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THE ARCHAEOLOGY OF ISOLATION? PREHISTORIC OCCUPATION IN THE
FURNEAUX GROUP OF ISLANDS, BASS STRAIT, TASMANIA.

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This thesis is the product of the author's research and the results presented are, except where otherwise acknowledged, the original work of the author.

Robin Sim

ABSTRACT

Early European explorers were puzzled by the absence of Aboriginal populations on the larger more remote larger islands of the Bass Strait as at least King and Flinders Islands appeared capable of supporting human populations. Subsequent discoveries of stone artefacts on several of the Bassian islands were variously ascribed to human occupation during the landbridge phase or historic times, when Aboriginal Tasmanians had been taken to the islands by sealers and by G.A. Robinson for re-settlement. However, the discovery of shell midden sites on Flinders Island in the 1970s brought new perspectives to the previous artefact finds — these prehistoric midden sites suggested people had been living on or visiting Flinders Island after the inundation of the Bassian landbridge.

Radiocarbon dating of the midden sites on Flinders Island indicated that people were on Flinders Island until about 4,500 BP but absent in more recent times. The aim of the research was to investigate why it should be that evidence of human occupation on Flinders Island disappears from the archaeological record about 4,500 years ago, some 5,000 years of so after insulation. The primary step in this investigation was to determine whether the habitation ceased due to the island being abandoned, or whether it was a case of *in situ* extinction of the island population. Lampert (1979) had investigated a similar mid-Holocene habitation cessation on Kangaroo Island, and although concluding that the population probably died out he could not dismiss the alternative possibility that people had watercraft and had ceased visiting or living on the island about 4,000 years ago.

Unlike Kangaroo Island, the Furneaux Group had outer islands which enabled the issue of watercraft use to be investigated and thus resolve the primary question of island abandonment or extinction. Results of surveys of the Outer Islands indicated that people in the Furneaux region in prehistoric times did not have watercraft and thus the mid-Holocene middens on Flinders Island were deposited by an isolated relict population. Subsequent excavations on Badger and Prime Seal Islands in the Furneaux Group indicated that people had not only been stranded on Flinders Island by the post-glacial sea level rise, but had been occupying the area from at least 23,000 years ago in late Pleistocene times.

The evidence from Beeton Rockshelter and Mannalargenna Cave suggests relatively low levels of human occupation from about 23,000 BP until the early Holocene when the post-glacial sea level rise resulted in the formation of the outer islands and

severed overland access to these peripheral Furneaux areas. A more intense phase of occupation is evident between about 18,000 BP and 15,500 BP, and it is argued that this phase reflects a greater mobility of people in the region during the last glacial maximum. The adaptation of stone working techniques to locally available fossil shell resources, and the continued practice of shell working for ten or more thousand years or so, suggests that these sites may have been part of a northeast Tasmanian cultural system focused on the plains of the Bassian region.

Despite the rapid onset of the terminal Pleistocene marine transgression, people remained in the Furneaux region. As the sea level continued to rise, fragmenting the Furneaux peninsula into the Furneaux Islands, people retreated toward the more upland areas that today comprise Flinders Island. The chronology of site abandonment in both the outer island excavations tracks the contracting land-use pattern in the region as areas were abandoned corresponding with retreating shorelines.

Ultimately a group of people became stranded on Flinders Island and lived there in isolation until about 4,000 or so years ago. The Flinders Island habitation cessation coincides with major changes in the archaeological record in mainland Australia and Tasmania, and a similar disappearance of evidence of human occupation on Kangaroo Island. Furthermore, these changes also coincide with a mid-Holocene climatic shift associated with the onset of the ENSO (El Niño Southern Oscillation) cycle which brought about droughts and fires to the southeast Australian region.

The demise of the Flinders Island population had been previously interpreted in light of the devolutionary cultural model posited for the Aboriginal Tasmanians by Jones (1977b). These interpretations suggested that Flinders Island represented a microcosm of the purported trajectory for Tasmania, played out to its ultimate conclusion. This proposition is examined in light of the cultural and palaeoenvironmental evidence from the Furneaux region and a number of case studies of island extinctions and abandonments. These other examples include a range of chronologically, geographically and culturally diverse societies and provide both biogeographic and cultural models for human habitation cessation on islands.

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THE ARCHAEOLOGY OF ISOLATION? PREHISTORIC OCCUPATION IN THE FURNEAUX GROUP OF ISLANDS, BASS STRAIT, TASMANIA.

Among the most tantalizing mysteries of archaeology are the unexplained disappearances of human populations isolated on islands (Diamond 1994:331).

CHAPTER ONE

INTRODUCTION

1.1 The Furneaux problem

When Europeans first arrived in Bass Strait at the end of the eighteenth century, the more remote islands in the strait, those furthest away from both Tasmania and mainland Australia were totally devoid of human inhabitants (Baudin 1803; Cumpston 1973:44-45; Flinders 1801, 1814; Peron 1802 in Micco 1971:11). In 1799 Bass and Flinders sailed south from Port Jackson in their sloop the *Norfolk* to resolve speculation about the existence of a strait between Van Diemen's Land (Tasmania) and New Holland (mainland Australia) (Murray-Smith 1969:11). They proved that the strait did in fact exist and spent several months exploring the Bass Strait region. Bass and Flinders were puzzled by the absence of Aboriginal populations on the larger resource-rich islands such as King and Flinders Islands. Other explorers following in their wake made similar observations (Baudin 1803; Cumpston 1973:44-45; Flinders 1801, 1814; Peron 1802 in Micco 1971:11).

On an early voyage to the region Flinders had noted that while there were constant 'smokes' being sighted (and thus Aboriginal inhabitants) on mainland Australia and Tasmania, there were 'none upon the [Bass Strait] islands' (Flinders 1814:cxxxvi). Because he assumed that Aboriginal people in Tasmania had originally colonised Van Diemen's Land from mainland Australia using watercraft, Flinders found it especially puzzling that there was a complete absence of Aboriginal inhabitants or evidence of their presence on the larger Bass Strait islands. He could not understand how the Aboriginal colonisation of Tasmania took place without the Bass Strait Islands being visited.

Flinders dismissed the possibility that Aboriginal seafarers had reached the islands but not managed to survive;

nor was it admissible that, having reached them, they had perished for want of food (Flinders 1814:xxxvi).

Both King and Flinders Islands were more than 1,000 square kilometres in size, and were stocked with abundant and seemingly reliable resources (Figure 1.1). There was no apparent shortage of fresh water or marine and terrestrial foods on these larger Bass Strait islands and the islands appeared, at least to Flinders, to be capable of sustaining human populations.

Peron, the senior naturalist on Napoleon's 1801-2 exploratory French Scientific Expedition, was similarly puzzled by the absence of Aboriginal people on the larger, more remote islands in Bass Strait:

Over the whole of King Island we saw no trace of humans, and everything indicates that this island is equally unknown both to the wild tribes of Van Diemen's Land and New Holland. On the other hand there are few places in the Southern regions that nourish so many useful animals (Peron 1802 in Micco 1971:11).

We now know that the less distant islands of the Hunter Group however were visited by indigenous Tasmanians during the contact and pre-contact period (Bowdler 1980:12-13; Meston 1936). Unlike King Island and the Furneaux Group, which would require open sea voyages of at least 60 kilometres and 13 kilometres respectively, the Hunter Islands are only a few kilometres offshore from mainland Tasmania. Hunter Island therefore is well within the range of watercraft in use around various parts of Tasmania at the time of first contact (Bowdler 1979; Jones 1979; Meston 1936; Roth 1899).

Early historic accounts suggest that Aboriginal people visiting the Hunter Islands swam between islands within the Hunter group (Bowdler 1980:12-13; Meston 1936). Notwithstanding, it is almost certain that the initial crossing between the Tasmanian mainland and the Hunter Islands could only have been achieved by the employment of watercraft. This infamous strait is a treacherous stretch of water with strong tidal rips and currents and represents a crossing of four and a half kilometres with some rocky islets midway (Bowdler 1988:45; Meston 1936; G. A Robinson's journal in Plomley 1966:176 [referred to hereafter as Plomley 1966]). While it is possible but extremely unlikely that people may occasionally have swum from mainland Tasmania to the Hunter Group, it is certainly not feasible that they would have reached more distant Bass Strait islands without watercraft.

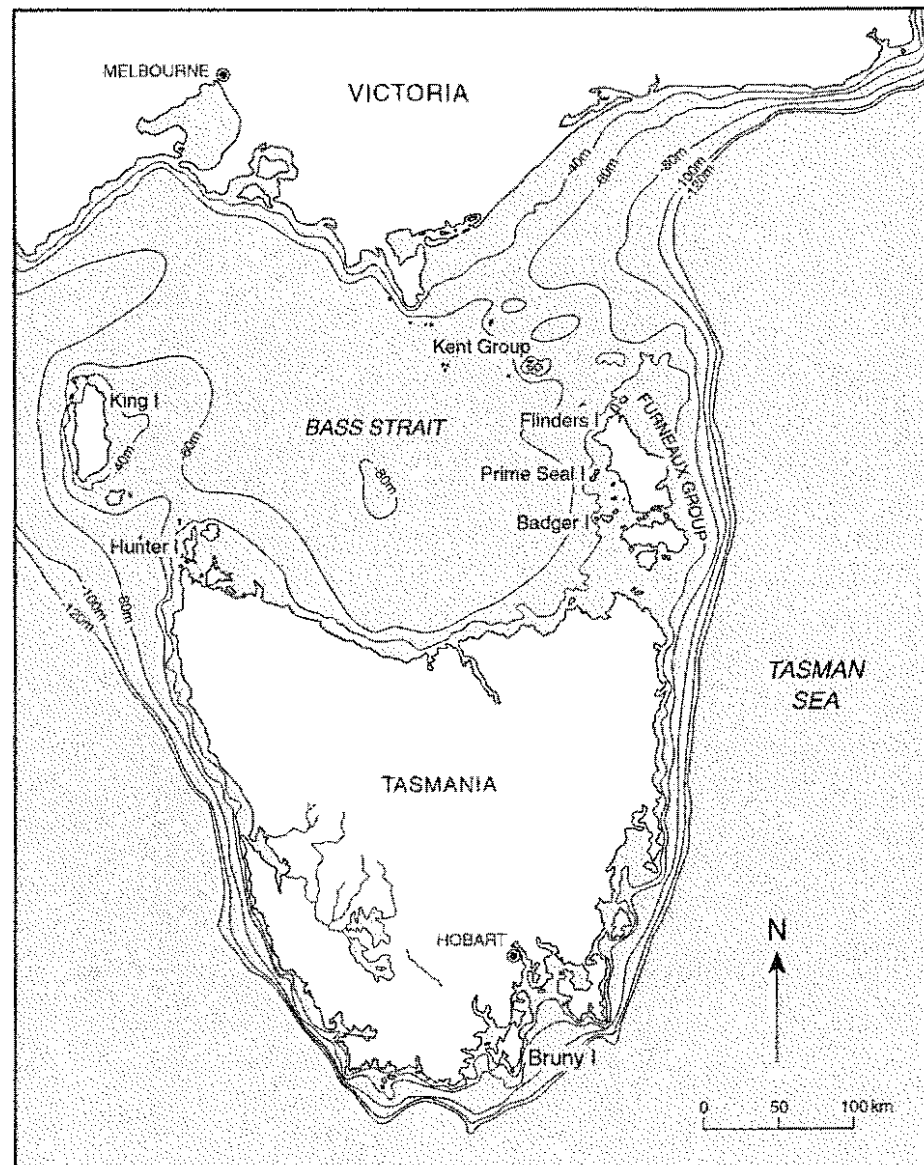


Figure 1.1: The Bass Strait region with bathymetric contours relevant to sea levels between 35,000 BP and present (at 4,000 year intervals from 32,000 BP to 8,000 BP).

The absence of Aboriginal people on Flinders and other large islands in the Furneaux Group, and also on King Island on the western side of Bass Strait, therefore suggested that these more remote islands were beyond the range of watercraft used by indigenous Tasmanians (Jones 1976:258, 1977a). Moreover, early European explorers found no evidence such as shell middens, stone tools or campsites which would suggest that the more remote Bass Strait islands had ever been populated or visited by Aboriginal people in prehistoric times. G.A. Robinson's historical journals clearly indicate that the Tasmanians did not visit either King or the Furneaux Islands, at least in late prehistoric times (Plomley 1966:400). At contact, the only place these Bass Strait islands had in the world of the Tasmanians was in their spiritual realm.

According to early contact accounts, the islands were associated with death lore, the west coast and northern Tasmanians believing that on death, a person's spirit travelled to the islands (Plomley 1966:400). From Robinson's accounts, it appears that amongst the Tasmanian Aboriginals some confusion arose between the 'traditional' islands to the north to which the spirits of the dead travelled and another island farther afield, England. There are reports of some Aborigines assuming that England and the spirit islands were one and the same, undoubtedly stemming from the English arrivals explaining their place of origin as an island far away. Thus it was that some Aborigines reported that when they were dead their spirit went to 'England' (Plomley 1966: 465). The ghost-like appearance of the English undoubtedly did little to dispel this notion. Robinson's journals indicate that islands which the indigenous Tasmanians knew existed but did not visit, whether England or the remote Bass Strait Islands, were amongst some groups at least thought to be associated with death.

This raises the possibility that the mythology of the islands referred to as the islands of the dead originates from earlier times when Aboriginal people witnessed the severing of lands by rising seas as the Bass Strait formed. What is certain however is that both the early explorers and the ethno-historical accounts concur that when Europeans arrived in the region, there was no evidence of Aboriginal inhabitants on any of the more remote Bass Strait islands. For the next century or more, it was assumed that the Tasmanian Aboriginals had never occupied or visited the Furneaux Islands or King Island in pre-contact times. It was not until the 1930s, when stone artefacts were discovered on several islands in the Furneaux Group, that prehistoric Aboriginal occupation of the Bass Strait islands was seriously contemplated (Mackay 1946; Tindale 1941). At that time the origin and antiquity of the Tasmanians was a matter of debate amongst anthropologists. Although it had been suggested that Tasmania might have been colonised overland, at a time of lower sea level, this was still a matter of conjecture as the mainland Australian Aboriginal

occupation was until the 1960s widely believed to be of Holocene antiquity (Abbie 1951:91; Casey 1940 26-29; Elkin 1943; Kemp 1963; Macintosh 1949:142; Mitchell 1949:3; Noetling 1911; Tindale 1941; Wood-Jones 1934).

When the stone tools were discovered on the Furneaux Islands in the 1930s, it was not known whether a Bassian landbridge had existed within the time span of prehistoric human occupation of Australia, let alone Tasmania. Consequently, there was some debate as to the status of the Furneaux Islands finds as 'prehistoric' artefacts. It was suggested that Aboriginal people, skilled in the manufacture and use of stone artefacts, who had been living on the islands in historic times may have been responsible for the deposition of the artefacts on Flinders and Cape Barren Islands (Bowdler 1979:39; Jones 1968:200).

In 1975 prehistoric shellfish middens were discovered on Flinders Island, clearly demonstrating that people were on the island in pre-contact times. This discovery indicated that the stone artefacts previously found on the islands may well have been from a pre-European occupation phase (Orchiston and Glenie 1978). More importantly, the midden discoveries raised the possibility that some of the remote Bass Strait islands may have had residual Aboriginal populations when rising sea levels finally severed the islands from mainland Tasmania in the early Holocene (Jones 1979; Orchiston 1984). The presence of marine shellfish with other cultural remains in middens at Palana on Flinders Island, suggested that these sites had been deposited sometime around or after 6,500 years ago, after the post-glacial sea level rise would have brought the shoreline, and thus marine food resources, to within several hundred metres or so of the midden sites (Figure 1.2) (Orchiston and Glenie 1978; Chappell 1994).

Further archaeological surveys on Flinders Island revealed midden sites in six other locations on Flinders Island and culturally deposited marine shell from five different midden locations was C14 dated (Sim 1989, 1991). The results of the shell dating demonstrated not only that people were on Flinders Island when the sea level stabilised about 6,500 or so years ago, but also that the island continued to be occupied or visited by Aborigines until at least about 4,700 years ago (Sim 1991:114, 1994). It is extremely improbable that the youngest midden site on the island has been dated, and thus the island was almost certainly inhabited for some period after 4,700 BP. The spread of five shell dates from the Flinders Island middens between 6250 BP and 4730 BP suggests that the island was possibly occupied until about 4,000 years ago (Sim 1991:237). These midden dates indicate that human occupation persisted on Flinders Island for about 5,000 years after the overland connection with mainland Tasmania had been severed by rising seas. All evidence of

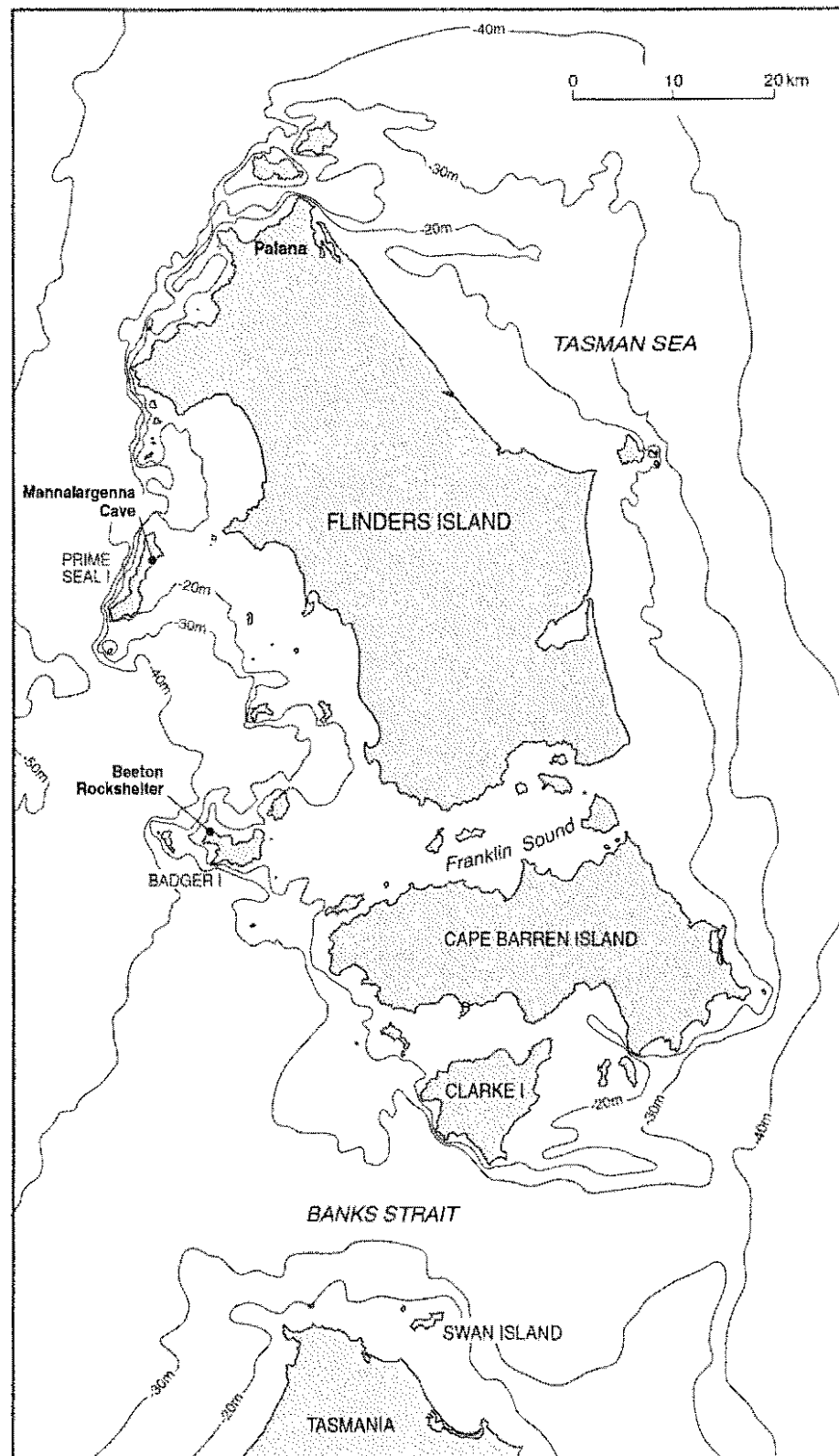


Figure 1.2: The Furneaux Group of Islands with bathymetric contours relevant to the past insulation of outer islands.

human occupation subsequently disappears from the Flinders Island archaeological record, and the island remained uninhabited for about four thousand years before it was re-discovered in historic times.

The problem I originally set out to address therefore arose directly from previous research I had undertaken on the Bass Strait Islands, and appeared to be fundamentally twofold;

- a) whether I was dealing with an isolated island population which became extinct, or a case of island abandonment (with the latter implying a human population with ocean-going watercraft technology), and
- b) why after persisting for 5,000 years or more, Aboriginal occupation in the Flinders Island environment ceased?

After my initial field season however it was clear that none of the archaeological sites in the Furneaux region could provide stratified sequences bearing directly on the chronological phase of island isolation and habitation cessation — that is occupation deposits spanning from the island formation phase through to the mid-Holocene habitation cessation on Flinders Island. During the initial island surveys the majority of sites found comprised surface artefacts, most of which were isolated finds and low density artefact scatters. Only one site was found which contained stratified cultural remains and this was Beeton Rockshelter on Badger Island. Radiocarbon dates from shell in the upper level of the test pit at this site indicated that while directly relevant to the insulation phase, the remains in this deposit pre-dated the actual isolation phase evident in the Flinders Island midden sites. The nature of the remains in the Beeton Rockshelter site suggested it probably contained deposits of similar antiquity to Mannalargenna Cave on Prime Seal Island, the only site previously known from the region to contain stratified cultural deposits.

Brown (1993) had previously excavated the outer overhang area of Mannalargenna Cave and recovered cultural remains spanning from about 9,000 BP to 21,000 BP. Due to time constraints however he had not been able to excavate to bedrock level or archaeologically sterile deposits. The more protected inner chamber which appeared to have further archaeological potential had also not been investigated at this site. Further work at Mannalargenna Cave was clearly warranted in order to further resolve questions regarding both the antiquity of occupation and the nature of human occupation in this region in the period leading up to the insulation and eventual isolation of Flinders Island population. This, along with results from the preliminary survey stage of the project led to a subtle change in direction of the research, to incorporate a longer term perspective of land use patterns in the Furneaux region. This broader chronological view incorporated human occupation in the eastern

Bassian region prior to the post-glacial marine transgression and ultimate inundation of the Bassian plains. Hence while the data base recovered from Beeton Rockshelter and Mannalargenna Cave, the two sites excavated for this thesis, did not provide a detailed sequence from the isolation and ultimate habitation cessation phases, it did facilitate the issue of regionality as reflected in the late Pleistocene archaeological record from the Furneaux and broader Tasmanian contexts to be examined. In turn this enabled the role that perceptions of regionality may have played in the decision of people to remain in the Furneaux region despite impending inundation and isolation. The thesis initially however focuses on the Holocene island habitation question and the issue of earlier regional occupation precursory to the island phase occupation is addressed explicitly in the discussions of the findings from the excavations.

1.1.1 Flinders Island — an isolated case? Analogues and explanations

There have been many cases documented where, for a range of reasons, regions and settlements have been abandoned (Anderson 1980, 1996; Bellwood 1978; Cameron and Tomka 1993; Cleghorn 1986; Diamond 1985; Gad 1970; Graham-Campbell and Kidd 1980; Higham and Johnson 1996; G. Jones 1984; Specht 1984; Steel 1965; Weisler 1994). There^{are} also numerous situations where human populations, languages and cultures have been extirpated in the process of war or invasion (Crosby 1986; Hoffman 1967). In these instances, historical and archaeological sources can be drawn upon to elucidate the process of invasion. Rarer and less easily understood is the situation where at some point in the chronology of an island's existence, the archaeological record comes to a complete halt for sufficiently long to indicate the extinction of human habitation.

To facilitate discussion of the issue of the disappearance of human populations from island environments, some clarification of terminology is required. For the purposes of this thesis the following terminology has been adopted;

island population is used generally to refer to a group of people resident on an island which is too distant to be consistently reached from the nearest other land mass by swimming,

habitation cessation is used as a general term referring to the disappearance of habitation evidence from an island's archaeological record,

extinction refers to the *in situ* termination of a totally isolated, permanently settled human population

island abandonment is where either

- a) an isolated, permanent island population leaves the island and does not return, even though they may have the watercraft technology to do so, or
- b) people using the island on a seasonal or other ephemeral basis cease visiting it.

Habitation cessation therefore is the archaeological manifestation of either 'extinction' or 'island abandonment' events or processes.

Underlying the problem of why human habitation on Flinders Island ceased is the question of whether the population abandoned the island or became extinct. The answer to this latter question fundamentally hinges on the access of the island population to watercraft technology. Did the population we are dealing with on Flinders Island possess the technological knowledge, skills and/or materials to construct watercraft sufficiently robust to facilitate island abandonment?

It has been suggested that the Andaman Islanders were similarly stranded by the post-glacial sea level rise and although they subsequently developed watercraft, these craft were unsuited to open ocean voyaging (Bellwood 1978; Cipriani 1966). Were watercraft, which enabled settlements to be made on several different islands in the Andaman group and facilitated marine resource exploitation, the critical difference between the Andaman and Flinders Islanders? Even if people on Flinders Island had watercraft and decided to abandon the island, this does not explain why it was not recolonised at some later date, and still leaves the question as to why the island was abandoned unanswered. Almost certainly an interplay of factors more complex than just watercraft is involved in the habitation cessation on Flinders Island.

It is unlikely that any single example of island occupation will *per se* provide an explanation for the Flinders Island context. Nonetheless, occupation histories from remote islands in other regions are useful in that they highlight factors that are known to have influenced the viability of island populations. Some caution is required however in using extinction and abandonment events from historic times to derive models for interpreting the prehistoric archaeological record, given the great disparity between the chronological span of these processes in historic times, and those in prehistoric times.

We cannot be sure that more recent, shorter term extinction or island abandonment processes (or events) are comparable to the longer term process evident in the

archaeological record (Jones 1987:24). Historic examples of habitation cessation, such as the extinction of the Norse in Greenland less than 600 years after initial colonisation, and after about 250 years of isolation from the outside world (Gad 1970; Graham-Campbell and Kidd 1980; G. Jones 1984), may well be essentially different in nature from prehistoric situations where isolated populations have survived for thousands of years, before disappearing from the archaeological record. Nonetheless, these historic cases are relevant to the problem in that certain circumstances, such as catastrophic events, have the potential to impact with disastrous consequences on island populations, regardless of the habitation span of that population. Historic cases have the added dimension of written documentation and provide a fine scale resolution not available in the archaeological record. Therefore it is possible that there may be factors involved in the viability of isolated populations which may not be immediately apparent in the archaeological record but are identifiable in historic records.

The main problem in the Bass Strait situation, and for islands in other regions, is essentially one of disentangling cultural factors from natural processes that may have contributed to habitation cessation (Kirch 1997a:14). Moreover this problem is further complicated by the issue of time scales, and disparities between (as well as within) archaeological time scales, those of human behavioural processes and those of natural processes (Bailey 1983; Diamond 1985, 1994; Frankel 1993). Are we dealing with a short-term catastrophic event – or with cultural responses to changing social or environmental circumstances, such as warfare or cannibalism – or with technological innovation such as the invention of watercraft? Or is habitation cessation on Flinders Island a consequence of a long-term process of decline, at a rate possibly imperceptible on a generational scale but which nevertheless eventually caused people on the island to either die out or abandon the island? Or is the explanation the interplay between short-term event or responses and the longer term processes and trends?

1.2 Island extinctions and abandonments

There are examples of prehistoric island extinctions and abandonments by human populations in a number of diverse ecological regions of the world, from 'mystery' tropical islands in the Pacific, to Greenland, north-west Scotland and Australia (Anderson 1980, 1996; Bellwood 1978; Specht 1984; Steel 1965; Terrell 1986). There are also examples such as the Canary Islands where isolated indigenous island populations have been extirpated by invaders with superior maritime transport and

warfare technology (Major 1872). These situations are generally not regarded as 'habitation cessation', as occupation of the island continues, and the causal factors for the demise of the indigenous population are self explanatory. Moreover, the truncation of one cultural group and replacement by another is usually quite distinct in the archaeological record.

Biogeographical and archaeological research as well as historical sources suggest a range of factors to which the cessation of habitation in isolated island environments may be related (Black 1980; Diamond 1985; Diamond and Keegan 1987; Kirch 1977b; Weisler 1994). These factors fall into three categories: environmental, cultural and genetic.

Climate and changes in sea levels are the two principal environmental factors relevant to habitation cessation. Short-term events or episodes of climatic extremes and more subtle shifts in regional climatic regimes can affect the long-term sustainability of island resources critical for human habitation, or render environments unsuitable for human occupation. Changes in sea level too can remove or reduce resource areas, and the insulation process itself has consequences for resource diversity. The long-term reduction in regional plant and terrestrial faunal suites associated with island formation is well documented in biogeographical studies (Gorman 1979; Hope 1973; Keegan and Diamond 1987; MacArthur and Wilson 1967; Martin 1984).

Cultural factors which may affect the viability of island populations can relate to social and technological systems. The relevant aspects of the social mechanisms are those that control or maintain a viable population in terms of both size and genetic composition (Alland 1972:229; Kirch 1997b:35). Uncontrolled population expansion can result in over-exploitation of island resources and environmental degradation, in an attempt to sustain an ever increasing population. On the other hand, if sufficient population levels are not maintained, continued population decrease will ultimately lead to the breakdown of the overall cultural system.

