THE REINVESTIGATION OF HOFFMAN'S/ROBBERG CAVE – THE ARTEFACTUAL AND SHELLFISH ASSEMBLAGES, 2007

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Thesis presented for the degree of Master of Philosophy

In the Department of Archaeology
University of Cape Town

February 2009

Abstract

This thesis documents the re-investigation of Hoffman's/Robberg Cave, a little known site located on the Robberg Peninsula near Plettenberg Bay on the southern Cape coast of South Africa. Previous excavations carried out at the site early in the twentieth century and again in the late 1950s are scantily documented. Furthermore, a large collection derived from Hoffman's excavations, which I examined and catalogued in 2006, is only a selective sample of the archaeological remains from the site. Small-scale excavations were carried out at Hoffman's/Robberg Cave in June/July 2007 with the dual objectives of documenting the stratigraphy of the Late Holocene deposits, and obtaining an unselected sample of material for analysis. The primary aim was to elucidate the lifeways of prehistoric hunter-gatherers living at the site for a short period during the Later Stone Age. The stratigraphy and chronology of the deposits indicate two episodes of occupation between 4000 and 3300 BP. Shellfish residues suggest exploitation patterns in keeping with the steep topography of the shore in the immediate vicinity of the cave. Changes in the size distributions of the most abundant limpet species, *S. cochlear*, are attributed to fluctuations in the intensity of human predation. A comparative sample from an open midden in Noetzie, Knysna, reflects slightly different exploitation patterns, as well as chronological changes in shellfish collection strategies which have been documented elsewhere. Changes in the size distributions of *T. sarmaticus* are probably also the result of human exploitation, and are consistent with changes observed at other sites along the southern Cape coast. The material cultural assemblages from Hoffman's/Robberg Cave and the neighbouring site of Nelson Bay Cave reflect some cultural continuity in the production of certain types of artefacts during the post-Wilton period.

Acknowledgements

I would firstly like to thank CapeNature for permitting us to excavate in the Robberg Peninsula Nature Reserve, and for facilitating our fieldwork in many different ways. I would like to thank my advisor, Judith Sealy, for her guidance and support throughout the excavation, analysis of the material and collation of results ; Tim Maggs, whose practical knowledge and experience proved invaluable in the field; and Louisa Hutten for her role in organizing many aspects of the excursion. Thanks are also due to all the other members of the 2007 field team: Susan Pfeiffer, Dolores Jacobs, Tara van Niekerk, Jane Noah, Celeste Boothe, Cuan Hahndiek, Deon Vaaltyn and Albon Pietersen. Dolores Jacobs deserves extra thanks for her assistance with the laboratory sorting of the material. Sally Adam is responsible for the re-drawing of the Hoffman's/Robberg Cave section, and for the map showing the location of Hoffman's/Robberg Cave. Tim Maggs re-drew the site plan. I am grateful to David Halkett and Jayson Orton for allowing me to participate in one of the excavations at Noetzie, and for granting me access to the shellfish remains from this site. I also wish to acknowledge Simon Hall, John Parkington, and Chopi Jerardino for their support and advice, and Gerda Coetzee of the National Museum for her continued attempts to find information on Hoffman's excavation. Financial support for this project was provided by the National Research Foundation, the South African Archaeological Society, through the Kent Bequest, and the University of Cape Town.

CONTENTS

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

1.1. THE SITE OF HOFFMAN'S/ROBBERG CAVE

Hoffman's/Robberg Cave is a large south-facing site located at 33° 23′S and 22° 11′E on the rocky shores of the Robberg Peninsula, near Plettenberg Bay on the southeastern coast of South Africa. Situated at approximately 12m above sea level on the eastern side of the "Gap", the cave contains highly visible mounds of shell midden deposit slumped down towards the entrance in addition to more protected deposits in the interior of the cave itself. This site is one of several along the Robberg Peninsula in which archaeological deposits have been found, recorded and excavated. Nelson Bay Cave, so-called because of its proximity to Nelson Bay (Inskeep 1987), which is located a few hundred metres to the east of Hoffman's/Robberg Cave, is widely recognized as one of the most informative and well-documented Later Stone Age sequences in southern Africa.

The southern Cape coast is, in general, known for its rich archaeological record and abundance of sites dating to the Middle and Later Stone Ages. Located approximately 14km east along the coast from Nelson Bay Cave and Hoffman's Robberg Cave is another well-studied site, Matjes River Rock Shelter. This site is best known for the wealth of skeletons recovered during early excavations, and for the large volumes of shell midden deposit accumulated within the rock shelter. Hoffman's/Robberg Cave has been largely ignored in relation to Nelson Bay Cave, Matjes River Rock Shelter and other southern Cape coastal sites which have been subject to intensive archaeological inquiry for the last fifty years. This thesis represents an attempt to correct this, and to integrate the site of Hoffman's/Robberg Cave into the substantial archaeological record of the southern Cape coast, and the growing body of knowledge regarding the lifeways of prehistoric foragers during the Holocene.

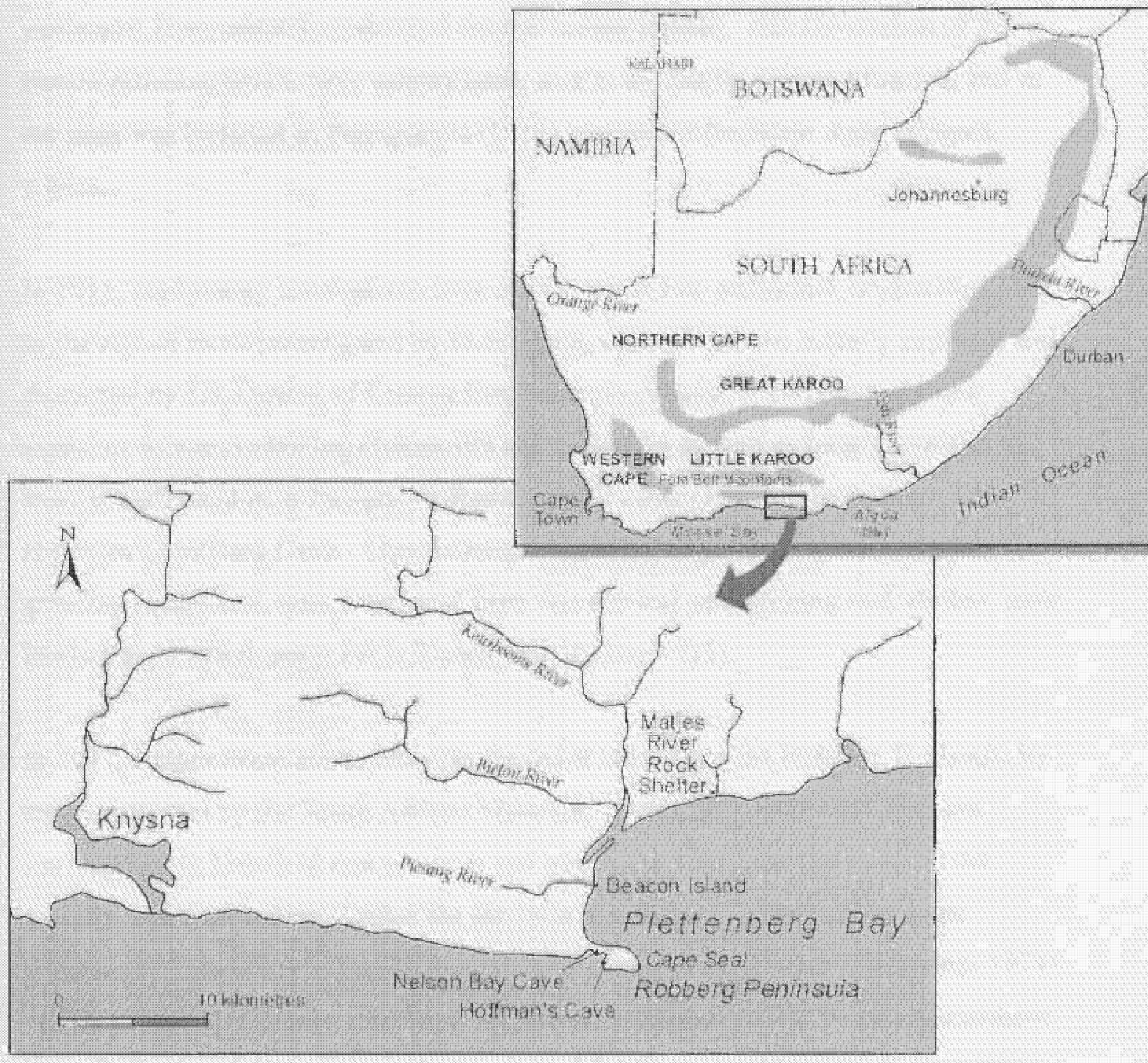


Figure 1.1.Map showing the location of Hoffman's/Robberg Cave and other important archaeological sites in the vicinity.

1.2. PREVIOUS INVESTIGATIONS AT HOFFMAN'S/ROBBERG CAVE

Several archaeological excavations are known to have taken place at Hoffman's/Robberg Cave, also referred to in the early literature as Cave F and East Guanogat, prior to the 2007 investigation. The first exploratory excavations carried out at sites at Cape Seal or Robberg early in the twentieth century were principally concerned with the recovery of human skeletons. At the request of Dr Peringuey, Mr R.E. Dumbleton of George investigated five caves and rock shelters along the peninsula, from which he exhumed several human burials. His description of the human remains, which were subsequently sent to the South African Museum, and of the sites was included in Peringuey's (1911) account of the Stone Ages of South Africa.

In 1913, exploratory excavations were carried out at two additional, unspecified sites to the east of those investigated by Dumbleton, which had been initially explored and described by J.S. Henkel of Knysna four years previously. The larger of these contexts, a cave containing stalagmites and stalactites as well as large quantities of marine shell residue, is thought by Rudner and Rudner (1973) to have been Hoffman's/Robberg Cave. Human remains, as well as painted stones and some grinding equipment, were recovered from this site and an adjoining rock shelter, most likely Cave E (Peringuey 1911; Rudner and Rudner 1973).

In 1917, further excavations were conducted at sites along the Robberg Peninsula by men contracted by the South African Museum. Hoffman's/Robberg Cave was investigated in March of that year. A test trench dug along the cave wall in the vicinity of the stalactites yielded the skeleton of a child, a painted stone, some fragments of red ochre and large quantities of bone points (Rudner and Rudner 1973). Hoffman's/Robberg Cave may have been re-investigated in 1932 by two researchers from Stellenbosch University, who conducted field work at three sites to the west of the Cape. Two of these, "probably Cave E and F" (Rudner and Rudner 1973: 96) had been previously excavated.

During the late 1950s, extensive excavations were carried out at Hoffman's/Robberg Cave by A.C. Hoffman. Large quantities of human, faunal and cultural remains were recovered from a 1.5 by 5m test trench dug through approximately 2m of Later Stone Age shell midden deposit. This large collection of material was stored at the National Museum, Bloemfontein, where it remained unstudied and unpublished for more than four decades. The site was re-visited by Hilary Deacon and Richard Klein in 1970, for the purpose of collecting samples for radiocarbon dating. Uncorrected dates of 3190 ± 110 BP (UW204) and 3370 ± 100BP (UW 205) from limpet shells from the top and bottom of the midden excavated by Hoffman (Fairhall, Young and Erickson 1976) place the deposit within the Late Holocene period. These researchers attempted to investigate what lay beneath the sterile dune sand at the bottom of Hoffman's trench, but were unsuccessful.

1.3. RECENT RESEARCH AT HOFFMAN'S/ROBBERG CAVE

In 2006, Judy Sealy and I visited the National Museum in order to examine and catalogue the previously undocumented collection of material from Hoffman's excavation. Our interest in the assemblage from this little-known site stemmed from previous isotopic and material cultural analyses conducted by Sealy and Ben Ludwig, respectively. Between the mid-1990s and 2006, Judith Sealy carried out a stable isotopic study on human remains from sites in Plettenberg Bay and along the Robberg Peninsula, including Hoffman's/Robberg Cave and Nelson Bay Cave, and those from Matjes River Rock Shelter on the opposite side of the Keurbooms/Bitou estuary. The results revealed significant variation in the diets of prehistoric groups living in the two closely adjacent regions during the Late Holocene. Such economic differentiation was regarded by Sealy (2006) as indicative of territorial and social separation among Later Stone Age hunter-gatherers residing along the southern Cape coast prior to the arrival of herders. In order to asses whether or not a material cultural expression of these economic and, by extension, social differences could be found in the archaeological assemblages from the two main sites included in Sealy's study, Ben Ludwig undertook a detailed examination of certain components of the curated collections from Nelson Bay Cave and Matjes River Rock Shelter. He identified a number of differences in the artefactual remains from both sites which he interpreted as possible evidence for social and territorial differentiation between their inhabitants, particularly during the Late Holocene.

My 2006 analysis of the Hoffman's/Robberg Cave collection was conducted with the primary goal of augmenting Ludwig's research. The main objective was the systematic comparison of the Hoffman's/Robberg Cave material with that from the contemporary post-Wilton levels of Nelson Bay Cave. This investigation was premised on the notion that the assemblages from Hoffman's/Robberg Cave and Nelson Bay Cave, located less than half a kilometre distant from one another, would evidence significant continuity. This is turn would indicate the recognition of a shared social identity and foraging territory by the Late Holocene inhabitants of these two sites. Sealy and I observed some broad similarities as well as a number of discrepancies between the two assemblages. Our interpretation of these was hampered by a lack of documentary evidence relating to Hoffman's excavation and a lack of clarity regarding the completeness of the collection of material from Hoffman's/Robberg Cave.

This situation warranted renewed excavations at the site. In 2007, a group of staff and students from the University of Cape Town, as well as a number of visiting researchers, commenced the re-investigation of Hoffman's/Robberg Cave. The 2007 field season focused upon the recording and interpretation of a small section of the considerable Late Holocene deposits located in the interior of the cave, as well as the recovery of an unselected sample of material from the site. Certain components of this material, notably the artefactual remains, were used in a refined comparison between Hoffman's/Robberg Cave, Nelson Bay Cave and, to a lesser extent, Matjes River Rock Shelter and other sites along the southern Cape coast. The examination and quantification of cultural material recovered also provided a means of evaluating the extent to which the collection in the National Museum may be skewed in favour of certain artefacts, and its resulting value and use in future research. The shellfish residues provided insight into the exploitation strategies of the site's prehistoric inhabitants.

1.4. THESIS LAYOUT

This thesis consists of seven chapters. Chapter 2 provides a review of previous research conducted at key sites along the southern Cape coast over the last 100 years. Particular emphasis is placed on Hoffman's/Robberg Cave, Nelson Bay Cave and Matjes River Rock Shelter. The Later Stone Age prehistory of the region, particularly the most recent geological epoch, the Holocene, is highlighted.

Details of the 2007 field season at Hoffman's/Robberg Cave are discussed in Chapter 3. The excavation procedures are outlined and the stratigraphy of the deposits described. Nine new radiocarbon dates obtained from samples of marine shell and charcoal from the site are presented.

Chapter 4 provides the results of quantitative analyses of the shellfish assemblage from Hoffman's/Robberg Cave, and a comparative sample from an open midden in Noetzie, Knysna. Problems in the sampling of marine molluscs from Nelson Bay Cave precluded the publication of detailed reports on the shellfish from this site (Klein 1972a: Inskeep 1987). The Noetzie shellfish were therefore identified and quantified for this thesis in order to provide a comparison with Hoffman's/Robberg Cave. Analysis of other faunal remains recovered from Hoffman's/Robberg cave, including large quantities of fish bones which are currently being studied by Karen van Niekerk as part of her doctoral research, are not dealt with in this thesis.

In Chapter 5, all of the lithic and non-lithic artefactual remains recovered from Hoffman's/Robberg Cave in 2007 are described, quantified, and compared with contemporary material from Nelson Bay Cave. Descriptions of bone and marine shell artefacts, as well as some lithic remains, from the material from an additional field season in 2008 are also included. Comparisons are also made between the unselected sample of material from the recent excavation and the original collection from Hoffman's excavation.

Chapter 6 recaps the most important features of the re-investigation of Hoffman's/Robberg Cave and the analysis of the new material. These are then further discussed within the context of the Late Holocene prehistory of the southern Cape coast. My final conclusions are summarized and presented in Chapter 7.

CHAPTER 2
PREVIOUS ARCHAEOLOGICAL RESEARCH ALONG THE CAPE COAST

2.1. INTRODUCTION

The Cape coastal region has been a focus for human occupation for thousands of years, leading to the accumulation of a rich and diverse material cultural record documenting the major developments undergone by Stone Age communities over the last 100 000 years at least (Bailey and Parkington 1988). Material traces of the activities and behaviour of prehistoric humans have been preserved in a number of contexts, including caves and rock shelters as well as open middens consisting primarily of shellfish remains and scatters of artefacts.

These sites and the people whose activities they represent have been a source of great interest to outside observers for hundreds of years. Succeeding generations of researchers have invoked a variety of paradigms in the attempt to account for the substantial variation evident in assemblages from different regions and times. Many of the research projects carried out along the Cape coast have been particularly interested in material cultural, environmental and behavioural changes associated with the most recent geological epoch, the Holocene, and the few thousand years immediately preceding it. Later Stone Age studies in the southern Cape coastal region were similar in character to those carried out along the western and eastern Cape coasts. Trends in southern African archaeology were in turn influenced by broader developments in archaeological theory and praxis in Europe and the United States.

2.2. EARLY ACCOUNTS AND ENCOUNTERS

The earliest descriptions of indigenous people living along the Cape coast were by European explorers and later, colonists, who "discovered" and began moving into the region towards the end of the fifteenth century. Travellers arriving at the Cape in the wake of Diaz's voyage around the southernmost tip of Africa encountered several different groups of aboriginals, some of whom owned relatively large herds of livestock, while some did not. Most documentary sources of the time depict the indigenous inhabitants of the Cape as bestial savages on the verge of starvation, completely ignorant of agriculture and having to eke out a miserable existence harvesting corms and shellfish and, at times, meat from the decayed carcasses of whales washed up onto beaches (Raven-Hart 1967).

The journal of Jan van Riebeeck (Thom 1954), who established a refreshment station at Table Bay in 1652, contains multiple references to indigenous people in the vicinity. It records trading transactions with stock-owners, confrontations between rival chiefdoms and a variety of other observations and encounters. Van Riebeeck employed a number of different terms in his descriptions of these people, ranging from the derogatory and generic to those which must have been used by different groups to identify themselves. His accounts also refer to various incidents of tobacco theft and cattle raiding allegedly committed by these people, and to attempts to indenture or imprison them.

The accounts of other colonial officials and travellers passing through the present-day Olifants River Valley in the Western Cape during the second half of the seventeenth century are similarly marred by prejudices and inconsistencies in labelling and describing the people they encountered there (Parkington 1977). The blanket terms "Bushman" and "Hottentot" were employed by early writers in reference to indigenous hunters and herders, respectively. The term Hottentot has largely been replaced by Khoekhoen as a classification for the prehistoric herders of the western Cape, while Bushmen may be referred to as San. Khoisan is recognized as the distinct racial category to which these people and their contemporary descendants belong. It should be noted, however, that the interactions and behaviour of different local groups inhabiting the Cape coast during the final stages of the Stone Age were complex and varied as they tried to formulate a response to the incursion of European settlers. Thus, herders who had lost their livestock may have fallen back on the exploitation of marine resources such as shellfish, thereby earning the well-known epithet of "Strandlopers". Hunters, faced with dwindling plant and game resources, may have retreated further into the interior of the country, or acquired stock from adjacent groups of herders. This precludes the drawing of absolute distinctions between hunters and herders (Raven-Hart 1967; Parkington 1977; Elphick 1985; Barnard 1992).

2.3. EARLY ARCHAEOLOGICAL EXCAVATIONS

From the mid-nineteenth century onwards, amateur antiquarians and collectors as well as specialists in a variety of scientific fields began to take an avid interest in the artefacts and living sites of Stone Age hunter-gatherers (Deacon 1990). Sites containing archaeological material were identified and explored at numerous locations in the eastern and southern Cape. These investigations ranged from the large-scale and often indiscriminate removal and sale of human remains by so-called "skeleton hunters" (Rudner and Rudner 1973: 94) to the collection of stone artefacts similar to those being unearthed from sites in Europe (Deacon 1990). Other interesting items of material culture, including bone tools, were also collected and sometimes donated to local museums (Rudner and Rudner 1973).

2.3.1. EXPLORATORY EXCAVATIONS AT SITES ALONG THE ROBBERG PENINSULA

Dr Peringuey, an entomologist and director of the South African Museum in Cape Town, was alerted to the existence of a series of potentially interesting caves along the Robberg Peninsula in 1908. At Peringuey's request, several of these sites were investigated by Mr Dumbleton of George and Mr Henkel of Knysna. Dumbleton reported the presence of shell midden deposits in five of the caves, which had previously been visited by guano diggers and local residents. Henkel described a cave "with stalagmites and stalactites, the former resting on the shell midden" (Rudner and Rudner 1973: 94). Peringuey went to the Robberg Peninsula himself in 1913. Test trenches were dug at two sites on the eastern side of the "Gap". Both contained human remains as well as artefacts.

More extensive excavations on behalf of the South African Museum were carried out in 1917 by Rev. Sharples and Mr van Rooyen. They investigated three caves, B, C and D. The first two proved to be sterile. In contrast, Cave D was found to contain an abundance of bone artefacts, ostrich eggshell beads, a grindstone and bored stone, some potsherds, ochre, and adult and juvenile burials with grave goods. Painted stones bearing images of animals and humans were discovered in close proximity to some of the skeletons (Rudner and Rudner 1973). Sharples and van Rooyen then proceeded to excavate the two sites on the eastern side of the "Gap" believed to have been investigated by Peringuey four years earlier. Excavations at these sites, namely Cave E and Cave F, the latter of which would come to be known as Hoffman's/Robberg Cave, yielded similar remains to those recovered from Cave D. An additional cave on the west coast of the Robberg Peninsula, designated Cave G, was subsequently explored. Like the majority of other sites investigated by Sharples and van Rooyen, Cave G evidenced considerable disturbance on account of the activities of guano diggers and skeleton hunters. Skeletons found during the excavation of this site proved too frail for removal and transportation to the museum. A number of painted stones similar to those recovered from Cave D were retrieved (Rudner and Rudner 1973).

2.4. LATER STONE AGE RESEARCH IN THE SOUTHERN AND EASTERN CAPE: 1920 - 1960

By the late 1920s, archaeology had begun to emerge as an accredited academic discipline in South Africa. Two persons instrumental to this process were A.J.H. Goodwin and C. van Riet Lowe. Goodwin and van Riet Lowe proposed a tripartite division of the South African Stone Age into three stages based on the recognition of different stone artefact types. These three periods in turn were divided into various industries on the basis of common artefact classes. For Goodwin and van Riet Lowe, lithic remains constituted tangible evidence for prehistoric peoples' adaptations to and modifications of their environment. They were also regarded as a means whereby the migration routes supposedly followed by successive waves of immigrants from North Africa could be reconstructed (Goodwin and van Riet Lowe 1929; Deacon 1990).

The most recent stage in human prehistory at the Cape, namely the Later Stone Age, was acknowledged as the one for which the greatest amounts of preserved material remains were available. The stone and other artefacts that originated during this period were regarded as the material legacy of groups who were physically and culturally similar to the modern hunter-gatherers of the Kalahari. Goodwin and van Riet Lowe recognized two distinctive Later Stone Age industries, namely the Smithfield and the Wilton. The former was classified by van Riet Lowe as a largely indigenous development confined to the interior of the country and characterized by various types of scrapers. Three distinct variants were discerned and designated as Smithfield A, B and C. The relative ages of these were determined by examining visible patina on stone objects, particularly those belonging to the oldest of these industries (Smithfield A) and by changes in the frequency of raw materials (Goodwin and van Riet Lowe 1929; Deacon 1990).

More pertinent to this discussion is Goodwin's description of the Wilton industry. His initial work on the subject is based on the examination of material from the Wilton Large Rock Shelter, a site located on a farm near Alicedale in the eastern Cape and excavated by Hewitt and his associates over several seasons beginning in 1921. The Wilton is defined by Goodwin in his 1929 synthesis co-authored with van Riet Lowe as a "pygmy" or microlithic industry characterized by an abundance of small scrapers and backed crescents, the latter being the "type-tool" of this industry (Goodwin and van Riet Lowe 1929). The Bushman origin of this material was inferred from the human skeletal remains, distinctive cave paintings and ethnographically documented cultural items such as ostrich eggshell beads often found in association with the lithic remains (Goodwin and van Riet Lowe 1929).

Between 1932 and 1935, Goodwin conducted excavations at an inland rock shelter on the farm of Oakhurst in George in the southern Cape. This was the property of the same Mr. Dumbleton who had participated in the first archaeological excavations at caves along the Robberg Peninsula. By the standards of the time, Goodwin's excavations at Oakhurst were meticulous and controlled. Changes in sediment were noted and the stratigraphy of the deposits recorded. The principle of super-position provided a relative chronological framework for the dating of archaeological materials and industries which had previously been lacking in Stone Age studies (Goodwin 1938; Deacon 1990). The excavated deposit was "sieved through three meshes" (Goodwin 1938), and particular care was taken during the exhumation of human skeletons and documentation of various grave goods.

Goodwin (1938) reported the presence of three Later Stone Age industries superimposed one on top of the other at the site. These included the Wilton, subdivided into two cultural phases designated as the Developed and Normal Wilton; a scraper-dominated industry known as Smithfield C; and older material classified as Smithfield B. Similar industries were identified at a number of other sites in the southern and eastern Cape in the course of archaeological excavations which were undertaken with increasing frequency during this time.

2.4.1. EXCAVATIONS AT MATJES RIVER ROCK SHELTER

2.4.1.1. Dreyer's excavations: 1928-1929

In 1928, a small pilot excavation was conducted at a rock shelter situated at the mouth of the Matjes River near Keurboomstrand, some 10km northeast of Plettenberg Bay. The site was discovered by T.F. Dreyer, an entomologist who recognized the richness of the extensive cultural deposits which had been protected within the overhang. Large-scale excavations carried out by Dreyer the following year resulted in the removal of significant quantities of archaeological and anthropological material, mostly from the portion of the cave closest to the back wall (Dreyer 1933; Louw 1960; Döckel 1998).

In his written description of the lithic cultures and Stone Age populations associated with Matjes River Rock Shelter, Dreyer (1933) does not mention the methods he used in the excavation of the site and removal of artefacts and human remains. Nor does he disclose the actual amount of time he spent in the field. It is suspected that his excavation may not have been as controlled as that carried out at the Oakhurst Shelter by Goodwin. It is furthermore thought that the careless excavations typically carried out at caves along the southern Cape coast during the first two decades of the twentieth century may have prompted Goodwin's calls for professional standards to be adhered to in the excavation of archaeological sites (Döckel 1998).

Dreyer (1933) discerned five different layers of occupation at the Matjes River Rock Shelter. Each of these was claimed to be associated with a specific racial group on the basis of physical attributes observed on human skeletal remains, notably crania, as well as distinctive lithic artefacts and burial types. The layer nearest the surface, M.R., A.I. contained no lithics and a number of human skeletons. The second layer, comprised principally of *Mytilus* shells, yielded a macrolithic quartzite industry now known as the post-Wilton. This layer also contained an abundance of burials. An underlying layer of black loamy deposit, labelled M.R., C, contained all the diagnostic artefact types associated with Goodwin's Wilton and burials which differed from those of the site's more recent occupants in several important respects. M.R., D, located beneath the Wilton layer, contained large stone implement representing, according to Dreyer, a variant of the Smithfield A, and burials interpreted as indicative of cremation. The final layer in the sequence, M.R.E, contained fairly large quantities of stone artefacts, especially side-scrapers.

2.4.1.2. Further excavations: 1952-1953

In 1952, further large-scale excavations were conducted at Matjes River Rock Shelter by A.C. Hoffman and A.D. Meiring. These were carried out under the auspices of the Bloemfontein National Museum, where Hoffman, a palaeontologist by training, served as director (Döckel 1998). Hoffman and Meiring dug a trench cross-cutting the original trench dug by Dreyer, and removed large quantities of archaeological and anthropological material "from the deepest part of the remaining deposits" (Sealy *et al.* 2006: 98). Based on the purported richness of the site and significance of the finds, and perhaps pressure from Hoffman as a longstanding member of the Historical Monuments Commision, Matjes River Rock Shelter attained National Monument status in 1953. Data derived from Hoffman and Meiring's research were collated and published by Louw several years later (Louw 1960; Döckel 1998).

As Dreyer had before them, Hoffman and Meiring identified five separate and clearly defined layers or horizons (Hoffman 1958; Louw 1960). The so-called Bushman Layer or M.R., A, was not re-excavated by Hoffman and Meiring, but was preserved as a witness section for future generations of researchers. This layer, which consisted primarily of ashy deposits, contained bedding grass along with a few lithic and non-lithic artefacts. The underlying *Mytilus* layer or Layer B contained large quantities of mussel shells erroneously identified by Dreyer and his successors as *Mytilus*; numerous informal stone tools manufactured on quartzite as well as a selection of bone artefacts. A few potsherds were also recovered from this layer, but these may have been *ex situ*. Layer C or the Wilton Layer yielded large quantities of microlithic stone artefacts manufactured on fine-grained raw materials, predominantly crypocrystalline silicates, as well as a variety of items manufactured from bone, marine shell and ostrich eggshell. Layer D comprised consolidated ashy and often burned deposits and yielded stone artefacts now recognized as belonging to the Albany industry, as well as bone and shell artefacts. The bottom-most layer, Layer E, consisted of mostly sterile deposit and a few quartzite flakes (Hoffman 1958; Louw 1960; Ludwig 2005; Sealy *et al.* 2006).

Hoffman and Meiring were among the first southern African researchers to make use of the newly developed radiocarbon method to determine absolute dates for the occupation of Matjes River Rock Shelter (Döckel 1998). Eight charcoal samples derived from two layers in the lower part of the sequence were submitted to Harvard University for analysis. Those from the Wilton layer (Layer C) yielded dates of 7750±300BP and 5400±250BP, indicating a relatively long period of occupation of the site by the Wilton people. Dates of 10 500±400BP and 11 250±400BP were obtained for the Proto-Bushman layer or Layer D (Hoffman 1958). These dates were not accepted as accurate by all archaeologists (Döckel 1998). In 1964, six additional charcoal and marine shell samples were taken by Inskeep from the standing section of Dreyer's trench and Hoffman and Meiring's cross-cutting. These were processed at the Gröningen Laboratory by Vogel (1970). The samples were labelled according to their relative position in the stratigraphic sequence, which did not correspond directly to the cultural layers described by Louw (1960). Vogel's (1970) radiocarbon age determinations ranged between 3555±35 BP (GrN 5888), a date obtained for marine shell from the "uppermost level" of the sequence, and 10030±50 BP (GrN 5871), which was obtained for charcoal from the "lowest level".

In his monograph on the finds from the 1952 excavation, Louw (1960) describes Hoffman and Meiring's field operations as scientific and systematic. He praises their record-keeping procedures and sampling strategies, and describes the finished product of their combined research as a work of great value and significance to the archaeological community. A scathing review of Louw's publication written by Inskeep in 1961 strongly rebuts this. Inskeep lists numerous errors and inconsistencies in both Hoffman and Meiring's field procedures as well as Louw's descriptions of them and the archaeological remains from Matjes River Rock Shelter. The methods employed by Louw in his analysis of human skeletal remains from the site were severely criticized by Singer (1961). It is clear from these reviews that the work of Hoffman, Meiring and Louw fell far short of the standards set by Goodwin at Oakhurst.

2.4.1.3. Renewed Excavations and other research

In 1993, in order to rehabilitate the badly slumping deposits, resolve the stratigraphy and dating of the sequence and obtain additional material for systematic analysis, Hilary Deacon and Willemien Döckel conducted additional, small-scale excavations at Matjes River Rock Shelter. They focused on the deposits known as the Apex, located at the junction of Dreyer's trench and Hoffman and Meiring's cross-cutting. They recognized a total of 215 individual stratigraphic units which varied in thickness and extent from a few millimetres to around 50mm thick and encompassing the entire area of excavation. These were grouped into five members designated as TSM – W, TSM – L, LSL – U, LSL – L and LSL - C on the basis of the overall stratigraphy and contents of the different strata. Deacon and Döckel also removed a small amount of material, known as member EE, from an area near the entrance to the rock shelter.

Nineteen charcoal and marine shell samples were submitted for radiocarbon dating. Age determinations for the Apex cutting ranged between 6720±25 BP and 10660±280 BP. A charcoal sample from Member EE yielded an age of 4740±50 BP. Thus, all of the strata sampled by Deacon and Döckel originated during the early and mid-Holocene; material dating to the Late Holocene had presumably eroded away and been lost prior to the re-investigation of the site. The stratigraphy and dating of the early and mid-Holocene layers, as well as their contents, was nevertheless informative. An occupational hiatus between 8000 and 9000 years ago was evident in the top of LSL – U. According to Döckel (1998), this correlates with the occurrence of a break in occupation at Nelson Bay Cave at around the same time. The succession of lithic industries in the Apex deposits excavated by Deacon and Döckel is also comparable with that observed at Nelson Bay Cave. Interesting patterns were also discerned in the shellfish assemblage, and were attributed primarily to changes in environmental conditions.

Sealy, Henderson and Ludwig (2006) obtained a series of additional dates from skeletal and other remains accessioned in the collection of material from Matjes River Rock Shelter housed at the National Museum. Age determinations for five skeletons derived from the Wilton layer or Layer C range between 7400 and 5000 BP, and correspond to those published by previous researchers. Dates obtained for five skeletons allegedly recovered from layer B fall within the Late Holocene, and range between 3600 and 2200 BP. A single charcoal sample from this layer was dated to 2050±120 BP. Two individuals reportedly derived from the base of Layer B yielded dates of ~ 5000 BP. These specimens are probably associated with the older Layer C. The dates published by Sealy and her colleagues thus confirm the mid – Holocene chronology of Layer C, and place the Layer C/B transition at around 3500 BP. The latter date is close to that obtained for the beginning of the post – Wilton at Nelson Bay Cave at 3300 BP (Sealy *et al.*).

2.4.2. EXCAVATIONS AT HOFFMAN'S/ROBBERG CAVE

Hoffman's excavations at Hoffman's/Robberg Cave probably took place shortly after his and Meiring's fieldwork at Matjes River Rock Shelter. The National Museum's Annual Reports refer to the collecting of samples from the site in 1952, and to several site excursions in the early 1960s. No record of the actual excavations could be located at the Museum. Hoffman filed a permit to excavate the site in 1958, so it is likely that the excavation took place in either 1958 or 1959. According to the only published source available for this excavation, Hoffman dug a 1.5 by 1.5m trench through approximately 2m of Later Stone Age shell midden deposit, recovering large quantities of human, faunal and cultural remains curated at the National Museum. The archaeological sequence bottomed out onto a sterile sand dune (Fairhall, Young and Erickson 1976). No details concerning the archaeological and anthropological material derived from the site, nor of the methods employed in the course of the excavation, were published by Hoffman or his associates at the time. In contrast to the programme of research carried out at Matjes River Rock Shelter, Hoffman's investigations at Cave F did not include radiocarbon dating, but dates were obtained almost two decades later by Deacon and Klein. Shell samples taken from the top and bottom of the remaining standing section of Hoffman's trench yielded uncorrected ages of 3190±90 BP and 3770±100 BP, respectively (Fairhall, Young and Erickson 1976).

2.5. ECOLOGICAL AND SYSTEMS APPROACHES: 1960 – 1980

From the 1960s to the 1980s, ecological approaches and models held sway in the increasingly professionalized field of South African archaeology (Deacon 1990). One of the first researchers to argue for the use of an ecological perspective in the analysis of prehistoric peoples and their associated archaeological remains was J. Desmond Clark. As early as 1959, Clark regarded the different forms of the Later Stone Age cultural complexes identified by Goodwin and van Riet Lowe and present in a variety of regions throughout the subcontinent as indicative of regional specialization during that period.

In a paper published in *Current Anthropology*, Clark discusses the evolution of specific cultural forms, social structures and behavioural patterns throughout the different stages of human prehistory in relation to a number of environmental factors and changes. The intimate relationship between human beings and their environment emphasized by Clark was to remain the hallmark of ecological studies well into the 1970s. In addition to renewed calls for systematic field procedures, Clark made a strong case for the benefits of multidisciplinary studies in understanding the ecological settings of Stone Age communities, and the investigation of open camp sites rather than cave sequences in the attempt to reconstruct prehistoric settlement patterns (Clark 1959; 1960).

Further impetus for the emergence and eventual predominance of ecological approaches in southern African Stone Age studies was provided by the re-orientation of American archaeology from a largely historical pursuit to an anthropological discipline concerned with the systematic testing of hypotheses informed by ethnographic data (Binford 1968). Contemporary hunter-gatherers living in marginal environments such as the Kalahari were increasingly seen as useful analogues for prehistoric populations, especially those of the Later Stone Age. Prevailing notions about hunter-gatherer existence were based primarily upon Richard Lee's detailed observations among the!Kung San of Botswana, and were cemented during the "Man the Hunter Conference". Quintessential foragers in southern Africa, both modern and prehistoric, were characterized as highly mobile people living in relatively small bands with flexible social structures geared towards the effective exploitation of a range of abundant and predictable resources occurring within a specific environment (Lee 1968). This did much to change the widely adhered to, negative view of prehistoric hunter-gatherers as barely eking out a miserable and unpredictable living in environments with very little to offer in the way of subsistence.

Additional changes to the field of archaeology in the United States, and later South Africa, concerned the central and often ambiguous concept of culture. In the majority of studies leading up to this period, culture had been perceived as a largely static entity exemplified by specific artefact assemblages. Change in these material packages was largely attributed to cultural contact or migration. Binford (1962 and 1965) advocated a completely different view of culture as a system composed of various subsystems intimately linked to people's adaptations to their local environments. The aspect of peoples' cultures deemed most actively constrained and determined by the environment was their subsistence strategies. This new focus within archaeological studies led to a more systematic and detailed recovery and analysis of floral and faunal remains neglected in the lithocentric analyses of the previous three decades.

2.5.1. LATER STONE AGE STUDIES IN THE EASTERN, SOUTHERN AND SOUTHWESTERN CAPE

These trends are evident in much of the Later Stone Age research carried out at sites in the southern, eastern and western Cape between the 1960s and 1980s. In the former two regions, emphasis was placed on the investigation of long sequences sealed within caves or rock shelters which could be scientifically excavated and dated (Inskeep 1987; Schweitzer 1979). The main objectives of these studies, as dictated by the dominant paradigm of the day, were to reconstruct and elucidate the subsistence ecology and lithic and non-lithic technology of Later Stone Age hunter-gatherers during the Holocene and the period immediately preceding it.

In the Albany district of the eastern Cape, Hilary Deacon launched an extensive programme of research into the prehistory of foraging populations living at sites in different ecological zones throughout the region. One of the key sites excavated by Deacon during the late 1960s and early 1970s was Melkhoutboom Cave. This site, originally investigated by Hewitt some three decades earlier, contained a long, well-stratified archaeological sequence dating to the terminal Pleistocene and Holocene. It was also remarkable on account of the unusually well-preserved plant food remains protected within its dry interior. Deacon carried out additional systematic excavations at a number of other contexts, notably Highland Rock Shelter, situated in the contrasting environment of the Cape-Karoo midlands. Deacon's analysis of the archaeological data derived from these excavations was explicitly ecological in its orientation. Thus, significant differences in the faunal and floral remains, and to a lesser extent the stone artefact assemblages, from sites located in different ecological settings were attributed to the pursuit of contrasting subsistence strategies geared towards the exploitation of resources in particular habitats (Deacon 1976).

Between 1966 and 1967, Janette Deacon carried out renewed excavations at another site in the eastern Cape previously investigated by Hewitt, namely Wilton Large Rock Shelter. Radiocarbon dates obtained for charcoal samples collected by Deacon in the course of her fieldwork, and a fragment of human bone from a burial uncovered fifty years earlier by Hewitt, provided dates of between 2270 ± 100 and 8260 ± 720 BP for the Later Stone Age sequence at this site. Deacon employed a framework drawn from cultural systems ontogeny, specifically the research of Clarke and Binford, in her analysis of the new Wilton dataset. In so doing, she ascribed changes evident within the Later Stone Age sequence at Wilton to the growth, maturation and eventual decline of the Wilton cultural tradition (Deacon 1972). Faunal remains were compared with those recovered by Hilary Deacon from Melkhoutboom Cave. Longer occupational sequences preserved at sites in the Cape Fold Mountain Belt were regarded as indicative of the existence of larger and more stable populations in this region as compared with the arid interior (Deacon 1972).

Controlled archaeological excavations were undertaken at a number of sites on the southern Cape coast during the 1960s and 1970s. One of the best known among these, namely Nelson Bay Cave, will be discussed in some detail further on.

Investigations at Die Kelders, a site located on the eastern shore of Walker Bay, commenced in response to alleged threats to archaeological deposits within the cave posed by increasing tourism in the area. They also marked the beginning of a broader project implemented by the Archaeology Department of the South African Museum concerned with understanding numerous aspects of the ecology of prehistoric people living in the southernmost part of Africa (Schweitzer and Wilson 1978; Schweitzer and Wilson 1979). Die Kelders Cave contained undisturbed Late Holocene deposits dating to between 2000 and 1500 years ago. Sterile layers formed during a substantial occupational hiatus at the site separated the Late Holocene occupation from much older deposits representing habitation during the Upper Pleistocene. The second phase of the South African Museum's study of the Agulhas region involved the excavation of Byneskranskop, a site located 10km inland of Die Kelders. The deposits in this cave covered a broader temporal range encompassing the terminal Pleistocene and Holocene. This occupational sequence was thus comparable to those preserved at Nelson Bay Cave and Melkhoutboom Cave.

Relatively little archaeological research had been carried out in the southwestern Cape prior to the late 1960s. At this time, John Parkington initiated a series of excavations at sites in the region. The first two sites examined in detail by Parkington were De Hangen, inland in the Cape Fold Mountain Belt, and Elands Bay Cave, on the coast. The data from these two contexts informed Parkington's development of a seasonal mobility model to account for variation in faunal remains from inland and coastal occurrences. He posited that seasonal movement between the coast and surrounding hinterland would have optimized Later Stone Age hunter-gatherers' exploitation of food resources distributed unevenly throughout time and space. Such a response would, moreover, have been consistent with ethnographic accounts of modern hunter-gatherers as well as those of European travellers who documented indigenous populations living during the final stages of the Later Stone Age (Parkington and Poggenpoel 1971; Parkington 1972; Parkington 1976).

Parkington and his associates went on to conduct surveys and excavations at open shell middens and cave sites at numerous other locations in the southwestern Cape, notably those in the vicinity of the Verlorenvlei. They maintained an interest in the seasonal occupation of sites and its archaeological indicators. From the mid-1980s, they began to focus upon spatial and temporal patterning in the occupation of sites along the southwestern Cape coast throughout the Holocene. During the early Holocene, for instance, several caves on the Elands Bay coast were the sites of fairly regular visits by hunter-gatherers. This was followed by a 3500 year hiatus during which these visits ceased, only to be resumed from around 4000BP. From this period onwards, hunter-gatherer occupation of the coastal regions intensified, and shifted between coastal caves and open locations. Shifts in hunter-gatherer residence patterns and the exploitation of coastal resources were attributed to a combination of environmental and social factors either favouring or discouraging settlement at or near the coast at different stages during the Later Stone Age. The former include sea levels and climatic changes, while the latter include population growth and subsequently, the movement of herders in to the area (Parkington *et al.* 1988). The Late Holocene prehistory of the Elands Bay region was further investigated by Antonietta Jerardino (1996) during the 1990s.

2.5.2. EXCAVATIONS AT NELSON BAY CAVE: A RECORD OF CULTURAL AND ENVIRONMENTAL CHANGE

Systematic archaeological excavations at Nelson Bay Cave, a site located on the southern side of the Robberg Peninsula near Plettenberg Bay, began in the early 1960s. Following a preliminary visit to the cave by Ray Inskeep in 1963, it was selected for excavation on account of the long sequence of Stone Age deposits preserved within its confines. Given the rarity of scientifically excavated and accurately dated archaeological contexts in the region prior to the advent of the "new archaeology" in the 1960s, these deposits provided an excellent opportunity for a programme of controlled excavation and radiocarbon dating. It was furthermore hoped that conscientious archaeological inquiry would result in the recovery of evidence by means of which the changing environmental settings and subsistence patterns of prehistoric hunter-gatherers in the southern Cape could be reconstructed and interpreted (Inskeep 1987; Deacon and Deacon 1998).

Nelson Bay Cave was excavated over a period of fifteen years in several field seasons held in 1964-1965, 1965-1966, 1970-1971 and 1979. Between 1964 and 1966, substantial Later Stone Age shell midden deposits which had accumulated near the entrance of the cave were removed under the direction of Ray Inskeep. A cutting subsequently known as "Inskeep's deep sounding" was also made into the deepest deposits further back in the cave. These contained a number of disturbances as a result of the uncontrolled digging of skeleton hunters and other early explorers whose activities at sites along the Robberg Peninsula have already been described (Inskeep 1987; Deacon and Deacon 1998; Ludwig 2005). Two subsequent field seasons held in 1970 and 1971 and led by Richard Klein focused on the late Pleistocene and early Holocene deposits exposed by Inskeep's previous, deep cutting (Klein 1972b; Deacon 1978). The final field season in 1979 was led by Inskeep.

Inskeep (1987) identified 148 discrete stratigraphic units in the Holocene deposits of Nelson Bay Cave. These represented a period of fairly regular episodes of occupation by Later Stone Age hunter-gatherers between 455-5890 BP. No major stratigraphic breaks were apparent in the sequence. Individual units were grouped into larger aggregates on the basis of changes in both faunal and artefactual remains. A close correspondence between shifts in these different types of remains has been noted (Deacon and Deacon 1998).

The youngest group of stratigraphic units (2 – 30), dated to between 500 and 2000 BP, consist of shell refuse found in association with pottery and the remains of sheep. The latter, which are present in the deposit in very small numbers, are believed to have been procured by the inhabitants of the site through either raiding or exchange with groups of herders. Other mammalian remains were well-represented in some of the units, notably units 22-29 (Inskeep 1987; Deacon and Deacon 1998).

The next subset of stratigraphic units (31 – 64) accumulated during a period of fairly regular and intensive occupation between 2000 and 3300 BP. This stratigraphic aggregate is composed of shell heaps interspersed with occasional ash spreads and hearths (Deacon and Deacon 1998). Locally available quartzite constitutes the predominant raw material used for the manufactured of large quantities of informal as well as small numbers of formal stone artefacts. Grinding equipment, especially upper grindstones and rubbing stones, was also relatively abundant (Inskeep 1987; Deacon and Deacon 1998).

A wide variety of bone artefacts, including awls which were preferentially manufactured on bird bone, were recovered from units 31-64. These stratigraphic units also contained an abundance of marine shell artefacts including perforated *Glycymeris queketti* valves and pendants manufactured from fragments of abalone and alikreukel shell. The latter pendants occur in a variety of shapes, generally bear two perforations, and are edge-nicked along the outer margins. These were included as grave goods in one of the four human burials recovered in the upper group of stratigraphic units (Inskeep 1987).

The faunal remains recovered from these units include large numbers of immature seals, mostly yearlings and second yearlings. Also included are the bones of more than ten species of deep sea fish. According to Inskeep (1987), the weight of fish bone per square foot of excavated deposit in units 31-64 is double the amount recorded in underlying strata. An increase in the number of species per units is also noted. A variety of marine birds, as well as molluscs including common rocky shore varieties were also recovered. The increased abundance of marine fauna in these units as well as units 2-30 of the Nelson Bay Cave sequence are indicative of increased reliance on these as food resources by the site's Late Holocene inhabitants (Deacon and Deacon 1998; Sealy and Pfeiffer 2000). Proportions of mammalian remains, by contrast, are lower in these units than in the overlying and underlying stratigraphic aggregates (Inskeep 1987).

The remainder of the Holocene layers excavated by Inskeep, and dating to between 3300 BP and 5800 BP, contained a microlithic stone artefact industry identified as the Wilton. Several differences between these units and the overlying post-Wilton deposit, as well as between different groups of layers within the Wilton, have been documented. The fine-grained raw materials quartz and crypocrystalline silicate (CCS) are much more common in stratigraphic units predating 3300BP. Quartz is particularly well-represented in units 65 – 78, while CCS is more abundant in older stratigraphic units. Miscellaneous retouched pieces manufactured on quartzite are more abundant in units which accumulated before 3300BP. Ochre pencils, the term applied by Inskeep to pieces of ochre showing evidence of utilization, and ochre-stained lithics, also figured more prominently in units below 64. Perforated *Donax serra* valves are better represented in units 79 – 104 than units 2-64 and 65 – 78.

Segments and drills were particularly abundant in the oldest group of stratigraphic units excavated by Inskeep, units 105 – 148. Distinctive pendants manufactured on relatively thin fragments of shell, possibly *Oxystele*, occurred exclusively in these units (Inskeep 1987).

The three youngest of the eleven Later Stone Age units recognized by Klein (1972b) also contained stone artefacts typical of the Wilton industry. These shell-rich units, which accumulated within a relatively short period between 5000 BP and 6000 BP, contained a wide range of microlithic stone implements including small scrapers and segments manufactured on a variety of raw materials (Deacon 1978; Deacon 1998). In addition to marine fauna including molluscs, mammals, fish and birds, the Wilton units of Nelson Bay Cave contained high frequencies of small browsing bovids. Individuals of the genus *Raphicerus* were particularly well represented. This species favours the type of forested environment interspersed with open grasslands prevalent in the region today. Its presence in the Wilton levels of Nelson Bay Cave attests to the existence of similar conditions during the mid-Holocene. High frequencies of *Raphicerus* remains had been previously noted in the Wilton levels of Melkhoutboom Cave, a site located in the different environmental setting of the Cape Folded Mountains. Thus, the relative increase in *Raphicerus* during the Wilton may reflect widespread cultural rather than environmental change, perhaps in the form of a shift to subsistence strategies focused on the capture of small bovids using new techniques, such as snares (Klein 1972b).

Four underlying stratigraphic units dating to between 8500 BP and 12 000 BP contained stone artefacts similar to those encountered at Melkhoutboom Cave and Wilton Large Rock Shelter. At these sites, stone artefact industries clearly different from the Wilton and recovered from stratigraphic units below those with Wilton type artefacts were simply referred to as pre-Wilton. At Nelson Bay Cave, stratigraphic units below the Wilton contained stone artefacts manufactured predominantly on quartzite. Large scrapers and miscellaneous retouched pieces replaced small backed scrapers and segments as the most abundant formal tool types. Backing as a form of retouch was absent in this part of the sequence. This industry, which was named the Albany, was also recognized at Boomplaas, a site located in the southern Cape interior and excavated by Hilary Deacon (Deacon 1978).

Faunal remains from the Albany layers include marine shell, which is present in small amounts in the oldest of these units and increases with time, as well as marine fish, mammals and birds (Klein 1972b; Deacon 1978). The presence of marine fauna in units post-dating 12 000 BP, and their absence in underlying strata, is a product of sea level changes which occurred during the late Quaternary. Specifically, a global rise in sea levels at 12 000 BP would have brought the coastline adjacent to the site within an acceptable distance for the collection of marine resources. The appearance of hippopotamus in the faunal remains postdating 12 000 BP may further attest to changes in sea level which "may have altered the local drainage in turn creating suitable habitats for hippo very close to the cave" (Klein 1972b: 139).

The replacement of *Choromytilus meridionalis* by *Perna perna* at around 10 000 BP occurred as a result of large-scale environmental changes, most likely relating to changes in ocean temperature. The remains of marine fish were larger, less varied and less abundant in the Albany units than the younger Wilton deposits. This may reflect fishing strategies centred on the use of nets to capture large species during this time, and the adoption of new, more efficient methods utilizing gorges during the Holocene (Klein 1972a; Deacon 1998). Among the mammalian fauna were two large bovids, namely the eland (*Taurotragus oryx*) and the warthog (*Phacochoerus africanus*), which were not present in the younger deposits and have not been documented in the region historically. Bushbuck (*Tragelaphus scriptus* and *sylvaticus*), which are well represented in the Wilton levels of the deposit, occur for the first time in the Albany units. The decline of large bovids and appearance of small species at this time corresponds to environmental changes associated with the development of more forested environments (Klein 1972b).

The bottom-most three Later Stone Age units at Nelson Bay Cave, which have been dated to between 12 000–18 000 BP, contained a previously unclassified stone artefact industry designated by Janette Deacon (1978) as the Robberg. In contrast to the Albany units, quartz rather than quartzite was the preferred raw material for the manufacture of the unretouched microbladelets which are characteristic of the Robberg Industry. These were struck from pyramidal bladelet cores which were also recovered from the lowest part of the Later Stone Age sequence at Nelson Bay Cave.

A "late expression" of this bladelet – dominated industry was subsequently documented by Lyn Wadley (1996: 64) at Rose Cottage Cave in the former Orange Free State. Similar microlithic assemblages post-dating 12 000 BP have been identified at other sites in the south-eastern part of South Africa (Mitchell 2002). The Robberg industry at Nelson Bay Cave and Rose Cottage Cave also includes small rather than large scrapers and some backed tools, although these are not nearly as abundant as in the Wilton units of both sites (Deacon 1978; Wadley 1996; Deacon 1998).

The Robberg units of Nelson Bay Cave are comprised exclusively of loamy soils and lack marine shell, in addition to other marine fish, avian and mammalian fauna. During the accumulation of these deposits following the Last Glacial Maximum at around 18 000 BP, characterized by a marine regression of more than 100 m, the shore would have been at too great a distance from the site for the exploitation of marine resources. The mammalian fauna from these units include the remains of numerous large bovids, including an equid and several alcelaphines, absent from deposits postdating 12 000 BP. At least two genera which are currently extinct, namely *Megalotragus* and *Pelorovis*, are present in the Pleistocene faunal assemblage from Nelson Bay Cave, along with species not found in the region historically. The presence of large grazing species in the Robberg units predating 12 000 BP attests to the existence of open grasslands during the terminal and late Pleistocene.

2.6. CHANGING APPROACHES FROM THE 1980s

The 1980s marked the beginning of another paradigm shift within the discipline of archaeology - one that would have far-reaching effects for archaeological research carried out in Europe and America, as well as Later Stone Age studies in southern Africa. The interpretive or post-processual approaches that would influence many of the projects carried out after 1980 emerged largely as a response to the perceived shortcomings of the ecological and systems models advocated by the proponents of the new archaeology during the previous two decades. Systems and ecological approaches were criticized for their portrayal of Later Stone Age hunter-gatherers as static entities at the mercy of the external forces of the environment (Mazel 1987; Jerardino 1996). Criticism was also directed towards the use of ethnographic data collected among the Kalahari San to elucidate subsistence and settlement patterns among prehistoric hunter-gatherers living in a variety of different settings and contexts. Contemporary hunter-gatherers, too, had been shown to be more complex and variable than had been previously accepted (Kelly 1995). Ethnographic data on San social institutions, notably *hxaro*, and cosmology, however, continued to inform archaeologists' interpretations of Later Stone Age social networks and burial practices.

Aspects of hunter-gatherer lifeways which had been bypassed in ecological studies with their emphasis on subsistence ecology were explored by the new generation of archaeologists. These include phenomena such as social relations and group organization which had previously been regarded as less archaeologically visible than, say, food procurement and stone tool production. Components of the archaeological record which had been given only cursory attention in previous studies were also addressed. Another development was the extensive application of stable isotopic analysis as a powerful tool for the reconstruction of prehistoric human diets.

