left and right margins.

Preservation: A diffuse manganese dioxide deposit extends over the surface of the fossil. Orange breccia may be seen in recessed areas. Surface preservation is good.

Weathering stage: 2.

SKX 38830, Figure 191.

Grid square: W4/S1; depth: 70 cm, on north wall of the Member 3 gully.

Date found: 23 October 1985 (Brain & Shipman 1993).

Size: 86.5 (L) x 14 (W) x 12 mm (T).

Origin: A right anteroproximal metacarpal shaft from a bovid size class II animal.

Conservation: The only breakage noted is in the form of an ancient fracture on the most distal part of the specimen. Both the left and right margins of the bone appear worn and weathered.

Worn tip: The tip of the specimen is rounded, with wear extending distally for 47 mm. Flake damage overlain with wear is noted on both the periosteal and endosteal surfaces.

Striations: Longitudinal striae are recorded on all aspects, while oblique striations are noted on only the periosteal surface.

Preservation: The fossil is in good condition, with all surface modifications extremely well preserved. A manganese dioxide deposit spreads across all aspects of the fossil, with growth particularly pronounced in unworn areas. An orange breccia deposit may be seen in the distal half of the medullary cavity and in the deep split line on the observer's right side of the specimen. Remnants of a moulding material adhere in places to the unworn surface of the medullary cavity, and are trapped in fine cracks caused by weathering.

Weathering stage: 1.

SKX 45806, Figures 192 and 193.

Grid square: W3/S2, SW quarter; depth: 260-270 cm.

Date found: 27 February 1985 (Brain & Shipman 1993).

Size: 23.5 (L) x 10 (W) x 10.5 mm (T).

Origin: A mammal bone flake.

Conservation: An ancient break is noted on the inferior end. The left and right sides appear worn and weathered.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 23.80 mm. Flake damage overlain by wear is observed on the periosteal surface.

Striations: Longitudinal striations are noted on all aspects.

Preservation: Manganese dioxide and an orange breccia deposit recorded on all aspects partly obscure the wear pattern. Residual moulding materials adhere to the periosteal surface. Surface preservation of the tip is good, though the extent of the wear pattern is limited as a result of breakage.

Weathering stage: 1.

SKX 37052, Figures 194 and 195.

Grid square: W3/S3, SW quarter; depth: 610-620 cm.

Date found: 26 September 1985 (Brain & Shipman 1993).

Size: 58 (L) x 7.5 (W) x 5.5 mm (T).

Origin: A long bone flake, possibly from an ulna.

Conservation: Ancient breaks are noted along the left and right margins distal to the tip, as well as on the inferior end of the piece. The left and right margins are weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 17 mm.

Striations: Longitudinal striae are recorded on all aspects, with the addition of oblique striae on the periosteal surface. Flake damage overlain with wear is recorded posteriorly.

Preservation: A diffuse manganese dioxide deposit extends over the ancient surface. An orange breccia is recorded in recessed areas. Surface preservation is good.

Weathering stage: 1.

SKX 47046*, Figures 196 and 197.

Grid square: E3/N4 SW quarter; depth: 690-700cm.

Date found: 13 May 1981 (Backwell 1999).

Size: 23.5 (L) x n/a (W) x 5.10mm (T).

Origin: A small mammal bone flake.

Conservation: An ancient break is noted on the left side. There is a fresh break on the inferior end. Both the left and right sides are worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 23.50 mm.

Striations: Longitudinal and transverse striations are noted on the periosteal surface and right margin. Only longitudinal striae are recorded on the left.

Preservation: A diffuse manganese dioxide deposit extends over the ancient surfaces. There is an orange breccia in recessed areas. White paint used for cataloguing obscures the inferior half of the periosteal surface. Preservation of surface detail is excellent.

Weathering stage: 1.

SKX 8741*, Figures 198 and 199.

Grid square: E4/N4, SW quarter; depth: 670-680 cm.

Date found: 1 April 1981 (Backwell 1999).

Size: 44 (L) x 15 (W) x 8 mm (T).

Origin: A rib fragment from a medium sized mammal.

Conservation: Ancient breaks are noted on the left and right, while a fresh break is recorded on the inferior end. Both margins are worn.

Worn tip: The shape of the tip is pointed and the wear pattern extends inferiorly for 27 mm. There is no evidence of flake damage at the tip.

Striations: Longitudinal striations are recorded on all aspects, with the addition of transverse striae on the periosteal surface.

Preservation: Manganese dioxide and an orange breccia deposit may be seen on all aspects, especially on the inferior third of the piece. Surface preservation is good.

Weathering stage: 1.

SKX 2787*, Figures 200 and 201.

Grid square: E6/S1; depth: 150-200 cm.

Date found: 6 June 1979 (Backwell 1999).

Size: 34 (L) x 5 mm (T).

Origin: A bone flake of indeterminate origin.

Conservation: The left and inferior ends are freshly broken. The right margin is worn and weathered.

Worn tip: The shape of the tip is indeterminable due to the longitudinal break on the left margin. The wear pattern extends inferiorly for 15.5 mm.

Striations: Longitudinal striations are recorded on the right and posterior surfaces, with the addition of oblique striae on the right.

Preservation: The surface structure of the bone is not well preserved. It is covered in fine cracks and is easily flaked. The wear pattern is easily distinguishable on the right, but not on the other surfaces. Manganese dioxide deposition is minimal. An orange breccia residue discolours the periosteal surface, and may be seen in recessed areas, particularly inferiorly.

Weathering stage: 2.

SKX b*, Figures 202 and 203.

Grid square: Member 1

Date found: (Backwell 1999).

Size: 52 (L) x n/a (W) x 11 (T).

Origin: A flake from the medial portion of a mammal size class IV long bone.

Conservation: A fresh break is noted on the left, and an ancient break on the inferior end. The right margin is worn and weathered.

Worn tip: The shape of the tip is described as linear, with wear extending inferiorly for 25 mm. There is no flake damage.

Striations: Longitudinal and oblique striations are recorded on all three of the ancient surfaces, with the addition of transverse striae in the medullary cavity.

Preservation: A manganese dioxide deposit is intermittently distributed over the entire surface of the specimen. An orange breccia deposit is noted in weather cracks on the periosteal surface, as well as distally on the unworn parts of the specimen. Glue has been used to refit a longitudinally fractured flake, and may be seen on the periosteal surface and along the right margin.

Weathering stage: 2.

SKX 39365*, Figures 204 and 205.

Grid square: Collapsed ESA after heavy rain.

Date found: November 1985 (Backwell 1999).

Size: 39 (L) x n/a (W) x 13 mm (T).

Origin: A mammal long bone flake.

Conservation: Ancient breaks are noted on the left and right margins. A fresh break is noted on the inferior end. The left and right margins appear weathered and worn.

Worn tip: The shape of the tip is pointed and the wear pattern extends inferiorly for 39 mm. Flake damage overlain with wear occurs on both the periosteal and posterior surfaces.

Striations: Longitudinal striations are observed on all facets, with the addition of oblique striae on the periosteal and posterior surfaces.

Preservation: A light manganese dioxide deposit is noted on all aspects. An orange breccia residue is recorded in recessed areas. Residual moulding materials may be seen on all aspects. Preservation of surface modifications is good.

Weathering stage: 2.

SKX 5847*, Figures 206 and 207.

Grid square: E3/W5, SW quarter; depth: 570-580 cm.

Date found: (Backwell 1999).

Size: 27 (L) x n/a (W) x 7 mm (T).

Origin: A flake from a medium sized mammal long bone.

Conservation: Fresh breaks are noted on the posterior aspect and inferior end of the piece. The left and right sides appear worn and weathered.

Worn tip: Th shape of the tip is pointed and wear extends inferiorly for 25 mm. There is no evidence of flake damage.

Striations: The striations on this piece are multi-directional. On the periosteal surface the striae are oblique. On the right they are longitudinal and oblique, and on the left border they are longitudinal, oblique and transverse. The posterior surface is broken.

Preservation: The fossil is greatly reduced in size as a result of breakage. A light manganese dioxide deposit may be seen on all aspects. An orange breccia residue is noted in recessed areas, particularly inferiorly and in the medullary cavity. Glue has been used to mend a longitudinal fracture on the posterior side of the piece. Preservation of surface detail is good.

Weathering stage: 2.

SKX 47045*, Figures 208 and 209.

Grid square: E3/N4, SW quarter; depth: 690-700 cm.

Date found: 13 May 1981 (Backwell 1999).

Size: 23.5 (L) x n/a (W) x 5 mm (T).

Origin: A bone flake fragment.

Conservation: There is a fresh break on the inferior end of the piece. Both the left and right sides are worn.

Worn tip: The shape of the tip is pointed, and the wear pattern extends for the short length of the piece.

Striations: Longitudinal striations are recorded on the periosteal surface as well as on the left and right margins. Transverse striae may be seen on the periosteal surface and right margin.

Preservation: A light manganese dioxide deposit covers all of the ancient surfaces. Orange breccia may be seen in recessed areas. Residual white paint used for numbering obscures the inferior half of the periosteal surface. Preservation of surface detail is excellent.

Weathering stage: 2.

SKX 9123*, Figures 210 and 211.

Grid square: E3/N5 NE quarter; depth: 620-630 cm below B.

Date found: 11 February 1981 (Backwell 1999).

Size: 79 (L) x 18 (W) x 18 mm (T).

Origin: The medial portion of a medium sized mammal long bone.

Conservation: The left, right and inferior fracture edges all have fresh breaks.

Worn tip: The shape of the tip is pointed, with wear extending inferiorly for 34 mm. Flake damage on the periosteal surface is overlain with wear.

Striations: Longitudinal striations are recorded on both the periosteal and endosteal surfaces, with the addition of oblique striae on the periosteum.

Preservation: Although the piece is inferiorly fractured, striation modifications recorded on the periosteal surface of the tip remain well preserved.

Weathering stage: 2.

SKX 8954*, Figures 212 and 213.

Grid square: E2/N4 SE quarter; depth: 500-510 cm.

Date found: 22 April 1980 (Backwell 1999).

Size: 46 (L) x 13 (W) x 7 mm (T).

Origin: The medial part of a medium size mammal long bone flake.

Conservation: Fresh breakage is noted on the left margin and inferior end of the specimen. The unbroken right margin is worn and weathered.

Worn tip: The shape of the tip is indeterminate due to the broken margin. Wear extends inferiorly for 30 mm.

Striations: Both longitudinal and oblique striations are recorded on the periosteal surface, while only longitudinal striations are recorded on the right margin and in the medullary cavity.

Preservation: An extensive manganese dioxide deposit is noted on the ancient surfaces of the specimen, persisting to a lesser degree on the two freshly broken surfaces. Remnants of a bright orange breccia deposit may be seen on all aspects of the specimen, especially inferiorly on the unworn surfaces, and in cracks on the periosteal face.

Weathering stage: 2.

SKX 29434*, Figures 214 and 215.

Grid square: W3/S2 SW quarter; depth: 280-290cm.

Date found: 27 February 1985 (Backwell 1999).

Size: 61 (L) x 20.5 (W) x 10 mm (T).

Origin: A bone flake from the medial portion of a medium to large sized mammal.