Not only are mechanisms that control population size relevant, but genetic diversity must also be maintained in an island population (Bodmer and Cavalli-Sforza 1976; Cavalli-Sforza *et al.* 1994; Diamond 1985). This is usually facilitated by social mechanisms such as incest taboos and laws governing marriage patterns, which in turn rely upon a minimum population size to function effectively. Subsistence technologies and strategies are also relevant in that they relate to anthropogenic

alteration of the habitat, an issue directly related to levels of resource exploitation and population control. Technological systems, and in particular watercraft availability, are critical in supporting inter-island social contacts, trade and migration. Technology such as watercraft assists in maintaining the interchange and diversity of ideas, resources and people (genes) in island environments.

Genetic factors are only likely to be involved in habitation cessation if the population is both totally isolated and of a sufficiently small size that adverse effects related to genetic diversity could come into play (Rowland 1996:192). The size of the founding population could be relevant therefore as this predetermines genetic variability or diversity within the longer term island population (Birdsell 1977; MacArthur and Wilson 1967). In the case of the Flinders Island population, where we are dealing with a population that has proved viable for 5,000 or more years, the longevity suggests that the founding population was sufficiently diverse. Nonetheless, the possibility that genetic diversity and genetic drift could have played a role in the process of extinction of the island population cannot be dismissed out of hand (Shaffer 1987:71). Clearly, environmental or cultural factors are stronger contenders as causal factors involved in the demise of human occupation in Flinders Island.

The process of island abandonment or extinction can occur as an unforewarned, instantaneous event as a result of catastrophic natural disasters such as tsunami and the like, or as a longer term process related to cultural responses to changes in island habitats (Kirch 1977b). Environmental degradation itself can also result from both natural and anthropogenic factors, and moreover these can be entwined in a mutually reinforcing system leading to inevitable breakdown of either or both (Bahn and Flenley 1992; Diamond 1985, 1994; Flannery 1994; Keegan and Diamond 1987; Kirch 1997b; McCoy 1979; Weisler 1994). For this reason island examples outside Bass Strait are useful not only in investigating direct causes of habitation cessations, but also for examining the interplay of cultural and natural processes that have led to habitation cessation in island environments, and the manifestation of these in the archaeological record.

Examples of island abandonments and extinctions from Australia and elsewhere are examined below. Cases from both hunter-gatherer and agricultural societies, and historic and prehistoric contexts are considered, as habitation cessation and subsistence mode are not always inextricably linked. In the section following the review of island abandonments and extinctions, several examples are evaluated in

light of the Bass Strait problem and used to formulate hypotheses relevant to the mid-Holocene habitation cessation on Flinders Island.

1.2.1 Australian offshore islands

Archaeological data from the Australian offshore islands suggest that Aboriginal use or occupation of islands falls into the following categories:

- a) a small number of larger islands which were continuously occupied, from sometime before the insulation phase through to the contact period,
- b) islands that were only occupied or visited sometime in the last 4,000 years
- c) islands where habitation cessation is associated with the insulation process, and people appear to have abandoned the region as rising seas separated it from the greater neighbouring land mass, and
- d) islands with evidence of post-insulation occupation which terminates prior to European arrival.

Islands continuously occupied from the insulation phase

There are archaeological and ethnographic data documenting the Aboriginal use of numerous islands around the Australian continent at the time of European contact (Bowdler 1995). Tasmania is the only Australian island for which there is unequivocal archaeological evidence demonstrating continuous human occupation from the pre-insulation phase through to the ethnographic present (Bowdler 1974; Jones 1977a; Kiernan *et al.* 1982). Although no archaeological data are available from Bathurst and Melville Islands in northern Australia, the distinctive character of Tiwi culture, and physical differences between the Tiwi people of the islands and those of mainland groups strongly suggests that these islands have also been continuously occupied from the time of insulation. Tindale (1977) has suggested that Bentinck Island in the Gulf of Carpentaria also falls in the continuous occupation category, although this has more recently been questioned by Bowdler (1995:949).

Late Holocene island use

While there appears to have been continuous Holocene occupation on three of the larger islands through to the contact period, the majority of offshore islands were not occupied or visited in the post-insulation phase earlier than about 4,000 years ago (Bowdler 1995; Clarke 1994; Rowland 1996; Sullivan 1982). There are currently dates for Holocene island phase occupation from some 27 islands around Australia,

of which only three are candidates for occupation prior to 4,000 BP (Bowdler 1995:949). Of these islands two have questionable, and one secure evidence of island phase occupation in the period prior to 4,000 BP. Evidence from the last, Bruny Island, comprises a sequence of midden shell dates between 4,000 BP and 6,000 BP, whereas the evidence from Hook and North Keppel Islands comprises charcoal dates the anthropogenic status of which is unclear (Barker 1989, 1991; Dunnett 1993; Rowland 1982, 1983, 1985, 1996).

Although it has been argued that evidence at Nara Inlet on Hook Island spans the insulation to late Holocene phase, the dates on which this proposition is based are radiocarbon dates of 8158 ± 80 (Beta 27835) and 3990 ± 60 (Beta 31742), both obtained on charcoal (non-hearth) from one stratigraphic unit. That this unit represents continuous occupation from the pre-insulation phase through to the mid-Holocene is equivocal. Barker contends that this unit represents cultural remains deposited continuously over a span of 4,000 years. While the unit does contain cultural remains, there are no cultural features such as hearths or other evidence to support his interpretation of continuity. Without dates from cultural remains in the early Holocene island phase, that is in the clearly post-insulation period between 7,500 and 4,000 years ago, the argument that occupation at this site spans the insulation to late Holocene phase is tenuous in the extreme.

Bruny Island, where there is a secure sequence of cultural remains dated which spans from the mid- to the recent Holocene is located in the sheltered D'Entrecasteaux Channel, less than 1.2 kilometres from the mainland in southeast Tasmania. It is possible therefore that crossings could have been made using rudimentary flotation aids such as logs, and that more sophisticated watercraft technology was not required to access this island.

These few exceptions aside, the archaeological data now demonstrate a consistent pattern of offshore island use in Australia, with use or occupation of offshore islands in the post-insulation phase commencing about 4,000 years ago and becoming more frequent at various times through to the contact period (Bowdler 1995; Gaughwin and Fullagar 1995; O'Connor 1992; Rowland 1980, 1981, 1986, 1996; Sim 1994; Sullivan 1982). There is to date no secure evidence of maritime watercraft technology in Australia in the Holocene earlier than about 4,000 years ago.

Islands abandoned at or before insulation

Based on an uncalibrated charcoal date of about 6,700 BP, O'Connor has suggested that High Clifty Island off the coast of northwest Western Australia was being visited after it had become an island. The evidence indicates that use of the 'island' then ceased until about 3,000 years ago, from which time visits became more frequent (O'Connor 1994, 1992). O'Connor's interpretation of the evidence from High Clifty reflecting island visitation was reached by correlating a sea level curve based on calendar years BP with an uncalibrated charcoal date, ie radiocarbon years BP (Belpiero 1989; Belpiero *et al.* 1983; Chappell 1994; Lambeck and Nakada 1990; Nakada and Lambeck 1989; Pirazzoli 1991; Playford 1988). When calibrated the C14 charcoal date could well date to the time just prior to insulation rather than after island formation and thus not be evidence of watercraft use at that time. This would also explain the subsequent lack of evidence of visitation in the mid-Holocene phase.

Similarly Veth has suggested that the Montebello Islands in northwest Western Australia were visited as islands for a short time after the initial separation of the area from mainland Australia by rising seas (1993 and pers. comm.) . Evidence of occupation ceases about 7,500 BP on the islands, after Veth contends the initial separation of the island area from the mainland took place (Veth 1993:46). For the same reasons as outlined above in relation to High Clifty Island, the interpretation of occupation at 7,500 BP as island phase occupation is also problematic. Nonetheless, whether these islands were abandoned just prior to, or shortly after insulation it is still clear that their abandonment was directly related to the insulation process.

There is also undated evidence of prehistoric human activity on other offshore islands in Western Australia, all of which would have been accessible overland prior to the last post-glacial sea level rise. The evidence comprises stone artefact surface finds on Rottnest and Garden Islands off Fremantle, and the Recherche Archipelago in the southwest (Dortch 1991; Dortch and Morse 1984). The type of chert used for the manufacture of artefacts found on Rottnest Island is believed to be from a source that has since been submerged by rising seas, suggesting occupation at times of lower sea level, when the islands would have been part of the mainland (Glover and Lee 1984). There is also an absence of evidence of island phase occupation on the islands of the Recherche Archipelago and in rockshelter deposits on Rottnest Island. This, in combination with the absence of ethnographic or archaeological evidence of watercraft in the southern region of Western Australia, all suggests that use of the

areas which now comprise these southwestern Australian islands ceased before the insulation phase (Bowdler 1995; Dortch and Morse 1984).

Similarly, stone artefact surface sites have been recorded on a number of offshore islands in Tasmania and Victoria, and while it is possible that they could date to the historic or island phases, there is no other evidence such as shell middens to suggest that the islands were occupied or visited in the post-insulation phase (Bowdler 1988; Brown 1986, 1991, 1993; Gaughwin and Fullagar 1995; Kee 1987).

Islands with evidence of post-insulation occupation, which terminates prior to European arrival

Evidence of human occupation disappears in the post-insulation phase archaeological record from several islands around Australia apart from Flinders Island: Kangaroo and King Islands which were devoid of Aboriginal inhabitants at the time of European arrival, and Cave Bay Cave on Hunter Island which was abandoned for several thousand years in the mid-Holocene but later re-occupied several thousand years ago (Bowdler 1979, 1984; Lampert 1979, 1981; Sim 1991, 1994). Both King and Hunter Islands have evidence of occupation in the late Holocene whereas occupation of Kangaroo Island ceases around 4,000 BP.

Hunter Island

Evidence from Cave Bay Cave indicates that people were visiting the Hunter Island area at least ephemerally from late Pleistocene times (Bowdler 1984:136). A relatively intense initial occupation pattern is evident about 23,000 years ago, probably associated with the exploitation of terrestrial fauna of the open grassy steppe or lowland plains of the vast Bassian landbridge. According to Bowdler's interpretation of the evidence, this initial Pleistocene occupation phase appears to have been relatively short lived, and was replaced by low intensity site use and after 18,000 years ago, the Cave Bay Cave was abandoned for some 12,000 or so years. Apart from one sporadic visit to the cave about 15,500 years ago, re-occupation does not occur until about 6,600 BP, after the sundering of the Bassian landbridge and the formation of the Hunter Islands as we know them today (Bowdler 1979, 1984).

While Hunter Island was certainly visited in the late Holocene and early historic times by groups of Aboriginal people from northwestern Tasmania, evidence for Holocene use of the island before about 2,500 BP is rather ambiguous (Bowdler

1984). The earliest evidence of human occupation in the Holocene period is the lower shell midden layer in the Cave Bay Cave site and charcoal dates from this shell layer indicate it was deposited about 6,600 years ago. It is unclear however whether this lower midden was deposited by a relict population resident on the island from the time of insulation, or by people visiting the island from northwest Tasmania. Although scant, the presence of stone artefacts throughout the occupation deposit underlying the lower midden arguably could suggest that a small group of people remained isolated on Hunter Island or made infrequent visits to the island from northwest Tasmania. The subsequent evidence for island occupation in the levels above the lower midden is similarly scant until the upper midden layer, the basal level of which has been dated to about 2,500 BP. Between the two middens there were a small number of stone artefacts recovered and two hearths, the latter dated to 3960 ± 110 (ANU-1614) and 3330 ± 100 (ANU-1615) respectively (Bowdler 1979:80).

Relatively intense seasonal occupation of Hunter Island from about 2,500 years ago until historic times is attested by numerous other midden site dates and ethnographic evidence (Bowdler 1979, 1980; Meston 1936:147; Plomley 1966:971-974). The evidence of prehistoric human activity on the island prior to the most recent, post 2,500 BP, phase is ambiguous as Bowdler (1995:950) has indicated, and this evidence can be interpreted in various ways. Evidence from this site therefore does not provide useful information for answering questions concerning island use elsewhere in the region. Evidence from the more recent late Holocene phase however does provide some clues regarding prehistoric midden sites on King Island (see below).

From about 4,000 years ago there is evidence of the beginnings of an expansion of the northwest Tasmanian economic system, and a more general shift toward a maritime focus to subsistence strategies around Tasmania (Bowdler 1988; Dunnett 1993; Jones 1971; Sim 1994; Stockton 1982). Although difficult to date, the use of watercraft appears to have been associated with this coastal economic expansion (Allen 1979:6; Sim 1994; Vanderwal 1978:123). The hearths from about 4,000 BP in the Cave Bay Cave deposit thus could represent the initiation of this late Holocene coastal expansion. The permanent inclusion of Hunter Island in the seasonal cycle of subsistence and social activities of the late Holocene northwest system would thus be evidence of these changes.

While the question of habitation cessation does arise in the earliest phase of Holocene occupation on Hunter Island, the evidence actually sheds little direct light on the Flinders Island problem as it poses similar questions. Moreover, because of the closer proximity of Hunter Island to mainland Tasmania, the possibility exists that all the pre 2,500 BP island-phase evidence, including the lower midden in Cave Bay Cave, was deposited by accidental voyagers. If this were the case, then it is not a case of habitation cessation about 6,000 years ago, and hence not comparable to the Flinders Island problem where habitation cessation is unambiguous.

King Island

The evidence for prehistoric occupation on King Island is similarly problematic. Although this island was uninhabited when Europeans arrived there is some scant, but unequivocal, dated evidence of prehistoric human occupation there in the late Holocene. There is also evidence of late Pleistocene and possible Holocene occupation (Sim 1991, 1994). Radiocarbon dates of about 7,700 BP were obtained by Jones (1979:89) from charcoal flecks in a dune palaeosol also containing stone artefacts. As has been demonstrated by dating paired samples of charcoal and shell from similar palaeosol contexts on Flinders Island, disparities of several thousand years between cultural remains and non-hearth charcoal can occur (Sim 1991:88). Hence it is far from certain that King Island was inhabited by a relict population stranded by the marine transgression of the Bassian region (Sim 1991, 1994). People were in the region in the late Pleistocene, pre-insulation period, as other dated sites from the island including a human burial demonstrate, but habitation in the region ceased sometime in the terminal Pleistocene or early Holocene (Sim 1991; Sim and Thorne 1990).

The only clear evidence of island occupation on King Island appears in the late Holocene with two midden sites dated to about 1,100 and 1,900 years BP and several artefact scatters containing a total of five spongolite artefacts. This stone type is only known to originate from one source on mainland northwest Tasmania and is only found in occupation deposits in mainland sites more recent than about 3,500 BP (Cosgrove 1990, 1991; Jones 1977b; Painter 1992; Thomas and Van Eckart 1989). The middens and spongolite artefacts are interpreted as evidence that a few castaways originally from the Hunter Islands area landed on the island in the last few thousand years. The absence of any other evidence of similarly recent antiquity and the scant nature of the evidence do not indicate that King Island was inhabited

for any length of time, or was being deliberately visited from mainland Tasmania since insulation (Brown 1993; Orchiston and Glenie 1978; Sim 1994).

Kangaroo Island

More analogous to the habitation cessation on Flinders Island is the archaeological record from Kangaroo Island off the coast of South Australia. Investigations there have revealed more than 100 prehistoric sites, including a Pleistocene rockshelter along with number of Holocene sites (Lampert 1979, 1981). Amongst the Holocene sites were stratified dune deposits containing stone artefacts and a number of shell middens containing predominantly limpet (*Cellana* sp.) shells. Lampert obtained secure occupation dates from four open sites, three stone artefact sites and a shell midden at Bales Bay. Occupation at the artefact sites dated to ca. 8,000 BP, 5,200 BP and 4,300 BP, and the midden site to about 6,000 BP (Lampert 1979, 1981). The Seton rockshelter on Kangaroo Island contains two discrete occupation layers, one near the basal levels of the deposit dated to about 16,000 BP and an upper level dated to about 11,000 BP.

The Kangaroo Island archaeological record therefore spans the terminal Pleistocene period when it was part of greater Australia, the subsequent insulation process and the island phase when Kangaroo Island would have been separated from the south Australian mainland by a 14.5 kilometre wide strait. From his investigations Lampert concluded that a relict population was the most feasible explanation for the presence of mid-Holocene, island phase sites on Kangaroo Island (Lampert 1979, 1981). Nevertheless, he also canvassed the possibility that people in the region may have had watercraft and concluded that this possibility could not be dismissed, although he argued cogently that the evidence weighed in favour of an extinct isolated island population (Lampert 1979:223-29). Despite Lampert's systematic and thorough assessment of all other possible explanations such as the use of watercraft and people swimming between the island and the mainland, it is not possible to demonstrate archaeologically that the island was not abandoned and thus while persuasive Lampert's conclusion is not totally convincing.

One of Lampert's many contributions to Australian archaeology has been his demonstration that neither typological studies nor dating alone provide the answers to what happened in the past, and particularly in the case of Kangaroo Island. There is a marked similarity not only in the chronology of habitation cessation in the evidence on Kangaroo Island and that on Flinders Island, but also in the problem

such evidence poses. However, unlike Kangaroo Island which is an isolated island about 15 kilometres offshore from the mainland, there are numerous outer islands in the Furneaux Group and also stopover islands en route to the mainland which could be investigated for evidence of watercraft use. The Furneaux region therefore affords the opportunity to test for watercraft use.

The review of archaeological evidence from Australian offshore islands is useful because it highlights two fundamental patterns of land/island use of possible relevance to the Bass Strait problem. Firstly, there is a consistent pattern of terminal Pleistocene and early Holocene abandonment of peripheral coastal regions — as these areas become threatened with separation from the greater mainland mass by the post-glacial sea level rise, people cease using them. The second point is that, apart from Kangaroo and Flinders Islands, no island that required craft capable of enduring open sea crossings has dated evidence of human occupation in the time span between the time of insulation and about 4,000 BP.

1.2.2 The Pacific region

The comparatively recent settlement of the central and eastern Pacific regions, several thousand years after the post-glacial sea level stabilisation, could suggest that parallels to the Bass Strait situation and questions concerning isolated island populations are not to be found in the Pacific. Given that colonisation of the Pacific region is clearly related to the development of highly sophisticated watercraft technology and navigational skills, the question of stranded relict populations could seem anachronistic in the Pacific context. While it is true that there are no documented relict populations stranded as a result of the marine transgression, there are cases of both a) islands which like Kangaroo and Flinders Island were unoccupied and unvisited at the time of European arrival, but which have archaeological evidence demonstrating the presence of people on the islands in the prehistoric past, and b) isolated groups on islands who did not possess watercraft capable of voyages to more distant islands. There are also examples of isolated remote island populations which although not extinct, were on a trajectory that would inevitably have led to extinction but for historic intervention (Bahn and Flenley 1992; Kirch 1997b; van Tilburg 1994).

Historically unoccupied islands with evidence of past habitation

These islands comprise the 'mystery islands', some twenty or more islands scattered as far apart as Norfolk Island, the Galapagos and Hawaiian Islands. Whereas some of these mystery islands have only scant evidence of past human activity, and were clearly never permanently settled, others have more substantial evidence indicating there were permanent settlements which were subsequently abandoned in prehistoric times (Anderson 1980, 1996; Anderson *et al.* 1997; Bellwood 1978; Cleghorn 1986; Diamond 1994; Irwin 1992; Higham and Johnson 1996; Specht 1984; Terrell 1986; Weisler 1994). Although turning to the Pacific for models of habitation cessation could appear to be drawing a long bow, on closer examination there are strong parallels, and explaining the truncated nature of the archaeological records of the Furneaux Islands in Bass Strait and at least some of the mystery islands of the Pacific raises similar problems. The following overview of habitation cessation in the Pacific context deals primarily with islands from which there is substantial evidence of occupation over an extended period—that is those which may have once been permanently settled, rather than those with evidence merely of discovery or a few sporadic and possibly accidental visits.

These 'mystery' islands include Norfolk and Raoul Islands to the north of New Zealand, several Hawaiian outlier islands such as Necker and Nihoa in the Northern Pacific, a number of the Line and Cook Islands in the central Pacific, and Pitcairn and Henderson Islands further to the east (Anderson 1980, 1996; Bellwood 1978; Higham and Johnson 1996; Kirch 1984; Terrell 1986; Weisler 1994). When discovered later by Europeans these islands were devoid of inhabitants or indigenous visitors and yet all have evidence of prehistoric colonisation by maritime voyagers with agricultural or horticultural economies.

It has been suggested that archaeological evidence found on four of the Galapagos Islands could also represent a former prehistoric settlement there (Black 1980; Heyerdahl and Skjolsvold 1956; Terrell 1986). The evidence for prehistoric settlement on the Galapagos Islands is however unconvincing; all sites containing prehistoric materials, including pre-Spanish ceramics and stone artefacts, also contained European items. Furthermore, the investigators themselves noted that none of the four sites discovered had characteristics of long term habitation and all could possibly have resulted from sporadic visits to the isles.

More secure is the evidence of prehistoric settlements and subsequent habitation cessation on islands in the Line, Cook and Hawaiian Islands. In particular, on Malden and Fanning in the Line Islands there are remnant house paving areas and other cultural items, including grave sites on Malden, which indicate these islands had permanent settlements in the past. Evidence of prehistoric occupation has also been found on Palmerston and Suvarrow in the Southern and Northern Cook Islands respectively, and on Howland Island in the Phoenix Islands, all of which were deserted and unvisited at the time of first European contact (Bellwood 1978; Irwin 1992; Terrell 1986).

Pitcairn and Henderson Islands also have a similar pattern of prehistoric habitation cessation. These islands are believed to have been Mangarevan outlier settlements, possibly associated with the settlement of Easter Island nearly 2,000 kilometres further to the east. There is evidence of a resident population on Henderson Island, from about 900 AD to 1650 AD, after which it is said to have been 'abandoned' (Weisler 1994:98). Whether the population became extinct or abandoned the island is unclear; what is unambiguous is that human habitation on the island ceased around 1650 AD (Weisler 1994).

The chronology of cultural, botanical and faunal introductions indicates that for the first four or five hundred years of settlement the parent society in Mangareva was still in contact with the Henderson and Pitcairn Islanders. As there were no trees suitable for canoe manufacture on either Pitcairn or Henderson, contact was facilitated by sophisticated watercraft of Mangarevan origin. Henderson is a 36 square kilometre raised coral atoll and Pitcairn an extinct volcano 4.5 square kilometres in area. Evidence from Henderson Island also indicates that for the last 200 or so years of human settlement, the island population existed in total isolation having no outside contact from about 1450 AD (Weisler 1994).

Weisler (1993:256) envisages that Henderson had a population of perhaps a few dozen people, permanently resident, with visitors augmenting this to up to 100 or so at times of abundance of seasonal resources. Diamond attributes the cessation of inter-island voyaging between Henderson, Pitcairn and Mangareva to untoward events on Mangareva, suggesting that Mangareva

descended into an orgy of war and cannibalism that made continuation of trade with Pitcairn and Henderson untenable (1994:332).

This social upheaval was purportedly a result of population stress and environmental degradation (Diamond 1994). Within two centuries of contact ceasing between the 'parent' society on Mangareva Island and the outliers, habitation ceased on both Henderson and Pitcairn Island — these smaller outlier populations succumbing, according to Diamond (1994:332), to the 'deleterious effects of inbreeding', environmental degradation and the psychological effects of isolation such as insanity, murder or cannibalism.

Weisler (1994:98) takes a more pragmatic approach to the issue, simply stating that 'the cessation of inter-island contact undoubtedly contributed to the abandonment' of Henderson Island. Nevertheless, he does stress that Henderson and Pitcairn are ecologically marginal islands:

Limited in terms of sustainable resources and situated peripherally...
such islands pushed the capabilities of colonisation to its limits
(Weisler 1994:84).

The Henderson Island archaeological record also suggests that island resources were probably inadequate for settlement requirements, as extirpations of avian and other taxa occur in the early phase of human settlement (Weisler 1994:98; Weisler and Gargett 1993; Wragg and Weisler 1994). That the one garden area known on the island dates to the terminal occupation period could arguably be a reflection of the island settlers' unsuccessful attempts to adapt to the depletion of marine and avian resources.

Archaeological investigations have also been undertaken on Nihoa and Necker Islands, two small, isolated Hawaiian islands, lying 240 and 480 kilometres respectively northwest of the main Hawaiian Islands. Nihoa, the closer island to Hawaii, covers about 63 hectares. Necker is less than 17 hectares and also a more ecologically marginal environment in terms of resources and cultivation potential (Cleghorn 1986). Both islands have evidence of past human activity although the only extensive evidence of habitation, suggesting permanent settlement, is found on Nihoa (Bellwood 1978:356; Cleghorn 1986:39,46).

While the radiocarbon dating of occupation on Nihoa and Necker is 'not without problems', the evidence available suggests that human activities on the islands probably span from about 1,000 AD to 1700 AD (Cleghorn 1986:46). Cleghorn (1986:48) suggests that as a consequence of human predation, the bird resources became depleted and these Hawaiian outposts were abandoned. This interpretation

fits well with increasing evidence of similar post-occupation bird extinctions from other Hawaiian Islands (Steadman 1989, 1995, 1997).

Other 'mystery islands' include Raoul Island in the Kermadecs and Norfolk Island. The former about 800 kilometres northeast, the latter 700 kilometres northwest, both are relevant to the colonisation phase of New Zealand (Anderson 1980, 1991, 1996; Higham and Johnson 1996). These islands represent stepping stones from eastern Polynesia to New Zealand:

... because we know that New Zealand was effectively cut off from the rest of Polynesia by European times, and both Norfolk and the Kermadecs had no human inhabitants then, one would expect archaeological evidence of contact with these small islands to be earlier rather than later in their prehistories, in the increasing isolation of this part of the Pacific (Irwin 1993:112-113).

The cessation of visits or settlements on these islands is seen as typical of the broader trend of the decline in long distance maritime explorations and voyaging that marks the post-colonisation phase in most regions of the Pacific (Anderson 1980, 1991; Higham and Johnson 1996; Irwin 1992; Terrell 1986).

Irwin (1992) proposes that the abandonment of the 'mystery' islands of the Pacific, particularly those of Polynesia, is related to the broader process of maritime colonisation and settlement in the Pacific region. This colonisation process was, according to Irwin, one of exploration and discovery during which attempts were made to settle a range of dispersed island environments, some of which proved unviable. Over time, human activity focussed around the more successful island settlements and long distance voyaging to remote outliers declined. Of the less successful island settlements Irwin states:

Some acted as intermediaries between the margins and the centre. But they were never successful 'stand-alone' islands, and their abandonment will calibrate the decline of voyaging (1992:178).

Taking this view, the mystery islands are not mysterious at all. They simply represent unsuccessful attempts at settlement. This raises the possibility that the Flinders Island middens might be evidence not from a relict population stranded by the insulation phase, but rather from a mid-Holocene exploratory phase, tracking the chronology and limits of Aboriginal watercraft use in the Bassian region.

Easter Island

Although Easter Island (Rapa Nui) society was in a state of turmoil at the time of European contact, the island nevertheless represented the most remote of the Pacific island colonisations still surviving at European contact. Easter Island was settled relatively early (about 500 AD) and has a relatively long history of continuous settlement compared with most of the Polynesian islands. However, the state of social and economic upheaval at European contact in the early eighteenth century suggests that, but for European intervention, Easter Island would probably also have joined the ranks of the mystery islands (Bahn and Flenley 1992:178-180; Bellwood 1978:363; van Tilburg 1994).

It is difficult to assess the impact of disease and other disruptions wrought by the initial arrival of Europeans, not to mention the removal of over 1,000 Rapa Nui by slave traders in 1862. Bellwood (1978:112) however suggests that the impact of these events did not play an 'overwhelming role' in the decline of the Rapa Nui population and it is widely accepted that the island population had already declined dramatically prior to historic contact in 1722. In prehistoric times, large tracts of land had been totally denuded of trees in attempts to sustain the island's population and intensive agricultural practices had led to extensive erosion problems. As a consequence the Rapa Nui were suffering from dire food and timber shortages, which had led to the state of famine and warfare witnessed by the first Europeans on their arrival. Undoubtedly the population decrease was exacerbated by historic contacts, but there is strong evidence to indicate that the population reduction had begun in late prehistoric times (Bellwood 1978; McCoy 1979).

With the loss of timber resources the islanders were unable to construct ocean-going outrigger canoes and at contact their only watercraft were reed boats and small planked vessels. Apart from some possible rare contacts with South America, the Rapa Nui appear to have been living in isolation from earliest times, and the subsequent loss of maritime navigational skills and the materials to construct canoes did not initially appear to constrict their universe or disadvantage the island settlement. Notwithstanding, island resources eventually became severely depleted as a result of the efforts to sustain increasing population levels and the absence of watercraft did prevent people from migrating elsewhere. Thus, had history not intervened with outside contact in the early eighteenth century, the Rapa Nui would

almost certainly have become extinct, and Easter Island relegated to the ranks of the 'mystery islands'.

The possibility that the Easter Island example provides a model for the decline and possible extinction of an isolated island society cannot be dismissed. Clearly the settlement there was well established and the initial colonisation phase, where founding population effects such as numbers and genetic diversity were critical, had passed. Easter Island had been a successfully colonised, isolated island settlement for some thousand years or more. And yet it appeared that even this once-flourishing society was probably not viable in the longer term.

Tikopia

Kirch suggests that Tikopia, a small Polynesian outlier of less than 4.6 square kilometres, provides a model for successful long term island habitation:

Tikopia is a model of the sustainable [island] microcosm, its agronomic system perhaps unparalleled by other Pacific examples (1997b:35).