2.6.1. SUBSISTENCE AND SOCIAL INTENSIFICATION DURING THE LATE HOLOCENE

Many Later Stone Age studies conducted after 1980 focused on the interesting Late Holocene period, a stage in human prehistory characterized by major shifts in hunter-gatherer subsistence strategies and settlement patterns, as well as social relations. These changes had been noted by previous researchers, but were only one component in research programmes aimed at the excavation of long sequences and documentation of wide-spread environmental and cultural change. More recent research took the form of limited-scale excavations and/or the application of isotopic techniques to existing collections of archaeological and anthropological material to gain insight into the lifeways of prehistoric hunter-gatherers living at the Cape during the last few thousand years of the Later Stone Age in that region.

Increased exploitation of a range of abundant, predictable, and aseasonal local resources has been documented at a number of Late Holocene contexts investigated during the 1980s and 1990s. These include the sites of Edgehill and Welgeluk, located in the eastern Cape and excavated by Simon Hall; occurrences in the Thukela Basin, Natal, examined by Aron Mazel; and sites in the Elands Bay - Lambert's Bay area of the western Cape coast which were re-interpreted by Antonietta Jerardino. In the former two regions, subsistence intensification became evident from 4500 BP and 4000 BP respectively (Hall 1990; Mazel 1989a, 1989b). In the western Cape, it appears to have commenced somewhat later, at around 3500 BP (Jerardino 1996). The prolongation of access to certain resources through storage has been recorded at Edgehill and Welgeluk, where seasonally restricted seeds were collected and stored for future consumption (Hall 1990) and at western Cape coastal occurrences where the harvesting of large quantities of shellfish resulted in the accumulation of impressive megamiddens (Jerardino 1996). The consumption of substantial amounts of marine food by the people who occupied the region between 3000 and 2000BP is borne out by the results of stable carbon isotope analyses undertaken on a sample of archaeological human skeletons (Sealy and van der Merwe 1988).

Subsistence intensification is regarded by a number of archaeologists as a response to increasing population densities and the curtailment of mobility accompanied by more permanent residence in circumscribed territories. In the Cape Fold Mountain Belt, populations expanded into regions showing few signs of habitation predating 5500BP. These include the riverine locations of Edgehill and Welgeluk (Hall 1990). Changes in hunter-gatherer lifeways at this interesting point in human prehistory also had an important social dimension; it has been suggested that prehistoric foragers implemented strategies for ameliorating social tensions and maintaining relationships with adjacent groups. Jerardino (1996) regards the periodic scheduling of highly formalized gatherings at the aggregation site of Steenbokfontein Cave on the western Cape coast as such a mechanism. She contends they would also have served to powerfully reaffirm peoples' relationships with the landscape on which they were settled.

Lyn Wadley was the first southern African archaeologist to differentiate between what she referred to as aggregation and dispersal sites on the basis of their material cultural remains. She developed a model based on San ethnography in terms of which certain criteria are employed to classify archaeological sites as representing either the aggregation or dispersal phases of prehistoric hunter-gatherer settlement patterns and social activity. According to Wadley's (1989) model, aggregation sites are characterized by the presence of standardized lithic assemblages as well as large amounts of debris from the manufacture of ostrich eggshell beads and other artefacts used in gift exchange, known as *hxaro* among the San. The manufacture and curation of these artefacts is an integral part of the formal, ritualized behaviour associated with aggregation. Structured arrangements with regard to the use of space, particularly those premised on gender, are furthermore observed during this public phase in the lives of hunter-gatherer bands Dispersal, on the other hand, represents a private, informal phase during which certain norms of behaviour are relaxed. Dispersal sites can be expected to contain expedient rather than standardized stone artefact assemblages and little evidence of gift exchange.

Two contemporary mid-Holocene sites in the Magaliesberg region of the North West Province, Cave James and Jubilee Shelter, contained assemblages which led Wadley to identify them as a dispersal and an aggregation site, respectively. The faunal assemblages from these sites were consistent with seasonal patterns in terms of which bands aggregated during the autumn and winter, and dispersed in spring and summer. Evidence for the use of small, locally abundant and previously unexploited food resources during the Late Holocene at these and several other small cave sites in the region, as well as a reduction in aggregation and *hxaro* activity testify to the disruption of existing seasonal patterns and increasing environmental stress. This is most marked in assemblages postdating 1300 BP and the incursion of farmers into the region (Wadley 1989).

Returning to the eastern Cape, the increased identification of groups of people with particular places during the Late Holocene has been inferred by Hall (1990; 2000) on the basis of changes in burial practices during this period. The presence of human burials and domestic debris in the archaeological deposits at Welgeluk is consistent with its use as a ritual centre and living site as well as a repository for the dead from 4500 BP; prior to this time, it had served only the latter purpose. Hall (1990; 2000) furthermore interprets the replacement of lithic technologies expediently manufactured on locally available hornfells with those made almost exclusively on exotic silcrete at around the same time as a deliberate campaign by the site's occupants to actively signal and assert group and territorial affiliation. The reformulation of social networks to increasingly exclude other groups is attested to in the reduction of artefacts associated with shamanistic activities and *hxaro* exchange in deposits post-dating 4000 BP (Hall 1990). Similar changes in social relationships among different groups of hunter-gatherers have been recorded by Mazel (1989a; 1989b) in the Thukela Basin.

Binneman (1995) presents an alternative view in asserting that intensification in subsistence strategies and stone tool production was cyclical rather than linear in nature, and that social networks among adjacent groups of hunter-gatherers living in the southeastern Cape remained fairly open and inclusive. He regards the distinctive macrolithic Kabeljous industry, which coexisted alongside a contemporary Wilton industry at caves such as Kabeljous River Shelter I and Klasies River Cave 5 for thousands of years, as a stylistic device whereby coastal hunter-gatherers "transmitted information about themselves and their territory" (Binneman 1995:152) to inland Wilton groups with an established routine of coastal visits. The discovery of human burials in stratigraphic units associated with the Wilton, as well as those associated with the Kabeljous industry indicate that prior to about 3000 BP, neither of these groups had secured exclusive access to the site. Thereafter, Klasies River Cave 5 assumed the status of a "special place" of ritual aggregation and interment of the dead – a place from which outside groups were selectively excluded (Binneman 1995).

Some of the human burials from Klasies River Cave were noticeably more elaborate than those documented at Welgeluk by Hall. Burials from both sites yielded a variety of grave goods including large numbers of perforated marine and ostrich eggshell pendants, ostrich eggshell beads, bone and stone artefacts. These were observed to be more abundant in the graves of young people and juveniles than in those belonging to older people. According to Binneman and Hall (1987: 150) a likely reason for this is the redistribution of the "material wealth" accrued by older individuals who had died according to the reciprocal *hxaro* relationships that they had formed with the members of neighbouring groups during their lifetimes, and which needed to be maintained. The relative richness of the burials at Klasies River Cave 5 compared with those from Welgeluk is interpreted by Hall and Binneman (1987) as a conscious display on the part of Late Holocene hunter-gatherers in response to pressures brought about by increased population densities. These social stresses would have exacerbated the demands placed on traditional *hxaro* exchange relationships in maintaining inter-group relations. Lower population densities are inferred for the more marginal eastern Cape environment (Hall and Binneman 1987).

2.6.1.1. Economic and social differentiation among the Late Holocene inhabitants of the Robberg Peninsula and Matjes River Rock Shelter

2.6.1.1.1. Dietary reconstructions based on stable isotopic analysis: a case for economic separation

Beginning in the 1970s, stable isotopic analysis of bone has been increasingly employed as a tool for palaeodietary reconstruction. These methods, based upon the differential fractionation of heavy and light isotopes of elements including carbon and nitrogen, are particularly useful in determining the relative contributions of terrestrial and marine resources to the diets of hunter-gatherer populations living in the southern and southwestern Cape during the Holocene. In the southwestern Cape, the terrestrial vegetation is predominantly C_3, so that plants and animals eaten by hunter-gatherers were depleted in ^{13}C. Consumption of marine foods, which are enriched in ^{13}C, is readily detectable in carbon isotope ratios in the collagen component of human bones. The southern Cape, on the other hand, receives year-round rainfall, and includes plants of both the C_3 and C_4 variety. As a result, the difference between average terrestrial and marine carbon isotope values is less clear. In this case, nitrogen isotope values serve as a better marker of marine food intake (Sealy 1997; Sealy and Pfeiffer 2000; Sealy 2006).

In an article published by *Current Anthropology* in 2006, Judith Sealy reports the stable carbon and nitrogen isotope ratios of 69 Later Stone Age human skeletons recovered from Plettenberg Bay and the Robberg Peninsula, including Nelson Bay Cave, and also from Matjes River Rock Shelter. The most interesting results are those for individuals dated to between 4500 and 2000 BP. Skeletons recovered from Plettenberg Bay and the Robberg Peninsula evidenced elevated nitrogen isotope ratios consistent with the consumption of large quantities of high trophic level marine protein (Pffeifer and Sealy 2000; Sealy 2006). Equally positive values were observed in the skeletons of males and females. Values for skeletons from Matjes River were considerably less enriched, reflecting the consumption of mixed diets including a significant terrestrial component as well as low-trophic level marine protein in the form of shellfish.

On the basis of this evidence, Sealy (2006) argues that prehistoric foragers in the Robberg / Plettenberg Bay area between 4500 and 2000 BP practised a specialized economy centred on the exploitation of high-trophic level marine resources. Cape fur seals living in a rare mainland colony would have represented a "special foraging opportunity" (Sealy 2006: 578). The environmental setting of Matjes River Rock Shelter presented no such opportunity, and so its inhabitants had to be satisfied with a more generalized diet. Subsistence strategies focused on the procurement and consumption of Cape fur seals appear to have been unaffected by significant shifts in artefact production documented at Nelson Bay Cave and numerous other sites at 3300 BP. Corresponding changes in subsistence behaviour, specifically the increased consumption of shellfish, inferred on the basis of faunal remains are furthermore not substantiated by isotopic analysis (Sealy 2006).

Sealy (2006) concludes that the clear economic separation between Late Holocene hunter-gatherers living along the Robberg Peninsula and at Matjes River Rock Shelter shown by her isotopic data could only have occurred among groups of people living in well-defined and demarcated territories on a more or less permanent basis. The sample of skeletons pre-dating 4500BP was too small to detect any localised dietary patterns that may have existed during this time, but significant variation in the nitrogen isotope values of skeletons from Robberg and Matjes River Rock Shelters appears to be largely a Late Holocene development. Sealy also suggests that hunter-gatherers settled in particular territories and carrying out markedly different economic activities would have recognized themselves as distinct social entities. This may have been manifested in differences in material cultural traditions between groups (Sealy 2006).

2.6.1.1.2. Differences in the artefactual assemblages from Nelson Bay Cave and Matjes River Rock Shelter: a material expression of separate identities?

In order to explore this last, very interesting, possibility, Ben Ludwig undertook a detailed comparison of the contemporary material cultural assemblages from Nelson Bay Cave and Matjes River Rock Shelter. Ludwig utilized previously published reports on the artefacts recovered from these sites, and examined certain components of the collections himself in the course of visits to the South African and National Museums made between 2003 and 2004. Material from Matjes River Rock Shelter required greater personal attention, given the vagueness and ambiguity of reports published by Hoffman and Meiring (1958) and Louw (1960).

Ludwig identified a number of potentially significant differences in the material cultural remains from Nelson Bay Cave and Matjes River Rock Shelter. These were most pronounced during the Wilton period (Ludwig 2005; Kyriacou 2006), and included variation in the production of backed microliths and use of specific raw materials. Specifically, while segments are present in similar abundances at both sites, backing of scrapers was more frequently observed on specimens from Matjes River Rock Shelter. The prehistoric inhabitants of this site also favoured fine-grained CCS in the manufacture of stone tools more than their counterparts at Nelson Bay Cave. Variation in stone tool manufacture at both sites was thought to reflect the existence and maintenance of distinct technological traditions by the sites' occupants.

Other quantitative and chronological differences were apparent in the distribution of certain artefacts in the sequences at the sites. For instance, shale sinkers were present in large quantities in the post-Wilton levels of Nelson Bay Cave, particularly in layers postdating 3500BP. Only three of these items were recovered from layers A and B of the Matjes River Rock Shelter sequence. Shale palettes and unmodified quartz crystals, both of which may have ritual connotations, were more numerous in the latter assemblage, particularly in Layer C.

Fragments of decorated bone, bone beads, and perforated freshwater turtle carapace were considerably more abundant in the post-Wilton assemblage from Nelson Bay Cave than that from Matjes River Rock Shelter. Differences in the distribution of marine shell artefacts in the Nelson Bay Cave and Matjes River Rock Shelter sequences were particularly interesting and significant. Shell crescents were manufactured in large quantities, but at different times, by the prehistoric inhabitants of both sites. At Nelson Bay Cave, the majority of these items derive from the post-Wilton levels. *Glycymeris* and edge-nicked marine shell pendants, too, characterize the post-Wilton assemblage of Nelson Bay Cave. Differences in these highly visible objects, especially those which may have been used in personal adornment, were attributed to the purposeful assertion of group identities by Later Stone Age hunter-gatherers who recognized themselves as separate social entities *vis a vis* other, adjacent groups (Ludwig 2005; Kyriacou 2006).

*2.6.1.1.3. **The Late Holocene assemblage from Hoffman's/Robberg Cave***

The results of Ludwig's analysis could be interpreted as tentative support for Sealy's finding of social and territorial separation between Late Holocene hunter-gatherers at Nelson Bay Cave and Matjes River Rock Shelter. The presence of significant differences in the material cultural assemblages from these sites are consistent with a scenario in which their prehistoric inhabitants belonged to two socially separate groups who occupied well-demarcated territories and maintained their own lifeways (Ludwig 2005; Kyriacou 2006). The Keurbooms/Bitou estuary, a significant geographical feature of the Plettenberg Bay region, most likely marked the boundary between the two groups. The analysis of additional assemblages on either side of this presumed cultural barrier and demonstration of material cultural continuity at sites located within each territory would add considerable weight to the arguments put forward by Sealy and Ludwig.

To this end, in 2006, Judith Sealy and I attempted to compare material recovered from Hoffman's/Robberg Cave with that from Nelson Bay Cave. The former site is on the Robberg Peninsula approximately 400 metres away from Nelson Bay Cave. Dates obtained in 1976 for the top and bottom of Hoffman's trench (3190±110 BP and 3770 ± 100BP respectively, uncorrected dates on marine shell), place its occupation within the 4500-2000 BP time bracket. During a week-long visit to the National Museum, Bloemfontein, we examined and catalogued the previously undocumented material from Hoffman's excavations. Particular attention was paid to those aspects of material culture most likely to indicate personal or group identity, including lithic and non-lithic artefactual remains.

There were a number of similarities between the two sites: both had informal, post-Wilton lithic industries consisting for the most part of unstandardized chunks and flakes manufactured on locally available quartzite. They also contained a wide range of beautifully manufactured bone artefacts. Several differences were noted, including greater emphasis on the use of ochre at Hoffman's/Robberg Cave. These were tentatively linked with the existence of slightly different social practices at the two sites.

Some of the discrepancies between the two collections were puzzling. Of particular concern were certain categories of objects noted by Ludwig to be characteristic of the post-Wilton levels at Nelson Bay Cave and extremely rare or absent among the curated material from Hoffman's/Robberg Cave. These included both utilitarian and decorative items such as stone sinkers, unmodified quartz crystals, bone rings, shell crescents, marine shell pendants and perforated freshwater turtle carapace. Our interpretation of these patterns was constrained by a dearth of written records concerning Hoffman's excavations, his field techniques and decisions regarding the retention or discard of specific types of remains. We were therefore unable to determine whether discrepancies between the two collections were artefacts of Hoffman's excavation and collection procedures, or indicate significant differences in the production of certain objects by Late Holocene hunter-gatherers. The re-excavation of Hoffman's /Robberg cave in 2007 was conducted in order to try to resolve these questions.

2.7. SUMMARY

Archaeological research in the Cape coastal region over the last century can be subdivided into four chronological periods, each with their own methods, theoretical constructs and interpretations of Later Stone Age prehistory. All of these stages are represented in the "history" of archaeological investigations carried out along the southern Cape coast and at the sites of most interest to me. Early exploratory excavations were concerned with the removal of aesthetically pleasing objects of material culture without due consideration of their provenience or context (Deacon

1990). This fetishist or thing-oriented approach (Deacon 1976) is clearly evident in the descriptions of excavations conducted at cave sites along the Robberg Peninsula in the early twentieth century. Fieldwork undertaken during the 1920s and 1930s varied with regard to the methods employed. Changes observed within the lithic assemblages of sites excavated during this period were most often attributed to the movement of new populations into different regions. Such thinking pervades Goodwin's (1938) interpretations of the Oakhurst, as well as Dreyer's (1933), Hoffman's (1958) and Louw's (1960) interpretations of the lithic and human skeletal remains from Matjes River Rock Shelter. Excavations undertaken during this period at Hoffman's/Robberg Cave are poorly documented.

In the 1960s and 1970s, variation in archaeological assemblages from sites in different ecological settings was thought to represent local adaptations to particular environments or conditions. Foremost among these was the availability and distribution of subsistence resources. Variation within archaeological sequences was attributed to widespread environmental changes which occurred during the transition between the Pleistocene and Holocene. Nelson Bay Cave, which was systematically excavated during the 1960s and 1970s, provides one of the most informative records of this interesting phase of human prehistory. Two different but not mutually exclusive strands of research characterize archaeological studies undertaken after 1980. These include those in which variation in material cultural assemblages is regarded as the product of strategies actively employed by Late Holocene hunter-gatherers to assert their identities and rights to certain territories, and the elucidation of prehistoric subsistence patterns by means of stable isotopic analysis. Both have played an important role in providing further insight into the lives of the Later Stone Age inhabitants of Matjes River Rock Shelter and Nelson Bay Cave. This thesis represents an attempt to integrate new data from the poorly understood site of Hoffmans'/Robberg Cave into this broader context.

CHAPTER 3

EXCAVATION, STRATIGRAPHY AND DATING

3.1. EXCAVATION: APPROACH AND PROCEDURES

As has been previously stated, the re-excavation of Hoffman's/Robberg Cave was undertaken to achieve a number of clearly formulated goals. The first of these concerned the recovery of an unselected sample of material from the site to facilitate further analyses and allow me to evaluate the extent to which the existing museum collection is representative of the remains left behind by the Late Holocene inhabitants of the site. The second involved the documentation and interpretation of the stratigraphy of the deposits. These goals structured and informed the field procedures and sampling strategies used in the renewed investigation of the site.

We elected to begin the new excavation by extending Hoffman's existing trench (Figure 3.1.), working our way back from the remains of his original section. The drier western face of the trench, which was better preserved than the eastern one, was chosen as the most suitable area for further investigation.

Before we could start excavating, we had to devise some means whereby fieldworkers could access the excavation area without causing too much damage to the surrounding deposit. The steep topography of the site, and the presence of several heaps of loose, shelly material near the cave mouth, renders these deposits particularly vulnerable to the effects of trampling. In order to minimize the impact of fieldworker traffic, a protective walkway was constructed using lengths of coir matting and numerous military sandbags filled with sand from a nearby beach. Areas where sieving and sorting were to be carried out were covered with plastic tarpaulins.

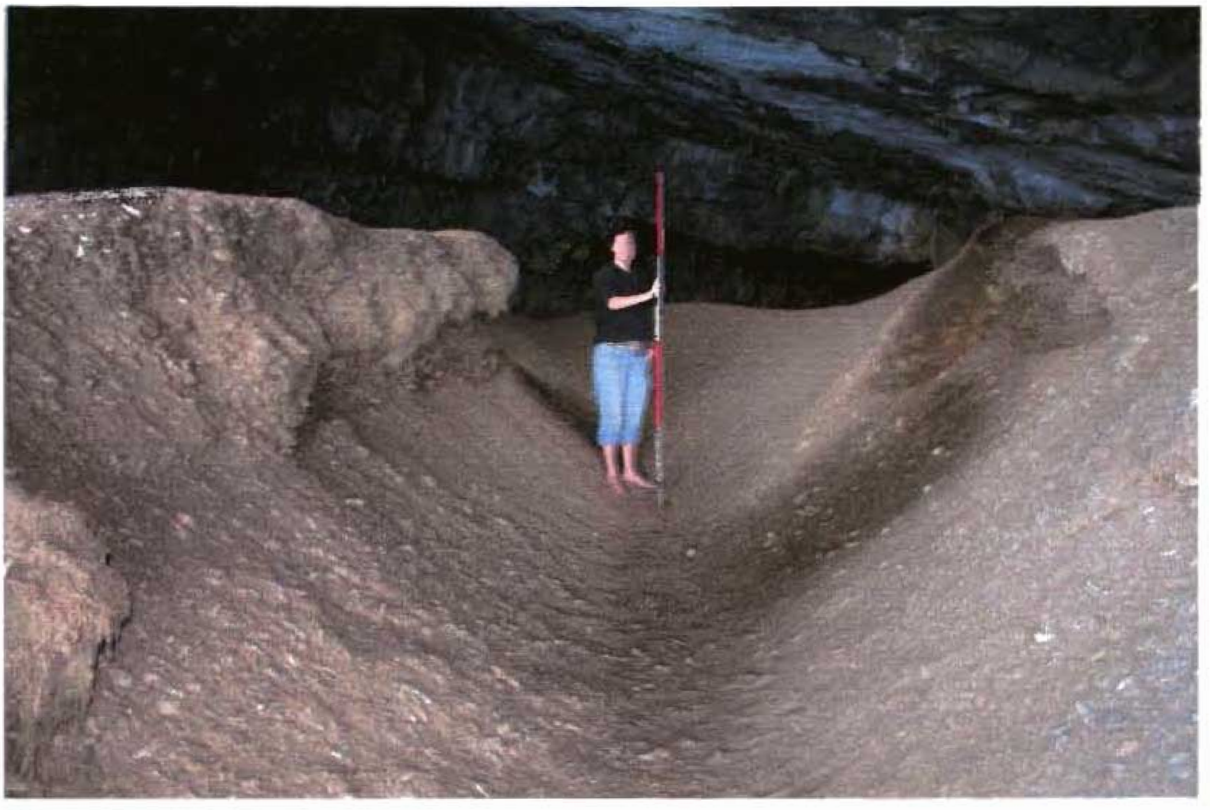


Figure 3.1.The remnants of Hoffman's trench prior to the 2007 excavation.

A limited-scale approach similar to that employed by Döckel (1998) in her re-investigation of Matjes River Rock Shelter was considered appropriate for Hoffman's/Robberg Cave. This strategy, whereby the volume of the new excavation is kept relatively small while individual strata within the stratigraphic sequence are sampled and recorded, serves the dual interests of site conservation and scientific inquiry. We began by excavating three squares, designated E4, E5 and E6, working back from what remained of Hoffman's original section to the point where we could cut a clean, vertical section. This was designated our new baseline. The deposit was removed according to natural stratigraphic layers, differentiated on the basis of colour, texture, etc. The identification of these layers was made much easier by their exposure in Hoffman's cutting, albeit slumped and eroded in places. In several places, we could identify disturbances as a result of earlier poorly-controlled excavations. The deposit removed from squares E4, E5 and E6 derives from only part of the 1x1m squares. We went on to remove two additional quarter squares or quadrats, D4a and D5b from an area of the deposit which we judged to be relatively undisturbed. Individual strata were recorded as they were exposed and the number of buckets filled with deposit removed from each excavation unit was logged. In the course of the excavation, the main features of the site were mapped and drawings of the section produced. An additional field season in 2008 focused upon the excavation of the remaining, unexcavated quadrats. Some of the lithic and non-lithic materials from this later excavation are described and referred to in this thesis, although they were not included in quantitative analyses.

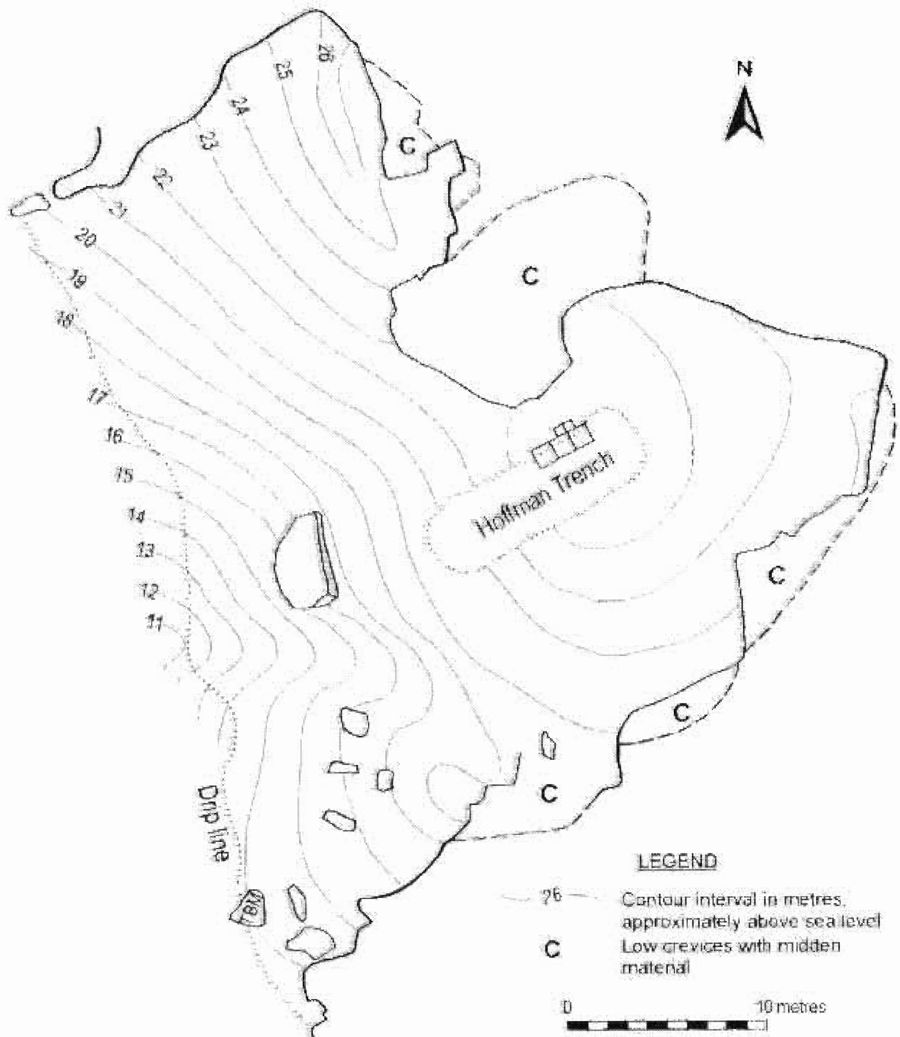


Figure 3.2.Site plan of Hoffman's/Robberg Cave showing the dripline, Hoffman's trench, the E-squares (from left to right E6, E5 and E4) and the quadrats (from left to right D5b and D4a).

Standard excavation and recording procedures were used in both excavations. The deposits were removed with trowels and brushes. The number of buckets of material removed from each stratigraphic unit was recorded. The bucket counts have been converted into a measure, in litres, of the volume of deposit in each layer. Each triangular bucket, when filled approximately to the rim, has a capacity of 10 litres. In 2007, the excavated material was sieved through a 3mm mesh stacked above a 1.5mm mesh. The 1.5mm fraction was bagged, unsorted, in its entirety, and transported to the University of Cape Town. As much as possible of the 3mm fraction was sorted in the field and the remainder in the laboratory. The material was separated into its main components, namely shell, bone, charcoal and stone by the field team. Worked bone and shell items and other special finds were removed and curated separately. All of the stone, bone and the larger fragments of charcoal were retained for subsequent analysis. During field sorting of the shellfish residues, all countable specimens were retained from the quadrats. Fragments of shell were discarded. With the exception of a bulk sample of partial and complete specimens as well as fragments from a thick, undisturbed shelly layer (Portia) present in E5 and E6, shellfish remains were not systematically sampled from these units, and were discarded during field sorting. On the completion of the field season, the section was lined with plastic and buttressed with military sandbags to prevent it from collapsing and preserve it intact for future investigations.

3.2. STRATIGRAPHY

A total of 35 separate stratigraphic units were identified during the 2007 field season at Hoffman's/Robberg Cave. These are more fully described in Appendix A. They can be divided into two broad groups on the basis of the deposit matrices, contents and in some cases orientation and slope of the layers. The upper group of units consisted of several layers dominated by consolidated mats of *Zostera capensis*, an estuarine grass believed to have been used by Later Stone Age people as bedding material. The presence of *Zostera* in caves and rock shelters along the Robberg Peninsula was noted by Peringuey as early as 1911. It has subsequently been documented at a number of other southern Cape coastal sites including Die Kelders and Matjes River Rock Shelter, although nowhere else is it as prominent as at Hoffman's/Robberg Cave.

At Hoffman's/Robberg Cave, eight *Zostera* – dominated units were removed. These consisted of compacted *Zostera* mats interspersed with faunal remains, small pieces of stone and fragments of poorly preserved and badly discoloured shell. These layers were very prominent in the remains of Hoffman's sections (Figure 3.1.), given that much of the finer sediment had eroded away. Once we had cut back to a clean vertical section along the E/D section line, these layers could be seen to form a series of natural hollows sloping gently towards the mouth of the cave. A number of disturbances were evident within these units. In E6 and the southern edge of E5, areas of loose, shelly, intrusive material were identified and removed separately in coarse units. Their irregular appearance and erratic jumble of contents contrasted sharply with the *Zostera* beds which were laid down in a more or less horizontal sequence. These layers, as well as some smaller areas of disturbance with which they can be related, most likely represent back-dirt from previous field activities carried out at the site. Furthermore, the presence of deep vertical cuts forming a step-like boundary where the intrusive layers have encroached upon and truncated the *in situ* deposits in E5 and E6, and a similar step-feature in the top-most *Zostera* units in one of the quadrats, is strongly suggestive of uncontrolled digging with shovels. A pit-like disturbance in the north-western corner of the quadrat furthest from the cave mouth may have a different, more recent origin. These disturbances are clearly visible in the section drawing (Figure 3.3.) In total, approximately 555.5 litres of *in situ* deposit were removed from the *Zostera* – dominated units.

At the interface between the *Zostera* – dominated units and underlying shell-rich strata was a thin, hard, heavily burned layer designated as Ivan (indicated by the arrows in Figure 3.4.). This unit was so hard that it formed a shelf supporting overhanging *Zostera*-rich units, even in areas where the lower, shell-rich layers had eroded away. This was clearly visible in the remnants of Hoffman's profile. Immediately beneath Ivan was a more extensive horizon (Judy) comprised of charcoal and ash, as well as some shellfish and *Zostera*. Together, these two layers mark the boundary between the consolidated *Zostera* beds and shelly units beneath them.

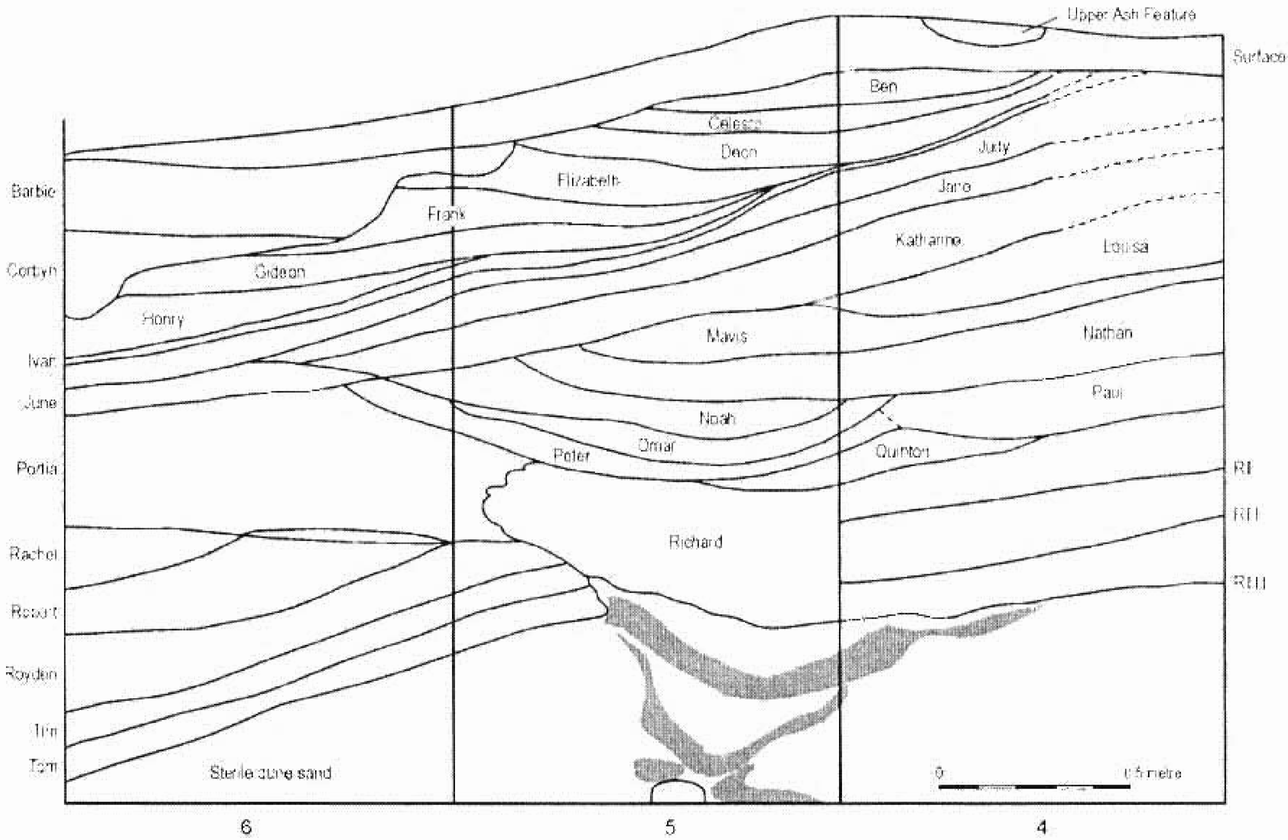


Figure 3.3.Section through the Late Holocene deposits of Hoffman's/Robberg Cave. Note pit – like disturbance on the surface of E4, and distinctive step – features in four *Zostera* – dominated units (Elizabeth, Frank, Gideon and Henry) in E5 and E6.Also see the top of a grave shaft encountered in the sterile dune sand underlying the archaeological deposit in E5.RI. RII and RIII in E4 represent subdivisions of the extensive burned layer Richard recognized in this square but not in E5 and E6.

Individual strata within the second major grouping of stratigraphic units could be differentiated from one another on the basis of variations in colour, texture and contents. Most of the layers contained large quantities of well-preserved faunal remains dominated by fish and shellfish species. Stone was observed to be much more common towards the bottom of the sequence. Charcoal was present throughout but was obviously concentrated in the vicinity of hearths and more heavily burned areas. While not apparent in the section, considerable lateral variation in colour within layers removed from adjacent squares could be observed during the sorting of excavated material, and is also related to proximity to centres of burning. During the removal of the shelly layers from D4a and D5b, the boundaries between them became more difficult to detect than had been the case previously, especially as we approached the bottom of the sequence. Approximately 1670 litres of archaeological deposit were removed from Ivan and the shell-rich layers. At a depth of approximately 1.6m, the archaeological deposit ceased and bottomed out onto a dune comprised of very soft, fine aeolian sand which would have constituted the original living floor of the site's earliest inhabitants during the Late Holocene. This is clearly visible in Figure 3.4., and is consistent with the description of Hoffman's trench provided by Fairhall, Young and Erickson (1976). The top of a grave shaft was evident in the dune sand beneath the archaeological deposit in E5.

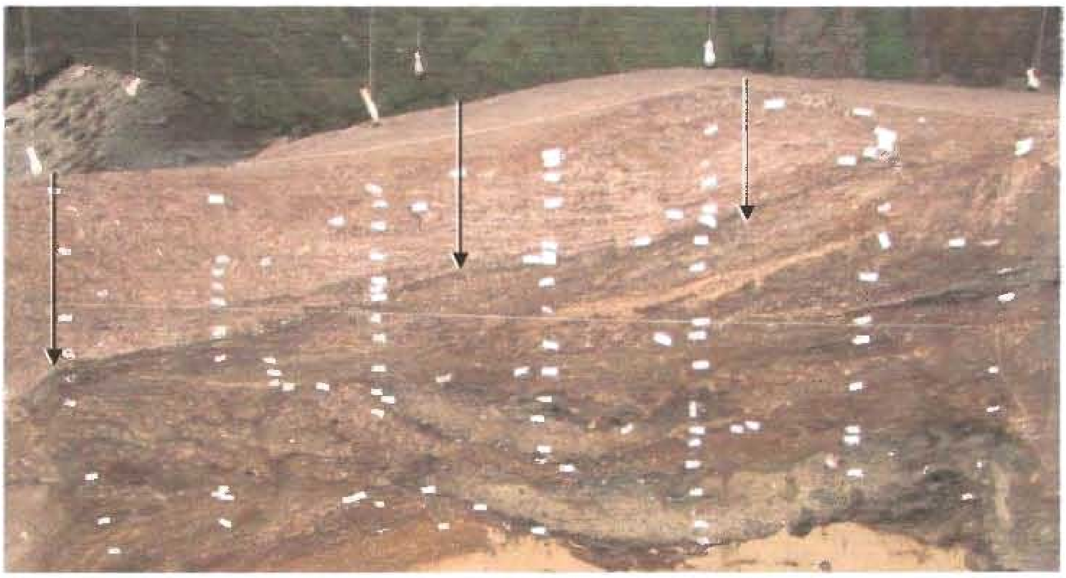


Figure 3.4. From left to right: E6, E5 and E5, after excavation. Note thin layer of dark, compacted material (Ivan) indicated by the arrows.

3.4. DATING

A suite of nine new radiocarbon dates was obtained for Hoffman's/Robberg Cave based on sample materials collected during the 2007 field season and submitted to Beta Analytic for age determination. Eight of these are derived from paired charcoal and shell samples taken from the top and bottom layers of the *Zostera* beds and the top and bottom of the shell-rich layers. An additional date on charcoal was obtained for a heavily burned layer directly above the sterile sand dune which marked the end of the occupation in question. With the exception of the shell samples from E6

Henry and E5 Tom, the samples were analyzed by means of Accelerator Mass Spectometry. The radiocarbon dates were converted into calendar years using the INTCAL04 and MARINE 04 calibration databases for terrestrial and marine samples, respectively. Both are based on data derived from the Northern Hemisphere.

Table 3.1.Radiocarbon dates for Hoffman's/Robberg Cave (2007).

Square and Layer	Reference No.	Material	Delta 13C	Conventional C14 Age	Calibrated BC (2 sigma calibration)
D5b BEN	Beta – 241142	Charcoal	-24.3 0/00	3370 ± 40 BP	1750 – 1590 BC & 1590 – 1530 BC
D5b BEN	Beta – 241143	Shell	+ 2.3 0/00	3640 ± 40 BP	1430 – 1260 BC
E6 HENRY	Beta – 241149	Charcoal	- 24.8 0/00	3310 ± 40 BP	1690 – 1500 BC
E6 HENRY	Beta – 241150	Shell	+ 0.6 0/00	3750 ± 60 BP	1610 – 1360 BC
E4 JUDY	Beta – 241144	Charcoal	- 24.2 0/00	3760 ±40 BP	2290 – 2110 BC & 2100 – 2040 BC
E4 JUDY	Beta – 241145	Shell	+ 2.0 0/00	4100 ± 40 BP	2000 – 1780 BC
E5 TOM	Beta – 241147	Charcoal	- 22.9 0/00	3920 ± 40 BP	2550 – 2540 BC & 2490 – 2290 BC
E5 TOM	Beta – 241148	Shell	+ 1.7 0/00	4330 ± 60 BP	2400 – 2030 BC
E4 RICHARD III	Beta - 241146	Charcoal	- 26.5 0/00	3990 ± 50 BP	2620 – 2440 BC, 2420 – 2400 BC & 2380 – 2350 BC

As can be seen from the calibrated radiocarbon dates obtained for the top and bottom of the consolidated *Zostera* beds, this portion of the archaeological deposit accumulated in a relatively short period of approximately 400 years. The laying down of consecutive layers of bedding grass one on top of the other in what had become the sleeping area of the cave would have produced the characteristic angle and slope of these layers observed in the section (Figure 3.3.). There is no overlap in the calibrated dates obtained for the oldest of the *Zostera*–dominated units (Henry) and the youngest of the shelly units (Judy). This is indicative of a short hiatus between the accumulation of the *Zostera* beds and the underlying shell–rich units. Dates derived from charcoal and shell samples and a single charcoal sample for the lowest lying artefact-bearing layers in E5 and E4 respectively, provide the oldest ages, *circa* 4000 BP. Thus, the radiocarbon dates are consistent with the stratigraphy.

Samples derived from marine organisms usually produce significantly older dates than those obtained from terrestrial ones. Uncalibrated radiocarbon dates on shellfish samples from Hoffman's/Robberg Cave conform to this trend, and are uniformly older than their counterparts on charcoal. Differences between dates on the two types of material range from 190 to 540 radiocarbon years. When compared to the two original uncorrected dates of 3190±110 BP and 3370±100 BP for Hoffman's/Robberg Cave derived from limpet shells recovered from the top and bottom of Hoffman's excavation (Fairhall *et al.* 1976), it is interesting to note that dates derived from samples taken in 2007 are significantly older. The date provided for the *Zostera*–rich layer near the top of the sequence (D5b Ben) by Beta Analytic predates the one for the top of the deposit cited in Fairhall, Young and Erickson by a minimum of 300 maximum of 590 years. A similar and possibly even greater difference can be observed in the date for the bottom-most shelly unit in E5 excavated in 2007 (Tom) and that provided previously for the bottom of the shell midden excavated by Hoffman. The younger dates for the shell samples obtained by Deacon and Klein are most likely related to their original provenience within Hoffman's trench. They may have been recovered higher up in the sequence than was previously thought. The nine new radiocarbon dates push the occupation of Hoffman's/Robberg Cave further back into the Late Holocene. They indicate a period of occupation spanning approximately 700 years. This contrasts significantly with the long occupational sequences documented at Nelson Bay Cave and other sites along the southern Cape coast.

3.4. SUMMARY

During the 2007 field season at Hoffman's/Robberg Cave, a small-scale excavation allowed for the collection of additional archaeological material, using currently accepted sampling and recording procedures as well as the documentation and interpretation of the stratigraphy of the Late Holocene deposits. Disturbed areas within the sequence were identified and their contents excluded from quantification and analysis. Nine new radiocarbon dates provide a refined temporal framework confirming the short-term occupation of the site, but situating this slightly earlier in the Late Holocene than previously realised.

CHAPTER 4
SHELLFISH ANALYSIS
4.1. INTRODUCTION

The analysis and quantification of shellfish remains recovered from archaeological contexts elucidates prehistoric exploitation patterns and foraging strategies as well as key environmental conditions which prevailed at the time of their collection (Henshilwood *et al.* 2001). Changes in the relative frequencies of shellfish species within archaeological sites are commonly attributed to environmental factors including fluctuations in ocean surface temperatures and changes in the morphology of coastlines as sea levels advanced and retreated. For instance, regional variations in shellfish assemblages from the west and south coasts of South Africa result from differences in temperature between the cooler Atlantic and warmer Indian oceans. These conditions account for the differential distribution of shellfish species in archaeological contexts from different coastal regions. The presence, for example, of species known to occur predominantly along the colder Atlantic coast in sites further east serves as an indication of cooler water temperatures at certain stages in prehistory (Kilburn and Rippey 1982; Jerardino 1997; Henshilwood *et al.* 2001).

Similarly, the presence of species commonly found on sandy beaches in assemblages from sites now surrounded by rocky shores reflects changes in sea level and coastline configuration. At Matjes River Rock Shelter, the transformation from sandy beaches to rocky shores brought about by marine transgression at the onset of the Holocene is documented by changing frequencies in the two dominant bivalve species associated with these two habitats, respectively, namely *Donax serra* and *Perna perna* (Jerardino 1997; Döckel 1998). At sites along the west coast including Yzerfontein and Pancho's Kitchen Midden, changes in the ratio of mussels, which favour rocky shores exposed to the open sea, to limpets, which do better in sheltered bays and gullies, provide further evidence for fluctuations in "the nature and extent" of coastlines (Klein *et al.* 2004) and their position relative to archaeological sites. These changes have also been linked to the occurrence, during the summer, of toxic red tides which would have rendered filter feeders such as mussels inedible, and have by extension been used as a means of establishing the season of occupation of sites along the Elands Bay shoreline (Jerardino 1997; Halkett *et al.* 2002; Parkington 2003).

The influence of human preferences and decisions on differences in shellfish frequencies within archaeological sites is equally significant but more difficult to demonstrate. It is accepted that the principle of least effort for maximum return would have been a salient feature of shellfish exploitation strategies, and that hunter-gatherers would have favoured species with higher flesh yields, and larger specimens over smaller ones (Jerardino 1997; Halkett *et al.* 2002; Klein *et al.* 2004). Metric data documenting changes in mean shellfish sizes through time are regarded by researchers including Parkington (2003), Henshilwood *et al.* (2001) and Klein *et al.* (2004), among others, as an additional source of insight into human subsistence strategies and marine resource exploitation.

Data obtained by Buchanan *et al.* (1978) on the maximum lengths of limpet shells from archaeological and modern contexts in the Paternoster region showed a difference in size between specimens sampled from archaeological middens and those collected by Buchanan and his colleagues from the adjacent shore. Mean lengths for limpets from 21 archaeological samples were substantially lower than those for modern samples collected in the course of five shore transects and seven "ten minute samples", in which as many large limpets as possible were identified and measured. The relatively small sizes of specimens in the archaeological samples was thought to reflect intensive exploitation of these species in such a manner as to "preclude most individuals from reaching maturity" (Buchanan *et al.* 1978: 91), thus driving the average size of individuals available for harvesting down. More recently, a statistically significant difference in the size of mollusc and limpet shells recovered from archaeological sites dated to the Middle Stone Age and Later Stone Age respectively has been observed in several west coast assemblages. In general, specimens from the former period are substantially larger than their counterparts from the latter. This difference has been attributed to the more intensive exploitation of shellfish as a critical food resource by hunter-gatherers during the latter period. It should be noted, however, that environmental factors including fluctuations in water temperature and turbidity also play an important role in determining the rate of growth and overall size of shellfish species (Jerardino 1997; Halkett *et al.* 2002; Parkington 2003).

In addition to the material from Hoffman's/Robberg Cave, this chapter includes a study of shellfish from an open midden site at Noetzie, on the coast just to the east of the Knysna Lagoon. The latter assemblage was selected for analysis due to the omission of data on shellfish remains in Inskeep's monograph on Nelson Bay Cave. The location of the site (30 km from Plettenberg Bay) and its Late Holocene dates make it an appropriate comparison for Hoffman's/Robberg Cave. The assemblages from Hoffman's/Robberg Cave and Noetzie are also compared with other Later Stone Age cave and open sites along the southern Cape coast.

4.2. SHELLFISH REMAINS FROM HOFFMAN'S/ROBBERG CAVE

4.2.1. METHODOLOGY

4.2.1.1. Sampling

During the 2007 excavation of Hoffman's/Robberg Cave, shellfish remains were recovered from all stratigraphic units. Shell from the incomplete squares E4, E5 and E6 was discarded at the site, with the exception of that from a particularly shell-rich layer (Portia) in E5 and E6. All the shell from Portia in E5 and E6 was retained for analysis. In quadrats D4a and D5b, all complete shells or countable fragments (i.e. the apices of gastropods and the hinges of bivalves were retained from the 3mm sieved fractions for identification and analysis. Uncountable fragments were discarded during preliminary field sorting of sieved material from the D4a and D5b, but were retained in the case of Portia. Below, I report on the analysis of all countable shell from these stratigraphic units.

4.2.1.2. Identification, Quantification and Measuring

Shellfish remains from Hoffman's/Robberg Cave were identified on the basis of their gross morphological characteristics (Schweitzer 1979). This was relatively simple with the aid of a reference collection of shellfish species common along the southern Cape coast. The shellfish remains from the midden layers of the Hoffman's/Robberg Cave sequence were relatively well preserved and therefore easy to identify. The *Zostera* beds, however, yielded few whole or countable specimens. Those that were recovered were quite badly decomposed. All specimens with the exception of those belonging to the genus *Burnupena* were identified to species level wherever possible. MNIs for the dominant bivalve species *Perna perna* were calculated by counting left and right hinges, then taking either the higher number of the two or half of their sum as the minimum number of specimens present. The method yielding the higher total per layer was applied in each case. MNIs for less well-represented bivalve species including *Donax serra* were obtained by adding all of the available hinges together and dividing them by two. No attempt was made to differentiate between left and right hinges, as this can only be done for relatively whole specimens.

MNIs for the range of limpets, whelks, winkles and abalones recovered from Hoffman's/Robberg Cave were determined by counts of their apices. For turban shells such as *Turbo sarmaticus,* counts were made on apices as well as opercula, with the element yielding the higher frequency providing the MNI for that species. Slightly higher counts were obtained on apices in the *Zostera*–dominated levels of Hoffmans's/Robberg Cave and on opercula in the underlying shell midden units. This is probably due to the greater resistance of the robust *Turbo* apices to decomposition caused by the acidic estuarine grass *Zostera capensis.* MNIs for chitons, specifically *Dinoplax gigas*, are based on counts of their distinctive front and rear valves, with the higher number providing the MNI.

Juvenile limpets (< 20 mm long), whelks, winkles and turban shells are too small to provide a significant amount of food, and were probably transported into the sites by accident: attached to the bodies of adult specimens, or in clumps of seaweed. They were excluded from these counts. An exception to this rule was the limpet *Scutellastra granularis,* which tended towards very small sizes in both assemblages. All specimens recovered from Hoffman's/Robberg Cave were included in the determination of MNIs for this species. The remains of other shellfish species that are not food remains, but were brought into archaeological contexts for other purposes, examples being *Nassarius kraussianus* and *Glycymeris,* are dealt with in the next chapter. Specimens with visible modifications such as perforations most likely attributed to human action are considered artefacts and have been discussed as such.

Weights were recorded for all shellfish species in both assemblages. These are reported in Appendix B, and include sub-adult specimens as well as other marine fauna such as barnacles incorporated into archaeological sites in a similar way and excluded from MNI counts. Shell fragments from Portia were weighed separately.

To assess size differences and changes through time within and between assemblages, measurements were taken on complete limpet shells as well as *Turbo sarmaticus* opercula from Hoffman's/Robberg Cave. Total lengths of a variety of limpet species and the maximum dimensions of *Turbo* opercula were recorded. The sample of measurable shell from D4a and D5b was small, so it was augmented with whole specimens from the E squares, where available. *Turbo sarmaticus* opercula from a partially sorted sample of material recovered from Hoffman's/Robberg Cave during a further field season in 2008 were also included. Sub-adult limpets (< 20mm) were excluded from this analysis. Only two species of shellfish, namely *Scutellastra cochlear* and *Turbo sarmaticus,* yielded sufficient metrical data for statistical analysis. Size distributions in different layers or at different sites were compared by means of the Kolmogorov-Smirnov test. This is a nonparametric test suitable for measuring differences in the cumulative distributions of paired samples in which data may or may not be normally distributed. The results of these tests are summarized in Appendix C.

4.2.2. RESULTS

4.2.2.1. Shellfish species abundances

The shellfish species abundances from Hoffman's/Robberg Cave are reported in Table 4.1. A total of 10 084 shells were identified. Of these, only 432 were recovered from the *Zostera* – dominated units at the top of the stratigraphic sequence. These specimens also tended to be poorly preserved, often crumbly and eroded at the edges. It seems likely that decomposition of the *Zostera* produced humic acids which led to decalcification of shell. The condition of these shells contrasted markedly with the much better-preserved specimens from the lower, shell-rich layers in the site.

The Hoffman's/Robberg Cave shellfish assemblage is heavily dominated by two species: *Perna perna* accounts for 48.9% of the shellfish remains, and the large, slow growing limpet *Scutellastra cochlear* for 24.7%. Proportions of the former species range between 32.6% and 63.8% in the *Zostera*–dominated units, excluding a single unit (Frank) from which only five countable specimens were recovered, none being *Perna perna*. In the underlying shell-rich layers of the deposit, proportions of this species are somewhat higher, ranging between 41.9% and 70.3%. Proportions of the dominant limpet species, *S. cochlear,* range between 13% and 34.4% in the shell-rich units of the sequence. The latter figure was obtained for a layer in the middle of the shelly deposit (Portia) for which the lowest frequency of *Perna perna* is recorded. Proportions of *S. cochlear* are considerably lower in the *Zostera*–dominated units, where they range between 2.1% and 9.1%. Once again, no specimens were recovered from Frank.

Other limpets, including specimens which could not be identified to species level, account for a further 14.5% of the assemblage as a whole. In the *Zostera*-dominated units, *S. longicosta* is particularly well-represented and is present in proportions of between 2.1 and 18.6%. The large limpet *S. tabularis* is also more numerous in the *Zostera* – dominated units than in the shell-rich layers beneath. Two additional large, heavy-shelled species, namely *Haliotis spadicea* and *Turbo sarmaticus*, were present in small but significant proportions of 3% and 2.4%, respectively. *T. sarmaticus* is considerably more abundant in the *Zostera*–dominated units, where it occurs in proportions of between 9.1 and 14%. In Frank, the layer from which the least countable specimens were recovered, this species accounts for 40% of the total shellfish remains. Proportions of *T. sarmaticus* are quite low in the underlying shell-rich strata, with proportions ranging between 0% and 3.9%. The latter, slightly higher frequency was recorded for an extensive and heavily burned layer (Richard) near the bottom of the sequence. Small numbers of *H. spadicea* were recovered from one of the *Zostera*–dominated units (Ben) and several of the shell-rich layers. Fragments of the larger species of abalone, *H. midae*, were also found in Ben and in the shelly layers. Winkles, whelks and white mussels constitute a minor component of the Hoffman's/Robberg Cave assemblage. The former two occur in only one of the *Zostera* – dominated units (Deon). The latter were recovered in greater quantities from the *Zostera*–dominated units.

Table 4.1. MNIs and percentages of the different shellfish species recovered from Hoffman's/Robberg Cave (D4a, D5b and Portia).