Conservation: Only the superior periosteal region of the specimen is well preserved. A fresh fracture extends along the left margin and inferior end of the012x34

Worn tip: The shape of the tip is round, with wear extending inferiorly for 36 mm. Flake damage on the periosteal surface is overlain with wear.

Striations: Well-defined longitudinal and oblique striations are recorded on the periosteal and endosteal surfaces.

Preservation: A manganese dioxide deposit lightly covers all aspects of the specimen. Orange breccia may be observed in recessed and fractured areas. Glue is noted along the edges of a refitted cortical lamella flake.

Weathering stage: 1.

SKX 30568*, Figures 216 and 217.

Grid square: W3/S2, SW quarter; depth: 310-320 cm.

Date found: 20 March 1985 (Backwell 1999).

Size: 9 (L) x n/a (W) x 5 mm (T).

Origin: A small mammal long bone flake.

Conservation: Ancient breaks are noted on the right margin and inferior end of the piece. The left border is worn.

Worn tip: The shape of the tip is pointed and the wear pattern appears to extend for the short length of the piece, though manganese dioxide and breccia obscure the worn surface. There is no evidence of flake damage.

Striations: Longitudinal striations are discernible on the left margin only.

Preservation: Manganese dioxide and an orange breccia deposit cover all aspects of the piece, thereby obscuring much of the worn surface. The size of the specimen has been greatly reduced through breakage.

Weathering stage: 0.

SKX 36969*, Figures 218 and 219.

Grid square:. W5/S4, SW quarter; depth: 550-600 cm.

Date found: 25 September 1985 (Backwell 1999).

Size: 63 (L) x 18 (W) x 8 mm (T).

Origin: A long bone flake from a medium sized mammal.

Conservation: An ancient break is noted on the inferior end. All the unbroken surfaces are weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 35 mm.

Striations: Longitudinal striations are noted on all aspects, with the addition of oblique striae on the periosteal and endosteal surfaces. Transverse striae are noted on the posterior surface only.

Preservation: A very small amount of manganese dioxide is noted on the tip and inferior break edge. An orange breccia deposit is recorded on all aspects. The smoothness and high degree of polish noted on the most elevated parts of the breccia suggest post-depositional abrasion of the piece. The preservation of surface modifications is excellent.

Weathering stage: 1.

SKX 19845*, Figures 220 and 221.

Grid square: W2/S5, NE quarter; depth: 190-200 cm.

Date found: 28 October 1983 (Backwell 1999).

Size: 34 (L) x 13 (W) x 9 mm (T).

Origin: A small bovid long bone flake.

Conservation: An ancient break is noted on the inferior end only. Both the left and right sides appear weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends distally for 29 mm.

Striations: Longitudinal, oblique and transverse striations are recorded on the periosteal surface, while only oblique striae are noted in the medullary cavity.

Preservation: A heavy manganese dioxide deposit obscures most of the surface modifications, particularly on the left and right sides. An orange breccia may be seen in the medullary cavity. Residual moulding materials are noted on the inferior end of the piece. Surface preservation is excellent, but modifications are obscured by the manganese dioxide deposit.

Weathering stage: 1.

SKX 34370*, Figures 222 and 223.

Grid square: W2/S6, SW; depth: 170-180 cm.

Date found: (Backwell 1999).

Size: 20 (L) x 13 (W) x 5 mm (T).

Origin: A long bone flake from a medium sized mammal.

Conservation: A fresh break is noted on the inferior end only. The left and right sides are worn and weathered.

Worn tip: The shape of the tip is rounded and the wear pattern extends for the length of the piece, that is inferiorly for 20.15 mm.

Striations: Longitudinal striations are recorded on all aspects, with the addition of oblique striae on the periosteal surface and left margin.

Preservation: A diffuse manganese dioxide deposit covers all aspects, particularly the posterior surface and right margin. An orange breccia residue is noted in recessed areas. Surface preservation is excellent.

Weathering stage: 1.

SKX SEM*, Figures 224 and 225.

Grid square: Member 1.

Date found: (Backwell 1999).

Size: 9 (L) x 10 (W) x 40.5 mm (T).

Origin: A long bone flake from a medium to large sized mammal.

Conservation: Fresh breaks are noted on the left side and inferior end of the specimen. Wear is noted along the right margin.

Worn tip: The shape of the tip is indeterminate due to the longitudinal fracture on the left. The wear pattern on the right extends inferiorly for 34 mm. There is no evidence of flake damage.

Striations: Longitudinal, oblique and transverse striations are noted on the periosteal surface, and only oblique striations on the right.

Preservation: Much of the specimen has been lost through recent breakage. However, striation modifications on what remain of the tip are well preserved. Gold palladium (used for coating specimens observed with the Scanning Electron Microscope) covers all of the ancient surfaces, while graphite (used to cement specimens to stubs) covers the freshly broken surface. A very light and diffuse manganese dioxide deposit may be seen inferiorly on the periosteal surface. An orange breccia deposit is visible on the freshly fractured edge. Remnants of a casting agent may be seen in recessed areas on the broken surfaces.

Weathering stage: 1.

SKX 39364*, Figures 226 and 227.

Grid square: Member 1. Collapsed ESA after heavy rain.

Date found: November 1985 (Backwell 1999).

Size: 47 (L) x 15 (W) x 7 mm (T).

Origin: A medium-sized mammal long bone flake.

Conservation: Fresh breaks are noted on the tip and inferior end of the piece. Both the left and right sides appear weathered and worn.

Worn tip: The shape of the tip is pointed, and wear extends distally for 34 mm. Flake damage overlain by wear is observable on both the periosteal and posterior surfaces.

Striations: Longitudinal and oblique striations are recorded on all aspects.

Preservation: A diffuse manganese dioxide deposit extends over most of the fossil, but is most dense on the posterior face. An orange breccia residue may be seen along the left margin and on the inferior end of the specimen. A white moulding material may be seen in recesses on the left border.

Weathering stage: 2.

5.1.4 Sterkfontein Member 5

SE 612, Figure 228.

Grid square: Member 5 Breccia

Date found: 5 June 1958 (Robinson 1959)

Size: 83 (L) x 29.5 (W) x 14.5 mm (T).

Origin: A bovid size class III metapodial piece.

Conservation: There is a fresh break on the inferior end only. Both the left and right margins appear weathered and worn.

Worn tip: The shape of the tip is pointed and wear extends inferiorly for 42 mm. There is no evidence of flake damage.

Striations: Longitudinal striations are recorded on all aspects.

Preservation: A relatively thick manganese dioxide deposit covers all of the ancient surfaces. A residual orange breccia is recorded in recessed areas. Glue may be seen on the posterior surface where it has been used to mend fractures. Putty may also be seen on this surface where it bridges a gap caused by breakage. Much of the posterior surface area has lost its outer surface structure, and like the inferior break edge exposes the friable internal structure of the fossil. Although in a fragile condition, the surface preservation of striations is good.

5.2 Summary of fossils

See the following Tables for summary descriptions of fossil specimen dimensions (Table 10); bone types and origin (Table 11); conservation patterns (Table 12); the worn area (Table 13) and striation attributes (Table 14).

According to the diagnostic criteria used in this study, three of Brain and Shipman's (1993) proposed tools were excluded from the 'bone tool' collection. These specimens did not exhibit any striation attributes in the vicinity of the tip, and although the two horncores (catalogue numbers SKX 17211 and SKX 36861) were smooth and rounded, they lacked a definitive wear pattern. The bone flake (catalogue number SKX 794) was entirely smooth and polished with evidence of etching, suggesting that modification of the piece resulted from hyaena gastric acid etching as opposed to use by early hominids.

Plotting the spatial distribution of the pieces revealed that the fossils clustered in three distinct areas. Members 1 and 2 overlapped in their horizontal distribution in the north-eastern quadrant of the site, though a few Member 1 specimens appear to have come from the south-western quadrant where the Member 3 specimens were found (see Figure 229). The Member 1 depth range is between 1.5 m and 12.4 m, with most pieces found at a depth of between 5.4 m and 6.8 m below the datum. Member 2 pieces were excavated from a depth range of between 0.8 m and 12.4 m, with most specimens coming from a depth of between 1.5 m and 2 m. Member 3 specimens were found in a depth range of between 0.7 m and 6.8 m, with most pieces coming from a depth of between 2 m and 3 m. Thus while the Member 1 and 2 fossils derived from the same spatial context, the Member 2 and 3 fossils were deposited at approximately the same stratigraphic depth.

Summary data of the purported bone tools shows that with regard to the type of bone constituting the collection, 62% are compact bone, 21% a combination of spongy and compact bone, and only 17% spongy bone only, with horncores comprising the majority of spongy bone elements. The majority of specimens derive from the medial portion of unidentifiable long bone shafts. One third of the specimens are designated Mammal size classes II-III, another third size classes III-IV, and the remainder of the pieces span the size ranges I to V, a finding that persists through all of the members. Of the eighty-one pieces examined, only five are complete. Breakage is evenly distributed between the left and right sides of the pieces, with seventy-three specimens broken inferiorly indicating that they were all originally longer. Only three pieces are broken superiorly. Most of the breakage occurs as weathered (as opposed to spiral/fresh) fractures almost always overlain with wear. The length size range of the pieces is between 9 mm and 186 mm, with a mean length of 58 mm. Considering that most specimens constitute compact bone, the average compact bone thickness measures 7.8 mm. Bone thickness 10 mm from the tip has a mean of 8 mm. Bone width 10 mm from the tip has a mean of 11.5 mm. Bone thickness 20 mm from the tip has a mean of 10.5 mm. Bone width 20 mm from the tip has a mean of 15.5 mm. With regard to the shape of the tips, 67% are pointed, 26% are rounded and 7% are linear. The length of the wear pattern ranges between 5 mm and 54 mm, with a mean of 27.5 mm from the tip. Longitudinal striations are recorded on almost 100% of the pieces studied, with the longitudinal striae found on all aspects of each piece. Oblique striations are recorded on nearly half of the pieces, occurring on all aspects with the majority recorded on the periosteal face. Transverse striae are few, occurring on all aspects, but particularly the periosteal surface posterior to the longitudinal striations. Carnivore damage in the form of tooth scores is observed on two pieces, and underlies the wear patterns on both. Small circular crushing observed in the tip area of most specimens is not the result of carnivore activity, but rather compaction by quartz crystals and silica granules.

CHAPTER 6 - DISCUSSION AND CONCLUSION

This thesis proposed that the modifications observed on bone objects from southern African hominid-bearing sites are not the result of human utilisation, but of non-human taphonomic processes.

The results of an analysis of the Swartkrans and Sterkfontein proposed 'bone tools' have been compared with those obtained from reference collections in Africa and Europe. The comparative collections included those modified by animals (hyaena, dog, leopard, cheetah, porcupine) and geological processes (river gravel, spring, flood plain, wind, trampling). Following a progressively more rigorous method of elimination, the selection process looked for pieces exhibiting gross morphological similarity to the Swartkrans and Sterkfontein purported bone tools. Bone tool mimics which reached the final phase of analysis were treated in the same manner as the Swartkrans and Sterkfontein fossils with regard to descriptive analyses based on predetermined criteria, the use of linear diagrams to record modification distribution, and photography. The tips of bone tool mimics and of the purported bone tools were replicated using high resolution impression and casting materials and observed with a Scanning Electron Microscope. A detailed examination of both micro- and macroscopic morphology was made, and the similarities and dissimilarities with the purported bone tools assessed. The author then commented on the damage observed, discussing possible causative agents and processes associated with the modification of each collection.