Factors pivotal in attaining and sustaining the island population he maintains were not only the diversification and adaptation of subsistence strategies to avoid mass environmental degradation, but the development of social mechanisms for population control such as 'celibacy, prevention of conception, abortion, infanticide' and 'sea-voyaging (generally suicidal) by young males' (Kirch 1997b:35-6). Disruption of the social system with missionary activity early this century however saw a rise in population which would probably have subsequently proved fatal when cyclones struck in the 1950s and famine ensued. Kirch (1997b:36) suggests that when this occurred the population had 'exceeded the capacity of the production system to respond to periodic environmental disasters' — only outside aid and the permanent evacuation of more than 30% of the population to other islands in the region saved the Tikopians from 'wholesale death' and 'social disintegration'.

The salient point here is that even the most balanced and sustainable production and social system ultimately could not have averted the deleterious effects of the missionary intervention or the subsequent natural disaster that befell them.

The Chatham Islands

An 'island in decline' scenario has been postulated for the Chatham Islands, although there is neither the historical nor archaeological evidence to support this (Bellwood 1978:416; Diamond 1985, 1998:65; Skinner 1923). Moreover, thriving population levels of the Moriori, the Chathams' indigenous population, prior to the historic Maori invasion certainly contradict this notion (Richards 1972; Sutton 1982). The cultural decline theory arose from comparisons of the Moriori material culture, social structure and economic system with that of stratified Polynesian societies (Diamond 1998:65,353; Skinner 1923, 1974; Skinner and Baucke 1928). While clearly some aspects of material culture and social structure changed as the Moriori became more settled and adapted to the island environment, one need not invoke notions of cultural devolution or other ill effects resulting from isolation to explain these changes (Sutton 1982).

The Moriori population declined dramatically in historic times as a direct consequence of warfare, disease and other ill effects of contact with the Maori and Europeans. The history or prehistory of the Chatham Islands therefore is not of direct relevance to the Bass Strait problem, as unlike Easter Island and Tikopia, population stress was a direct consequence of invasion (Diamond 1998:54-56).

1.2.3 Examples of habitation cessation on islands elsewhere

The Aleutian Islands

At higher latitudes in the northernmost Pacific Ocean lie the Aleutian Islands. This archipelago comprises an extensive chain of more than 100 islands extending westward nearly 2,000 kilometres along the southern border of the Bering Sea, from the Alaskan Peninsula (Damas 1984). Neither the arctic climate nor rugged terrain of the Aleutian Islands would suggest these island environments are well suited to human habitation. Nevertheless, the islands provide a habitat rich in marine resources, and when the Russians, the first non-indigenous visitors, arrived in 1741 there were an estimated 15,000 Aleutians occupying the southwestern tip of the Alaskan Peninsula and islands between the peninsula and Attu Island, the westernmost occupied island in the chain (Laughlin and Reeder 1966:92; McCartney 1984:119).

Some 300 or so kilometres further west lie the Commander Islands, a group of islands not dissimilar in size and resources to many occupied groups in the main Aleutian chain. These islands were unoccupied when Bering discovered them in the eighteenth century, and there is no evidence to suggest that this was not also the case in prehistoric times (McCartney 1984:135). The evidence supports not only the east to west direction of island colonisation of the Aleutians from southwest Alaska (rather than west to east from Siberia), but also indicates that the crossing required to reach the Commander Islands was beyond the range of watercraft or exploration limits of the Aleutians.

Although it was at one time suggested that cultural variation occurs along an east-west cline, reflecting increasing physical isolation of islands toward the Rat and Near Islands toward the western end of the chain, more recent research has failed to support this proposition (Laughlin and Reeder 1966; McCartney 1971, 1984:132,138). In fact the material culture of the entire archipelago is principally distinguished by its homogeneity, which McCartney attributes to

a common insular environment, common marine-oriented procurement systems ... movement of styles through the exchange and movement of people ... and geographic isolation of the chain from external cultural influences except along the eastern extremity (1984:122).

Of more direct relevance to the Bass Strait problem however is the earliest evidence of human occupation in the Aleutian region, a single occupation lens dated to around 8,000 BP in a site at Anangula Island. This early Holocene cultural level is capped by a number of volcanic ash layers and McCartney interprets this evidence as reflecting a relatively short span of human occupation around 8,000 years ago, which ceased due to local volcanic activity and airborne ash (1984:123). This site contains culturally and chronologically quite diverse remains compared with other Aleutian Islands sites, where evidence is more recent than about 4,500 BP and of different technological traditions (McCartney 1984:1984).

The absence of intermediary evidence between 8,000 BP and 4,500 BP supports a regional occupational hiatus between this early Holocene site and later widespread island occupation in the Aleutian archipelago (Laughlin and Reeder 1966; McCartney 1984:121). It is unclear if this early Holocene evidence dates from a time of lower sea level, when there would have been overland access to Anangula, or from the post-insulation phase (Black 1974; McCartney 1984). Hence it is unclear whether the

abandonment of this region was associated with volcanic activity or the insulation process.

Mediterranean Islands

The majority of Mediterranean island colonisations were associated with the florescence of Neolithic cultures from about 10,000 years ago, and involved virtually all habitable islands in the Mediterranean (Cherry 1990). The Mediterranean also has a tradition of seafaring in the region predating the post-glacial marine transgression, as attested by evidence of late Pleistocene exploitation of obsidian sources on Melos Island, a relatively remote Cycladic island that has been insular for at least 100,000 years (Simmons 1991:865). There is also a continuity in human occupation through to historic times on nearly all Mediterranean islands which have been archaeologically investigated. The rare exceptions to this are Kephallinia, Skyros and Sporades, and possibly also Sardinia and Cyprus, although the evidence from these latter two is problematic (Cherry 1990; Simmons 1991).

Because of the long and widespread tradition of watercraft in the Mediterranean, it is unlikely that relict populations would have become isolated on islands in the region. From the few islands that do have discontinuities in their archaeological records, evidence does not appear to reflect cessation of long term habitation but rather cessation of sporadic and short term 'utilization' rather than 'occupation' (Cherry 1990:198). Hence no models of island habitation or cessation relevant to the Bass Strait problem are evident in the archaeological record from the Mediterranean region.

The Channel Islands

There is also evidence of sporadic phases of human occupation prior to the Neolithic colonisation on the Channel Islands (Bender and Caillaud 1986; Callow and Cornford 1986). The evidence suggests that there were several habitation cessations associated with sea level changes and the insulation process. Use of the sites in the Palaeolithic appears to have been abandoned as sea level rises severed the islands from the greater mainland areas of France and England (Bender and Caillaud 1986:218). Interestingly, archaeological evidence of pre-Neolithic occupation indicates that these early occupation phases, which occurred within the 120,000 BP to 35,000 BP period, are attributable to Neanderthal populations, their occupational hiatuses coinciding neatly with periods of insulation. Bender suggests that there may have been an intervening post-Neanderthal Palaeolithic occupation phase, but that

this was confined to areas subsequently submerged by the post-glacial marine transgression (Bender and Caillaud 1986:219). The earlier evidence that has survived however is interesting in that it shows a similar response to imminent insulation as that evident in regions such as Australia and possibly the Aleutian region — when faced with rising seas and isolation as a result of insulation, people retracted to the mainland land mass.

Historic cases of island habitation cessations

Turning to the historic period there are several cases of island extinctions and abandonments which are of interest, as they offer a finer scale resolution of the processes involved in habitation cessations of specific islands. Islands such as the Bahamas and the Canaries, where indigenous occupation was terminated principally because of invasion and warfare, are not included here as they are obviously of little relevance to the Bass Strait situation (Crosby 1986; Hoffman 1967; Major 1872).

Historic extinctions and abandonments that may relate to the problem include the termination of occupation of the Norse settlements in Greenland, and on the St Kilda Islands, a remote archipelago some 60 kilometres west of the Outer Hebrides off the northwest coast of Scotland. The former is basically a case of *in situ* extinction and the latter island abandonment.

The abandonment of St Kilda

The evacuation of the last 36 inhabitants from St Kilda Island in the 1930s is arguably the best known example of abandonment of an island. After what appears to be some 4,000 or more years of occupation, the settlement on St Kilda ceased to be a viable proposition (Fleming 1995; Macgregor 1960). It was undoubtedly a combination of illness and famine compounded by declining population numbers which ultimately brought the St Kilda population to its knees, but undoubtedly the island population had faced similar trials in the past and survived. Why then was the population less resilient in recent historic times? The explanation lies in social and economic changes instigated and exacerbated by increasing social interaction with the Outer Hebrides and mainland Scotland, from the latter half of the eighteenth century (Macgregor 1960; Steele 1975).

St Kilda comprises four islands, three of which are less than 100 hectares, and Hirta which is some 637 hectares and is the only island thought ever to have been

permanently settled (Fleming 1995:25; Macgregor 1960; Williamson and Boyd 1960). Little is known of prehistoric occupation of St Kilda although it is thought to have been first settled by human occupants in the Bronze Age with subsequent influxes of Norse probably about 1,000 years ago, and Gaelic settlers 700 or so years ago (Campbell 1974; Fleming 1995). Although the existence of St Kilda was mentioned in an Icelandic saga of 1249 (Campbell 1974:11), historic documentation of the island and its inhabitants began in the account of historian Martin Martin's visit to St Kilda in 1697 (Martin 1698 in Campbell 1974:11).

Martin reported the St Kildans to be an isolated, but relatively content group of 180 hard-working people, surviving principally on exploitation of fulmars, puffins and gannets, and the export of bird feathers and oil. At that time they also farmed but agricultural pursuits were regarded as subsidiary to seabird exploitation, as inclement weather often caused crop failures and these resources were less reliable than the seabirds and their eggs. It appeared that the fowling and agricultural balance worked well; the community was described as being 'vigorous and self-reliant' throughout the eighteenth century (Macauley 1764 and Seton 1878 as cited in Macgregor 1960:42). With increasing contact with the outside world from about 1840 onward, however, the population started to decrease markedly (Morton Boyd 1974:7). Disease and emigration of 36 St Kildans to Australia in 1856 reduced the population of 140 by half, and it remained at that level until after the First World War, when it steadily declined to 36 by the time of evacuation in the 1930s.

A series of compounding circumstances led to the abandonment, from any one of which in isolation, the population could have recovered; increased social contact, dwindling export markets for seabirds and by-products, increased reliance on charity and food imports, prolonged periods of adverse weather delaying food supplies, famine and generally poor diet, migration and ultimately the depletion of the work force to the level that crops could neither be sown or harvested, and birding all but ceased.

In 1929 an epidemic of wet eczema broke out sounding the final death knell for the St Kildans. With the epidemic came bad weather and the islanders failed to gather in their crops, which in any case lay unripened in the fields due to an exceptionally overcast season; the last years harvest had been their last (Steele 1975:32).

The islanders themselves had lost heart in the struggle for survival and preferred, with hesitation and sadness, to leave their island home to the seabirds (Steele 1975:48).

Both the social and economic fabric of the previously hardy society had irretrievably broken down.

It has been suggested that in prehistoric times the island population was markedly larger, and this was associated with more intensive and productive farming activities (Fleming 1995). Climatic deterioration, possibly the 'Little Ice Age' which preceded historic documentation of the island population, is mooted as a factor in the shift away from farming toward seabird exploitation as the primary subsistence mode. Fleming (1995:33) suggests that the increased emphasis on fowling activities appears to have come at the cost of neglect of agricultural expertise, and reduced both the population and the resource base from which commercial returns could have been gained in more recent times.

Steele also views the demise of St Kilda as the result of a longer term process of decline, one he attributes to the psychological effects of the isolation that ensued as 'the climate deteriorated with the passage of centuries' (1965:20). Isolation he maintained 'led to ignorance' and eventually a fear and distrust of the unknown, particularly people and things from the mainland. This distrust fostered a mentality whereby St Kildans

were unable to accept new ideas; neither were they able to better themselves by applying new methods to their work (Steele 1965:25).

Hence alternative avenues of food supply and exports such as fishing and cloth production were shunned, and the collapse of the seabird market upon which they had become dependent and repeated crop failures and famine brought the St Kilda population to the point where it was too fragile to withstand the stress of an eczema outbreak; and the survivors were evacuated.

The extinction of the Norse of Greenland

Whereas increased contact with the outside world proved to be pivotal in abandonment of St Kilda, it was a decline in contact and ensuing isolation that set in train the demise of the Norse population in Greenland in the late sixteenth century. The colony of Norse settlers in Greenland has a history not unlike that of the St Kildans, although it was of much shorter duration, spanning about 1,000 to 1,500 AD.

By the close of the tenth century the Norwegian Vikings had successively invaded the Scottish Isles, parts of the Irish coast and the Isle of Man. In quest of 'homes for their

families, pasture for their animals, havens for their ships, and all such prospects of spoil or profit as offered' the Norse sea voyaging had taken them to the Faroes and subsequently westward to Iceland, and by 986 AD, to Greenland (Crosby 1986:45; G. Jones 1984:272). It is believed that the initial Norse colonisation of Greenland was by a group of some 450 people from a Norse settlement on Iceland. The Greenland climate and rich pastures suited the agricultural settlers and the farms initially thrived.

The Norse population in Greenland is believed to have rapidly increased to somewhere around 3,000 at its peak (G. Jones 1984:293). Within two decades of their arrival, the Norse established a second settlement, further to the north. Explorations further west brought the discovery of the northern coast of America (Vinland) and a brief but unsuccessful attempt was made to establish a settlement there in the first decades of the eleventh century AD (Gad 1970:46-51; G. Jones 1984:303). With the decline of political stability in Scandinavia and eastern Europe, the Viking long distance sea trading and opportunistic venturing all but ceased, effectively isolating the Atlantic outposts such as Iceland and Greenland.

The increasing development of internal European trade networks meant a decline in demand for Greenland export products such as hides, furs, woollen products and walrus hides and tusks; and as a consequence trade with Greenland had virtually ceased by 1300 (G. Jones 1984:306). Isolation brought by the decreasing numbers of trading voyagers from abroad was compounded by a cooler climatic shift in the mid-thirteenth century. As temperatures steadily dropped and glaciated polar regions extended southwards over Greenland, drift ice became an increasing deterrent to ocean voyaging in the region. From the early fourteenth century until their demise a century or more later, the Norse of Greenland were almost totally isolated from Iceland, Norway and the rest of the world.

With cooler climates the more northerly Norse settlement, the Western settlement, experienced not only increasing isolation and crop failures, but new competition for their territory as the indigenous Greenland Eskimo populations followed the arctic hunting resources southwards. By 1340 Norse habitation in the Western settlement ceased, although the more southerly settlers in the Eastern settlement managed to hold out until about 1500 (Gad 1970:155,163; G. Jones 1984:311). While a few of the Norse inhabitants may have managed to emigrate as the settlements foundered, archaeological and historical evidence attests overall to the *in situ* extinction of Greenland's Norse population by about 1500 AD (Gad 1970:155).

While it was the climatic shift which brought about cooler climes from about 1250 AD that prompted the sequence of events that eventually lead to the demise of the Norse Greenlanders, this is not to say that the Norse extinction was inevitable. Should the Norse have shifted their economy away from farming and focused more on high latitude hunting strategies such as those used by their indigenous neighbours in Greenland, they would have probably survived. Elsewhere in Europe Norse settlers, such as the specialised craftsmen and tradesfolk of southern Denmark, embraced new technologies and local resources they encountered, adapting them for their own purposes (Graham-Campbell and Kidd 1980:30).

The Norse of Greenland did not adapt. Although they had first hand knowledge of the highly adaptive and successful Greenland Eskimo subsistence strategies, they clung to the more familiar European agricultural way of life. Rather than responding to the famines which resulted from both the climatic deterioration and their increased isolation, by shifting their focus to the exploitation of indigenous resources, they vainly persisted in their agricultural and grazing pursuits. Even faced with almost certain death they resolutely failed to take on the high risk, high return hunting strategies employed by the Greenland Eskimo. Hunting did not appear to the Norse to have the same consistent, predictable returns that they could reap from their crops and domesticated animals, and they seem to have rejected it entirely as a subsistence mode, even as an emergency tactic.

As isolation increased and farming returns became marginal, the Norse seem to have been even more reluctant to take risks, despite skeletal evidence suggesting extreme dietary hardship due to famine (Gad 1970:155). Eventually climatic deterioration became so severe that crops failed entirely and pastures that a few centuries before had been relatively lush and readily supported grazing animals, disappeared along with the stock. Because of its closer proximity to Scandinavia, and its more southerly latitude, the Icelanders suffered much less isolation and the effects of the climatic shift were less severe. Consequently Iceland has been continuously occupied by farming communities ever since the initial Norse settlement there. When a shipload of Icelanders arrived in Greenland around 1540 they found deserted farms and houses and the intact, clothed body of a Norse farmer frozen on the shore (Gad 1970:164). Although indigenous Greenland Eskimo populations had survived three thousand or more years there and have continued to do so until present times, the Norse settlers survived barely five centuries.

The overriding issue in the Greenland case is the sheer persistence with which the Norse clung to their agriculturally-based subsistence mode, despite it putting their very survival in jeopardy. Could it be that some island group in Bass Strait several thousand years before had similarly faced an environmental shift that threatened their basic subsistence strategies, and that they too persisted against all odds until overcome by the greater forces of nature? This proposition, along with other models of island abandonments and extinctions brought to light above, is examined in relation to the Bass Strait problem in the following section.

1.3 Models of habitation cessation

In the Pacific it is evident that many apparent habitation cessations are actually short term visits associated with discovery and maritime exploration rather than terminations of longer term occupation. On a number of islands where habitation cessation is evident, it appears to be related to depletion of resources such as seabirds due to over-exploitation, environmental degradation due to non-sustainable agricultural practices, human population numbers exceeding sustainable levels and changing patterns of maritime voyaging (Cleghorn 1986; Irwin 1989, 1990, 1992; Keegan and Diamond 1987; Kirch 1997b; Steadman 1997; Weisler 1994; Wragg and Weisler 1994).

Other examples of historic island populations such as the Norse of Greenland, the St Kildans, the Rapa Nui of Easter Island, and the Tikopians offer finer scale insights into the interplay of social and environmental factors that can be involved in the demise of remote island populations. In the case of the Norse, the St Kildans and the Rapa Nui it appears that these societies failed to adapt to increasing environmental degradation and resource depletion – and that whether these circumstances were anthropogenic or natural in origin was not in itself important: ultimately it was the ability to adapt that was critical. It has further been suggested that due to the psychological effects of isolation, adaptation is inhibited in island societies. This has not however been tested and is not supported by cases such as the Andaman Islands where long term isolated island societies have proved viable.

When faced with the threat of anthropogenically induced environmental degradation, people on Tikopia responded by adopting more sustainable agricultural practices and instigating population controls through social mechanisms (Kirch 1977b). While Kirch argues that Tikopia provides a model for successful island habitation, historically this has not proven to be the case. As he admits, the population would

probably have perished as a result of the combined effects of social breakdown and cyclones had it not been for emergency relief measures.

These examples of island populations suggest that the process of habitation cessation almost certainly involves a compounding feedback mechanism between external stresses and internal responses, that is between environmental stress (whether natural or anthropogenically induced) and the ways in which the island society responds to this stress. In each of these cases the process of population decline takes some decades and possibly a century or more to reach a critical level. While far from being an instantaneous event in historical terms it may well be manifest as such in the longer term archaeological record. Hence what may initially appear in the archaeological record of an island to be an extinction or abandonment event is more likely to be the result of a longer term process involving both social and environmental circumstances.

A number of issues pertinent to the Bass Strait problem can be extracted from the island histories and prehistories outlined in the previous section. The first point is the necessity to distinguish between

- a) isolated discovery events and short term colonisation attempts,
- b) longer term sporadic or seasonal visitation, and
- c) longer term permanent settlement (Anderson 1995; Cherry 1990; Graves and Addison 1995).

Cherry makes the distinction between initial discovery or 'utilization' and 'occupation' with the latter being

the point at which [the island] has become the principal provider of a group's subsistence requirements and the focus of its residential pattern throughout the year (1990:198).

This raises an initial question as to the nature of human occupation on Flinders Island in prehistoric times; was it a colonisation attempt, island use or permanent occupation? In accordance with the above definitions Hunter Island would be defined as a place of seasonal visitation rather than occupation whereas Bruny Island can be regarded as occupied. While the sequence of midden dates on Flinders Island does imply permanent occupation, if watercraft were used in the Bassian region in the mid Holocene then it is possible that the middens could have been associated with ephemeral island use. As with the distinction between abandonment and extinction, the question of island use as opposed to island occupation is also underpinned by the watercraft issue.

Both the island abandonment and island utilisation models in the Flinders Island scenario would require a regional technology producing watercraft capable of navigating open sea crossings of more than 13 kilometres. At the time of European contact watercraft of such capacity were found only in the northern regions of Australia, and both archaeological and ethnographic documentation indicates that such craft were a late Holocene adaptation from southeast Asian technologies (Davidson 1935). This does not preclude the possibility however that prehistoric watercraft technologies may have changed over time and that watercraft may have been used in areas devoid of such craft in historic times. This again raises the possibility that the sites on Flinders Island may, like those on many of the 'mystery islands', be associated with a maritime exploratory phase — which in this case would relate to the use of watercraft in the northeast Tasmanian region in early to mid Holocene — a possible but improbable explanation given the absence of watercraft in the region in more recent times, and lack of evidence of early or mid-Holocene watercraft use elsewhere in the archaeological record of Australia or Tasmania.

Are there analogies between habitation cessation on islands in other regions and the Bass Strait situation which could suggest models for the Furneaux problem? I would argue strongly that there are, despite the closest analogy being Kangaroo Island, the 'mystery' island for which the question of habitation cessation has not been satisfactorily resolved (Lampert 1979). There are principally two models suggested by the evidence from island use, occupation and/or cessation elsewhere that could be relevant to the Bass Strait problem - models that could explain the absence of Aboriginal people on the Furneaux Islands in historic times while there are numerous shell middens of mid-Holocene antiquity on Flinders Island, the main island in the group.

The first model based on evidence from Australia and the Pacific suggests an initial abandonment phase as insulation of the Furneaux region became imminent about 10,000 years ago, followed by an attempted (re-)colonisation or discovery phase in the island period in the mid-Holocene which would have required watercraft. In this model the cessation of use or occupation of Flinders Island could relate to a possible contraction of voyages after about 4,500 BP and the disappearance of watercraft from northeast Tasmania in the late Holocene.

A second model, also based on the pattern of retraction with marine transgression, could be that people on the Bassian plains retreated to the higher ground of the Furneaux region, which due to the rapid rate of sea level rise became severed from mainland Tasmania, permanently separating people in the Furneaux region from mainland Tasmania. Under this model there are two possible fates for the island population; in the mid-Holocene people either used watercraft to abandon the island, or like people stranded on the outlier Pacific islands such as Henderson, they eventually died out.

Other models of finer scale resolution pertaining to the actual process of habitation cessation are suggested by the historic examples. These suggest that in more remote island societies there was an inherent psychologically based conservatism which was manifest in a lack of flexibility or inability to adapt to changed environmental and/or social circumstance. How useful this model would be in investigating the more gross scale of the prehistoric archaeological record in the Furneaux region is uncertain. Moreover, before the question concerning the process of habitation cessation were to be addressed, it was necessary to resolve the primary question as to the fate of the Flinders Island population; whether it was a situation of island abandonment or *in situ* extinction of an isolated population.

The research strategy and design aimed at resolving this question are outlined more fully in the following chapter, along with the results of stage one, the preliminary surveys undertaken for the project. Follow-up excavations resulting from the survey are documented in the subsequent Chapters Three, Four and Five. These are followed by a discussion of the findings and the implications for prehistoric land and island use in the Furneaux and wider southeast Australian region. The discussion also includes a review of the broader issues concerning the viability of island populations, and presents conclusions reached about the seemingly enigmatic archaeological record of the Furneaux region. The conclusion has wider implications not only for patterns of Holocene coastal and island use around Australia, but for questions concerning the role of culture in the long term viability of isolated human populations and of biogeographical theory as an explanatory framework.

CHAPTER TWO

RESEARCH DESIGN AND ISLAND SURVEYS

2.1 Research design - a preliminary hypothesis

Models of remote island abandonments and extinctions derived from the case studies indicate that habitation cessation is generally precipitated by externally derived stress, and that watercraft and the degree of external contact is a critical factor in terms of the range of cultural choices available to the island population in response. If the island population is completely isolated and has no access to external contact, abandonment is not possible and extinction the only possible outcome if the population fails to respond successfully to the stress situation.

As outlined in the previous chapter, in order to address the problem of *why* habitation on Flinders Island ceased around 4,000 or so years ago, it was necessary first to resolve the question of *what* happened. Was Flinders Island inhabited by an isolated island population who died out on the island? Or did evidence of human activity disappear from the archaeological record around 4,000 years ago because people had abandoned or ceased visiting the island? Underpinning this question of extinction or abandonment is the issue of watercraft; whether

- a) the island inhabitants had no watercraft and were thus truly isolated, or
- b) people there did have watercraft and therefore could have abandoned the island settlement, or alternatively ceased visiting the island from mainland Tasmania.

2.1.1 The use of watercraft in Tasmania in prehistoric and contact times

At the time of contact watercraft were absent from the entire northeast region of Tasmania, nor was there archaeological evidence to suggest this had not been the case also in the past (Jones 1976:248-9, 251). Elsewhere in Tasmania people in the late Holocene used watercraft to visit offshore islands close to mainland Tasmania regularly to obtain seasonally available seabird and seal resources (Bowdler 1979, 1988:45; Jones 1976:249; Vanderwal and Horton 1984:117). The chronology of watercraft use in Tasmania is uncertain although archaeological evidence to date strongly suggests it was confined to the late Holocene and possibly the last 3,000 or so years, and was in many instances associated with seal and seabird exploitation on offshore islands around Tasmania (Bowdler 1984; O'Connor 1982:133; Vanderwal 1978; Vanderwal and Horton 1984:117).

On many of the Outer Furneaux Islands these seasonal resources are also abundant and it could be expected that these would have been similarly targeted for exploitation in the past if the Flinders Island inhabitants had possessed watercraft technology. On the larger Furneaux Islands (ie, Flinders, Clarke and Cape Barren Islands) these seasonal resources are almost non-existent and there is no evidence to suggest that this was not the case in the past. In historic times there has only been one muttonbird rookery located on the larger islands, and no seal colonies documented (Skira and Davis 1987). Hence exploitation of these abundant seasonal resources by people living on Flinders Island in the past would inevitably have involved watercraft crossings to various outer islands in the Furneaux Group. The problem was however how was it possible to test for watercraft, and thus identify whether the Flinders Island population had watercraft and thus possibly abandoned the Furneaux region about 4,000 years ago, or whether they did not and therefore perished in isolation.

2.1.2 Testing for evidence of watercraft in the Furneaux region in the mid-Holocene

A major difficulty is faced when attempting to determine whether or not the Furneaux population possessed watercraft technology as it is extremely unlikely that *direct* evidence of watercraft technology (such as boat parts) from the mid-Holocene would have survived in the archaeological record. Nevertheless, geographical circumstances in the Furneaux region make it possible to test indirectly for *the use* of watercraft. Unlike Kangaroo Island, which is an isolated island, Flinders Island is surrounded by numerous offshore islands of varying sizes and distances from its shores (Figure 1.2). Many of these islands are also abundant in muttonbird and seal rookeries. If people on Flinders Island in prehistoric times did possess watercraft then it would be expected that they would have at least been visiting these islands, if not Tasmania, and that middens or other archaeological evidence of antiquity similar to the Flinders Island middens would be found on other islands in the Furneaux Group.

It would also be expected that if the Flinders Island middens had been deposited by people visiting the Furneaux Group rather than permanently settled on the island, then there would be archaeological evidence on en-route stopover islands such as Swan and Clarke between Flinders Island and mainland Tasmania. Hence the use of watercraft, and thus the proposition that Flinders Island was abandoned in the mid-

Holocene (rather than the population becoming extinct) could be tested by surveying other islands in the region for evidence of mid-Holocene visits.

2.1.3 The implications if middens were located on the outer Furneaux Islands

The discovery of prehistoric shell midden sites on stopover or other islands around Flinders would be of particular interest, as evidence of marine shellfish exploitation would point to occupation sometime since the sea stabilised at a level similar to that of today. This would indicate the use of watercraft in the region since few outer islands are accessible by swimming crossings from Flinders Island. Moreover, all of the outer islands, including those where seal and bird rookeries are found, are too small to have supported isolated human populations. Apart from Flinders Island itself, only three of the 39 islands in the Furneaux Group are larger than 10 square kilometres. Therefore, should prehistoric middens or other evidence of prehistoric mid-Holocene human activity be found on these islands, then it could reliably be inferred that watercraft had been used to access these islands.

If the Outer Furneaux Islands or any stop-over islands had midden sites or other evidence of similar antiquity to the Flinders Island midden sites, then abandonment (of either permanent settlement or ephemeral visits) would be a plausible explanation as to what ultimately happened to the Flinders Island inhabitants.

2.1.4 The archaeological manifestation of an isolated population

The archaeological manifestation of the counter-proposition, that watercraft were not used in the Furneaux Islands, would be an absence of evidence of mid-Holocene island occupation other than on Flinders Island. If it could be demonstrated that other islands were not visited this would indicate that people living on Flinders Island lacked watercraft. Moreover, if it could be unequivocally established that people in the Furneaux region in prehistoric times did *not* have watercraft, then the possibility of the termination of human habitation in the mid-Holocene being due to island abandonment could safely be excluded. It would also exclude the possibility that the Flinders Island middens were deposited by people using watercraft to visit the island ephemerally, and thus demonstrate that the mid-Holocene midden sites on Flinders Island could only have been deposited by a truly isolated group of people; a relict population from the time of insulation of the Greater Furneaux region about 10,000 years ago who died out about 4,000 years ago.