LAYER	SURFACE IN SITU		BEN		CELESTE		DEON		ELIZABETH		FRANK		IVAN		JUDY		JANE	
Shellfish species	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**
Perna perna	42	32.6	61	51.7	30	63.8	52	52.5	13	38.2	0	0	7	33.3	72	58.1	318	46.2
Donax serra	13	10.1	8	6.8	2	4.3	1	1.0	0	0.0	0	0	5	23.8	3	2.4	9	1.3
Barbatia obliquata	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0
Donax sordidus	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0
Scutellastra argenvillei	3	2.3	0	0.0	3	6.4	2	2.0	0	0.0	0	0	0	0.0	1	0.8	5	0.7
Scutellastra barbara	2	1.6	3	2.5	0	0.0	0	0.0	0	0.0	1	20	0	0.0	5	4.0	25	3.6
Scutellastra cochlear	7	5.4	5	4.2	1	2.1	9	9.1	3	8.8	0	0	0	0.0	26	21.0	134	19.4
Scutellastra longicosta	24	18.6	15	12.7	1	2.1	4	4.0	3	8.8	0	0	3	14.3	1	0.8	12	1.7
Scutellastra tabularis	7	5.4	1	0.8	1	2.1	13	13.1	2	5.9	1	20	0	0.0	1	0.8	5	0.7
Scutellastra granularis	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	13	1.9
Cymbula miniata	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0
Cymbula oculus	0	0.0	0	0.0	0	0.0	0	0.0	1	2.9	0	0	0	0.0	0	0.0	9	1.3
Unidentified limpet	0	0.0	4	3.4	0	0.0	7	7.1	0	0.0	1	20	4	19.0	7	5.6	38	5.5
Dendrofissurella scutellum	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0
***Fissurellidae* unidentified**	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	2	0.3
Turbo sarmaticus	18	14.0	12	10.2	5	10.6	9	9.1	4	11.8	2	40	0	0.0	3	2.4	13	1.9
Turbo* cf *cidaris	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0
***Turbo* sp.**	12	9.3	6	5.1	4	8.5	1	1.0	6	17.6	0	0	1	4.8	0	0.0	0	0.0
Nucella squamosa	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	1	0.1
Burnupena	0	0.0	0	0.0	0	0.0	1	1.0	2	5.9	0	0	1	4.8	0	0.0	17	2.5
Oxystele sinensis	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	1	0.8	10	1.5
Oxystele tigrina	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0
Oxystele variegata	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0
***Oxystele* sp.**	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	23	3.3
Haliotis spadicea	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0	0	0	0	0.0	3	2.4	50	7.3
Dinoplax gigas	1	0.8	1	0.8	0	0.0	0	0.0	0	0.0	0	0	0	0.0	1	0.8	5	0.7
TOTAL:	129	100.0	118	100.0	47	100.0	99	100.0	34	100.0	5	100	21	100.0	124	100	689	100

LAYER	KATHARINE		LOUISA		MAVIS		NATHAN		NOAH		OMAR		OMAR/PETER		PETER		PORTIA	
Shellfish species	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**
Perna perna	325	47.5	49	53.3	422	53.2	568	50.1	197	64.0	230	70.3	96	46.6	104	53.3	963	41.9
Donax serra	41	6.0	3	3.3	9	1.1	15	1.3	3	1.0	3	0.9	1	0.5	1	0.5	2	0.1
Barbatia obliquata	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Donax sordidus	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Scutellastra argenvillei	0	0.0	1	1.1	3	0.4	5	0.4	0	0.0	2	0.6	2	1.0	0	0.0	40	1.7
Scutellastra barbara	22	3.2	1	1.1	17	2.1	16	1.4	4	1.3	5	1.5	4	1.9	1	0.5	71	3.1
Scutellastra cochlear	121	17.7	14	15.2	130	16.4	252	22.2	40	13.0	38	11.6	64	31.1	55	28.2	790	34.4
Scutellastra longicosta	12	1.8	4	4.3	11	1.4	12	1.1	1	0.3	1	0.3	3	1.5	2	1.0	55	2.4
Scutellastra tabularis	14	2.0	1	1.1	1	0.1	3	0.3	0	0.0	0	0.0	0	0.0	0	0.0	26	1.1
Scutellastra granularis	8	1.2	5	5.4	55	6.9	58	5.1	9	2.9	15	4.6	0	0.0	5	2.6	17	0.7
Cymbula miniata	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.1
Cymbula oculus	15	2.2	1	1.1	1	0.1	23	2.0	0	0.0	2	0.6	1	0.5	2	1.0	43	1.9
Unidentified limpet	18	2.6	3	3.3	28	3.5	56	4.9	17	5.5	12	3.7	20	9.7	10	5.1	136	5.9
Dendrofissurella scutellum	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
***Fissurellidae* unidentified**	1	0.1	0	0.0	3	0.4	3	0.3	0	0.0	0	0.0	2	1.0	2	1.0	1	0.0
Turbo sarmaticus	7	1.0	2	2.2	11	1.4	17	1.5	3	1.0	5	1.5	6	2.9	3	1.5	31	1.3
Turbo* cf. *cidaris	0	0.0	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
***Turbo* sp.**	0	0.0	1	1.1	0	0.0	3	0.3	0	0.0	0	0.0	0	0.0	3	1.5	0	0.0
Nucella squamosa	0	0.0	0	0.0	0	0.0	0	0.0	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0
Burnupena	14	2.0	1	1.1	52	6.6	48	4.2	17	5.5	5	1.5	1	0.5	1	0.5	27	1.2
Oxystele sinensis	2	0.3	0	0.0	5	0.6	3	0.3	0	0.0	0	0.0	1	0.5	0	0.0	5	0.2
Oxystele tigrina	0	0.0	0	0.0	0	0.0	1	0.1	3	1.0	1	0.3	0	0.0	0	0.0	3	0.1
Oxystele variegata	0	0.0	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
***Oxystele* sp.**	10	1.5	1	1.1	24	3.0	25	2.2	6	1.9	4	1.2	0	0.0	1	0.5	25	1.1
Haliotis spadicea	66	9.6	2	2.2	15	1.9	19	1.7	6	1.9	1	0.3	4	1.9	3	1.5	56	2.4
Dinoplax gigas	8	1.2	3	3.3	4	0.5	6	0.5	1	0.3	3	0.9	1	0.5	2	1.0	3	0.1
TOTAL:	684	100.0	92	100.0	793	100.0	1133	100	308	100	327	100	206	100	195	100	2298	100.0

LAYER	PAUL		PETER/QUINTON		QUINTON		RICHARD		SECTION CUT	TOTAL	
Shellfish species	MNI	%	MNI	%	MNI	%	MNI	%	MNI	MNI	%
Perna perna	157	48.0	99	60.4	29	50.0	1018	49.2	78	4930	48.9
Donax serra	9	2.8	1	0.6	4	6.9	16	0.8	10	159	1.6
Barbatia obliquata	0	0.0	0	0.0	0	0.0	1	0.0	1	2	0
Donax sordidus	0	0.0	0	0.0	0	0.0	1	0.0	0	1	0
Scutellastra argenvillei	0	0.0	0	0.0	0	0.0	8	0.4	3	78	0.8
Scutellastra barbara	9	2.8	7	4.3	1	1.7	19	0.9	5	218	2.2
Scutellastra cochlear	98	30.0	38	23.2	9	15.5	631	30.5	23	2488	24.7
Scutellastra longicosta	1	0.3	0	0.0	1	1.7	32	1.5	11	209	2.1
Scutellastra tabularis	0	0.0	0	0.0	0	0.0	6	0.3	2	84	0.8
Scutellastra granularis	10	3.1	2	1.2	3	5.2	33	1.6	3	236	2.3
Cymbula miniata	0	0.0	0	0.0	0	0.0	0	0.0	0	2	0
Cymbula oculus	3	0.9	1	0.6	1	1.7	13	0.6	4	120	1.2
Unidentified limpet	15	4.6	9	5.5	6	10.3	121	5.8	1	513	5.1
Dendrofissurella scutellum	0	0.0	0	0.0	0	0.0	2	0.1	0	3	0
***Fissurellidae* unidentified**	3	0.9	0	0.0	0	0.0	5	0.2	0	22	0.2
Turbo sarmaticus	7	2.1	0	0.0	0	0.0	80	3.9	1	239	2.4
Turbo* cf *cidaris	0	0.0	0	0.0	0	0.0	0	0.0	0	1	0
***Turbo* sp.**	0	0.0	0	0.0	0	0.0	5	0.2	0	42	0.4
Nucella squamosa	1	0.3	0	0.0	0	0.0	0	0.0	0	3	0
Burnupena	5	1.5	3	1.8	2	3.4	10	0.5	4	211	2.1
Oxystele sinensis	0	0.0	0	0.0	0	0.0	0	0.0	1	28	0.3
Oxystele tigrina	0	0.0	0	0.0	0	0.0	0	0.0	0	8	0.1
Oxystele variegata	0	0.0	0	0.0	0	0.0	0	0.0	0	2	0
***Oxystele* sp.**	3	0.9	0	0.0	1	1.7	4	0.2	4	131	1.3
Haliotis spadicea	4	1.2	3	1.8	0	0.0	54	2.6	10	298	3
Dinoplax gigas	2	0.6	1	0.6	1	1.7	11	0.5	2	56	0.6
TOTAL:	327	100	164	100	58	100	2070	100	163	10084	100

4.2.2.2. Changes in the size of two shellfish species

The lengths of complete specimens of *Scutellastra cochlear* and opercula of *Turbo sarmaticus* were measured with digital callipers to the nearest 0.1 mm.
Since sample sizes were small, an attempt was made to explore the effect of sample size on these results. To this end, the small numbers of measurable shells from the most shell-rich layers in quadrats D4a and D5b were measured first. The same measurements were then made on expanded samples including whole shells recovered from the E squares. Some difference in the pattern is indicated.

Size distributions for *S. cochlear* from Hoffman's/Robberg Cave are presented in Figures 4.1–4.5. Specimens from the combined *Zostera* – dominated units and one of the uppermost shell-rich layers (Katharine) are most frequently within the larger size categories. This applies to both the small and expanded samples. The largest sizes were recorded for *S. cochlear* from Katharine. No specimens smaller than 0.4cm were recovered from the *Zostera* – dominated units. Taphonomic processes, as well as the relatively low frequencies of *S. cochlear* observed in the *Zostera* beds, may have played a role in producing this distribution.

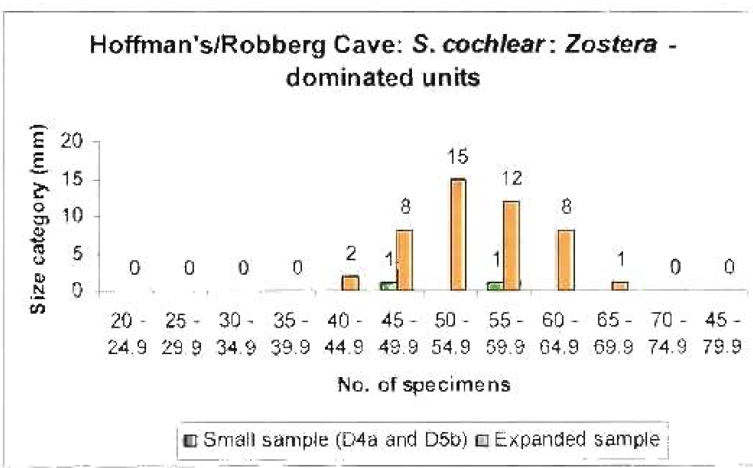


Figure 4.1.Size distributions of *S. cochlear* from the *Zostera*–dominated units, Hoffman's/Robberg Cave.

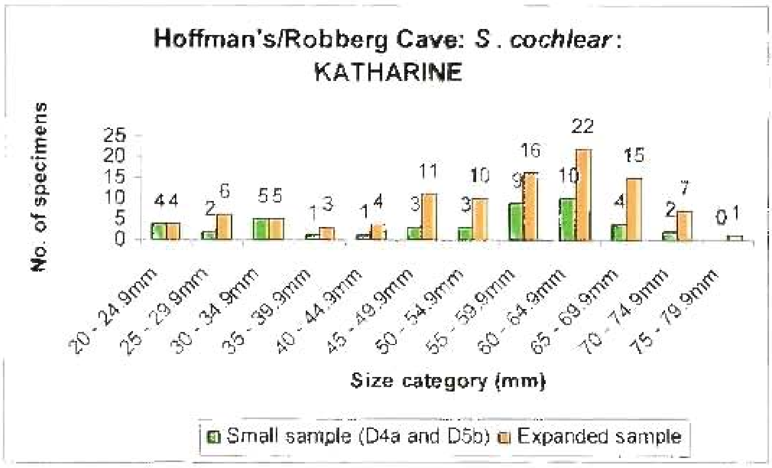


Figure 4.2.Size distributions of *S. cochlear* from Katharine, Hoffman's/Robberg Cave.

Size distributions for three underlying shelly layers near the middle (Nathan and Portia) and bottom (Richard) of the sequence are clearly bimodal. Significant quantities of specimens from these strata are within the two smallest size categories (20-24.9mm and 24.9–29.9mm) and two of the larger size categories (45–49.9mm and 50–54.9mm). Considerably fewer are within the intermediate size brackets or those exceeding 55mm. Distributions differ slightly in the small and expanded samples from Nathan and Richard but both are bimodal. These distributions may be the result of the phenomenon whereby the smallest juvenile *S. cochlear* live on the backs of larger juveniles and adults in a "multi-tiered arrangement" (Branch 1975). Juvenile specimens which would have had little value as food resources may be incorporated into archaeological sites by being carried in on the backs of larger individuals collected for consumption.

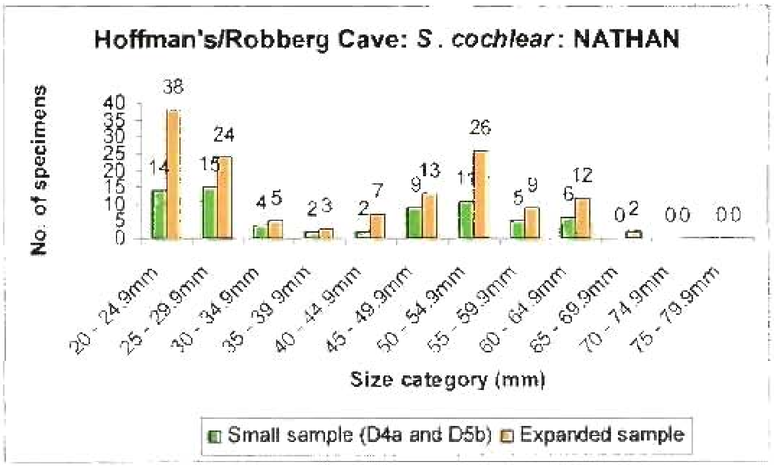


Figure 4.3.Size distributions of *S. cochlear* from Nathan, Hoffman's/Robberg Cave.

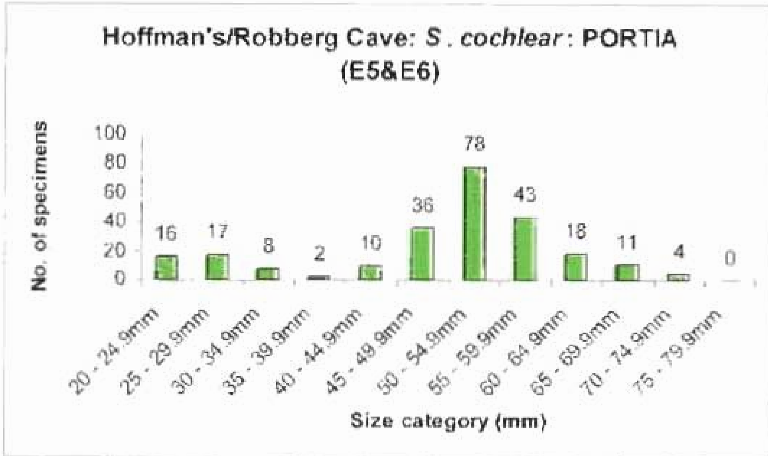


Figure 4.4.Size distributions for *S. cochlear* from Portia, Hoffman's/Robberg Cave.

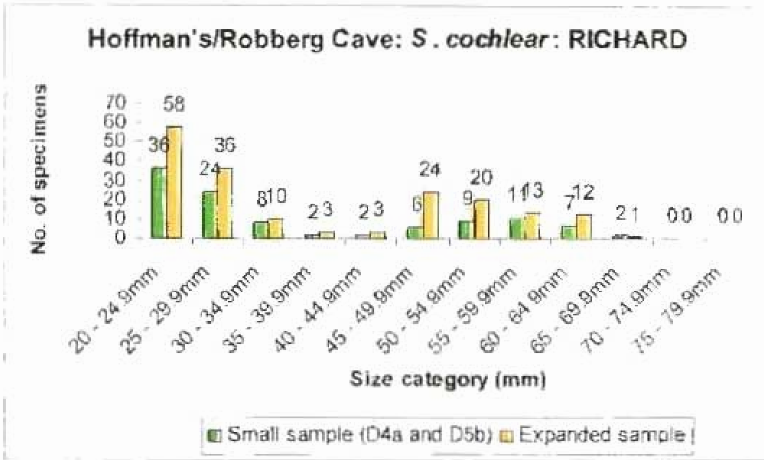


Figure 4.5.Size distributions for *S. cochlear* from Richard, Hoffman's/Robberg Cave.

Kolmogorov-Smirnov tests carried out on small samples of *S. cochlear* from individual layers at the top (Katharine), middle (Nathan) and bottom (Richard) of the midden sequence reveal statistically significant differences at the 0.05 significance level in sizes between Katharine and the two underlying layers Nathan and Richard (Tests 1 and 2). No significant differences exist between Nathan and Richard (Test 3). Tests conducted on larger samples yielded slightly different results. There is no statistically significant difference in sizes between the *Zostera*–dominated units and Katharine and Portia (Tests 4 and 6). They are all layers in which the larger size categories (45–64.9mm) are well represented. Results for Kolmogorov-Smirnov tests conducted on specimens from Katharine and Portia (Test 9) revealed statistically significant differences between them. Greater numbers of smaller specimens are included among the recovered remains from Portia. Differences were also evident between the Zostera-dominated units, Katharine and Portia as compared to two other shell-rich units, Nathan and Richard (Tests 5, 6, 7, 8, 10 and 11). No statistically significant differences were observed between the latter two units (Test 12). These included significant numbers of specimens from the smaller size classes.

Juvenile *S. cochlear* often leave distinct, pear-shaped indentations or impressions on the backs of the adults on which they live (Figure 4.6.). The maximum lengths of these indentations, where complete, where measured in order to reconstruct and plot the approximate size distributions of juvenile limpets from a single shelly layer, Portia. In this way, an attempt was made to determine whether or not the smaller individuals present in Nathan, Portia and Richard were incorporated into the site accidentally. The reconstructed size distributions are presented in Figure 4.7.

Figure 4.6. Adult *S. cochlear* with visible indentations caused by juveniles living on its back. The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

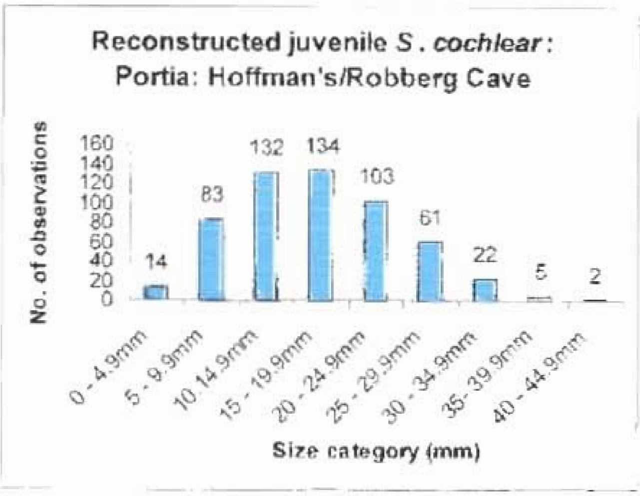


Figure 4.7.Reconstructed size distributions of juvenile *S. cochlear* from Portia, Hoffman's/Robberg Cave.

The majority of the indentations on adult *S. cochlear* from Portia measure between 10– 14.9mm and 15 – 19.9mm. A significant number of the observations also fall within the 2 –24.9mm size category. The slightly larger size category 25 – 29.9mm is also fairly well represented. Although specimens larger than 30mm may live on the backs of adults, it appears as if the majority of individuals that do so range between 10–30mm in size. Thus, it is probable that the numerous individuals from these size categories present in the shell-rich layers Nathan and Richard, and to a lesser extent, Portia, would have entered the deposit coincidentally rather than intentionally. This does not, however, mean that these small specimens were not consumed by the prehistoric inhabitants of the site.

T. sarmaticus opercula recovered from Hoffman's/Robberg Cave in 2007 were also measured, but the small sample sizes precluded meaningful analysis. These samples were augmented with specimens derived from a subsequent field season carried out in 2008, during which six additional quadrats were excavated. Metric data for the combined *Zostera* – dominated units, and three shell-rich layers at the middle and bottom of the midden sequence, are presented in Table 4.2. The highest mean sizes for *T. sarmaticus* opercula were recorded for the *Zostera* beds. Smaller values were obtained for two underlying shelly layers, Nathan and Portia. Means and medians recorded for the bottom-most shelly layer were slightly higher.

Table 4.2.Lengths and basic descriptive statistics for *T. sarmaticus* opercula from Hoffman's/Robberg Cave.

	Zostera beds	NATHAN	PORTIA	RICHARD
Valid *n*	39	16	36	38
Mean length	27.5	23.5	23.9	26.1
Median	27.2	23.3	23.9	24.7
Minimum	15.3	13	15.5	14.2
Maximum	41.4	38.9	38.4	43.3
Standard Deviation	6.2	6.9	5.6	6.9

Size distributions for the combined *Zostera* –dominated units, and three shell-rich layers at the middle and bottom of the midden sequence, are presented (Figures 4.8.-4.11.). In common with the patterns observed for *S. cochlear*, most of the *T. sarmaticus* opercula from the *Zostera* beds fall within the larger size categories (20 – 24.9mm and 25-29.9mmmm). No specimens smaller than 15mm were recovered from these strata. The deleterious effects of estuarine grass are probably responsible.

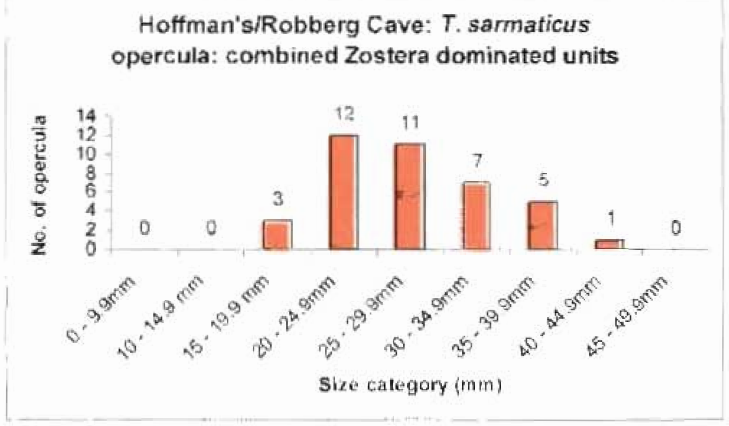


Figure 4.8.Size distributions of *T. sarmaticus* opercula from the *Zostera*–dominated units, Hoffman's/Robberg Cave.

Size distributions for the three underlying shelly layers are biased towards the smaller size categories. Specimens from Nathan and Richard were frequently within the 20–24.9mm category, while those from Portia were slightly larger. Size distributions for *T. sarmaticus* opercula from these layers resemble those for *S. cochlear* with regard to the increased frequency of smaller specimens. Unlike the distributions for the most intensively exploited limpet species, the distributions for *T. sarmaticus* are not bimodal. As juvenile alikreukel do not live upon the backs of adults, as do juvenile *S. cochlear*, small opercula more likely represent the remains of specimens deliberately brought to the site and consumed by its prehistoric inhabitants. Slight differences in the cumulative distributions of opercula from different layers in the sequence proved statistically insignificant (Tests 14 – 19). This may be a result of the very small samples available to me.

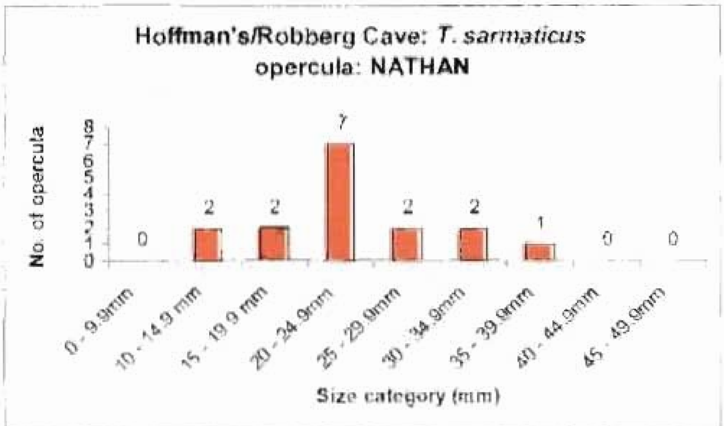


Figure 4.9.Size distributions of *T. sarmaticus* opercula from Nathan. Hoffman's/Robberg Cave.

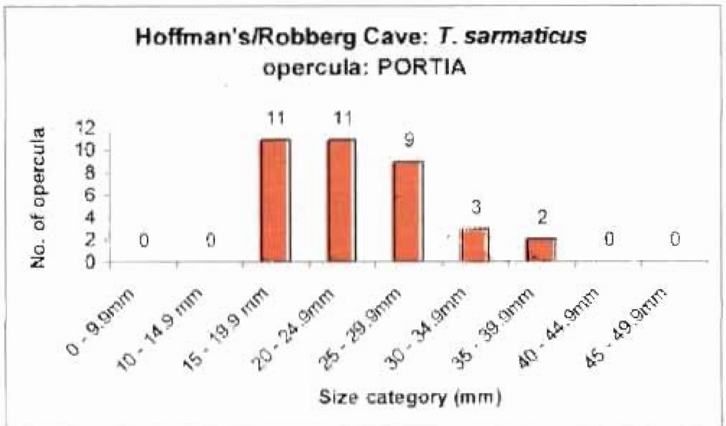


Figure 4.10.Size distributions of *T. sarmaticus* opercula from Portia, Hofffman's/Robberg Cave

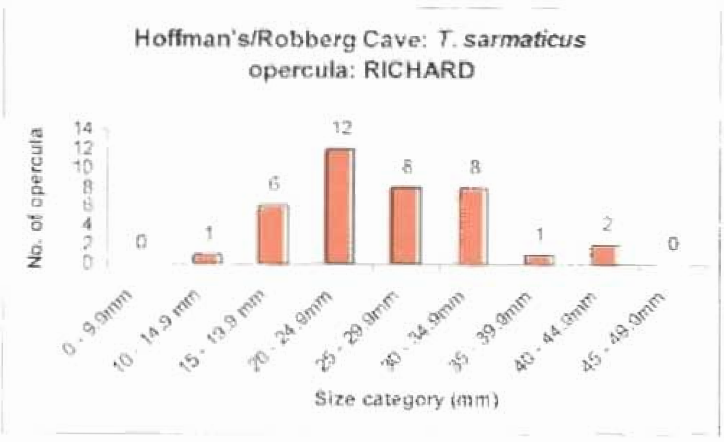


Figure 4.11.Size distributions of *T. sarmaticus* opercula from Richard, Hoffman's/Robberg Cave.

4.3. SHELLFISH REMAINS FROM AN OPEN MIDDEN IN NOETZIE, KNYSNA

4.3.1. METHODOLOGY

4.3.1.1. Sampling and Dating

It has already been mentioned that problems with the sampling of shellfish remains from Nelson Bay Cave rendered them unsuitable for quantification (Klein 1972a; Inskeep 1987). This precludes a systematic comparison between the assemblage from Hoffman's/Robberg Cave and Nelson Bay Cave. Instead, for comparative purposes, I examined shellfish from excavations carried out in 2006 and 2007 by the Archaeology Contracts Office of the University of Cape Town at a large open air shell midden on Noetzie Beach near Knysna. The contents of five military sandbags of shell bulk sample removed from five different layers (Layers 2, 4, 10, 13 and 17) in the stratigraphic sequence of a single square (G8 – see Figures 4.12 and 4.13.) were identified, counted and, where possible, measured.

Figure 4.12.North section of square G8, Noetzie midden. Depth below surface of 1.529 m at east corner and 1.446 m at west showing slope of sterile underlying dune sand. Pottery was found in layers between the dotted yellow lines. From Halkett & Orton 2006.

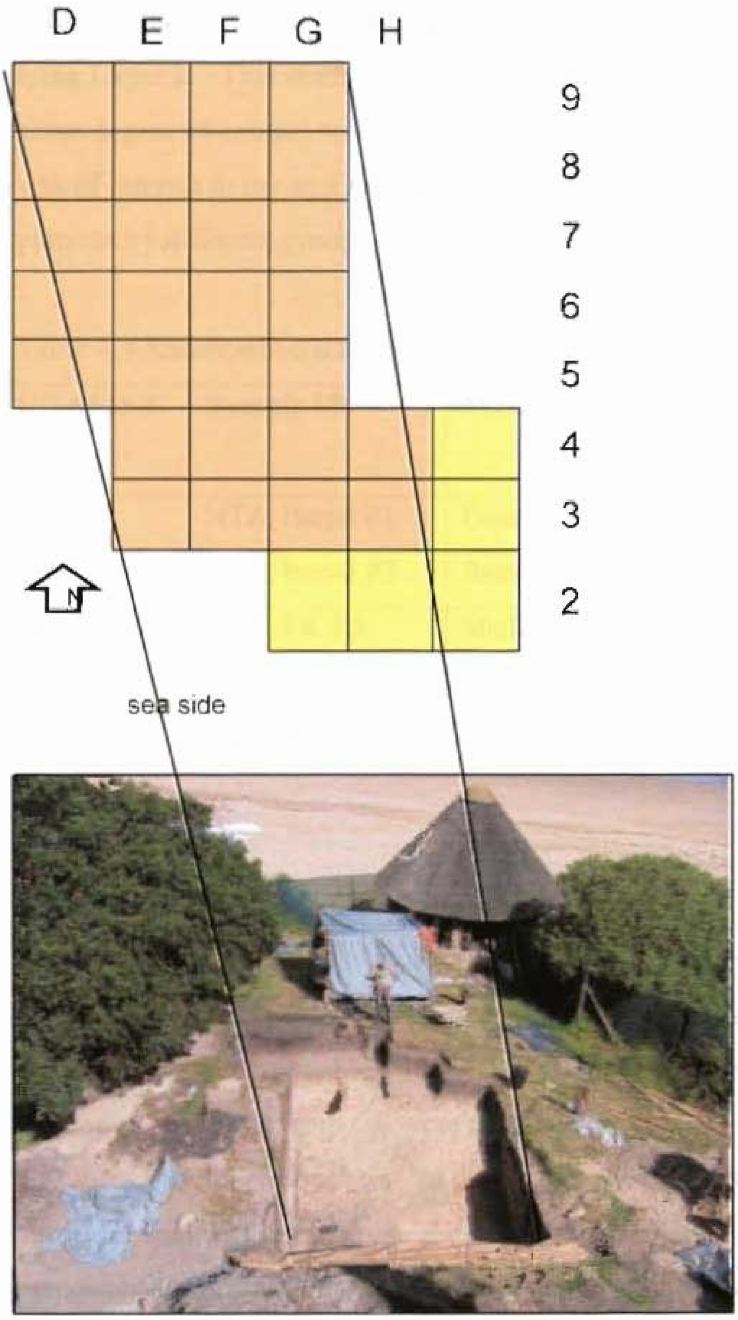


Figure 4.13.Layout of the Noetzie grid, showing the position of G8.Courtesy of David Halkett.

Radiocarbon dates (Table 4.3.) of 3300±40 BP, 3980±40 BP and 5800±40 BP were obtained on marine shell from Layers 3, 8 and 20, respectively, of the Noetzie midden. Layers 10 and 13 may be contemporary with the occupation of Hoffman's/Robberg Cave, or could, like Layer 17, be older. The remaining layers, namely 2 and quite possibly 4, postdate the most recent occupation layers of Hoffman's/Robberg Cave. Layers 2 and 3 contained ceramics. The excavators believed that the pottery from Layer 3 was not *in situ* but derived from the above – lying Layer 2. This stratum is associated with herders or hunter-gatherers who had some degree of contact with ceramic-producing people. The shellfish from Layer 2 was of interest to me as a means of reconstructing possible changes in exploitation patterns by different groups of people during the Late Holocene.

Table 4.3.Radiocarbon dates for the Noetzie Midden.

UGAMS #	**Sample ID**	**Material**	**^{14}C Age, Years BP**
2797	NTZ, burial #1	Bone	3800±40
2798	NTZ, burial #2	Bone	3190±40
2800	NTZ, F8, L3	Shell	3300±40
2801	NTZ, F8, L8	Shell	3980±40
2799	NTZ, D7, L20	Shell	5800±40

4.3.1.2. Identification, quantification and measuring

I applied the same methods to analyse the Noetzie material as those used at Hoffman's/Robberg Cave. Weights were recorded for all identified specimens as well as bulk samples (Table 3 in Appendix B). Relatively small numbers of *Turbo sarmaticus* opercula from G8 were measured in order to assess possible changes in size throughout the sequence. In the case of the pre-pottery levels, these were supplemented with measurable specimens from adjacent squares. For layer two, measurable opercula from an additional sandbag of bulked shell from G8 were measured and added to the original sample.

4.3.2. RESULTS

4.3.2.1. Shellfish species abundances

A total of 8099 specimens were identified. The abundances of the different species are summarized in Table 4.4. As is the case for Hoffman's/Robberg Cave, *Perna perna* is the most abundant species, accounting for almost 70% of the total shellfish analyzed. Proportions of this mussel range between 88.1% and 76.1% in Layers 2 and 10, respectively, and 51%, 54.4% and 55.9% in Layers 4, 13 and 17. The second most abundant species in the Noetzie assemblage is the large turban shell *Turbo sarmaticus,* which accounts for 7.9% of the recovered shellfish remains. Proportions of this species range between 15.5% and 2.8%. The lowest frequencies occur in layers with the highest abundances of *P. perna*, namely Layers 2 and 10. Thus, there is an inverse relationship between the abundances of this species and *T. sarmaticus*. This was evident to a lesser extent in the Hoffman's/Robberg Cave assemblage, where proportions of *P. perna* were lower and those of *T. sarmaticus*, higher, in the *Zostera*–dominated units of the sequence.

The best represented limpet species in the Noetzie assemblage as a whole is *Scutellastra longicosta*, followed by *S. cochlear*. These two species, respectively, account for 3.7% and 2.3% of the assemblage as a whole. In Layer 10, the relative abundances of these species are reversed, with *S. cochlear* present in higher proportions than *S. longicosta*. Other limpets occurred throughout most of the sequence in relatively small proportions, as did the abalones *H. spadicea* and *H. midae*. Winkles and whelks represent a small percentage (5.2%) of the shellfish remains recovered from the Noetzie midden. These are present in somewhat greater amounts in the youngest layers of the deposit. The small limpet *S. granularis* occurs in significantly greater proportions in Layer 2 than in the underlying pre-pottery units.

Table 4.4.MNIs and percentages of shellfish species recovered from Noetzie.

LAYER	2		4		10		13		17		**TOTAL**	
Shellfish species	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	MNI	%	MNI	%
Perna perna	2101	88.1	968	51	1614	76.1	628	54.4	310	55.9	5621	69.40
Donax serra	0	0	1	0.1	0	0	1	0.1	2	0.4	4	0.05
Scutellastra argenvillei	1	0	10	0.5	1	0	2	0.2	2	0.4	16	0.20
Scutellastra Barbara	0	0	18	0.9	19	0.9	10	0.9	24	4.3	71	0.80
Scutellastra cochlear	1	0	33	1.7	132	6.2	13	1.1	9	1.6	188	2.32
Scutellastra granularis	71	3	0	0	1	0	2	0.2	1	0.2	78	0.93
Scutellastra longicosta	6	0.3	97	5.1	55	2.6	93	8.1	38	6.8	289	3.57
Scutellastra tabularis	5	0.2	22	1.2	6	0.3	19	1.6	7	1.3	59	0.73
Scutellastra barbara/longicosta	0	0	5	0.3	12	0.6	5	0.4	5	0.9	27	0.33
Scutellastra barabara/tabularis	1	0	0	0	0	0	0	0	0	0	1	0.01
Cymbula miniata	0	0	0	0	1	0	5	0.4	0	0	6	0.07
Cymbula oculus	5	0.2	36	1.9	10	0.5	55	4.8	8	1.4	114	1.41
Unidentified limpets	6	0.3	125	6.6	48	2.3	79	6.8	39	7	297	3.67
Fissurella mutabilis	0	0	3	0.2	0	0	0	0	0	0	3	0.04
Dendrofissurella scutellum	2	0.1	0	0	0	0	2	0.2	0	0	4	0.05
Fissurella sp.	13	0.5	1	0.1	9	0.2	6	0.5	0	0	29	0.36
Turbo sarmaticus	66	2.8	218	11.5	137	6.5	132	11.4	87	15.7	640	7.90
Turbo cidaris	0	0	0	0	1	0	2	0.2	0	0	3	0.04
Turbo cf. cidaris	*0*	*0*	*4*	*0.2*	*0*	*0*	*0*	*0*	*1*	*0.2*	*5*	*0.06*
Turbo sp.	0	0	111	5.8	21	1	18	1.6	0	0	150	1.85
Burnupena	13	0.5	62	3.3	4	0.2	5	0.4	1	0.2	85	1.05
Nucella squamosa	2	0.1	2	0.1	2	0.1	0	0	2	0.4	8	0.04
Bullia unidentified	3	0.1	0	0	0	0	0	0	0	0	3	0.10
Oxystele sinensis	23	1	44	2.3	3	0.1	14	1.2	1	0.2	85	1.05
Oxystele tigrina	35	1.5	21	1.1	1	0	0	0	0	0	57	0.70
Oxystele variegate	0	0	2	0.1	0	0	1	0.1	0	0	3	0.04
Oxystele sp.	19	0.8	47	2.5	3	0.1	13	1.1	0	0	82	1.01
Haliotis spadicea	3	0.1	49	2.6	33	1.6	37	3.2	15	2.7	137	1.69
Dinoplax gigas	6	0.3	12	0.6	3	0.1	12	1	3	0.5	37	0.46
TOTAL	**2382**		**1891**		**2117**		**1154**		**555**		**8099**	

4.3.2.2. Changes in the mean size of *Turbo sarmaticus* opercula

Data obtained from metrical and statistical analyses carried out on *Turbo sarmaticus* opercula reveal small but significant variations in size between different layers in the stratigraphic sequence. In the small and expanded samples from Noetzie (Tables 4.5. and 4.6., respectively), high means and medians were recorded for opercula from Layer 2, a pottery-bearing unit near the top of the midden. In the pre-pottery levels, the lowest and highest means were recorded for specimens from the youngest and oldest layers, respectively. Values for the bottom-most level were similar to those obtained for the layer nearest the surface. Intermediate values were recorded for Layers 10 and 13.

Table 4.5.Lengths and basic descriptive statistics for small samples of *T. sarmaticus* opercula from Noetzie.

	G8L2	G8L4	G8L10	G8L13	G8L17
Valid *n*	23	58	50	35	24
Mean length	26.8	20.3	22.7	23.8	26.9
Median	27.6	18.9	21	22.5	28.6
Minimum	13.3	11.4	14.4	14.5	9.6
Maximum	37.4	36.1	39.8	37.4	36.9
Standard Deviation	6.2	5.81	5.9	5.3	6.96

Table 4.6.Lengths and basic descriptive statistics for expanded samples of *T. sarmaticus* opercula from Noetzie.

	L2	L4	L10	L13&14a	L17
Valid *n*	31	95	87	44	45
Mean length	25.4	20.8	23.5	22.9	24.9
Median	24.6	19.7	22.4	21.9	25.2
Minimum	13.3	11.4	13.5	13.1	9.6
Maximum	37.4	37.5	39.8	37.4	36.9
Standard Deviation	6.2	5.7	6.1	5.3	6.76

Size distributions of *T. sarmaticus* opercula from the Noetzie midden are plotted in Figures 4.14.–4.18. The best-represented size category for opercula from Layer 2 is 20–24.9mm. Specimens from this layer nevertheless range fairly widely in size. In Layers 4 and 10, most specimens are within the 15–19.9mm and 20–24.9mm categories. In layer 13, although 20–24.5mm remains the best represented category, more specimens are in the larger category, 25–29.9mm. This is the best represented category in the bottom-most layer that I analyzed (Layer 17), which includes many more specimens from the larger size categories. Small differences are again apparent between the small and expanded samples of measurable shells.

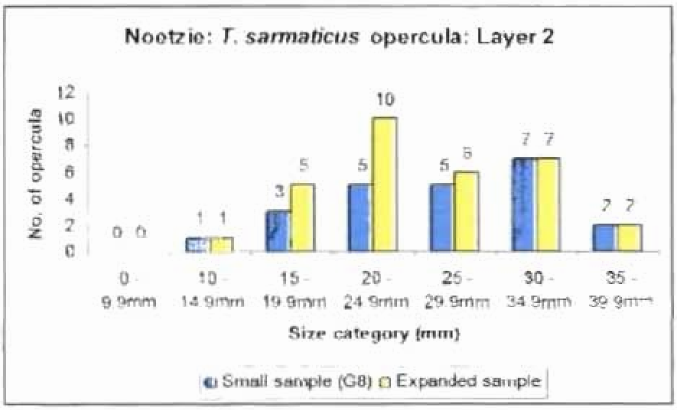


Figure 4.14.Size distributions of *T. sarmaticus* opercula from Layer 2, Noetzie.

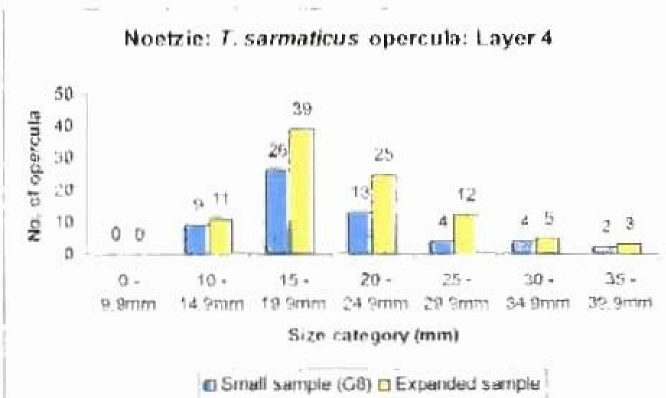


Figure 4.15.Size distributions of *T. sarmaticus* opercula from Layer 4, Noetzie.

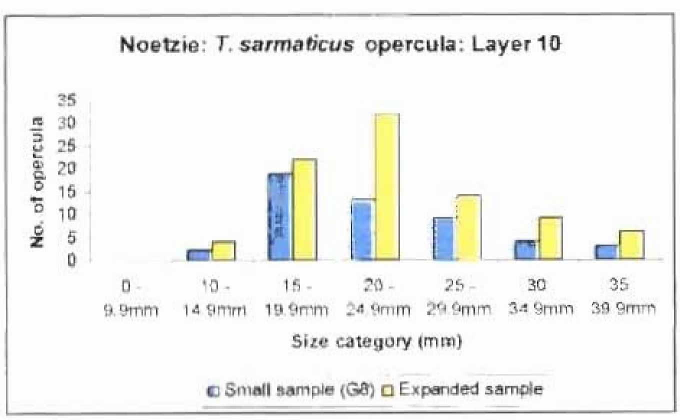


Figure 4.16.Size distributions of *T. sarmaticus* opercula from Layer 10, Noetzie.

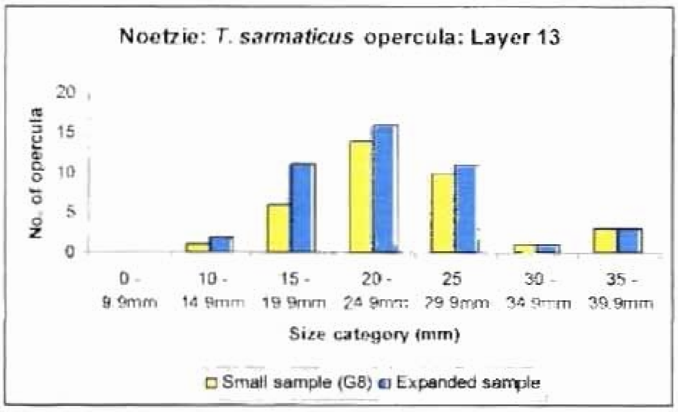


Figure 4.17.Size distributions of *T. sarmaticus* opercula from Layer 13, Noetzie.

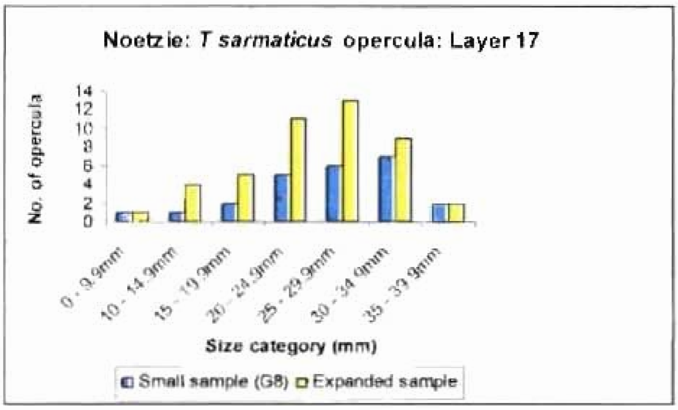


Figure 4.18.Size distributions of *T. sarmaticus* opercula from Layer 17, Noetzie.

Kolmogorov-Smirnov tests carried out on the smaller samples indicated a statistically significant difference in the size of opercula from Layer 2 and 4 (Test 29), and well as Layers 4 and 17 (Test 26). All other combinations and comparisons showed no differences. As with the dataset from Hoffman's/Robberg Cave, tests conducted on larger samples of measurable specimens from Noetzie provided slightly different results. A statistically significant difference in the size of *Turbo* opercula continued to be evident between Layers 2 and 4 (Test 30), and 4 and 17 (Test 36). An additional difference was indicated between Layers 4 and 10 (Test 34).

4.4. DISCUSSION AND COMPARISON

4.4.1. PREHISTORIC EXPLOITATION PATTERNS AT HOFFMAN'S/ROBBERG CAVE

The two best represented molluscs in the Hoffman's/Robberg Cave assemblage are both species which occur relatively low on the shore of high energy rocky coastlines. The most abundant of these, *Perna perna*, inhabits dense beds located "from the mid-intertidal to a few metres in depth" (Branch *et al.* 2002: 114). This species is well-represented at the majority of Holocene coastal sites in the vicinity. The next most abundant species, *Scutellastra cochlear*, can be found in closely packed colonies on exposed shorelines in the so-called Cochlear Zone between the infratidal and lower Balanoid zones (Branch and Branch 1981; Branch *et al.* 2002). The frequencies of this limpet species determined for Hoffman's/Robberg Cave are unusually high. Similarly high frequencies of *P. perna* and *S. cochlear* have nevertheless been reported for Late Holocene shell middens in the dunefield area of Cape St Francis, as well as at Thysbaai and White Point (Binneman 1995). These species also feature fairly prominently in similarly dated assemblages from sites located in the Garcia State Forest Nature Reserve (Henshilwood 1995).

The high frequencies of *Perna perna* and *Scutellastra cochlear* observed in the Hoffman's/Robberg Cave assemblage are most likely a function of the steep topography of the coast in the vicinity of the site. Given this distinctive coastal morphology, it is likely that Late Holocene hunter-gatherers would have had to have focused their shellfish collecting activities in the lower intertidal zones. The high proportions of *P. perna* and *S. cochlear*, and presence of other large varieties which inhabit the lower Balanoid and infratidal zones, including *T. sarmaticus*, *H. midae* and *H. spadicea*, may reflect the scheduling of shellfish collecting to coincide with spring low tides (Binneman 1995).

Scutellastra cochlear appears to have been less numerous in some of the *Zostera*–dominated units overlying the shell midden. In the layers closest to the surface, it tends to be outnumbered by *Turbo sarmaticus* and the limpet *Scutellastra longicosta*.

Rock pools in the mid-intertidal are the preferred habitat of juvenile *T. sarmaticus*, while larger, more mature specimens form substantial populations in the low intertidal zone (McLachlan and Lombard 1981). *S. longicosta* occur in the lower Balanoid zone (Branch and Branch 1981). Differences in the relative proportions of *P. perna* and *S. cochlear* and *T. sarmaticus* between the *Zostera* beds and underlying shelly layers may reflect shifts in shellfish exploitation strategies employed by the inhabitants of the site at different times. Binneman (1995:105) points out that while large limpets such as *S. cochlear* carry substantial amounts of meat, these species are not the most economical to collect "in terms of the total weight versus the meat mass return". According to Binneman (1995), the large alikreukel *T. sarmaticus*, with its larger meat mass relative to its size and weight, represented a better choice in providing maximum returns for the energy expended in its collection. The larger quantities of *T. sarmaticus* as well as the large limpet *S. tabularis* recovered from the Zostera–dominated units may alternatively be an artefact of taphonomic processes favouring the preservation of large, robust specimens.

4.4.2. SHELLFISH COLLECTION STRATEGIES AT THE NOETZIE MIDDEN

The shellfish assemblage from Noetzie is even more heavily dominated by *Perna perna* than that from Hoffman's/Robberg Cave. While the frequencies of this mollusc were consistently high throughout the stratigraphic sequence, unusually large quantities have been noted for certain layers. The highest frequencies of *P. perna* were observed for one of the youngest layers in the sequence, Layer 2, which also contained the remains of ceramics. Shellfish assemblages composed primarily of brown mussels have been documented by Binneman (1995) at a number of "ceramic sites" in the vicinity of Cape St Francis. *Turbo sarmaticus* is well-represented in the majority of stratigraphic units within the Noetzie assemblage, with the exception of those characterized by the highest frequencies of *Perna perna*.

On the whole, alikreukel features much more strongly in this assemblage than in the shell-dominated units of Hoffman's/Robberg Cave. This may reflect the greater accessibility of rock pools to the Late Holocene inhabitants of Noetzie beach. It may also be indicative of different preferences with regard to the selection and harvesting of particular species. Intensive exploitation of *Turbo sarmaticus* has been previously documented at a number of Later Stone Age sites in the Garcia State Forest nature reserve near to Still Bay, excavated by Henshilwood in the 1990s. *Turbo sarmaticus* was found to be the major component of shellfish assemblages from several open midden sites predating 2000 BP and the introduction of pastoralism to the region. This species, with its high flesh yield and easily processed meat, was collected in greater numbers by Later Stone Age hunter-gatherers residing in the area than any other mollusc (Henshilwood 1995), including *Perna perna*. More recently, Hine (2008) has noted a similar emphasis on the collection of alikreukel at open midden sites in the Paapkuilfontein region located on the southern Cape coast near Cape Agulhas.

High abundances of *T. sarmaticus* have been reported for Late Holocene cave occurrences, too. At Byneskranskop I, for instance, this species accounted for 31.4% of the almost 25000 shellfish recovered during excavations conducted by Schweitzer and Wilson (1978; 1982). These frequencies are considerably higher than those obtained for the Noetzie assemblage. Simultaneously large proportions of *P. perna* and *T. sarmaticus* similar to those observed in the Noetzie assemblage have been documented in south-eastern Cape assemblages from Kabeljous River Shelter and Klasies River Mouth (Binneman 1995).

Scutellastra longicosta, a large, star-shaped species occurring in the mid-tidal zone (Kilburn and Rippey 1982), is the best-represented limpet species in the Noetzie assemblage. In this respect, the Noetzie midden once again resembles earlier occurrences in the Garcia State Forest, specifically those predating 2700 BP, and the oldest of the Paapkuilfontein sites investigated by Hine, which has been dated to 4870 ±80 BP (Henshilwood 1995; Hine 2008). In all of these sites, *S. longicosta* was exploited more regularly and intensively than any other limpet species. In the assemblage from Noetzie, *S. longicosta* slightly outnumbers *S. cochlear* in all but one of the layers I analyzed. The exception to this pattern is Layer 10, in which frequencies of the latter species are somewhat higher. There appears to be an inverse relationship in the Hoffman's/Robberg Cave and Noetzie assemblages between these two limpet species. Where frequencies of one are high, those of the other tend to be low. A similar correlation has been noted in the frequencies of *P. perna* and *T. sarmaticus*.

A slight but significant increase in the abundance of winkles and whelks is evident in the more recent layers of the Noetzie occurrence. Percentages of *Burnupena* increase from 0.2-0.4% in Layers 17, 13 and 10 to 3.3% in Layer 4, the youngest of the pre-pottery units. Slightly higher frequencies of *Oxystele sinensis* and *Oxystele tigrina* have also been noted in Layer 4. The highest frequencies for the smaller species, *O. tigrina,* were recorded for Layer 2. Considerably higher frequencies of the small granular limpet *S. granularis* have also been recorded for Layer 2. A shift in shellfish collecting strategies after 2000 BP whereby smaller species occurring higher on the shore assumed greater importance as food resources is evident in assemblages from the Garcia State Forest. Henshilwood (1995) observed an increase in *Oxystele* spp in these later occurrences and concomitant decrease in larger species available in lower intertidal zones which had figured prominently in earlier assemblages. Binneman (1995) notes increasing proportions of *Oxystele* in shell middens associated with so-called "ceramic groups" in the archaeological record of St. Francis Bay.

Changes in the frequencies of winkles and whelks were also recorded at Paapkuilfontein, where younger assemblages contained greater numbers of these species and fewer *Turbo* and limpets. A trend towards increased abundances of *Oxystele* spp. in stratigraphic units of more recent origin was also evident in the assemblage from the inland cave site Byneskranskop I (Schweitzer and Wilson 1982). Schweitzer (1979) furthermore reports an increase in frequencies of *Burnupena* in layers of the sequence at Die Kelders in which more friable species have been destroyed due to fragmentation. I do not think, however, that this can account for the increase in whelks observed in the Noetzie sequence. Although the percentage of identified specimens in layer 4 is admittedly somewhat lower than in underlying units, indicating a greater degree of fragmentation, several other species regarded by Schweitzer as friable and prone to fragmentation, including *H. spadicea* and *T. sarmaticus,* occur in the more recent layer in amounts similar to underlying levels.

Henshilwood and Hine speculate about the impetus for the reorientation of shellfish subsistence strategies during the later years of the Late Holocene, citing increased population pressure as a possible cause. This hypothesis is at least partially supported by data relating to size changes in *T. sarmaticus* opercula recovered from sites in the Garcia State Forest and Paapkuilfontein. At these sites, a time-related decrease in the size of *T. sarmaticus* opercula was noted, in terms of which specimens became progressively smaller in the more recent units of the deposits. In Layer 4 of the Noetzie midden, proportions of *T. sarmaticus* and *Perna perna* seem to have remained unaffected by the increased exploitation of *Oxystele* spp. and *Burnupena*. In layer 2, frequencies of *T. sarmaticus* decreased while *P. perna* increased to 88.8%. This suggests continued exploitation of the middle and lower intertidal zones and simultaneous inclusion of species occurring higher up on the shore in the diets of people living at the site some time before 3300 BP.

4.4.3. VARIATION IN *S. COCHLEAR* AND *T. SARMATICUS* SIZE AT HOFFMAN'S/ROBBERG CAVE: THE EFFECTS OF HUMAN SETTLEMENT AND PREDATION

Statistically significant differences in *S. cochlear* sizes have been observed in the assemblage from Hoffman's/Robberg Cave. Variation in limpet size has been recorded in numerous southern and western Cape coastal assemblages, and has been attributed to a number of factors including fluctuations in ocean temperature and changing coastal morphology. It has been shown, for instance, that limpets grow more rapidly and attain larger sizes where ocean surface temperatures are cooler. Thus, increases in the average temperature of ocean water may be accompanied by a decrease in the mean size of limpets (Jerardino 1997). Schweitzer (1979) invokes this as a possible explanation for the decrease in mean length over time of *S. longicosta* observed at the site of Die Kelders.

Changes in sea levels and coastline configuration may also have an impact on the size and accessibility of certain limpet species. Changing sea levels are unlikely to have had an effect on limpet sizes during the Late Holocene occupation of Hoffman's/Robberg Cave. Reddering (1988) reports radiocarbon dates of 5180 BP and 3880 BP, respectively, for a raised terrace which accumulated during a high stand of the sea at the modern Keurbooms estuary, and an abandoned estuarine channel incised into the terrace. The morphology of these features and their radiocarbon ages are consistent with mid - Holocene sea levels approximately 1.5m higher than those of today. This was followed by fairly rapid regression of the shore to its current position. The rocky shore adjacent to Hoffman's/Robberg Cave would have been in much the same position that it is today throughout the majority of its occupation by Late Holocene hunter-gatherers.

Some interesting patterns are evident in the size distributions of *S. cochlear* from different layers of the Hoffman's/Robberg Cave sequence. The *Zostera* –dominated units and one of the uppermost shell-rich layers (Katharine) contain predominantly large individuals, with little or no contribution from shells less than 40mm in length. Ten individuals from the uppermost shell-rich layer (Katharine) exceed 70mm in length; the maximum length of mature *S. cochlear* cited by Branch (1975) and Branch *et al.*(2002). Individuals greater than 54.9mm in length are rare, and those exceeding 70mm in length are absent, in the underlying shell-rich layers Nathan, Portia and Richard. These layers also include greater quantities of individuals from small size categories. Individuals between 10–30mm in length are likely to have been brought to the site on the backs of adult specimens harvested for consumption.