6.1 The Swartkrans and Sterkfontein purported bone tools

Examination of the Swartkrans and Sterkfontein material shows an association of surface features which are different from those recorded on bones modified by non-human natural agents, and similar to those found on archaeological and experimentally produced specimens encountered in the course of research (see Table 15).

Features common to the 'bone tool' collection include the presence of a rounded or pointed tip at one end of the specimen, and smoothing and polishing confined to an area of between 5 mm and 50 mm from the tip, with a mean length of 27.5 mm. Microscopically, features include individual striations which cover the tip, but are absent on the remaining surface of the bone; striations oriented parallel or sub-parallel to the main axis of the bone which decrease in number and intensity away from the tip, and that vary in width from 20 to 100 microns; and very few striations oriented perpendicular to the main axis of the bone. These are generally posterior to the longitudinal parallel striations and range between 100 and 400 microns in width.

On the basis of these criteria, sixteen previously unidentified 'bone tools' were discovered in the course of re-examining the Swartkrans faunal collection.

6.2 The comparative collections

According to the criteria observed on the Swartkrans and Sterkfontein purported bone tools, no exact match was found in any of the comparative collections studied. However, twenty-four pseudotools with broadly similar macro-morphologies were identified and their surface modifications studied in an attempt to source the modifying agent or process.

Aside from the description and analysis of the Swartkrans and Sterkfontein fossil material, an important motivation for this thesis was to evaluate whether signature patterns could be elicited from faunal collections modified by specific agents. Collections were examined using a configurational approach that included thirty-two variables. Distinct and recognisable patterns were observed in all of the collections studied, irrespective of their geological age.

Features characteristic of biotic agents

According to the collections studied, features characteristic of carnivore damage include elements which have been chewed on one end, resulting in long bones with gnawed and ragged ends, and flat bones with shredded ends. Gnawing out of cancellous bone is common on epiphyses. Carnivore damage categories may be broadly divided into 'dog-like' and 'felid-like'. More specifically, tooth scores produced by hyaenas and large domestic dogs exhibit a similar pattern in that they are generally broad and deep and have rounded troughs. They tend to be discretely positioned, and for the most part are oriented perpendicular to the axes of shafts. Leopard and cheetah tooth scores manifest either as grazes or fine V-shaped striations of multidirectional orientation. Tooth scores and tooth pits may be positioned anywhere on carnivore-modified bones, but are most commonly observed on shafts, as are tooth punctures, tooth notches and conchoidal flake scars. Tooth crushes occur on and around epiphyses. Porcupine modification of bone is distinguishable from the two above categories and is characterised by multiple broad and flat gnaw marks with finer longitudinal striae within the width of each incisor. Gnaw marks on long bones tend to extend for the length of the specimen at an angle perpendicular to the axis of the shaft. Ends may be reduced through gnawing at an angle longitudinal to the axis of the shaft to produce a 'serviette ring' effect (see Figure 6).

Features characteristic of abiotic agents

Faunal modification by abiotic agents has shown that in the collections studied, trampling is characterised by extremely smooth surfaces, most of which are polished. Striations tend to occur as unidirectional sub-parallel scratches, oriented most often at angles perpendicular or oblique to the axis of the main shaft. Scratch marks on large elements are localised in their distribution, occurring on shafts as opposed to epiphyses. Smaller pieces are entirely scratched.

Specifically, spring modification is characterised by amorphous bone structures that evidence a high degree of overall smoothing and polishing, resulting in pieces reminiscent of Plaster of Paris casts, not only in appearance but also in weight and friability. This is in sharp contrast to riverine contexts which produce highly fragmented pieces, most of which have pointed ends. The surface of the material is matt and rough due to micro crushing and mosaic cracking.

Wind modification is characterised by material with extremely smooth surfaces that have a talcum powder-like finish. Elevations and raw edges are smoothed and rounded.

Pseudotools

Having established that recognisable signature patterns exist in collections modified by specific agents, the author was able to identify that seventeen of the twenty-four pseudotools found were not modified by the agent associated with the context from which they derived, but rather by intrusive agents or multiple secondary processes. In the case of the pseudotool from the Uitkomst hyaena lair ($n = 234$), it became evident at a microscopic scale that modification of the piece resulted from porcupine and not hyaena involvement. The same was true of the pseudotool from the Erfkroon A flood plain collection ($n = 301$), where a calcrete deposit largely obscured the distinctive gnaw marks characteristic of porcupine damage. The ten pseudotools from the Bacon Hole hyaena lair ($n = 199$) are presumed to be the consequence of secondary processes acting on the faunal remains in the immediate vicinity of the cave at the time of deposition. The humid and acid environment coupled with trampling abrasion shifts the inferred modifying agent from the position of singular biotic hyaena to multiple biotic processes combined with abiotic geomorphological activity. The five pseudotools from the wind erosion collection from Duinefontein 2 (Melkbos) (n = 152) are smooth and polished, and some are covered with sets of parallel striations at an angle oblique to the main axis of the shaft. While smoothing and polish are associated with wind modification, the striations recorded on these pieces are classic markers of trampling damage.

That 71% of the pseudotools found were not the result of modification by the presumed agent demonstrates the importance of a comprehensive understanding of taphonomy for the interpretation of prehistoric sites.

6.3 Discussion

In none of the comparative collections studied do we see the association of features peculiar to the purported bone tool collection. From the comparative analyses conducted it is clear that both biotic and abiotic agents produce pseudotools, but that the type and distribution of attributes recorded does not fit the pattern observed on the 85 fossils studied. The wear pattern recorded on the Swartkrans and Sterkfontein material is thus explained in terms of three possibilities: i) the wear pattern results from non-human natural processes that we are as yet unable to identify, ii) the wear pattern results from utilisation by early hominids, or iii) natural attrition within the faunal assemblage through time, resulting in the selective sorting of an enormous sample down to a relatively small sample size. the extent of which cannot be established. In order to test the first hypothesis, one would have to increase the non-human reference material to include longitudinal studies of taphonomic, geomorphological and fossilisation processes, an undertaking not testable within the scope of this project. To test the second hypothesis, one should develop work based on experimentation and the ethnographic and archaeological records. Indicators of how to approach the study are found in the wear pattern itself, in that the agent producing the wear pattern allows us to infer the mechanics of the action involved. Firstly, the striations are individual, indicating that single particles abraded the bone surface simultaneously. This is demonstrated by adjacent striae following different end paths, and the fact that the wear pattern occurs in recessed areas of bone structure (see for example specimen SKX 35196).

Secondly, the direction of the striations is always longitudinal to the main axis of the bone. Knowing that the wear pattern consists of individually created longitudinal striations suggests that an expanded reference collection should include archaeological and ethnographic digging sticks and perforators, and that experimental studies be conducted in an environment rich in abrasive particles.

Given that the scope of this project does not allow me to test the possibilities of i) and ii) as stated above, and in the absence of additional data, this study concludes that the modified bones from Swartkrans and Sterkfontein are artefactual in nature.

6.3.1 Taphonomy

Presuming that the fossils are tools, data collected from the Swartkrans and Sterkfontein material provide the framework for making tentative inferences and reconstructing a taphonomic sequence of events.

According to the diagnostic criteria used in this study, three of Brain and Shipman's (1993) proposed tools were excluded from the 'bone tool' collection. These specimens did not exhibit any striation attributes in the vicinity of the tip, and although the two horncores (catalogue numbers SKX 17211 and SKX 36861) were smooth and rounded, they lacked a definitive wear pattern. The bone flake (catalogue number SKX 794) was entirely smooth and polished with evidence of etching, suggesting that modification of the piece resulted from hyaena gastric acid etching as opposed to use by early hominids.

Plotting the spatial distribution of the pieces revealed that the fossils clustered in three distinct areas. Members 1 and 2 overlapped in their horizontal distribution in the north-eastern quadrant of the site, though a few Member 1 specimens appear to have come from the south-western quadrant where the Member 3 specimens were found (see Figure 229). The Member 1 depth range is between 1.5 m and 12.4 m, with most pieces found at a depth of between 5.4 m and 6.8 m below the datum. Member 2 pieces were excavated from a depth range of between 0.8 m and 12.4 m, with most specimens coming from a depth of between 1.5 m and 2 m. Member 3 specimens were found in a depth range of between 0.7 m and 6.8 m, with most pieces coming from a depth of between 2 m and 3 m. Thus while the Member 1 and 2 fossils derived from the same spatial context, the Member 2 and 3 fossils were deposited at approximately the same stratigraphic depth.

Summary data of the purported bone tools show that with regard to the type of bone constituting the collection, 62% are compact bone, 21% a combination of spongy and compact bone, and only 17% spongy bone only, with horncores comprising the majority of spongy bone elements. The majority of specimens derive from the medial portion of unidentifiable long bone shafts. One third of the specimens are designated Mammal size classes II-III, another third size classes III-IV, and the remainder of the pieces span the size ranges I to V, a finding that persists through all of the members. Of the eighty-one pieces examined, only five are complete. Breakage is evenly distributed between the left and right sides of the pieces, with seventy-three specimens broken inferiorly, indicating that they were all originally longer. Only three pieces are broken superiorly. Most of the breakage occurs as weathered fractures (as opposed to spiral/fresh), almost always overlaid with a wear pattern. The length size range of the pieces is between 9 mm and 186 mm, with a mean length of 58 mm. Considering that most specimens constitute compact bone, the average compact bone thickness measures 7.8 mm. Bone thickness 10 mm from the tip has a mean of 8 mm. Bone width 10 mm from the tip has a mean of 11.5 mm. Bone thickness 20 mm from the tip has a mean of 10.5 mm. Bone width 20 mm from the tip has a mean of 15.5 mm. With regard to the shape of the tips, 67% are pointed, 26% are rounded and 7% are linear. The length of the wear pattern ranges between 5 mm and 54 mm, with a mean of 27.5 mm from the tip. Longitudinal striations are recorded on almost 100% of the pieces studied, with the longitudinal striae found on all aspects of each piece. Oblique striations are recorded on nearly half of the pieces, occurring on all aspects with the majority recorded on the periosteal face. Transverse striae are few, occurring on all aspects, but particularly the periosteal surface posterior to the longitudinal striations.

Carnivore damage in the form of tooth scores is observed on two pieces, and underlies the wear patterns on both. Small circular crushing observed in the tip area of most specimens is not the result of carnivore activity, but rather compaction by quartz crystals and silica granules. Based upon the very limited number of anthropically modified tools examined, the Swartkrans specimens appear to be broadly consistent with those caused by digging. By expanding the experimental repertoire, new functional interpretations may become apparent.