2.1.5 The testing strategy

Because of preservation factors and the absence of sites with excavation potential on Flinders Island, it was neither practicable nor useful to attempt to search for watercraft remains *per se* in the Flinders Island archaeological record. It was however possible to test for the prehistoric use of watercraft in the Furneaux region by surveying offshore islands beyond swimming range, for evidence of Holocene prehistoric human activity such as shell middens, or sites which might contain datable stratified deposits such as rockshelters. Thus in order to test whether people abandoned Flinders Island or became extinct about 4,000 BP archaeological site surveys were undertaken on the outer Furneaux Islands, Cape Barren, Clarke and Swan Island.

2.2 Surveys of The Outer Furneaux Islands

The survey aims were principally to locate and record archaeological sites on these islands, including sites with dating potential. Following the survey it was intended to further investigate sites with dating potential to address the questions concerning prehistoric island and land-use patterns in the Furneaux region, particularly regarding the question of use of the islands in Holocene times, and the habitation cessation evident on Flinders Island. With the exception of areas on Flinders, Cape Barren and Prime Seal Islands, none of the Furneaux Group had been previously surveyed for prehistoric sites. When the surveys for this project were undertaken, there was no evidence known on any of the Outer Furneaux Islands which indicated that the offshore islands were being visited in prehistoric times (Brown 1993; Harris 1988; Sim 1989).

An historic archaeologist accompanied me on the outer island surveys as the prehistoric site surveys provided an ideal opportunity for historic remains including early nineteenth century sealing camps on many of the Furneaux Islands to be documented professionally. Ian Stuart joined the survey team on the first stage, and Pamela Gait on the second to record historic sites, and each co-authored the respective survey reports. I was the principal archaeologist and author on both the stages of the survey and was solely responsible for all prehistoric site survey and recording. Darrell West and Colin Hughes, two Tasmanian Aboriginal Heritage Officers, were also employed on the survey project.

Because of time and financial constraints, it was not possible to survey all of the outer Furneaux Islands. Five small rocky islets totally devoid of vegetation or soils were regarded as having little or no archaeological potential and were therefore excluded from the survey. Two other islands could not be surveyed because it was not possible to get access permission from owners or lessees, and a further three were not surveyed as the sea crossings involved were too dangerous to undertake in the dinghy available for the project and alternate transport was not available. Islands other than rocky islets which were not surveyed were Long, Chappell, the Outer (East) Sister, Cat and Storehouse Islands. In each of these instances however, the unsurveyed island was in close proximity to a surveyed island and was considered to have a similar habitat.

Both muttonbird rookery and non-rookery islands were included in the islands surveyed. Similarly, a number of islands that in early historic times were recorded as having seal colonies were surveyed along with those where colonies were absent. From the survey results it was anticipated that it would be possible to determine if bird rookery or seal colony islands were a focus of prehistoric activity, and also to shed light on the question of whether people possessed the means to get to these islands in Holocene times.

The granite geology of most islands suggested that rockshelters or cave sites would be uncommon, as on Flinders Island, and that evidence of prehistoric human occupation in the island phase was most likely to be evident as shell midden sites in open contexts. The major focus of the surveys therefore was on the coastal margins of the islands. Since coastal margins generally consist of both depositional and erosional landforms, it was also expected

- a) that a satisfactory degree of archaeological visibility would be present in at least some places around the islands' coasts, and
- b) that places conducive to preservation of midden material such as those in midden locations on Flinders Island would also be found.

Previous survey experience on Flinders Island had indicated that aerial photographs of the region were of insufficiently large scale to identify areas where ground visibility would be sufficient to enable detection of coastal sites (except for dune blowout areas) (Sim 1989, 1991). Consequently, wherever practicable, the survey aimed to include the entire coastal margin of all islands examined for sites.

The results of previous extensive site surveys on Flinders Island also suggested that locations where fresh water was available were a focus of human activity in the

region in past times (Mackay 1946; Sim 1989). Therefore, where present, island water sources were targeted for more intensive survey. Fresh water is scarce on the smaller islands but on larger islands sources included freshwater lagoons, soaks, creeks and rivers, all of which were targeted during the survey.

2.2.1 Survey method

The survey method involved two people walking the entire coastal margin and two inland transects (coast to coast) on 29 of the islands surveyed. In the case of smaller islands such as Rum, Little Chalky, Isabella, Mile, Fisher Islands and Billy Goat Reef, it was possible to examine the entire island surface comprehensively. This meant that the surveyed zone in these cases included areas with a wide variation in ground visibility.

It was not possible to examine the larger islands in their entirety, so areas with good ground visibility in both coastal and inland zones were deliberately targeted for survey. In order to sample an area on the larger islands with a *range* of ground visibility comparable to that of the survey areas on the smaller islands, at least two coast to coast inland transects across a variety of terrain were carried out, in addition to surveys of other areas such as erosion gullies, sand dune blowouts, birders' and stock tracks which provided good visibility. Because the burrowing activities of muttonbirds often expose artefacts, island rookeries in less densely vegetated or recently burnt areas were also surveyed. On islands with greater topographic relief, such as Vansittart and Little Dog, Babel, Cape Barren and Clarke Islands, the stony crests and ridges were also examined for sites.

Because of the size of Cape Barren Island, both inland transects and coastal zone surveys were confined to the southern area of the island for logistical reasons. This strategy aimed to provide a comparable and representative sample of prehistoric sites, for this area of the island, rather than a smattering of information for the entire island. Jeannette Hope (pers. comm.) had previously surveyed the east coast of Cape Barren Island for faunal remains and not noted any archaeological artefacts or midden sites. Similarly, the size of Clarke Island prohibited the entire coast being surveyed. Nevertheless, more than one third of the coast was surveyed and the survey covered the range of coastal habitats found on that island. One complete (north-south) transect of approximately 14 kilometres was undertaken on Clarke Island along with a number of shorter creek, inland track and ridge surveys.

The coastal margins of the islands were generally surveyed by one person walking along the immediate foreshore area, with another travelling between 10 and 20 metres inland from the high water mark. Along some coastal stretches, dense tussock vegetation extended right down to the rock margin of the shoreline. In these instances there was no ground visibility apart from the hard shoreline itself, and the survey was undertaken by one person while the other team member surveyed another similar stretch of low visibility coast. Inland transects were covered by either one or two people, depending on ground visibility on the transect line. Where the transect line was along narrow birders' or stock tracks these were walked by one person, whereas firebreaks or open terrain transects were generally surveyed by two people walking about 10 metres apart.

More intensive survey was undertaken on Babel, Little Dog, East Kangaroo and Prime Seal Islands, because the survey team was marooned for longer than anticipated on these islands due to high seas. In fine weather most islands were safely accessible from Flinders Island using a 3.5 metre aluminium dinghy with a 40 horsepower outboard motor and a small auxiliary outboard for emergency use. A light aircraft was chartered to reach Badger and Swan Islands, and a larger fishing boat provided a safe crossing to Clarke and the Inner Sister Island. This latter island, although close to Flinders Island, involves crossing a narrow but extremely dangerous tidal passage.

2.2.2 Site recording method

All sites were recorded on the standard Tasmanian Parks and Wildlife Service Aboriginal site recording form. In accordance with Parks and Wildlife Service criteria a site is defined by the presence of one or more stone artefacts, humanly deposited shellfish remains, rock art, a stone arrangement or a rockshelter or cave. The last may either have evidence of human occupation or be suitable for human habitation, in which case it is recorded as a potential site because the cave or shelter deposits could contain archaeological remains. All sites were documented photographically using colour transparency and monochrome of the general location of a site, and monochrome shots of any artefacts or cultural remains.

2.3 Survey results

Thirty-one of the Furneaux Islands offshore from Flinders Island, and Swan Island in Banks Strait off northeast Tasmania were surveyed for prehistoric sites. The

Furneaux Islands surveyed were: Cape Barren, Clarke, Preservation, Rum, Forsyth, Goose, Passage, Royden, Mile, Wybalenna, Prime Seal, Inner (West) Sister, Babel, Little Green, Big Green, East Kangaroo, Chalky, Little Chalky, Isabella, Billy Goat Reef (northern island), Big Dog, Little Dog, Anderson (Woody), Little Anderson, Tin Kettle, Vansittart (Gun Carriage), Fisher, Badger, and the three Pasco Islands.

A total of 64 prehistoric Aboriginal sites were recorded and all of these contained stone artefacts. Stone artefacts were found on 14 of the 32 islands surveyed (Figure 2.1; Table 2.1). No prehistoric sites were recorded on the other 18 islands examined.

2.3.1 Site types

With the exception of the Beeton Rockshelter site on Badger Island, all sites recorded were open sites comprising either isolated stone artefact finds or relatively low density scatters of stone artefacts (Table 2.1). The Beeton Rockshelter was the only prehistoric site where shellfish midden remains were found. Along with these midden remains, more than 100 stone artefacts, including clear, quartz crystal flakes and flaked fossil shell were observed on the surface of the Beeton Rockshelter deposit. This was the only site recorded during the survey where there appeared to be undisturbed archaeological deposits. A number of *historic* middens were also observed at sealing camp and nineteenth century settlement locations. Unlike the Beeton Rockshelter which was totally devoid of European items, the historic middens contained crockery, metal, glass and other European-derived items. These sites were documented by the historic archaeologist accompanying the prehistoric survey team (Sim and Gait 1992; Sim and Stuart 1991).

2.3.2 Site locations and distribution patterns

Consistency in ground visibility on both an intra- and inter-island scale, was a problem during the survey. Sites were generally more common on islands with areas of good ground visibility, and most sites were located in disturbed or erosion areas. On islands where no sites were found, poor visibility was certainly more common than on the other islands surveyed. This suggests that visibility is an influential factor in regard to finding sites on the islands, and that a greater number of sites and artefacts would be recorded if there was increased ground visibility. Nevertheless, on islands where sites were found, both coastal and inland survey zones included areas with a diverse range of ground surface visibility and both survey zones had proportionately similar areas with visibility >50%.

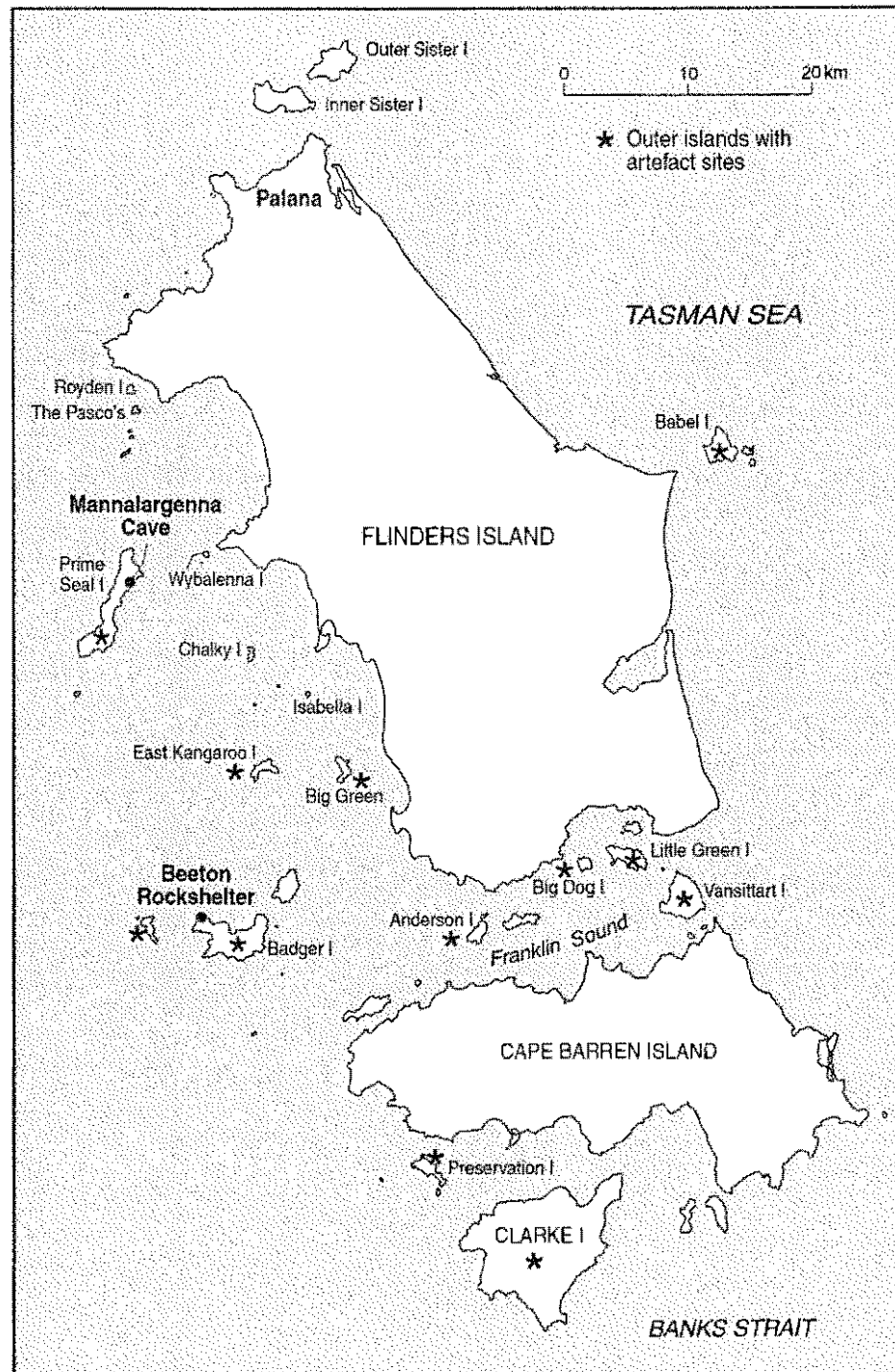


Figure 2.1: Outer Furneaux Islands where Aboriginal sites were recorded during the surveys.

ISLAND • Site name	No. of artefacts recorded
BIG GREEN:	
• Ridge	5
• Rookery	9
• Rookery Sth	3
• East	1
• North A	11
• North B	1
• North C	1
BIG DOG:	
• Willis Shed North	1
• Willis Shed West	1
• Willis Shed South	2
• Homest'd paddock	1
• Willis Shed track	1
• Main Birders track	2
• East Birders track A	2
• East Birders track B	1
• East Birders track C	2
LITTLE DOG:	
• North A	1
• North B	1
• North C	1
• North D	1
• Northeast	2
• Southeast A	3
• Southeast B	6
• Southeast C	2
• East	2
• Southwest A	5
• Southwest B	3
• Southwest C	9
• Southwest D	13
BADGER:	
• Badger South	1
• Badger West	12
• Beeton Rockshelter	>100*
EAST KANGAROO:	
• Kangaroo Southeast	17
• Kangaroo South	4

ISLAND • Site name	No. of artefacts recorded
ANDERSON:	
• Trig north	1
• Everett's Cove	1
VANSITTART:	
• Bates Bay	14
• Vansittart West	11
BABEL:	
• Hawks Nest	1
PRIME SEAL:	
• Spit Point	1
CAPE BARREN:	
• Wombat Point 1	5
• Wombat Point 2	44 *
• Bishops Creek	9
• Crystal Lagoon 1	41
• Crystal Lagoon 2	25 *
• Passage Point West	16
• Petticoat Bay Point	46 *
• Battery Bay Hills	10
• Battery Bay Creek 1	2
• Battery Bay Creek 2	4
• Kent Bay East	1
CLARKE:	
• Stock Run	1
• Maclaines Creek	1
• Spike Bay South 1	3
• Spike Bay South 2	2
GOOSE:	
• House Bay North	1
• Northeast Bay	3
• Natural Harbour 1	11
• Natural Harbour 2	1
PRESERVATION:	
• Northwest	1
• Little Gulch	1
• North Cairn	1
SWAN:	
• Goose Rock	9
• Jetty Bay	1

* sites where >100 artefacts were observed but a one square metre sample area only recorded

Table 2.1: Sites recorded during island surveys.

Because the Outer Furneaux Islands represent a very small sample area of the land area that would have been available for human use in times of lower sea level, site location patterns detectable in the survey results are unlikely to be a reliable indicator of land-use patterns prior to about 6,500 years ago. What was recorded may also be a palimpsest of sites from the pre-island formation period, and possibly those from occupation in more recent Holocene times, after the sea reached its present level. Nonetheless, if there had been prehistoric Aboriginal visits to the outer islands in the period since the islands had formed, then one would expect coastal resource exploitation to be reflected in cultural remains and/or the site distribution pattern.

This however was not the case, and apart from the Beeton Rockshelter on Badger Island, neither shellfish nor any other evidence of marine exploitation was found in the prehistoric cultural remains discovered; nor was there a concentration of sites in the coastal zone (Table 2.2). There was no consistent pattern in the location of sites recorded in regard to their proximity to the present coast. What can be seen from the distribution of the sites recorded in the southern Furneaux region is a clear correlation between the location of sites and freshwater sources (Table 2.3). This association was not evident on the northern islands surveyed principally because of the scarcity of fresh water sources on the smaller, more northerly Outer Furneaux Islands. However, the regional association of prehistoric stone artefact sites and water sources has previously been remarked upon by Sim (1989) in reference to Flinders Island. The location of freshwater therefore is considered to be a vital factor in terms of site location, and a useful indicator for predicting site locations in this region.

Several outcrops or localised sources of crystal quartz were located on Cape Barren Island during the survey. Sites were also found in some of these locations. It appeared that sites were associated with such stone sources only where the exposure of the stone was unrelated to coastal landform processes. That is, sites were found only where the quartz crystal source was exposed in granite boulders that would have been exposed prior to the stabilisation of the sea at its present level, or in stream and river watercourses. Two sources of abundant, high quality quartz crystal cobbles were found directly on the coastline (one in the tidal shallows) on Cape Barren Island. No sites were found in the immediate area of these sources, and nor was there any evidence of smashing or quarrying of the stone at the source. This supports other evidence found during the survey which suggests that people were not inhabiting the Outer Furneaux Islands after the sea reached its present level.

ISLAND	Sites no. < 50 m from shoreline	Sites no. > 50 m from shoreline
Big Green	4	9
Big Dog	2	7
Little Dog	1	6
Badger	2	1
East Kangaroo	0	2
Anderson	1	1
Vansittart	0	2
Babel	1	0
Prime Seal	1	0
Cape Barren	7	4
Clarke	0	4
Goose	1	3
Preservation	3	0
Swan	2	0
TOTAL %	25 39%	39 61%

Table 2.2: Location of sites on islands in relation to the present high water mark

Islands with permanent fresh water sources	Sites no. < 150 m from fresh water	Sites no. > 150 m from fresh water
Goose	1	0
Cape Barren	8	3
Clarke	4	0
Preservation	2	1
Swan	2	0
TOTAL %	17 81%	4 19%

Table 2.3: Location of sites on islands in relation to freshwater sources.

2.3.3 Density of stone artefacts

Although only seven of the 64 sites recorded contained more than 16 (prehistoric) stone artefacts, on four sites in excess of 100 stone artefacts were observed (Table 2.1). The Wombat Point and Crystal Lagoon sites on southeast Cape Barren Island are, in terms of *prehistoric* artefact numbers, the richest surface sites recorded to date in the Furneaux region. Although similarly large numbers of flaked stone artefacts were also observed at the Petticoat Point and Bishops Creek sites, it is highly probable that some of these at least, are the product of recent gem hunters exploiting local crystal quartz and topaz sources. In these locations, only quartz which had undergone either secondary reduction or which had unequivocal negative retouch flake scars was included along with the exotic stone artefacts in the sample recorded in these locations.

The relatively low density of artefacts is attributed to a low level of stone working activity at the sites, and is probably a reflection of stone source distributions. Apart from the unusually dense Crystal Lagoon and Wombat Point sites, the numbers of prehistoric artefacts on sites were generally scant. The increase in density of artefacts at the Wombat Point and Crystal Lagoon sites probably relates to an advantageous combination of stone sources, freshwater availability and open eucalypt vegetation. Both these sites are located on the southern coast of Cape Barren Island and none of the other Outer Furneaux Islands had similar resources in one locale.

Beeton Rockshelter was the only other site where a high number of stone artefacts was recorded. This site was also atypical as it was not an open site and no quartz outcrops or other stone sources were observed in the immediate vicinity of the shelter. The higher density of artefacts at this site suggests a higher concentration of human activity because of the protection afforded by the shelter formation.

Documentation of stone surface artefacts at this site was undertaken during a subsequent trip and thus the survey analysis of artefact types and raw materials does not include artefacts from the Beeton Rockshelter site. Cultural remains from this site are described in more detail in Chapter Four. Apart from Mannalargenna Cave on Prime Seal Island, no other shelters are known to exist on the outer Furneaux Islands.

2.3.4 Artefact raw materials

Quartz was the predominant stone type evident amongst artefacts recorded on 81% of the 63 sites where artefacts were recorded. Of the 12 sites where quartz was not

the predominant stone type seven comprised isolated finds and the remainder were mainly very low density scatters. Isolated finds or sites with low artefact numbers such as these are, in themselves, unlikely to provide a representative sample of artefact raw materials. However in the total, combined artefact assemblage (i.e. all artefacts recorded overall), there was a marked predominance of quartz (including vein/reef and crystal) with this stone type representing some 74% of all artefacts recorded. Due to the intractable nature of quartz and the resultant difficulty in some cases in distinguishing between naturally occurring fragmented quartz and worked quartz, this proportion of quartz is most probably an underestimate. In any ambiguous cases, quartz was excluded from the artefacts recorded. Quartz is found in abundance throughout the region and granite outcrops containing quartz veins were widespread on all islands surveyed. Crystal quartz which is also common in the Furneaux region was also employed in artefact manufacture, and facets were clearly evident on many of the crystal and other high grade quartz artefacts.

Other locally available artefact raw materials are various grades of granites and quartzites, although there are no specific quarry sites for these stone types. Quartzite represented 18% of the artefacts recorded, and was the second most common raw material recorded. Granite and basalt each represented 1%, and a range of other exotic (or transported) raw materials represented the remaining 6% of artefacts (Table 2.4).

The range of different types of transported raw materials does not appear to reflect quarrying of one specific source, although a number of the transported stone artefacts were made from chalcedony, the nearest known source of which is on the coast of northeast Tasmania (Kee 1987). The types of quartzite varied considerably and included a range of colours (white, cream, pale pink and various shades of greys) and grain sizes. There were varying degrees of metamorphosis amongst the artefact quartzites, some highly siliceous whereas others were low grade metamorphics. Several basalt cobble manuports recorded on East Kangaroo Island appeared to be of similar material. No artefacts made from chert or silcrete appeared to have come from the same source or parent rock. The geology of the Furneaux region does not preclude any of these stone types being locally obtained, although specific sources were not located during the survey, except for quartz. The diverse range of quartzites, silcrete, chalcedony and cherts suggests nevertheless that stone was being obtained from a number of distant sources, rather than from intensive exploitation of specific local sources.

ISLAND no. of sites	Stone Type -Artefact no.					Total
	Quartz*	Quartzite	Granite	Basalt	Exotic	
Big Green - 7	22	7	0	0	2	31
Big Dog - 9	12	0	0	0	1	13
Little Dog - 13	28	18	0	0	3	49
Badger - 2	11	2	0	0	0	13
East Kangaroo - 2	10	6	0	3	2	21
Anderson - 2	1	1	0	0	0	2
Vansittart - 2	16	8	0	0	1	25
Babel - 1	0	1	0	0	0	1
Prime Seal - 1	1	0	0	0	0	1
Cape Barren - 11	176	16	1	1	9	203
Clarke - 4	4	2	1	0	0	7
Goose - 4	7	3	2	0	4	16
Preservation - 3	3	0	0	0	0	3
Swan - 2	3	6	0	0	1	10
TOTAL no.	294	70	4	4	23	395
% of all artefacts	74%	18%	1%	1%	6%	100%

* includes crystal quartz

Table 2.4: Stone artefact raw materials (stone type).

2.3.5 Types of artefacts

The distinction between primary (unmodified) flakes, cores and retouched implements was readily detectable on quartzite, silcrete and chert artefacts. However, the inherent physical properties and fracture patterns of quartz made the identification of artefact types amongst worked quartz pieces problematic. To overcome this, pieces of quartz which had obviously been knapped and had no more than two negative flake scars, were categorised together with primary flakes as worked pieces. Quartz artefacts with three or more negative flake scars were recorded as cores. Manuports comprised granite and basalt cobbles, three of which had been split and one of which had surface pitting consistent with its use as an anvil.

Of the 395 artefacts recorded on 63 of the sites during the survey, 78% comprised unmodified primary flakes or worked pieces, 12% were cores (identified by the presence of three or more negative flake scars), 6% had been retouched and 4% were manuports (Table 2.5). All artefacts recorded or observed during the survey were consistent with those found on other sites in mainland Tasmania (Jones 1971, 1977b; Lourandos 1977). As expected, no geometric microliths, backed blades, points or other tools attributable to the Australian Small Tool Tradition have been recorded on any of the Furneaux Islands — either during this project's survey work or any other archaeological investigations on the islands. The 26 retouched implements recorded during the survey comprised two thumbnail scrapers, one notched flake, one notched and retouched flake, two notched small steep-edged scrapers, one bifacially flaked large scraper, 10 large steep-edge scrapers, six small steep-edged scrapers and three large flat scrapers.

ISLAND	Artefact Type - no.				Total
	Unretouched flake & flaked piece with < 3 neg. flake scars	Core - inc. flaked quartz with >2 neg. flake scars	Retouched Implement	Manuport	
Cape Barren	162	25	13	3	203
Clarke	6	0	1	0	7
Goose	13	0	0	3	16
Preservation	1	0	2	0	3
Swan	7	0	3	0	10
Big Green	22	7	1	1	31
Big Dog	9	4			13
Little Dog	34	11	3	1	49
Badger	13				13
East Kangaroo	15	1	1	4	21
Anderson	1		1		2
Vansittart	25				25
Babel			1		1
Prime Seal	1				1
TOTAL no.	309	48	26	12	395
%	78%	12%	7%	3%	100%

Table 2.5: Artefact types recorded.

Although quartz was by far the most common stone type amongst all artefacts recorded, proportionately less of the quartz was retouched. The proportion of retouched implements amongst all other artefacts recorded (quartzite, granite, basalt, chalcedony, silcrete and chert) was overall about three times that of the quartz. The high percentage of unretouched quartz is almost certainly due to more intensive, localised working of this stone associated with local quartz sources. Virtually all cores which were recorded were also quartz. The absence of cores of other materials supports the suggestion that quartz was the principal material being worked at the sites recorded. Exotic stone was in the main found as retouched implements rather than unretouched flakes or pieces, and the absence of debitage apart from quartz suggests that the finished implements were being transported to the region and that working of exotic stone was not occurring on sites in the region.

Overall, the range of artefact types recorded on the Outer Furneaux Islands generally concurred with those previously recorded on Flinders Island (Orchiston 1984; Orchiston and Glenie 1978; Sim 1989). The one notable exception was the absence of large block implements and horse-hoof cores in the Outer Island sites. These types of artefacts have been reported on Flinders Island (Orchiston 1979b; Orchiston and Glenie 1978) and described as reminiscent of major elements of the Kangaroo Island Kartan industry assemblages (Lampert 1979). Similar artefacts have also been recorded on King Island in the western Bass Strait region (Jones 1979; Sim 1988, 1990). These artefact types are predominantly made from a particular type of grey quartzite, sometimes described as an arkosic sandstone (Jones 1979), and found in close proximity to sources of this type of quartzite (Lampert 1979; Sim 1991). Although sources of this type of grey quartzite have been observed on Flinders Island, none were found on the outer islands during the survey. The absence of such artefacts on the outer islands is consistent with distribution patterns elsewhere since these artefacts have previously been recorded only in the immediate vicinity of stone sources.

2.3.6 Condition of sites

Many sites recorded during the island surveys were to some degree disturbed, although a large number of artefacts were also found resting on flat exposed granite rock surfaces and may have been undisturbed except for natural weathering. Erosion due to natural wind and water activity in coastal areas resulted in increased ground visibility, and played a key role in the discovery of sites. Animal disturbance was less common although it was an important factor in ground visibility and the

exposure of artefacts in muttonbird rookery areas. Disturbance and subsequent erosion associated with the clearance of birders' tracks in rookery areas and stock tracks on some islands, also exposed sites. Stock activity had also disturbed the uppermost level of the Beeton Rockshelter deposit, enabling it to be recognised as a site. Relatively low current numbers of introduced stock on the island mean that the disturbance of the deposit is no longer occurring.

Given the overall ground visibility problem, it is not unexpected that most open sites were found in erosional environments, and that erosion will continue to expose further sites on the islands. Erosion is unlikely however to destroy the potential for further archaeological research at any of the open sites recorded. The nature of these sites is such that the erosional processes which exposed the artefacts have already destroyed any stratigraphic integrity that may have existed. Moreover, most of the remains were found resting on shallow soils or bedrock, and there was no evidence of further (as yet undisturbed) remains existing at any of the open sites.

The Beeton Rockshelter site was markedly different from the open sites in that it was evident that it contained some depth of archaeologically rich sub-surface deposit. The surface deposit had been disturbed by introduced stock, and it appeared that artefacts from the sub-surface levels were being churned to the surface. There was no evidence of other disturbance such as wind or water erosion at this site. It was assumed therefore that the sub-surface deposit was probably undisturbed, and judging by the remains in the exposed upper levels, most probably contained stratified archaeological material including shellfish remains.