These patterns may be indicative of fluctuations in the intensity of predation throughout the two episodes of Late Holocene occupation at Hoffman's/Robberg Cave. The emphasis on smaller individuals in three shelly layers from the middle and bottom of the sequence (Nathan, Portia and Richard) may reflect high population densities and heavy exploitation of shellfish resources when the site was first occupied at around 4000BP. The presence of larger individuals in a younger shelly layer (Katharine) and in the *Zostera*–dominated units in turn suggests lower population densities and less intensive exploitation of *S. cochlear* before and after an occupational hiatus at around 3700BP. A similar pattern in the size of *S. granularis* and *S. granatina* has been documented by Robertshaw (1977) at a shell midden in Paternoster.

One key variable governing the maximum length attained by *S. cochlear* is the density at which these creatures are packed together in colonies. High densities, which may reach up to 1700 individuals per square metre, are common in regions characterized by strong wave action. A linear relationship has been shown to exist between mean length and the density of colonies. Specifically, average length decreases as densities increase, and vice versa. Therefore, high density populations consist predominantly of smaller individuals while lower densities include greater numbers of large, mature specimens, which may live for up to 25 years (Branch 1975; Branch *et al.* 2002). Colonies in the vicinity of Hoffman's/Robberg Cave are likely to have been dense during the period of initial Late Holocene occupation. It is plausible that the continuous and intensive harvesting of *S. cochlear* would have reduced the size of colonies. In periods of less intensive human exploitation, larger specimens would again be available for collection. Fluctuations in the intensity of collecting and the densities of colonies may therefore account for differences in the size distributions of limpets from different layers in the sequence.

Some differences in the mean sizes of *T. sarmaticus* opercula, which serve as a good proxy for the size of these shells, could be observed throughout the Hoffman's/Robberg Cave sequence. This variation, however, was found to be statistically insignificant. The *Zostera*–dominated units and Portia included more specimens from the larger size categories than Nathan and Richard. Nevertheless, opercula from all stratigraphic units were most frequently within the 20–24.9mm size category. These size distributions are similar to those reported by Hine (2008) for considerably larger samples of opercula from Paapkuilfontein 4, the only one of his sites older than 2000 BP, and slightly older than the occupation at Hoffman's/Robberg Cave. Opercula from Hoffman's/Robberg Cave and Paapkuilfontein 4 are slightly smaller than those recovered by Henshilwood (1995) at sites predating 2000 BP in the Garcia State Forest. Hine's three younger sites, post-dating 2000BP, yielded specimens biased towards smaller size categories between 10 –14.9 mm and 15–19.9 mm. Individuals from these smaller size classes are rare at Hoffman's/Robberg Cave, where the youngest occupation layers predate 2000BP by over a thousand years.

Mean shell breadths were determined from the mean lengths of opercula by means of the equation **op Ø (mm) = 0.504 shell breadth (mm) + 1.791** (McLachlan and Lombard 1981). These, which are summarized in Table 4.7., are to some extent consistent with metric data for *S. cochlear*. The mean shell breadth of 51mm for *T. sarmaticus* from the *Zostera* beds is slightly larger than the means of 43.1mm, 43.9mm and 48.2mm for those derived from the shell-rich layers Nathan, Portia and Richard. As has been previously mentioned, the larger size of specimens recovered from the *Zostera* – dominated units may indicate less intensive shellfish collection during the second episode of occupation at the site. It may alternatively be the result of taphonomic processes.

Table 4.7.Mean shell breadths of *T. sarmaticus* from Hoffman's/Robberg Cave, calculated from the mean lengths of opercula.

Layer	**Mean length of opercula**	**Standard deviation of opercula**	**Mean shell breadth**
Combined *Zostera* beds	27.5 mm	6.2	51mm
Nathan	23.5 mm	6.9	43.1mm
Portia	23.9 mm	5.6	44mm
Richard	26.1 mm	6.9	48.2 mm

T. sarmaticus from Hoffman's/Robberg cave are considerably smaller than the average size of 100mm attained by mature individuals, as well as the 63.5mm legal limit imposed on modern collectors (Branch *et al.* 2002). This reflects the exploitation of smaller individuals throughout the Late Holocene occupation of Hoffman's/Robberg Cave. These alikreukel were most likely obtained from the mid-tidal. The presence of larger specimens in the *Zostera*–dominated units, in which this species accounts for greater proportions of the total assemblage, may reflect the harvesting of larger individuals from the lower infratidal. The average breadth of specimens from Richard is slightly larger than those of individuals from Nathan and Portia. *T. sarmaticus* is also slightly more abundant in this layer than in all of the overlying shell-rich strata.

4.4.4. TIME – RELATED CHANGES IN THE SIZE DISTRIBUTION OF *T. SARMATICUS* FROM THE NOETZIE MIDDEN

Changes in mean size over time were apparent in *T. sarmaticus* opercula recovered from the Noetzie midden. In the four pre-pottery levels, there is a bias towards larger size categories in the earliest layers and a decrease in the sizes in more recent units. Individuals from the youngest of the pre-pottery units cluster within the 15–19.9mm category. Those from two underlying layers roughly contemporary with the later stages of occupation at Hoffman's/Robberg Cave cluster within the slightly larger 20 –24.9mm category. There thus appears to be some chronological correspondence in the distribution of *T. sarmaticus* opercula from both sites. The results of Kolmogorov-Smirnov tests carried out on opercula from both sites (Appendix C). support this. No statistically significant differences in the cumulative distributions of *T. sarmaticus* are evident in specimens from two shell-rich layers from Hoffman's/Robberg Cave (Portia and Richard), and Layers 10, 13 and 17 of the Noetzie deposit (Tests 42 – 47). Cumulative distributions did, however, differ between the *Zostera*–dominated units of Hoffman's/Robberg Cave and Layer 4 of the Noetzie midden (Test 41). In the pottery-bearing layer 2, individuals also cluster within the 20 – 24.9mm size class.

A decrease in average size over time is also apparent in the mean shell breadths of *T. sarmaticus* (Table 4.8.) from the pre-pottery layers of the sequence. Specimens from the oldest layer (Layer 17) are larger than those from the middle layers (Layers 13 and 10). The smallest mean shell breadth was recorded for the youngest of the pre-pottery layers (Layer 4). The largest mean shell breadth was obtained for Layer 2. This increase in size is consistent with reduced collection of this species and a preference for *P. perna*. Shell breadths for Layers 17, 13 and 10 are similar to those for the three shell – rich layers from Hoffman's/Robberg Cave (Nathan, Portia and Richard). Those for Layer 4 are somewhat smaller than those from all the layers from Hoffman's/Robberg Cave, perhaps indicating the more intensive exploitation of this species by the Late Holocene inhabitants of the Noetzie midden. All of the shell breadths for *T. sarmaticus* from Noetzie are also below the maximum size of mature individuals, and the current minimum size for collection.

Table 4.8.Shell breadths of *T. sarmaticus* from the Noetzie midden (expanded samples), calculated from the mean lengths of opercula.

Layer	Mean length of opercula	Standard deviation of opercula	Mean shell breadth
2	25.4mm	6.2	46.8mm
4	20.8mm	5.7	37.7mm
10	23.5mm	6.1	43mm
13	22.9 mm	5.3	42mm
17	24.9mm	6.7	45.8 mm

A time-related decrease in the size of *T. sarmaticus* opercula has been documented at a number of sites along the southern Cape coast. In the Garcia State Forest, for instance, larger opercula were found in assemblages pre-dating 5000 BP, while smaller ones were common in those younger than 2700 BP. Patterns of change through time were also evident within individual sequences, in the form of a decrease in size from lower to upper units (Henshilwood 1995). As discussed above, Hine (2008) reports a statistically significant decrease through time in the sizes of *T. sarmaticus* opercula recovered from several open middens in Paapkuilfontein.

A number of explanations have been put forward for chronological changes in shellfish size. Intensification of shellfish extraction towards the later years of the Late Holocene is frequently cited as a possible cause for small opercula sizes. Metric data on *T. sarmaticus* opercula from the pre-pottery layers of the Noetzie midden support such an explanation. Size distributions recorded for one of the earliest layers of the deposit are very likely indicative of the availability of larger individuals during the initial occupation of the site. Thereafter, the site's prehistoric occupants would have had to collect increasingly smaller individuals. Changes in the size distributions of *T.*

sarmaticus opercula from the pre-pottery levels of the Noetzie midden are consistent with this explanation.

4.4.5. CHRONOLOGICAL PATTERNS IN THE SIZE DISTRIBUTION OF *T. SARMATICUS* FROM HOFFMAN'S/ROBBERG CAVE, NOETZIE AND THE PAPPKUILFONTEIN MIDDENS

Patterns in the size distributions of *T. sarmaticus* opercula from Hoffman's/Robberg Cave and, to a greater extent, the Noetzie midden, correspond to broader chronological trends documented by Hine (2008) at four open sites in Paapkuilfontein. The results of Kolmogorov-Smirnov tests carried out on samples from these three different sites attest to this. Size distributions of opercula from Layers 10, 13 and 17 (Test 48) of the Noetzie midden do not differ from those of specimens from Paapkuilfontein 4, a site which is broadly contemporary with those three occupational horizons. A difference is, however, apparent between Paapkuilfontein 5, which has been dated to 2250±60BP and 2320±60BP, and Layers 10, 13 and 17 of the Noetzie sequence (Test 49). The latter statigraphic units are significantly older than Paapkuilfontein 5, and contained fewer individuals in the smaller size categories. Layers 10, 13 and 17 of the Noetzie midden differed considerably from Paapkuilfontein 7 and 11, which both postdate 2000BP Tests 50 and 51). *T. sarmaticus* opercula from the most recent of the pre-pottery layers of the Noetzie midden (Layer 4), which differed from those from the underlying pre-pottery layers, also differed from opercula recovered from Paapkuilfontein 4 and 5. The latter 2 sites, respectively, pre- and post-date the accumulation of Layer 4. Size distributions of opercula from Noetzie Layer4 also differed from those from the two Paapkuilfontein sites postdating 2000BP. Layer 2 of the Noetzie midden, which contained ceramics, differed from the oldest of the two Paapkuilfontein sites predating 2000BP, namely Paapkuilfontein 4. Opercula from Noetzie Layer 2 did not differ from those from Paapkuilfontein 5. Size distributions for opercula from Noetzie Layer 2 furthermore did not differ from those from the two Paapkuilfontein sites post-dating 2000BP.

Size distributions of *T. sarmaticus* opercula from Hoffman's/Robberg Cave did not differ from those from Paapkuilfontein 4, a site which predates the Late Holocene occupation of Hoffman's/Robberg Cave. Distributions do, however, differ between opercula from Hoffman's/Robberg Cave and the younger site of Paapkuilfontein 5. The latter assemblage contains significantly more specimens in the smaller size categories. Differences have also been noted in the size distributions of opercula from Hoffman's/Robberg Cave and the two Paapkuilfontein sites postdating 2000BP. Taken together, the evidence from Hoffman's/Robberg Cave and the Noetzie midden supports the trend toward smaller sizes in sites and occupational units of increasingly recent origin commented upon by Henshilwood (1995) and Hine (2008).

4.5. SUMMARY

The shellfish assemblages from Hoffman's/Robberg Cave and the Noetzie midden are indicative of prehistoric exploitations patterns in keeping with the sites' local conditions and coastal topographies. The shellfish assemblage from Hoffman's/Robberg Cave is dominated by two species in particular, one a mussel and the other a limpet. The brown mussel, *Perna perna*, and pear-shaped limpet, *S. cochlear*, are the best represented species at the site. A comparative sample from an open occurrence in Noetzie contains even greater proportions of brown mussels, with significant contributions by the large alikreukel, *Turbo sarmaticus*. These species abundances are consistent with shellfish collection strategies focused upon the harvesting of large species with high meat yields available in the mid-tidal region and/or the lower Balanoid zone.

Some intra-assemblage variability is evident in both sequences. In the Hoffman's/Robberg Cave assemblage, a decrease in the importance of *S. cochlear*, and to a lesser extent, *P. perna*, and concomitant increase in proportions of *T. sarmaticus* and the star-shaped limpet, *S. longicosta*, is apparent in the *Zostera* – dominated units of the deposit. This may reflect the adoption of different shellfish exploitation strategies following a break in the occupation of the site at around 3700 BP. An inverse relationship between *P. perna* and *T. sarmaticus*, and to some degree *S. cochlear* and *S. longicosta*, is also apparent in the Noetzie assemblage. Furthermore, a slight increase in the exploitation of smaller species from higher on the shore is evident in the youngest of the pre-pottery layers (Layer 4), and to a lesser extent in Layer 2. The increased abundances of these relatively small species which occur high on the shore has been extensively documented at other southern Cape coastal sites. This pattern is most pronounced in sites postdating 2000BP and the arrival of herders in the region, and is frequently associated with intensification in shellfish collecting at this time. At Noetzie, the highest frequencies of *P. perna* have been recorded for a layer which contained pottery (Layer 2). This species, with its high flesh yield, was preferentially selected by prehistoric foragers at this time.

Metric data derived from some of the dominant species recovered at Hoffman's/Robberg Cave and Noetzie revealed patterns previously documented at other sites but for which explanations remain partial at best. Statistically significant variation in the sizes of *S. cochlear* from Hoffmans'/Robberg Cave, and in *T. sarmaticus* opercula from Noetzie, is evident. For instance, larger *S. cochlear* occur in the *Zostera*–dominated units and one of the uppermost shelly layers (Katharine) of the Late Holocene deposit at Hoffman's/Robberg Cave. Smaller specimens predominate in three of the older shell-rich layers, particularly Nathan and Richard. This pattern could indicate more intensive collection of this species during the initial Late Holocene occupation of the site, with less intensive exploitation towards the latter stages, and following an occupational hiatus.

Turbo opercula are larger in the *Zostera* layers and in Richard, but smaller in Nathan and Portia. These differences, however, are statistically insignificant. *T. sarmaticus* opercula from Noetzie vary in size according to a time-related pattern which has been previously documented at a number of other assemblages and sites. Specifically, sizes decrease progressively throughout the pre-pottery layers of the sequence. This decrease is consistent with increased human exploitation of this species from around 5800–3300BP. Opercula from the layer containing ceramics (Layer 2) are slightly larger than those from the underlying Layer 4. In the former layer, proportions of *T. sarmaticus* are considerably smaller than those of *P. perna*, indicating decreased exploitation of the former species at that time.

On the whole, size distributions of opercula from Hoffman's/Robberg Cave and the pre-pottery levels of the Noetzie midden are similar to those recorded by Hine (2008) for Paapkuilfontein 4. Those from Layer 2 of the Noetzie deposit are somewhat similar to size distributions of specimens from the two more recent Paapkuilfontein middens, namely 7 and 11. The data from Hoffman's/Robberg Cave and Noetzie are consistent with regional patterns indicating a decrease in the size of *T. sarmaticus* in more recent times. Mean shell breadths of *T. sarmaticus* from Hoffman's/Robberg Cave and Noetzie reflect the exploitation of relatively small, sub-adult individuals throughout their occupational sequences.

CHAPTER 5

ARTEFACTUAL ANALYSIS

5.1. INTRODUCTION

Lithic and non-lithic material cultural remains serve as an important source of insight into aspects of the lifeways of prehistoric peoples. Stone artefacts, in particular, have been the backbone of archaeological research for many years, as the most durable and often best preserved remains of prehistoric behaviour. Changes in stone artefact assemblages have been interpreted in a number of ways by different researchers. Janette Deacon, for instance, regards the succession of Later Stone Age industries at sites such as Nelson Bay Cave and Boomplaas as a reflection of people's adaptations to periods of social stress which accompanied environmental changes throughout the terminal and late Pleistocene and Holocene (Deacon 1978; Deacon 1984). Mazel and Parkington (1981) attribute variation between assemblages belonging to the Wilton industry to the extraction of specific food resources in different environments. Differences in the frequencies of Wilton artefacts, notably scrapers and adzes, serve as an indication of the relative importance of certain subsistence activities in certain places and at certain times. More recently, differences in the raw materials selected for stone artefact production, and the types of artefacts produced, have been interpreted as markers of group territoriality and identity (Hall 1990; Binneman 1995).

Assemblages of worked bone, which are an important characteristic of the Later Stone Age in southern Africa, have been regarded as indicative of prehistoric peoples' proficiency in hunting and skin working. Artefacts manufactured on marine and ostrich eggshell were used by Later Stone Age hunter-gatherers as jewellery, as items for reciprocal exchange with members of adjacent groups and sometimes as grave goods. These objects therefore play an important role in elucidating the ritual and social lives of prehistoric people (Hall 1990; Binneman 1995). Ludwig (2005) has furthermore suggested that the manufacture of certain decorative items, notably marine shell pendants, by the Late Holocene inhabitants of Nelson Bay Cave served as a means whereby they asserted their group identity and differentiated themselves from contemporary foragers living at Matjes River Rock Shelter.

I analysed all the artefacts recovered from Hoffman's/Robberg Cave in 2007. These include a typically informal post-Wilton lithic assemblage and a number of items of worked bone and shell. Although the samples of material cultural remains derived from this excavation are relatively small, they are unbiased and complete. The analysis of these objects therefore allowed me to make meaningful statements about the manufacture of stone, bone and shell artefacts by the Late Holocene inhabitants of Hoffman's/Robberg Cave.

It also enabled me to compare the lithic and non-lithic remains from this site with contemporary southern Cape coastal assemblages. Artefacts recovered from Hoffman's/Robberg Cave in 2007 are compared with those from the post-Wilton pre-ceramic units of the Nelson Bay Cave deposit, specifically units 31-62. Radiocarbon dates of 2950±80BP and 3270±70 BP have been obtained for these units, respectively. The bottom-most post-Wilton unit (63), which yielded a date of 3600±50 BP, was sterile. The youngest units in the sequence (2–21) were located in the south west corner of the cave, and contained the remains of pottery and sheep. Ceramics and sheep bones were also recovered from the youngest of the post-Wilton units, namely 22-30. These stratigraphic units are therefore associated with prehistoric people who practised herding or had contact with groups of herders, and postdate the occupation of Hoffman's/Robberg Cave by over a thousand years. Dates for the oldest layers at Hoffman's/Robberg Cave are a few hundred years older that those obtained by Inskeep for the lowest-lying post-Wilton units (62 and 63). Nevertheless, stratigraphic units 31-62 of the Nelson Bay Cave sequence are culturally equivalent and very broadly contemporary with the Late Holocene occupation of Hoffman's/Robberg Cave. I was also able to refer back to my 2006 analysis of the curated material from Hoffman's excavation, and to confirm or dismiss tentative patterns which I observed in that collection as compared to the assemblage from Nelson Bay Cave.

5.2. THE LITHIC ASSEMBLAGE

5.2.1. METHODOLOGY

5.2.1.1. Classification System and Typology

I sorted the lithic material recovered from Hoffman's/Robberg Cave in 2007 into categories according to the typology developed by Deacon (1984) for the Later Stone Age of South Africa. Her approach has been widely applied. Where necessary, I have used terms developed by Inskeep (1987) specifically to describe stone artefacts recovered from Nelson Bay Cave. The lithic material recovered from Hoffman's/Robberg Cave included relatively large amounts of roofspall, as well as fire-spalled rock. These were easily differentiated from other categories of lithic remains, and were not quantified. Weights for the different categories of stone artefacts are presented in Appendix D. Counts of lithic artefacts in the Nelson Bay Cave assemblage were derived from the appendix to Inskeep's 1987 monograph.

5.2.2. RESULTS

A total of 1644 lithic items were recovered from Hoffman's/Robberg Cave during the 2007 season (Table 5.1). In common with the vast majority of Late Holocene southern Cape assemblages, quartzite is the dominant raw material. Quartzite chunks, which account for 31.3% of the assemblage as a whole, are the best represented category. These were present in the majority of layers from which stone was recovered in frequencies ranging from 6.5% to 61.1%. The highest frequencies were recorded for the *Zostera* – dominated units and some of the shell-rich layers which yielded small samples of stone. Quartzite chips and unretouched quartzite flakes also constitute significant proportions of the assemblage, with frequencies of 4.7% and 5.7%, respectively. Like quartzite chunks, these items were found to occur throughout the sequence. Other waste materials including blades, bladelets and flakelets and cores, were recovered in smaller amounts.

Table 5.1. Numbers and percentages of the different categories of lithic remains recovered from Hoffman's/Robberg Cave.

Raw Material	Layer	SURFACE *IN SITU*		BEN		CELESTE		DEON		ELIZABETH		FRANK		GIDEON		IVAN		JUDY		JANE		JUNE		KATHARINE		LOUISA	
	Category	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Quartzite	**Manuports**																										
	Pebbles			1	5.6			2	7.1	1	2.9																
	Cobbles					1	7.7							1	10					1	0.9					1	2.2
	Waste material																										
	Chips							5	17.9							1	10	10	9.9	16	14.5	1	5.9	1	1.2	5	10.9
	Chunks	3	60	5	27.8	4	30.8	11	39.3	17	50.0	3	42.9	2	20.0	5	50.0	38	37.6	23	20.9	5	29.4	13	16.0	13	28.3
	Bladelet/flakelet cores	1	20															1	1.0								
	Irregular/other cores													1	10	1	10										
	Unretouched flakes			1	5.6			1	3.6	4	11.8							2	2.0	4	3.6	1	5.9	4	4.9	3	6.5
	Unretouched blades			1	5.6									1	10			1	1.0								
	Unretouched flakelets																	1	1.0								
	Unretouched bladelets																										
	Utilized pieces																										
	Hammerstones									1	2.9															1	2.2
	Upper grindstones					1	7.7													1	0.9						
	Lower grindstones																										
	Cobbles with evidence of utilization																										
	Grooved stones																										
	Formal tools																										
	Miscellaneous retouched pieces																										
	Total quartzite	4	80	8	44.5	6	46.2	19	67.9	23	67.6	3	42.9	5	50	7	70	53	52.5	45	40.9	7	41.2	18	22.2	23	50.0
Quartz	**Manuports**																										
	Unmodified quartz																									3	6.5
	Waste material																										
	Chips															1	10	2	2.0	17	15.5	3	17.6	4	4.9		
	Chunks																	7	6.9	18	16.4	4	23.5	17	21.0	6	13.0
	Unretouched flakes																	5	5.0	5	4.5			1	1.2	1	2.2
	Unretouched blades																							1	1.2		
	Unretouched flakelets																							1	1.2		
	Unretouched bladelets																										
	Total quartz															1	10	14	13.9	40	36.4	7	41.2	24	29.6	10	21.8
CCS	Chips																	1	1.0	1	0.9			2	2.5		
	Chunks																	1	1.0	3	2.7			3	3.7	1	2.2

	Cores																										
	Unretouched flakes			1	5.6													1	1.0					1	1.2		
	Unretouched blades																										
	Unretouched flakelets																			1	0.9						
	Unretouched bladelets																										
	Formal tools																										
	Miscellaneous retouched pieces																	1	1.0								
	Scrapers																										
	Total CCS			**1**	**5.6**													**4**	**4.0**	**5**	**4.5**			**6**	**7.4**	**1**	**2.2**
Silcrete	**Waste Material**																										
	Unretouched flakes																										
	Total silcrete																										
Sandstone	**Utilized pieces**																										
	Palettes																										
	Total sandstone																										
Shale	**Utilized pieces**															1	10										
	Palettes																										
	Total Shale															**1**	**10**										
Other																											
Ochre	**Manuports**																										
	Unmodified			5	27.8	2	15.4	4	14.3	6	17.6	2	28.6			1	10	19	18.8	13	11.8			24	29.6	3	6.5
	Utilized pieces																										
	Flaked					2	15.4																				
	Ground																									1	2.2
Aeolionite	**Manuports**																										
	Unmodified			1	5.6													3	3.0								
	Utilized pieces																										
	Flaked																										
	Ground													1	10												
Other	**Manuports**	1	20	3	16.7	3	23.1	5	17.9	5	14.7	2	28.6	4	40.0	1	10	8	7.9	7	6.4	3	17.6	9	11.1	8	17.4
	Total other	**1**	**20**	**9**	**50.1**	**7**	**53.8**	**9**	**32.1**	**11**	**32.4**	**4**	**57.1**	**5**	**50.0**	**1**	**10**	**30**	**29.7**	**20**	**18.2**	**3**	**17.6**	**33**	**40.7**	**12**	**26.1**
	TOTAL	**5**		**18**		**13**		**28**		**34**		**7**		**10**		**10**		**101**		**110**		**17**		**81**		**46**	

Raw Material	Layer	MAVIS		NATHAN		NOAH		OMAR		OMAR/PETER		PETER		PAUL		PORTIA		PETER/QUINTON		QUINTON		RACHEL		ROBERT		ROYDEN	
	Category	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Quartzite	**Manuports**																										
	Pebbles	3	3.2	4	3.8							1	1.5			1	1.4			1	4.0						
	Cobbles							1	1.8																		
	Waste material																										
	Chips	4	4.3	9	8.5	1	3.7			3	8.3			1	3.3	1	1.4			1	4.0	3	25.0	1	6.3	1	2.8
	Chunks	14	14.9	24	22.6	12	44.4	17	30.4	17	47.2	17	25.8	11	36.7	27	36.5	8	50.0	7	28.0	1	8.3	3	18.8	18	50.0
	Bladelet/flakelet cores	2	2.1	1	0.9			1	1.8							2	2.7										
	Irregular/other cores											1	1.5														
	Unretouched flakes	1	1.1	7	6.6	1	3.7	5	8.9	3	8.3	4	6.1	3	10.0	6	8.1	1	6.3	4	16.0					2	5.6
	Unretouched blades											2	3.0													1	2.8
	Unretouched flakelets											1	1.5														
	Unretouched bladelets																										
	Utilized pieces																										
	Hammerstones															1	1.4										
	Upper grindstones			1	0.9																						
	Lower grindstones																										
	Cobbles with evidence of utilization					1	3.7	1	1.8			1	1.5														
	Grooved stones																										
	Formal tools																										
	Miscellaneous retouched pieces																										
	Total quartzite	**24**	**25.5**	**46**	43.4	**15**	**55.5**	**25**	44.7	**23**	63.9	**27**	**40.8**	**15**	**50.0**	**38**	**51.4**	**9**	**56.3**	**13**	**52.0**	**4**	**33.3**	**4**	**25.0**	**22**	**61.1**
Quartz	**Manuports**																										
	Unmodified quartz	1	1.1																								
	Waste material																										
	Chips	23	24.5	4	3.8	3	11.1	2	3.6			3	4.5	4	13.3	2	2.7	2	12.5	1	4.0	2	16.7				
	Chunks	24	25.5	15	14.2	5	18.5	9	16.1	3	8.3	12	18.2	2	6.7	10	13.5	2	12.5	1	4.0	2	16.7	10	62.5	5	13.9
	Unretouched flakes	4	4.3									2	3.0	1	3.3	5	6.8					2	16.7			3	8.3
	Unretouched blades			2	1.9																						
	Unretouched flakelets	1	1.1	1	0.9																						
	Unretouched bladelets	1	1.1			1	3.7																				
	Total quartz	**54**	**57.5**	**22**	**20.8**	**9**	**33.3**	**11**	19.6	**3**	**8.3**	**17**	**25.8**	**7**	**23.3**	**17**	**23.0**	**4**	**25.0**	**2**	**8.0**	**6**	**50.1**	**10**	**62.5**	**8**	**22.2**
CCS	Chips	1	1.1	6	5.7							3	4.5	1	3.3	1	1.4			1	4.0	1	8.3				
	Chunks	2	2.1	5	4.7			1	1.8	4	11.1	1	1.5	2	6.7	3	4.1	1	6.3	1	4.0			2	12.5		

	Cores			1	0.9																						
	Unretouched flakes	1	1.1	3	2.8					1	2.8	4	6.1			7	9.5	1	6.3	3	12.0	1	8.3				
	Unretouched blades													1	3.3												
	Unretouched flakelets																										
	Unretouched bladelets									1	2.8																
	Formal tools																										
	Miscellaneous retouched pieces															1	1.4										
	Scrapers																										
	Total CCS	**4**	**4.3**	**15**	**14.1**			**1**	**1.8**	**6**	**16.7**	**8**	**12.1**	**4**	**13.3**	**12**	**16.3**	**2**	**12.6**	**5**	**20.0**	**2**	**16.6**	**2**	**12.5**		
Silcrete	**Waste Material**																										
	Unretouched flakes									1	2.8																
	Total silcrete									**1**	**2.8**																
Sandstone	**Utilized pieces**																										
	Palettes							1	1.8																		
	Total sandstone							**1**	**1.8**																		
Shale	**Utilized pieces**																										
	Palettes																										
	Total Shale																										
Other																											
Ochre	**Manuports**																										
	Unmodified	4	4.3	11	10.4			16	28.6	2	5.6	2	3.0	2	6.7	4	5.4			2	8.0					1	2.8
	Utilized pieces																										
	Flaked																										
	Ground	1	1.1											1	3.3												
Aeolionite	**Manuports**																										
	Unmodified			1	0.9			1	1.8			1	1.5			1	1.4										
	Utilized pieces																										
	Flaked													1	3.3	1	1.4										
	Ground																									1	2.8
Other	**Manuports**	6	6.4	11	10.4	3	11.1	1	1.8	1	2.8	11	16.7			1	1.4	1	6.3	3	12.0					4	11.1
	Total other	**11**	**11.7**	**23**	**21.7**	**3**	**11.1**	**18**	**32.2**	**3**	**8.4**	**14**	**21.2**	**4**	**13.3**	**7**	**9.6**	**1**	**6.3**	**5**	**20.0**					**6**	**16.7**
	TOTAL	**93**		**106**		**27**		**56**		**36**		**66**		**30**		**74**		**16**		**25**		**12**		**16**		**36**	

Raw Material	Layer	RICHARD		RICHARD II		RICHARD III		SUSAN		SELVINO		TIM		TOM		TOP OF DUNE		GF		SECTION CLEANING	TOTAL	
	Category	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**No.**	**%**
Quartzite	**Manuports**																					
	Pebbles	6	1.8									1	9.1	2	4.8					2	25	1.52
	Cobbles	2	0.6			3	4.6			1	7.7										11	0.67
	Waste material																					
	Chips	7	2.0									1	9.1	1	2.4					4	77	4.68
	Chunks	123	36.0	2	6.5	21	32.3	22	61.1	3	23.1	3	27.3	13	31.0					9	514	31.27
	Bladelet/flakelet cores	4	1.2							1	7.7	1	9.1	2	4.8						16	0.97
	Irregular/other cores	3	0.9																		6	0.36
	Unretouched flakes	26	7.6	5	16.1	3	4.6	1	2.8					1	2.4					1	94	5.72
	Unretouched blades	6	1.8	1	3.2	2	3.1														15	0.91
	Unretouched flakelets																				2	0.12
	Unretouched bladelets	1	0.3																		1	0.06
	Utilized pieces																					
	Hammerstones	5	1.5			1	1.5							1	2.4						10	0.61
	Upper grindstones	2	0.6							1	7.7					1	100				7	0.43
	Lower grindstones			1	3.2																1	0.06
	Cobbles with evidence of utilization					1	1.5			1	7.7										5	0.30
	Grooved stones	2	0.6																		2	0.12
	Formal tools																					
	Miscellaneous retouched pieces					1	1.5														1	0.06
	Total quartzite	**187**	**54.7**	**9**	**29.0**	**32**	**49.2**	**23**		**7**	**53.9**	**6**	**54.6**	**20**	**47.6**	**1**	**100**			**16**	**787**	**47.87**
Quartz	**Manuports**																					
	Unmodified quartz	1	0.3	2	6.5	5	7.7														12	0.73
	Waste material																					
	Chips	12	3.5			1	1.5			1	7.7	1	9.1							1	89	5.41
	Chunks	39	11.4	4	12.9	4	6.2	1	2.8	3	23.1	3	27.3	4	9.5					3	213	12.96
	Unretouched flakes	1	0.3	1	3.2	2	3.1			2	15.4			2	4.8						37	2.25
	Unretouched blades																			1	4	0.24
	Unretouched flakelets																				3	0.18
	Unretouched bladelets																				2	0.12
	Total quartz	**53**	**15.5**	**7**	**22.6**	**12**	**18.5**	**1**	**2.8**	**6**	**46.2**	**4**	**36.4**	**6**	**14.3**					**5**	**360**	**21.90**
CCS	Chips	6	1.8																		24	1.46
	Chunks	34	9.9	1	3.2	8	12.3	3	8.3					1	2.4						77	4.68

	Cores	4	1.2			1	1.5	1	2.8												7	0.43
	Unretouched flakes	11	3.2	2	6.5	4	6.2	5	13.9											1	47	2.86
	Unretouched blades																				1	0.06
	Unretouched flakelets																				1	0.06
	Unretouched bladelets																				1	0.06
	Formal tools																					
	Miscellaneous retouched pieces																				2	0.12
	Scrapers																	1	100		1	0.06
	Total CCS	**55**	**16.1**	**3**	**9.7**	**13**	**20.0**	**9**	**25.0**					**1**	**2.4**			**1**	100	**1**	**161**	**9.79**
Silcrete	**Waste Material**																					
	unretouched flakes																				1	0.06
	Total silcrete																				**1**	**0.06**
Sandstone	**Utilized pieces**																					
	Palettes																				1	0.06
	Total sandstone																				**1**	**0.06**
Shale	**Utilized pieces**																					
	Palettes			1	3.2																2	0.12
	Total Shale			**1**	**3.2**																**2**	**0.12**
Other																						
Ochre	**Manuports**																					
	Unmodified	19	5.6	2	6.5	1	1.5	1	2.8			1	9.1	13	31.0					3	164	9.98
	Utilized pieces																					
	Flaked																				2	0.12
	Ground																				3	0.18
Aeolionite	**Manuports**																					
	Unmodified	9	2.6	9	29.0	2	3.1	1	2.8					1	2.4					1	31	1.89
	Utilized pieces																					
	Flaked																				2	0.12
	Ground																				2	0.12
Other	**Manuports**	16	4.7			5	7.7	1	2.8					1	2.4					3	128	7.79
	Total other	**44**	**12.9**	**11**	**35.5**	**8**	**12.3**	**3**	**8.4**			**1**	**9.1**	**15**	**35.8**					**7**	**332**	**20.19**
	TOTAL	**342**		**31**		**65**		**36**		**13**		**11**		**42**		**1**		**1**		**29**	**1644**	

Two different types of quartzite core were identified in the Hoffman's/Robberg Cave assemblage. The first consists of very irregular cores on beach cobbles or other lumps of quartzite featuring several fairly rough flake removals. Six specimens were recovered from two adjacent *Zostera*–dominated layers near the top of the stratigraphic sequence, as well as from heavily burned and shell-rich layers near the bottom of the excavation.

The other type of quartzite cores resemble specimens commented upon by Inskeep (1987) and Binneman (1995; 2006/2007) in their analyses of stone artefacts from Nelson Bay Cave and Kabeljous River Shelter, respectively. Inskeep (1987) notes the presence of several anomalous cores with bruising and abrasions on the arrises and several irregular flake removals consistent with the use of bipolar flaking techniques. These are referred to by Inskeep as bladelet/flakelet cores. At least six of these specimens, which he describes as "roughly cylindrical in shape" (1987:74) had smooth surfaces indicative of their origin as either naturally water-worn cobbles or grindstones. In his analysis of lithic remains from Kabeljous River Shelter, Binneman (2006/2007) recognized a distinctive macrolithic quartzite industry peculiar to the Late Holocene, consisting of various formal and informal artefacts. Among these were large quantities of cores bearing the marks of previous utilization as rubbers, hammerstones and particularly, grindstones. These testify to the "recycling" (2006/2007: 66) of various utilized pieces available to the prehistoric inhabitants of these sites into cores from which flakes could be produced without having to obtain fresh raw materials.

Sixteen of the total of 22 quartzite cores recovered from Hoffman's/Robberg Cave in 2007 bear several flake scars from smooth striking platforms, either the external cortex of pebbles or possibly surfaces that had been ground prior to the flake removals (Figure 5.1.). These are highly standardized in form and, with the exception of a particularly large specimen from Judy (Figure 5.2.), in size. Following Inskeep (1987), I have classified these objects as bladelet/flakelet cores. These items were present in ten out of 35 stratigraphic units in the Hoffman's/Robberg Cave sequence. Two of the shell–rich units (Mavis and Portia) contained two of these items, while one of the lowest–lying midden layers (Richard) yielded four. On the whole, bladelet/flakelet cores are well represented in this assemblage.

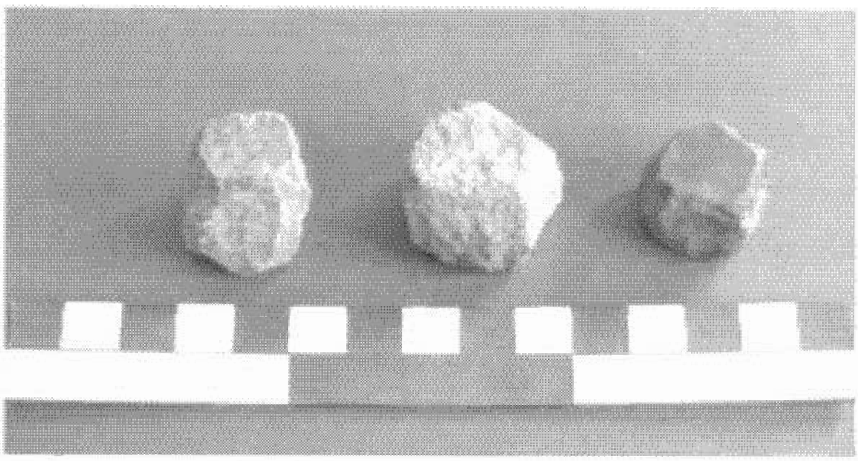


Figure 5.1.Bladelet/flakelet cores from E5 Tom, E4 Selvino, and E6 Portia, Hoffman's/Robberg Cave (2007).The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

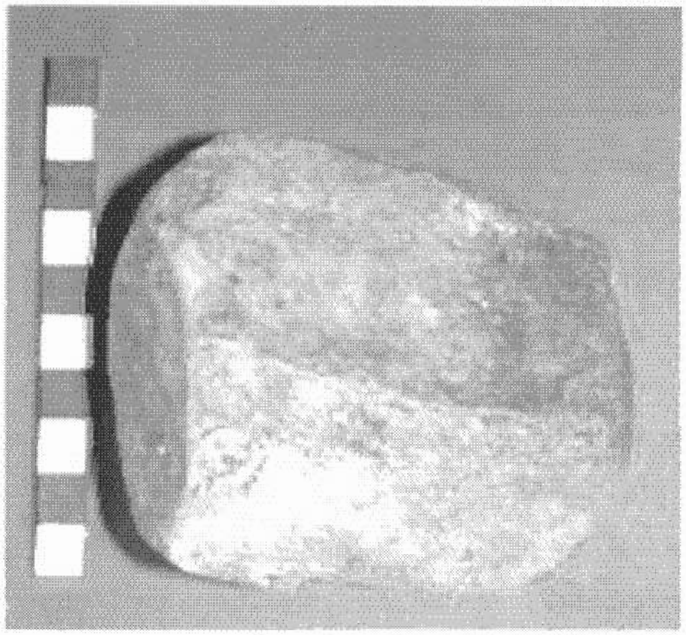


Figure 5.2.Large bladelet/flakelet core from E6 Judy, Hoffman's/Robberg Cave. The scale used is 100mm in length, with subdivisions every 10mm.

Utilized pieces including upper and lower grindstones, hammerstones, and cobbles with some hammerstone damage or edge-milling, are present in small numbers throughout the sequence. Together, these items account for 1.4% of the lithic assemblage. No flakes or blades with clear evidence of utilization were found. A large miscellaneous retouched piece recovered near the bottom of the shell midden is the only retouched artefact in quartzite.

Fine-grained quartz and crypto-crystalline silicates (CCS) are also present among the lithic remains from Hoffman's/Robberg Cave, and account for 21.9% and 9.7% of the assemblage, respectively. Chips, chunks, cores and unretouched flakes and blades in these raw materials were recovered almost exclusively from the shell-rich layers underlying the consolidated *Zostera* beds. Quartz chips, chunks and unretouched flakes are fairly abundant in the shelly layers of the sequence. Chunks are particularly substantial, and account for 13% of the assemblage as a whole. Proportions of quartz chunks fluctuate throughout the individual shell-rich strata, with frequencies ranging from 6.5% to 62.5%. Quartz chips account for 5.5% of the assemblage: a slightly higher proportion than that of quartzite chips. Unretouched flakes constitute 2.3% of the assemblage. No quartz was found in the *Zostera*–dominated units overlying unit Ivan.

The CCS from Hoffman's/Robberg Cave is of a number of different hues, including honey-coloured, red and almost white. The latter coloration seems to be related to exposure to burning. With the exception of a single CCS flake recovered from one of the top-most *Zostera*–dominated units, this raw material, like quartz, occurred only in the shell-rich layers of the deposit. CCS chips, chunks and unretouched flakes are present in proportions of 1.5%, 4.7% and 2.9%, respectively. Frequencies of these and other categories of waste material vary between the different shell-dominated layers. They tend to be somewhat higher in the burned layers near the bottom of the sequence. This is especially pertinent in the case of cores, which constitute 0.4% of the assemblage as a whole. A single bipolar CCS core was recovered from a heavily burned layer (Nathan) near the middle of the midden sequence. The remaining CCS cores, all of which are irregular in shape and form and often have relatively few flake removals, were found concentrated in two heavily burned layers (Richard and Richard III) and a sandy layer (Susan) near the bottom of the deposit. Three formal tools made from CCS, including two miscellaneous retouched pieces and a single scraper, are present in the lithic assemblage.

A single unretouched flake of silcrete from one of the shell-rich layers in the middle of the sequence constitutes the only specimen of this raw material found at Hoffman's/Robberg Cave. Sandstone and shale are present in negligible proportions of 0.6% and 0.12%, respectively.

In addition to the above, there are numerous fragments of red, orange and yellow ochre, weighing a total of 224.7g, which account for almost 10% of the lithic remains (by number of pieces). A small number of specimens with clear evidence of grinding or flaking were identified. Another item present in small but significant amounts is aeolianite, available on the nearby "island". As was the case with ochre, some of these pieces had been flaked or ground. Numerous other manuports could not be identified, and are listed under the category "other".

5.2.3. DISCUSSION AND COMPARISON

5.2.3.1. Sample Comparability

The issue of sample comparability was important throughout this analysis, given the significant disparity in size between the large assemblage from Nelson Bay Cave and small amount of material recovered from Hoffman's/Robberg Cave. Bucket counts are the most common means of recording the total volume of sediment removed during archaeological excavations. Unfortunately, these were not reported in Inskeep's monograph on Nelson Bay Cave. Instead, I used counts of quartzite chips, chunks and unretouched flakes recovered from the two sites as a measure of sample size.

A total of 1889 quartzite chips and chunks and 2229 flakes were recovered from units 31–62 of Nelson Bay Cave. In this assemblage, unretouched flakes significantly outnumber chips and chunks. The reverse is true for Hoffman's/Robberg Cave, with 591 quartzite chips and chunks and 112 unretouched flakes, including those classified as blades, flakelets and bladelets. Based on these counts, the archaeological material from the 2007 excavation at Hoffman's/Robberg Cave represents 17.1% of that from post-Wilton, pre-pottery units at Nelson Bay Cave. I have applied this ratio in all of the calculations necessary for determining the relative frequencies of different artefact types in the Hoffman's/Robberg Cave and Nelson Bay Cave assemblages. The resulting numbers of stone artefacts per 100 quartzite chips, chunks and flakes are presented in Table 5.4.

Hoffman's original excavation at Hoffman's/Robberg Cave can be estimated, from the dimensions of the remaining trench, to have been approximately 5 x 1.5m and around 1.5m deep. There is, however, sufficient uncertainty in these measurements (e.g. the trench may have been 2m wide) that it is impossible to make quantitative comparisons between this and other assemblages.

5.2.3.2. A comparison with Nelson Bay Cave

5.2.3.2.1. Chips, chunks, unretouched flakes and cores: patterns in relative abundance and raw material frequencies

As has already been mentioned, quartzite chips and chunks are the best represented category of lithic material in the Hoffman's/Robberg Cave assemblage. They are also present in significant quantities in the post-Wilton levels of Nelson Bay Cave. Unretouched quartzite flakes are a substantial component of the lithic assemblage from Nelson Bay Cave. This artefact class is particularly abundant in the post-Wilton units, where it accounts for between 21.2-100% of the stone artefacts recovered (Inskeep 1987). Proportions of these items are considerably lower in the Hoffman's/Robberg Cave assemblage, and do not exceed 16% in any individual stratum.

According to Inskeep (1987) a total of 39 quartzite cores was recovered from units 31 –62 of Nelson Bay Cave. This figure includes 11 of the distinctive bladelet/flakelet cores which were found clustered together in unit 43, and which cut out completely above this stratum. Significantly lower frequencies of these and other types of quartzite cores were recorded in the post-Wilton units of the sequence as compared to those which predate them. A total of 16 bladelet cores and 6 irregular cores were recovered during the 2007 field season at Hoffman's/Robberg Cave. When the numbers of quartzite cores from both sites are measured against the counts of quartzite chips, chunks and unretouched flakes, it becomes apparent that these items are more abundant in the Hoffman's/Robberg Cave assemblage than in the post-Wilton levels from Hoffman's/Robberg Cave.

A chi – squared test was used to determine whether or not this difference is statistically significant. This test measures the extent to which the proportions of cores relative to chips, chunks and unretouched flakes differ between the two sites, The total numbers of quartzite cores, and quartzite chips, chunks and unretouched flakes from each site are tabulated in Table 5.2.

Table 5.2.Numbers of quartzite cores, and quartzite chips, chunks and unretouched flakes from Hoffman's/Robberg Cave (2007) and Nelson Bay Cave (units 31 – 62).

Site	**Total quartzite cores**	**Total quartzite chips, chunks and unretouched flakes**	**Total**
Hoffman's/Robberg Cave	22	703	725
Nelson Bay Cave	39	4118	4157
Total	61	4821	4882

The results, which are summarized in Appendix F, show that the difference in the relative abundance of cores in the assemblages from Hoffman's/Robberg Cave and Nelson Bay Cave is in fact statistically significant at the 0.05 level. While cores were present in the *Zostera* beds and the marker layer Ivan, the majority were recovered from shell-rich units near the middle and especially the bottom of the sequence. Four bladelet/flakelet cores as well as three irregular cores were derived from a single, extensive layer (Richard) near the base of the archaeological deposit. It appears that artefact production was more intense during this stage of occupation than before and after an occupational hiatus, which occurred between ~3700 – 3300 BP. The post – Wilton levels at Nelson Bay Cave are younger than the shell midden deposits from Hoffman's/Robberg Cave. This may account for the greater abundance of cores in the assemblage from the latter site.

Chips, chunks and unretouched flakes of quartz and CCS are present in both assemblages. At Nelson Bay Cave, the frequencies of these items are lowest in the Late Holocene, with 57 quartz chips and chunks and 26 unretouched quartz flakes from units 31-62. Chalcedony is even rarer, with only six chips and chunks and 12 flakes from these layers. Despite the smaller sample size, these items are more common at Hoffman's/Robberg Cave: 89 chips, 213 chunks and 46 unretouched flakes of quartz, and 24 chips, 77 chunks and 47 unretouched flakes of CCS. The post-Wilton levels of Nelson Bay Cave yielded 2 quartz and 3 chalcedony cores. The 2007 sample of material from Hoffman's/Robberg Cave includes none of the former and 7 of the latter. The total absence of quartz cores from the Hoffman's/Robberg Cave assemblage and presence of fairly large quantities of chips, chunks and unretouched flakes suggests that the latter items were being exported from elsewhere. Frequencies of CCS cores, which are significantly higher in the case of Hoffman's/Robberg Cave, are consistent with patterns previously observed for chips, chunks and unretouched flakes.

Chips, chunks, unretouched flakes, and in the case of CCS, cores of fine-grained raw material were recovered almost exclusively from the shell-rich units of Hoffman's/Robberg Cave. With the exception of a single CCS flake recovered from one of the youngest *Zostera* beds (Ben), all of the stone artefacts in the *Zostera* – dominated units were manufactured on quartzite. Differences in raw material frequencies in the two groups of statigraphic units at Hoffman's/Robberg Cave indicate different patterns of raw material exploitation during the two episodes of occupation at the site. The shell-rich units, which date to between ~4000–3700BP, accumulated during a period in which quartz and CCS were still in use by the inhabitants of Nelson Bay Cave. The *Zostera* beds, with dates of ~3300BP, were much more heavily dominated by quartzite, in common with the post-Wilton units of Nelson Bay Cave.

5.2.3.2.2. Grinding equipment and other utilized pieces

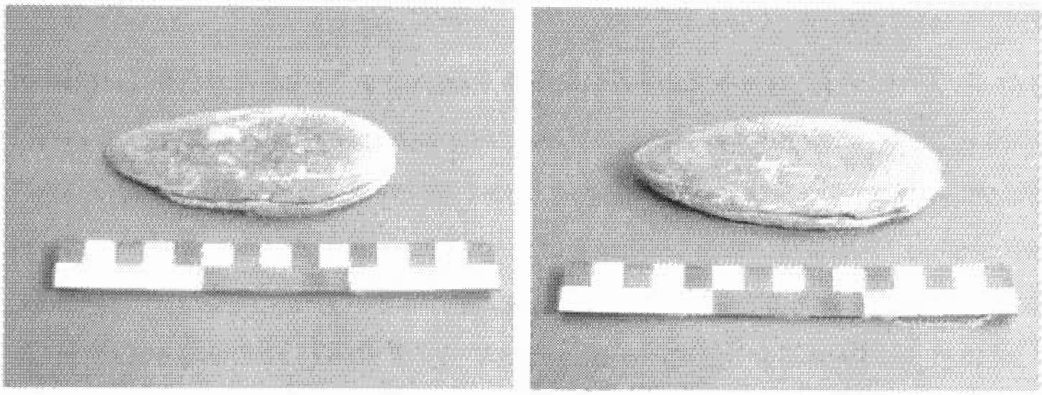
A range of items classified under the broad category of grinding equipment was recovered from the Holocene levels of Nelson Bay Cave. While cores were observed to decrease in the upper group of statigraphic units, grindstones, hammerstones, and "rubbers" (Inskeep 1987: 105) were reportedly more abundant in layers above unit 63. Inskeep (1987) lists eight complete quartzite grindstones and 15 fragments with the remains of recognizable grinding facets among the utilized pieces from Nelson Bay Cave. Of these, 10 fragments and 2 whole specimens derive from units 31-62 (Inskeep 1987). In addition, 28 hammerstones, four rubber/hammerstones and ten rubbers were recovered from these units. The majority of these specimens were of quartzite. The 2007 sample from Hoffman's/Robberg Cave includes seven complete upper grindstones and a single probable lower grindstone; ten hammerstones and five cobbles with hammerstone damage and/or milling. All of the grinding equipment from this site is of quartzite. When the different categories of grinding equipment from the two sites are combined and measured against counts of quartzite chips, chunks and unretouched flakes (Table 5.3.), it is clear that these artefacts were more abundant at Hoffman's/Robberg Cave.

Both assemblages include objects known as palettes. These are flat pieces of stone, generally shale, with noticeably ground edges. They vary in shape from round to oval, and are sometimes recovered within the context of burials (Hall 2000). A total of ten shale palettes were recovered from Nelson Bay Cave. Two derive from the pre-ceramic, post-Wilton layers. Two complete palettes and one fragment were recovered during the 2007 excavation at Hoffman's/Robberg Cave. Both of the complete specimens derive from burned, shell-dominated units within the deposit. One, manufactured on sandstone, is fairly small and round with relatively rough edges (Figure 5.3.). The other is narrow and elongated, with considerably smoother edges. It is manufactured on dark grey shale, which has become quite badly abraded on one of the surfaces (Figure 5.4.).

Figure 5.3. Sandstone palette from E5 Omar, Hoffman's/Robberg Cave. The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

Figure 5.4.Elongated shale palette from E4 Richard II, Hoffman's/Robberg Cave. The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

A single fragment of similarly smoothed, dark grey shale was found in unit Ivan, separating the *Zostera* beds from the shell-dominated units. Two additional shale palettes were recovered from a test spit dug during 2008 (Figures 5.6. and 5.7.). None of the specimens from Hoffman's/Robberg Cave or Nelson Bay Cave bear perforations. Also present in the new sample of material are two pieces of aeolianite with similarly ground and/or smoothed edges. Two further pieces show signs of possible flaking. The numerous other pieces of aeolianite included in the assemblage may also have been smoothed, if not along the edges, then on the two faces of slabs which were removed from outcrops of this rough, porous material.



Figures 5.5. and 5.6.Two oval shale palettes from O12d Spit 6, Hoffman's/Robberg Cave (2008).The scale used is 150 mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

Other lithic remains showing evidence of utilization were recovered from the post-Wilton layers of Nelson Bay Cave. These include flakes with various types of edge-damage and wear, and *pièces esquillées*. In both cases, quartzite predominated in the more recent stratigraphic units while quartz and CCS were present in older deposits. No such specimens were recovered during the 2007 field season at Hoffman's/Robberg Cave.

5.2.3.2.3. Formal tools

As in other southern Cape coastal sites, formal stone artefacts are rare in the post-Wilton levels at Nelson Bay Cave. Thirty-four scrapers and 16 miscellaneous retouched pieces were recovered from units 31-62, all of quartzite. The 2007 excavation at Hoffman's/Robberg Cave yielded only four retouched artefacts: a single CCS scraper and three miscellaneous retouched pieces, one quartzite and two CCS. A difference in the relative frequency of CCS in the post-Wilton levels of Nelson Bay Cave and Hoffman's/Robberg Cave has already been commented upon, and is again clearly relevant. Comparison of ratios of retouched pieces to quartzite chips, chunks and unretouched flakes shows that scrapers are more common at Nelson Bay Cave, but miscellaneous retouched pieces occur in similar proportions in both assemblages. Stone sinkers were recovered in significant quantities at Nelson Bay Cave, primarily from the post-Wilton units. None were found during the 2007 excavation at Hoffman's/Robberg Cave.

5.2.3.2.4. Ochre-stained lithics

Inskeep (1987) reports the occurrence of only five ochre-stained pebbles, chunks, flakes, grinding equipment and unspecified stone pieces from units 31-62 at Nelson Bay Cave. There were also seven "ochre pencils", elongated pieces of ochre showing evidence of intensive grinding, sufficient to produce facets. The 2007 sample from Hoffman's/Robberg Cave includes a total of 13 visibly ochre-stained lithic items, all of which are quartzite (Table 5.3.). Among these are a single spall, six chunks, one core, one flake, a miscellaneous retouched piece and a small upper grindstone that probably served as an ochre-grinder. Two ochre-stained blades were also recovered, both from the lower levels of the site (below Ivan). One is ochre-stained on the ventral surface. The other is a snapped blade with a faceted platform reminiscent of the Middle Stone Age with traces of ochre on the entire surface of the artefact. Three pieces of ochre with obviously ground edges are also included in the 2007 sample of material from Hoffman's/Robberg Cave.

Table 5.3.Ochre-stained lithics from Hoffman's/Robberg Cave (2007).

Layer	Item	*n*
CELESTE	Small upper grindstone	1
IVAN	Core	1
JUDY	Blade	1
JUDY	Flake	1
OMAR	Chunk	1
OMAR	Spall	1
PETER	Blade	1
PORTIA	Chunk	1
RICHARD	Chunk	3
PAUL	Chunk	1
RICHARD	Miscellaneous retouched piece	1
TOTAL:		13

Table 5.4.Numbers of stone artefacts per 100 quartzite chips, chunks and unretouched flakes for Nelson Bay Cave and Hoffman's/Robberg Cave.