6.3.2 'Bone tool' contexts

Swartkrans

Of the five depositional units currently recognised at Swartkrans, Members 1-3 contain the remains of robust australopithecines, and fall within the time span 1.8-1.0 million years ago (Mya). Member 1 represents the oldest and most abundant of the fossiliferous deposits, dating to between 1.8 and 1.5 Mya (Brain 1993). Based on faunal analysis conducted by Vrba (1982) and Watson (1993), Members 2 and 3 do not differ significantly from Member 1, and are assumed to be between 1.5 and 1.0 million years old. Members 1 and 2 have yielded the remains of a second hominid that has been assigned to the genus *Homo*. The rapid morphological changes inherent in the transition from *Homo habilis* to *Homo erectus* at approximately 1.8 Mya renders the identification of hominid species at this time depth inconclusive. However, factors including the age of the Member 1 deposit, and the homogeneity of the associated Developed Oldowan/Early Acheulean Industry throughout Members 1 to 3 (Field 1999), have resulted in the designation of the second Swartkrans hominid as *Homo erectus* (Brain *et al.* 1988).

While arguably the best method for dating early hominid sites, comparative faunal analysis has its limitations. Faunal seriation is a relative method of dating, the success of which is dependent on sealed deposits of time-sensitive species with no evidence of mixing. McKee *et al.* (1995) discuss the problems associated with faunal dating, highlighting the following considerations, for example:

i) members may bracket large time-spans, making it unclear as to exactly when in the time-frame a species was present, creating problems when geochronologically-distinct fossils are found in association; and

ii) the fact that faunally contemporaneous sites, for example, Kromdraai B and Sterkfontein Member 5, may share fewer than half the number of species present at this time-depth, and only 27% of these are time-sensitive. This may be the result of a) differing environmental conditions; b) taphonomic factors, including the influence of early *Homo* on the composition of an assemblage as opposed to the effects of hyaena feeding lairs and death-trap contexts; and c) temporally distinct deposits having mixed within members.

In addition, taphonomic processes have a marked attritional effect on assemblages, resulting in biased faunal representations, and thus inaccurate data. Further, limited sample sizes continue to pose a problem. Researchers should take cognisance of the above-mentioned before arriving at strict conclusions about early hominid sites.

Electron Spin Resonance (ESR) conducted by Curnoe *et al.* (1998) and Blackwell (1998) on fossilised teeth from Swartkrans has revealed inconsistencies in the dates obtained, implying the reworking of deposits. Plotting the spatial distribution of the bone tools has revealed that many of the pieces come from the Member 1 Lower Bank. This is significant because Member 1 constitutes the oldest fossil deposit at the site, thereby eliminating the possibility that the bone tools are recent intrusions in substantially older deposits. Moreover, the orange breccia deposit encrusted on *all* of the fossil material derives from Member 1 sediments, suggesting that the pieces found in Members 2 and 3 may have originated in Member 1. According to the faunal dating method applied at Swartkrans, a bone tool culture existed unchanged for nearly a million years. However, evidence of mixing suggested by Electron Spin Resonance may limit this time-span to between 1.8 and 1.5 Mya (Member 1).

Sterkfontein

Partridge (1978) has classified the Sterkfontein depositional sequence into six Members. The Member 4 deposit is essentially comprised of a talus slope of australopithecine remains, and is abutted to the west by a stony artefact-bearing breccia known as the Extension Site (Robinson 1957), Middle Breccia (Robinson 1962) or Member 5 deposit (Partridge 1978; Clarke 1985, 1988, 1994; Kuman 1994). To date, the remains of 19 hominids attributed to *Homo* have been recovered from this area, including the Stw 53 cranium designated *Homo habilis* by Hughes *et al.* (1977) and Clarke (1985). Hominid fossils from the Early Acheulean orange sandy breccia dated to about 1.5 Mya are less definitive, and may represent the more advanced form of hominid *Homo erectus* (Robinson 1961), also called *Homo ergaster* (Clarke 1994). Two cultural entities are recognised from Member 5; an Oldowan Industry from the lower part of the excavation (Kuman 1994), and on the basis of well-defined hand-axes and cleavers an Early Acheulean Industry (Mason 1962, 1976; Clarke 1985; Kuman 1994). It was in association with the Early Acheulean artefacts that the bone tool specimen SE 612 was found.

Kromdraai

Kromdraai joins Sterkfontein and Swartkrans as the newest of only three well-documented Plio-Pleistocene sites in southern Africa with early artefact assemblages associated with fauna and in reliable contexts (Kuman *et al.* 1997). The site is divided into two main sections; namely A and B. To date, A (also termed the faunal site) has yielded one hundred stone artefacts and manuports of the Early Acheulean/Developed Oldowan Industry (Kuman *et al.* 1997). Kromdraai A is a non-hominid bearing deposit dated to between 2 and 1 Mya.

Kromdraai B, the hominid-bearing deposit associated with *Australopithecus robustus* is dated to between 2 and 1.5 Mya, and has yielded only four stone artefacts. No bone tools have been recovered from either Kromdraai A or B.

Drimolen

The new site of Drimolen , dated to between 2.5 and 1.6 Mya has to date yielded at least 23 as yet undescribed 'bone tools'. Two hominid species are associated with this deposit, namely *Paranthropus robustus* and an early form of *Homo* (Keyser pers. comm.). Only a single core tool and two flakes constitute the stone tool component at this site.

Associated hominids

A survey of well-documented Plio-Pleistocene sites in southern Africa shows a tempero-spatial association of hominids and material culture (see Table 16). Except for Drimolen, with its small sample size, all of the sites have yielded stone tools of the Developed Oldowan/Early Acheulean type, and except for Kromdraai, all of the sites are associated with two forms of hominid, namely *Australopithecus* (*Paranthropus*) *robustus* and an early form of *Homo*. To date, Kromdraai has not yielded any remains of the genus *Homo*, nor has it produced any bone tools.

Since both *Paranthropus* and early *Homo* are associated with bone tools, the question remains as to who made them. Cranial capacity and architecture has historically been the accepted measure of cognitive ability, and as such has been pivotal in the separation of taxa. This in itself is an inconclusive assumption questioned by Clarke (1995), who highlights the morphological similarities between crania designated *Australopithecus africanus* and *Homo habilis*. The inference is that *Homo habilis* may have evolved from a population of *Australopithecus africanus*, and that we cannot be sure that the latter was not also 'culturally endowed'. This problem is evident in the fact that stone tools predating the emergence of *Homo*, and contemporaneous with the robust australopithecine clade were already in existence in sites in Ethiopia at around 2.5 Mya (Roche & Tiercelin 1977; Harris 1983; Howell *et al.* 1987; Semaw *et al.* 1997).

On anatomical grounds, Susman (1989, 1993, 1994) argues that from the postcranial evidence it would appear that *Paranthropus* exhibits all the salient features indicative of a refined precision grip. The thumb was stout, with a broad saddle-shaped carpo-metacarpal joint, a well-developed opponens pollicis muscle, an extensive area of insertion for the flexor pollicis longus muscle on the distal phalanx, and a prominent apical tuft on the tip of the thumb. The fingers were straight and had broad apices, while the metacarpus was similar to that of later hominids, including modern humans. These features represent many of the criteria on which Leakey *et al.* (1964) based their assumption that O.H. 7 (*Homo habilis*) was a member of the genus *Homo* and thus capable of tool production. Following Susman (1989), the notion no longer seems tenable that tool behaviour provided the adaptive wedge that separated the 'robust' australopithecines from the *Homo* lineage (see for example Leakey 1961; Tobias 1965; Robinson 1972).

The postcranial morphology of *Paranthropus*, together with Grine's (1981) dental evidence for a largely vegetarian diet have led Brain *et al.* (1988) to consider tool-making in the robust australopithecines as an adaptation for the procurement and perhaps processing of plant foods. They suggest that the regular occurrence of bone 'digging tools' and stone culture throughout Members 1, 2 and 3 may reflect their use as a long-standing tradition amongst hominids living on the highveld, and advocate the likelihood that both *Paranthropus* and *Homo* participated in implement-assisted food procurement strategies. At this stage we can only postulate who the maker of the bone tools was, but future research may include comparative studies focusing on new dental analytical techniques; isotopic evidence for diet in the different hominid taxa; and geomorphological processes affecting fossilisation morphology. There is therefore a need to expand the comparative data base of natural processes and their effects on bone assemblages.

6.3.3 Scanning Electron Microscopy

While the Scanning Electron Microscope (SEM) offers superior resolution of three-dimensional structures, extensive depth of field, the capacity for high magnification and the facility to record observed modifications, its application to the study of early hominid bone tools is somewhat limited. For example, replicas observed with the SEM are limited to a height-width dimension in the region of 25 mm x 25 mm. These size constraints are determined by the diameter of the entrance chamber, the limited degree of tilt achieved with elongated pieces, and the stability of the specimen relative to the degree of tilt. In attempting to situate the surface features relative to the tip, all fossil specimens were moulded and cast so as to include the end-most portion of the tip. In so, doing many of the replicas were dominated by smoothing and polish, with very little space left for recording the immediately distal wear pattern. Second, in order to highlight surface features, the replica has to be tilted to the extent that only an oblique view of the wear pattern is most effective for observation purposes, thereby eliminating the possibility of striation measurement. Future research may consider exploring the use of more sophisticated technology in terms of the Confocal microscope, and micro-image capture using a photomacroscope in conjunction with image analysis technologies.

6.4 Conclusion

Based on the results of the accumulated data, this analysis confirms Brain and Shipman's (1993) diagnosis that the wear on many of the bone tips should be interpreted as resulting from use by hominids. Future research may consider expanding the experimental digging repertoire in order to increase the comparative sample of human modified material, as well as expanding the database of non-human agents. The exploration of alternative task-related activities may greatly change our perceptions of early hominid diet, subsistence, and land use patterns, factors that not only have direct bearing on behaviour, but also on the evolution and extinction of species. The Swartkrans and Sterkfontein bone tool collection has significant behavioural implications, as the wear pattern suggests a wider range of tasks and activities than previously considered.

The first systematic use of formal bone points (associated only with *Homo sapiens*) enters the archaeological record *c.* 103 000 years ago at the Middle Stone Age site of Blombos Cave, South Africa (Henshilwood & Sealy 1997; Vogel *et al.* 1999). Barbed and unbarbed points, as well as a dagger-like object, dated to 89 000 years ago are reported from Zaïre (Brooks *et al.* 1995; Yellen *et al.* 1995). While shaped or used bones have been reported from Middle Pleistocene sites in Africa and Europe, they are a rarity in Middle Stone Age contexts (Klein 1989). Being less formal in appearance, the Swartkrans bone tools differ from those obtained from more recent sites. However, they too exhibit features characteristic of modifications observed on archaeological and human experimental material. Thus, together with the fossil bone material from Olduvai Beds I and II, the Swartkrans and Sterkfontein specimens confirm Leakey's (1971), Shipman's (1989), and Brain & Shipman's (1993) contention that hominids used bone tools nearly 2 million years ago. The association of hominids in southern Africa between 1 and 2 Mya, and the increasing complexity in cultural remains, is mirrored in the East African record which chronicles an expansion of archaeological sites into a greater variety of geographic settings by 1.6 Mya (Rogers *et al.* 1994; Kuman 1998). This temporal overlap and spatial variance, together with the diagnostic criteria identified in the framework of this study, seem relevant to the question of inter-site variability in the use of bone by early hominids.