2.3.7 Summary of the survey results

A total of 19 weeks was spent over two field seasons surveying for archaeological sites on the Outer Furneaux Islands. Thirty-one of the 44 Outer Furneaux Islands were surveyed in addition to Swan Island in Banks Strait. Islands which were not surveyed were a number of bare rocky islets and a few islands which were inaccessible for logistical reasons. Sixty-three stone artefact sites were recorded along with a rockshelter site, Beeton Rockshelter, on Badger Island (Table 2.1) [Appendix I]. The Beeton Rockshelter was the only site recorded which included shellfish remains, or other evidence of marine resource exploitation. Overall, the evidence of prehistoric human activity was scant, and confined to low density stone artefact scatters. The number of artefacts on average was less than seven per site.

Despite the general paucity of prehistoric evidence of human activity, some conclusions could be drawn concerning past land-use patterns in the Furneaux region from the survey results. In keeping with previous findings on Flinders Island, where freshwater sources were present on the islands, sites were found in close proximity to these (Sim 1989). More illuminating, however, was that there was no correlation between the location of stone artefact sites on the Outer Islands and the present coastline of the islands. This, along with the absence of shell midden sites, suggested that these artefacts were not associated with human exploitation of island marine resources. The presence of certain exotic types of raw materials, from which some artefacts were made, indicated that stone was either being traded or carried from outside the Furneaux region. Overall the results supported the interpretation of the outer island prehistoric sites as most probably dating to the late Pleistocene landbridge phase. Apart from the shellfish remains in Beeton Rockshelter, there was no evidence found on any of the islands during the survey which might suggest inter-island travel or island phase, Holocene human activity .

In general, the sites marked by stone artefacts recorded a consistent pattern of low density past occupation, with habitation often focused around permanent freshwater sources and evidence of intense opportunistic exploitation of the local quartz sources. All evidence discovered from these sites discovered is consistent with that from other archaeological research in the Furneaux region (Brown 1993; Sim 1989, 1991). The Outer Furneaux Island sites, along with the sites found on Swan Island and results from archaeological excavations on the Furneaux Islands, clearly demonstrate that Aboriginal people were occupying the eastern Bassian region in prehistoric times, although the nature of the evidence suggests that the sites were probably occupied during the landbridge phase (Brown 1993; Sim 1991; Sim and Gait 1992). The Beeton Rockshelter midden site was the only site which does not fit the pattern suggested by the other evidence recorded during the survey. The implications of the general findings of the survey and the presence of shellfish remains at the Beeton Rockshelter site are discussed further below in relation to the broader problem.

2.4 Implications of the island survey results

The location of prehistoric sites recorded during the survey did not appear to relate to present shore lines, and apart from the remains in the Beeton Rockshelter on Badger Island, there was no evidence of marine or coastal resource exploitation. This suggested that the people who deposited the shell middens on Flinders Island in the

mid-Holocene were not visiting the offshore islands, and therefore probably did not possess watercraft.

The discovery of shell midden deposits in the Beeton Rockshelter however cast some doubt on this interpretation. There was clear evidence of coastal exploitation at this site, suggesting that people were using the shelter sometime since the sea had risen close to its present level, to bring the shoreline within reasonable walking distance to the site. The present area of Badger Island is only 16 square kilometres, too small to support a viable long term human population in isolation. Therefore, if the Beeton Rockshelter site had, as the evidence suggested, been occupied since the sea reached a level similar to that at present, then this would indicate that people had been making sea crossings of more than 10 kilometres, from Flinders or Cape Barren Islands.

The main implication of use of watercraft capable of undertaking crossings of this distance is that the same people would almost certainly have been able also to make the 15 kilometre crossing between the Furneaux Islands and mainland Tasmania, via Swan Island. Thus should the midden evidence in the Beeton Rockshelter have been deposited more recently than about 6,500 years ago, this would indicate that people had the watercraft technology for abandonment of Flinders Island and therefore need not have become extinct (Orchiston 1979b; Sim 1991).

Assuming that people were using watercraft to visit Badger Island, then the question remains as to why there is no evidence of island occupation on the other islands. Why are there shell midden sites in more than 15 localities on Flinders Island, and yet only one found on the outer islands surveyed? Two explanations could be initially surmised from the survey results; either a) open midden sites once existed on the outer islands but have since been destroyed due to the exposed conditions, or b) that (of the islands surveyed), people were only visiting Badger Island.

The possibility had to be considered that middens were once located on other Outer Furneaux Islands but had not survived, particularly since shell midden remains were found in the Beeton Rockshelter on Badger Island and also in light of the low density and thus fragile nature of remains in the Flinders Island middens (Orchiston and Glenie 1978; Sim 1989, 1991; Sim and Gait 1992; Sim and Stuart 1991). Nevertheless, during the surveys there were several coastal locations examined which had preservation conditions similar to those observed in midden site environs on Flinders

Island, but which contained no sites. Given the excellent preservation conditions afforded and the absence of sites in these locations, it is considered that the absence of midden sites observed during the surveys is a true reflection of a general absence of midden sites on the outer Furneaux Islands.

The presence of culturally deposited marine shellfish remains in the Beeton Rockshelter on Badger Island was therefore somewhat enigmatic. It is possible that in the past Badger Island provided food resources that were not obtainable or were not as abundantly available on islands closer to Flinders Island, or on Flinders Island itself. Hence Badger Island could conceivably have been a particular focus for human activity, with other islands being less attractive destinations and not visited. Badger Island currently has an aberrantly high number of wallabies and the region's densest breeding colony of Cape Barren Geese (Irynej Skira pers. comm.), a situation which could reflect past faunal regimes. Because of its relatively large size there may have also been relict populations of landbridge species such as the Grey Forester Kangaroo and emu which, along with more recent colonies of seals and muttonbirds, could have provided the impetus for people to make visits to Badger Island.

The evidence from Badger Island could therefore have represented human occupation on the island in the mid- to recent Holocene period, and thus indicated the use of relatively sophisticated watercraft in the region. Nevertheless, on the basis of the survey results from the other Outer Furneaux Islands, an equally strong argument could be made for abandonment of the outer islands as they became severed from the greater Furneaux region by rising seas between them about 9,000 years ago. The ocean bed topography drops steeply northwest of Badger Island, just near the Beeton site. Therefore, because the actual shoreline may still have been quite close to the site when the sea was about 30 metres lower than at present, it was possible also that shellfish were deposited in the shelter at a time of lower sea level, when Badger Island would have been still part of a greater Furneaux land mass.

This latter explanation would also account for the cessation of cultural remains about 8,000 years ago in stratified deposits excavated by Brown (1993) in the Mannalargenna Cave site on Prime Seal Island, another Outer Furneaux Island. The evidence at this site suggested that after some 12,000 years of visiting this site, it was abandoned as rising seas threatened to sever the broader area containing the site from the greater land mass of (what is now) Flinders Island (Brown 1988, 1990). It had not been possible for Brown to date the cessation of habitation with any precision due to the nature of the stratigraphy and an absence of datable organic material in the

upper cultural levels of the area he excavated (Brown 1993:261). Like Badger Island, Prime Seal Island would also have been an attractive island destination in terms of its terrestrial fauna, and seasonal seabird and seal resources. Prime Seal Island was also only half the distance of Badger Island from Flinders Island, and yet there was no evidence of visitation of the island after about 8,000 years ago.

Together, the results from the outer island surveys and the previous Mannalargenna Cave excavation suggests that people could have ceased visiting peripheral areas as rising sea levels cut overland access and they became islands. Nonetheless, the presence of a shell midden site in Beeton Rockshelter on Badger Island could also be interpreted as evidence of island phase occupation and hence evidence of watercraft. To resolve this issue it was essential that secure radiocarbon dates for the span of prehistoric human occupation on Badger and Prime Seal Islands be obtained from controlled excavations.

CHAPTER THREE

BEETON ROCKSHELTER, BADGER ISLAND EXCAVATIONS

3.1 Background to the excavation

The discovery of shell midden in the Beeton Rockshelter on Badger Island was intriguing in light of the survey results from the Outer Furneaux Islands previously described. Introduced stock activity in the shelter had disturbed cultural deposits, exhuming flaked stone and fossil shell artefacts in addition to a range of shellfish food remains. The initial discovery suggested three alternative explanations for the presence of such remains:

- a) that Aboriginal people on the island in historic times last century had been using the shelter,
- b) that people in prehistoric times had been making sea crossings to Badger Island from Flinders Island and had occupied the shelter, or
- c) that the shelter had been used at times of lower sea level when what is now Badger Island was part of the greater Furneaux landmass, and that habitation cessation was associated with the insulation process.

Although the absence of European items such as ceramic sherds or glass, and the nature of the remains strongly suggested that the shelter had been used by people in prehistoric rather than historic times, a recent origin could not be discounted without further investigation and C14 dating of the cultural deposit. If the remains were prehistoric, then because of the watercraft issue, it was vital to determine whether these were deposited prior to the severance of the Beeton Rockshelter area from the greater Furneaux land mass, by overland access, or by sea crossings in more recent prehistoric times.

Dating the occupation span at this site could potentially resolve the watercraft question for the Furneaux region, particularly if occupation was of a similar span to the midden sites on Flinders and thus indicated people were making sea crossings to Badger Island. Further investigation was therefore carried out at this site with an initial test pit and more extensive subsequent excavations over two field seasons.

The aims of the excavations were to provide a secure chronology for prehistoric occupation of the site, and to examine the findings in terms of how people were responding to palaeogeographic changes in the Furneaux region. That is, how people

responded to the inundation of vast tracts of land in the Furneaux region with the post-glacial sea level rise, and how this was reflected in the archaeological record. It was anticipated that the findings from the Beeton Rockshelter site would resolve the primary watercraft issue. Moreover, these findings in combination with further data from the Mannalargenna Cave site on Prime Seal Island, would provide the basis from which the question of why habitation ceased in the Furneaux region 4,000 years ago could be addressed.

3.1.1 Badger Island - an historical background

Although Badger Island is now uninhabited except for occasional visits from the lessee, for much of last century it was the hub of the Furneaux Island community. The island was home to a number of early European settlers, and more significantly one of the most highly regarded Tasmanian Aboriginal families, the Beetons (also referred to in historical accounts as Beedon, Beadon and Beaton). Lucy Beeton was the daughter of a Tasmanian Aboriginal woman Emmerenna and a sealer from London, and was born on Badger Island in 1829. She spent most of her life there and was a matriarch to the Aboriginal community in the Straits. An astute and widely respected businesswoman, Lucy Beeton ran a successful commercial shipping and trading business, and was responsible for setting up a school on Badger Island which employed two school teachers (Ryan 1996).

Historic accounts talk of the thriving community that was on Badger Island last century, and historic ruins are still evident in the old settlement area (Brownrigg in Murray-Smith 1987). Also in that area is the headstone which marks Lucy Beeton's grave where she was buried in 1886. Nowadays however the sheltered coves of Badger Island hold little attraction for visitors as the island is fairly remote from the Flinders and Cape Barren Island settlements. Furthermore, Badger Island does not have any extant muttonbird rookeries and therefore, unlike many of the other outer Furneaux Islands, is not a destination for the seasonal muttonbirders. Nonetheless, despite its remoteness and lack of visitors, Badger Island continues to be of particular importance to the Tasmanian Aboriginal community because of historical and genetic links to the Beeton family.

The shallow soils of the low-lying island are, in the main, now vegetated by dense tussock (*Poa poiformis*) grasslands. According to historic accounts, Badger Island was densely vegetated by she-oak (*Casuarina* sp.) forest and coastal ti-tree (*Leptospermum* sp.) thicket in the mid-nineteenth century (Brownrigg in Murray-Smith

1987:63). Small pockets of she-oak scrub are still to be found on the island, along with the introduced irises, Persian garlic and other botanical legacies of settlers in historic times. Apart from timber cutting, virtually all human activity on the island in historic times has been focused around the settlement area in the southeast of the island. An airstrip, the present day homestead, shearing sheds, woolshed, and a wharf are still in use in the southeast. Nearby on the east coast is Lucy Beeton's grave, gardens and a small boat harbour; remains of the settlement last century.

Except for the land clearance and occasional fence-line, the remainder of the island is virtually devoid of evidence of human activity; there are no tracks and even fences are absent on the western half of the island. Nor is there reference to historic habitation on Badger Island outside the settlement area. In the northwestern area of the island however there are two locations with historic structural remains. One of these is a small dry-stone-walled shelter ruin, and the other Beeton Rockshelter. This latter site is a spacious crescent-shaped limestone rockshelter located some 200 metres from the shore on the northwestern-most tip of the island. Fencing remnants and a boxthorn thicket enclosure attest to its use in recent times as a stockyard (Alfred Stackhouse, island lessee, pers. comm.).

3.1.2 Geographical background

Badger Island is one of the more remote outer islands in the Furneaux Group, and one of the largest. It is located at latitude 40°20' south and longitude 147°50', 13 kilometres southwest of Flinders Island. An open sea crossing of 10 kilometres is required to reach Badger Island via Chappell Island from Flinders Island (Figure 1.2). Badger Island is approximately 8 kilometres east-west by about 3 kilometres north-south and is 1616 hectares in area. It is of markedly low relief with its highest point being only 34 metres above sea level. As a consequence Badger Island cannot be sighted from Flinders Island on all but exceptionally clear days. Furthermore, from most of Flinders Island the view of Badger Island is obscured by the intervening rise of Mount Chappell on a neighbouring island.

Geologically Badger Island is bounded on both the west and east coasts by broad, intrusive granite formations, the eastern one extends northwards to Flinders Island and composes the Mount Chappell peak. The shoreline along the eastern and western shores of Badger Island comprises large rounded granite boulders, similar to those found along the scenic west coast of Flinders Island. Abutting the granite on the northwest tip of Badger Island there is a substantial limestone outcrop. This

outcrop contains the Beeton Rockshelter site. The limestone formation is a type of aeolianite, the bedding of which is clearly evident principally due to wind erosion of the limestone faces.

The majority of the Badger Island surface rock however is not granite or limestone, but a dark grey, slaty hornfels rock (Lin Sutherland pers. comm.). This rock type results from metamorphism of sedimentary beds by the intrusion of the granites and forms a central band, running north-south across the island, sandwiched between the two granite formations (Pinkard and Richley 1982). Although this band is principally a contact zone, and thus potentially a source of fine-grained stone types suitable for knapping, the mineralogy of the original sedimentary beds was such that the metamorphosis has not produced conchoidally fracturing rock types. In a central band across the island, the contact rock is visible on the surface in numerous low outcrops and also along the north and south coastal margins. These northern and southern shorelines are characterised by hard rocky shores, fringed with sharp, jagged vertical rock outcrops and pebbles in the intertidal zones.

The coastal margins of the island provide a range of environments for intertidal and subtidal shellfish, many species of which are readily obtainable from both the granite and slaty hornfels shores. Crayfish (*Jasus lalandei*) are obtainable close to shore in the subtidal zone, although in recent years the number of these has diminished and professional fishermen no longer set pots around Badger Island. The most abundant food resources currently on the island are not the littoral resources but Bennetts Wallaby (*Macropus rufogriseus*) and Cape Barren geese (*Cereopsis novaehollandiae*).

At present, Cape Barren geese are particularly abundant on Badger Island, especially in the nesting season. These birds demonstrate a preference for small islands as breeding grounds, possibly due to the absence of indigenous carnivore predators. Chicks and eggs are readily obtainable on Badger Island and are highly regarded foods amongst the islands' present-day Aboriginal population. Both chicks and mature geese are hunted on the Furneaux Islands and there is an official annual goose cull. Firearms are generally used to hunt mature birds while the chicks are usually chased down on foot. It is reported that the wallaby population, which has now reached the stage where hundreds are also culled annually, derives from animals introduced to Badger Island in Lucy Beeton's time (Hope 1973:181). Nonetheless, two indigenous macropod populations were documented on the island in the early 1800s: Bennetts Wallaby (*Macropus rufogriseus*) and the Tasmanian pademelon (*Thylogale billardierii*) (Hope 1973:181)

Other terrestrial animals which were on the island in early historic times and could have been human food resources in prehistoric times were Tiger and Copperhead Snakes (*Notechis ater* and *Austrelaps superba*), Blue-tongued Lizards (*Tiliqua nigrolutea*) and possibly indigenous murid species (Hope 1973). There is no record of possums (*Trichosurus vulpecula*, *Pseudocheirus peregrinus* or *Cercartetus nanus*), echidna (*Tachyglossus aculeatus*) or wombat (*Vombatus ursinus*) on Badger Island in historic times, although wombat bones had been observed in erosion hollows around the island (Sim and Stuart 1991:7). Muttonbird (*Puffinus tenuirostris*) bones have also been found exposed in eroding sections on Badger Island, and like wombats, these birds were notably absent from the range of Badger Island fauna in historic times.

At times of high rainfall, surface soaks form in several areas on Badger Island including in the immediate vicinity of the Beeton Rockshelter. There are however no permanent sources of surface fresh water on Badger Island although there is good quality bore water at a shallow depth in several places on the island. In this respect Badger Island is unusual as even bore water is a scarce resource on most of the outer Furneaux Islands at present. Nevertheless, in past climatic regimes when sea levels were lower and water tables different, there may well have been permanent freshwater sources such as streams and lakes in close proximity to the area that now constitutes Badger Island.

3.1.3 Site description

Beeton Rockshelter is 21 metres long and contains more than 60 square metres of habitable space (Figure 3.1). The typical of wave-cut notch morphology of the shelter, and its orientation and location in relation to the present shoreline, indicate it was formed when sea levels were between five and ten metres higher than at present. Sea levels of this order have not have occurred in the region since about 120,000 years ago, although the initial formation could even predate that last interglacial (Bowden and Colhoun 1984). About five metres above sea level, the shelter has a north-westerly aspect, and Flinders and Prime Seal Islands along with most of the others in the Furneaux Group are visible from the top of the shelter outcrop in fine weather. Access to the shelter is gained through a small opening in the dense thicket of African Boxthorn bushes that obscures the front of the shelter (Photographs 1 and 2).

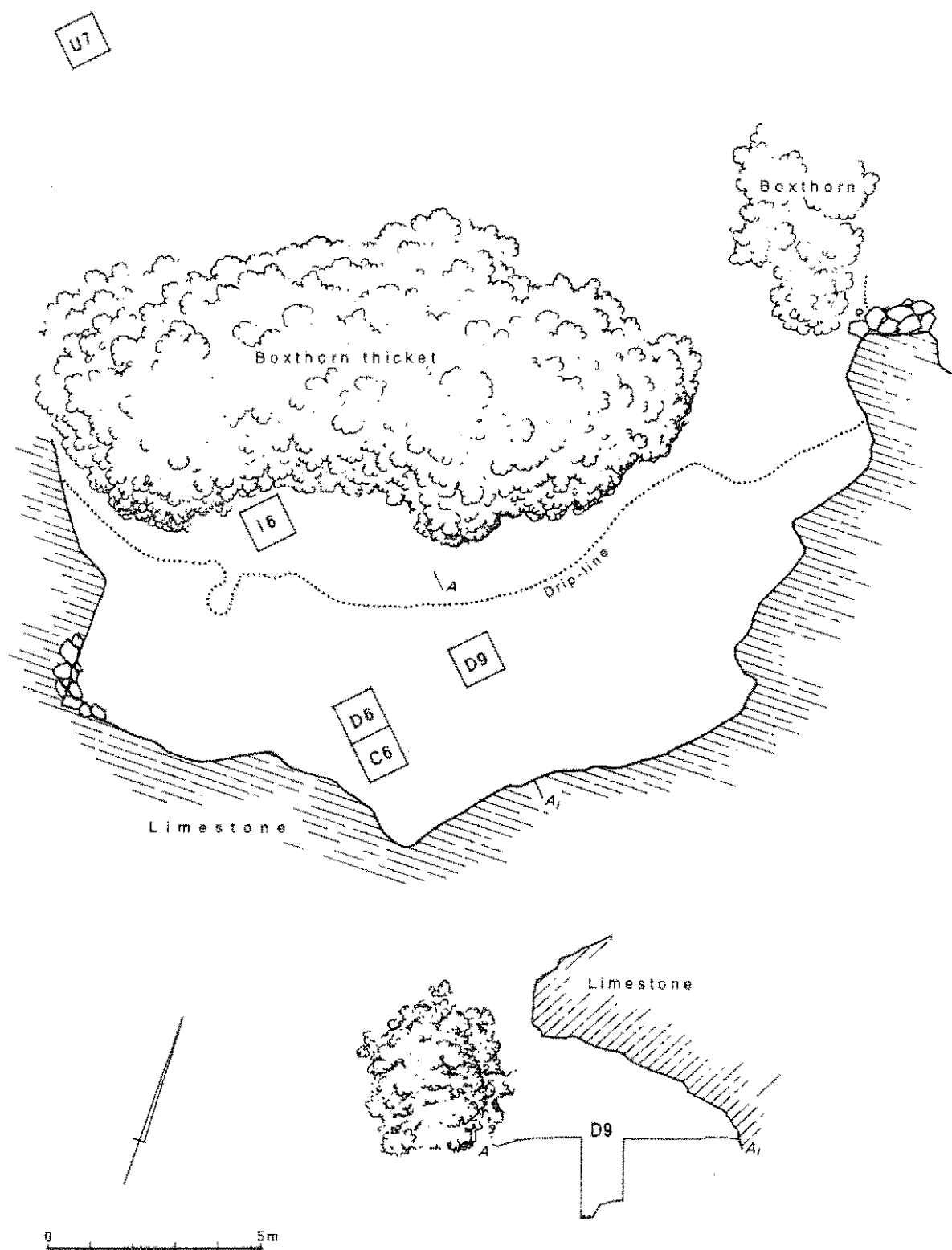


Figure 3.1: Beeton Rockshelter - site plan and section.

The boxthorn appears to have been deliberately planted to facilitate the use of the shelter as a stock pen (building timber was a scarce commodity on the islands in the past and boxthorn hedges were often used fences). Fortunately the root system of the boxthorn is relatively contained and, despite its close proximity to the thicket, the deposit in the shelter shows minimal evidence of root activity. During excavation the few roots that were exposed were in the main resting directly on bedrock in the base of the deposit, below the levels containing cultural remains.

Despite being more open prior to the growth of the boxthorn thicket, the shelter would still have been a hospitable place, well protected from the prevailing southerly winds. It is also dry and spacious with a relatively level, soft sandy floor, scenic views and sheltered from the sun and all but north-westerly winds. It is less than 200 metres to the shore from the shelter. Both granite boulder shorelines, and rocky hornfels and pebbly bays, are within a few minutes walk. The current coastal zone provides a range of shellfish and other marine resources close to the site.

3.2 Excavation strategy and method

Excavations at the site were undertaken in two consecutive field seasons with a one metre square test pit being excavated shortly after finding the site, and a further four one metre squares when the main excavations at the site were undertaken the following field season.

3.2.1 The test excavation

A one metre square test pit, D9, was excavated in the central area of the shelter where headroom was greater than 1.75 metres (Figure 3.1; Photograph 3). This location was selected for the test excavation because preliminary probing of the deposit indicated that this area contained a substantial depth of deposit, and the surface deposits suggested it would be an area where undisturbed midden material could be located.

The test pit was excavated to a depth of about 1.4 metres when a large piece of roof-fall rock, which covered most of the pit area, was encountered. The roof-fall was too large to remove and as a result the excavation area reduced to a small portion in one corner of the pit. This area was filled with a loose limestone rubble which was excavated a further 25 centimetres in depth at which point it became too cramped to continue the excavation in a controlled manner. Although the lowest level of the test

pit comprised rubble, it was unclear whether it was decaying roof-fall or bedrock, and hence further, more extensive excavations were planned at the site (Figure 3.2a; Photograph 4).

3.2.2 The main excavations

Over a period of seven weeks in January and February 1992, U7, I6 and two adjoining squares D6 and C6, were excavated at the site (Figure 3.1; Photograph 3).

The location of these pits was chosen to provide a sample of remains from

- a) a well protected area within the shelter itself,
- b) a less sheltered area directly in front of the overhang, and
- c) an open area, unprotected but still in close proximity to the shelter.

It was anticipated that the sample of remains recovered from these pits would provide information about possible variation in human behaviour at the site, both diachronically and synchronically. The strategy of investigating different areas within the site aimed to provide a representative sample, and some control for the possibility that there was chronologically related variation in site use within different areas in the site. Thus, the selection of a broad spatial sample from the site ensured a more secure overall temporal sequence (span) of human occupation of the shelter could be obtained. In light of the roof-fall problem encountered during the test excavation, it was also important that either bedrock or culturally sterile depths of deposit be reached in some of the sample area excavated. The range of pit locations chosen for the main excavations and preliminary probing using a hollow 12 millimetre steel tube aimed to counteract this problem.

3.2.3 Excavation methods

Deposit was excavated using standard 125 millimetre trowels and removed from the pits in 10 litre buckets. Buckets of excavated deposit were counted and weighed, and the contents sieved using nested 7 millimetre and 3 millimetre metal-meshed sieves. Shell, bone, charcoal, eggshell, fossil shell and worked or manuport stone was bagged from each sieve size, and sieve residue samples were retained from each excavated spit. Excavated rock was included in bucket volumes and also recorded separately by weight. In most instances, a dumpy level and staff were used to measure pit depths using a datum point (A) on the shelter wall. This method could not be employed for U7, the excavated square furthest from the shelter. This pit was marked out with a levelled datum string line which in turn was correlated to a

secondary datum point (B). Spit depths were measured relative to the levelled line during excavation of the U7 pit. Concrete nails have been embedded in the shelter wall as permanent datum markers.

Where no stratigraphic differentiation was apparent, the deposit was excavated in measured levels. Spits in the D9 test pit which was excavated some months prior to the main excavations, were generally five centimetres in depth. During the excavation of the D6, C6, I6 and U7 squares arbitrary spits were reduced to 2.5 centimetres in depth although some five centimetre spits were removed in the surface manure deposit and in the basal levels. In the main excavations each of the square metres was subdivided into 50 centimetre square quadrants which were excavated separately. The quadrants in each spit were labelled clockwise W, X, Y, and Z; with the W quadrant always being the western corner of the main square. Remains from each quadrant were bagged separately, effectively providing four consistent sample areas within each of the squares excavated should it have been required for analytical purposes.

A bulk sample of deposit was retained from each spit in all squares. The bulk samples comprise a 15 centimetre square excavated progressively from within each square as it was being excavated. Wherever possible the sample was taken from the same portion of the square so that in total, the bulk samples represent a column sample subdivided into excavation spits. In a few instances where roof-fall rock was encountered obscuring the bulk sample area, the sample was collected from an area as close as possible to the previous overlying sample area. The volume of the bulk sample has not been included in the spit volumes for any of the calculations used in the analysis.

3.2.4 Recording procedures

The shelter and location of excavated squares was drawn to scale using 20 metre tapes, compass, a dumpy level and staff using two datum points. Monochrome and colour photography was used to document features, sections and the excavation in progress. Each spit excavated was described and drawn in plan at 1:10 scale on standard recording forms. Munsell colours and pH values were recorded using dry sediments from the bulk samples. Numbers of buckets of excavated deposit, and the weight of these were also recorded in a notebook for each spit. *In situ* flaked stone and fossil shell artefacts were recorded in three dimensions, and features with depth such as hearths and dense clusters of bone or shell were noted and drawn on the spit

plans. At the completion of the excavation, scale drawings were made of all wall sections.

3.3 Stratigraphy and chronology

There was a similar stratigraphic sequence evident in each of the pits excavated inside the shelter. The sequence comprised four major units, each being defined by comparable changes in deposit colour and composition. A similar sequence was also evident in the square (U7) located outside the shelter although here the stratigraphy was vertically compacted as the depth of unconsolidated sediments overlying the basal unit was much shallower. Stratigraphic junctions in the U7 square were also slightly less distinct than those in the squares located inside the shelter, and the basal deposit comprised consolidated, fine clayey sand sediments rather than limestone bedrock. Overall however there was a marked consistency evident in the stratigraphy in all squares excavated, including the test pit and those located beyond the confines of the shelter drip-line.

3.3.1 Stratigraphic units

The four major stratigraphic units comprised: a surface deposit of sand and humic matter, a thin band of sterile compacted sand, a darker layer up to 50 centimetres deep containing a mix of marine shell, muttonbird bones and artefacts in a sand matrix, and a lower pale sand unit containing a low density of artefacts but no shell or muttonbird bones (Figure 3.2; Photographs 4 to 10). These units and variations within them are described below. Following these descriptions is Table 3.1 which correlates the spits in each of the excavated squares to the stratigraphic units.

UNIT I Surface deposits

Unit I was a humic rich, dark brown surface deposit which was principally comprised of two layers, loose surface material overlying more consolidated sheep and cattle dung. The depth of unit I varied between nine and 12 centimetres, and comprised two sub-units.

Ia: Toward the front of the shelter, the surface of the deposit was covered by a thin layer of loose, dark brown (10YR/3/4) deposit rich in humic material. This layer consisted of a mix of silty sand, loose animal excreta and leaf litter. This unit also

contained a minor component of shell and stone artefacts which had been churned (from the underlying unit II) to the surface by stock activity.

Ib: Underlying unit Ia and on the surface of the rear of the shelter was a consolidated brownish black (10YR/3/1) layer comprising bands of sheep and cow excreta. This compacted excreta deposit covered virtually the entire area within the shelter, forming a solid capping over the looser underlying cultural deposits. In some small areas this consolidated unit Ib layer had been broken up by hooved stock, thus explaining the presence of a small quantity of shellfish remains, bone and stone artefacts in the Ia surface deposit.

UNIT II Sterile sand band

Ila: This sub-unit comprised a thin band of lightly compacted, yellow (2.5Y8/4) sand which immediately underlay unit Ib. It varied from a few millimetres to three centimetres in thickness and was absent entirely in the squares outside the drip-line and some areas within the rockshelter. Where it was not present there was either a thin band of darker, compacted sterile sand (unit IIb), or the darker shell bearing sands (unit III), both of which are described below.