Item	Nelson Bay Cave (units 31-62)	Hoffman's/Robberg Cave
Quartzite cores	0.95	3.14
CCS cores	0.07	1
Grinding equipment	1.07	4
Scrapers	0.83	0.14
MRPs	0.39	0.42
Ochre-stained lithics	0.12	1.9

5.2.3.3. A comparison between the 2007 sample from Hoffman's/Robberg Cave and the curated collection from Hoffman's excavation

As a result of my analysis of the 2007 sample of lithic remains from Hoffmans'/Robberg Cave, some assessment can be made of the completeness of the curated collection of stone from Hoffman's earlier excavation (Table 5.5.). It appears, for instance, that quartzite chunks are underrepresented relative to unretouched flakes in the older sample. Both samples contained few quartzite blades relative to flakes. The blade-to-flake ratios for the two collections of material are very similar. The same can be said with regard to the ratios of quartzite flakes to quartzite cores. The sample of quartzite flakes, blades and cores from Hoffman's excavation of the site does not seem to be biased with regard to these items. However, the majority of the artefacts included in the original collection are large, meaning that there may be some bias in the sizes of objects curated. Quartz and CCS were severely underrepresented in the original collection, perhaps because the majority of quartz and CCS pieces recovered during the 2007 excavation were rather small, and could have been discarded by Hoffman's crew if they were using a coarse meshed sieve. The burned and dirty appearance of the CCS from the burned units in the lower part of the deposit could also have been a factor.

In the course of my previous examination of the original collection of material from Hoffman's excavation of the site, I noted the prevalence of ochre-staining on various lithics (Table 5.6.). This was especially apparent on several different categories of grinding equipment. Seventeen of a total of 51 securely identified upper grindstones bore visible traces of ochre. In seven cases, ochre-stains were observed on grinding facets (Kyriacou 2006), a pattern which would be consistent with their use as ochre-grinders. Four out of eight ochre-stained flakes included in the curated collection were ochre-stained on their ventral surfaces. Tentative statements regarding the more prolific use of ochre by the inhabitants of Hoffman's/Robberg Cave in relation to those at Nelson Bay Cave based upon Hoffman's original collection are supported by the new data.

Table 5.5.Lithics from Hoffman's excavation of Hoffman's/Robberg Cave.

Raw Material	**Category**	**Total No.**
Quartzite	**Manuports**	
	Slabs	4
	Pebbles	48
	Cobbles	32
	Waste Material	
	Chunks	46
	Cores	15
	Unretouched flakes	78
	Unretouched blades	15
	Unretouched flakes/blades	3
	Utilized Pieces	
	Upper grindstones	51
	Hammerstones	24
	Upper grindstones/hammerstones	6
	Milled-edge pebbles	3
	Pebbles/cobbles with evidence of grinding	12
	Pebbles/cobbles with hammerstone damage	29
	Conjoining fragments of a bored stone	3
	Perforated stones	1
Quartz	**Manuports**	
	Pebbles	1
	Formal Tools	
	Scraper	1
CCS	**Waste Material**	
	Chunks	6
	Unretouched flakes	1
Other	**Manuports**	
	Ochre	9
	Sandstone	15
Sandstone	Ground sandstone	11
	Grooved stones	2
Shale	**Palettes**	2
Sandstone	**Fragments of palettes**	2

Table 5.6.Ochre-stained lithics from Hoffman's excavation of Hoffman's/Robberg Cave (all quartzite).

Category	Total No.
Spalls	2
Slabs	2
Fragments	1
Pebbles	4
Cobbles	2
Chunks	3
Cores	4
Flakes	8
Blades	1
Upper grindstones	17
Hammerstones	2
Upper grindstones/hammerstones	3
Milled-edge pebbles	1
Pebbles/cobbles with grinding facets	2
Pebbles/cobbles with hammerstone damage	1

5.3. THE NON-LITHIC ASSEMBLAGE

5.3.1. METHODOLOGY

In classifying and describing the bone and marine shell artefacts in the Hoffman's/Robberg Cave assemblage, I have adhered to the definitions devised by Schweitzer (1979) for Die Kelders. Ostrich eggshell beads were measured using digital callipers. Several measurements were taken on each specimen in order to determine maximum external bead diameter. Specimens were subjected to digital photo-microscopy to determine which stage of the production sequence as described by Orton (2008) they most likely represent, and to examine them for traces of wear consistent with their having been sewn onto garments of clothing or strung together to make pieces of jewellery. To assess the relative frequencies of these items in the Hoffman's/Robberg Cave and Nelson Bay Cave assemblages, counts of worked bone and shell objects will be expressed in relation to total numbers of quartzite chips, chunks and unretouched flakes (Table 5.9.). In order to increase the sample, additional bone and shell artefacts recovered during further excavations at the site in 2008 are described but not quantified.

5.3.2. RESULTS

5.3.2.1. Worked bone

A total of twenty items of worked bone were recovered from Hoffman's/Robberg Cave during the 2007 field season (Table 5.7.) These are more fully described in Appendix E. They include two bone awls, a broken bone point; a somewhat thicker bone object classified as a linkshaft; three hollow tipped points; and one small and four larger undecorated bone beads. The 2007 sample furthermore contains six fragments (five of which conjoin) of badly burned bone shaft decorated with sets of parallel incisions, the proximal part of a ringed and snapped mammal bone shaft, and a piece of robust bone showing evidence of flaking and perhaps smoothing. Of these specimens, all of the points as well as the small bone bead were recovered from the surface of the site, or from disturbed deposit. The larger bone beads and bone awls derive from two adjacent *Zostera*-dominated layers, while the remainder of the finds were found in the shell-rich units.

Table 5.7.Worked bone from Hoffman's/Robberg Cave (2007). Includes items recovered from the *in situ* and disturbed deposits, as well as from the surface of the site.

Category	**Total No.**
Awls	2
Points	1
Hollow-tipped points	3
Linkshafts	1
Beads/tubes	5
Decorated/incised	6 fragments
Ringed/snapped	1
Flaked/smoothed/cut	1

5.3.2.2. Worked shell

Worked, modified and utilized marine shells from the 2007 excavations at Hoffman's/Robberg Cave are presented in Table 5.8. These, as well as an additional sample from 2008, are described in Appendix E.

Table 5.8. Worked, modified, utilized and other non-food related marine shell from Hoffman's/Robberg Cave (2007). Includes items recovered from the *in situ* and disturbed deposits as well as the surface of the site.

Category	**Total No.**
Pendants	3
Perforated *Donax serra* valves	3
Glycymeris	2
Nassarius kraussianus	11
Phalium labiatum zeylanicum	1
Ochre – stained shells	1

5.3.2.2.1. Marine shell pendants, perforated shells and shells with evidence of ochre-staining

Three marine shell pendants were recovered from Hoffman's/Robberg Cave in 2007. All were manufactured on fragments of *T. sarmaticus* shell, have two perforations, and lack any signs of edge-nicking. Two of the specimens are round, and one is oval. One specimen derives from the top-most *in situ Zostera*-dominated layer of the deposit; the remaining two were recovered from shell-rich layers near the top and bottom of the midden. These items are therefore quite evenly distributed throughout the archaeological sequence. All of them are poorly preserved.

Two additional shell pendants have been found among the sorted material removed from Hoffman's/Robberg Cave during the most recent (2008) excavation. One of these is a square-shaped specimen on what appears to be a fragment of limpet shell, edge-nicked along three of the four corners and with a single smooth, round perforation drilled from the nacreous face, outwards. The other is a triangular piece of alikreukel shell with edge-nicking on both sides and the outlines of three distinct perforations which were not completely drilled. The absence of these items from the original collection of material recovered by Hoffman may be a result of their friability. The 2007 sample also includes three roughly perforated white mussel shells, two of which were recovered from the *in situ* deposits, as well as a number of specimens with perforations which may or may not have been drilled by the prehistoric inhabitants of the site.

Both recent field seasons yielded several *Glycymeris* shells, some of which were found on the surface of the site and others derived from the excavated units. None of these specimens are perforated. Numerous unmodified *Nassarius kraussianus* shells were also recovered from the surface and archaeological deposits of Hoffman's/Robberg Cave. Six bear small perforations frequently drilled into these shells by carnivorous gastropods. *Nassarius kraussianus* is an estuarine species which commonly occurs in the mud banks of lagoons or estuaries (Branch *et al.* 2002). The specimens from Hoffman's/Robberg Cave were probably brought into the site along with the estuarine grass used as bedding material.

The original museum collection lacks both of these species. This is mostly likely a result of their small size, and of excavator bias which deemed them unremarkable. A complete and obviously water-worn *Phalium labiatum zeylanicum* shell was recovered from Hoffman's/Robberg Cave in 2007. As this species occurs at fairly great depths subtidally (Branch *et al.* 2002), it was probably obtained as a wash-up on one of the beaches in the vicinity of the cave. Residues of ground ochre were evident on the inner surface of a complete *S. cochlear* specimen from one of the shell-rich layers near the bottom of the archaeological deposit. Thick crusts of dried ochre powder were present on a large *S. tabularis* shell from Hoffman's excavation.

5.3.2.2.2. Marine shell crescents

Shell crescents or segments are crescent-shaped fragments of mussel shell with evidence of grinding on the arc edge. Due to the similarity in appearance between naturally broken specimens and those deliberately modified by humans, these finds are seldom quantified in archaeological site reports, and are not always recognized as artefacts (Schweitzer 1979). The new sample of material from Hoffman's/Robberg Cave contains large quantities of broken *Perna* shells of the right size and shape to be tentatively labelled shell crescents. Only 17 of these specimens, all of which derive from the shell-rich layers of the deposit, have convincing evidence of grinding on the arc edges.

5.3.2.2.3 .Ostrich Eggshell Beads

A total of 40 ostrich eggshell beads were recovered from Hoffman's/Robberg Cave in 2007. Eighteen were collected from the surface of the site. The remaining 22 derive from the excavation, mostly from units Jane, Louisa and others near the top of the shell midden sequence. None were recovered from the *Zostera* –dominated units. No worked or unworked fragments of ostrich eggshell were found, and all of the beads represent finished specimens. An additional 13 whole and three broken beads are present in the partial sample of material from the 2008 field season. All but 2 of these were surface finds and again, none derive from the *Zostera*-dominated units. This is unlikely to be a taphonomic issue, as other shell and bone artefacts were preserved in these layers. A single fragment of unworked ostrich eggshell was also recovered from one of the lower-lying shell midden units of the deposit during 2008.

The size distributions of ostrich eggshell beads are presented in Figure 5.7. All of the ostrich eggshell beads from Hoffman's/Robberg Cave are relatively small. The majority of specimens recovered from the surface of the site and from the 3mm fraction of sieved material fall into the 4.5 – 4.9 mm and 4 – 4.4 mm size categories, respectively. The smallest beads are just less than 3mm in maximum diameter. Ostrich eggshell beads from an open midden in Noetzie range between 3.2 mm and 4.8mm in size (Halkett and Orton 2006).

Henshilwood (1995) noted a trend toward smaller bead sizes in sites dated to between 5000-6000 BP in the Garcia State Forest, with an increase in the size of beads recovered from sites postdating 3000 BP. In their quantitative analysis of ostrich eggshell beads from the site of Geduld in Namibia, which was inhabited by hunter-gatherers and subsequently by herders, Smith and Jacobson (1995) observed a statistically significant difference in the average size of ostrich eggshell beads manufactured by the two groups of people. Specimens recovered from the pre-pottery levels (Figure 5.8.) of the site tended to be small, similar to those found at Hoffman's/Robberg Cave. Those derived from layers containing pottery and associated with herding peoples (Figure 5.9.) were larger. The small mean sizes of ostrich eggshell beads found at Hoffman's/Robberg Cave, as well as the absence of pottery, are consistent with other evidence that the site was occupied by hunter-gatherers during the Late Holocene. Ostrich eggshell beads from Noetzie do not conform to this pattern. Only two specimens >5mm in maximum diameter were recovered from the two youngest layers of deposit. The majority of specimens from the layers containing ceramics were of similar dimensions to those from the pre-pottery levels (Orton and Halkett 2006).

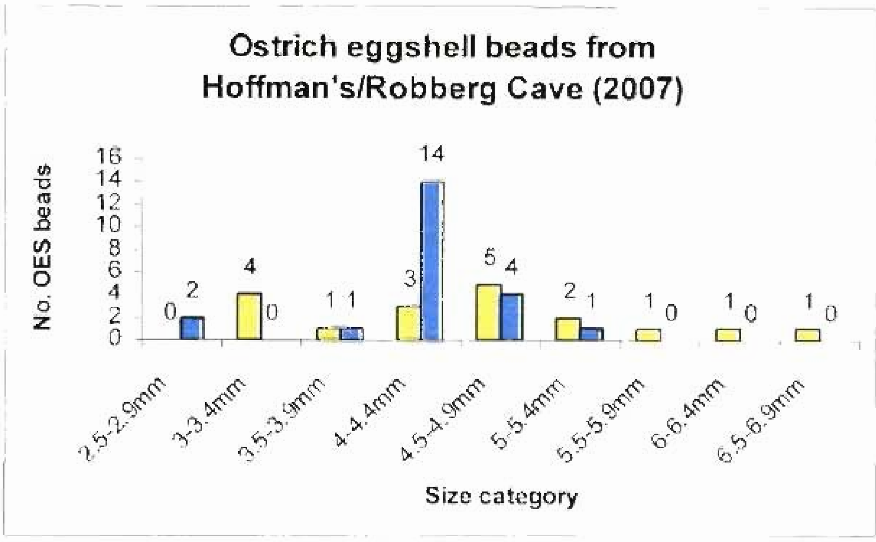


Figure 5.7.Size distributions of ostrich eggshell beads from the surface (yellow) and excavated units (blue) of Hoffman's/Robberg Cave (2007).

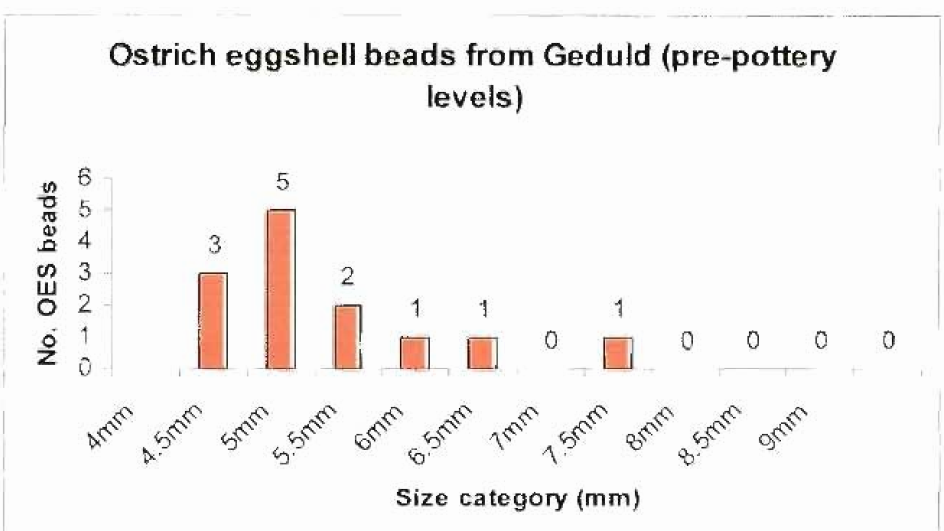


Figure 5.8.Size distributions of ostrich eggshell beads from Geduld, Namibia (pre-pottery levels).Reconstructed from Smith and Jacobson (1995) and Yates (1995).

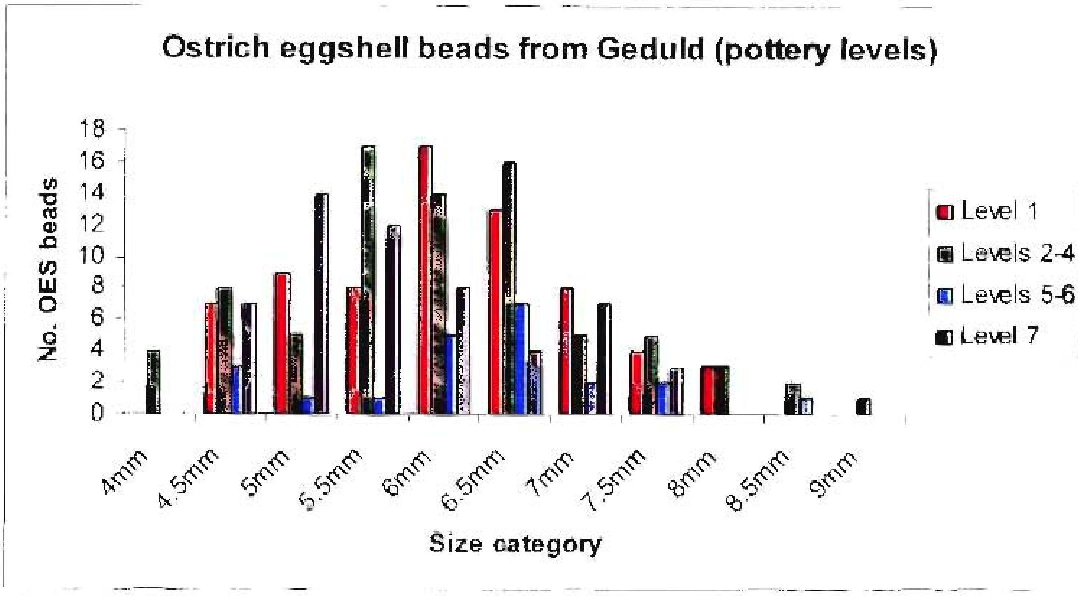


Figure 5.9.Size distributions of ostrich eggshell beads from Geduld, Namibia (pottery levels).Reconstructed from Smith and Jacobson (1995) and Yates (1995).

5.3.3. DISCUSSION AND COMPARISON

5.3.3.1. Bone and shell artefacts from Nelson Bay Cave and Hoffman's/Robberg Cave

5.3.3.1.1. Bone artefacts

The beauty and formality of worked bone assemblages from southern Cape coastal sites occupied during the Late Holocene is frequently juxtaposed against the informality that characterizes lithic remains dating to the post-Wilton. A variety of bone artefacts were recovered from the Holocene levels of Nelson Bay Cave. With the exception of those believed to represent different archery components, including bone points and linkshafts, these items occur in greater abundances in the upper units. Thirty one complete and incomplete bone awls, 19 spatulae, nine archery components, three bone tubes and six bone rings were recovered from units 31-62 (Inskeep 1987). Small numbers of bone awls, archery components (Figures 5.10. and 5.11.), bone beads/tubes (Figure 5.12.), snapped and ringed bone (Figure 5.13.) and decorated bone were recovered from Hoffman's/Robberg Cave. There is some variation in the relative abundance of these items at Hoffman's/Robberg Cave and Nelson Bay Cave.

While no bone spatula or bone rings were found at Hoffman's/Robberg Cave during the 2007 field season, the 2008 sample includes one bone spatula (Figure 5.14.) and three bone rings.

Figure 5.10.Broken bone point (above) and thicker linkshaft (below) from the surface of the site and E6 Royden, respectively. The divisions on the scale are 10mm in length.

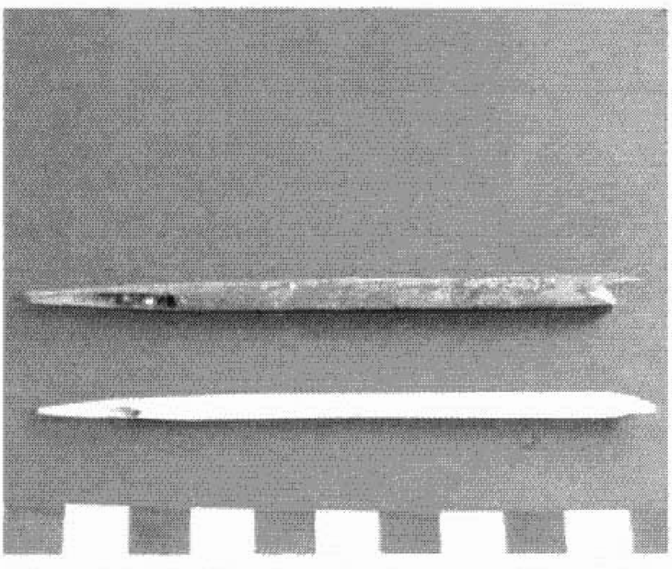


Figure 5.11.Hollow-tipped points from E6 Barbie (above) and the surface of Hoffman's/Robberg Cave (below). The scale used is 150mm in length, with subdivisions every 10mm.

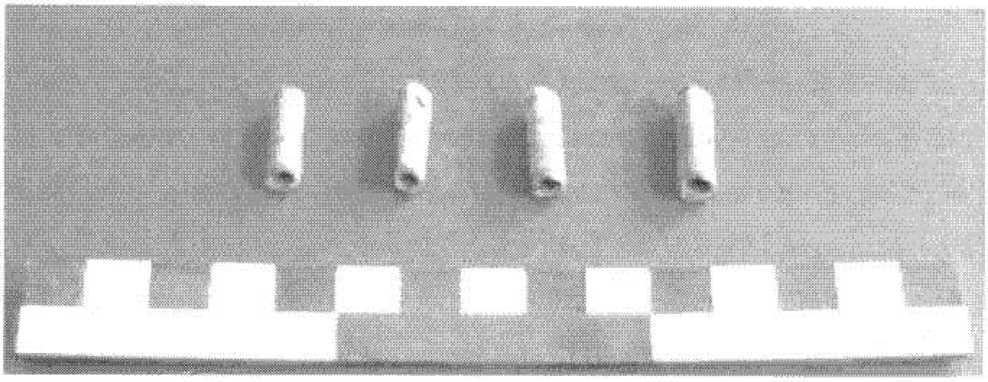


Figure 5.12.Bird bone beads/tubes from E5 Elizabeth, Hoffman's/Robberg Cave. The scale used in 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

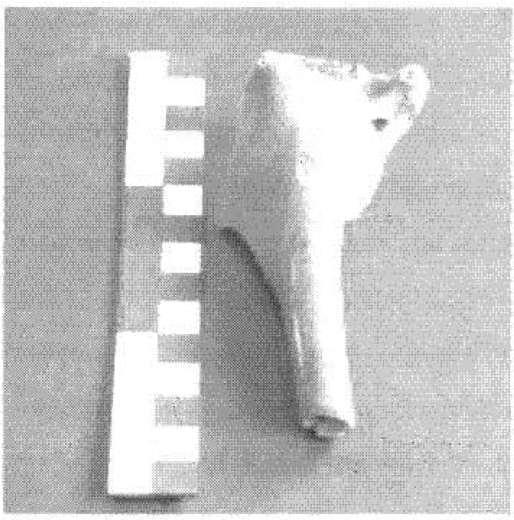


Figure 5.13.Ringed and snapped bird bone from E4 Quinton, Hoffman's/Robberg Cave. The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

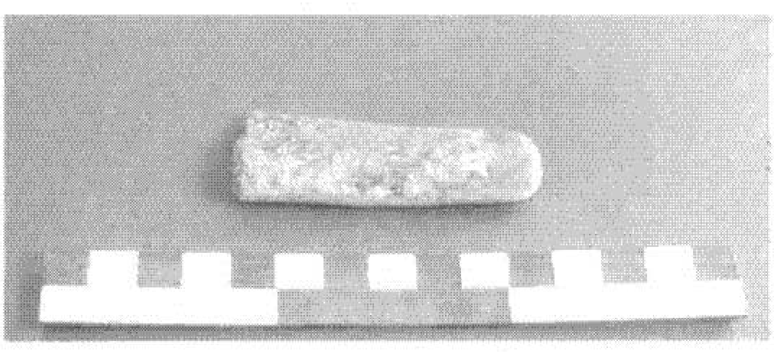


Figure 5.14.Bone spatula from D5d Gideon, Hoffman's/Robberg Cave (2008). The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

5.3.3.1.2. Perforated and ground Pelomedusa carapace

Inskeep (1987) documents the presence of numerous artefacts manufactured on what he erroneously refers to as tortoiseshell in the assemblage from Nelson Bay Cave. In addition to a large tortoiseshell bowl found in association with Burial 5, 34 partially or completely drilled and/or ground fragments of this material were recovered the site. The perforated fragments most likely represent pendants, while those with ground and smoothed edges are probably the remains of bowls and other utensils. With the exception of the bowl from Burial 5, these derive exclusively from the post-Wilton units. The presence of these items at Nelson Bay Cave, where terrestrial tortoises were rare if not absent and did not contribute significantly to the diets of prehistoric foragers, was interpreted by Inskeep (1987) as evidence for the import of tortoiseshell utensils as finished products from inland regions. It has subsequently been noted by Royden Yates that the fragments of carapace recovered from Nelson Bay Cave are thinner and flatter than those of the terrestrial tortoise and probably derive from the freshwater turtle, *Pelomedusa subrufa*. This species is likely to have been present in a number of freshwater rivers and estuaries in the vicinity of both Nelson Bay Cave and Matjes River Rock Shelter (Ludwig 2005). No examples of perforated *Pelomedusa* carapace were recovered from Hoffman's/Robberg Cave in 2007. A single fragment of un-ground freshwater turtle shell with one perforation (Figure 5.15) is included among the partially sorted material from the 2008 excavation.

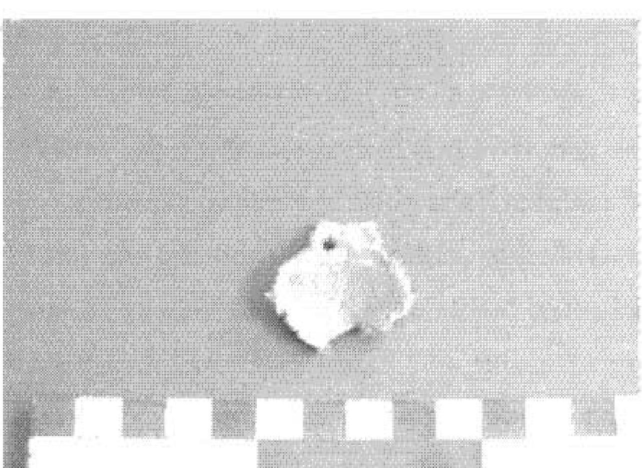


Figure 5.15.Perforated *Pelomedusa* carapace from D5d Below Portia, Hoffman's/Robberg Cave (2008). The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

5.3.1.1.3. Marine shell artefacts

Inskeep (1987) documents the occurrence of a wide range of marine shell pendants manufactured on fragments of nacreous shell in the material cultural assemblage from Nelson Bay Cave. These include specimens both with and without edge-nicking; a number of different forms including round, oval and shield shaped; perforated and unperforated as well as finished and unfinished pendants. A total of 15 type 1 pendants were found in units 31-62. These are oval, heart or shield shaped specimens, usually with two perforations and edge-nicking, manufactured on nacreous shell. In addition, 32 Type 1 pendants were found as grave goods with Burial 4 in unit 65. Type 2 and 3 pendants were recovered from older stratigraphic units. One of the specimens recovered from the youngest *in situ Zostera* layer of Hoffman's/Robberg Cave (specimen on the left, Figure 5.16.) is similar to Inskeep's (1987) description of Type 1 pendants: it is round, shallow in curvature, manufactured on a fragment of *T. sarmaticus* shell and bears two perforations. The pendant from Hoffman's/Robberg Cave, however, lacks the edge-nicking typical of those from the post – Wilton units of Nelson Bay Cave.

Another shell pendant recovered from Hoffman's/Robberg Cave, this time from one of the older midden layers, has a deeper curvature than the one previously described. A specimen from one of the youngest shell-rich units closely resembles Inskeep's (1987) description of Type 2b pendants. It is oval, made on *T. sarmaticus* shell, has a deep curvature, and lacks edge-nicking. Inskeep (1987) regarded Type 2b pendants as unfinished specimens of Type 2a pendants, which were similar in shape and differed only in the respect that they were edge-nicked. This category of shaped shell-pendants occurred in fairly small numbers in stratigraphic units 90–143 (Inskeep 1987). An additional shell pendant, manufactured on a triangular fragment of *T. sarmaticus* which had been edge-nicked on the two unbroken ends, was recovered from the site in 2008 (Figure 5.17.). When the numbers of marine shell pendants from each site, excluding those found in Burial 4 of Nelson Bay Cave, are expressed relative to quartzite chips, chunks and unretouched flakes, it appears that these artefacts are slightly more abundant in the Hoffman's/Robberg Cave assemblage.

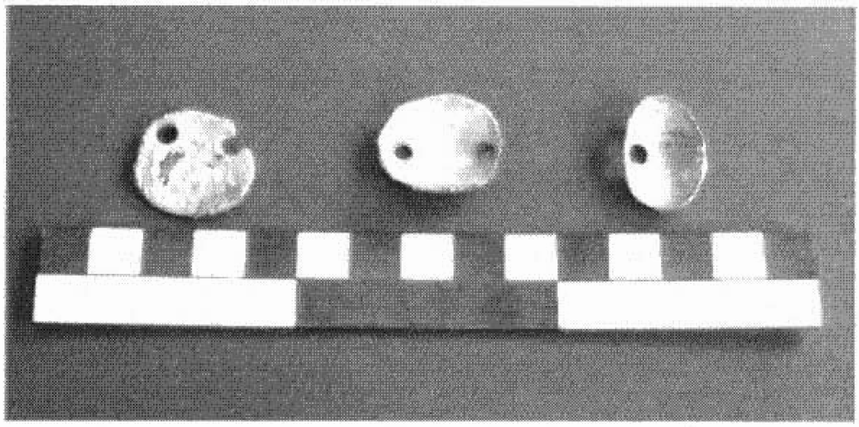


Figure 5.16. *T. sarmaticus* pendants from D5b Surface *Zostera in situ* (left), D4a Peter (middle) and E5 Katharine (right), Hoffman's/Robberg Cave. The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

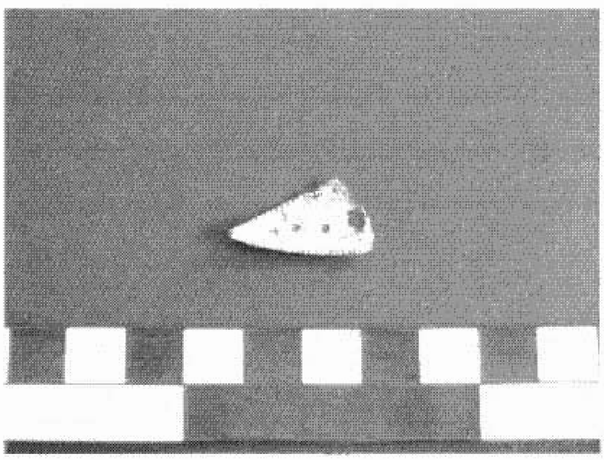


Figure 5.17.Marine shell pendant recovered from D5c Jane, Hoffman's/Robberg Cave, (2009). The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

The assemblage from Nelson Bay Cave also contains a number of perforated and unperforated *Glycymeris* shells included by Inskeep in the category of marine shell pendants. It has been previously noted (Inskeep 1987) that these items cluster in the Late Holocene units of the deposit. The opposite trend is apparent in the distribution of perforated white mussel valves throughout the archaeological sequence. It is interesting to note that out of a total of 195 perforated *Donax serra* valves recovered from Nelson Bay Cave, none derive from the post-Wilton units. Six perforated

Nassarius kraussinus shells were found between units 118 – 130. A single ochre-stained *Perna* shell was derived from unit 66 of the Nelson Bay Cave sequence.

Table 5.9. Numbers of bone and marine shell artefacts per 100 quartzite chips, chunks and unretouched flakes for Nelson Bay Cave and Hoffman's/Robberg Cave.

Item	**Nelson Bay Cave (units 31-62)**	**Hoffman's/Robberg Cave**
Bone awls	0.75	0.28
Archery components	0.22	0.71
Bone beads/tubes	0.07	0.71
Marine shell pendants	0.36	0.42

5.3.1.1.4. Ostrich eggshell beads

At Nelson Bay Cave, 458 ostrich eggshell beads were recovered from units 31-62. The middle and lower groups of units contained 53 and 23 specimens, respectively. Considering the much greater volumes of archaeological deposit accumulated during the more recent phase of occupation at the site, Inskeep concludes that ostrich eggshell beads were distributed more or less evenly throughout the archaeological sequence at Nelson Bay Cave.

In total, 534 ostrich eggshell beads were recovered from the Holocene levels of the site. This figure, which excludes specimens directly associated with burials, is regarded by Inskeep as relatively small in relation to the number of beads required for the manufacture of items such as beaded necklaces and aprons. With the exception of one partially drilled fragment derived from unit 111, none of the ostrich eggshell recovered from the site seemed to suggest the manufacture of ostrich eggshell beads and/or containers at the site. Inskeep (1987: 172) regards those specimens recovered from the cave as "occasional accidental losses" from already manufactured pieces of jewellery or garments.

The majority of the beads recovered from Hoffman's/Robberg Cave in 2007 seem to represent finished, or almost entirely finished, products. None of the beads in the 2007 sample have any traces of wear obviously associated with their having been sewn onto garments or strung on pieces of twine for use as objects of personal

5.3.2. RESULTS

5.3.2.1. Worked bone

A total of twenty items of worked bone were recovered from Hoffman's/Robberg Cave during the 2007 field season (Table 5.7.) These are more fully described in Appendix E. They include two bone awls, a broken bone point; a somewhat thicker bone object classified as a linkshaft; three hollow tipped points; and one small and four larger undecorated bone beads. The 2007 sample furthermore contains six fragments (five of which conjoin) of badly burned bone shaft decorated with sets of parallel incisions, the proximal part of a ringed and snapped mammal bone shaft, and a piece of robust bone showing evidence of flaking and perhaps smoothing. Of these specimens, all of the points as well as the small bone bead were recovered from the surface of the site, or from disturbed deposit. The larger bone beads and bone awls derive from two adjacent *Zostera*-dominated layers, while the remainder of the finds were found in the shell-rich units.

Table 5.7.Worked bone from Hoffman's/Robberg Cave (2007). Includes items recovered from the *in situ* and disturbed deposits, as well as from the surface of the site.

Category	Total No.
Awls	2
Points	1
Hollow-tipped points	3
Linkshafts	1
Beads/tubes	5
Decorated/incised	6 fragments
Ringed/snapped	1
Flaked/smoothed/cut	1

5.3.2.2. Worked shell

Worked, modified and utilized marine shells from the 2007 excavations at Hoffman's/Robberg Cave are presented in Table 5.8. These, as well as an additional sample from 2008, are described in Appendix E.

Table 5.8.Worked, modified, utilized and other non-food related marine shell from Hoffman's/Robberg Cave (2007). Includes items recovered from the *in situ* and disturbed deposits as well as the surface of the site.

Category	**Total No.**
Pendants	3
Perforated *Donax serra* valves	3
Glycymeris	2
Nassarius kraussianus	11
Phalium labiatum zeylanicum	1
Ochre – stained shells	1

5.3.2.2.1. Marine shell pendants, perforated shells and shells with evidence of ochre-staining

Three marine shell pendants were recovered from Hoffman's/Robberg Cave in 2007. All were manufactured on fragments of *T. sarmaticus* shell, have two perforations, and lack any signs of edge-nicking. Two of the specimens are round, and one is oval. One specimen derives from the top-most *in situ Zostera*-dominated layer of the deposit; the remaining two were recovered from shell-rich layers near the top and bottom of the midden. These items are therefore quite evenly distributed throughout the archaeological sequence. All of them are poorly preserved.

Two additional shell pendants have been found among the sorted material removed from Hoffman's/Robberg Cave during the most recent (2008) excavation. One of these is a square-shaped specimen on what appears to be a fragment of limpet shell, edge-nicked along three of the four corners and with a single smooth, round perforation drilled from the nacreous face, outwards. The other is a triangular piece of alikreukel shell with edge-nicking on both sides and the outlines of three distinct perforations which were not completely drilled. The absence of these items from the original collection of material recovered by Hoffman may be a result of their friability. The 2007 sample also includes three roughly perforated white mussel shells, two of which were recovered from the *in situ* deposits, as well as a number of specimens with perforations which may or may not have been drilled by the prehistoric inhabitants of the site.

Both recent field seasons yielded several *Glycymeris* shells, some of which were found on the surface of the site and others derived from the excavated units. None of these specimens are perforated. Numerous unmodified *Nassarius kraussianus* shells were also recovered from the surface and archaeological deposits of Hoffman's/Robberg Cave. Six bear small perforations frequently drilled into these shells by carnivorous gastropods. *Nassarius kraussianus* is an estuarine species which commonly occurs in the mud banks of lagoons or estuaries (Branch *et al.* 2002). The specimens from Hoffman's/Robberg Cave were probably brought into the site along with the estuarine grass used as bedding material.

The original museum collection lacks both of these species. This is mostly likely a result of their small size, and of excavator bias which deemed them unremarkable. A complete and obviously water-worn *Phalium labiatum zeylanicum* shell was recovered from Hoffman's/Robberg Cave in 2007. As this species occurs at fairly great depths subtidally (Branch *et al.* 2002), it was probably obtained as a wash-up on one of the beaches in the vicinity of the cave. Residues of ground ochre were evident on the inner surface of a complete *S. cochlear* specimen from one of the shell-rich layers near the bottom of the archaeological deposit. Thick crusts of dried ochre powder were present on a large *S. tabularis* shell from Hoffman's excavation.

5.3.2.2.2. Marine shell crescents

Shell crescents or segments are crescent-shaped fragments of mussel shell with evidence of grinding on the arc edge. Due to the similarity in appearance between naturally broken specimens and those deliberately modified by humans, these finds are seldom quantified in archaeological site reports, and are not always recognized as artefacts (Schweitzer 1979). The new sample of material from Hoffman's/Robberg Cave contains large quantities of broken *Perna* shells of the right size and shape to be tentatively labelled shell crescents. Only 17 of these specimens, all of which derive from the shell-rich layers of the deposit, have convincing evidence of grinding on the arc edges.

5.3.2.2.3 .Ostrich Eggshell Beads

A total of 40 ostrich eggshell beads were recovered from Hoffman's/Robberg Cave in 2007. Eighteen were collected from the surface of the site. The remaining 22 derive from the excavation, mostly from units Jane, Louisa and others near the top of the shell midden sequence. None were recovered from the *Zostera* –dominated units. No worked or unworked fragments of ostrich eggshell were found, and all of the beads represent finished specimens. An additional 13 whole and three broken beads are present in the partial sample of material from the 2008 field season. All but 2 of these were surface finds and again, none derive from the *Zostera*-dominated units. This is unlikely to be a taphonomic issue, as other shell and bone artefacts were preserved in these layers. A single fragment of unworked ostrich eggshell was also recovered from one of the lower-lying shell midden units of the deposit during 2008.

The size distributions of ostrich eggshell beads are presented in Figure 5.7. All of the ostrich eggshell beads from Hoffman's/Robberg Cave are relatively small. The majority of specimens recovered from the surface of the site and from the 3mm fraction of sieved material fall into the 4.5 – 4.9 mm and 4 – 4.4 mm size categories, respectively. The smallest beads are just less than 3mm in maximum diameter. Ostrich eggshell beads from an open midden in Noetzie range between 3.2 mm and 4.8mm in size (Halkett and Orton 2006).

Henshilwood (1995) noted a trend toward smaller bead sizes in sites dated to between 5000-6000 BP in the Garcia State Forest, with an increase in the size of beads recovered from sites postdating 3000 BP. In their quantitative analysis of ostrich eggshell beads from the site of Geduld in Namibia, which was inhabited by hunter-gatherers and subsequently by herders, Smith and Jacobson (1995) observed a statistically significant difference in the average size of ostrich eggshell beads manufactured by the two groups of people. Specimens recovered from the pre-pottery levels (Figure 5.8.) of the site tended to be small, similar to those found at Hoffman's/Robberg Cave. Those derived from layers containing pottery and associated with herding peoples (Figure 5.9.) were larger. The small mean sizes of ostrich eggshell beads found at Hoffman's/Robberg Cave, as well as the absence of pottery, are consistent with other evidence that the site was occupied by hunter-gatherers during the Late Holocene. Ostrich eggshell beads from Noetzie do not conform to this pattern. Only two specimens >5mm in maximum diameter were recovered from the two youngest layers of deposit. The majority of specimens from the layers containing ceramics were of similar dimensions to those from the pre-pottery levels (Orton and Halkett 2006).

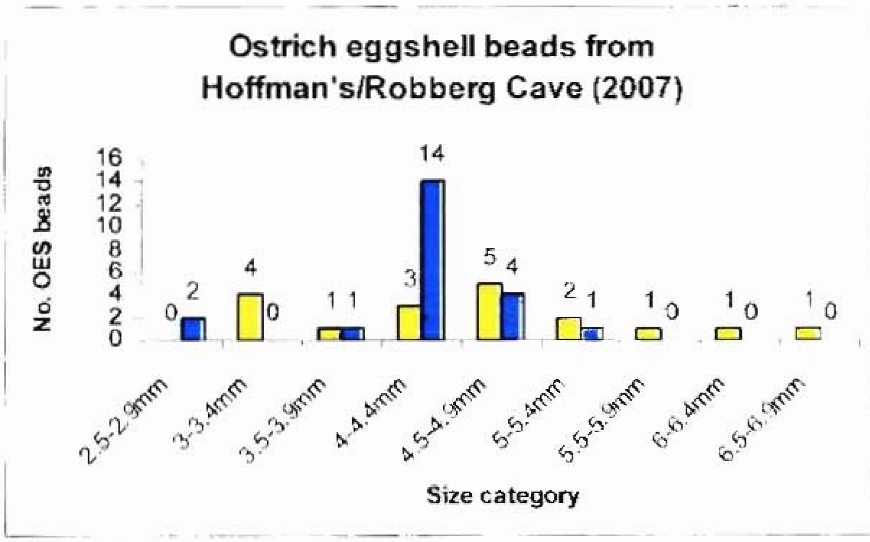


Figure 5.7.Size distributions of ostrich eggshell beads from the surface (yellow) and excavated units (blue) of Hoffman's/Robberg Cave (2007).

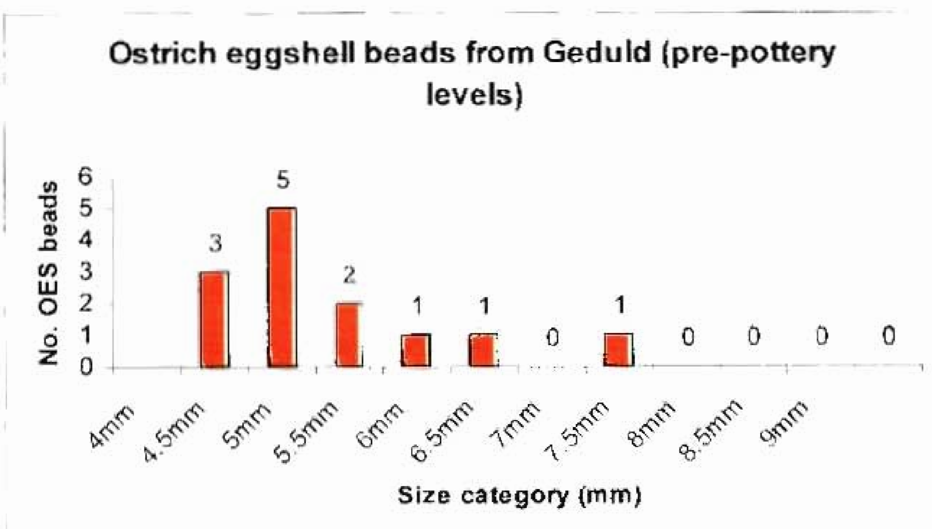


Figure 5.8.Size distributions of ostrich eggshell beads from Geduld, Namibia (pre-pottery levels).Reconstructed from Smith and Jacobson (1995) and Yates (1995).

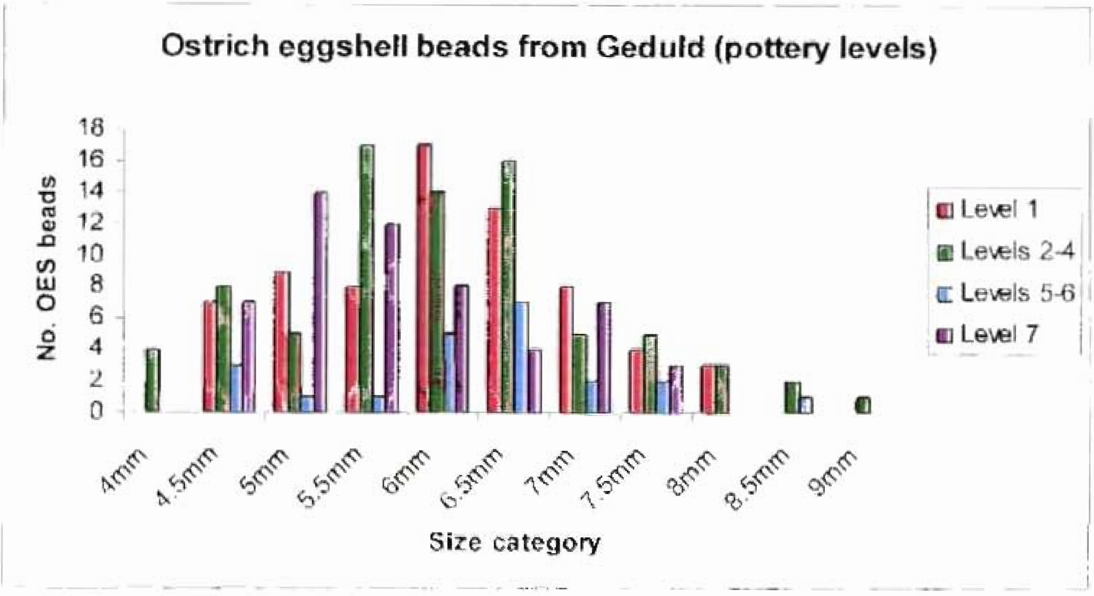


Figure 5.9.Size distributions of ostrich eggshell beads from Geduld, Namibia (pottery levels).Reconstructed from Smith and Jacobson (1995) and Yates (1995).

5.3.3. DISCUSSION AND COMPARISON

5.3.3.1. Bone and shell artefacts from Nelson Bay Cave and Hoffman's/Robberg Cave

5.3.3.1.1. Bone artefacts

The beauty and formality of worked bone assemblages from southern Cape coastal sites occupied during the Late Holocene is frequently juxtaposed against the informality that characterizes lithic remains dating to the post-Wilton. A variety of bone artefacts were recovered from the Holocene levels of Nelson Bay Cave. With the exception of those believed to represent different archery components, including bone points and linkshafts, these items occur in greater abundances in the upper units. Thirty one complete and incomplete bone awls, 19 spatulae, nine archery components, three bone tubes and six bone rings were recovered from units 31-62 (Inskeep 1987). Small numbers of bone awls, archery components (Figures 5.10. and 5.11.), bone beads/tubes (Figure 5.12.), snapped and ringed bone (Figure 5.13.) and decorated bone were recovered from Hoffman's/Robberg Cave. There is some variation in the relative abundance of these items at Hoffman's/Robberg Cave and Nelson Bay Cave.

While no bone spatula or bone rings were found at Hoffman's/Robberg Cave during the 2007 field season, the 2008 sample includes one bone spatula (Figure 5.14.) and three bone rings.

Figure 5.10.Broken bone point (above) and thicker linkshaft (below) from the surface of the site and E6 Royden, respectively. The divisions on the scale are 10mm in length.

Figure 5.11.Hollow-tipped points from E6 Barbie (above) and the surface of Hoffman's/Robberg Cave (below). The scale used is 150mm in length, with subdivisions every 10mm.

Figure 5.12.Bird bone beads/tubes from E5 Elizabeth, Hoffman's/Robberg Cave. The scale used in 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

Figure 5.13.Ringed and snapped bird bone from E4 Quinton, Hoffman's/Robberg Cave. The scale used is 150mm in length. with smaller subdivisions every 10mm and larger subdivisions every 50mm.

Figure 5.14.Bone spatula from D5d Gideon, Hoffman's/Robberg Cave (2008). The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

5.3.3.1.2. Perforated and ground Pelomedusa carapace

Inskeep (1987) documents the presence of numerous artefacts manufactured on what he erroneously refers to as tortoiseshell in the assemblage from Nelson Bay Cave. In addition to a large tortoiseshell bowl found in association with Burial 5, 34 partially or completely drilled and/or ground fragments of this material were recovered the site. The perforated fragments most likely represent pendants, while those with ground and smoothed edges are probably the remains of bowls and other utensils. With the exception of the bowl from Burial 5, these derive exclusively from the post–Wilton units. The presence of these items at Nelson Bay Cave, where terrestrial tortoises were rare if not absent and did not contribute significantly to the diets of prehistoric foragers, was interpreted by Inskeep (1987) as evidence for the import of tortoiseshell utensils as finished products from inland regions. It has subsequently been noted by Royden Yates that the fragments of carapace recovered from Nelson Bay Cave are thinner and flatter than those of the terrestrial tortoise and probably derive from the freshwater turtle, *Pelomedusa subrufa*. This species is likely to have been present in a number of freshwater rivers and estuaries in the vicinity of both Nelson Bay Cave and Matjes River Rock Shelter (Ludwig 2005). No examples of perforated *Pelomedusa* carapace were recovered from Hoffman's/Robberg Cave in 2007. A single fragment of un-ground freshwater turtle shell with one perforation (Figure 5.15) is included among the partially sorted material from the 2008 excavation.

Figure 5.15.Perforated *Pelomedusa* carapace from D5d Below Portia, Hoffman's/Robberg Cave (2008). The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

5.3.1.1.3. Marine shell artefacts

Inskeep (1987) documents the occurrence of a wide range of marine shell pendants manufactured on fragments of nacreous shell in the material cultural assemblage from Nelson Bay Cave. These include specimens both with and without edge-nicking; a number of different forms including round, oval and shield shaped; perforated and unperforated as well as finished and unfinished pendants. A total of 15 type 1 pendants were found in units 31-62. These are oval, heart or shield shaped specimens, usually with two perforations and edge-nicking, manufactured on nacreous shell. In addition, 32 Type 1 pendants were found as grave goods with Burial 4 in unit 65. Type 2 and 3 pendants were recovered from older stratigraphic units. One of the specimens recovered from the youngest *in situ Zostera* layer of Hoffman's/Robberg Cave (specimen on the left, Figure 5.16.) is similar to Inskeep's (1987) description of Type 1 pendants: it is round, shallow in curvature, manufactured on a fragment of *T. sarmaticus* shell and bears two perforations. The pendant from Hoffman's/Robberg Cave, however, lacks the edge-nicking typical of those from the post – Wilton units of Nelson Bay Cave.

Another shell pendant recovered from Hoffman's/Robberg Cave, this time from one of the older midden layers, has a deeper curvature than the one previously described. A specimen from one of the youngest shell-rich units closely resembles Inskeep's (1987) description of Type 2b pendants. It is oval, made on *T. sarmaticus* shell, has a deep curvature, and lacks edge-nicking. Inskeep (1987) regarded Type 2b pendants as unfinished specimens of Type 2a pendants, which were similar in shape and differed only in the respect that they were edge-nicked. This category of shaped shell-pendants occurred in fairly small numbers in stratigraphic units 90–143 (Inskeep 1987). An additional shell pendant, manufactured on a triangular fragment of *T. sarmaticus* which had been edge-nicked on the two unbroken ends, was recovered from the site in 2008 (Figure 5.17.). When the numbers of marine shell pendants from each site, excluding those found in Burial 4 of Nelson Bay Cave, are expressed relative to quartzite chips, chunks and unretouched flakes, it appears that these artefacts are slightly more abundant in the Hoffman's/Robberg Cave assemblage.

Figure 5.16. *T. sarmaticus* pendants from D5b Surface *Zostera in situ* (left), D4a Peter (middle) and E5 Katharine (right), Hoffman's/Robberg Cave. The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

Figure 5.17.Marine shell pendant recovered from D5c Jane, Hoffman's/Robberg Cave, (2009). The scale used is 150mm in length, with smaller subdivisions every 10mm and larger subdivisions every 50mm.

The assemblage from Nelson Bay Cave also contains a number of perforated and unperforated *Glycymeris* shells included by Inskeep in the category of marine shell pendants. It has been previously noted (Inskeep 1987) that these items cluster in the Late Holocene units of the deposit. The opposite trend is apparent in the distribution of perforated white mussel valves throughout the archaeological sequence. It is interesting to note that out of a total of 195 perforated *Donax serra* valves recovered from Nelson Bay Cave, none derive from the post-Wilton units. Six perforated

Nassarius kraussinus shells were found between units 118 – 130. A single ochre-stained *Perna* shell was derived from unit 66 of the Nelson Bay Cave sequence.

Table 5.9. Numbers of bone and marine shell artefacts per 100 quartzite chips, chunks and unretouched flakes for Nelson Bay Cave and Hoffman's/Robberg Cave.

Item	Nelson Bay Cave (units 31-62)	Hoffman's/Robberg Cave
Bone awls	0.75	0.28
Archery components	0.22	0.71
Bone beads/tubes	0.07	0.71
Marine shell pendants	0.36	0.42

5.3.1.1.4. Ostrich eggshell beads

At Nelson Bay Cave, 458 ostrich eggshell beads were recovered from units 31-62. The middle and lower groups of units contained 53 and 23 specimens, respectively. Considering the much greater volumes of archaeological deposit accumulated during the more recent phase of occupation at the site, Inskeep concludes that ostrich eggshell beads were distributed more or less evenly throughout the archaeological sequence at Nelson Bay Cave.

In total, 534 ostrich eggshell beads were recovered from the Holocene levels of the site. This figure, which excludes specimens directly associated with burials, is regarded by Inskeep as relatively small in relation to the number of beads required for the manufacture of items such as beaded necklaces and aprons. With the exception of one partially drilled fragment derived from unit 111, none of the ostrich eggshell recovered from the site seemed to suggest the manufacture of ostrich eggshell beads and/or containers at the site. Inskeep (1987: 172) regards those specimens recovered from the cave as "occasional accidental losses" from already manufactured pieces of jewellery or garments.

The majority of the beads recovered from Hoffman's/Robberg Cave in 2007 seem to represent finished, or almost entirely finished, products. None of the beads in the 2007 sample have any traces of wear obviously associated with their having been sewn onto garments or strung on pieces of twine for use as objects of personal adornment. This does not, however, mean that they were not used or worn in such a manner, as visible traces of wear would take a long time to develop. No debris relating to the manufacture of ostrich eggshell beads was found at the site in 2007. This indicates that ostrich eggshell beads were imported from elsewhere.

5.3.3.2. Bone and shell artefacts in the original Hoffman's/Robberg Cave collection

The previous collection of non-lithic material from Hoffman's/Robberg Cave (Table 5.10.) included a larger number and wider variety of bone artefacts than those present in the 2007 sample. Ostrich eggshell beads, however, were completely absent. This may indicate the use of a larger mesh sieve by Hoffman and his field team. Worked marine shell was significantly underrepresented in the older sample. The marine shell pendants recovered from Hoffman's/Robberg Cave in 2007 were in very poor condition. Similar specimens may have been overlooked or damaged in the course of Hoffman's excavation.

Table 5.10. Non-lithic remains from Hoffman's excavation of Hoffman's/Robberg Cave.

Category	**Total No.**
Bone	
Awls	21
Points	10
Hollow-tipped points	3
Spatulae	4
Beads/tubes (complete)	4
Beads/tubes (partial)	2
Ringed/snapped bone	7
Decorated/incised bone	4
Ringed/snapped and incised bone	1
Section of hippo tusk, split and smoothed	1
Flaked bone	1
Ground and smoothed bone	3
Bones with impact fractures	3 and 2 fragments
Fish gorge	1 possible
Ground freshwater turtle carapace	3
Shell	
Perforated marine shell	3
Marine shell crescents	2
Incised ostrich eggshell	1

5.4. SUMMARY

A number of continuities are evident in the post–Wilton assemblages from Hoffman's/Robberg Cave and Nelson Bay Cave. Quartzite constitutes the predominant lithic raw material at both sites, while quartzite chips, chunks and unretouched flakes are the most well represented stone artefacts. Distinctive bladelet/flakelet cores documented by Inskeep (1987) and Binneman (1995; 2006/2007) for Nelson Bay Cave and Kabeljous River Shelter, respectively, are also a component of the lithic assemblage from Hoffman's/Robberg Cave. Quartzite cores, as well as numerous waste materials of quartz and CCS were more abundant at Hoffman's/Robberg Cave. The majority of these artefacts were derived from the shell-rich units of the sequence, which accumulated before the beginning of the post–Wilton at Nelson Bay Cave. This difference in chronology accounts for the aforementioned differences between Hoffman's/Robberg Cave and units 31–62 of the latter site.