APPENDIX I
Phase 1 analysis spreadsheet

COLLECTION: ____
COLLECTOR: ____
REFERENCE: ____
INSTITUTION: ____
DATE: ________________________________ **TOTAL #:** ____________

spec #	catalogue #	smoo	r/p	poli	stri	flak

List of abbreviations: spec # = specimen number; smoo = smoothing; r/p = rounded/pointed; poli = polish; stri = striations; flak = flake damage; skul = skull; calv = calvaria; maxi = maxilla; mand = mandible; atla = atlas; vert = vertebra; sacr = sacrum; caud = caudal vertebra; scap = scapula; pelv = pelvis; hupr = humerus proximal; hudi = humerus distal; hush = humeral shaft; rapr = radius proximal; radi = radius distal; rash = radial shaft; ulpr = ulna proximal; uldi = ulna distal; ulsh = ulna shaft; fepr = femur proximal; fedi = femur distal; fesh = femoral shaft; pate = patella; tibp = tibia proximal; tibd = tibia distal; tibs - tibial shaft; mcar = metacarpal complete; mecp = metacarpal proximal; mecd = metacarpal distal; mecs = metacarpal shaft; mtar = metatarsal complete; metp = metatarsal proximal; metd = metatarsal distal; mets = metatarsal distal; mepd = metapodial complete; mpop = metapodial proximal; mpod = metapodial distal; mpos = metapodial shaft; astr = astragalus; calc = calcaneus; tars = tarsal; carp = carpal; phpr = phalanx proximal; phme = phalanx medial; phdi = phalanx distal; avec = aves cranial; avel = aves long bone; avev = aves vertebra; frag = fragment; flak = flake; shaf = shaft piece.
See Chapter 3.1.1 for definitions of flake and shaft piece.

Skul	oalv	horn	maxi	mand	atla	axis	vert	saor	caud	ribs	scap	pelv	hupr	hudi	hush	rapr	radi	rash	ulpr	uldi	ulsh	fepr	fedi	fesh	pate	tibp

tibd	tibs	mcar	mecp	mecd	mecs	mtar	metp	metd	mets	mepd	mpop	mpod	mpos	astr	calc	tars	carp	phpr	phmc	phdi	avcc	avel	avev	frag	flak	shaf

APPENDIX II
Phase 2 analysis spreadsheet

COLLECTION: ______________________________
COLLECTOR: ______________________________
REFERENCE: ______________________________
INSTITUTION: ______________ ______________
DATE: ______________ ______________ **TOTAL #:** ________

spec #	catalogue #	length x breadth	wea ther stag	smo oth enti	smo oth loca	poli sh enti	poli sh loca	sedi men	etch ing	stri atio ns	scra pe mar	gro ove s	flak ed tip	con choi flak	mn. di-ox

List of abbreviations: spec # = specimen number; weather stag = weathering stage; smooth enti = smoothing entire; smooth loca = smoothing local; polish enti = polish entire; polish loca = polish local; sedimen = sediment; scrapemar = scrapemarks; conchoi flak = conchoidal flake scar; mn. di-ox = manganese dioxide; rod en ch = rodent end chewing; sm rod gn = small rodent gnawing; porcu gn = porcupine gnawing; shred en = shredded end; step fra = step fracture; root aci = root acid; larva da = larvae damage; dimplin = dimpling; fine pittin = fine pitting; wind erosio = wind erosion; water abras = water abrasion; % surf damage = % surface damage.
See Chapter 3.1.6 for definitions of the weathering stages.
See Chapter 3.5.1 for definitions of the terms smoothing, polish, and flake damage.
See Chapter 3.1.2 for definitions of the damage categories.

rod en ch	sm rod gn	por cu gn	too th sco	too th cru	too th pit	too th not	pu nct ure	cre nul ate	shr ed en	ste p fra	pe eli ng	dig est ed	roo t aci	be etl e	lar va da	di mp lin	fin e pit tin	abr asi on	wi nd ero sio	wa ter abr as	oth er	% surf dam age

APPENDIX III
'Bone tool' data sheet

COLLECTION: ____________________

INSTITUTION: ____________________

CATALOGUE #: ____________________

superior

periosteal right posterior left

DESCRIPTION/ORIGIN:

ROUNDED/POINTED:

SIZE:

WEATHERING STAGE:

FRACTURE:

STRIATIONS:

SCRATCHES:

GROOVES:

SMOOTHING:

POLISH:

FLAKE DAMAGE:

PITTING:

TOOTH MARKS:

ETCHING/ACID:

ABRASION/EROSION:

SEDIMENT:

MnO_2:

CUTMARKS:

OTHER:

MICROMORPHOLOGY:

INTERPRETATION:

COMMENTS:

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A critical assessment of southern African 'early hominid bone tools'

Lucinda Ruth Backwell

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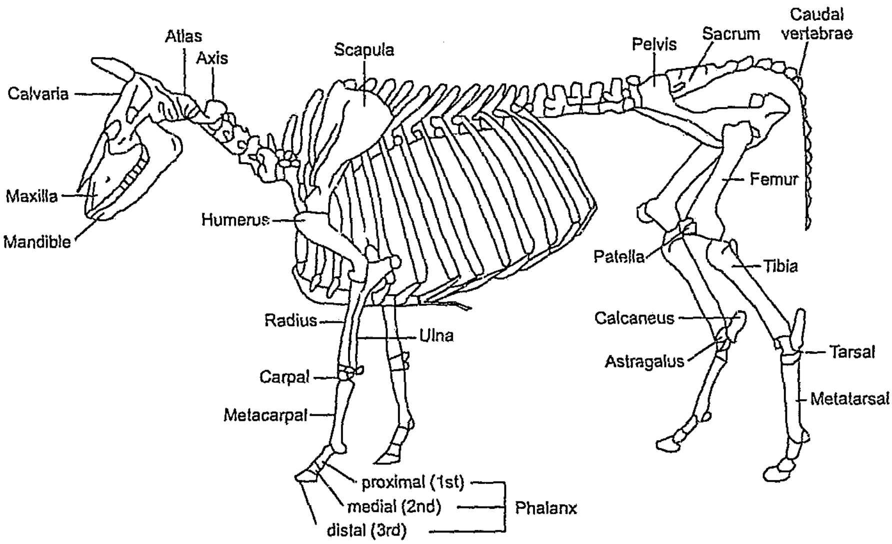


Figure 1. Diagram of a bovid skeleton showing locations of major skeletal elements (modified after Schmid 1972).

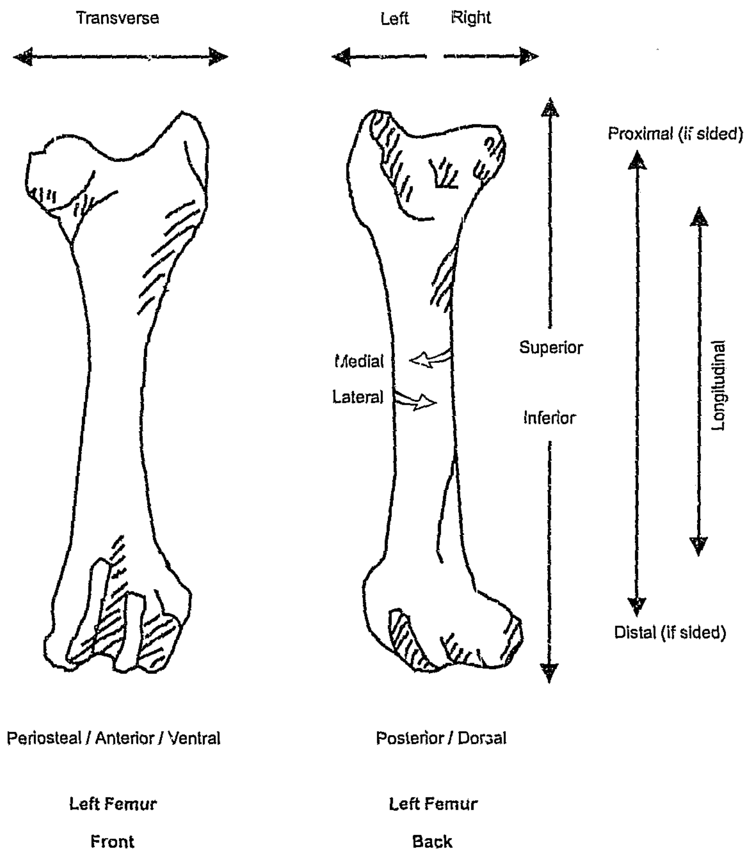


Figure 2. Diagram of a generalised left bovid femur illustrating directional terms used for vertebrate skeletons.

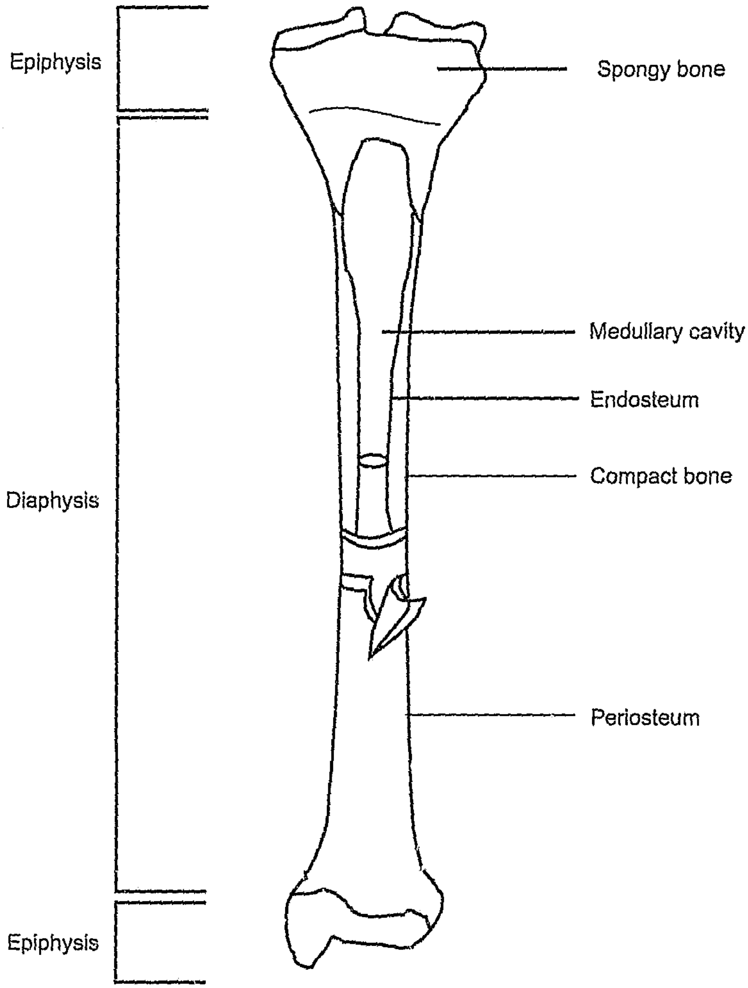


Figure 3. Longitudinal section of a tibia showing long bone structures (after Thibodeau & Patton 1993).