I Ib: This deposit consisted of semi-consolidated sand sediments, slightly finer in texture and darker (2.5Y 7/2) in colour than Ila. Much of the surface of this layer was 'dimpled' with impressions from the base of the overlying compacted sheep dung (unit Ib).

UNIT III Deposit with midden remains

Unit III contained a range of archaeological remains in a greyish, yellow brown (10YR5/2) medium to coarse sand matrix. The upper portion of this unit was flecked with precipitated soft white lime in sub-surface areas near the drip-line of the shelter. Relatively dense quantities of muttonbird bones, whole and fragmented marine shell, stone artefacts and other cultural remains were found in this unit, although within the unit this material decreased with depth. There were also burrow-like features detectable in the western area of D9 in the unit III layer. Numerous pieces of limestone rock (almost certainly roof-fall) were also incorporated in this unit. Pieces of limestone rock (most less than 15 centimetres in size) were most common in this unit although a few were also found in over- and underlying units.

Where clear junctions were present, the overall depth, from the top to the base of unit III was between 45 and 50 centimetres. The base of this unit was unusual in that it was undulating rather than flat (Figures 3.2a and 3.2b).

UNIT IV Lower sand deposit

IVa: This unit comprised the majority of the deposit underlying the midden level. It consisted of yellow orange(10YR7/4), loosely consolidated medium to coarse calcareous sands. The stratigraphic change between the midden /rookery unit and this underlying deposit was in a few places gradual, and thus not always detectable during excavation. This was evident in the sections where the change from unit III to unit IV varied from a distinct junction in places to a gradual change or mottling in others (Figures 3.2a, 3.2b and 3.2c).

IVb: A thin band of slightly coarser, darker (10YR7/6) damp sand similar in colour to unit IVa was generally found resting directly on the limestone bedrock. Although principally distinguishable by the colour difference this sub-unit was also slightly coarser in sediment texture—probably because it contained a component of decomposing bedrock. Several live roots, less than 5 millimetres in diameter, were encountered in this sub-unit intruding along the top of the bedrock. These were presumably from the boxthorn thicket enclosing the shelter and associated with the dampness in the sediments immediately overlying the bedrock. .

IVc: In several places in the sections of both the test and main excavation pits inside the shelter there were dark bands (10YR2/1). Although no distinct lumps of charcoal were found in these bands, concentrations of charcoal flecks were present and the bands appeared to be decayed charcoal stains. As discussed below, these are interpreted as hearths.

IVd: In direct association with the dark bands (IVc) there were bands of darker, slightly orange coloured sediment. Except for the colour difference, this sediment is of the same texture and characteristics as that in unit IVa. The orange bands were found underlying the dark stains (IVc) in some places, and above them in others. These bands are interpreted as heat affected deposit, consistent with the interpretation of the associated charcoal stained areas as hearths.

BEDROCK

At the base of pits inside the shelter, and adjacent to the shelter drip-line, this unit comprised solid bedrock. As discussed above, the basal unit of the U7 pit located some 20 metres outside in front of the shelter was a consolidated calcareous deposit, whereas limestone bedrock was encountered at the base of C6, D6, D9 and I6. It was clear that the basal rock was bedrock in squares D6 and C6 because it obviously sloped upwards to meet the rear wall of the shelter (Figure 3.2b; Photograph 8). The surface of the bedrock limestone had a distinctive crust of decaying limestone which clearly distinguished it from the more consolidated surface of the roof-fall rock found in the deposits. This enabled the basal rock in the I6 square to be readily identified as an uneven bedrock formation, and rubble in the base of D9 as decaying bedrock.

STRATIGRAPHIC UNIT	SPIT NUMBERS (inc.)				
	C6	D6	D9	I6	U7
unit I (surface humic matter)	1 — 4	1 — 3	1 — 3	1 — 4	1 — 4
unit II (sterile sand)	5	4	absent	absent	absent
unit III (shell bearing deposit)	6 — 20	5 — 25	4 — 13	5 — 15	5 — 12
unit IV (deposit overlying bedrock)	21 — 36	26 — 45	14 — 21	16 — 24	13 — 18

Table 3.1: Excavated spits and stratigraphic unit correlations.

3.3.2 Chronology

A total of 19 radiocarbon dates were obtained for the analysis of the remains excavated from the Beeton Rockshelter site (Table 3.2). These comprised nine conventional radiocarbon dates and 10 AMS dates. Of the conventional dates three were obtained from charcoal and six from marine shell (*Cellana solida*). Nine of the AMS dates were from muttonbird bone and one from a piece of emu eggshell. The emu eggshell date was obtained by Gifford Miller for his independent research into

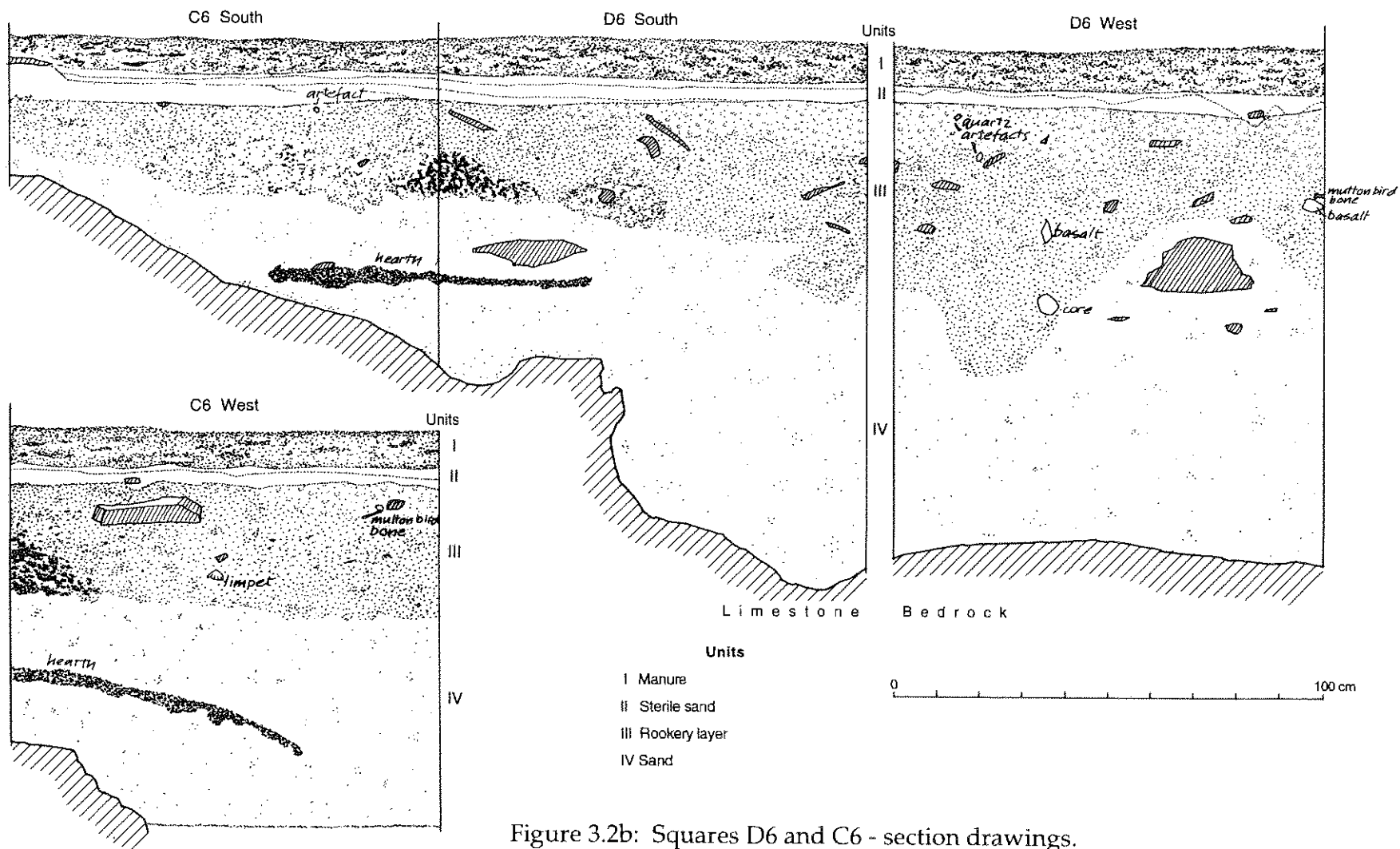


Figure 3.2b: Squares D6 and C6 - section drawings.

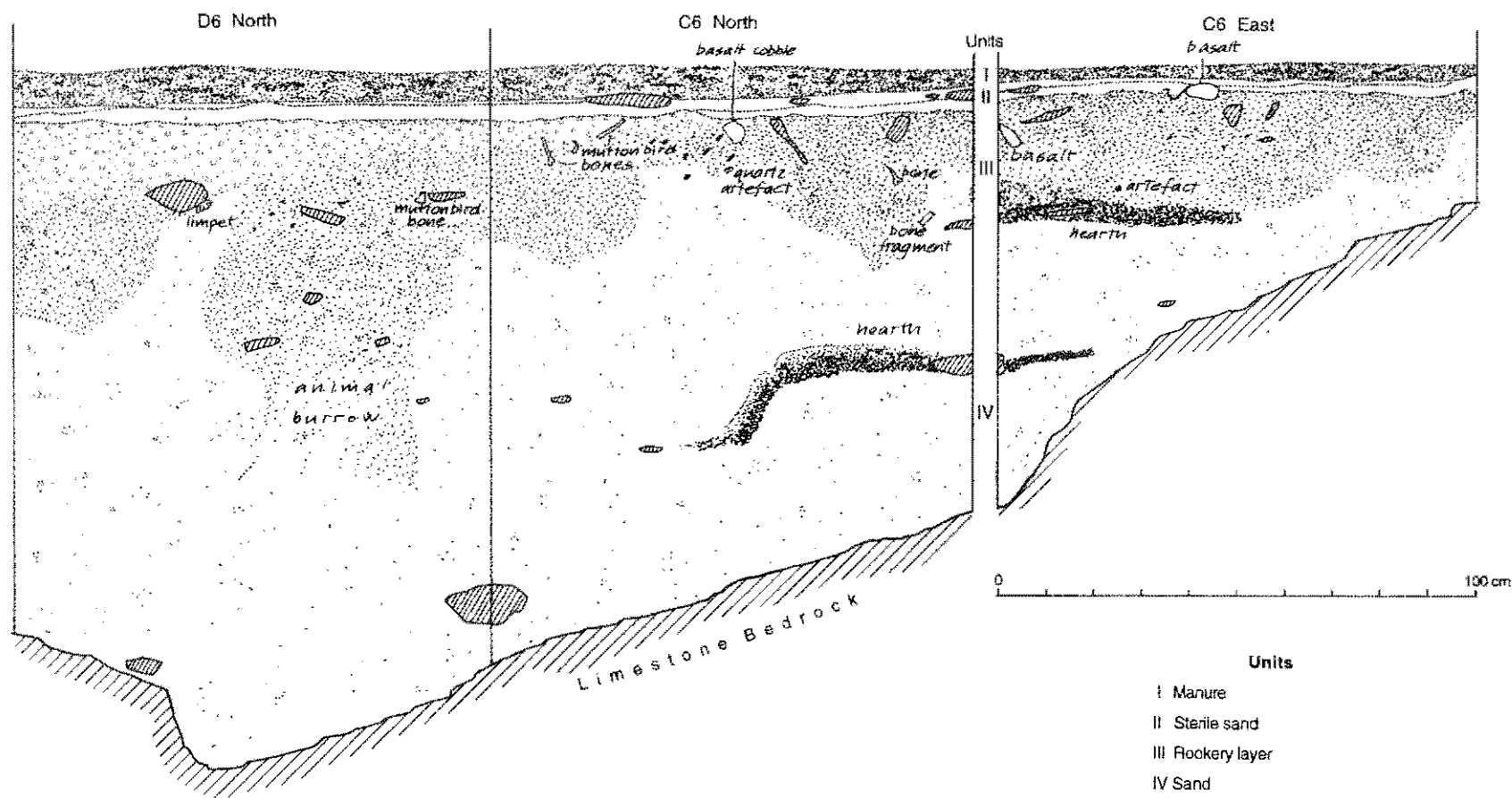


Figure 3.2b: Squares D6 and C6 (continued from previous page).

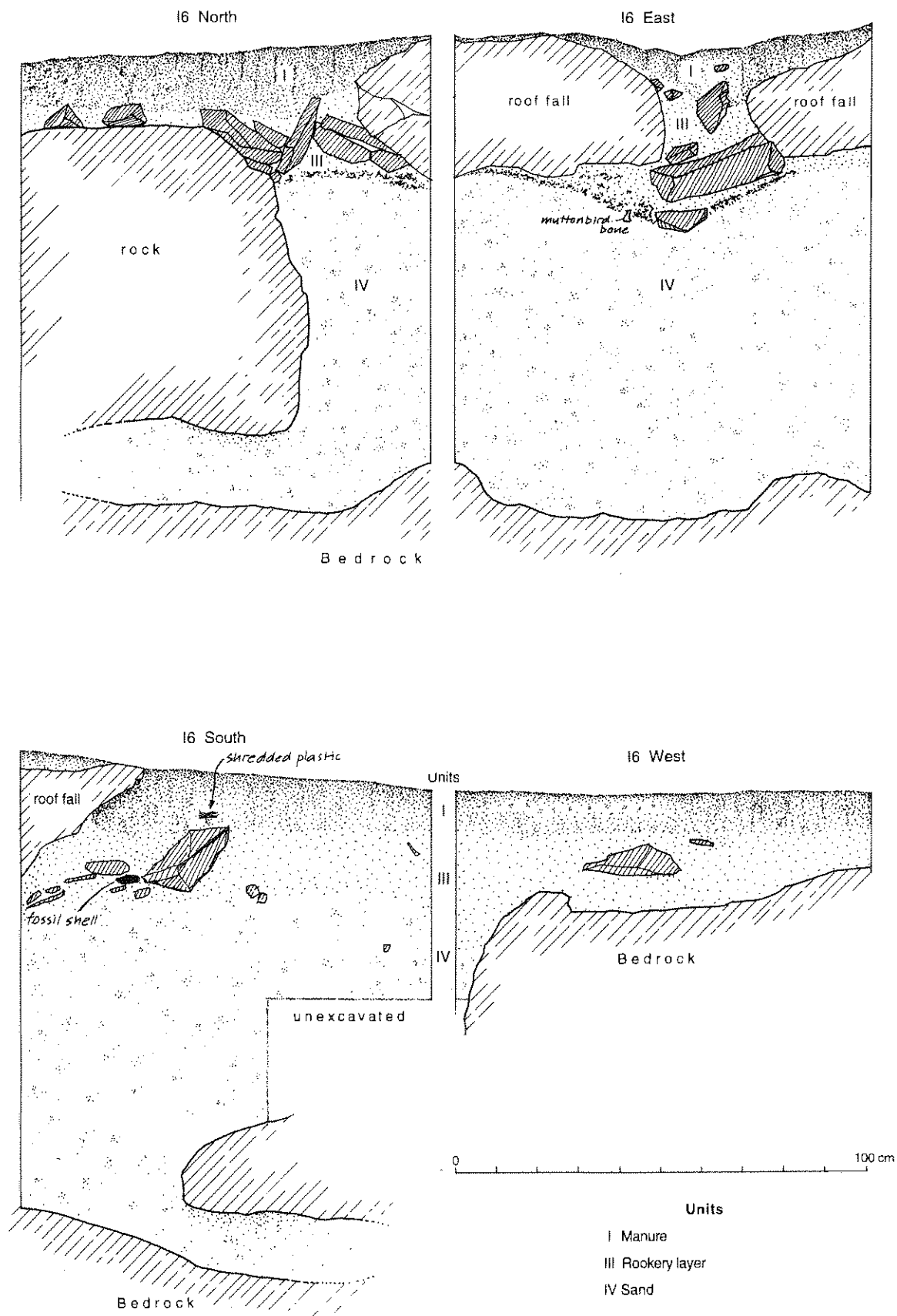


Figure 3.2c: Square I6 - section drawings.

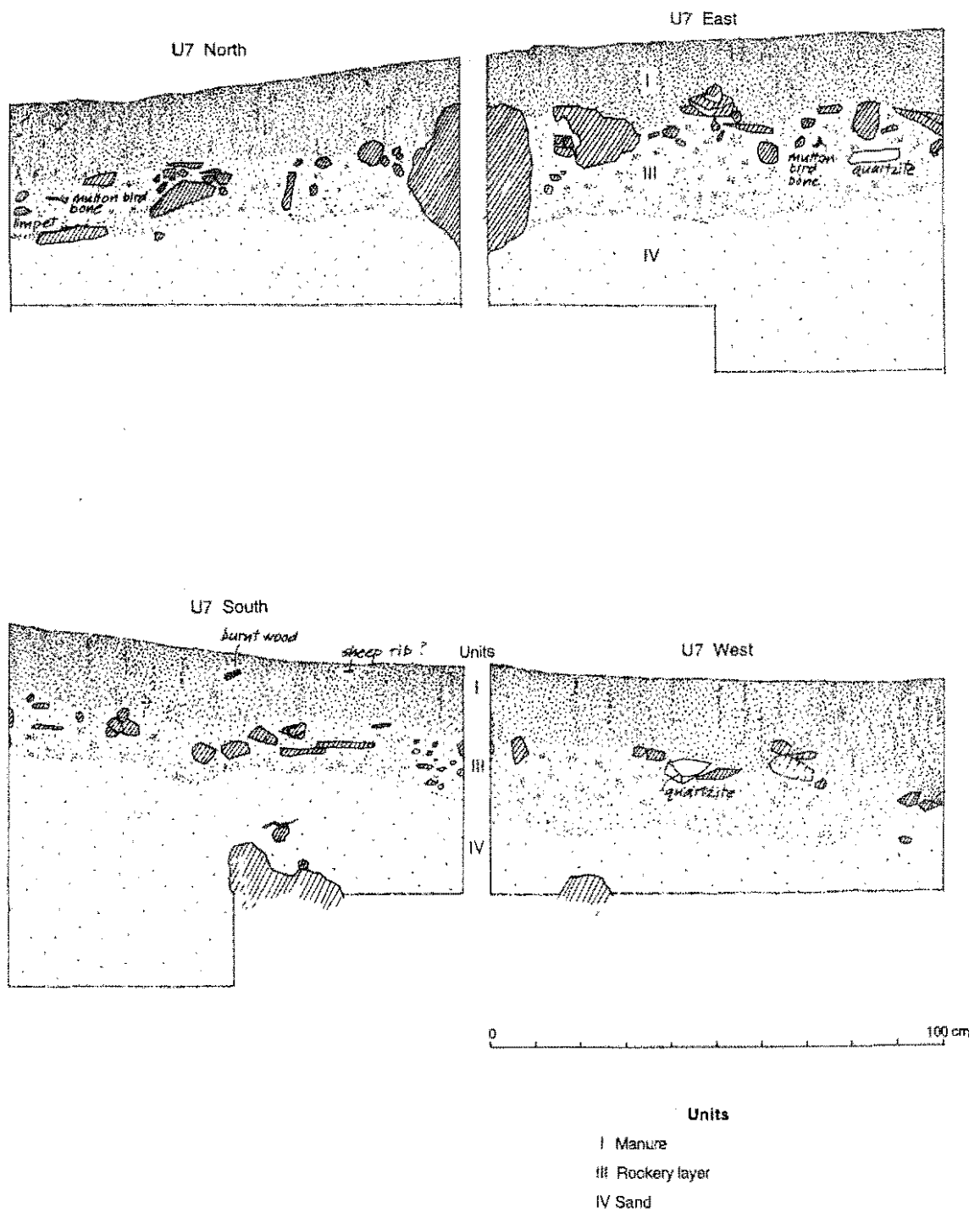


Figure 3.2d: Square U7 - section drawings.

ratite eggshell dating methods. The conventional radiocarbon dates were supplied by the Australian National University Quaternary Dating Research Centre, and the AMS muttonbird bone dates by the ANSTO dating facility at the Lucas Heights Research Laboratories.

MATERIAL DATED Square/spit	C ₁₄ date BP & lab. no.	Calibrated age BP (2 std deviations)
MUTTONBIRD BONE		
D9/6 <i>Puffinus carneipes</i>	4540 ± 90 OZB 591	4960 - 5330
D6/18 <i>P. carneipes</i>	4910 ± 60 OZB 590	5570 - 5760
D9/7 <i>P. griseus</i>	4950 ± 90 OZB 593	5570 - 5910
D9/7 <i>P. pacificus</i>	5080 ± 80 OZB 594	5650 - 5950
D6/17 <i>P. griseus</i>	5370 ± 80 OZB 589	5980 - 6300
C6/17 <i>P. tenuirostris</i>	5400 ± 110 OZA 783	5940 - 6350
D9/11 <i>P. tenuirostris</i>	5440 ± 110 OZA 782	5980 - 6420
D6/24 <i>P. tenuirostris</i>	5530 ± 110 OZA 784	6160 - 6560
C6/15 <i>P. pacificus</i>	8900 ± 70 OZB 592	9810 - 10010
SHELL		
D9/4 <i>Cellana solida</i>	8,700 ± 125 BP ANU-8130*	9450 - 9930*
C6/17 <i>C. solida</i>	8,794 ± 152 BP ANU-8746*	9480 - 10020*
D6/5 <i>C. solida</i>	8,676 ± 93 BP ANU-8748*	9480 - 9880*
D6/9 <i>C. solida</i>	8,754 ± 97 BP ANU-8749*	9520 - 9920*
D6/20 <i>C. solida</i>	8,811 ± 214 BP ANU-8747*	9420 - 10210*
D6/24 <i>C. solida</i>	8,441 ± 136 BP ANU-8750*	9080 - 9660*
CHARCOAL		
D9/14 hearth	18,180 ± 940 BP ANU-8751	beyond calibration**
D9/17 cluster	19,300 ± 730 BP ANU-8752	beyond calibration**
D9/20 hearth	16,250 ± 2,620 BP ANU-8753	beyond calibration**
EMU EGGSHELL		
D9/10	23,180 ± 1,280 BP AA-15143	beyond calibration**

* all shell dates listed have been corrected for O13 oceanic reservoir effects by -450 ± 35 years (Gillespie and Polach 1979; Head *et al.* 1983; Stuiver and Pearson 1993).

** at one standard deviation the charcoal dates are beyond the present range of calibration data

Table 3.2: Radiocarbon dates from Beeton Rockshelter.

Table 3.2 includes uncalibrated and calibrated dates. For reasons discussed below, dates referred to in the text are uncalibrated unless specifically stated otherwise. Dates were calibrated using the Calib 3.0 programme, bidecadal calibration (Stuiver and Pearson 1993; Stuiver and Reimer 1993a, 1993b). All shell dates referred to have been corrected for O13 oceanic reservoir effects by subtracting 450 ± 35 years (Gillespie and Polach 1979; Head *et al.* 1983; Stuiver and Pearson 1993).

Dates are uncalibrated, that is C14 years rather than calendar years, for several reasons. In both Beeton Rockshelter and Mannalargenna Cave (the latter discussed in Chapter Five) there is a sequence of cultural remains which spans from the early Holocene through to 23,500 (C14) years ago. Since it is only possible at present to calibrate material younger than about 18,300 (C14) years, the early occupation phase at both these sites can be presented only as C14 years. While it is possible to estimate the calibration curve using regression analysis, this is problematic. The disparity between C14 years and calendar years may not continue to diverge lineally before 18,300 BP, especially toward the limits of the dating method. Thus the certainty of reliable estimates decreases as the C14 age increases beyond 18,300 BP (see also O'Connell and Allen 1998:136-37).

The use of calibrated dates in sequences which also contain dated material beyond the calibration limit presents further problems of data comparability. While it is now generally considered *de rigueur* to use calibrated dates wherever possible, it is clearly impractical to construct a chronological sequence for a site using a combination of both calibrated and uncalibrated dates. Moreover, so far, none of the interpretation or discussion of the Tasmanian archaeological record, which now includes over 150 C14 dates, is based on calibrated data. Therefore for the sake of consistency both on an intra and inter-site level, uncalibrated dates have been used in the analysis and discussion unless stated otherwise.

It should also be recognised that discussion of much of the Pleistocene material hinges around the late glacial maximum climatic shift, the timing of which at 18,500 BP (C14 years) is based on uncalibrated radiocarbon data and in calibrated age is probably nearer 21,500 BP (calendar years ago). Uncalibrated archaeological dates therefore are consistent with the common perception of the last glacial maximum occurring around 18,500 BP. The sea level curve however is based on oxygen isotope, ^{230}Th and ^{234}U dating methods and is therefore more compatible with calibrated C14 data. The discrepancy between the sea level curve and the uncalibrated dates is acknowledged but not regarded as critical given the chronological scale of the

archaeological record we are dealing with, the rate of palaeoenvironmental change and the inherent imprecisions in the sea level curve (as discussed further in Chapter Six).

Shell dates

The shellfish remains represent readily datable evidence of human occupation at the site. In order to avoid problems of combined dating samples, and possible difference between species, all shell dates were obtained from single shells of the one limpet species (*Cellana solida*). Samples dated came from a range of levels within the unit III 'midden' layer, and included five samples from the adjoining C6 and D6 squares, and one from the D9 test pit (Figure 3.2a and 3.2b).

At two standard deviations, that is the 95.4% probability range, the shell dates overlap for the span of 150 years between 8,560 BP and 8,713 BP (Table 3.3; Figure 3.3). These results indicate that deposition of shellfish remains at the site was probably restricted to a relatively short period sometime around 8,600 years ago, although it may have commenced as early as about 9,200 years ago and continued for another thousand years or so. One of the samples (ANU 8750) is slightly younger than the other four and could represent the time that shellfish deposition ceased, that is the most recent evidence of anthropogenic activity at the site. At two standard deviations the date for this shell suggests that people were last using the shelter sometime around 8,200 years ago.

Sq/spit	C14 age	1 std deviation	2 std deviations
D6/24	8,441 ± 136 BP ANU-8750	8305 — 8577	8169 — 8713
D6/20	8,811 ± 214 BP ANU-8747	8597 — 9025	8383 — 9239
D9/4	8,700 ± 125 BP ANU-8130	8575 — 8825	8450 — 8950
C6/17	8,794 ± 152 BP ANU-8746	8642 — 8946	8490 — 9098
D6/5	8,676 ± 93 BP ANU-8748	8583 — 8769	8490 — 8862
D6/9	8,754 ± 97 BP ANU-8749	8657 — 8851	8560 — 8948

Table 3.3: Beeton Rockshelter corrected shell dates to two standard deviations.

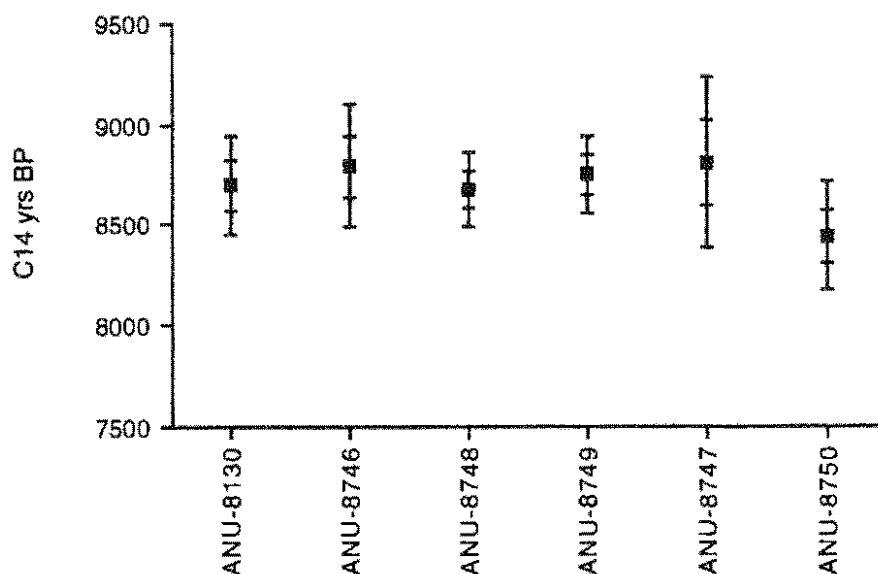


Figure 3.3: Graph of Beeton Rockshelter corrected shell dates to two standard deviations.

Whether the shellfish dates reflect a short period of midden deposition of about 150 years around 8,600 BP as suggested by the two standard deviation overlap, or a longer term period spread over 1,000 years or so it is clear that the midden phase is the most recent and last phase of human occupation at the site. The interpretation of the shell dates and vertical distribution of these in the Beeton Rockshelter deposit is discussed further below in regard to the depositional history of the site.

Charcoal dates

All three charcoal samples dated were from the sand layer (unit IV) underlying the midden layer in the D9 square (Figure 3.2a). The uppermost sample (ANU-8751) came from a hearth 77 centimetres below the surface of the deposit in spit 14, towards the top of unit IV. This charcoal sample was taken from a concentration of charcoal lumps which was surrounded by ash and burnt orange consolidated earth, indicating it had been a hearth. The date obtained from charcoal lumps collected from this hearth area was $18,180 \pm 940$ BP (ANU-8751) (Table 3.2).