Grinding equipment appears to be more abundant at Hoffman's/Robberg Cave than at Nelson Bay Cave. Ochre–staining on various types of lithic remains was also more prevalent during the Late Holocene at the former site. These two patterns were previously commented upon by me following my examination of the collection from Hoffman's/Robberg Cave. They are borne out in my analysis of the unselected sample from 2007. Shale palettes of a type similar to those manufactured throughout the Holocene at Nelson Bay Cave were recovered from Hoffman's/Robberg Cave. Other utilized pieces, notably sinkers and *pièces esquillées*, are absent from the 2007 sample. Some variation in the relative abundances of scrapers and miscellaneous retouched pieces is evident, although formal tools are rare at both sites.

The prehistoric inhabitants of Hoffman's/Robberg Cave appear to have manufactured a similar range of bone artefacts to those made by their neighbours at Nelson Bay Cave, as well as a number of other southern Cape coastal sites. They also made pendants from fragments of *T. sarmaticus* shell, similar to those reported by Inskeep (1987) for the Holocene levels of Nelson Bay Cave. These items, which were absent from the material collected by Hoffman, were recovered in small quantities during the

2007 and 2008 field seasons. Interestingly, although the sample from Nelson Bay Cave is much larger, it appears that shell pendants are equally abundant in the post – Wilton units of this site and the Late Holocene deposits of Hoffman's/Robberg Cave. Ostrich eggshell beads were recovered from both sites, but were probably not manufactured at either of these locations.

CHAPTER 6

THE LATE HOLOCENE OCCUPATION OF HOFFMAN'S/ROBBERG CAVE

6.1. INTRODUCTION

The Holocene has long been regarded as a period of regionalization and intensification (Mitchell 2002); one which encompasses significant environmental and cultural change. The last few thousand years of the Later Stone Age in southern Africa are characterized by marked shifts in hunter-gatherer subsistence strategies, settlement patterns and social relationships. In the eastern Cape, for instance, subsistence intensification, the occupation of previously uninhabited riverine environments, and restructuring of social networks are apparent in the archaeological record from around 5500BP (Hall 1990). Patterns associated with the intensive exploitation of marine molluscs, more sedentary lifeways, and increased social activity emerge somewhat later at sites in the southwestern Cape, and culminate in the formation of impressive megamiddens between 3000 and 2000BP (Jerardino 1996).

Sealy's (2006) isotopic data testify to the existence of economic and, by extension, territorial and social separation among hunter-gatherers living at sites along the Robberg Peninsula and at Matjes River Rock Shelter by at least 4500BP. Substantial changes in the content of faunal and artefactual assemblages from southern Cape coastal sites with long occupational sequences dating to the Holocene, notably Nelson Bay Cave, are evident from about 3300BP. New excavations carried out in 2007 at Hoffman's/Robberg Cave provided insight into the prehistoric lifeways of this site's Late Holocene inhabitants. Systematic fieldwork and radiocarbon dating have allowed for a better understanding of the stratigraphy and chronology of the site's Late Holocene deposits. Patterns in shellfish exploitation strategies and artefact production have been identified and compared with those from other contemporary sites and sequences.

6.2. THE STRATIGRAPHY AND CHRONOLOGY OF THE LATE HOLOCENE DEPOSITS

The Late Holocene deposits at Hoffman's/Robberg Cave comprise two broad groups of stratigraphic units. The uppermost portion of the sequence consists of eight layers dominated by consolidated estuarine grass or *Zostera capensis*. Radiocarbon dates for charcoal samples taken from the top- and bottom-most of these strata overlap, indicating the fairly rapid accumulation of these deposits at around 3300BP. Underlying the *Zostera*–dominated units are 27 shell-rich layers dating to between ~4000BP and 3700BP. These are separated from the *Zostera* beds by a thin layer of hard, dark material. The stratigraphy and dating of the Late Holocene deposits of Hoffman's/Robberg Cave are consistent with two episodes of occupation separated from one another by a three to four hundred year hiatus.

At Nelson Bay Cave, a date of 3600±50 BP was obtained for a charcoal sample from a sterile unit (63) at the base of the post–Wilton deposits. The unit immediately above 63 (62) has been dated to 3270± 70 BP. This may indicate a break in the occupational of Nelson Bay Cave at around the same time as the occupational hiatus at Hoffman's/Robberg Cave. However, a younger date of 3350 ± 60 BP was obtained for the unit (64) immediately underlying 63, making this unlikely. The stratigraphy of the Noetzie deposits suggests a period of intense occupation during which the pre–ceramic Layers 4 -8, as well as Layers 1, 2 and 3, accumulated (Halkett and Orton 2006; Orton and Halkett 2007). Dates of 3300±40 BP and 3980±40 BP have been obtained for Layers 3 and 8 of the Noetzie midden, respectively. Additional dates would be required to ascertain whether or not an occupational break occurred between the recent pre–pottery layers and Layer 3. However, the stratigraphy of the midden makes this unlikely. The older portion of the sequence consists of shell midden deposits interspersed with layers of sterile sand, indicating more "sporadic" episodes of occupation during this time (Halkett and Orton 2006; Orton and Halkett 2007).

There are as yet no indications of archaeological deposits predating the Late Holocene at Hoffman's/Robberg Cave. The lack of a mid-Holocene occupation at this site is not unusual, and has in fact been documented at a number of sites throughout the coastal and interior regions of the western, eastern and southern Cape (Deacon 1974). Radiocarbon dates obtained by Reddering (1988) for a raised terrace adjacent to the Keurbooms estuary, and by Marker and Miller (1993, 1995) for inland shell beds in the Knysna district, serve as evidence for elevated sea levels on the southern Cape coast during the mid-Holocene. Raised sea levels seem to have discouraged human settlement at Hoffman's/Robberg Cave, but not its sister site of Nelson Bay Cave, or Matjes River Rock Shelter. This is most likely a result of the steeper and more exposed coastline surrounding Hoffman's/Robberg Cave. The occupation of the site at around 4000BP appears to coincide with the lowering of sea levels to their current position, which Reddering (1988) places at around 3880BP. It furthermore follows the appearance of economic separation among the inhabitants of sites located on opposite sides of the Keurbooms/Bitou estuary. The occupation of Hoffman's/Robberg Cave was probably spurred by increasing population densities among Late Holocene hunter-gatherers living in the eastern and southern Cape.

The youngest date obtained for the Late Holocene deposits (3310±40BP), and lack of ceramics or the remains of domestic sheep at the site show that it was not occupied by hunter-gatherers who had contact with herders who entered the region at around 2000BP. The small sizes of ostrich eggshell beads recovered from the excavated units, as well as the surface of the site, further supports this. The incursion of herders into regions already populated by hunter-gatherers brought about a number of changes in hunter-gatherer settlement and subsistence patterns. At sites in the southwestern Cape, for instance, occupation shifted from large, open midden sites to caves and rock shelters by around 1800 BP, and diets became more mixed. Open sites in the Garcia State Forest excavated by Henshilwood (1995), too, predate 2000 BP, while more recent occupations were focussed upon caves and rock shelters. The remains of sheep and pottery have also been recovered from sites with long archaeological sequences, notably Nelson Bay Cave and Die Kelders, and more recently, a large open midden in Noetzie. Sealy notes a "sharp decline" (2006: 578) in the nitrogen isotope ratios of human skeletons postdating 2000 BP and recovered from sites along the Robberg Peninsula, which she ascribes to the possible inclusion of domesticated stock in the diets of the sites' inhabitants. The lack of occupation during this time at

Hoffman's/Robberg Cave may reflect declining population densities, and perhaps the dispersal of hunter-gatherers into different regions.

6.3. SHELLFISH COLLECTING AT HOFFMAN'S/ROBBERG CAVE

The presence of substantial shellfish residues at Hoffman's/Robberg Cave indicates that these resources contributed to the diets of the site's Late Holocene inhabitants. These remains, as well as those from an open site at Noetzie, were examined in detail. As has been previously mentioned, sampling biases precluded the quantitative analysis of shellfish remains from Nelson Bay Cave. Furthermore, while Döckel (1998) analyzed a small sample of shellfish recovered during renewed excavations at Matjes River Rock Shelter, this assemblage spans the early and mid–Holocene. Shellfish exploitation strategies during the Late Holocene occupation of the site have not been documented. The analysis of shellfish remains from Hoffman's/Robberg Cave and the Noetzie midden therefore represents a significant contribution to understanding the role of shellfish as food resources among Late Holocene hunter–gatherers living in the Plettenberg Bay region.

A sample of shellfish remains recovered from Hoffman's/Robberg Cave in 2007 contained large quantities of brown mussels or *Perna perna*, a major component of assemblages from many southern Cape coastal sites, and unusually large amounts of the pear-shaped limpet *S. cochlear*. Both species are common on high energy, exposed coastlines, and are particularly productive in regions characterized by strong wave action (Branch 1975; Binneman 1995). The coast in the immediate vicinity of Hoffman's/Robberg Cave is rocky and steep, with substantial wave action during high tide. Large beds of brown mussels still exist on the rocky shore near the site, and are exposed when the tide is low. The large quantities of *S. cochlear* recovered from Hoffman's/Robberg Cave attest to the existence of colonies of these limpets during the Late Holocene, even though they are not there today. These colonies are known to occur low on the shore, and are exposed at low tide (Branch and Branch 1981).

The high frequencies of *P. perna* and *S. cochlear* in the Hoffman's/Robberg Cave assemblage indicate exploitation strategies centred on the lower Balanoid zone in the immediate vicinity of the site. Collection strategies centred on the lower Balanoid have been documented at a number of other sites, including pre-pottery shell middens in the Cape St Francis region excavated by Johann Binneman, as well as two shell middens along the Tsitsikama coast investigated in the 1960s by Hilary Deacon (Deacon 1970; Binneman 1995). The negligible contribution of sandy shore species, notably *Donax serra*, to the shellfish assemblage from Hoffman's/Robberg Cave indicates that sandy beaches located only a few kilometres away from the site were ignored. Shellfish collecting activities were more or less restricted to an area very close to the cave.

Very little is published about the shellfish assemblage from Nelson Bay Cave, other than that *P. perna* and limpets are the best-represented species in the Holocene levels (Deacon and Deacon1998). Species which occur relatively low on the shore feature more prominently in what Klein (1974) refers to as the late Wilton layers, indicating "a greater willingness to get wet in the food quest" (275). Brown mussels and large limpets also figure prominently in the shellfish assemblage from the early and mid–Holocene levels of Matjes River Rock Shelter. Subsistence strategies at that site were apparently geared toward the collection of whichever species were available nearby (Döckel 1998). It would appear, from Döckel's (1998) data, that this pattern was well established prior to the emergence of economic separation among the inhabitants of Matjes River Rock Shelter and sites located on the Robberg Peninsula. An alternative interpretation of the high frequencies of *P. perna* and *S. cochlear*, and presence of other large species from the infratidal zone, in the Hoffman's/Robberg Cave assemblage could be that shellfish collecting was scheduled for specific times in the tidal cycle. These activities could have been planned to coincide with spring low tides, during which the lower infratidal zones would have been exposed and accessible to humans (Binneman 1995).

The large alikreukel *T. sarmaticus* constitutes the best represented species following *P. perna* in the *Zostera*–dominated units of Hoffman's/Robberg Cave, where it is considerably more abundant than *S. cochlear*. The larger proportions of *T. sarmaticus* in the youngest layers of the sequence may reflect the existence of slightly different exploitation strategies during the more recent episode of occupation at the site. However, taphonomic processes associated with *Zostera capensis* may have favoured the preservation of the large and robust *T. sarmaticus* apices in these layers.

The shellfish assemblage from Noetzie is dominated by brown mussels and *T. sarmaticus*. The best represented limpet is the star–shaped species, *S. longicosta*. These species abundances are indicative of exploitation strategies centred on the lower infratidal and perhaps mid–intertidal throughout most of the Holocene occupation. Small species occurring higher on the shore, notably *Burnupena and Oxystele,* are more abundant in one of the more recent pre–ceramic layers than in older portions of the deposit. Increased frequencies of *P. perna* and a concomitant decrease in the proportions of alikreukel have been noted for one of the youngest layers containing pottery, Layer 2. The shellfish assemblage from the Noetzie midden therefore evidences two important patterns associated with the intensive use of shellfish resources and hunter-gatherers' reactions to the presence of herders during the later years of the Holocene along the southern Cape coast.

Variation in the size distributions of *S. cochlear* and *T. sarmaticus* has been documented at Hoffman's/Robberg Cave. The *Zostera*–dominated units as well as one of the uppermost shell-rich layers (Katharine) include greater numbers of specimens greater than 60mm in length, compared with the three underlying shelly strata (Nathan, Portia and Richard). The lower-lying layers, particularly Nathan and Richard, contain greater numbers of specimens in the smaller size categories. Individuals measuring less than 40mm in length are absent in the *Zostera* beds and rare in the shelly layer Katharine. The scarcity of small specimens in the former layer, where the preservation of shellfish remains was excellent, reduces the extent to which their absence in the *Zostera*–dominated units may be entirely ascribed to taphonomic processes.

Because of the densities at which *S. cochlear* cluster together in closely packed colonies, juveniles of this species frequently live on the backs of adults. These immature specimens may then be transported into archaeological sites on the backs of larger individuals harvested for human consumption. An approximate size distribution of the population of juveniles living on the backs of adult *S. cochlear* recovered from the shell-rich layer Portia indicates that the majority of these specimens range between 5-30 mm in length. Thus, the large numbers of small specimens recovered from two of the older, shell-rich layers (Nathan and Richard) and to a lesser extent, Portia, were probably incorporated into the assemblage accidentally. This explanation does not, however account for the under – representation of larger specimens in these strata relative to those of more recent origin. Environmental factors affecting the availability and productivity of shellfish species, notably sea level changes and shifts in ocean temperature, are unlikely to have played a role. Conditions would have remained relatively stable throughout the Late Holocene occupation of Hoffman's/Robberg Cave. A behavioural explanation must then be sought to be explain these changes.

The average length of *S. cochlear* shells is constrained by the density of the colonies this species inhabit (Branch 1975). Smaller specimens predominate in dense colonies. Furthermore, regular and intensive exploitation of these colonies by groups of prehistoric foragers would serve to drive the average size of individuals down, and reduce the density of the colonies. Fluctuations in the quantities of smaller or larger specimens within archaeological deposits may be linked to periods of intensified or reduced predation, respectively. At Hoffman's/Robberg Cave, it appears that *S. cochlear* was collected fairly intensively during the early stages of occupation, which commenced shortly after 4000BP. Economic specialization, along with increasingly sedentary and territorial residence patterns, had begun to emerge at sites along the Robberg Peninsula approximately 500 years previously. This economic intensification, which continued to escalate in the region up until the arrival of herders in 2000BP, may in fact have prompted the occupation of Hoffman's Robberg Cave.

The presence of larger *S. cochlear* in the shell-rich layer Katharine, which accumulated shortly before a break in the occupational sequence at the site, may reflect less intensive harvesting of this species thereafter. Some of the specimens from this stratum are substantially larger than the average length cited by Branch (1975) and Branch *et al.* (2002) for this species. Size distributions for *S. cochlear* in the *Zostera*–dominated units, which postdate the occupational hiatus, favour the medium to large size classes, indicating that intensification remained fairly low throughout the second episode of occupation.

Changes in the average size of *T. sarmaticus* being exploited by the prehistoric inhabitants of the site are also informative. Mean shell breadths, which were calculated from the maximum lengths of opercula by means of the formula published by McLachlan and Lombard (1981), are larger in the *Zostera*–dominated units than in three shell-rich layers from the middle and bottom of the sequence (Nathan, Portia and Richard). This is consistent with the data for *S. cochlear*, and indicates intensive human predation during the initial occupation of the site between ~4000 and 3700BP. Shell breadths for the *Zostera*–dominated units and shell-rich layers are small relative to the average size of 100mm achieved by mature alikreukel today. They are furthermore well below the current minimum size limit of 63.5 mm imposed on modern shellfish collectors (Branch *et al.* 2002).

T. sarmaticus from the Noetzie midden showed a clear pattern of change through time associated with increasingly intensive exploitation of this species throughout the pre-pottery levels of the sequence. Mean shell breadths of specimens from these layers are all less than 50 mm. Smaller sizes were obtained for alikreukel from the more recent layers as opposed to older layers near the bottom of the sequence. Larger sizes and lower frequencies in the youngest ceramic-bearing layer are consistent with reduced predation of this species following contact with herders. *T. sarmaticus* from the Paapkuilfontein middens near Cape Agulhas investigated by Hine (2008) are also relatively small (< 50 mm mean shell breadth). They were also considerably smaller in sites of more recent origin than in older sites, following a pattern first commented upon by Henshilwood (1995) for *T. sarmaticus* opercula from sites in the coastal Garcia State Forest. The small sizes of *T. sarmaticus* from the Noetzie midden, as well as Hoffman's/Robberg Cave, may indicate fairly intensive exploitation of this species throughout the Late Holocene, or the harvesting of small individuals available in the mid – intertidal rather than larger and more mature individuals occurring lower on the shore. They may also indicate that environmental conditions on these parts of the southern Cape coast do not favour the growth and productivity of alikreukel.

6.4. PATTERNING IN THE ARTEFACTUAL ASSEMBLAGES FROM HOFFMAN'S/ROBBERG CAVE AND NELSON BAY CAVE

My interest in the Hoffman's/Robberg Cave material began as an investigation into possible material cultural continuities between the Late Holocene assemblages from this site and another site on the Robberg Peninsula, Nelson Bay Cave. This followed Ludwig's (2005) identification of a number of stylistic differences in material cultural objects produced by the inhabitants of Nelson Bay Cave and a site located on the opposite side of the Keurbooms/Bitou estuary, Matjes River Rock Shelter. The curated collection of material from Hoffman's excavation of Hoffman's/Robberg Cave proved unsatisfactory in exploring possible similarities or differences in material culture between contemporary groups of hunter–gatherers living at this site and at Nelson Bay Cave. This was largely due to the dearth of written documentation about Hoffman's excavation, and doubts about the completeness of the museum collection. The analysis of additional material obtained during small-scale excavations in 2007 allowed for a much better assessment of material cultural continuity between Hoffman's/Robberg Cave and Nelson Bay Cave, as well as other sites along the southern Cape coast.

6.4.1. MATERIAL CULTURE AND IDENTITY IN ARCHAEOLOGY

6.4.1.1. Theoretical perspectives and archaeological applications

The recognition of style as an aspect of material culture, and as a source of insight into the social and spatial organization of prehistoric communities, has been a feature of archaeological studies since at least the 1920s. Style can be very loosely defined as the physical manifestation of the characteristic ways in which people do certain things, at certain times and in certain places (Sackett 1977). It is therefore an inherent property of the things or artefacts archaeologists use as a means of reconstructing the past. The culture-historical approach is premised on the correlation between discrete archaeological cultures characterized by recurring types of artefacts with particular groups of prehistoric people (Jones 1997). In southern African archaeology, this approach is exemplified in Goodwin and van Riet Lowe's (1929) description of the major lithic entities of the Stone Age. The relationship between particular material cultural forms, including stone artefact assemblages and funerary practices, with specific ethnic groups also permeates Dreyer's (1933), Hoffman and Meiring's (1958) and Louw's (1960) interpretations of the archaeological sequence at Matjes River Rock Shelter.

The equation of "bounded cultural entities" (Jones 1997:107) or archaeological cultures with particular groups of prehistoric people was strongly criticized by the proponents of the "new archaeology" of the 1960s. Processual archaeology, as the name implies, moved away from the description of archaeological cultures in time and space, and redirected itself towards the investigation of the complex cultural processes involved in the production of the archaeological record. Binford (1965) argued that, rather than reflecting poorly defined and over simplified cultural similarities and differences between groups, variation in archaeological distributions is in fact a result of differences in the numerous subsystems of which larger archaeological systems are comprised (Binford 1965; Jones 1997).

Binford (1965) furthermore recognized and distinguished between two types of formal or stylistic variation which cross-cut these categories and could not be accounted for in functional terms. The first of these, namely primary functional variation, was directly determined by the specific function the object in question was designed to serve. The latter emerged as a consequence of the particular social contexts in which artefacts were produced and/or used, largely as a result of adherence to traditions of manufacture or use adhered to by prehistoric people. This type of variation may have also played a role in asserting and expressing group identity or social cohesion (Binford 1965; Jones 1997).

Sackett (1977; 1985; 1986) proposes a duality rather than a dichotomy between style and function, and regards the former as a passive or latent quality of material cultural remains and an as an "adjunct to the utilitarian, functional form of an object" (1986: 268). He developed the term "isochrestic variation" (1977; 1985; 1986) to account for the recurrence of certain forms within the archaeological record when numerous culturally acceptable alternatives for the manufacture of objects would have been available to prehistoric toolmakers. According to Sackett (1977), this repeated use of particular forms is an artefact of the enculturation process whereby preferred ways of doing things are transmitted to the members of occupational and social groups where they eventually become entrenched as traditions. Measures of similarity or dissimilarity in material cultural assemblages thereby become useful measures or indices of social interaction or distance (Jones 1997) between groups.

From around the 1970s, numerous researchers began to advocate a more active view of style as a form of assertive communication and boundary definition between adjacent groups. Wiessner (1983, 1984), regarded style as a form of nonverbal communication whereby important information regarding group identity or social affiliation may be transmitted between adjacent groups. The process whereby individuals and groups identify and define themselves in relation to other individuals and groups is embedded within the human cognitive process. Thus, according to Wiessner (1984), much of the variation which characterizes archaeological assemblages has an explicitly behavioural basis. Wiessner (1983) differentiates between what she refers to as assertive style and emblematic style. The latter, she argues, concerns the deliberate transmission of messages concerning the definition and maintenance of social and territorial boundaries from one group to another population.

In an ethnographic investigation of variability in arrow shafts manufactured by different language groups among the Kalahari San, she found that these artefacts played an important role in San social organization and boundary definition. Hodder's (1979) ethnographic research among cattle-owning populations in western Kenya suggests that in situations characterized by increased inter-group conflict or competition for economic resources, the role of material culture in proclaiming territorial affiliation will intensify. This point is particularly salient when one considers the major shifts in subsistence strategies, demographic and residential patterns, and social networks that characterize the Late Holocene.

The idea of material culture as a means whereby prehistoric hunter-gatherers were able to actively assert and reinforce their rights to specific territories and the resources located within them underpins Hall's (1990) and Binneman's (1995) interpretations of variability in the Late Holocene assemblages of sites in the eastern and southeastern Cape. Ludwig (2005) describes a number of potentially significant differences in assemblages from Nelson Bay Cave and Matjes River Rock Shelter which may have been used by the sites' prehistoric occupants to signal and maintain their separate economic and social identities. Variation within Wilton stone tools as well as a number of lithic and non-lithic remains was documented. One of main objectives of this thesis is to determine whether or not and to what extent material cultural continuities can be demonstrated in the post-Wilton assemblages from Hoffman's/Robberg Cave and Nelson Bay Cave. The degree to which these contrast to distributions at Matjes River Rock Shelter is also relevant.

6.4.2. MATERIAL CULTURAL PATTERNING IN THE POST-WILTON ASSEMBLAGES FROM HOFFMAN'S/ROBBERG CAVE AND NELSON BAY CAVE

6.4.2.1. Raw material frequencies

In his comprehensive comparison of the lithic assemblages from Nelson Bay Cave and Matjes River Rock Shelter, Ludwig (2005) reports several differences in the frequencies of different stone artefact types at these sites. For instance, proportions of formal tools featuring a steep form of retouch known as backing are significantly higher for Matjes River Rock Shelter than Nelson Bay Cave. The existence of different toolmaking traditions at these closely adjacent sites is regarded by Ludwig (2005) as evidence of social separation. In his investigation of changing social relations among Holocene hunter-gatherers in the Thukela Basin, Mazel (1989a, b) regards variation in the abundances of backed artefacts as a styilistic marker at the regional level. Henshilwood (1995) notes the occurrence of backed segments in assemblages from sites to the west of the Gouritz river in the Garcia State Forest Nature Reserve, where they may have served as regional expressions of identity. Toolmakers at Matjes River Rock Shelter also displayed a more marked preference for the fine-grained raw material CCS than their counterparts at Nelson Bay Cave. The use of exotic raw materials as "social-spatial stylistic markers" by the Late Holocene inhabitants of sites in the Cape Folded Mountain belt has been convincingly argued by Hall (1990). A similar interpretation of raw material variability at Matjes River Rock Shelter and Nelson Bay Cave is offered by Ludwig (2005).

The aforementioned differences between the assemblages from Nelson Bay Cave and Matjes River Rock Shelter are evident during the mid-Holocene or Wilton period. No contemporary assemblage exists for Hoffman's/Robberg Cave, which was not occupied during at this time. The post-Wilton assemblages from Hoffman's/Robberg Cave and Nelson Bay Cave are highly informal, with very few formal stone artefacts. Locally available quartzite is the dominant raw material. However, in my analysis of the material from Hoffman's/Robberg Cave, I noted that both quartz and CCS are considerably more abundant in this assemblage than in the post-Wilton units (31-62) of Nelson Bay Cave. These fine-grained raw materials occur almost exclusively in the shell-rich layers at Hoffman's/Robberg Cave (4000 – 3700BP), and are virtually absent in the *Zostera*–dominated units (3300BP).

The earliest occupation of Hoffman's/Robberg Cave in the Late Holocene predates 3300 BP and the onset of significant changes in the manufacture of stone artefacts at Nelson Bay Cave. Prior to this date, quartz and CCS were used in the manufacture of stone artefacts at Nelson Bay Cave, albeit not as intensively as at Matjes River Rock Shelter. I propose that the Late Holocene inhabitants of Hoffman's/Robberg Cave obtained these raw materials from the same source as their neighbours at Nelson Bay Cave. Raw material frequencies for the *Zostera*–dominated units of Hoffman's/Robberg Cave resemble those for the post-Wilton levels of Nelson Bay Cave, where the assemblage is most heavily dominated by quartzite. According to Orton and Halkett (2007), quartz was present throughout the Noetzie sequence, with slightly higher proportions occurring in Layer 5, which may be contemporary with the occupation of Hoffman's/Robberg Cave. Quartzite was, however, the predominant lithic raw material at Noetzie. Fluctuating frequencies of this raw material and quartz were documented by Binneman (1995) for the lithic assemblage from Kabeljous River Shelter. At this site, the Wilton industry was replaced by the macrolithic Kabeljous industry only at around 2450 BP, after which quartzite became the primary raw material for stone tool manufacture.

Only one unretouched flake of silcrete was recovered from Hoffman's/Robberg Cave in 2007. This raw material was also very rare in the Later Stone Age assemblages from Nelson Bay Cave and Matjes River Rock Shelter. This contrasts with other southern Cape coastal sites, notably those in the Garcia State Forest, where silcrete was the preferred raw material for stone artefact manufacture at sites predating 3000 BP. Those postdating 2000 BP were characterized by increasing proportions of quartz. The scarcity of silcrete at Matjes River Rock Shelter as well as Nelson Bay Cave is tentatively interpreted by Ludwig (2005) following Henshilwood (pers. comm. in Ludwig 2005) as evidence of territorial circumscription among Late Holocene hunter-gatherers. It is by extension indicative of restricted access to the sources of this raw material (Ludwig 2005). Binneman (1995: 41) commented upon the "virtual absence" of silcrete in the assemblage from Havens Cave, an inland site located in the Cambria Valley, as well as other sites located in the Baviaanskloof, and its abundance at Later Stone Age sites located 12 km away in the Langekloof. The preferential use of quartz and quartzite by the Later Stone Age inhabitants of Havens Cave is regarded by Binneman as a self conscious expression of their social identity.

6.4.2.2. Stone artefacts

Slight variation in the proportions of quartzite chips and chunks and unretouched flakes are evident for the post-Wilton assemblages from Hoffman's/Robberg Cave and Nelson Bay Cave. While chips and chunks occur in greater abundances at the former site, unretouched flakes are more numerous at the latter. Nevertheless, these three items constitute the most numerically significant categories of lithic remains at both sites. The informal lithic assemblage from the Noetzie midden is dominated by medium to large quartzite flakes, with considerably less quartzite cores and chunks (Halkett and Orton 2006; Orton and Halkett 2007). At Nelson Bay Cave, cores were less numerous in the post-Wilton levels of the deposit than in underlying stratigraphic units (Inskeep 1987). Included among the quartzite cores recovered from units 31-62 are 11 distinctive specimens with smoothly faceted striking platforms reminiscent of water worn cobbles or grindstones. Sixteen of these cores were recovered from Hoffman's/Robberg Cave in 2007. Cores previously used as grinding equipment have been reported by Binneman (2006/2007) at Late Holocene sites in the vicinity of the Kabeljous River, where they formed part of a macrolithic quartzite industry he termed the 'Kabeljous'. The formal stone artefacts characteristic of this industry, including large segments manufactured on beach cobbles, are not present at Hoffman's/Robberg Cave. However, the use of recycled grinding equipment as cores appears to have occurred at three known sites on the southern Cape coast, including Hoffman's/Robberg Cave. The quartzite cores recovered from the Noetzie midden are described by Halkett and Orton (2007: 5) as fairly large, with significant amounts of remaining cortex "suggesting very casual and ad hoc use". The six irregular cores from Hoffman's/Robberg Cave match this description.

Grindstones and rubbing stones were considerably more abundant in the post-Wilton levels of Nelson Bay Cave than in older stratigraphic units. The reverse was apparent for hammerstones. Nevertheless, proportions of the different categories of grinding equipment combined were higher for units 31-62. According to Inskeep (1987), this may indicate shifts in the types of food resources being processed by the Late Holocene inhabitants of the site. Henshilwood (1995) reports the recovery of 39 grindstones from Later Stone Age sites in the Garcia State Forest. Following Deacon (1976) and Inskeep (1987), he suggests that these artefacts may have been used for the processing of shellfish. At Kabeljous River Shelter, Binneman (1995) found rubbers and hammerstones which had been used opportunistically as scrapers or adzes, in addition to being flaked. Large quantities of grinding equipment and cobble tools were also recovered from the rear excavation of Klasies River Cave 5. According to Binneman (1995), ochre-staining was evident on many of these items.

Grinding equipment is very well-represented in the original collection from Hoffman's excavation of Hoffman's/Robberg Cave. Small numbers of these items were recovered during the re-excavation of the site in 2007. While Hoffman's collection contained greater numbers of upper grindstones than hammerstones, hammerstones outnumber grindstones in the 2007 sample. It appears that grinding equipment was even more abundant at Hoffman's/Robberg Cave than Nelson Bay Cave. Ochre-staining on different types of stone artefacts was also more prevalent at the former site. The original collection includes numerous chunks, flakes, cores and especially grinding equipment with visible ochre-residues. Ochre-stained chunks, cores, flakes and grinding equipment were also recovered during the 2007 field season. At least one of the grindstones in the 2007 sample is covered in ochre-powder, indicating its probable use as an ochre grinder.

Shale palettes were recovered from Nelson Bay Cave, Hoffman's/Robberg Cave as well as Matjes River Rock Shelter. According to Ludwig (2005), these items are more numerous in the assemblage from the last-mentioned site. He also notes that while palettes were recovered from all the chronological groupings in the Holocene levels at Nelson Bay Cave, all of those from Matjes River Rock Shelter derive from Layer C, which dates to the mid-Holocene. A single complete shale palette and one fragment, as well as a sandstone palette, were recovered from Hoffman's/Robberg Cave in 2007. The two complete specimens derive from shell-rich layers near the middle of the sequence, while the fragment was recovered from Ivan. Two additional palettes manufactured on black shale were recovered from test pits dug at the site in 2008. Two complete palettes on shale and another two on sandstone are included in the original collection from Hoffman's excavation. Some formal similarities exist between the specimens from Hoffman's/Robberg Cave and Nelson Bay Cave, in contrast to the older specimens from Matjes River Rock Shelter. Two specimens from Matjes River Rock Shelter are perforated near the edges (Ludwig 2005). None of the specimens from Nelson Bay Cave or Hoffman's/Robberg Cave are perforated.

Several items in the utilized piece category present in the post-Wilton assemblage from Nelson Bay Cave are absent in the older collection and new sample of material from Hoffman's/Robberg Cave. These include sinkers, utilized flakes and *pièces esquillées*. Shale sinkers were the most interesting lithic remains recovered from the Swartsdrift midden on the Tstistikamma coast excavated by Hilary Deacon. The appearance of these artefacts, and their occurrence with large quantities of fish remains led Deacon (1970) to suggest that they served as weights for fishing lines. Four small stone sinkers were recently recovered from Layer 3 (~ 3300 BP) of the Noetzie midden. The absence of these items in the 2007 sample of material from Hoffman's/Robberg Cave does not mean that they were not being manufactured or used by the site's inhabitants. The superabundance of fish remains in certain of the shell midden layers, notably Katharine, indicates that fish were being heavily exploited during the Late Holocene occupation of the site.

As with many Late Holocene sites on the southern Cape coast, stone artefacts with systematic retouch are rare in the Hoffman's/Robberg Cave assemblage and post – Wilton levels of Nelson Bay Cave. The informality of post-Wilton assemblages from sites along the southern Cape coast is thought to be related to the intensive exploitation of marine resources by these sites' Late Holocene inhabitants – a subsistence strategy which required little in the way of specialized technology (Klein

1974). Some variation in the ratios of formal tools is evident between the assemblages from Hoffman's/Robberg Cave and Nelson Bay Cave.

6.4.2.3. Bone artefacts

Ludwig (2005) reports several differences in the chronological distributions of bone artefacts in the Holocene material from Nelson Bay Cave and Matjes River Rock Shelter. Large quantities of worked bone were recovered from the post-Wilton levels of Nelson Bay Cave, and from Layer C of Matjes River Rock Shelter. Bone awls, particularly robust specimens manufactured on cannon bone, were especially numerous in the upper group of stratigraphic units at the former site. This pattern is tentatively regarded by Ludwig (2005:43) as evidence of more intensive "production and maintenance of clothing and other accessories" during the Late Holocene at Nelson Bay Cave. According to Ludwig (2005), it may also reflect that skin-working activities were by preference carried out in the front section of the cave, where the post-Wilton deposits accumulated. This would account for the relatively low frequency of bone awls in the mid-Holocene deposits from the site, which were located further back in the interior of the cave. Bone awls are the best represented bone artefacts in the original collection of material from Hoffman's/Robberg Cave. This pattern is not born out in the 2007 sample of material. It appears that bone awls are less numerous and bone points more numerous at Hoffman's/Robberg Cave. The majority of bone awls from Matjes River Rock Shelter derived from Layer C. No variation in the style or distribution of bone points was observed between Nelson Bay Cave and Matjes River Rock Shelter.

According to Ludwig (2005) bone tubes are more numerous in the assemblage from Matjes River Rock Shelter, where they occurred predominantly in Layer C. A single, highly decorated specimen derived from Layer B. At Nelson Bay Cave, bone tubes were recovered from units 64 and above in the Holocene deposits excavated by Inskeep. Deacon (1978) lists a single specimen, and illustrates three specimens, from the Wilton units of Klein's excavation. Thus, the absence of bone tubes in stratigraphic units underlying unit 64 of Inskeep's Holocene deposits may result from differences in the size of the areas being sampled (Inskeep 1987). Bone tubes are present in the original collection of material from Hoffman's/Robberg Cave as well as in new samples of material from the site. These items appear to be more numerous at this site than at Nelson Bay Cave. Bone rings were recovered in significant quantities from Nelson Bay Cave, the majority deriving from the Post-Wilton units (Inskeep 1987). No bone rings were recovered from Matjes River Rock Shelter. These items were also absent in the original collection from Hoffman's/Robberg Cave, as well as the sample from 2007. However, three specimens were recovered during the 2008 field season. This indicated that, like their contemporaries at Nelson Bay Cave, the Late Holocene inhabitants of Hoffman's/Robberg Cave were manufacturing these items.

Differences in the abundance and distribution of ground and/or perforated *Pelomedusa* carapace have also been demonstrated in the assemblages from Nelson Bay Cave and Matjes River Rock Shelter. At the former site, these items were numerous and clustered within stratigraphic units dating to the Late Holocene (Inskeep 1987; Ludwig 2005). At Matjes River Rock Shelter, only two perforated specimens are reported by Louw and described by Ludwig (2005). Both derive from Layer A. Ludwig (2005) dismisses the possibility that crude excavation procedures employed during the excavation of this site would have been biased against the recovery of these small and rather delicate items. Whatever excavation techniques were used, the collection of material from Matjes River Rock Shelters includes a wide variety of decorative objects manufactured on a range of raw materials. Rather, he attributes the presence or absence of perforated freshwater carapace in the two assemblages to deliberate decisions made by the sites' inhabitants about the use of certain materials for the manufacture of pendants.

Ground fragments of turtle carapace found in association with one of the burials at Nelson Bay Cave are thought by Inskeep (1987) to be the remains of a large carapace bowl. A single, intact *Pelomedusa* carapace was recovered from one of the midden sites located in the Garcia State Forest Reserve. The presence of scrape marks in the interior, evidence of grinding on the outer edges, as well as visible traces of ochre suggest that this item was used as a bowl for the mixing of ochre-based paint. According to Henshilwood (1995), the turtle from which the carapace was derived had most likely been captured near the Duivenhoks or Kafferkuils Rivers. Perforated *Pelomedusa carapace* is not present in the original collection from Hoffman's/Robberg Cave; nor is it included in the sample from 2007. A single fragment of freshwater turtle carapace with one perforation was recovered from one of the shell-rich layers (Below Portia) in 2008.

6.4.2.4. Marine shell artefacts

Differences in the assemblages from Nelson Bay Cave and Matjes River Rock Shelter are particularly pronounced in the relative abundance and distribution of worked marine shell. Shell crescents were recovered primarily from the post-Wilton levels of Nelson Bay Cave, and from Layer C at Matjes River Rock Shelter (Ludwig 2005). These items were present but scarce in the original collection of material from Hoffman's excavation. The 2007 sample includes 17 specimens with ground edges. This indicates that these items, the likely function of which remains unknown, were being manufactured by the Late Holocene inhabitants of Hoffman's/Robberg Cave.

Variation in the shape and decoration of marine shell pendants recovered at different points in the Nelson Bay Cave and Matjes River Rock Shelter sequences is also reported by Ludwig (2005). At Nelson Bay Cave, shaped shell pendants, classified by Inskeep (1987) as Type 1, predominate in the post-Wilton levels of the deposit. Types 2 and 3 were more common in older layers. The typology employed by Inskeep in describing these artefacts made systematic comparisons with specimens from Matjes River Rock Shelter problematic (Ludwig 2005). Nevertheless, Ludwig (2005) notes that all of the shaped marine shell pendants from Matjes River Rock Shelter derived from Layer C; that the majority are of similar dimensions to those defined as Type 2 and Type 1, and that the specimens from Matjes River Rock Shelter are larger than the Type 3 specimens from Nelson Bay Cave with which they are broadly contemporary. Edge-nicking was also more prevalent at Nelson Bay Cave, particularly on Type 1 pendants.

Excavations carried out at Hoffman's/Robberg Cave in 2007 yielded three badly damaged specimens. Except for the absence of edge-nicking, two of these correspond with Inskeep's (1987) Type 1 pendants. They are round, shallow in curvature, and bear two perforations. The other, which is oval in shape, twice perforated and deeper in curvature, is more reminiscent of those classified as Type 2b. A single edge-nicked specimen with three partial perforations was found during the 2008 field season. Despite the small numbers, when the relative sizes of the assemblages are taken into consideration, these items occur in similar frequencies at Nelson Bay Cave and Hoffman's/Robberg Cave. This is a completely different scenario than the one suggested by Hoffman's collection, from which shaped marine shell pendants were conspicuously absent. No specimens resembling those described by Inskeep (1987) as Type 3, which were restricted to the older units of the Nelson Bay Cave sequence, have been found at Hoffman's/Robberg Cave. Four *T. sarmaticus* pendants recovered from the Noetzie middden and described by Orton and Halkett (2007) are similar to those found at Hoffman's/Robberg Cave and the mid- and Late Holocene levels of Nelson Bay Cave. These include two shield shaped specimens, one of which is edge-nicked, with two perforations; one oval pendant with edge-nicking and a single perforation; and one specimen with three perforations (the remains of a forth one is evident at the broken margin of this object) without edge – nicking.

6.5. SUMMARY

The re-excavation of Hoffman's/Robberg Cave in 2007 allowed for the integration of *this site into the interesting Late Holocene prehistory of the southern Cape coast.* Radiocarbon dates indicate that this site was first occupied at around 4000BP. This followed the emergence of economic separation among hunter-gatherers resident on the Robberg Peninsula and at sites on the opposite side of the Keurbooms/Bitou estuary, and coincides with a period of intensified subsistence and social activity extensively documented at sites in the southern and eastern Cape. The occupation of Hoffman's/Robberg Cave at this time may have been a consequence of high population densities combined with a reduction in foraging territories in the region. The stratigraphy and chronology of the site indicate an occupational hiatus between ~3700 and 3300BP, followed by another, much shorter episode of occupation at around 3300 BP.

The shellfish assemblage is composed predominantly of *P. perna* and *S. cochlear* shells. High frequencies of these species reflect the harvesting of shellfish resources available in the lower Balanoid zone; a strategy which is consistent with the steep and rocky shoreline in the immediate vicinity of the site. Some differences in the choice of particular species are apparent between the youngest *Zostera*–dominated units of the deposit and the underlying shell-rich layers. Changes in the size distributions of *S. cochlear* recovered from different levels in the sequence suggest more intensive exploitation at the beginning of the first episode of occupation. Human predation was somewhat less intense near the end of this episode, and following an occupational hiatus. The relatively small sizes of *T. sarmaticus* from the site resemble Hine's (2008) sample from open middens in the vicinity of Paapkuilfontein, and are consistent with fairly intense predation, or the selection of immature individuals from the mid-intertidal.

Some continuity in the material cultural assemblages from Hoffman's/Robberg Cave and the post-Wilton levels of Nelson Bay Cave, as well as other southern Cape coastal sites dating to the Late Holocene, is evident. Distinctive cores with smooth striking platforms reminiscent of grindstones and/or water-worn cobbles are present at Hoffman's/Robberg Cave and Nelson Bay Cave, as well as Kabeljous River Shelter. Shale palettes recovered from the former two sites differ in form from those manufactured by the inhabitants of Matjes River Rock Shelter. Certain categories of bone and shell artefacts were manufactured by Late Holocene hunter-gatherers at Hoffman's/Robberg Cave and Nelson Bay Cave but not by their contemporaries at Matjes River Rock Shelter. These items include bone tubes and rings, perforated *Pelomedusa* carapace and marine shell crescents. Marine shell pendants of a similar form were also manufactured by the Late Holocene inhabitants of Hoffman's/Robberg Cave and Nelson Bay Cave.

CHAPTER 7
CONCLUSION

Hoffman's/Robberg Cave is a relatively little-known site located on the Robberg Peninsula 300m away from Nelson Bay Cave, and 14km from Matjes River Rock Shelter. Several decades of archaeological research carried out at the latter two sites has culminated in a good understanding of their deposits and stratigraphy, faunal and artefactual assemblages, as well as their overall significance in the rich and varied Holocene prehistory of the southern Cape coast. Previous excavations at Hoffman's/Robberg Cave failed to provide a comprehensive account of the site's Later Stone Age inhabitants. Early exploratory excavations carried out under the auspices of the South African Museum in 1917 focused on the collection of aesthetically pleasing artefacts as well as human skeletons. Further excavations conducted in the late 1950s by Hoffman remain largely undocumented. My examination of the curated material from Hoffman's excavation in 2006 raised several questions regarding the completeness of this collection, and highlighted the need for renewed excavations.

Small-scale excavations were conducted at Hoffman's/Robberg Cave in June/July 2007, with the dual objectives of elucidating the stratigraphy and chronology of the Late Holocene deposits, and obtaining an unselected sample of material for analysis. Three squares (E4, E5 and E6) were removed from the western face of Hoffman's original trench. Two quadrats were subsequently excavated in the least disturbed areas of the deposit. A total of 35 stratigraphic units were recognized and divided into two clearly differentiated groups. The younger portion of the deposits consisted of eight layers of compacted estuarine grass or *Zostera capensis*. These were underlain by extensive shell midden deposits characterized by different degrees of burning. The *Zostera*–dominated units and underlying shelly layers were separated from one another by a thin layer of hard, heavily burned and compacted material (Ivan). This suggests a break in the occupation of the site between the two different groups of stratigraphic units. The archaeological deposits bottomed out onto a sand dune.

Nine new radiocarbon dates indicate that the excavated deposits accumulated over a relatively brief 700 year period during the Late Holocene. Radiocarbon dates of 3990±50BP, 3920±40BP and 3760±40BP were obtained for charcoal samples taken from two of the oldest shell midden layers (Richard and Tom, respectively), and the uppermost of the lower set of units (Judy). Charcoal samples from two layers (Henry and Ben) at the bottom and top of the upper set of units yielded dates of 3310±40 BP and 3370±40 BP, respectively. These radiocarbon dates, like the stratigraphy of the deposits, indicate an occupational hiatus between the formation of the shell-rich units and the *Zostera* beds. It appears that the site was initially occupied at around 4000 BP. This episode of occupation lasted between 200 to 300 radiocarbon years, and was followed by a hiatus of about the same length. Occupation of the site was resumed for a short period at around 3300 BP. The onset of the first episode of occupation occurred after the emergence of economic separation among Later Stone Age hunter-gatherers living along the Robberg Peninsula and at Matjes River Rock Shelter, and coincided with a lowering of sea levels following a mid-Holocene high stand at the sea. The abandonment and subsequent reoccupation of the site may reflect fluctuations in the density of hunter-gatherer populations residing at Cape Seal. The site does not appear to have been inhabited following the movement of herders into the region.

The analysis of shellfish remains from Hoffman's/Robberg Cave indicate that two species in particular, namely *P. perna* and *S. cochlear*, were an important dietary component during the Late Holocene occupation of the site. *P. perna* and the large alikreukel *T. sarmaticus* constitute the best represented species in the assemblage from a comparative shell midden occurrence in Noetzie, Knysna. The exploitation of *P. perna* and *S. cochlear*, and *P. perna* and *T. sarmaticus* are both well documented patterns at Holocene sites located on the rocky shores of the southern Cape coast. The preferential collection of large species from the mid- to low-intertidal zones has been regarded as a specialized and highly efficient strategy implemented by prehistoric hunter-gatherers living at the coast (Binneman 1995). One of the main determinants of the shellfish exploitation strategies at Hoffman's/Robberg Cave is the morphology of the coastline in the vicinity of the site. Specifically, the high abundances of *P. perna* and especially *S. cochlear* in the assemblage is most likely a function of the steep topography of the shore immediately adjacent to the site. The more significant contribution of *T. sarmaticus* to the assemblage from Noetzie may reflect the greater accessibility of the mid-tidal zones to that site's inhabitants.

T. sarmaticus appears to supercede *S. cochlear* in importance in the *Zostera*–dominated units of the sequence. Proportions of *P. perna* also decrease slightly in some of the *Zostera* beds. This may reflect slight differences in the choice of particular species as food resources during the two episodes of occupation at Hoffman's/Robberg Cave. The higher frequencies of *T. sarmaticus* and the large tabular limpet, *S tabularis*, in the *Zostera* beds may be an artefact of taphonomic processes favouring the preservation of these large, robust specimens. An inverse correlation between *P. perna* and *T. sarmaticus* is evident in the assemblage from Noetzie. Both of these are large species with high meat yields, making them an ideal choice for prehistoric foragers. An inverse correlation is also apparent in the relative abundances of *S. cochlear* and *S longicosta* in Layer 10 of the Noetzie midden. These limpet species are of a similar size and inhabit the lower intertidal zone. Changes in the relative abundance of *S. cochlear* and *S longicosta* may be a result of changes in human preferences or slight fluctuations in the availability of these species. An increase in the significance of small species occurring relatively high on the shore, notably *Oxystele*, is apparent in the youngest pre-pottery layer (Layer 4) of the Noetzie midden. This is consistent with similar observations at sites in the Garcia Forest Nature Reserve and along the Cape St. Francis Coast, as well as Paapkuilfontein on the southern Cape coast. Increased reliance on *P. perna* following the introduction of ceramics and contact with herding groups is also indicated.

Changes in the size distribution of *S. cochlear* through time are evident in the Hoffman's/Robberg Cave sequence. These can plausibly be linked to fluctuations in the intensity of human predation during the two different episodes of occupation. Three shell-rich units near the middle and bottom of the sequence (Nathan, Portia and Richard) contained fewer individuals from size categories >55mm than a younger shelly layer (Katharine) and the combined *Zostera* beds. This is indicative of more intensive exploitation of this species during the initial occupation of the site, with less intensive shellfish collection towards the end of the first episode of occupation and following an occupational hiatus.

Distributions of *T. sarmaticus* opercula, and mean shell breadths determined on the basis of mean opercula lengths, indicate the exploitation of relatively small individuals (<51 mm) throughout the Late Holocene occupation of Hoffman's/Robberg Cave. A decrease in the size of *T. sarmaticus* opercula has also been documented in the pre-pottery levels of the Noetzie midden. This is consistent with chronological patterns documented by Henshilwood (1995) and Hine (2008), and can be attributed to the effects of human predation and the "farming down" of alikreukel populations through continuous and intensive exploitation.

The lithic and non-lithic assemblages from Hoffman's/Robberg Cave were compared to those from the post–Wilton units (31- 62) of Nelson Bay Cave. The lithic remains from both sites are typical of the post-Wilton industry: they are highly informal and dominated by locally available quartzite. Unretouched chips, chunks and flakes of this raw material constitute the most abundant lithic remains at Hoffman's/Robberg cave as well as units 31–62 of Nelson Bay Cave. Quartz and CCS were present in the shell-rich layers of Hoffman's/Robberg Cave. These predate 3300 BP and the commencement of the post-Wilton at Nelson Bay Cave, and would therefore have been obtained from the same source by the inhabitants of both sites. The few formal artefacts on quartzite and CCS recovered from Hoffman's/Robberg Cave also derive from the shell-rich units. Lithic artefacts from the *Zostera*-dominated units (~3300 BP) are almost exclusively quartzite and lack any form of secondary retouch. They closely resemble the contemporary post-Wilton levels of Nelson Bay Cave, and testify to the commencement of this period at around 3300 BP on the Robberg Peninsula.

Both assemblages contain distinctive and highly standardized quartzite bladelet (or flakelet) cores which have also been reported by Binneman (1995) at Late Holocene sites on the southeastern Cape coast. The macrolithic formal tools that characterize the Kabeljous industry, notably large segments, are not represented at Hoffman's/Robberg Cave. While the assemblage from Hoffman's/Robberg Cave lacks some of the utilized pieces present in the post-Wilton units of Nelson Bay Cave, notably stone sinkers and utilized flakes, grinding equipment appears to be more abundant at the former site. These items appear to be well represented at a number of other southern Cape coastal sites, including those in the Garcia State Forest and at

Cape St Francis (Binneman 1995; Henshilwood 1995). The use of ochre, as indicated by the presence of ochre-stains of a variety of lithic remains, appears to have been more prevalent at Hoffman's/Robberg Cave than at Nelson Bay Cave. Un-perforated shale palettes were recovered from both sites. These differ from the perforated palettes found in the mid-Holocene deposits of Matjes River Rock Shelter, but this may be a reflection of sample size effect rather than stylistic variation.

The 2007 and 2008 samples of non-lithic remains from Hoffman's/Robberg Cave include a range of bone artefacts similar to those recovered from Nelson Bay Cave. Numerous ostrich eggshell beads as well as small quantities of marine shell artefacts were also recovered. These objects were either absent or rare in Hoffman's collection of material from the site, resulting in a skewed perception of their occurrence in the Late Holocene deposits of Hoffman's/Robberg Cave. It is now clear that delicate marine shell crescents were manufactured by the Late Holocene inhabitants of this site as well as Nelson Bay Cave. As has been previously mentioned, these do not feature in the contemporary assemblage from Matjes River Rock Shelter. Pendants of a similar type were also manufactured by the Late Holocene inhabitants of the two sites on the Robberg Peninsula. Ostrich eggshell beads are also present in both assemblages. The lack of manufacturing debris at both sites indicates that these were imported as finished products from elsewhere.

Hoffman's/Robberg Cave holds an interesting place in the Holocene prehistory of the southern Cape. The nearby sites of Nelson Bay Cave and Matjes River Rock Shelter have extensive archaeological deposits encompassing much of the Later Stone Age. Hoffman's/Robberg Cave, by contrast, appears to have been occupied only briefly during the Late Holocene. This is a period characterized by wide-spread changes in hunter-gatherer settlement and subsistence strategies, as well as social relations, of which the occupation of this previously uninhabited cave site represents only a small part. Shellfish residues from the site indicate the intensive exploitation of a commonly occurring limpet species, *S. cochlear*, for at least part of the first episode of occupation. Furthermore, a degree of material cultural continuity in the artefactual assemblages from Hoffman's/Robberg Cave and the neighbouring site of Nelson Bay Cave is demonstrated. This is particularly apparent in the manufacture of distinctive bladelet/flakelet cores, and marine shell pendants. The observation that similar types of artefacts were produced by the Late Holocene inhabitants of two sites located just 300m apart on the Robberg Peninsula may be construed as evidence for cultural affinity. However, a number of broad continuities exist between the assemblage from Hoffman's/Robberg Cave and other Late Holocene sites located on the southern Cape coast, including middens in the Garcia State Forest Reserve, sites in the Cape St. Francis region and an open occurrence in Noetzie. The identification of cultural boundaries between groups of Late Holocene hunter-gatherers living in the Plettenberg Bay region during the Late Holocene, and of the particular types of artefacts used by them as markers of their social identities, warrants further investigation.

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APPENDIX A

DESCRIPTION OF LAYERS IN THE HOFFMAN'S/ROBBERG CAVE DEPOSIT

SURFACE *IN SITU*: A layer comprised of relatively dark, moist, loose estuarine grass (*Zostera capensis*) containing some marine shell and charcoal, located beneath approximately 10cm of disturbed, trampled surface material in E4. Total volume: 45 litres.

BEN: A thin layer of compacted *Zostera* with some soil and fragments of decomposed marine shell. Located immediately beneath the surface and above several similar strata in E4 and 5. Extends into D4a, where it is present in the southern portion of the adjacent quadrat D5b, and in D5b. Total volume: 70 litres.

CELESTE: Underlies Ben. A layer of consolidated *Zostera* mats interspersed with fragments of mussel and alikreukel shell, some bone and some lithics in E4 and E5 and the quadrats D4a and D5b. A disturbance comprised of grey soil, fragmented marine shell and loose strands of estuarine grass was evident in the northwestern portions of E4 and D4a. Total volume: 67 litres.

DEON: A thick layer of compacted *Zostera* underlying Celeste and containing fragmented and decomposed marine shell, as well as some fish, bird, seal and possible juvenile hippopotamus bone. Extends into E4 and E5, and D4a and D5b. Total volume: 110 litres.

ELIZABETH: A layer of relatively loose *Zostera capensis* beneath Deon in E4 and E5, and D4a and D5b. In E6, this stratum underlies and is truncated by intrusive dark, loose, shelly material designated as Barbie. Barbie is much more extensive in the adjacent square E5, where it cross-cuts Elizabeth at the southern edge of the square. Total volume: 91 litres.