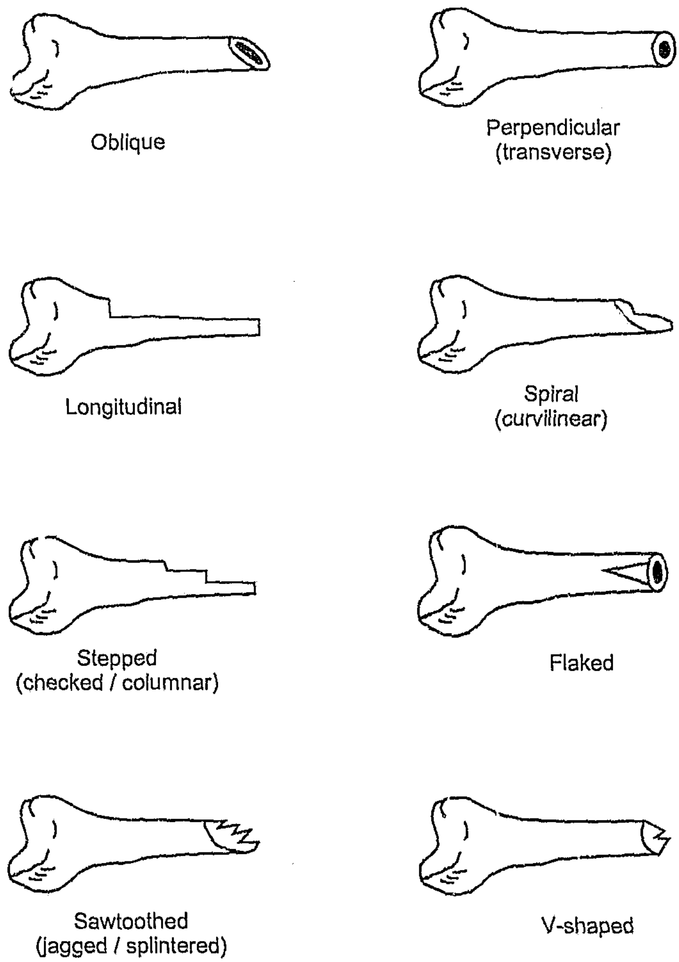


Figure 4. Fracture patterns shown on distal femora (modified after Shipman *et al.* 1981; Marshall 1989). Multiple definitions are given in parentheses.

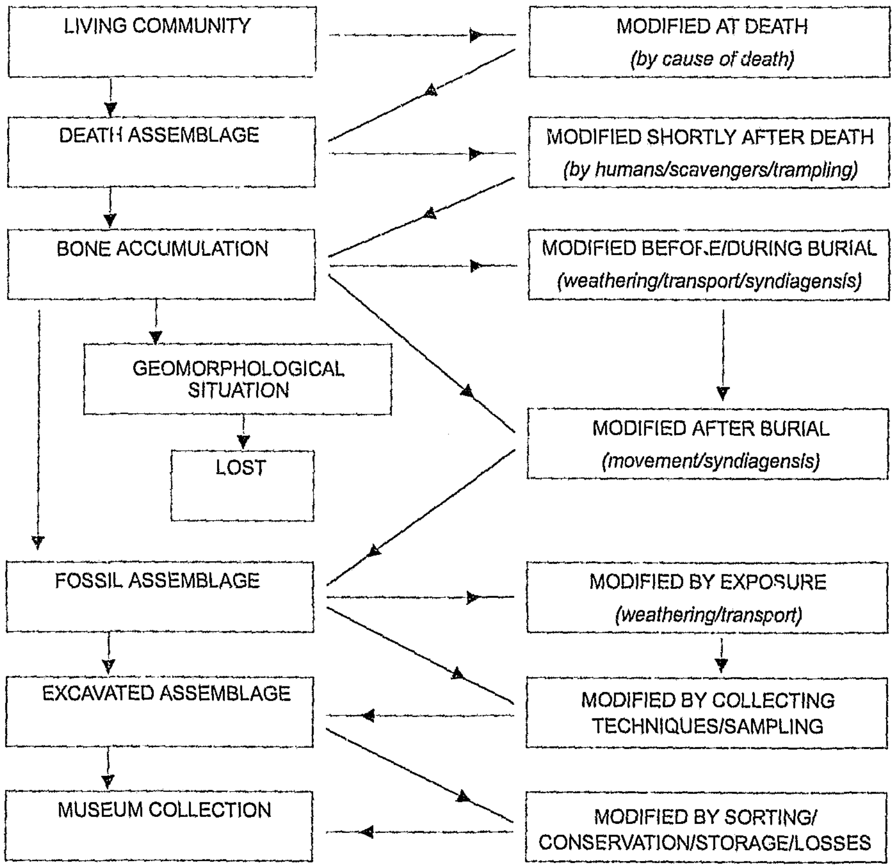


Figure 5. Model of a taphonomic history showing stages in the formation and modification of a bone assemblage (after Andrews & Cook 1985).

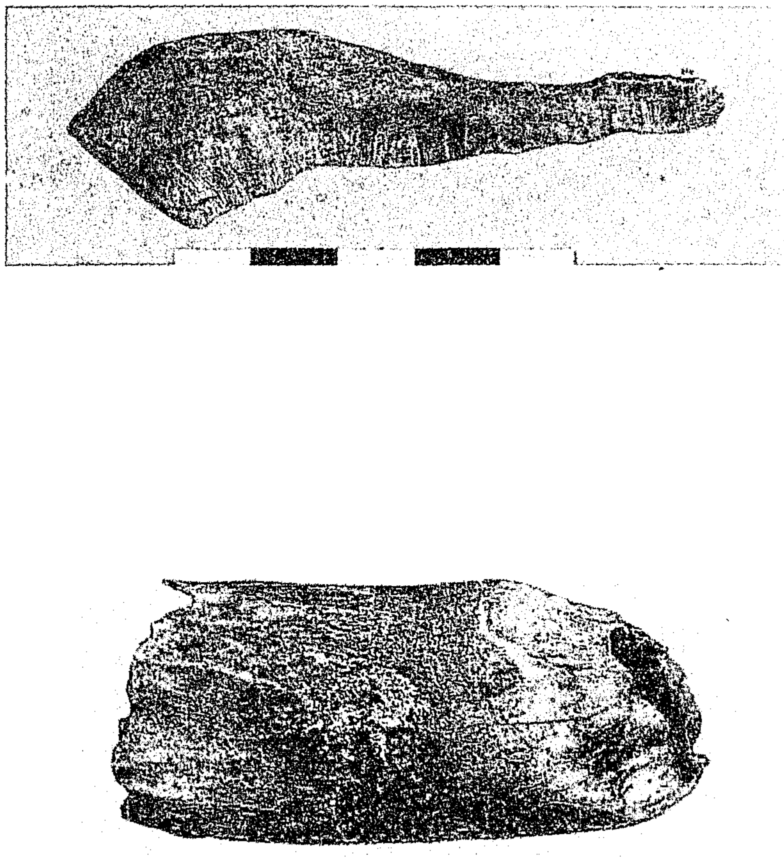


Figure 6. Example of porcupine gnaw marks created by broad and flat incisors. Scale = 1 cm.

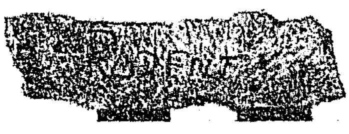


Figure 7. Example of small rodent gnawing. Scale = 1 cm.

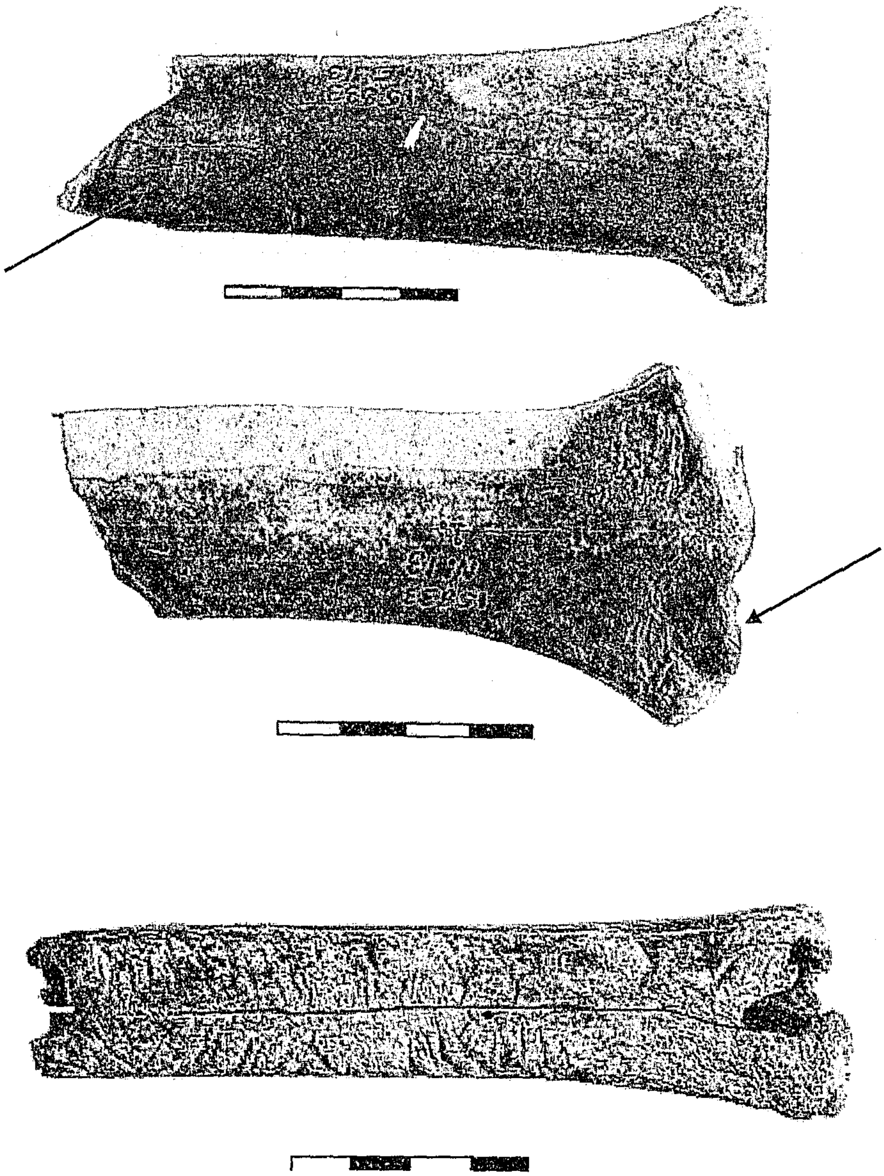


Figure 8. Examples of tooth scores. Scale = 1 cm.