About 27 centimetres below the upper hearth dated, a charcoal sample was dated from a small area of concentrated charcoal fragments in spit 17. The charcoal from

spit 17 in D9 dated to $19,300 \pm 730$ BP (ANU-8752). The third and lowest charcoal sample dated was from a hearth in spit 20, located 23 centimetres above the basal limestone rubble. The charcoal in this lowest sample had decomposed and comprised fine specks which were extremely fragile and totally disintegrated when disturbed. As a result the sample collected comprised fine flecks and weighed in total less than 0.2 grams. This sample dated to $16,250 \pm 2,620$ BP (ANU-8753). Because of the nature and size of this sample, the results may not be very reliable and the sample problems resulted in a large standard deviation (John Head pers. comm.). Nonetheless it is clear this *in situ* hearth must pre-date those overlying it, so in combination with the other dates a closer approximation of its age is possible than would be suggested by the large standard deviation. The age of the lower hearth therefore must be within the older range of the date span, most probably about 21,000 BP (Table 3.4; Figure 3.4)

The charcoal in this lower hearth had disintegrated and the hearth was mainly manifest as a distinct charcoal-flecked stain. This was concentrated in a patch of consolidated burnt orange earth, similar to that in spit 14. The samples from spits 14 and 20 are interpreted as hearth samples, and while the charcoal dated from spit 17 may also be from a hearth area, in the absence of burnt earth or ash it is not designated such.

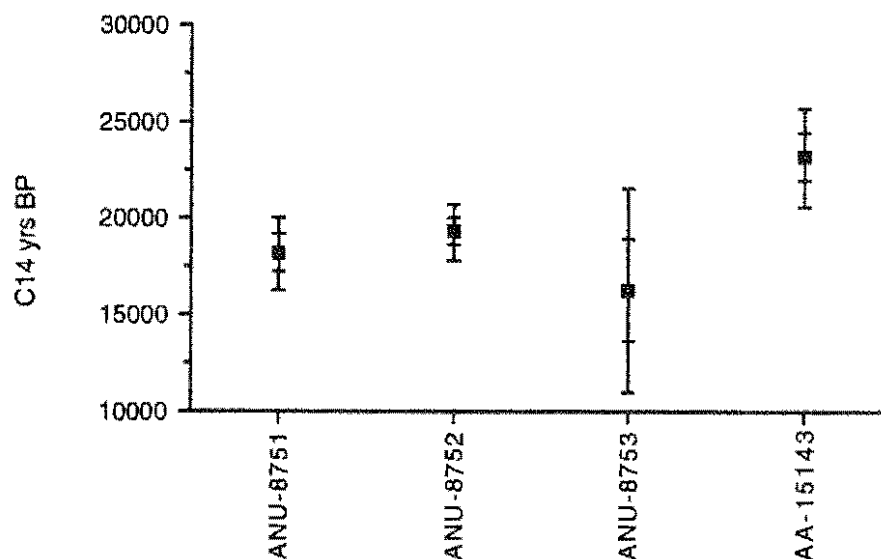


Figure 3.4: Graph of Beeton Rockshelter charcoal (ANU) and emu eggshell (AA) dates to two standard deviations.

spit	C14 age	1 std deviation	2 std deviations
14	18,180 ± 940 BP ANU-8751	17,240 — 19,120	16,300 — 20,060
17	19,300 ± 730 BP ANU-8752	18,570 — 20,030	17,840 — 20,760
20	16,250 ± 2620 BP ANU-8753	13,630 — 18,870	11,010 — 21,490

Table 3.4: Beeton Rockshelter charcoal dates at two standard deviations.

Muttonbird bone dates

Although sufficient quantities of bird bone were recovered to use conventional radiocarbon methods, it would have been necessary to combine a number of separate bones to obtain the sample size required for conventional dating purposes. It was not initially clear if the muttonbird bones were undisturbed cultural remains or if these had been included in the deposit as the result of the shelter being used as a bird rookery in prehistoric times. If the site had been a bird rookery then undoubtedly the deposit would have been disturbed by burrowing activities, and combining bones for dating purposes could result in the mixing of bones of different ages in combined dating samples, with problematic results.

AMS dating was employed as this enabled dates to be obtained from single bird bones rather than combined samples. It was also anticipated that the results of the AMS dating would provide some indication as to whether the midden layer had been subjected to post-depositional disturbance.

Initially three AMS dates were obtained, all from bones of the common extant muttonbird species of the region, the Short-tailed Shearwater (*Puffinus tenuirostris*). The three samples dated, OZA-782, OZA-783 and OZA-784, came from different squares and various depths within the unit III midden layer. The AMS results showed all these bones to be of similar age, between about 5,400 and 5,500 years old, despite the variation in location and depth of each sample (Table 3.5).

Square/spit species	C14 age BP	1 std deviation	2 std deviations
D9/6 <i>P. carneipes</i>	4540 ± 90 OZB 591	4450 — 4630	4360 — 4720
D6/18 <i>P. carneipes</i>	4910 ± 60 OZB 590	4850 — 4970	4790 — 5030
D9/7 <i>P. griseus</i>	4950 ± 90 OZB 593	4860 — 5040	4770 — 5130
D9/7 <i>P. pacificus</i>	5080 ± 80 OZB 594	5000 — 5160	4920 — 5240
C6/17 <i>P. tenuirostris</i>	5400 ± 110 OZA 783	5290 — 5510	5180 — 5620
D9/11 <i>P. tenuirostris</i>	5440 ± 110 OZA 782	5430 — 5450	5420 — 5460
D6/17 <i>P. griseus</i>	5370 ± 80 OZB 589	5290 — 5450	5210 — 5530
D6/24 <i>P. tenuirostris</i>	5530 ± 110 OZA 784	5420 — 5640	5310 — 5750
C6/15 <i>P. pacificus</i>	8900 ± 70 OZB 592	8830 — 8970	8760 — 9040

Table 3.5: Beeton Rockshelter muttonbird bone dates.

During the preliminary analysis, four other species of muttonbirds were also identified in the excavated remains including several known to have warmer climatic requirements than *Puffinus tenuirostris*, the species extant in the region today. Hence, a further six muttonbird bone samples were submitted for AMS dating to investigate both the palaeoenvironmental significance of the presence of multiple muttonbird species, and the question of prehistoric human exploitation of muttonbirds (Anderson *et al.* 1996). Five of these six additional samples dated to between about 4,500 and 5,500 years ago, whereas the remaining sample was considerably older, dating to about 8,900 BP. This older bone coincides with the period of human occupation at the site indicated by the shell dates (Table 3.2).

Emu eggshell date

An AMS date of $23,180 \pm 1,280$ BP (AA-15143) was obtained from a piece of emu eggshell recovered from spit 10 in the D9 square. This date was obtained by Gifford Miller (University of Colorado) as part of his on-going investigations into amino-acid

racemisation in ratite eggshell and the use of this data for palaeoclimatic reconstruction (Brooks *et al.* 1990; Miller *et al.* 1997) [Appendix II].

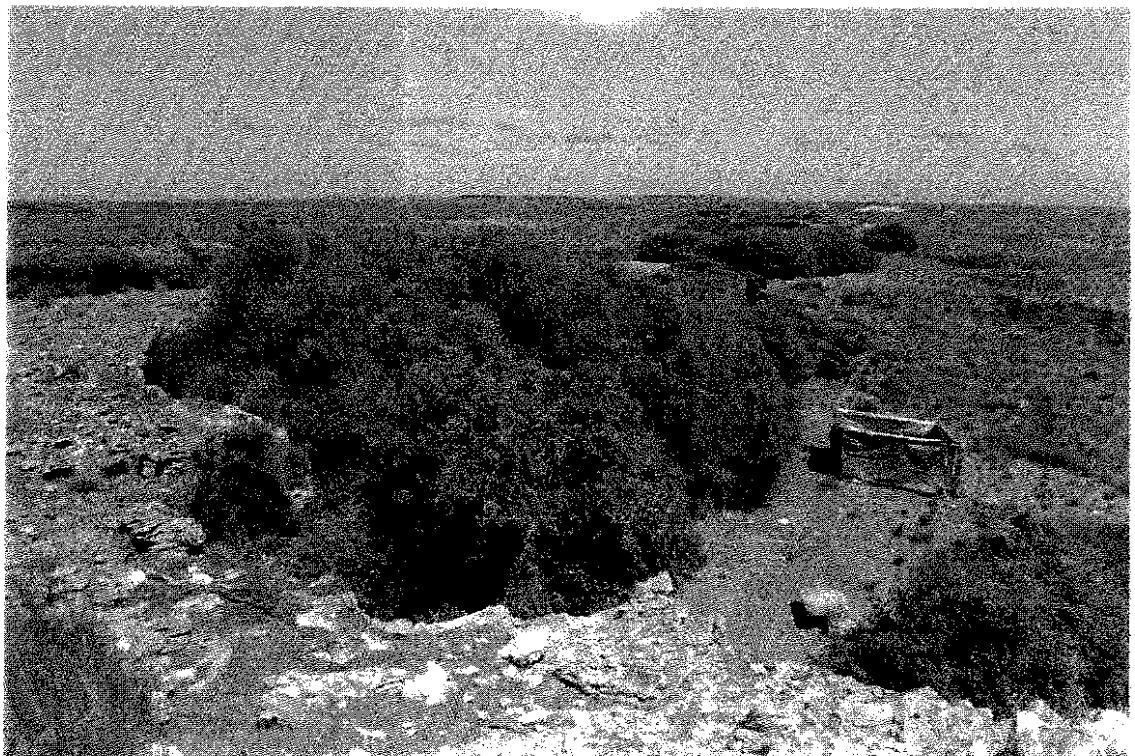
Age estimations can be made by comparing changes in amino acids, as measured by the D/L ratio, which occur at a predictable rate. Radiocarbon dating methods are used as a benchmark for samples of specific species from a particular region. The D/L ratio is a measure of the 'racemisation of the L-amino acid isomers to a mixture of D and L isomers' (Brooks *et al.* 1990:60), and the ratio increases with age. This ratio can be affected by chemical changes occurring in the eggshell as a result of exposure to raised temperatures such as those in hearths, which can cause eggshell to give D/L ratios typical of much older eggshell (Gifford Miller and John Magee pers. comm.) Therefore until tests are developed that can demonstrate unequivocally that emu eggshell is not heat affected, radiocarbon techniques are the only reliable dating methods at present for eggshell in sites where there is evidence of hearths.

Miller calculated D/L ratios for eight samples (including the AMS dated sample) from the Beeton Rockshelter site. These samples were all from spits 6, 7, 9 and 10 in the unit III 'midden' layer of the D9 square. According to Miller's calculations there is also emu possibly 5,000 years or more older than the AMS dated sample in the same spit, and some several thousand years younger in the underlying spit [Appendix II]. The older dates obtained using the D/L ratios are problematic given the presence of hearths in the deposit at the site and the possibility that the eggshell may be heat affected. Nonetheless the lack of depth/age correlations in the emu eggshell analysed by Miller did support other evidence suggesting disturbance of some kind had reworked the layer containing the shellfish remains. There was also a major discrepancy between the age of the emu eggshell and shellfish remains from the same stratigraphic context.

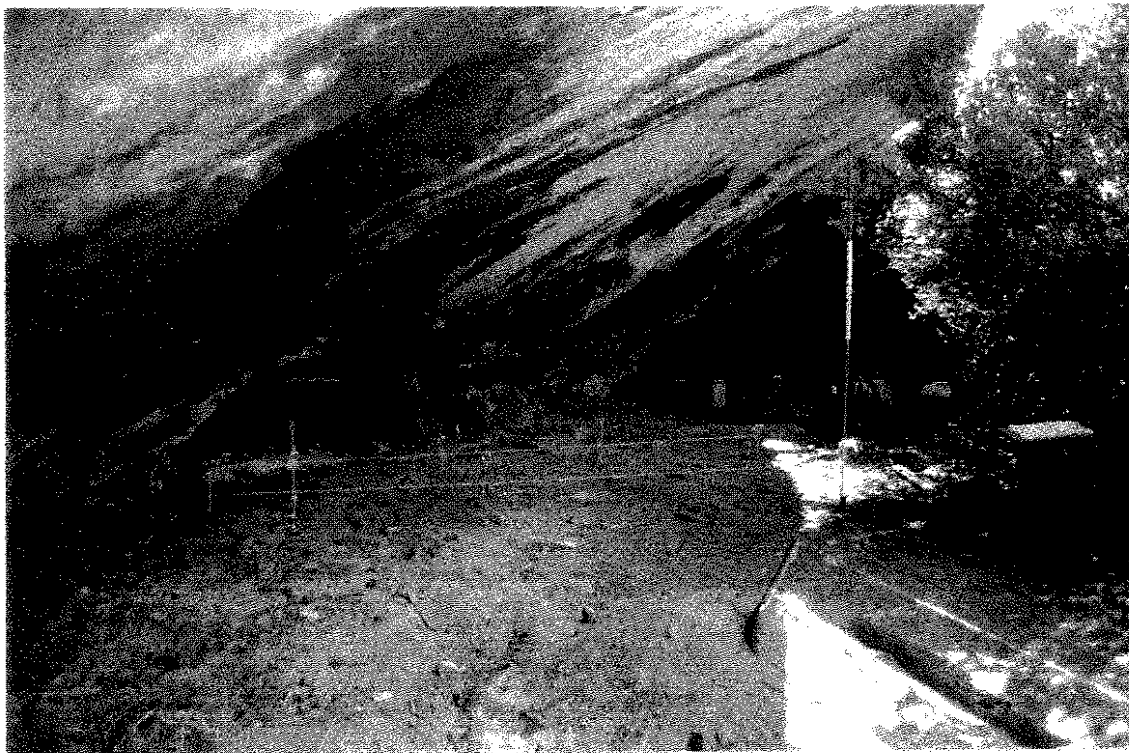
It should also be noted that although slightly older, at two standard deviations, the emu eggshell date from D9 spit 6 is relatively close to that of the C14 dated hearth about 30 centimetres below in spit 14 near the top of the underlying stratigraphic unit IV (Table 3.3; Figure 3.2a). The taphonomic implications of the emu eggshell, marine shell and charcoal dates are discussed further when the depositional history of the site is outlined later in this chapter.



Photograph 1: Northeast view from the top of the limestone outcrop above Beeton Rockshelter — the Strzelecki Ranges on Flinders Island are in the background and Chappell Island in between Badger and Flinders Islands.



Photograph 2: View to the east with Beeton Rockshelter below and the U7 pit windbreak in the foreground.



Photograph 3: Beeton Rockshelter with string lines marking out adjoining squares C6/D6 and D9 partially backfilled in the foreground.



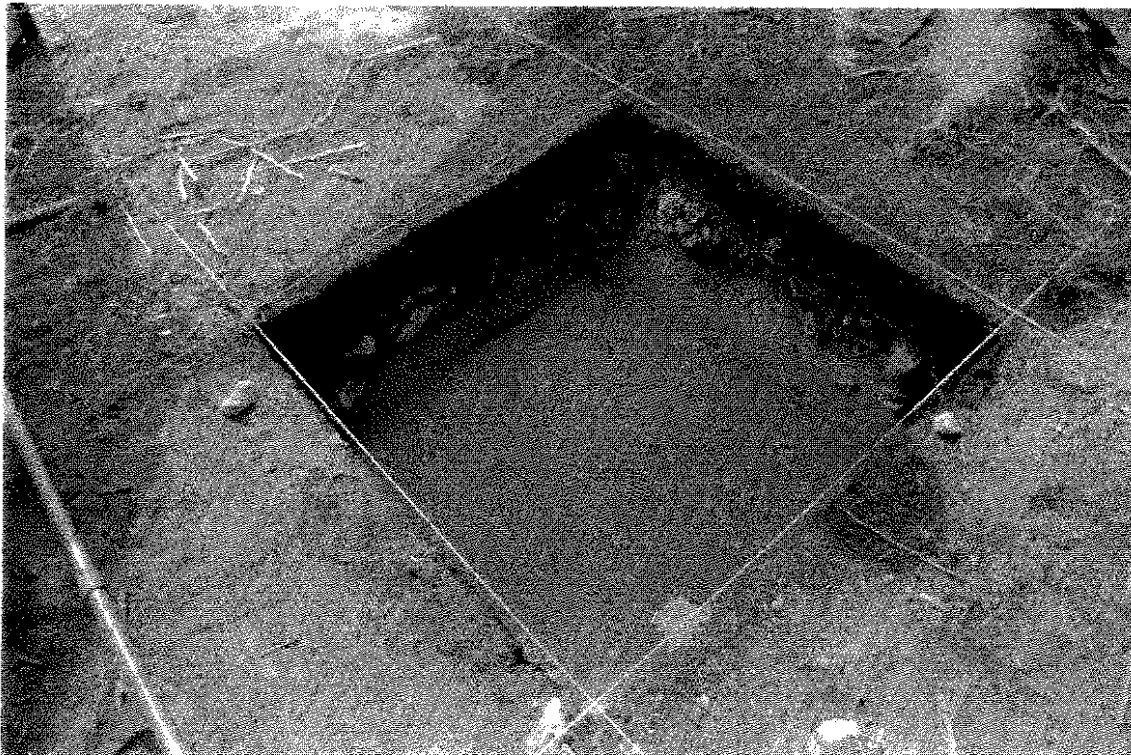
Photograph 4: Beeton Rockshelter square D9 viewed toward the east section.



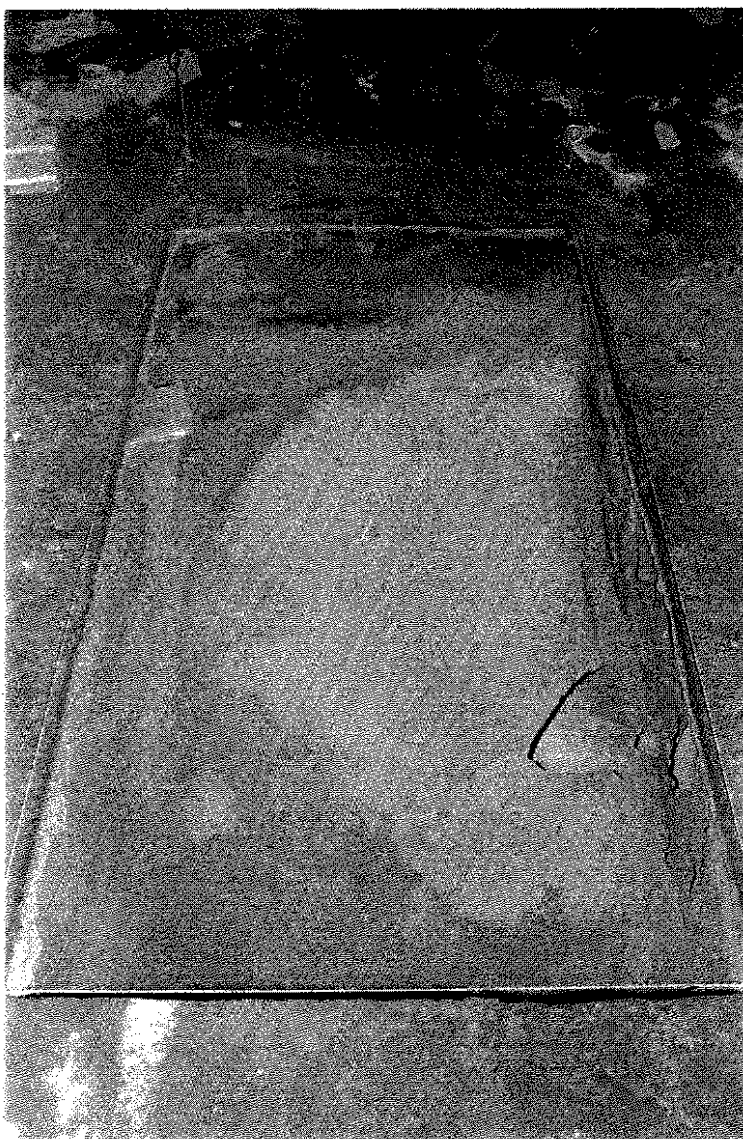
Photograph 5: Beeton Rockshelter square D9 viewed toward the west section with muttonbird burrow features.



Photograph 6: Beeton Rockshelter square I6 viewed toward the north section.



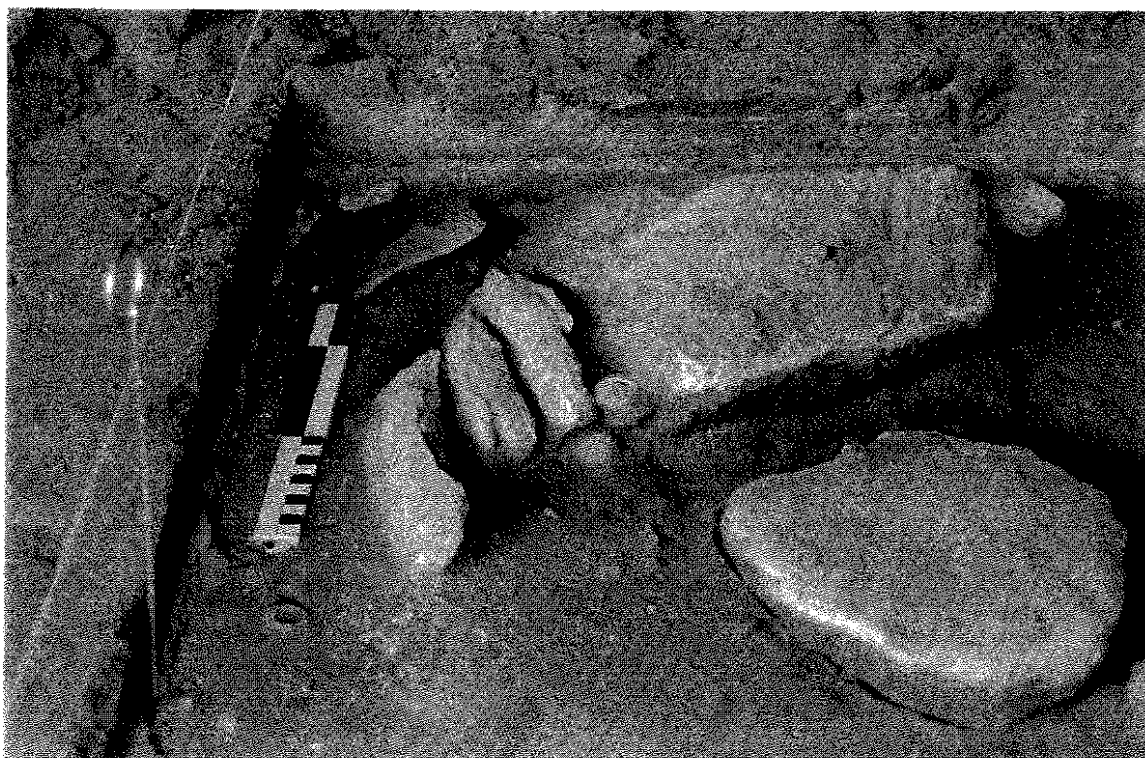
Photograph 7: Beeton Rockshelter square U7 viewed toward the northeast corner.



Photograph 8: Beeton Rockshelter D6/C6 viewed toward the C6 east section near the rear wall of the shelter.



Photograph 9: Beeton Rockshelter square C6 west, prior to removal with excavation of adjoining D6.



Photograph 10: Beeton Rockshelter square C6 northeast corner toward the back of the shelter — base of spit 6 showing *in situ* limpets.

3.3.3 Sediment textural analysis

Sediments from units III and IV from squares within and outside the shelter were analysed by a procedure detailed in Appendix III. The aim of the sediment analysis was to provide a comprehensive description of the sediments to assist with the interpretation of the stratigraphy. Sediment analysis can also assist in determining the source of sediments in cave and shelter environments (Collcutt 1979). The sediments in Beeton Rockshelter could have derived from weathering of the immediate shelter formation, or have been blown in during periods of greater dune mobility in the past. However, since the shelter was formed in limestone which consisted of consolidated aeolian calcareous sands, sediments resulting from *in situ* weathering would be indistinguishable from those blown in (John Magee pers. comm.). Nevertheless, the textural analysis provided other information, which in combination with the chronological data was useful in reconstructing the depositional history of the site.

Samples from the D9, C6 and U7 squares were analysed. These provided a comparative sample of sediments from both within (D9/C6) and (U7) outside the shelter. The samples for the deposit within the shelter came from the D9 square, except for the basal deposit, which was taken from the C6 square because decaying roof-fall rock was at the base of D9, rather than sediments as in the base of the other squares. The D9 square was selected for sediment analysis as the overall depth of deposit there was deeper, and thus it was more probable that variation in the sediment texture over time would be detected within this square.

Sediments analysed came from upper and lower spits within unit III (the shell-bearing rookery layer), and from the underlying unit IV deposit. Figure 3.5 shows the relative percentages of sand, silt and clays in the Beeton Rockshelter and other comparative samples analysed. The latter comprised sediments from a non-cultural, aeolian dune deposit on nearby Prime Seal Island. Sediments were sampled from 15 centimetres and 2.4 metres below the A horizon in an eroding section of the dune which abuts Target Hill on the eastern coast of the island. The samples were taken from at the top of the eroded dune section. These provided a comparative sample of relict aeolian dune sediments in the region (Figure 3.5).

The results of sediment analyses supported the field observations that the shelter and surrounding deposits were predominantly medium to coarse calcareous sand, consistent with those in Holocene and late Pleistocene aeolian dune and aeolianite limestone formations on the Furneaux and other Bass Strait islands (Bowden 1983;

Kershaw and Sutherland 1972). More informative was the variation in the minor component of silt and clays. There was a marked decline in these with depth in both the deposit inside the Beeton Rockshelter and the non-cultural dune deposit on Prime Seal Island. The marked increase in silt in the upper levels of these deposits is attributable to an extended period of stability, that is a period during which no sand was being deposited but the surface deposits were being enriched by aeolian silts. The results from the U7 square, located in front of the shelter in a flatter and slightly lower area of the terrain, reflect the lesser deposit of aeolian sands and the post-depositional formation of a soil profile.

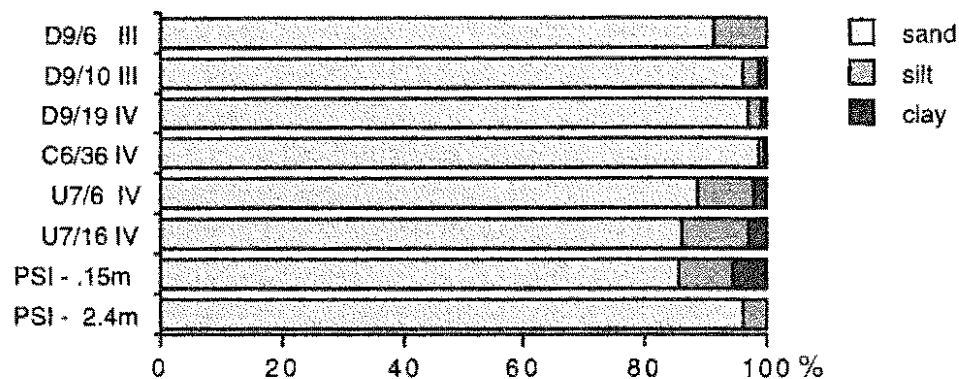


Figure 3.5: Sediment analysis - proportions of sand, silt and clay in samples from Beeton Rockshelter samples (square/spit ,unit) and the Prime Seal Island dune (PSI - depth).

The increase in clay in the lower spit analysed from U7, unit III, is typical of the clay enrichment associated with the formation of the B horizon in soil profiles. The consistency in the silt component over the depth of the U7 square reflects a lesser, but possibly longer term and more consistent, rate of sedimentation than within the actual shelter. The relatively low silt component in the subsurface deposits in the D9/C6 square within the shelter reflects a sedimentation rate higher than that in the U7 square (located in the open flat area in front of the shelter). This is further supported by the increased depth of deposit within the shelter, and the radiocarbon dates obtained from material in deposits in the shelter.

There was no marked difference between sediments analysed from unit III (the shell bearing layer), and those from the underlying unit IV layer. Nor was there any variation evident within units in the sediment analysis. The lack of variation

suggested that the deposit sediments were all derived from the same source, and therefore most probably a product of one or closely related depositional events or periods.

In summary, the sediment textural analysis indicated the shelter sediments were consistent with aeolian deposits in the region. Some of the shelter sediments may have come from the weathering of the parent rock although it is most probable that they resulted from the trapping of aeolian sediments. It was unclear from the sediment analysis alone whether the majority of the sediments in the shelter were attributable to one depositional phase or event, or whether they had steadily accumulated since the peak of the last glacial period.

The sediment analysis strongly suggests the deposit is associated with a period, or periods, of increased wind regime and greater dune sediment mobility in the region. The aeolian origin of the shelter sediments is supported by the relatively low rate of deposition in the mid to recent Holocene. With the post-glacial sea level rise continental shelf sediment sources in the region were inundated and changes in climatic regimes more conducive to dune stabilisation. As a result, deposition of sand sediments in the Beeton Rockshelter has been minimal since the mid-Holocene and only a minor component of silt and humic matter appears to have been deposited since that time.

3.3.4 Sediment chemical analysis

During the excavation the 'cultural' status of numerous muttonbird bones recovered was somewhat ambiguous. The muttonbird bones were found in unit III deposits in all squares at the site, including the U7 square in front of the shelter. Although these bones were clearly in stratigraphic association with the shellfish and other cultural remains, the unburnt and generally pristine condition of the bird bone did not suggest human exploitation was responsible for its inclusion in the deposit. However there was no record of muttonbirds nesting on Badger Island, in either historic or prehistoric times, and the origin of the bones in the midden deposit was unclear.

Both AMS dating and chemical analysis of the midden layer sediments were used to assist in the resolution of the problem of the origin of the muttonbird bones. As it was not known initially whether it would be possible to obtain funding for AMS dates, chemical analysis of sediments was undertaken to see if it was possible to detect increased nitrogen levels, as nitrogen is one of the principal components of bird

excreta and is known to survive in some extinct rookery deposits (Mizutani *et al.* 1991).