FRANK: Underlies Elizabeth in E5 and D5b, and Elizabeth and Barbie in E6. Consists of compacted *Zostera*, soil, decomposed marine shell, and bird, fish, mammal and possibly tortoise bone. Total volume: 57.5 litres.

GIDEON: A layer of rich, dark, humified *Zostera* containing marine shell and fish and seal bone, located beneath Frank in E5 and E6. Total volume: 65 litres.

HENRY: A layer of moist, soft, humified *Zostera* underlying Gideon in E6, and containing seal bone and marine shell. Total volume: 50 litres.

IVAN: A thin layer of dark, compacted material underlying the bottom-most *Zostera* – dominated units in E4, E5 and E6, and well as D4a and D5b. This layer, which contained some humified *Zostera,* decomposed marine shell and stone, formed a "shelf" supporting the overlying *Zostera* beds. Total volume: 35.8 litres.

JUDY: A horizon of dark material underlying the thin scraping Ivan in all excavated units. This layer consisted of a hard, heavily burned surface above softer, less dark material. Significant horizontal variation in colour was also observed between the excavated units. The deposit became progressively darker from E4 to E6. D5b was also darker and more heavily burned than the adjacent quadrat D4a. These excavated units were also less heavily burned towards the new baseline than in the portions closest to the remnants of Hoffman's trench. Judy contained large quantities of charcoal in addition to some *Zostera* and decomposed marine shell. Total volume: 145.8 litres.

JANE: A layer of dark material similar to the overlying stratum, Judy, but containing large quantities of well-preserved marine shell and bone. Total volume: 114.5 litres.

KATHARINE: Underlies Jane in all excavated units. A distinctive layer of loose, sandy, yellow material overlying darker, ochre-coloured material, probably the remains of an extensive hearth. Contained large quantities of well preserved marine shell and an abundance of fish bones. The latter were particularly concentrated in E5. Total volume: 107.5 litres.

JUNE: A small layer of dark, organic material similar to Judy in contents and appearance located beneath Judy in the southern portion of E6. Total volume: 22.5 litres.

LOUISA: A thin wedge of variegated, ashy deposit below and adjacent to Katharine in E4 and part of E5. Extends into the quadrats D4a and D5b and contained some bone, stone and marine shell. Total volume: 62 litres.

MAVIS: A layer of medium brown, loose soil located beneath Louisa in E4 and D4a, and below Katharine and Louisa in E5 and D5b. Some lateral variation in soil colour noted in the quadrats. Contained marine shell and in D5b, a small charcoal concentration, possibly the remains of a small hearth. Total volume: 95 litres.

NATHAN: An extensive layer comprised of marine shell and red-brown soil. Underlies Mavis in E4 and E5, and D4a and D5b, where the deposit was less shell-rich. Total volume: 120 litres.

NOAH: A layer of burned, fragmented shell and loose, grey-black material, possibly ash. Underlies Nathan in E5 and D5b, and extends partially into E6. Total volume: 25 litres.

OMAR: A layer of pale grey ash forming a natural hollow. Located beneath underlying Nathan in E4 and D4a and Noah in E5 and D5b. The bottom of this layer, which contained a little marine shell and bone, was poorly defined in D5b. Total volume: 72.5 litres.

OMAR/PETER: A small layer consisting of burned, dark material towards the back and soft, brown ash towards the front of D5b. Underlies Noah and Nathan. Total volume: 10 litres.

PETER: A thin layer comprised of marine shell and grey-black ash underlying Omar in E4 and E5, and beneath Noah in E6, where it pinches out. This stratum extends into D4a, where it is overlain by Omar and another shelly layer, Paul. Total volume: 60 litres.

PETER – QUINTON: An arbitrary unit in D5b below Omar and Nathan, where the boundaries between the strata identified in E4 and E5 were difficult to discern. Total volume: 7.5 litres.

PORTIA: An extensive, shell-rich layer beneath Peter in E5, and below June and Peter in E6. This stratum slopes down from E6 into E5, where it grades into and interdigitates with an underlying layer of dark, heavily burned material (Richard). Total volume: 107.5 litres.

BELOW PORTIA: A small layer comprised of soily material without shell underlying Portia in the northern portion of E6. Total volume: 3.3 litres.

PAUL: Underlies Nathan and grades into Peter in E4, and extends into D4a. This layer is comprised of shell, ash and reddish-brown soil. Total volume: 18 litres.

QUINTON: A layer of soft, brown ash, with some marine shell, underlying Peter in E4 and E5, and extending slightly into D4a. Total volume: 45.5 litres.

RICHARD: An extensive layer of burned shell beneath Quinton in E4 and underlying Peter and Quinton in E5. In the latter square, this stratum overlaps Portia to the south. Extended into D4a and D5b beneath Peter and Quinton, and bottoming out onto sterile aeolian sand. Richard contained larger quantities of stone than any of the above lying layers. Total volume: 225 litres.

RICHARD II: A layer of loose, grey-brown material and whole mussels shells beneath Richard in E4. This stratum is a subsection of the extensive layer Richard. Total volume: 30 litres.

RICHARD III: Also a subsection of Richard, this layer of very loose, dark, shelly material underlies Richard II in E4. Total volume: 37.5 litres.

RACHEL: A wedge-shaped layer comprised of variegated grey and brown ash, sand and decomposed shell. Underlies Portia in the southern Portia of E6 and is adjacent to Below Portia. Total volume: 7.5 litres.

ROBERT: A layer of yellow sand underlying Rachel and Below Portia in E6, where it slopes upwards from the E6/E7 section line in the same direction as Rachel. Total volume: 23.3 litres.

ROYDEN: A loose, shelly layer with patches of burned material and some *Zostera* underlying Robert, Portia and Below Portia in E6 and beneath Portia in E5. Total volume: 60 litres.

SUSAN: A layer comprised of marine shell and multicoloured ashy lenses. Underlies Richard III and Richard in E4 and E5, respectively. Total volume: 30 litres.

SELVINO: Comprised of a series of alternating lenses of ash and sand, with marine shell, this layer is located beneath Susan and Richard III in E4, and underlies and is conformable with Susan in E5. In both squares, Selvino overlies a sterile sand dune. Total volume: 70 litres.

TIM: A homogenous layer of sand and a few marine shells underlying Royen in E5 and E6. Total volume: 25 litres.

TOM: A shelly layer with some *Zostera* beneath Tim in E5 and E6. This stratum constitutes the bottom of the archaeological deposit in these squares, and overlies the basal sand dune below. Total volume: 60 litres.

APPENDIX B

WEIGHTS OF SHELLFISH REMAINS INCLUDING THE HINGES OF BIVALVES; APICES OF LIMPETS, WINKELS, WHELKS, AND ABELONES; APICES AND OPERCULA OF TURBAN SHELLS; VALVES OF CHITONS AND FRAGMENTS OF BARNACLE AND *H. MIDAE*

Table 1. Weights (g) for the shellfish remains recovered from D4a and D5b, Hoffman's/Robberg Cave.

LAYER	SURFACE *IN SITU*		BEN		CELESTE		DEON		ELIZABETH		FRANK		IVAN		JUDY		JANE	
Shell species	No.	g	No.	g	No.	g	No.	g	No.	g	No.	g	No.	g	No.	g	No.	g
Perna perna	84	120.4	121	201.5	60	59	103	149.7	23	36	0	0	7	14.9	143	476.6	636	2801
Donax serra	26	100	16	67.3	3	4.2	2	6.1	0	0	0	0	9	3.2	5	43.5	17	106.7
Barbatia obliquata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Donax sordidus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scutellastra argenvillei	3	18.6	0	0	3	31.1	2	37.1	0	0	0	0	0	0	1	52.6	5	54.2
Scutellastra barbara	2	28.4	3	64.2	0	0	0	0	0	0	1	11.1	0	0	5	52.7	25	552
Scutellastra cochlear	7	50.6	5	22.1	1	2.5	9	44.2	3	13.9	0	0	0	0	26	217.6	134	939.3
Scutellastra longicosta	24	222	15	130.8	1	4	4	39.5	3	16.7	0	0	3	32.6	1	13.1	12	154.3
Scutellastra tabularis	7	237.9	1	62.2	1	44.8	13	381.3	2	98.1	1	55.2	0	0	1	177.9	5	181.8
Scutellastra granularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	6
Cymbula miniata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cymbula oculus	0	0	0	0	0	0	0	0	1	4.6	0	0	0	0	0	0	9	93.2
Unidentified limpet	0	0	4	19.2	0	0	7	82.8	0	0	1	1.5	4	26.3	7	23.5	37	181.1
Juvenile limpet	2	0.7	0	0	1	0	1	0.6	0	0	0	0	0	0	9	12	46	12.4
Dendrofissurella scutellum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fissurellidae unidentified	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	2.2
Turbo sarmaticus apices	18	190.3	12	73.2	5	66.2	9	84	3	35.6	2	16.6	0	0	1	40.8	4	64.2
Turbo sarmaticus opercula	0	0	3	15.6	3	2.7	7	28	4	13.1	0	0	0	0	3	11.5	13	49.3
Turbo cf *cidaris* apices	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turbo cf *cidaris* opercula	0	0	0	0	0	0	0	0	0	0	0	0	1	4.3	0	0	0	0
Turbo sp.	12	25	6	15.5	4	8.9	1	5.6	6	8.9	0	0	0	0	0	0	0	0
Juvenile nerites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nucella squamosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burnupena	1	0.2	0	0	0	0	1	2.4	2	10.6	0	0	1	1.8	0	0	17	64.4
Juvenile whelk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.9
Oxystele sinensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8.2	10	98.7
Oxystele tigrina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxystele variegata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxystele sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	48.1
Juvenile *Oxystele/Turbo*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.6
Haliotis spadicea	0	0	2	9.9	0	0	0	0	0	0	0	0	0	0	3	15.4	50	419.4
Haliotis midae	0	1.7	0	11.6	0	0	0	0	0	0	0	0	0	0		5.5		10.9
Dinoplax gigas	2	8	2	2.7	0	0	0	0	0	0	0	0	0	0	1	1	23	57.2
Land Snail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3	0	0
Barnacle	0	0.2	0	0.3	0	0.1	0	0	0	0	0	0	0	0		0.6		2.7
Total		**1004**		**696.1**		**223.5**		**861.3**		**237.5**		**84.4**		**83.1**		**1152.8**		**5901.6**

LAYER	KATHARINE		LOUISA		MAVIS		NATHAN		NOAH		OMAR		OMAR/PETER		PETER		PAUL	
Shell species	No.	g	No.	g	No.	g	No	g	No.	g	No.	g	No.	g	No.	g	No.	g
Perna perna	630	2974.1	92	257.3	825	1866.6	1086	2690.2	379	768.2	439	1061	181	507.3	205	493.6	319	828
Donax serra	81	603.3	5	17.6	17	115.2	30	167.1	5	18.1	6	57.2	1	0.1	2	11.4	17	90.9
Barbatia obliquata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Donax sordidus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scutellastra argenvillei	6	121.7	1	13.1	3	38.9	5	66.2	0	0	2	10.7	2	23.3	0	0	0	0
Scutellastra barbara	22	469.9	1	39.4	17	193.8	16	197.3	4	25.3	5	66.1	4	39	1	8.3	9	85
Scutellastra cochlear	121	1011.7	14	76.9	130	515.1	252	741.1	40	137	38	189.6	64	0	55	177.6	98	364.7
Scutellastra longicosta	12	177.2	4	48.9	11	118.7	12	79.3	1	2.9	1	3.5	3	22.8	2	11	1	10.5
Scutellastra tabularis	14	585.8	1	24.3	1	194.1	3	191.2	0	0	0	0	0	0	0	0	0	0
Scutellastra granularis	8	2.9	5	1.3	55	33.3	58	22.3	9	8.2	15	6.1	0	0	5	1.5	10	2.5
Cymbula miniata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cymbula oculus	15	279.4	1	11	1	8.8	23	93	0	0	2	8.5	1	4.6	2	8.9	3	16.4
Unidentified limpet	18	63.9	3	5.4	28	93.8	56	182.1	17	61.1	12	40	20	31.4	10	23.7	15	44.8
Juvenile limpet	39	15.4	8	3.7	47	30	170	59.3	30	7.1	47	22	63	0	51	9.3	37	10.7
Dendrofissurella scutellum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fissurellidae unidentified	1	0.3	0	0	0	0	3	0.5	0	0	0	0	2	0.2	2	0.1	3	0.3
Turbo sarmaticus apices	3	97.4	0	0	1	17.2	3	11.4	1	4.4	1	1	0	0	3	7.7	0	0
Turbo sarmaticus opercula	7	24.6	2	7.9	11	42.2	17	46.5	3	2.5	4	7.4	6	20.4	0	0	7	25.4
Turbo cf *cidaris* apices	0	0	0	0	1	0.8	0	0	0	0	0	0	0	0	0	0	0	0
Turbo cf *cidaris* opercula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turbo sp.	0	0	1	1.3	0	0	3	4.5	0	0	0	0	0	0	3	5.3	0	0
Juvenile nerites	0	0	1	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nucella squamosa	0	0	0	0	0	0	0	0	1	2.1	0	0	0	0	0	0	1	1.9
Burnupena	14	74.5	1	0.6	52	88.1	48	66.7	17	38.4	5	6.8	1	0.6	1	0.8	5	9.2
Juvenile whelk	2	2.4	0	0	14	2.2	16	2.2	6	0.8	4	0.3	5	0.1	3	0.3	5	0.3
Oxystele sinensis	10	19	0	0	5	22.5	3	13.1	0	0	0	0	1	5.3	0	0	0	0
Oxystele tigrina	0	1.1	0	0	1	3	1	3.3	3	14.5	1	0.5	0	0	0	0	0	0
Oxystele variegata	0	0	0	0	1	0.6	0	0	0	0	0	0	0	0	0	0	0	0
Oxystele sp.	0	24.4	1	0.9	24	37.9	25	58.4	6	15.3	4	4.2	0	0	1	0.7	3	2.1
Juvenile *Oxystele/Turbo*	0	0	0	0	3	0.4	1	0.4	5	1.3	2	0.1	1	0.1	3	0.3	0	0
Haliotis spadicea	0	527.9	2	10.3	15	70.1	19	125.8	6	11.4	1	8.2	4	12	3	6	4	24.5
Haliotis midae	0	14.3	0	0		5.2		1.4	0	0	0	0	0	0	0	0	0	0
Dinoplax gigas	0	89	6	10.6	7	28.1	12	24	1	0.8	3	3.8	0	0	2	4.5	3	7.9
Land Snail	0	0	0	0	2	0.1	3	0.5	1	0.2	1	2.3	0	0	0	0	1	0.6
Barnacle		5.5		1.2		5.3		10		2.3						1.8		
Total		**7185.7**		**532**		**3532**		**4857.8**		**1121.9**		**1499.6**		**667.2**		**772.8**		**1525.7**

LAYER	PETER/QUINTON		QUINTON		RICHARD		SECTION CUT	
Shell species	No.	g	No.	g	No.	g	No.	g
Perna perna	191	442	57	112.7	1938	5148	153	776.2
Donax serra	1	9.1	7	34.1	32	94.1	19	165.7
Barbatia obliquata	0	0	0	0	2	0.8	0	0
Donax sordidus	0	0	0	0	2	0.9	0	0
Scutellastra argenvillei	0	0	0	0	8	96.1	3	42.2
Scutellastra barbara	7	67.5	1	7.6	19	218	5	125.1
Scutellastra cochlear	38	100.7	9	36.8	631	2452	23	217.2
Scutellastra longicosta	0	0	1	0	32	209.4	11	201.6
Scutellastra tabularis	0	0	0	0	6	357	2	51.8
Scutellastra granularis	2	0.5	3	1.1	33	13.8	3	0.7
Cymbula miniata	0	0	0	0	0	0	0	0
Cymbula oculus	1	5	1	7.2	13	100.8	4	42.3
Unidentified limpet	9	27.3	6	12.2	121	475.1	1	7.2
Juvenile limpet	22	6.7	6	2.3	393	128.6	18	14.8
Dendrofissurella scutellum	0	0	0	0	2	3.3	0	0
***Fissurellidae* unidentified**	0	0	0	0	5	0.3	0	0
***Turbo sarmaticus* apices**	0	0	0	0	7	44.6	1	9
***Turbo sarmaticus* opercula**	0	0	0	0	80	265	1	7.4
***Turbo* cf *cidaris* apices**	0	0	0	0	0	0	0	0
***Turbo* cf *cidaris* opercula**	0	0	0	0	0	0	0	0
***Turbo* sp.**	0	0	0	0	5	6.5	0	0
Juvenile nerites	0	0	0	0	1	2.6	0	0
Nucella squamosa	0	0	0	0	0	0	0	0
Burnupena	3	2.1	2	5.7	10	29.9	4	14.7
Juvenile whelk	0	0	0	0	23	2.3	0	0
Oxystele sinensis	0	0	0	0	0	0	1	7.3
Oxystele tigrina	0	0	0	0	0	0	0	0
Oxystele variegata	0	0	0	0	0	0	0	0
***Oxystele* sp.**	0	0	1	0.6	4	7.7	4	6.9
Juvenile *Oxystele/Turbo*	0	0	0	0	11	3.3	0	0
Haliotis spadicea	3	5.6	0	0	54	161	10	75.5
Haliotis midae	0	0	0	0		15.5	0	0
Dinoplax gigas	1	2.4	1	1.3	19	69.6	4	22.6
Land Snail	0	0	0	0	1	0.2	0	0
Barnacle		0.4				6.7	0	0
Total		**669.3**		**221.6**		**9913.9**		**1788.2**

Table 2. Weights (g) for the shellfish remains recovered from Portia, Hoffman's/Robberg Cave.

LAYER	PORTIA	
Shell species	No.	g
Perna perna	1996	5447.6
Donax serra	4	23.5
Barbatia obliquata	0	0.0
Donax sordidus	0	0.0
Scutellastra argenvillei	40	442.7
Scutellastra barbara	71	932.9
Scutellastra cochlear	790	5511.8
Scutellastra longicosta	55	490.7
Scutellastra tabularis	26	698.7
Scutellastra granularis	17	12.3
Cymbula miniata	2	9.3
Cymbula oculus	43	285.3
Unidentified limpet	136	390.0
Juvenile limpet	75	20.9
Dendrofissurella scutellum	1	0.9
Fissurellidae unidentified	1	0.5
Turbo sarmaticus apices	10	87.3
Turbo sarmaticus opercula	31	125.9
Turbo cf *cidaris* apices	0	0.0
Turbo cf *cidaris* opercula	0	0.0
Turbo sp.	0	0.0
Juvenile nerites	0	0.0
Nucella squamosa	0	0.0
Burnupena	27	119.6
Juvenile whelk	3	0.5
Oxystele sinensis	5	38.5
Oxystele tigrina	3	15.4
Oxystele variegata	1	1.0
Oxystele sp.	25	43.2
Juvenile *Oxystele/Turbo*	0	0.0
Haliotis spadicea	56	276.0
Haliotis midae	0	2.2
Dinoplax gigas	4	16.7
Land Snail	0	0.0
Barnacle	0	2.8
Total g counted shells		**14996.2**
Total g fragments		**14917.7**
Total		**29913.9**

Table 3. Weights (g) for the shellfish remains recovered from the Noetzie midden.

LAYER	G8L2		G8 L4		G8 L10		G8 L13		G8 L 17	
Shell species	No.	g	No.	g	No.	g	No.	g	No.	g
Perna perna	4202	1846.7	1881	937.6	3228	1752	1257	800.7	702	549
Donax serra	0	0	1	0.6	0	0	1	0.5	2	5.9
Scutellastra argenvillei	1	16.3	10	97.2	1	8.7	2	41.6	2	32.1
Scutellastra barbara	0	0	18	272.9	19	202.2	10	212.7	24	375.7
Scutellastra cochlear	1	8.8	33	169.5	132	612.4	13	108.4	9	102.8
Scutellastra longicosta	6	79.9	97	811.5	55	375.1	93	904.2	38	516.7
Scutellastra tabularis	5	414.4	22	996.2	6	554.9	19	1422.4	7	445.3
S barbara/longicosta	0	0	5	66.5	12	184.3	5	40.8	5	35.3
S barbara/tabularis	1	7.6	0	0	0	0	0	0	0	0
Cymbula granularis	71	17.6	0	0	1	2.2	2	2.3	1	0.8
Cymbula miniata	0	0	0	0	1	3.4	5	81	0	0
Cymbula oculus	5	28.5	36	325.2	10	74.8	55	562.7	8	69.3
Unidentified limpet	6	16.7	125	308.4	48	112.7	79	183.5	39	138.1
Juvenile limpet	91	24.3	259	45.8	357	85.9	116	33.6	93	28.9
Fissurella aperta	0	0	0	0	0	0	0	0	0	0.0
Fissurella mutabilis	0	0	3	0.3	0	0	0	0	0	0.0
Dendrofissurella scutellum	2	0.9	0	0	0	0	2	0.6	0	0.0
Fissurellidae unidentified	13	0.8	1	0.03	9	0.3	6	0.1	0	0.0
Turbo sarmaticus apices	66	185.8	164	1032.9	137	1554.1	116	859.4	87	633.3
Turbo sarmaticus opercula	50	858.2	218	490.3	128	383.3	132	372.6	67	255.8
Turbo cf cidaris apices	0	0	4	7.1	0	0	2	11.8	1	2.2
Turbo cidaris opercula	0	0	0	0	1	0.14	1	0.1	0	0.0
Turbo sp.	25	15.5	111	132.3	21	30.1	18	18	0	0.0
Juvenile nerites	0	0	12	2.6	0	0	0	0	4	1.7
Nucella squamosa	2	5.1	2	0.85	2	2.4	0	0	2	1.1
Burnupena	13	37.4	69	169.9	4	4.9	5	6.7	1	1.3
Bullia unidentified	3	0.4	0	0	0	0	0	0	0	0.0
Juvenile whelk	33	3.5	23	2.2	14	1.46	8	2.2	3	0.8
Oxystele sinensis	23	106.9	44	218.6	3	16	14	34.3	1	2.3
Oxystele tigrina	35	82.9	21	81.8	1	0.43	0	0	0	0.0
Oxystele variegata	0	0	2	0.69	0	0	1	1.8	0	0.0
Oxystele sp.	19	12.4	47	26.8	3	0.46	13	12.5	0	0.0
Juvenile *Oxystele*	0	0	0	0	0	0	2		1	0.0
Juvenile Oxystele/Turbo	31	4.9	131	31.8	0	0	0	0	0	0.0
Land snail	3	0.5	3	0.2	4	1.19	14	5.3	5	1.3
Haliotis spadicea	3	6.4	49	15.4	33	61.7	37	46.2	15	35.0
Haliotis midae	0	0	0	2.76	0	20.2		1.7		7.3
Dinoplax gigas	6	35.9	24	90.9	18	40.1	70	151	3	13.8
Barnacle		17.6		30.2		88.6		18.7		29.9
Weight identified specimens		**3835.9**		**6369.0**		**6173.98**		**5937.4**		**3285.7**
Bulk sample weight		**12317.2**		**25211.4**		**19537.8**		**16067.9**		**10849.5**
Total Weight		**16153.1**		**31580.4**		**25711.8**		**22005.3**		**14135.2**

APPENDIX C

KOLMOGOROV – SMIRNOV TESTS ON *S. COCHLEAR* AND *T. SARMATICUS* OPERCULA FROM HOFFMAN'S/ROBBERG CAVE, AND *T. SARMATICUS* OPERCULA FROM THE NOETZIE AND PAAPKUILFONTEIN MIDDENS

Test 1. Kolmogorov-Smirnov test on small samples of *S. cochlear* from KATHARINE (D4a&D5b) and NATHAN (D4a&D5b).

Size category	KATHARINE	f	NATHAN	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	4	0.091	14	0.206	0.091	0.206	0.115
25 - 29.9mm	2	0.045	15	0.221	0.136	0.427	0.291
30 – 34.9mm	5	0.114	4	0.059	0.250	0.485	0.235
35 – 39.9mm	1	0.023	2	0.029	0.273	0.515	0.242
40 – 44.9mm	1	0.023	2	0.029	0.296	0.544	0.248
45 – 49.9mm	3	0.068	9	0.132	0.364	0.677	0.313
50 – 54.9mm	3	0.068	11	0.162	0.432	0.838	0.406
55 – 59.9mm	9	0.205	5	0.074	0.636	0.912	0.276
60 – 64.9mm	10	0.227	6	0.088	0.864	1.000	0.136
65 – 69.9mm	4	0.091	0	0.000	0.955	1.000	0.045
70 – 74.9mm	2	0.045	0	0.000	1.000	1.000	0
75 – 79.9mm	0	0.000	0	0.000	1.000	1.000	0
Total:	**44**	1	**68**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\ (n1 \mathrm{x} n2)}$

$1.36\sqrt{(44+68)\ (44 \mathrm{x} 68)} = 0.263$

Dmax = 0.406

0.406 > 0.263

Therefore reject H0 that there is no significant difference between KATHARINE and NATHAN

Test 2. Kolmogorov – Smirnov test on small samples of *S. cochlear* from KATHARINE (D4a&D5b) and RICHARD (D4a&D5b).

Size category	KATHARINE	f	RICHARD	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	4	0.091	36	0.336	0.091	0.336	0.245
25 0 29.9mm	2	0.045	24	0.224	0.136	0.560	0.424
30 – 34.9mm	5	0.114	8	0.075	0.250	0.635	0.385
35 – 39.9mm	1	0.023	2	0.019	0.273	0.654	0.381
40 – 44.9mm	1	0.023	2	0.019	0.296	0.672	0.376
45 – 49.9mm	3	0.068	6	0.056	0.364	0.729	0.365
50 – 54.9mm	3	0.068	9	0.084	0.432	0.813	0.381
55 – 59.9mm	9	0.205	11	0.103	0.636	0.915	0.279
60 – 64.9mm	10	0.227	7	0.065	0.864	0.981	0.116
65 – 69.9mm	4	0.091	2	0.019	0.955	1.000	0.045
70 – 74.9mm	2	0.045	0	0.000	1.000	1.000	0
75 – 79.9mm	0	0.000	0	0.000	1.000	1.000	0
Total:	**44**	1	**107**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\ (n1 \mathrm{x} n2)}$

$1.36\sqrt{(44+107)\ (44 \mathrm{x} 107)} = 0.243$

Dmax = 0.424

0.424 > 0.243

Therefore reject H0 that there is no significant difference between KATHARINE and RICHARD

Test 3. Kolmogorov-Smirnov test for small samples of *S. cochlear* from NATHAN (D4a&D5b) and RICHARD (D4a&D5b).

Size category	NATHAN	f	RICHARD	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	14	0.336	36	0.336	0.206	0.336	0.130
25 0 29.9mm	15	0.224	24	0.224	0.427	0.560	0.133
30 – 34.9mm	4	0.075	8	0.075	0.485	0.635	0.150
35 – 39.9mm	2	0.019	2	0.019	0.515	0.654	0.139
40 – 44.9mm	2	0.019	2	0.019	0.544	0.672	0.128
45 – 49.9mm	9	0.056	6	0.056	0.677	0.729	0.052
50 – 54.9mm	11	0.084	9	0.084	0.838	0.813	0.025
55 – 59.9mm	5	0.103	11	0.103	0.912	0.915	0.003
60 – 64.9mm	6	0.065	7	0.065	1.000	0.981	0.019
65 – 69.9mm	0	0.019	2	0.019	1.000	1.000	0.000
70 – 74.9mm	0	0.000	0	0.000	1.000	1.000	0.000
75 – 79.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**68**	1	**107**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\ (n1 \mathrm{x} n2)}$

1.36√(68+107) (68x107) = 0.210

Dmax = 0.150

0.150 < 0.210

Therefore accept H0 that there is no significant difference between NATHAN and RICHARD

Test 4. Kolmogorov-Smirnov test for expanded samples of *S. cochlear* from the combined *Zostera* – dominated units and KATHARINE.

Size category	*Zostera* beds	f	KATHARINE	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	0	0.000	4	0.038	0.000	0.038	0.038
25 - 29.9mm	0	0.000	6	0.058	0.000	0.096	0.096
30 – 34.9mm	0	0.000	5	0.048	0.000	0.144	0.144
35 – 39.9mm	0	0.000	3	0.029	0.000	0.173	0.173
40 – 44.9mm	2	0.043	4	0.038	0.043	0.211	0.168
45 – 49.9mm	8	0.174	11	0.106	0.217	0.317	0.100
50 – 54.9mm	15	0.326	10	0.096	0.543	0.413	0.130
55 – 59.9mm	12	0.261	16	0.154	0.804	0.567	0.237
60 – 64.9mm	8	0.174	22	0.212	0.978	0.778	0.200
65 – 69.9mm	1	0.022	15	0.144	1.000	0.923	0.077
70 – 74.9mm	0	0.000	7	0.067	1.000	0.990	0.010
75 – 79.9mm	0	0.000	1	0.010	1.000	1.000	0
Total:	**46**	1	**104**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\ (n1 \mathrm{x} n2)}$

1.36√(46+104) (46x104) = 0.240

Dmax – 0.237

0.237 < 0.240

Therefore accept H0 that there is no significant difference between the *Zostera* – dominated units and KATHARINE

Test 5. Kolmogorov – Smirnov test for expanded samples of *S. cochlear* from the *Zostera* – dominated units and NATHAN.

Size category	*Zostera* beds	f	NATHAN	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	0	0.000	38	0.273	0.000	0.273	0.273
25 0 29.9mm	0	0.000	24	0.173	0.000	0.446	0.446
30 – 34.9mm	0	0.000	5	0.036	0.000	0.482	0.482
35 – 39.9mm	0	0.000	3	0.022	0.000	0.503	0.503
40 – 44.9mm	2	0.043	7	0.050	0.043	0.554	0.511
45 – 49.9mm	8	0.174	13	0.094	0.217	0.647	0.430
50 – 54.9mm	15	0.326	26	0.187	0.543	0.834	0.291
55 – 59.9mm	12	0.261	9	0.065	0.804	0.899	0.095
60 – 64.9mm	8	0.174	12	0.086	0.978	0.985	0.007
65 – 69.9mm	1	0.022	2	0.014	1.000	1.000	0
70 – 74.9mm	0	0.000	0	0.000	1.000	1.000	0
75 – 79.9mm	0	0.000	0	0.000	1.000	1.000	0
Total:	**46**	1	**139**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(46+139) (46X139) = 0.231

Dmax = 0.482

0.482 > 0.231

Therefore reject H0 that there is no significant difference between *Zostera* – dominated units and NATHAN

Test 6. Kolmogorov-Smirnov test for expanded samples of *S. cochlear* from the *Zostera* – dominated units and PORTIA.

Size category	*Zostera* beds	f	PORTIA	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	0	0.000	16	0.066	0.000	0.066	0.066
25 0 29.9mm	0	0.000	17	0.070	0.000	0.136	0.136
30 – 34.9mm	0	0.000	8	0.033	0.000	0.169	0.169
35 – 39.9mm	0	0.000	2	0.008	0.000	0.177	0.177
40 – 44.9mm	2	0.043	10	0.041	0.043	0.218	0.175
45 – 49.9mm	8	0.174	36	0.148	0.217	0.366	0.149
50 – 54.9mm	15	0.326	78	0.321	0.543	0.687	0.144
55 – 59.9mm	12	0.261	43	0.177	0.804	0.864	0.060
60 – 64.9mm	8	0.174	18	0.074	0.978	0.938	0.040
65 – 69.9mm	1	0.022	11	0.045	1.000	0.984	0.016
70 – 74.9mm	0	0.000	4	0.016	1.000	1.000	0
75 – 79.9mm	0	0.000	0	0.000	1.000	1.000	0
Total:	**46**	1	**243**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(46+243) (46x243) = 0.218

Dmax = 0.177

0.177 < 0.218

Therefore accept H0 that there is no significant difference between *Zostera* – dominated units and PORTIA

Test 7. Kolmogorov – Smirnov tests for expanded samples of *S. cochlear* from the *Zostera* – dominated units and RICHARD.

Size category	*Zostera* beds	f	RICHARD	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	0	0.000	58	0.322	0.000	0.322	0.322
25 0 29.9mm	0	0.000	36	0.200	0.000	0.522	0.522
30 – 34.9mm	0	0.000	10	0.056	0.000	0.578	0.578
35 – 39.9mm	0	0.000	3	0.017	0.000	0.594	0.594
40 – 44.9mm	2	0.043	3	0.006	0.043	0.600	0.577
45 – 49.9mm	8	0.174	24	0.133	0.217	0.733	0.516
50 – 54.9mm	15	0.326	20	0.111	0.543	0.844	0.301
55 – 59.9mm	12	0.261	13	0.072	0.804	0.916	0.112
60 – 64.9mm	8	0.174	12	0.067	0.978	0.983	0.005
65 – 69.9mm	1	0.022	1	0.006	1.000	0.989	0.011
70 – 74.9mm	0	0.000	0	0.000	1.000	0.989	0.011
75 – 79.9mm	0	0.000	0	0.000	1.000	0.989	0.011
Total:	**46**	1	**180**	0.989			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(46+180) (46x180) = 0.356

Dmax = 0.594

0.594 > 0.356

Therefore reject H0 that there is no significant difference between the *Zostera* – dominated units and RICHARD

Test 8. Kolmogorov-Smirnov test for expanded samples of *S. cochlear* from KATHARINE and NATHAN.

Size category	KATHARINE	f	NATHAN	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	4	0.038	38	0.273	0.038	0.273	0.235
25 - 29.9mm	6	0.058	24	0.173	0.096	0.446	0.350
30 – 34.9mm	5	0.048	5	0.036	0.144	0.482	0.338
35 – 39.9mm	3	0.029	3	0.022	0.173	0.503	0.335
40 – 44.9mm	4	0.038	7	0.050	0.211	0.554	0.343
45 – 49.9mm	11	0.106	13	0.094	0.317	0.647	0.330
50 – 54.9mm	10	0.096	26	0.187	0.413	0.834	0.430
55 – 59.9mm	16	0.154	9	0.065	0.567	0.899	0.332
60 – 64.9mm	22	0.212	12	0.086	0.778	0.985	0.207
65 – 69.9mm	15	0.144	2	0.014	0.923	1.000	0.077
70 – 74.9mm	7	0.067	0	0.000	0.990	1.000	0.010
75 – 79.9mm	1	0.010	0	0.000	1.000	1.000	0
Total:	**104**	1	**139**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(104+139) (104x139) = 0.176

Dmax = 0.430

0.430 > 0.176

Therefore reject H0 that there is no significant difference between KATHARINE and NATHAN.

Test 9. Kolmogorov – Smirnov test for expanded samples of *S. cochlear* from KATHARINE and PORTIA.

Size category	**KATHARINE**	**f**	**PORTIA**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
20 – 24.9mm	4	0.038	16	0.066	0.038	0.066	0.028
25 - 29.9mm	6	0.058	17	0.070	0.096	0.136	0.040
30 – 34.9mm	5	0.048	8	0.033	0.144	0.169	0.025
35 – 39.9mm	3	0.029	2	0.008	0.173	0.177	0.004
40 – 44.9mm	4	0.038	10	0.041	0.211	0.218	0.007
45 – 49.9mm	11	0.106	36	0.148	0.317	0.366	0.049
50 – 54.9mm	10	0.096	78	0.321	0.413	0.687	0.274
55 – 59.9mm	16	0.154	43	0.177	0.567	0.864	0.297
60 – 64.9mm	22	0.212	18	0.074	0.778	0.938	0.160
65 – 69.9mm	15	0.144	11	0.045	0.923	0.984	0.061
70 – 74.9mm	7	0.067	4	0.016	0.990	1.000	0.010
75 – 79.9mm	1	0.010	0	0.000	1.000	1.000	0
Total:	**104**	1	**243**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(104+243) (104x243) = 0.159

Dmax = 0.297

0.297 > 0.159

Therefore reject H0 that there is no significant difference between KATHARINE and PORTIA

Test 10. Kolmogorov – Smirnov test for expanded samples of *S. cochlear* from KATHARINE and RICHARD.

Size category	**KATHARINE**	**f**	**RICHARD**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
20 – 24.9mm	4	0.038	58	0.322	0.038	0.322	0.284
25 0 29.9mm	6	0.058	36	0.200	0.096	0.522	0.426
30 – 34.9mm	5	0.048	10	0.056	0.144	0.578	0.434
35 – 39.9mm	3	0.029	3	0.017	0.173	0.594	0.421
40 – 44.9mm	4	0.038	3	0.006	0.211	0.600	0.389
45 – 49.9mm	11	0.106	24	0.133	0.317	0.733	0.416
50 – 54.9mm	10	0.096	20	0.111	0.413	0.844	0.431
55 – 59.9mm	16	0.154	13	0.072	0.567	0.916	0.349
60 – 64.9mm	22	0.212	12	0.067	0.778	0.983	0.205
65 – 69.9mm	15	0.144	1	0.006	0.923	0.989	0.066
70 – 74.9mm	7	0.067	0	0.000	0.990	0.989	0.001
75 – 79.9mm	1	0.010	0	0.000	1.000	0.989	0.011
Total:	**104**	1	**180**	0.989			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(104+180) (104x180) = 0.167

Dmax = 0.434

0.434 > 0.167

Therefore reject H0 that there is no significant difference between KATHARINE and RICHARD

Test 11. Kolmogorov – Smirnov test for expanded samples of *S. cochlear* from NATHAN and PORTIA.

Size category	NATHAN	f	PORTIA	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	38	0.273	16	0.066	0.273	0.066	0.207
25 0 29.9mm	24	0.173	17	0.070	0.446	0.136	0.310
30 – 34.9mm	5	0.036	8	0.033	0.482	0.169	0.313
35 – 39.9mm	3	0.022	2	0.008	0.503	0.177	0.326
40 – 44.9mm	7	0.050	10	0.041	0.554	0.218	0.336
45 – 49.9mm	13	0.094	36	0.148	0.647	0.366	0.281
50 – 54.9mm	26	0.187	78	0.321	0.834	0.687	0.147
55 – 59.9mm	9	0.065	43	0.177	0.899	0.864	0.035
60 – 64.9mm	12	0.086	18	0.074	0.985	0.938	0.047
65 – 69.9mm	2	0.014	11	0.045	1.000	0.984	0.016
70 – 74.9mm	0	0.000	4	0.016	1.000	1.000	0
75 – 79.9mm	0	0.000	0	0.000	1.000	1.000	0
Total:	**139**	1	**243**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(139+243) (139x243) = 0.144

Dmax: 0.336

0.336 > 0.144

Therefore reject H0 that there is no significant difference between NATHAN and PORTIA

Test 12. Kolmogorov – Smirnov test for expanded samples of *S. cochlear* from NATHAN and RICHARD.

Size category	NATHAN	f	RICHARD	f	Cumulative % 1	Cumulative % 2	Difference
20 – 24.9mm	38	0.273	58	0.322	0.273	0.322	0.049
25 0 29.9mm	24	0.173	36	0.200	0.446	0.522	0.076
30 – 34.9mm	5	0.036	10	0.056	0.482	0.578	0.096
35 – 39.9mm	3	0.022	3	0.017	0.503	0.594	0.091
40 – 44.9mm	7	0.050	3	0.006	0.554	0.600	0.046
45 – 49.9mm	13	0.094	24	0.133	0.647	0.733	0.086
50 – 54.9mm	26	0.187	20	0.111	0.834	0.844	0.010
55 – 59.9mm	9	0.065	13	0.072	0.899	0.916	0.017
60 – 64.9mm	12	0.086	12	0.067	0.985	0.983	0.002
65 – 69.9mm	2	0.014	1	0.006	1.000	0.989	0.011
70 – 74.9mm	0	0.000	0	0.000	1.000	0.989	0.011
75 – 79.9mm	0	0.000	0	0.000	1.000	0.989	0.011
Total:	**139**	1	**180**	0.989			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(139+180) (139x180) = 0.153

Dmax – 0.096

0.096 < o.153

Therefore accept H0 that there is no significant difference between NATHAN and PORTIA

Test 13. Kolmogorov-Smirnov test for expanded samples of *S. cochlear* from PORTIA and RICHARD.

Size category	PORTIA	f	RICHARD	f	Cumulative 1	Cumulative 2	Difference
20 – 24.9mm	16	0.066	58	0.322	0.066	0.322	0.256
25 0 29.9mm	17	0.070	36	0.200	0.136	0.522	0.386
30 – 34.9mm	8	0.033	10	0.056	0.169	0.578	0.409
35 – 39.9mm	2	0.008	3	0.017	0.177	0.594	0.417
40 – 44.9mm	10	0.041	3	0.006	0.218	0.600	0.382
45 – 49.9mm	36	0.148	24	0.133	0.366	0.733	0.367
50 – 54.9mm	78	0.321	20	0.111	0.687	0.844	0.157
55 – 59.9mm	43	0.177	13	0.072	0.864	0.916	0.052
60 – 64.9mm	18	0.074	12	0.067	0.938	0.983	0.045
65 – 69.9mm	11	0.045	1	0.006	0.984	0.989	0.005
70 – 74.9mm	4	0.016	0	0.000	1.000	0.989	0.011
75 – 79.9mm	0	0.000	0	0.000	1.000	0.989	0.011
Total:	**243**	*1*	**180**	0.989			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(243+180) (234x180) = 0.133

Dmax – 0.417

0.417 > 0.133

Therefore reject H0 that there is no statistically significant different between PORTIA and RICHARD

Test 14. Kolmogorov – Smirnov test on *T. sarmaticus* opercula from the *Zostera* – dominated units and NATHAN.

Size category	*Zostera* beds	f	NATHAN	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	0	0.000	2	0.125	0.000	0.125	0.125
15 – 19.9mm	3	0.077	2	0.125	0.077	0.250	0.173
20 – 24.9mm	12	0.308	7	0.438	0.385	0.688	0.303
25 – 29.9mm	11	0.282	2	0.125	0.667	0.813	0.146
30 – 34.9mm	7	0.179	2	0.125	0.846	0.938	0.092
35 – 39.9mm	5	0.128	1	0.063	0.974	1.000	0.026
40 – 44.9mm	1	0.026	0	0.000	1.000	1.000	0
45 – 49.9mm	0	0.000	0	0.000.	1.000	1.000	0
Total:	**39**	1	**16**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(39+16) (39x16) = 0403

Dmax: 0.303

0.303 > 0.403

Therefore accept H0 that there is no significant difference between the *Zostera* – dominated units and NATHAN

Test 15. Kolmogorov – Smirnov test on *T. sarmaticus* opercula from the *Zostera* – dominated units and PORTIA.

Size category	***Zostera* beds**	**f**	**PORTIA**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	0	0.000	0	0.000	0.000	0.000	0.000
15 – 19.9mm	3	0.077	11	0.306	0.077	0.306	0.229
20 – 24.9mm	12	0.308	11	0.306	0.385	0.612	0.227
25 – 29.9mm	11	0.282	9	0.250	0.667	0.862	0.185
30 – 34.9mm	7	0.179	3	0.083	0.846	0.945	0.099
35 – 39.9mm	5	0.128	2	0.056	0.974	1.000	0.026
40 – 44.9mm	1	0.026	0	0	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0	1.000	1.000	0.000
Total:	**39**	1	**36**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(39+36) (39x36) = 0.314

Dmax: 0.229

0.229 < 0.314

Therefore accept H0 that there is no statistically significant difference between the *Zostera* – dominated units and PORTA

Test 16. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from the *Zostera* – dominated units and RICHARD.

Size category	***Zostera* beds**	**f**	**RICHARD**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	0	0.000	1	0.026	0.000	0.026	0.026
15 – 19.9mm	3	0.077	6	0.158	0.077	0.184	0.107
20 – 24.9mm	12	0.308	12	0.316	0.385	0.500	0.115
25 – 29.9mm	11	0.282	8	0.211	0.667	0.710	0.043
30 – 34.9mm	7	0.179	8	0.211	0.846	0.921	0.075
35 – 39.9mm	5	0.128	1	0.026	0.974	0.947	0.000
40 – 44.9mm	1	0.026	2	0.053	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**39**	1	**38**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(39+38) (39x38) = 0.316

Dmax: 0.115

0.115 > 0.316

Therefore accept H0 that there is no significant difference between the *Zostera* – dominated units and RICHARD

Test 17. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from NATHAN and PORTIA.

Size category	NATHAN	f	PORTIA	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	2	0.125	0	0.000	0.125	0.000	0.125
15 – 19.9mm	2	0.125	11	0.306	0.250	0.306	0.056
20 – 24.9mm	7	0.438	11	0.306	0.688	0.612	0.076
25 – 29.9mm	2	0.125	9	0.250	0.813	0.862	0.049
30 – 34.9mm	2	0.125	3	0.083	0.938	0.945	0.007
35 – 39.9mm	1	0.063	2	0.056	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000.	0	0.000	1.000	1.000	0.000
Total:	**16**	1	**36**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(16+36) (16x36) = 0.408

Dmax = 0.125

0.125 < 0.408

Therefore accept H0 that there is no significant difference between NATHAN and PORTIA

Test 18. Kolmogorov-Smirnov test for *T. sarmaticus* opercula from NATHAN and RICHARD.

Size category	NATHAN	f	RICHARD	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	2	0.125	1	0.026	0.125	0.026	0.099
15 – 19.9mm	2	0.125	6	0.158	0.250	0.184	0.066
20 – 24.9mm	7	0.438	12	0.316	0.688	0.500	0.188
25 – 29.9mm	2	0.125	8	0.211	0.813	0.710	0.103
30 – 34.9mm	2	0.125	8	0.211	0.938	0.921	0.017
35 – 39.9mm	1	0.063	1	0.026	1.000	0.947	0.053
40 – 44.9mm	0	0.000	2	0.053	1.000	1.000	0.000
45 – 49.9mm	0	0.000.	0	0.000	1.000	1.000	0.000
Total:	**16**	1	**38**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(16+38) (16x38) = 0.405

Dmax = 0.188

0.188 < 0.405

Therefore accept H0 that there is no significant difference between NATHAN and RICHARD

Test 19. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from PORTIA and RICHARD.

Size category	**PORTIA**	**f**	**RICHARD**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	0	0.000	1	0.026	0.000	0.026	0.026
15 – 19.9mm	11	0.306	6	0.158	0.306	0.184	0.122
20 – 24.9mm	11	0.306	12	0.316	0.612	0.500	0.112
25 – 29.9mm	9	0.250	8	0.211	0.862	0.710	0.152
30 – 34.9mm	3	0.083	8	0.211	0.945	0.921	0.024
35 – 39.9mm	2	0.056	1	0.026	1.000	0.947	0.053
40 – 44.9mm	0	0	2	0.053	1.000	1.000	0.000
45 – 49.9mm	0	0	0	0.000	1.000	1.000	0.000
Total:	**36**	1	**38**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(36+38) (36x38) = 0.316

Dmax = 0.152

0.152 < 0.316

Therefore accept H0 that there is no significant difference between PORTIA and RICHARD

Test 20. Kolmogorov – Smirnov test for small samples of *T. sarmaticus* opercula from G8L2 and G8L4.

Size category	**G8L2**	**f**	**G8L4**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	1	0.043	9	0.155	0.043	0.155	0.112
15 – 19.9mm	3	0.130	26	0.448	0.174	0.603	0.429
20 – 24.9mm	5	0.217	13	0.224	0.391	0.827	0.436
25 – 29.9mm	5	0.217	4	0.069	0.609	0.896	0.287
30 – 34.9mm	7	0.304	4	0.069	0.913	0.965	0.052
35 – 39.9mm	2	0.087	2	0.034	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**23**	1	**58**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(23+58) (23x58) = 0.335

Dmax = 0.436

0.436 > 0.335

Therefore reject H0 that there is no significant difference between G8L2 and G8L4

Test 21. Kolmogorov - Smirnov test for small samples of *T. sarmaticus* opercula from G8L2 and G8L10.

Size category	G8L2	f	G8L10	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	1	0.043	2	0.040	0.043	0.040	0.003
15 – 19.9mm	3	0.130	19	0.380	0.174	0.420	0.246
20 – 24.9mm	5	0.217	13	0.260	0.391	0.680	0.289
25 – 29.9mm	5	0.217	9	0.180	0.609	0.860	0.251
30 – 34.9mm	7	0.304	4	0.080	0.913	0.940	0.027
35 – 39.9mm	2	0.087	3	0.060	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**23**	1	**50**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(23+50) (23x50) = 0.342

Dmax = 0.289

0.298 < 0.342

Therefore accept H0 that there is no significant difference between G8L2 and G8L10

Test 22. Kolmogorov – Smirnov test for small samples of *T. sarmaticus* opercula from G8L2 and G8L13.

Size category	G8L2	f	G8L13	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	1	0.043	1	0.029	0.043	0.029	0.014
15 – 19.9mm	3	0.130	6	0.171	0.174	0.200	0.026
20 – 24.9mm	5	0.217	14	0.400	0.391	0.600	0.209
25 – 29.9mm	5	0.217	10	0.290	0.609	0.890	0.281
30 – 34.9mm	7	0.304	1	0.029	0.913	0.919	0.006
35 – 39.9mm	2	0.087	3	0.080	1.000	0.999	0.001
40 – 44.9mm	0	0.000	0	0.000	1.000	0.999	0.001
45 – 49.9mm	0	0.000	0	0.000	1.000	0.999	0.001
Total:	**23**	1	**35**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(23+35) (23x35) = 0.365

Dmax = 0.281

0.281 < 0.365

Therefore accept H0 that there is no significant difference between G8L2 and G8L13

Test 23. Kolmogorov – Smirnov test for small samples of *T. sarmaticus* opercula from G8L2 and G8L17.

Size category	G8L2	f	G8L17	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	1	0.042	0.000	0.042	0.042
10 – 14.9mm	1	0.043	1	0.042	0.043	0.084	0.041
15 – 19.9mm	3	0.130	2	0.083	0.174	0.167	0.007
20 – 24.9mm	5	0.217	5	0.208	0.391	0.375	0.016
25 – 29.9mm	5	0.217	6	0.250	0.609	0.625	0.016
30 – 34.9mm	7	0.304	7	0.300	0.913	0.925	0.012
35 – 39.9mm	2	0.087	2	0.083	1.000	1.009	0.009
40 – 44.9mm	0	0.000	0	0.000	1.000	1.009	0.009
45 – 49.9mm	0	0.000	0	0.000	1.000	1.009	0.009
Total:	**23**	1	**24**	1.010			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\,(n1 \mathrm{x} n2)}$

$1.36\sqrt{(23+24)\,(23\mathrm{x}24)} = 0.396$

Dmax = 0.042

0.042 < 0.396

Therefore accept H0 that there is no significant difference between G8L2 and G8L17

Test 24. Kolmogorov – Smirnov test for small sample of *T. sarmaticus* opercula from G8L4 and G8L10.

Size category	G8L4	f	G8L10	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	9	0.155	2	0.040	0.155	0.040	0.115
15 – 19.9mm	26	0.448	19	0.380	0.603	0.420	0.183
20 – 24.9mm	13	0.224	13	0.260	0.827	0.680	0.147
25 – 29.9mm	4	0.069	9	0.180	0.896	0.860	0.036
30 – 34.9mm	4	0.069	4	0.080	0.965	0.940	0.025
35 – 39.9mm	2	0.034	3	0.060	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**58**	1	**50**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\,(n1 \mathrm{x} n2)}$

$1.36\sqrt{(58+50)\,(58\mathrm{x}50)} = 0.262$

Dmax = 0.183

0.183 < 0.262

Therefore accept H0 that there is no significant difference between G8L4 and G8L10

Test 25. Kolmogorov – Smirnov test for small samples of *T. sarmaticus* opercula from G8L4 and G8L13.

Size category	**G8L4**	**f**	**G8L13**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	9	0.155	1	0.029	0.155	0.029	0.026
15 – 19.9mm	26	0.448	6	0.171	0.603	0.200	0.403
20 – 24.9mm	13	0.224	14	0.400	0.827	0.600	0.227
25 – 29.9mm	4	0.069	10	0.290	0.896	0.890	0.006
30 – 34.9mm	4	0.069	1	0.029	0.965	0.919	0.046
35 – 39.9mm	2	0.034	3	0.080	1.000	0.999	0.001
40 – 44.9mm	0	0.000	0	0.000	1.000	0.999	0.001
45 – 49.9mm	0	0.000	0	0.000	1.000	0.999	0.001
Total:	**58**	1	**35**	1			

Significance level: 0.05

1.36√(n1+n2) (n1xn2)

1.36√(58+35) (58x35) = 0.291

Dmax = 0.403

0.403 > 0.291

Therefore reject H0 that there is no significant difference between G8L4 and G8L13

Test 26. Kolmogorov – Smirnov test for small samples of *T. sarmaticus* opercula from G8L4 and G8L17.

Size category	**G8L4**	**f**	**G8L17**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	1	0.042	0.000	0.042	0.042
10 – 14.9mm	9	0.155	1	0.042	0.155	0.084	0.071
15 – 19.9mm	26	0.448	2	0.083	0.603	0.167	0.441
20 – 24.9mm	13	0.224	5	0.208	0.827	0.375	0.452
25 – 29.9mm	4	0.069	6	0.250	0.896	0.625	0.271
30 – 34.9mm	4	0.069	7	0.300	0.965	0.925	0.040
35 – 39.9mm	2	0.034	2	0.083	1.000	1.009	0.009
40 – 44.9mm	0	0.000	0	0.000	1.000	1.009	0.009
45 – 49.9mm	0	0.000	0	0.000	1.000	1.009	0.009
Total:	**58**	1	**24**	1.010			

Significance level: 0.05

1.36√(n1+n2) (n1xn2)

1.36√(58+24) (58x24) = 0.330

Dmax = 0.452

0.452 > 0.330

Therefore reject H0 that there is no significant difference between G8L4 and G8L17

Test 27. Kolmogorov – Smirnov test for small samples of *T. sarmaticus* opercula from G8L10 and G8L13.

Size category	**G8L10**	**f**	**G8L13**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	2	0.040	1	0.029	0.040	0.029	0.011
15 – 19.9mm	19	0.380	6	0.171	0.420	0.200	0.220
20 – 24.9mm	13	0.260	14	0.400	0.680	0.600	0.080
25 – 29.9mm	9	0.180	10	0.290	0.860	0.890	0.030
30 – 34.9mm	4	0.080	1	0.029	0.940	0.919	0.021
35 – 39.9mm	3	0.060	3	0.080	1.000	0.999	0.001
40 – 44.9mm	0	0.000	0	0.000	1.000	0.999	0.001
45 – 49.9mm	0	0.000	0	0.000	1.000	0.999	0.001
Total:	**50**	1	**35**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\ (n1 \mathrm{x} n2)}$

$1.36\sqrt{(50+35)\ (50 \mathrm{x} 35)} = 0.229$

Dmax = 0.220

0.220 < 0.229

Therefore accept H0 that there is no significant difference between G8L10 and G8L13

Test 28. Kolmogorov-Smirnov test for small samples of *T. sarmaticus* opercula from G8L10 and G8L17.

Size category	**G8L10**	**f**	**G8L17**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	1	0.042	0.000	0.042	0.042
10 – 14.9mm	2	0.040	1	0.042	0.040	0.084	0.044
15 – 19.9mm	19	0.380	2	0.083	0.420	0.167	0.253
20 – 24.9mm	13	0.260	5	0.208	0.680	0.375	0.305
25 – 29.9mm	9	0.180	6	0.250	0.860	0.625	0.235
30 – 34.9mm	4	0.080	7	0.300	0.940	0.925	0.015
35 – 39.9mm	3	0.060	2	0.083	1.000	1.009	0.009
40 – 44.9mm	0	0.000	0	0.000	1.000	1.009	0.009
45 – 49.9mm	0	0.000	0	0.000	1.000	1.009	0.009
Total:	**50**	1	**24**	1.010			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\ (n1 \mathrm{x} n2)}$

$1.36\sqrt{(50+24)\ (50 \mathrm{x} 24)} = 0.337$

Dmax = 0.305

0.305 < 0.337

Therefore accept H0 that there is no significant difference between G8L10 and G8L17

Test 29. Kolmogorov – Smirnov test for small samples of *T. sarmaticus* opercula from G8L13 and G8L17.