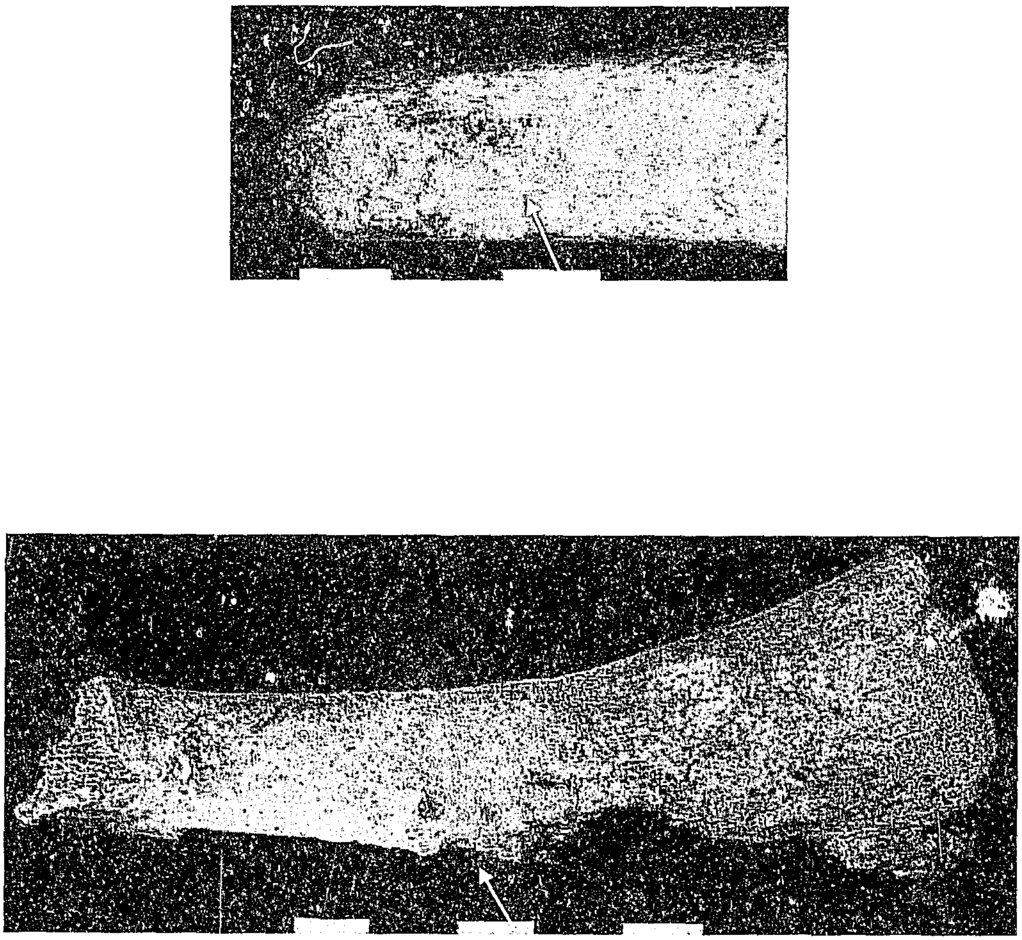


Figure 9. Examples of tooth pits made by hyaena canines. Scale = 1 cm.

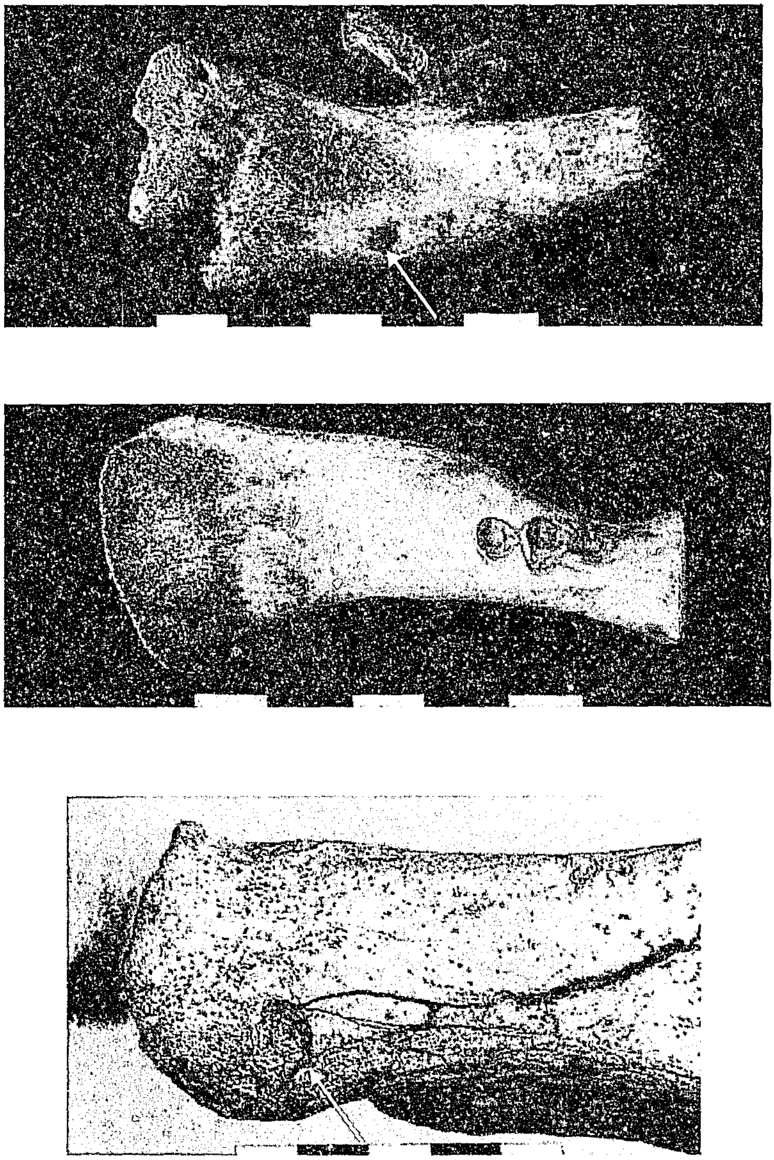


Figure 10. Examples of punctate depressions / tooth crushes. Scale = 1 cm.

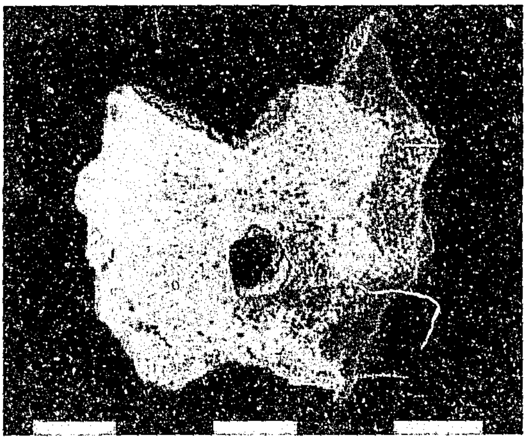


Figure 11. Example of a tooth puncture. Scale = 1 cm.

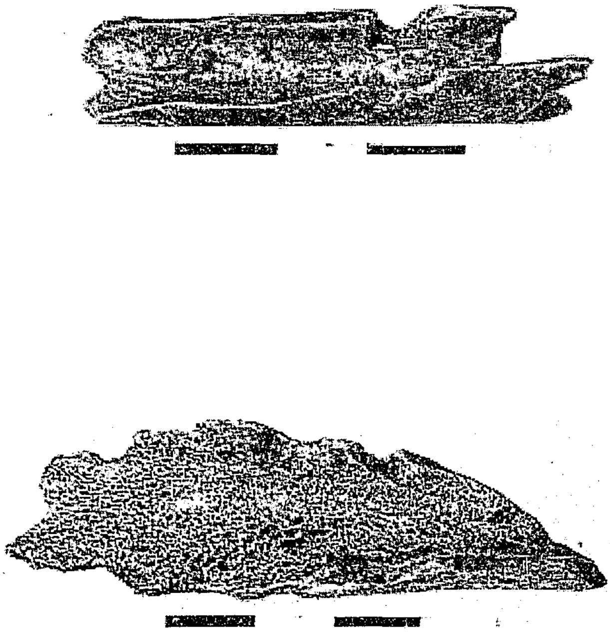


Figure 12. Examples of tooth notches. Scale = 1 cm.

Figure 13. Examples of ragged edge chewing. Scale = 1 cm.

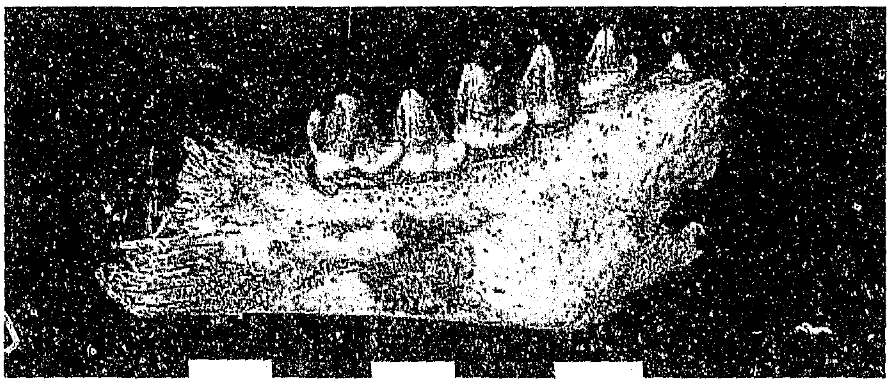


Figure 14. Example of a shredded end. Scale = 1 cm.

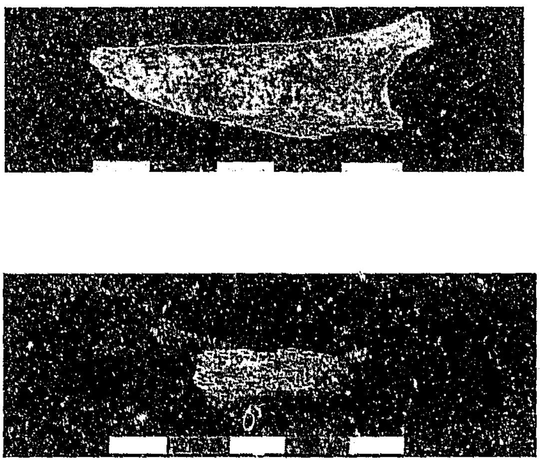
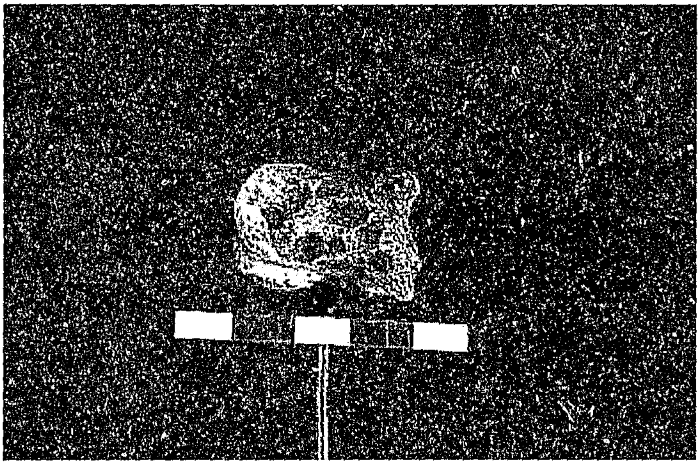


Figure 15. Examples of hyaena digested flakes. Scale = 1 cm.



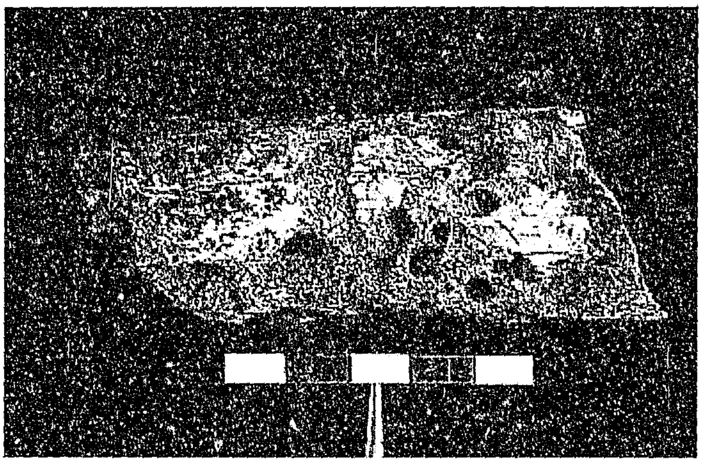


Figure 16. Examples of beetle boring. Scale = 1 cm.

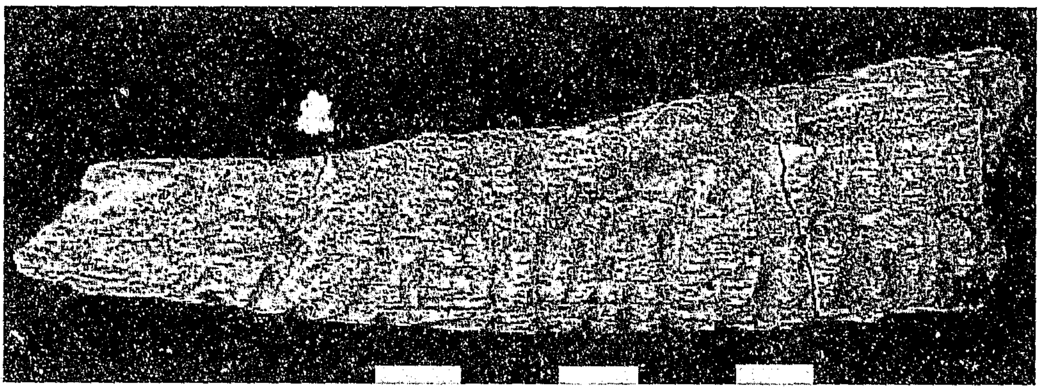


Figure 17. Example of larvae damage. Scale = 1 cm.

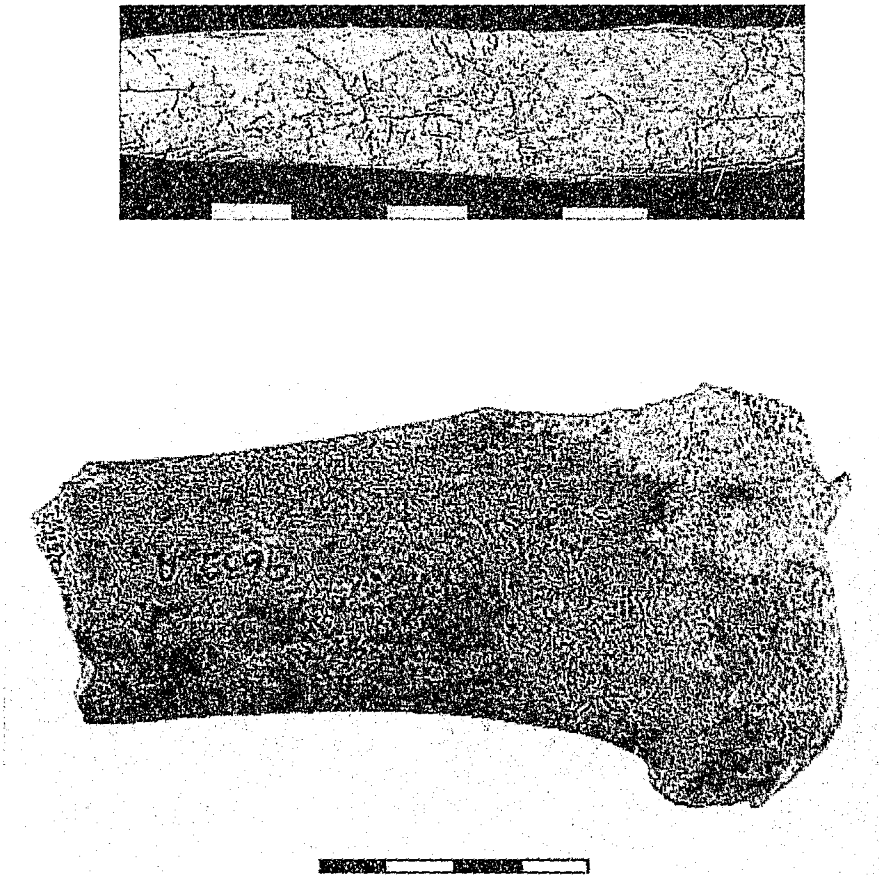


Figure 18. Examples of root acid etching. Scale = 1 cm.

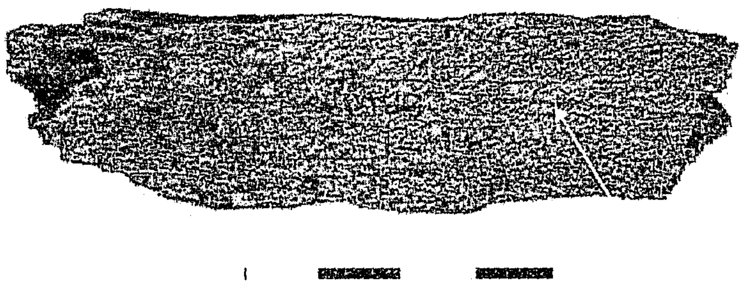


Figure 19. Example of trampling. Note multiple parallel striations. Scale = 1 cm.

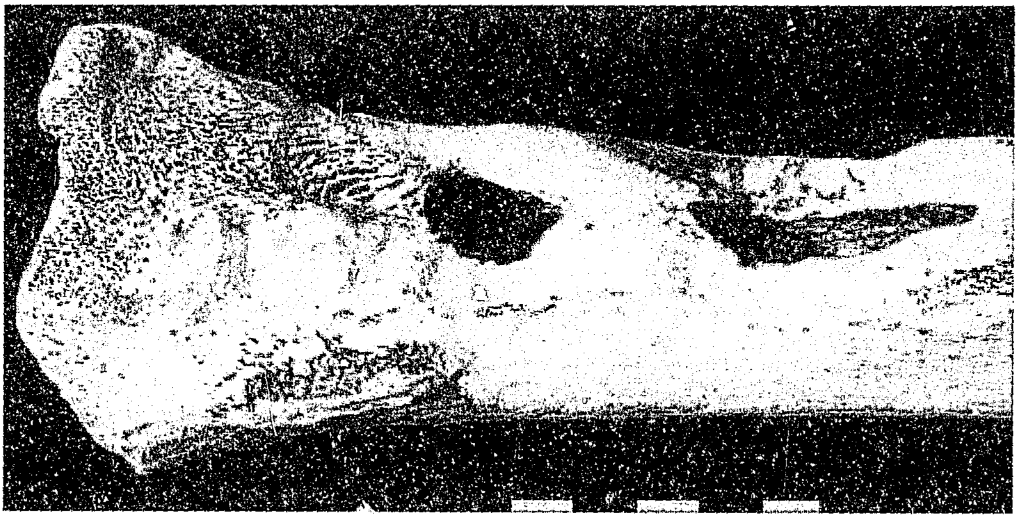


Figure 20. Example of hollowing caused by spring water. Scale = 1 cm.

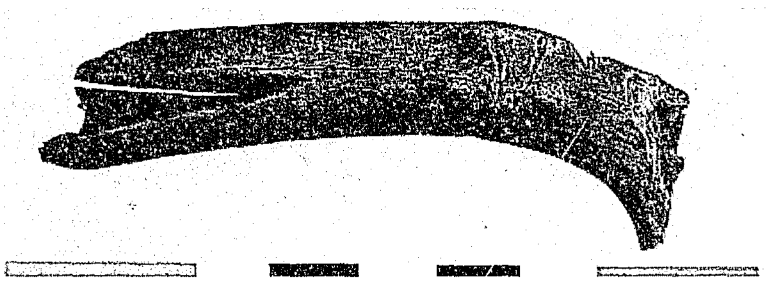


Figure 21. Example of cut marks. Scale = 1 cm.

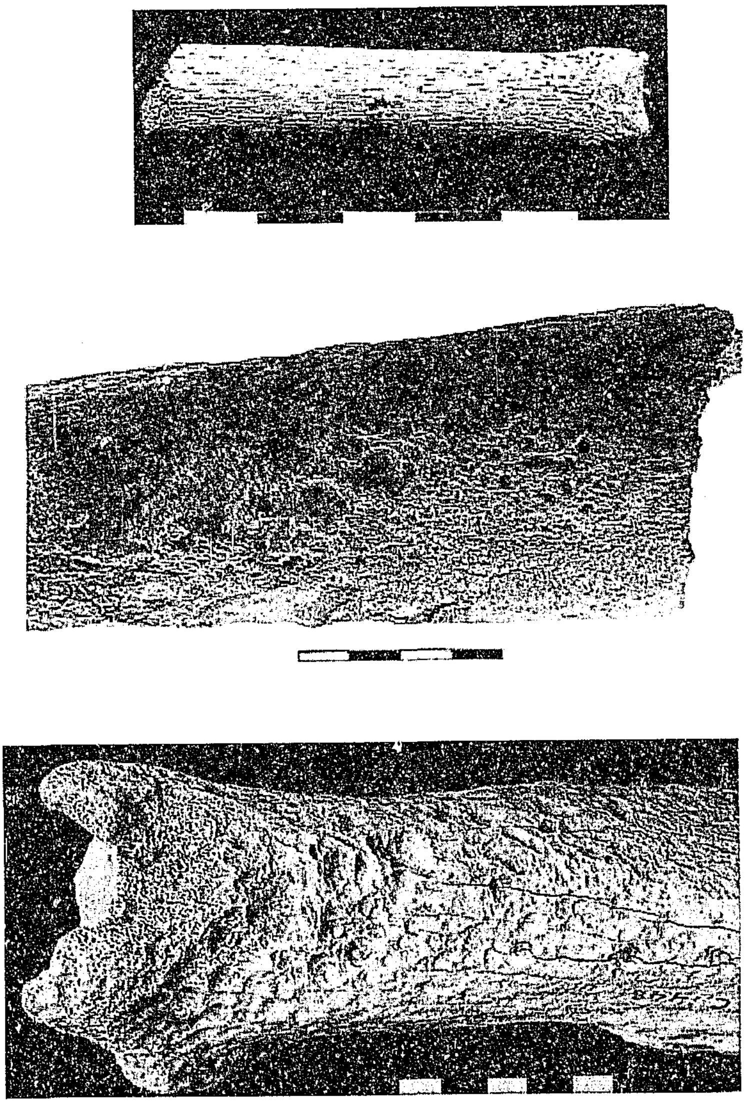


Figure 22. Examples of acid etching / dissolution. Top: specimen from hyaena lair in central Namib Desert; middle: dissolution pits caused by acid soil conditions; bottom: dissolution pits caused by possible spring water action after acid soil conditions. Scale = 1 cm.