Size category	G8L13	f	G8L17	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	1	0.042	0.000	0.042	0.042
10 – 14.9mm	1	0.029	1	0.042	0.029	0.084	0.055
15 – 19.9mm	6	0.171	2	0.083	0.200	0.167	0.033
20 – 24.9mm	14	0.400	5	0.208	0.600	0.375	0.225
25 – 29.9mm	10	0.290	6	0.250	0.890	0.625	0.265
30 – 34.9mm	1	0.029	7	0.300	0.919	0.925	0.006
35 – 39.9mm	3	0.080	2	0.083	0.999	1.009	0.010
40 – 44.9mm	0	0.000	0	0.000	0.999	1.009	0.010
45 – 49.9mm	0	0.000	0	0.000	0.999	1.009	0.010
Total:	**35**	1	**24**	1.010			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(35+24) (35x24) = 0.360

Dmax = 0.265

0.265 < 0.360

Therefore accept H0 that there is no significant difference between G8L13 and G8L17

Test 30. Kolmogorov – Smirnov test for expanded samples of *T. sarmaticus* opercula from L2 and L4.

Size category	L2	f	L4	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	1	0.032	11	0.116	0.032	0.116	0.084
15 – 19.9mm	5	0.161	39	0.411	0.193	0.527	0.334
20 – 24.9mm	10	0.323	25	0.263	0.516	0.790	0.274
25 – 29.9mm	6	0.194	12	0.126	0.709	0.916	0.207
30 – 34.9mm	7	0.226	5	0.053	0.935	0.969	0.034
35 – 39.9mm	2	0.065	3	0.032	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**31**	1	**95**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(31+95) (31x95) = 0.281

Dmax = 0.334

0.334 > 0.281

Therefore reject H0 that there is no significant difference between L2 and L4

Test 31. Kolmogorov – Smirnov test for expanded samples of *T. sarmaticus* opercula from L2 and L10.

Size category	L2	f	L10	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	1	0.032	4	0.046	0.032	0.046	0.014
15 – 19.9mm	5	0.161	22	0.253	0.193	0.299	0.106
20 – 24.9mm	10	0.323	32	0.368	0.516	0.667	0.151
25 – 29.9mm	6	0.194	14	0.161	0.709	0.828	0.119
30 – 34.9mm	7	0.226	9	0.103	0.935	0.931	0.004
35 – 39.9mm	2	0.065	6	0.069	1.000	1.000	1.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	1.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	1.000
Total:	**31**	1	**87**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\,(n1 \mathrm{x} n2)}$

$1.36\sqrt{(31+87)\,(31\mathrm{x}87)} = 0.284$

Dmax = 0.151 < 0.284

Therefore accept H0 that there is no significant difference between L2 and L10

Test 32. Kolmogorov – Smirnov test for expanded samples of *T. sarmaticus* opercula from L2 and L13.

Size category	L2	f	L13	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	1	0.032	2	0.045	0.032	0.045	0.013
15 – 19.9mm	5	0.161	11	0.250	0.193	0.295	0.102
20 – 24.9mm	10	0.323	16	0.364	0.516	0.659	0.143
25 – 29.9mm	6	0.194	11	0.250	0.709	0.909	0.200
30 – 34.9mm	7	0.226	1	0.023	0.935	0.931	0.004
35 – 39.9mm	2	0.065	3	0.068	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**31**	1	**44**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)\,(n1 \mathrm{x} n2)}$

$1.36\sqrt{(31+44)\,(31\mathrm{x}44)} = 0.318$

Dmax = 0.200

0.200 < 0.318

Therefore accept H0 that there is no significant difference between L2 and L13

Test 33. Kolmogorov-Smirnov test for expanded samples of *T. sarmaticus* opercula from L2 and L17.

Size category	L2	f	L17	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	1	0.022	0.000	0.022	0.022
10 – 14.9mm	1	0.032	4	0.089	0.032	0.111	0.079
15 – 19.9mm	5	0.161	5	0.111	0.193	0.222	0.029
20 – 24.9mm	10	0.323	11	0.244	0.516	0.466	0.050
25 – 29.9mm	6	0.194	13	0.289	0.709	0.755	0.046
30 – 34.9mm	7	0.226	9	0.200	0.935	0.955	0.020
35 – 39.9mm	2	0.065	2	0.044	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**31**	1	**45**	1			

Significance level: 0.05

1.36√(n1+n2) (n1xn2)

1.36√(31+45) (31x45) = 0.317

Dmax = 0.079

0.079 < 0.317

Therefore accept H0 that there is no significant difference between L2 and L17

Test 34. Kolmogorov – Smirnov test for expanded samples of *T. sarmaticus* opercula from L4 and L10.

Size category	L4	f	L10	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	11	0.116	4	0.046	0.116	0.046	0.070
15 – 19.9mm	39	0.411	22	0.253	0.527	0.299	0.228
20 – 24.9mm	25	0.263	32	0.368	0.790	0.667	0.123
25 – 29.9mm	12	0.126	14	0.161	0.916	0.828	0.088
30 – 34.9mm	5	0.053	9	0.103	0.969	0.931	0.038
35 – 39.9mm	3	0.032	6	0.069	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**95**	1	**87**	1			

Significance level: 0.05

1.36√(n1+n2) (n1xn2)

1.36√(95+87) (95x87) = 0.201

Dmax = 0.228

0.228 > 0.201

Therefore reject H0 that there is no significant difference between L4 and L10

Test 35. Kolmogorov – Smirnov test for expanded samples of *T. sarmaticus* opercula from L4 and L13.

Size category	**L4**	**f**	**L13**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.0000
10 – 14.9mm	11	0.116	2	0.045	0.116	0.045	0.071
15 – 19.9mm	39	0.411	11	0.250	0.527	0.295	0.232
20 – 24.9mm	25	0.263	16	0.364	0.790	0.659	0.131
25 – 29.9mm	12	0.126	11	0.250	0.916	0.909	0.007
30 – 34.9mm	5	0.053	1	0.023	0.969	0.931	0.038
35 – 39.9mm	3	0.032	3	0.068	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**95**	1	**44**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(95+44))95x44) = 0.248

Dmax = 0.232

0.232 < 0.248

Therefore accept H0 that there is no significant difference between L4 and L13

Test 36. Kolmogorov – Smirnov test for expanded samples of *T. sarmaticus* opercula from L4 and L17.

Size category	**L4**	**f**	**L17**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	1	0.022	0.000	0.022	0.022
10 – 14.9mm	11	0.116	4	0.089	0.116	0.111	0.005
15 – 19.9mm	39	0.411	5	0.111	0.527	0.222	0.305
20 – 24.9mm	25	0.263	11	0.244	0.790	0.466	0.324
25 – 29.9mm	12	0.126	13	0.289	0.916	0.755	0.161
30 – 34.9mm	5	0.053	9	0.200	0.969	0.955	0.014
35 – 39.9mm	3	0.032	2	0.044	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**95**	1	**45**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(95+45) (95x45) = 0.246

Dmax = 0.324

0.324 > 0.246

Therefore reject H0 that there is no significant difference between L4 and L17

Test 37. Kolmogorov – Smirnov test for expanded samples of *T. sarmaticus* opercula from L10 and L13.

Size category	L10	f	L13	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	4	0.046	2	0.045	0.046	0.045	0.001
15 – 19.9mm	22	0.253	11	0.250	0.299	0.295	0.004
20 – 24.9mm	32	0.368	16	0.364	0.667	0.659	0.008
25 – 29.9mm	14	0.161	11	0.250	0.828	0.909	0.081
30 – 34.9mm	9	0.103	1	0.023	0.931	0.931	0.000
35 – 39.9mm	6	0.069	3	0.068	1.000	1.000	1.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	1.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**87**	1	**44**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(87+44) (87x44) = 0.251

Dmax = 0.081

0.081 < 0.251

Therefore accept H0 that there is no significant difference between L10 and L13

Test 38. Kolmogorov – Smirnov test for expanded samples of *T. sarmaticus* opercula from L10 and L17.

Size category	L10	f	L17	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	1	0.022	0.000	0.022	0.022
10 – 14.9mm	4	0.046	4	0.089	0.046	0.111	0.065
15 – 19.9mm	22	0.253	5	0.111	0.299	0.222	0.077
20 – 24.9mm	32	0.368	11	0.244	0.667	0.466	0.201
25 – 29.9mm	14	0.161	13	0.289	0.828	0.755	0.073
30 – 34.9mm	9	0.103	9	0.200	0.931	0.955	0.024
35 – 39.9mm	6	0.069	2	0.044	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**87**	1	**45**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(87+45) (87x45) = 0.249

Dmax = 0.201

0.201 < 0.249

Therefore accept H0 that there is no significant difference between L10 and L17

Test 39. Kolmogorov – Smirnov test for expanded samples of *T. sarmaticus* opercula from L13 and L17.

Size category	**L13**	**f**	**L17**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	1	0.022	0.000	0.022	0.022
10 – 14.9mm	2	0.045	4	0.089	0.045	0.111	0.066
15 – 19.9mm	11	0.250	5	0.111	0.295	0.222	0.073
20 – 24.9mm	16	0.364	11	0.244	0.659	0.466	0.193
25 – 29.9mm	11	0.250	13	0.289	0.909	0.755	0.154
30 – 34.9mm	1	0.023	9	0.200	0.931	0.955	0.024
35 – 39.9mm	3	0.068	2	0.044	1.000	1.000	0.000
40 – 44.9mm	0	0.000	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**44**	1	**45**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(44+45) (44x45) = 0.288

Dmax = 0.154

0.154 < 0.288

Therefore accept H0 that there is no significant difference between L13 and L17

Test 40. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from *Zostera* – dominated units of Hoffman's/Robberg Cave and Noetzie, Layer 2.

Size category	***Zostera* beds**	**f**	**L2**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	0	0.000	1	0.032	0.000	0.032	0.032
15 – 19.9mm	3	0.077	5	0.161	0.077	0.193	0.116
20 – 24.9mm	12	0.308	10	0.323	0.385	0.516	0.131
25 – 29.9mm	11	0.282	6	0.194	0.667	0.709	0.042
30 – 34.9mm	7	0.179	7	0.226	0.846	0.935	0.089
35 – 39.9mm	5	0.128	2	0.065	0.974	1.000	0.026
40 – 44.9mm	1	0.026	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**39**	1	**31**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(39+31) (39x31) = 0.327

Dmax = 0.131

0.131 < 0.327

Therefore accept H0 that there is no significant difference between the *Zostera* – dominated units (Hoffman's/Robberg Cave) and Layer 2 (Noetzie).

Test 41. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from the *Zostera* – dominated units (Hoffman's/Robberg Cave) and Layer 4 (Noetzie).

Size category	*Zostera* beds	f	L4	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	0	0.000	11	0.116	0.000	0.116	0.116
15 – 19.9mm	3	0.077	39	0.411	0.077	0.527	0.450
20 – 24.9mm	12	0.308	25	0.263	0.385	0.790	0.405
25 – 29.9mm	11	0.282	12	0.126	0.667	0.916	0.249
30 – 34.9mm	7	0.179	5	0.053	0.846	0.969	0.123
35 – 39.9mm	5	0.128	3	0.032	0.974	1.000	0.026
40 – 44.9mm	1	0.026	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**39**	1	**95**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36 √(39+95) (39x95) = 0.258

Dmax = 0.450

0.540 > 0.258

Therefore reject H0 that there is no significant difference between the *Zostera* – dominated units (Hoffman's/Robberg Cave) and Layer 4 (Noetzie).

Test 42. Kolmogorov-Smirnov test for *T. sarmaticus* opercula from PORTIA (Hoffman's/Robberg Cave) and Layer 10 (Noetzie).

Size category	PORTIA	f	L10	f	Cumulative 1	Cumulative 2	Difference
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	0	0.000	4	0.046	0.000	0.046	0.046
15 – 19.9mm	11	0.306	22	0.253	0.306	0.299	0.007
20 – 24.9mm	11	0.306	32	0.368	0.612	0.667	0.055
25 – 29.9mm	9	0.250	14	0.161	0.862	0.828	0.034
30 – 34.9mm	3	0.083	9	0.103	0.945	0.931	0.014
35 – 39.9mm	2	0.056	6	0.069	1.000	1.000	0.000
40 – 44.9mm	0	0	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0	0	0.000	1.000	1.000	0.000
Total:	**36**	1	**87**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(36+87) (36X87) = 0.269

Dmax = 0.055

0.055 < 0.269

Therefore accept H0 that there is no significant difference between PORTIA (Hoffman's/Robberg Cave) and Layer 10 (Noetzie).

Test 43. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from PORTIA (Hoffman's/Robberg Cave) and Layer 13 (Noetzie).

Size category	**PORTIA**	**f**	**L13**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	0	0.000	2	0.045	0.000	0.045	0.045
15 – 19.9mm	11	0.306	11	0.250	0.306	0.295	0.011
20 – 24.9mm	11	0.306	16	0.364	0.612	0.659	0.047
25 – 29.9mm	9	0.250	11	0.250	0.862	0.909	0.047
30 – 34.9mm	3	0.083	1	0.023	0.945	0.931	0.014
35 – 39.9mm	2	0.056	3	0.068	1.000	1.000	0.000
40 – 44.9mm	0	0	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0	0	0.000	1.000	1.000	0.000
Total:	**36**	1	**44**	1			

Significance level: 0.05

1.36√(n1+n2) (n1xn2)

1.36√(36+44) (36x44) = 0.305

Dmax = 0.047

0.047 < 0.305

Therefore accept H0 that there is no significant difference between PORTIA (Hoffman's/Robberg Cave) and Layer 13 (Noetzie).

Test 44. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from PORTIA (Hoffman's/Robberg Cave) and Layer 17 (Noetzie).

Size category	**PORTIA**	**f**	**L17**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	1	0.022	0.000	0.022	0.022
10 – 14.9mm	0	0.000	4	0.089	0.000	0.111	0.111
15 – 19.9mm	11	0.306	5	0.111	0.306	0.222	0.084
20 – 24.9mm	11	0.306	11	0.244	0.612	0.466	0.146
25 – 29.9mm	9	0.250	13	0.289	0.862	0.755	0.107
30 – 34.9mm	3	0.083	9	0.200	0.945	0.955	0.010
35 – 39.9mm	2	0.056	2	0.044	1.000	1.000	0.000
40 – 44.9mm	0	0	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0	0	0.000	1.000	1.000	0.000
Total:	**36**	1	**45**	1			

Significance level: 0.05

1.36√(n1+n2) (n1xn2)

1.36√(36+45) (36x45) = 0.304

Dmax = 0.146

0.146 < 0.304

Therefore accept H0 that there is no significant difference between PORTIA (Hoffman's/Robberg Cave) and Layer 17 (Noetzie).

Test 45. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from RICHARD (Hoffman's/Robberg Cave) and Layer 10 (Noetzie).

Size category	**RICHARD**	**f**	**L10**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	1	0.026	4	0.046	0.026	0.046	0.020
15 – 19.9mm	6	0.158	22	0.253	0.184	0.299	0.115
20 – 24.9mm	12	0.316	32	0.368	0.500	0.667	0.167
25 – 29.9mm	8	0.211	14	0.161	0.710	0.828	0.118
30 – 34.9mm	8	0.211	9	0.103	0.921	0.931	0.010
35 – 39.9mm	1	0.026	6	0.069	0.947	1.000	0.000
40 – 44.9mm	2	0.053	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**38**	1	**87**	1			

Significance level: 0.05

1.36√(n1+n2) (n1xn2)

1.36√(38+87) (38x87) = 0.264

Dmax = 0.167

0.167 < 0.264

Therefore accept Ho that there is no significant difference between RICHARD (Hoffman's/Robberg Cave) and Layer 10 (Noetzie).

Test 46. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from RICHARD (Hoffman's/Robberg Cave) and Layer 13 (Noetzie).

Size category	**RICHARD**	**f**	**L13**	**f**	**Cumulative 1**	**Cumulative 2**	**Difference**
0 – 9.9mm	0	0.000	0	0.000	0.000	0.000	0.000
10 – 14.9mm	1	0.026	2	0.045	0.026	0.045	0.019
15 – 19.9mm	6	0.158	11	0.250	0.184	0.295	0.111
20 – 24.9mm	12	0.316	16	0.364	0.500	0.659	0.159
25 – 29.9mm	8	0.211	11	0.250	0.710	0.909	0.199
30 – 34.9mm	8	0.211	1	0.023	0.921	0.931	0.010
35 – 39.9mm	1	0.026	3	0.068	0.947	1.000	0.053
40 – 44.9mm	2	0.053	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**38**	1	**44**	1			

Significance level: 0.05

1.36√(n1+n2) (n1xn2)

1.36√(38+44) (38x44) = 0.301

Dmax = 0.199

0.199 < 0.301

Therefore accept H0 that there is no significant difference between RICHARD (Hoffman's/Robberg Cave) and Layer 13 (Noetzie).

Test 47. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from RICHARD (Hoffman's/Robberg Cave) and Layer 17 (Noetzie).

Size category	RICHARD	f	L17	f	Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	1	0.022	0.000	0.022	0.022
10 – 14.9mm	1	0.026	4	0.089	0.026	0.111	0.085
15 – 19.9mm	6	0.158	5	0.111	0.184	0.222	0.062
20 – 24.9mm	12	0.316	11	0.244	0.500	0.466	0.034
25 – 29.9mm	8	0.211	13	0.289	0.710	0.755	0.045
30 – 34.9mm	8	0.211	9	0.200	0.921	0.955	0.034
35 – 39.9mm	1	0.026	2	0.044	0.947	1.000	0.053
40 – 44.9mm	2	0.053	0	0.000	1.000	1.000	0.000
45 – 49.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**38**	1	**45**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) (*n*1x*n*2)

1.36√(38+45) (38x45) = 0.299

Dmax = 0.085

0.085 < 0.299

Therefore accept H0 that there is no significant difference between RICHARD (Hoffman's/Robberg Cave) and Layer 17 (Noetzie).

Test 48. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Layers 10, 13 and 17 (Noetzie) and Paapkuilfontein 4.

Size category	NTZ10,13 &17	f	P4		Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	1	0.006	5	0.004	0.006	0.004	0.002
10 – 14.9mm	10	0.057	130	0.120	0.063	0.124	0.061
15 – 19.9mm	38	0.216	216	0.200	0.279	0.324	0.045
20 – 24.9mm	59	0.335	299	0.275	0.614	0.559	0.055
25 – 29.9mm	38	0.216	223	0.206	0.830	0.805	0.025
30 – 34.9mm	19	0.108	118	0.109	0.939	0.914	0.025
35 – 39.9mm	11	0.063	61	0.056	1.000	0.970	0.030
40 – 44.9mm	0	0.000	27	0.025	1.000	0.995	0.005
45 – 49.9mm	0	0.000	6	0.005	1.000	1.000	0.000
50 – 54.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**176**		**1085**				

Significance level: 0.05

1.36√(*n*1+*n*2) / (*n*1x*n*2)

1.36 (176+1085) / (176x1085) =

1261/190960 = 0.11

Dmax = 0.055

0.055 < 0.11

Therefore accept H0 that there is no significant difference between Noetzie (Layers 10, 13 and 17) and Paapkuilfontein 4.

Test 49. Kolmogorov-Smirnov test for *T. sarmaticus* opercula from Layers 10, 13 and 17 (Noetzie) and Paapkuilfontein 5.

Size category	NTZ10,13 &17	f	P5		Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	1	0.006	28	0.028	0.006	0.028	0.022
10 – 14.9mm	10	0.057	167	0.168	0.063	0.196	0.133
15 – 19.9mm	38	0.216	269	0.270	0.279	0.466	0.187
20 – 24.9mm	59	0.335	255	0.255	0.614	0.721	0.107
25 – 29.9mm	38	0.216	73	0.073	0.830	0.794	0.036
30 – 34.9mm	19	0.108	30	0.030	0.939	0.824	0.115
35 – 39.9mm	11	0.063	39	0.040	1.000	0.864	0.136
40 – 44.9mm	0	0.000	108	0.108	1.000	0.972	0.028
45 – 49.9mm	0	0.000	27	0.027	1.000	0.999	0.001
50 – 54.9mm	0	0.000	1	0.001	1.000	1.000	0.000
Total:	**176**		**997**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) / (*n*1x*n*2)

1.36√(176+997) / (176x997) = 0.111

Dmax = 0.187

0.187 > 0.111

Therefore reject H0 that there is no significant difference between Noetzie (Layers 10, 13 and 17) and Paapkuilfontein 5.

Test 50. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Noetzie (Layers 10, 13 and 17) and Paapkuilfontein 7.

Size category	NTZ10,13 &17	f	P7		Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	1	0.006	11	0.017	0.006	0.017	0.011
10 – 14.9mm	10	0.057	144	0.218	0.063	0.235	0.172
15 – 19.9mm	38	0.216	299	0.452	0.279	0.687	0.408
20 – 24.9mm	59	0.335	110	0.166	0.614	0.853	0.239
25 – 29.9mm	38	0.216	27	0.041	0.830	0.894	0.064
30 – 34.9mm	19	0.108	12	0.018	0.939	0.912	0.027
35 – 39.9mm	11	0.063	7	0.010	1.000	0.992	0.008
40 – 44.9mm	0	0.000	25	0.038	1.000	0.960	0.040
45 – 49.9mm	0	0.000	26	0.040	1.000	1.000	0.000
50 – 54.9mm	0	0.000	0	0	1.000	1.000	0.000
Total:	**176**	1	**661**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) / (*n*1x*n*2)

1.36√176+661) / (176x661) = 0.115

Dmax = 0.408

0.408 > 0.115

Therefore reject H0 that there is no significant difference between Noetzie (Layers 10, 13 and 17) and Paapkuilfontein 7.

Test 51. Kolmogorov-Smirnov test for *T. sarmaticus* opercula from Noetzie (Layers 10, 13 and 17) and Paapkuilfontein 11.

Size category	NTZ L10,13 &17	f	P11		Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	1	0.006	19	0.048	0.006	0.048	0.032
10 – 14.9mm	10	0.057	100	0.252	0.063	0.300	0.237
15 – 19.9mm	38	0.216	123	0.310	0.279	0.610	0.331
20 – 24.9mm	59	0.335	69	0.174	0.614	0.784	0.170
25 – 29.9mm	38	0.216	20	0.050	0.830	0.834	0.004
30 – 34.9mm	19	0.108	14	0.035	0.939	0.869	0.070
35 – 39.9mm	11	0.063	23	0.058	1.000	0.927	0.093
40 – 44.9mm	0	0.000	24	0.060	1.000	0.987	0.013
45 – 49.9mm	0	0.000	3	0.008	1.000	0.995	0.005
50 – 54.9mm	0	0.000	2	0.005	1.000	1.000	0.000
Total:	**176**	1	**397**	1			

Significance level: 0.05

1.36√(n1+n2) / (n1xn2)

1.36√(176+397) / (176x397) = 0.123

Dmax = 0.331

0.331 > 0.123

Therefore reject H0 that there is no significant difference between Noetzie (Layers 10, 13 and 17) and Paapkuilfontein 11.

Test 52. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Noetzie (Layer 4) and Paapkuilfontein 4.

Size category	NTZL4	f	P4		Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	5	0.004	0.000	0.004	0.004
10 – 14.9mm	11	0.116	130	0.120	0.116	0.124	0.008
15 – 19.9mm	39	0.411	216	0.200	0.527	0.324	0.203
20 – 24.9mm	25	0.263	299	0.275	0.790	0.559	0.231
25 – 29.9mm	12	0.126	223	0.206	0.916	0.805	0.111
30 – 34.9mm	5	0.053	118	0.109	0.969	0.914	0.055
35 – 39.9mm	3	0.032	61	0.056	1.000	0.970	0.030
40 – 44.9mm	0	0.000	27	0.025	1.000	0.995	0.005
45 – 49.9mm	0	0.000	6	0.005	1.000	1.000	0.000
50 – 54.9mm	0	0	0	0.000	1.000	1.000	0.000
Total:	**95**	1	**1085**				

Significance level: 0.05

1.36√(n1+n2) / (n1xn2)

1.36√(95+1085) / (95x1085) = 0.145

Dmax = 0.231

0.231 > 0.145

Therefore reject H0 that there is no significant difference between Noetzie (Layer 4) and Paapkuilfotnein 4.

Test 53. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Noetzie (Layer 4) and Paapkuilfontein 5.

Size category	NTZL4	f	P5	f	Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	28	0.028	0.000	0.028	0.028
10 – 14.9mm	11	0.116	167	0.168	0.116	0.196	0.080
15 – 19.9mm	39	0.411	269	0.270	0.527	0.466	0.061
20 – 24.9mm	25	0.263	255	0.255	0.790	0.721	0.069
25 – 29.9mm	12	0.126	73	0.073	0.916	0.794	0.122
30 – 34.9mm	5	0.053	30	0.030	0.969	0.824	0.145
35 – 39.9mm	3	0.032	39	0.040	1.000	0.864	0.136
40 – 44.9mm	0	0.000	108	0.108	1.000	0.972	0.028
45 – 49.9mm	0	0.000	27	0.027	1.000	0.999	0.001
50 – 54.9mm	0	0	1	0.001	1.000	1.000	0.000
Total:	**95**	1	**997**	1			

Significance level: *0.05*

1.36√(*n*1+*n*2) / (*n*1x*n*2)

1.36√(95+997) / (95x997) = 0.146

Dmax = 0.145<0.145

Therefore reject H0 that there is no significant difference between Noetzie (Layer 4) and Paapkuilfontein 5.

Test 54. Kolmogorov-Smirnov test for *T. sarmaticus* opercula from Noetzie (Layer 4) and Paapkuilfontein 7.

Size category	NTZL4	f	P7	f	Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	11	0.017	0.000	0.017	0.017
10 – 14.9mm	11	0.116	144	0.218	0.116	0.235	0.069
15 – 19.9mm	39	0.411	299	0.452	0.527	0.687	0.160
20 – 24.9mm	25	0.263	110	0.166	0.790	0.853	0.063
25 – 29.9mm	12	0.126	27	0.041	0.916	0.894	0.022
30 – 34.9mm	5	0.053	12	0.018	0.969	0.912	0.057
35 – 39.9mm	3	0.032	7	0.010	1.000	0.922	0.078
40 – 44.9mm	0	0.000	25	0.038	1.000	0.960	0.040
45 – 49.9mm	0	0.000	26	0.040	1.000	1.000	0.000
50 – 54.9mm	0	0	0	0	1.000	1.000	0.000
Total:	**95**	1	**661**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) / (*n*1x*n*2)

1.36√(95+661) / (95x661) = 0.149

Dmax = 0.160

0.160 > 0.149

Therefore reject H0 that there is no significant difference between Noetzie (Layer 4) and Paapkuilfontein 7.

Test 55. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Noetzie (Layer 4) and Paapkuilfontein 11.

Size category	NTZL4	f	P11	f	Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	19	0.048	0.000	0.048	0.048
10 – 14.9mm	11	0.116	100	0.252	0.116	0.300	0.184
15 – 19.9mm	39	0.411	123	0.310	0.527	0.610	0.083
20 – 24.9mm	25	0.263	69	0.174	0.790	0.784	0.006
25 – 29.9mm	12	0.126	20	0.050	0.916	0.834	0.082
30 – 34.9mm	5	0.053	14	0.035	0.969	0.869	0.100
35 – 39.9mm	3	0.032	23	0.058	1.000	0.927	0.073
40 – 44.9mm	0	0.000	24	0.060	1.000	0.987	0.013
45 – 49.9mm	0	0.000	3	0.008	1.000	0.995	0.005
50 – 54.9mm	0	0	2	0.005	1.000	1.000	0.000
Total:	**95**	1	**397**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) / (*n*1x*n*2)

1.36√(95+397) / (95x397) = 0.155

Dmax = 0.184

0.184 > 0.155

Therefore reject H0 that there is no significant difference between Noetzie (Layer 4) and Paapkuilfontein 11.

Test 56. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Noetzie (Layer 2) and Paapkuilfontein 4.

Size category	NTZL2	f	P4		Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	5	0.004	0.000	0.000	0.000
10 – 14.9mm	1	0.032	130	0.120	0.116	0.032	0.084
15 – 19.9mm	5	0.161	216	0.200	0.527	0.193	0.334
20 – 24.9mm	10	0.323	299	0.275	0.790	0.516	0.274
25 – 29.9mm	6	0.194	223	0.206	0.916	0.709	0.207
30 – 34.9mm	7	0.226	118	0.109	0.969	0.935	0.034
35 – 39.9mm	2	0.065	61	0.056	1.000	1.000	0.000
40 – 44.9mm	0	0.000	27	0.025	1.000	1.000	0.000
45 – 49.9mm	0	0.000	6	0.005	1.000	1.000	0.000
50 – 54.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**31**	1	**1085**				

Significance level: 0.05

1.36√(*n*1+*n*2) / (*n*1x*n*2)

1.36√(31+1085) / (31x1085) = 0.247

Dmax = 0.334

0.334 > 0.247

Therefore reject H0 that there is no significant difference between Noetzie (Layer 2) and Paapkuilfontein 4.

Test 57. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Noetzie (Layer 2) and Paapkuilfontein 5.

Size category	NTZL2	f	P5	f	Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	28	0.028	0.000	0.028	0.028
10 – 14.9mm	1	0.032	167	0.168	0.116	0.196	0.080
15 – 19.9mm	5	0.161	269	0.270	0.527	0.466	0.061
20 – 24.9mm	10		255	0.255	0.790	0.721	0.069
25 – 29.9mm	6	0.194	73	0.073	0.916	0.794	0.122
30 – 34.9mm	7	0.226	30	0.030	0.969	0.824	0.145
35 – 39.9mm	2	0.065	39	0.040	1.000	0.864	0.136
40 – 44.9mm	0	0.000	108	0.108	1.000	0.972	0.028
45 – 49.9mm	0	0.000	27	0.027	1.000	0.999	0.001
50 – 54.9mm	0	0.000	1	0.001	1.000	1.000	0.000
Total:	**31**	1	**997**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) / (*n*1x*n*2)

1.36√(31+997) / (31x997) = 0.248

Dmax = 0.145

0.145 > 0.248

Therefore accept H0 that there is no significant difference between Noetzie (Layer 2) and Paapkuilfontein 5.

Test 58. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Noetzie (Layer 2) and Paapkuilfontein 7.

Size category	NTZL2	f	P7	f	Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	11	0.017	0.000	0.017	0.017
10 – 14.9mm	1	0.032	144	0.218	0.116	0.235	0.119
15 – 19.9mm	5	0.161	299	0.452	0.527	0.687	0.160
20 – 24.9mm	10	0.323	110	0.166	0.790	0.853	0.063
25 – 29.9mm	6	0.194	27	0.041	0.916	0.894	0.022
30 – 34.9mm	7	0.226	12	0.018	0.969	0.912	0.057
35 – 39.9mm	2	0.065	7	0.010	1.000	0.922	0.078
40 – 44.9mm	0	0.000	25	0.038	1.000	0.960	0.040
45 – 49.9mm	0	0.000	26	0.040	1.000	1.000	1.000
50 – 54.9mm	0	0.000	0	0	1.000	1.000	1.000
Total:	**31**	1	**661**	1			

Significance level: 0.05

1.36√(*n*1+*n*2) / (*n*1x*n*2)

1.36√(31+661) / (31x661) = 0.249

Dmax = 0.160

0.160 > 0.249

Therefore accept H0 that there is no significant difference between Noetzie (Layer 2) and Paapkuilfontein 7.

Test 59. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Noetzie (Layer 2) and Paapkuilfontein 11.

Size category	**NTZL2**	**f**	**P11**	**f**	**Cumulative % 1**	**Cumulative % 2**	**Difference**
0 – 9.9mm	0	0.000	19	0.048	0.000	0.048	0.048
10 – 14.9mm	1	0.032	100	0.252	0.116	0.300	0.184
15 – 19.9mm	5	0.161	123	0.310	0.527	0.610	0.083
20 – 24.9mm	10	0.323	69	0.174	0.790	0.784	0.006
25 – 29.9mm	6	0.194	20	0.050	0.916	0.834	0.082
30 – 34.9mm	7	0.226	14	0.035	0.969	0.869	0.100
35 – 39.9mm	2	0.065	23	0.058	1.000	0.927	0.073
40 – 44.9mm	0	0.000	24	0.060	1.000	0.987	0.013
45 – 49.9mm	0	0.000	3	0.008	1.000	0.995	0.005
50 – 54.9mm	0	0.000	2	0.005	1.000	1.000	0.000
Total:	**31**	1	**397**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)}\ /\ (n1xn2)$

$1.36\sqrt{(31+397)}\ (31x397) = 0.253$

Dmax = 0.184

0.184 < 0.253

Therefore accept H0 that there is no significant difference between Noetzie (Layer 2) and Paapkuilfontein 11.

Test 60. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Hoffman's/Robberg Cave and Paapkuilfontein 4.

Size category	**H/RC**	**f**	**P4**		**Cumulative % 1**	**Cumulative % 2**	**Difference**
0 – 9.9mm	0	0.000	5	0.004	0.000	0.000	0.000
10 – 14.9mm	3	0.023	130	0.120	0.023	0.032	0.009
15 – 19.9mm	22	0.171	216	0.200	0.194	0.193	0.001
20 – 24.9mm	42	0.326	299	0.275	0.519	0.516	0.003
25 – 29.9mm	30	0.233	223	0.206	0.752	0.709	0.043
30 – 34.9mm	20	0.155	118	0.109	0.907	0.935	0.028
35 – 39.9mm	9	0.070	61	0.056	0.976	1.000	0.024
40 – 44.9mm	3	0.023	27	0.025	1.000	1.000	0.000
45 – 49.9mm	0	0.000	6	0.005	1.000	1.000	0.000
50 – 54.9mm	0	0.000	0	0.000	1.000	1.000	0.000
Total:	**129**	1	**1085**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)}\ /\ (n1xn2)$

$1.36\sqrt{(129+1085)}\ /\ (129x1085) = 0.126$

Dmax = 0.043

0.043 < 0.126

Therefore accept H0 that there is no significant difference between Hoffman's/Robberg Cave and Paapkuilfontein 4.

Test 61. Kolmogorov – Smirnov test for T. sarmaticus opercula from Hoffman's/Robberg Cave and Paapkuilfontein 5.

Size category	H/RC	f	P4	f	Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	28	0.028	0.000	0.028	0.028
10 – 14.9mm	3	0.023	167	0.168	0.023	0.196	0.173
15 – 19.9mm	22	0.171	269	0.270	0.194	0.466	0.272
20 – 24.9mm	42	0.326	255	0.255	0.519	0.721	0.202
25 – 29.9mm	30	0.233	73	0.073	0.752	0.794	0.042
30 – 34.9mm	20	0.155	30	0.030	0.907	0.824	0.083
35 – 39.9mm	9	0.070	39	0.040	0.976	0.864	0.112
40 – 44.9mm	3	0.023	108	0.108	1.000	0.972	0.028
45 – 49.9mm	0	0.000	27	0.027	1.000	0.999	0.001
50 – 54.9mm	0	0.000	1	0.001	1.000	1.000	0.000
Total:	**129**	1	**997**	1			

Significance level: 0.05

1.36√(n1+n2) / (n1xn2)

1.36(129+997) / (129x997) = 0.127

Dmax = 0.272

0.272 > 0.127

Therefore reject H0 that there is no significant difference between Hoffman's/Robberg Cave and Paapkuilfontein 5.

Test 62. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Hoffman's/Robberg Cave and Paapkuilfontein 7.

Size category	H/RC	f	P7	f	Cumulative % 1	Cumulative % 2	Difference
0 – 9.9mm	0	0.000	11	0.017	0.000	0.017	0.017
10 – 14.9mm	3	0.023	144	0.218	0.023	0.235	0.011
15 – 19.9mm	22	0.171	299	0.452	0.194	0.687	0.493
20 – 24.9mm	42	0.326	110	0.166	0.519	0.853	0.334
25 – 29.9mm	30	0.233	27	0.041	0.752	0.894	0.142
30 – 34.9mm	20	0.155	12	0.018	0.907	0.912	0.005
35 – 39.9mm	9	0.070	7	0.010	0.976	0.922	0.054
40 – 44.9mm	3	0.023	25	0.038	1.000	0.960	0.040
45 – 49.9mm	0	0.000	26	0.040	1.000	1.000	0.000
50 – 54.9mm	0	0.000	0	0	1.000	1.000	0.000
Total:	**129**	1	**661**	1			

Significance level: 0.05

1.36√(n1+n2) / (n1xn2)

1.36√(129+661) / (129x661) = 0.130

Dmax = 0.493

0.493 > 0.130

Therefore reject H0 that there is no significant difference between Hoffman's/Robberg Cave and Paapkuilfontein 7.

Test 63. Kolmogorov – Smirnov test for *T. sarmaticus* opercula from Hoffman's/Robberg Cave and Paapkuilfontein 11.

Size category	**H/RC**	**f**	**P11**	**f**	**Cumulative % 1**	**Cumulative % 2**	**Difference**
0 – 9.9mm	0	0.000	19	0.048	0.000	0.048	0.048
10 – 14.9mm	3	0.023	100	0.252	0.023	0.300	0.277
15 – 19.9mm	22	0.171	123	0.310	0.194	0.610	0.416
20 – 24.9mm	42	0.326	69	0.174	0.519	0.784	0.265
25 – 29.9mm	30	0.233	20	0.050	0.752	0.834	0.082
30 – 34.9mm	20	0.155	14	0.035	0.907	0.869	0.038
35 – 39.9mm	9	0.070	23	0.058	0.976	0.927	0.049
40 – 44.9mm	3	0.023	24	0.060	1.000	0.987	0.013
45 – 49.9mm	0	0.000	3	0.008	1.000	0.995	0.005
50 – 54.9mm	0	0.000	2	0.005	1.000	1.000	0.000
Total:	**129**	1	**397**	1			

Significance level: 0.05

$1.36\sqrt{(n1+n2)} / (n1 \mathrm{x} n2)$

$1.36\sqrt{(129+397)} / (129 \mathrm{x} 397) = 0.137$

Dmax = 0.416

0.416 > 0.137

Therefore reject H0 that there is no significant difference between Hoffman's/Robberg Cave and Paapkuilfontein 11.

APPENDIX D

WEIGHTS (G) FOR THE LITHIC REMAINS RECOVERED FROM HOFFMAN'S/ROBBERG CAVE

Table 5.1. Weights (g) for the lithic remains recovered from Hoffman's/Robberg Cave.

Raw Material	Layer	SURFACE *IN SITU*	BEN	CELESTE	DEON	ELIZABETH	FRANK	GIDEON	IVAN	JUDY	JANE	JUNE	KATHARINE	LOUISA	MAVIS
	Category	g	g	g	g	g	g	g	g	g	g	g	g	g	g
Quartzite	**Manuports**														
	Pebbles		7.59		2	0.1									18.6
	Cobbles			53				184.6			79.4			227.1	
	Waste material														
	Chips				2				0.3	2.2	5.1	0.4	0	2.4	2.2
	Chunks	33.7	83.5	30	732.3	313.1	3.4	28.2	116.5	962.3	215.8	119.2	227.4	35.8	134.7
	Bladelet/flakelet cores	83.2								595.1					21.9
	Irregular/other cores							98.8	946						
	Unretouched flakes		0		28.8	141.9				277.6	44.4	3.4	13.5	26.5	7.9
	Unretouched blades		9.6					6.2		0					
	Unretouched flakelets									0					
	Unretouched bladelets														
	Utilized pieces														
	Hammerstones					215								97.4	
	Upper grindstones			24.2							80.7				
	Lower grindstones														
	Cobbles with evidence of utilization														
	Grooved stones														2.8
	Formal tools														
	Miscellaneous retouched pieces														
Quartz	**Manuports**														
	Unmodified quartz													1.6	7.4
	Waste material														
	Chips								0.1	0.5	1.5	0.7	0.9		6.1
	Chunks									9.2	39.1	29.2	16.6	8	24.3
	Unretouched flakes									3	14		1.2	0.8	7.7
	Unretouched blades												0.5		
	Unretouched flakelets												0.7		1
	Unretouched bladelets														0.3
CCS	Chips									0.1	0		0.4		0.3
	Chunks									0.5	0.6		7.4	1.8	2.2
	Cores														
	Unretouched flakes		3.7							0.9			0.4		0.6
	Unretouched blades														
	Unretouched flakelets										0				
	Unretouched bladelets														
	Formal tools														
	Miscellaneous retouched pieces									*1.4*					
	Scrapers														
Silcrete	**Waste Material**									•					
	Unretouched flakes														
Sandstone	**Utilized pieces**														
	Palettes														
Shale	**Utilized pieces**								14.9						
	Palettes														
Other															
Ochre	**Manuports**														
	Unmodified		*31.1*	*0.8*	*0.3*	*67.5*	2.2		0.7	26	48		79.8	26	7.2
	Utilized pieces														
	Flaked			32.5											
	Ground													7.1	0.6
Aeolionite	**Manuports**														
	Unmodified		6.4							0.3					
	Utilized pieces														
	Flaked														
	Ground							11.5							
Other	**Manuports**	4.9	16.9	26.8	41.7	0.3	3.6	86.5	1	84.8	24.6	12.2	67.5	10.9	7.3
	TOTAL	**121.8**	**158.79**	**167.3**	**807.1**	**737.9**	**9.2**	**415.8**	**1079.5**	**1963.9**	**553.2**	**165.1**	**416.3**	**445.4**	**253.1**

Raw Material	Layer	NATHAN	NOAH	OMAR	OMAR/PETER	PETER	PAUL	PORTIA	PETER/QUINTON	QUINTON	RACHEL	ROBERT	ROYDEN	RICHARD	RICHARD II
	Category	g	g	g	g	g	g	g	g	g	g	g	g	g	g
Quartzite	**Manuports**			0											
	Pebbles	5.9				0.9		1.4		1.5				32	
	Cobbles													1390.7	
	Waste material														
	Chips	1.8	0		0.4		0.5	0.4		0.1	0.6	0.1	0.1	2.6	
	Chunks	258	392.1	910	42.5	53.9	166.1	398.2	63.9	46.5	0.5	4.4	140.8	4769	105.6
	Bladelet/flakelet cores	18.9		15.2				33.1						46.7	
	Irregular/other cores					357								603.8	
	Unretouched flakes	7.2	161.9	31.8	32.5	219.1	24.8	26.9	6.6	16.8			172.3	143.1	27.6
	Unretouched blades					63.7							0.38	161.7	4.1
	Unretouched flakelets					0									
	Unretouched bladelets													0.2	
	Utilized pieces														
	Hammerstones							94.2						729.6	
	Upper grindstones	79.9												494.3	
	Lower grindstones														248.2
	Cobbles with evidence of utilization		74.2	65.3		205.4									
	Grooved stones													0.9	
	Formal tools														
	Miscellaneous retouched pieces														
Quartz	**Manuports**														
	Unmodified quartz													6.4	11.57
	Waste material														
	Chips	0.9	0.4	0.9		0.9	0.4	0.6	0.7	0.1	0.1			0.1	
	Chunks	10.9	2.5	47.2	3.3	31.8	1.2	25.2	1.9	0.2	2.6	6.3	6	48.6	4
	Unretouched flakes					3.2	0.6	1.2			1.8		6.8	0.4	0.1
	Unretouched blades	0.3													
	Unretouched flakelets	0.1													
	Unretouched bladelets		1.6												
CCS	Chips	0.6				0.8	0.1	0		0	0.1			1	
	Chunks	11.7		9.2	1.4	0	1.4	6.6	0.5	1.6		1.1		43.9	0.3
	Cores	1.6												21.3	
	Unretouched flakes	3.3			0.3	1.8		28.4	1.9	1.6	0.5			8	1.9
	Unretouched blades						0.4								
	Unretouched flakelets														
	Unretouched bladelets				0										
	Formal tools														
	Miscellaneous retouched pieces							1.9							
	Scrapers														
Silcrete	**Waste Material**														
	Unretouched flakes				1.4										
Sandstone	**Utilized pieces**														
	Palettes			24.4											
Shale	**Utilized pieces**														
	Palettes														154.4
Other															
Ochre	**Manuports**														
	Unmodified	14.3		55	3.5	0	2.7	19.9		6.5			1.2	134.6	0.8
	Utilized pieces														
	Flaked														
	Ground						1.9								
Aeolianite	**Manuports**														
	Unmodified	4.9		2.3		1.4		118.9						273.9	536.1
	Utilized pieces														
	Flaked						178.5	648.6							
	Ground												159		
Other	**Manuports**	56	0	0	0	103.4		0	5.1	2.6			23.7	59.2	
	TOTAL	**476.3**	**632.7**	**1161.3**	**85.3**	**1043.3**	**378.6**	**1405.5**	**80.6**	**77.5**	**6.2**	**11.9**	**510.28**	**8972**	**1094.7**

Raw Material	Layer	RICHARD III	SUSAN	SELVINO	TIM	TOM	TOP OF DUNE	GF	SECTION CLEANING	TOTAL
	Category	g	g	g	g	g	g	g	g	g
Quartzite	**Manuports**									
	Pebbles				9.8	2.2			34.8	**82.0**
	Cobbles			125.1						**1515.8**
	Waste material									
	Chips				0.3	0.1			0.4	**5.2**
	Chunks	868.5	283.3	16.6	13.1	221.9			111.2	**7209.6**
	Bladelet/flakelet cores			31.8	28.4	79.3				**219.3**
	Irregular/other cores									**603.8**
	Unretouched flakes	50.6	24.4			1			5	**499.1**
	Unretouched blades	7.9								**174.1**
	Unretouched flakelets									**0.0**
	Unretouched bladelets									**0.2**
	Utilised pieces									
	Hammerstones	183.4				300.2				**1307.4**
	Upper grindstones			173.5			186.4			**854.2**
	Lower grindstones									**248.2**
	Cobbles with evidence of utilization	47.1		120						**167.1**
	Grooved stones									**0.9**
	Formal tools									**0.0**
	Miscellaneous retouched pieces	81.2								**81.2**
Quartz	**Manuports**									
	Unmodified quartz	26.4								**44.4**
	Waste material									**0.0**
	Chips	0.1		0.2	0.2				0	**2.5**
	Chunks	2.8	0.5	2	13	40.8			4.1	**159.2**
	Unretouched flakes	2.7		7.8		3.5				**24.9**
	Unretouched blades								1.2	**1.2**
	Unretouched flakelets									**0.0**
	Unretouched bladelets									**0.0**
CCS	Chips									**1.2**
	Chunks	25.2	7.1			0.1				**87.8**
	Cores	6.1	11.5							**38.9**
	Unretouched flakes	5.2	11.1						1	**59.6**
	Unretouched blades									**0.4**
	Unretouched flakelets									**0.0**
	Unretouched bladelets									**0.0**
	Formal tools									**0.0**
	Miscellaneous retouched pieces									**1.9**
	Scrapers							0.2		**0.2**
Silcrete	**Waste Material**									
	unretouched flakes									**0.0**
Sandstone	**Utilized pieces**									**0.0**
	Palettes									**0.0**
Shale	**Utilised pieces**									
	Palettes									**154.4**
Other										
Ochre	**Manuports**									**0.0**
	Unmodified	0.6	0.7		0.1	32.4			7.6	**207.1**
	Utilised pieces									**0.0**
	Flaked									**0.0**
	Ground									**1.9**
Aeolionite	**Manuports**									
	Unmodified	129.4	3.6			28.9			59	**1149.8**
	Utilised pieces									**0.0**
	Flaked									**827.1**
	Ground									**159.0**
Other	**Manuports**	31.3	11.8			6.8			50	**190.5**
	TOTAL	**1468.5**	**354**	**477**	**64.9**	**717.2**	**186.2**	**0.2**	**274.3**	**16079.6**

APPENDIX E

DESCRIPTION OF BONE AND SHELL ARTEFACTS RECOVERED FROM HOFFMAN'S/ROBBERG CAVE IN 2007 AND 2008

E.1. BONE ARTEFACTS (2007)

SURFACE: small, undecorated bone bead measuring 4.mm in length; smoothed at both ends and with cut-marks on the body

SURFACE: long hollow-tipped bone point, broken at unworked end and partially split down the middle; few visible striations

SURFACE: hollow-tipped bone point similar to specimen above, except somewhat shorter; also broken at the unworked end

SURFACE: thick bone point, broken at one end; entire specimen highly polished, especially at the tip

E6 BARBIE (disturbed material): hollow-tipped point, broken at one end; deep striations densely concentrated around the tip, on which some polish is evident

E4 DEON: slender awl measuring 52.8mm in length, manufactured on fragment of bone shaft; tip highly polished

E5 ELIZABETH: fine, slender bone awl (76.3mm) manufactured on a complete bird bone

E5 ELIZABETH: undecorated bird bone bead/tube measuring 21.1mm in length; both ends only partially ground/smoothed; cut-marks visible on body of specimen

E5 ELIZABETH: bone bead (20.4mm) similar to specimen described above

E5 ELIZABETH: bone bead (21.5mm) similar to specimens described above

E5 ELIZABETH: bone bead (21.4m) similar to aforementioned specimens; deep cut-marks and a rough, bony protrusion visible on body

E6 NOAH: six badly burned and broken pieces of incised bone shaft; three conjoining pieces are decorated with what appear to be sets of parallel incisions all along their lengths; two additionally conjoining pieces (which do not conjoin with the three previously described) are more lightly incised; the larger of these fragments is only incised at one end

D5b OMAR: piece of large, robust bone with evidence of flaking along the shaft; visible polish at one end; possible areas of smoothing on both sides; three parallel cut-marks on inner surface and several less regular striations on the outer surface

E4 QUINTON: proximal part of a ringed bone, snapped at mid-shaft; clear cut-marks present near the snapped end as well as along the remainder of the shaft

E6 ROYDEN: complete bone "linkshaft" measuring 36.9mm in length; both ends flattened; one smoother than the other; specimen highly polished with longitudinal striations along the body

E.2. BONE ARTEFACTS (2008)

O12 SURFACE: piece of almost crescent-shaped bone shaft with evidence of grinding on the "arc-end"

D6a SURFACE/BARBIE/CORBYN: slender, almost banana-shaped bone point/linkshaft measuring 97 mm in length; worked to points at both ends

D5d SURFACE/BARBIE: flat piece of bone, broken at the ends, both of which display some evidence of grinding; at the rougher end, cancellous bone is visible at the break

D5d GIDEON: spatula made on a fairly dense fragment of bone; high polish evident on the smooth, wedge-shaped tip; the end where this fragment was detached from the original piece of bone is rough (69 mm in length)

D6c JUDY: bone awl measuring 90.8mm in length, manufactured on a fragment of bone shaft; no polish visible on tip

D6c JUDY: small, cylindrical bone bead measuring 5.3mm in length; undecorated, with multiple striations visible on the body; both ends fairly smooth

D6b JUDY: complete, undecorated bone bead measuring 5.5mm in length; dark brown/red coloration of the specimen may be the result of burning; single cut-mark visible in close proximity to one of the smoothly ground edges

D6c JUDY: flat, triangular fragment of bone or fish spine measuring 20.3mm in length deliberately shaped into a point at one end; un-pointed end appears round but not smooth; resembles a fish gorge

D5d BELOW PORTIA: fragment of bone ring; circular dimension preserved

D5c RICHARD: complete bone ring measuring 10.8mm in diameter; undecorated and bearing multiple striation and grinding-marks

D5c RICHARD: bone fragment or fish spine with pointed tip on which polish is visible, possibly indicating utilization (37.23mm)

D5c RICHARD/ROYDEN: tanged bone or ivory point, similar to a specimen present in the curated collection of material from Hoffman's original excavation; dark coloration most likely the result of burning; specimen measures 43 mm in length

D5c RICHARD/ROYDEN: bone ring measuring 21.5mm in external diameter; similar to specimen recovered in RICHARD

D5a RACHEL: complete bone bead measuring 7.8mm in length; narrow and cylindrical in shape

R23a SECTION CLEANING: hollow-tipped bone point; unevenly broken at unworked end

R23b SECTION CLEANING: fragment of hollow bird bone shaft; broken and partially ground at one end and ground at the other

R23b SECTION CLEANING: broken bone bead; undecorated; multiple striations and cut-marks evident on surface

D6d BELOW PORTIA: fragment of *Pelomedusa* carapace with single perforation; bevelling clearly apparent around hole on surface from which it was drilled; edges of fragment unground

E.3. WORKED, MODIFIED OR UTILIZED MARINE SHELL (2007)

D5b SURFACE: *Donax serra* valve roughly perforated some distance from the apex; bevelling around the perforation evident on the outer surface of the specimen, which is broken around the edges

D5b SURFACE *ZOSTERA IN SITU*: round pendant manufactured on a fragment of *Turbo* shell; edges fairly roughly ground and slightly broken; two very smooth perforations; *Zostera* strands adhered to both nacreous and other surface

D4a SURFACE *IN SITU*: *Donax serra* valve with a small, fairly rough perforation; as with the previous specimen, bevelling is visible around the hole on the outer surface, and the edges are broken

E5 BEN: partial *Turbo sarmaticus* operculum with a small hole, most likely made by a carnivorous gastrapod

E5 KATHARINE: very thin, delicate pendant on a fragment of *Turbo* shell; oval in shape; two smoothly drilled, round perforations; specimen has split apart at one end

D5b KATHARINE: unbroken *Donax serra* with small perforation; heavy circular bevelling surrounds the hole on the outer surface

E5 OMAR: complete *Perna perna* hinge with a very smooth perforation on the end opposite the apex; possible evidence of grinding on the nacreous surface

D5b OMAR: broken fragment of *Perna* shell with small perforation

PORTIA: almost complete *Perna* hinge with a small, fairly rough perforation; bevelling around the perforation evident on the nacreous surface

D4a PETER: round pendant with two round perforations; drilling/grinding-marks evident around the holes on the nacreous surface, indicating it was drilled from the inside out; flaking and peeling of the specimen evident on the outer surface; specimen also slightly broken around the edges

D4a PETER: complete *S cochlear* with ochre residues on the inner surface

E.4. DESCRIPTION OF WORKED, MODIFIED OR UTILIZED MARINE SHELL (2008)

D6c BARBIE: two *S argenvillei* shells with possibly ground edges

D6c JANE: triangular fragment of nacreous shell with edge-nicking on both sides; outlines of three distinct, partial perforations

D5d JANE: fragment of *Perna* shell with small perforation

D6c MAVIS: broken *Perna perna* hinge with a small, very smooth perforation

D5c NATHAN: two fragments of *Perna* shell with small perforations

D5a NOAH: *Perna perna* hinge with a small, smooth, very regular perforation

R23a/b/c spits: *S tabularis* shell with single, rough perforation slight distance from apex; possibly caused by a pick

APPENDIX F

CHI – SQUARED TEST ON QUARTZITE CORES FROM HOFFMAN'S/ROBBERG CAVE AND NELSON BAY CAVE

Table 1.Results for Chi – squared test between numbers of quartzite cores relative to quartzite chips, chunks and unretouched flakes from Hoffman's/Robberg Cave and Nelson Bay Cave.

K	Oi	Ei	(Oi – Ei)	(Oi – Ei)2	(Oi – Ei)2 / Ei
1	22	9	13	169	18.7
2	39	52	-13	169	3.2
3	703	715	-13	169	0.2
4	4118	4105	13	169	0.0

$$X2 = \sum^{k} (Oi - Ei)2 / Ei$$

K: Number of categories

Oi: Observed number of cases in each category

Ei: Expected number of cases in each category

Df = (2 – 1) (2 – 1) = 1

X2 = 22.1

Significance level 0.05

22.1 > 3.84

Therefore reject Ho that there is no significant difference between the number of quartzite cores relative to chips, chunks and unretouched flakes from Hoffman's/Robberg Cave and Nelson Bay Cave.