Sediments from unit III (BSD6-7 and BSD9-5) and unit IV (BSD9-19 and BSD6-35) were analysed, along with control samples. These control samples comprised sediments from an extant muttonbird rookery on King Island (CP1 and CP2) and from a prehistoric limestone cave site on nearby Prime Seal Island (MCF1-12 and MCF1-23). This site, Mannalargenna Cave, had a similar chronological span of human occupation to Beeton Rockshelter although no shellfish or muttonbird bones were recovered from it (Brown 1993; Sim 1994). (Cultural remains from this site are discussed in Chapter Five).

The relative quantities of nitrogen, phosphorus and potassium, were assayed in these samples. The coarse grain size in the Beeton Rockshelter sediments posed some problems in the chemical analysis, and for this reason, the absence of a particular chemical element could not be regarded as conclusive evidence that it was not present. Positive detection nonetheless is an unequivocal indicator of the presence of an element.

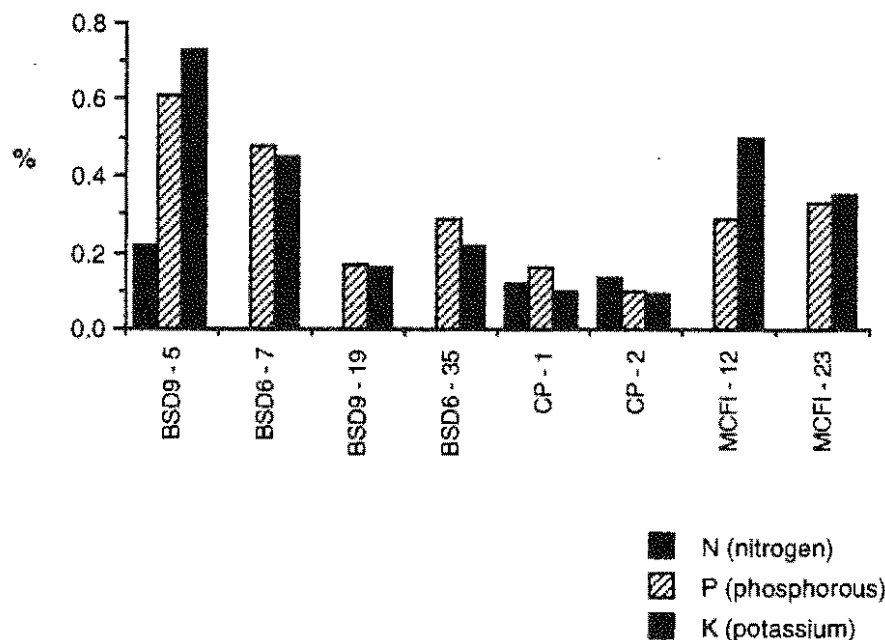


Figure 3.6: Nitrogen, potassium and phosphorous levels in Beeton Rockshelter (BS), the King Island rookery (CP) and Mannalargenna Cave (MC) sediment samples.

With the exception of nitrogen, all chemical levels were consistent with natural levels for sample soil types and environments. There were relatively high amounts of nitrogen in the two extant rookery samples and one sample from the D9 square in the Beeton Rockshelter site (Figure 3.6). No other sediments sampled contained nitrogen.

The presence of nitrogen in the control rookery sample and one sample from the Beeton Rockshelter site supported the interpretation of the rockshelter as an extinct muttonbird rookery. However, the results of the chemical analysis *per se* had to be treated with some caution: the shelter had been used by introduced stock in historic times and it was possible that this had contributed to the nitrogen content of the deposit. Subsequent AMS dating of the muttonbird bones however did support the chemical analysis findings that the site was an extinct bird rookery.

3.3.5 Depositional history

This section outlines the depositional history and taphonomy of the Beeton Rockshelter, as indicated by the stratigraphy, analyses of sediments and dating of remains recovered from the deposit. Since this shelter is a key site to the overall problem of island abandonments in the Bass Strait region, its depositional history is critical to understanding the significance of the remains.

Deposition and erosion of sediments in the shelter have undoubtedly occurred at various periods since its formation, although the ages of charcoal and faunal remains indicate that the present deposit is relatively recent, having all been deposited sometime in the last 25,000 or so years. The present day stratigraphy has resulted from a combination of depositional and taphonomic events at the site, which are best described in four phases, as described below and illustrated Figure 3.8:

pre-Phase 1: last interglacial to >25,000 BP

Sediments present in the shelter scoured out to bedrock by wind activity.

Phase 1: ca. 25,000 to ca. >9,000 BP

This phase is represented by the aeolian deposition of about 1.5 metres of medium to coarse calcareous sand in the bare rockshelter, and accounts for the bulk of the sediment now present there. There is evidence of human use of the shelter throughout this depositional phase as a small component of cultural remains was recovered

throughout these deposits. The stratigraphy shows no evidence of fine-scale layering such as would be expected from a series of interspersed periods of sedimentation and stability, or even erosion. Similarly, stratigraphic delineation of human occupation phases is also absent. The homogeneous nature of the sediments from the vast bulk of the deposit indicates that these are almost certainly from the one source — a source which has since been inundated by rising seas.

Aeolian deposits in the Beeton Rockshelter almost certainly originate from dune and sediment mobility associated with the peak of the last glacial. Palaeoenvironmental and climatic evidence indicates that the Tasmanian and southeast Australian region experienced decreasing temperatures and precipitation from at least 32,000 BP to about 25,000 BP (Colhoun 1977, 1983:10; Colhoun and van der Geer 1987:69). Concomitant vegetation changes in the northeast Tasmania and Bassian region reflect the increasing aridity as open forest and heath taxa give way to semi-arid steppe grasslands toward the glacial maximum (Colhoun *et al.* 1982; Hope 1978:508, 1989:92).

Regional dune mobility undoubtedly resulted from a combination of factors; increasing sediments in the system as declining sea levels exposed marine sediment beds, increasing wind regimes, increasing aridity and the resultant decline in more resilient vegetation regimes (Ash and Wasson 1983:22; Wasson 1986:60-61). Relict terrestrial dunes across southeastern Australia indicate that Pleistocene dune building in the last glacial phase occurred as far south and east as Kangaroo Island, the Bass Strait region and northern Tasmania (Bowden 1983:172; Bowler 1982; Lampert 1981:19; Ross *et al.* 1992:77).

Climatic amelioration and decreasing wind conditions, in combination with the drowning of dune sediment sources, led to the stabilisation of the shelter deposit at a level only slightly less than the present surface. This would probably have been sometime before people began depositing shellfish remains in the shelter about 8,600 years ago. Whether the shelter had filled relatively rapidly with sediments and stabilised at that level around 15,000 or more years ago, or whether sediments accumulated more slowly until about 9,000 years ago or so is unclear.

At two standard deviations, the charcoal radiocarbon dates indicate that these samples could be of similar antiquity, suggesting there was a major depositional event or rapid sedimentation at the site sometime between about 18,000 and 22,000 years ago (Figure 3.7). That the emu eggshell appears to be older than the hearths can be attributed to the differential stability of carbon in the materials being dated (i.e. eggshell carbon is more stable than charcoal and thus produces older and more accurate dates than charcoal of similar antiquity: John Head, John Magee pers. comm.). The antiquity of the emu eggshell AMS date is not therefore anomalous, but further supports the case for a very rapid, depositional phase associated with the glacial maximum (Figure 3.4). The rate of sedimentation represented by the period between the uppermost dated hearth, that is about 18,000 years ago and the midden shell deposition about 8,600 years ago cannot be determined with any certainty because of the post-depositional disturbance of the upper levels by muttonbird burrowing. Late Pleistocene dune building episodes elsewhere in Tasmania suggest that major aeolian activity had declined by about 15,000 BP, in keeping with other evidence from the broader southern Australian region (Bowden 1983:172; Colhoun 1978; Kershaw and Sutherland 1972; Sigleo and Colhoun 1975; Wasson 1986).

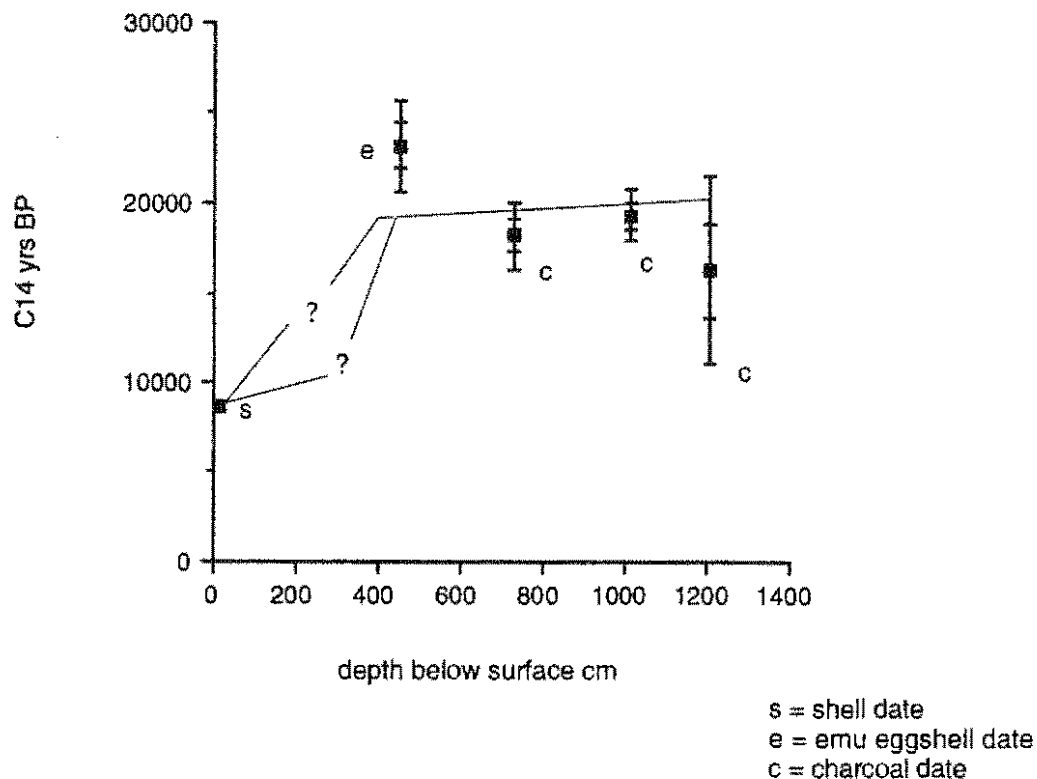


Figure 3.7: Beeton Rockshelter sedimentation curve.

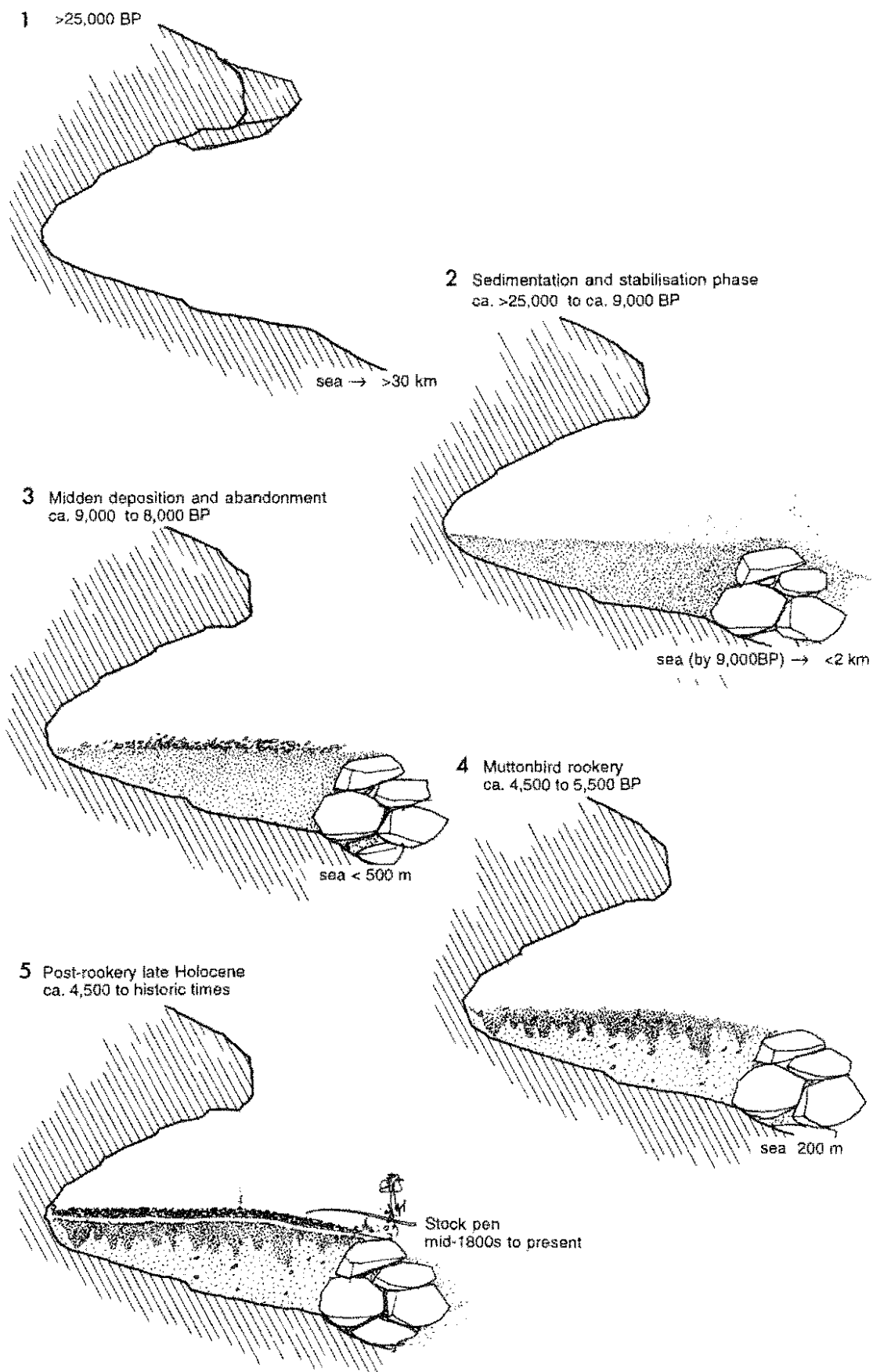


Figure 3.8: Schematic depositional history of Beeton Rockshelter.

From the chronological and stratigraphic evidence it is evident that the bulk of the deposit accumulated during the glacial maximum and sedimentation had virtually ceased by about 9,000 years ago. Whether the deposits represent virtually a single depositional event at the height of the last glacial, or an initially rapid deposit followed by a steady accumulation from about 18,000 to 9,000 is uncertain. Nonetheless, it is clear that sedimentation had virtually ceased by the time sea levels rose sufficiently to bring marine shellfish resources within easy walking distance of the site around 8,000 to 9,000 years ago, and cut off the source of aeolian sediments being deposited in the shelter.

Phase 2: deposition of shellfish remains ca. 9,000 to 8,000 BP

Sometime after about 9,000 BP and almost certainly before 8,000 BP people using the rockshelter left a thin layer of limpet (*Cellana* sp.), warrener (*Subnirrella undulata*) and other shellfish remains on the surface of the deposit. Some *in situ* shell was found less than 5 centimetres below the base of the manure capping toward the back of the shelter, indicating that the deposit had by this time stabilised at a surface level similar to that represented by the base of the stock manure layer (Photograph 10).

Phase 3: bird rookery period 4,500 to 5,500 BP

The discrepancy between the age of the shellfish remains and the majority of the muttonbird bone, and the chemical analysis of the sediments indicated that the muttonbird bone originated from muttonbirds using the shelter as a rookery several thousand years after people had ceased using the site (Table 3.2). Eight of the nine bones dated to between 4,360 BP and 5,750 BP, that is some three to four thousand years younger than the midden shell. There was both a lack of chronological association between the dated shell and the intermixed muttonbird bone in the same stratigraphic unit, and a lack of correlation between ages of the muttonbird bones and shells and their depth within the unit. The absence of correlation between the ages of material and depths from which these were recovered indicated that the midden and bone material were not in their original depositional contexts and had been reworked.

The shell and bird bone dating evidence supports the interpretation of the site as an extinct rookery, with muttonbirds birds burrowing and nesting in the shelter between about 4,500 and 5,500 years ago (Tables 3.2 and 3.5). Bird burrowing over 1,000 years or so has churned the shellfish remains from the surface into the upper 45

centimetres or so of what was the underlying Pleistocene (and possibly also early Holocene) aeolian sand deposit. This is now evident as unit III which, rather than being a midden layer in the strict sense, is a secondary deposition of what was originally a surface scatter of midden shell with the upper levels of sand and earlier cultural material from unit IV. Thus unit III, the unit containing the shellfish remains, is actually a re-worked rookery layer rather than a midden deposit *per se*. Prior to the muttonbird burrowing, the depth of the unit IV deposit would have been equivalent roughly to existing units III and IV combined.

Because of the intense bioturbation resulting from the bird burrowing activity, it is no longer possible to determine the extent or depth of the original shell midden deposit with any precision.

Phase 4: 4,500 BP to historic times

The penultimate phase comprises a period of relative stability of the shelter deposit after its abandonment by the muttonbirds about 4,500 years ago through to historic times. After bird activity at the site ceased and prior to use of the shelter in historic times as a stock pen, a thin layer of lighter coloured, slightly coarser sand up to 3 cm deep was deposited across the floor of the shelter (Figure 3.2b). The sands from this phase are consistent with those produced from weathering of the limestone parent rock in the immediate shelter environs.

There is also some evidence of animal activity in the shelter in this period as a burrow was evident in the area of the D6 square toward the drip-line. This burrow appeared to be too deep for a muttonbird nest, and intruded downwards through the midden unit (unit III) into unit IV sediments (Figure 3.2b). Some muttonbird bone and cultural material including shell and possibly other material from the midden phase occupation had been transported downward in the burrowing process. During the excavation the boundaries of the burrow feature were indistinguishable in places. For this reason, no charcoal was dated from this square. Similarly, because of the indistinct changes between the burrow area and surrounding deposits, small quantities of shell, bone and other material were included in spits that otherwise contained Pleistocene remains from unit IV sediments. No other (non-avian) burrows were detected; although during the excavation at the site, mice (*Mus musculus*) were observed burrowing into the deposit along the rear wall of the shelter.

Since historic settlement of the area early last century, stock have been run on Badger Island, and Beeton Rockshelter has been used as a temporary stock pen during this period. As a consequence, there is a thick capping of compacted sheep and cow excreta more than 10 centimetres deep covering most of the floor deposit at the site. More recent stock activity has eroded this capping in places, churning shell, stone artefacts and other cultural materials to the surface. The depth of this stock disturbance however is minimal and the prehistoric midden or rookery level (unit III) appeared to be principally undisturbed by the stock.

The introduction of African Boxthorn (*Lycium ferocissimum*) plants to the island last century has also to some extent disturbed the deposit in the shelter in recent times. Roots from the boxthorn thicket that enclosed most of the shelter activity were evident in the excavated deposit. Because of the direction and position of the boxthorn roots, it is considered highly unlikely that root activity has caused any significant changes to cultural remains or sediments in the deposit. Root intrusions can however cause chemical changes in the deposit and for this reason no charcoal samples collected from areas where roots were evident were dated.

All remains recovered from the deposit during the excavation have been documented and a sample analysed in detail. The analysis of the remains is described in Chapter Four, and the implications of these results are discussed along with those from Mannalargenna Cave in Chapter Six.

CHAPTER FOUR

BEETON SHELTER, ANALYSIS OF EXCAVATED REMAINS

4.1 Analysis of excavated remains

Five square metres were excavated at the Beeton Rockshelter site; three of them, D6 and the adjoining C6 and D9, were located within the shelter itself, one square I6 just beyond the drip-line and a fifth square, U7 was about 16 metres seaward of the shelter (Figure 3.1). In total 4.8 cubic metres of deposit weighing 6.64 tonnes was removed. This included roof-fall and other rocks < 30 centimetres, sediment and cultural and other remains but not the relatively light, compacted dry manure capping the deposit as this was not weighed during excavation. The average weight/volume ratio of the entire deposit removed (including cultural remains) is 1.38. By comparison, the weight/volume ratio for sieved sediment from unit IV is 1.47. As the unit IV sediment sample contained no organics, this sample represents the upper range of the expected weight/volume ratio for the deposit in this shelter.

Materials recovered from each of the squares included marine shell, bird and mammal bone, small reptile remains, muttonbird and emu eggshell, worked stone and fossil shell artefacts, charcoal and land snails (Photographs 11 and 12). There was notable consistency not only in the stratigraphy, but also in the suite of cultural and other faunal remains found in all the squares excavated. The stratigraphic distribution of some faunal remains was consistent in all squares, most notably the restriction of marine shell and muttonbird bone to the unit III layer. As demonstrated in the preceding chronology and the depositional history of the site, the 'midden' layer which was present across the site, is a product of post-depositional mixing of early Holocene midden remains with underlying late Pleistocene deposits by muttonbirds burrowing in the shelter in the mid-Holocene.

Nonetheless, despite the intra-site stratigraphic and distributional consistencies, the density of cultural remains recovered varied across the site. There was markedly less found in the two squares excavated outside the drip-line, and within the shelter itself, fewer remains were recovered from the C6 square. This was located close to the back wall and was excavated principally to establish the line of the bedrock in the shelter rather than to recover cultural remains. During the excavations it was noted that the D6 and D9 squares, which contained the highest density of cultural remains, were located in the area of the rockshelter most suited to habitation.

Because of the relative sparseness of remains in the I6 and U7 squares located outside the shelter, the analyses of the faunal and artefactual remains focused primarily on finds from the squares located within the shelter. As further demonstrated in the analyses of faunal remains, the midden or rookery deposit was generally homogeneous and no stratigraphy or features apart from bird burrows were discernible within it (Figures 3.2a and 3.2b). Clearly it would have been inappropriate to attempt to address questions of variation over time in material recovered from a single horizon which was a product of post-depositional disturbance.

Hence spits within unit III, the rookery layer, have been conflated into a single unit for analytical purposes, unless stated otherwise. In the underlying unit IV layer however, measured spits were retained in some instances because, in the absence of stratigraphic layering, these provided the only means for examining variation over time in the lower undisturbed remnant of the Pleistocene deposit.

4.2 Invertebrate fauna - marine molluscs

Marine mollusc shell comprised the bulk of invertebrate faunal remains found in the Beeton Rockshelter site deposits although a small quantity of land snail was also recovered. The marine shellfish species present in the Beeton Rockshelter deposit were predominantly species commonly exploited as food resources elsewhere in Tasmania. Species common in deposits of storm-wash shell which fringe the numerous small bays around the islands were not present in the deposit (Bowdler 1979; Dunnett 1993; Stockton 1982; Vanderwal and Horton 1984) (Table 4.1). This, along with the antiquity of the shell and the altitude and location of the shelter, preclude any natural (i.e. non-anthropogenic) explanation for the shellfish remains at this site.

The shell midden at the Beeton Rockshelter site on one of the outer islands was of interest principally because of the chronological implications of evidence of marine resource exploitation on a remote island. As with the Flinders Island middens, such evidence indicates human activity sometime around or after the sea level stabilised about 6,500 years ago, and thus indicates human occupation in the island phase. Because of the small size and remoteness of Badger Island the presence of a midden site there suggested visitation by watercraft from Flinders Island, and hence was pertinent to the broader problem of the fate of the prehistoric island population

evidenced in the Holocene archaeological record from Flinders Island (Figure 1.2). The principal aim of the shellfish analysis from Beeton Rockshelter was therefore to date the period of human occupation indicated by the shellfish remains, and to examine the implications of the occupation span to the archaeological record from the broader Furneaux region.

A secondary focus of the shellfish analysis was the investigation of the range of shellfish species present in the midden at Beeton Rockshelter. This was of interest as elsewhere in Tasmania there is no evidence of intensive exploitation of subtidal species such as abalone (*Haliotis* sp.) before about 4,000 years ago. Sub-tidal resource exploitation is seen as part of a broader maritime focus to the economy that appears to have occurred in Tasmania sometime since the mid-Holocene, and which involves the use of watercraft. The types of shellfish present in the midden on Badger Island therefore may be relevant to the overall issue of human occupation on the islands, and the possible use of watercraft in the Furneaux region in the early to mid-Holocene. For the reasons already outlined, the midden material was analysed as a single unit within each square.

4.2.1 Method

Sorting

Unsorted shell from each excavated spit was bagged separately as 3 millimetre and 7 millimetre sieve finds in the field. In the laboratory the contents of each bag were subsequently washed in 1 millimetre plastic sieves and dried for 24 hours in a forced air drying cabinet. The drying cabinet temperature varied from 34°C to 42°C according to shelf height, and samples were routinely rotated to ensure equitable heat exposure. After drying, 3 millimetre and 7 millimetre sieve shell from each spit was sorted separately and identified to lowest taxonomic level possible and weighed.

Identifications and analytical nomenclature

Identifications followed Macpherson and Gabriel (1962) and Phillips (1984). Filemaker Pro 2.0, a data base management programme, was used to record the complete list of all shell recovered, the shell provenance, identification, weight and diagnostic parts used to quantify numbers of individual shells. All shell recovered from the D9, D6 and C6 squares was sorted, identified and analysed. The full Filemaker data base is presented in Appendix IV.



Photograph 11: Sorting 7 mm sieve shellfish remains from Beeton Rockshelter square D9 spit 6.



Photograph 12: Sorting 7 mm sieve bone remains from Beeton Rockshelter square D9 spit 15.

For identification purposes, shells were divided into two main categories: 'food types' and 'other shellfish remains', defined by the Tasmanian Aboriginal vernacular and shellfish exploitation patterns. Each of these categories was then further sorted, following standard taxonomic nomenclature, to species level if possible (Tables 4.1a and 4.1b).

The 'food type' category employed in the analysis follows the nomenclature used by Tasmanian Aboriginal people gathering shellfish in historic and present day times (Darrell West, Phyllis Pitchford and Ronnie Summers pers. comm.). A recognised food type can comprise one or more species; for example 'warrener' is used by Tasmanian Aborigines specifically and solely for the one species, *Subnirrella undulata*, whereas 'periwinkle' is used to refer to three similar but separate species of small gastropods. Although there is also a range of various common names for the individual 'periwinkle' species (i.e. 'speckledy hens' and 'black witches') these are more commonly referred to by the generic term 'periwinkle'.

FOOD TYPE (*Aboriginal name)	FAMILY	SPECIES
*Periwinkle	Trochidae, Neritidae	<i>Austrocochlea constricta</i> , <i>A. concamerata</i> <i>Nerita atramentosa</i>
*Limpet	Patellidae	<i>Cellana solida</i> , <i>Patellanax peroni</i>
*Mussel	Mytilidae	<i>Hormomya erosa</i> , <i>Mytilus planulatus</i>
*Warrener	Turbinidae	<i>Subnirrella undulata</i>
*Whelk	Cymatiidae, Muricidae, Fascioliariidae	<i>Cabestana spengleri</i> , <i>Dicathais textilosa</i> , <i>Pleuroploca australasia</i>
*Abalone or muttonfish	Haliotidae	<i>Haliotis ruber</i> , <i>H. laevigata</i>
Chiton	Chitonidae	unidentified
Shellfish fragments	unidentified**	unidentified

** identifiable to 'food type' families but not sorted.

Table 4.1a: Shellfish exploited as food resources: Tasmanian Aboriginal and scientific names.

	FAMILY	SPECIES
Other: miscellaneous small gastropods not exploited for food plus cuttlefish & sea -urchin frags.	Cerithiidae, Potamididae, Littorinidae, Hipponicidae, Acmaeidae, Conidae, Trochidae, Turritellidae	<i>Notoacmea</i> sp., <i>Hipponyx conicus</i> , <i>Bembicum nanum</i> , <i>Phasantrochus</i> sp, <i>Conus</i> sp. plus other bivalves & g'pods <20 mm identified to family level

Table 4.1b: Other shellfish remains (non-food).

Table 4.1: Categories used in the sorting and analysis of shellfish remains from the Beeton Rockshelter site.

The Aboriginal food type groupings are archaeologically useful because they divide the range of exploited shellfish into categories that reflect human behavioural aspects of shellfish exploitation. Moreover these relate to commonalities in species traits such as shell morphology, habitat requirements, meat quantity and other features that relate to particular species and human exploitation patterns. There is also a strong coincidence between the Aboriginal nomenclature and the scientific taxonomy (Tables 4.1a and 4.1b).

In the case of whelks however, scientific taxonomy separates the species known to be targeted as Aboriginal food resources into three different gastropod families. In this case it is more useful for archaeological purposes to use the broader Aboriginal nomenclature which lumps these species together as 'whelks'. The Aboriginal categorisation reflects a conceptual commonality based on shell and mollusc colour, morphology and size; an empirical grouping directly related to predation factors rather than scientific taxonomy. Hence, the 'food type' category provided a unit more appropriately scaled to the analysis of culturally significant shellfish remains than the disparate scientific taxonomy.

Although abalone are generally known as 'muttonfish' to the older members of the Flinders Island community, the term 'abalone' has been adopted as it is more widely used these days. The term 'abalone' is used in the Furneaux region most commonly in reference to the *Halotis ruber* and *H. laevigata* species. These are the only species

currently exploited in Tasmania, and the most common abalone species found in midden sites. Only a small quantity of abalone shell was present in the midden remains excavated, and the only species identifiable was a small complete *H. scalaris* shell. Currently this is a relatively rare species in the region and too small and scant for exploitation. It is possible that this single complete shell was collected for ornamental rather than food purposes. Nonetheless, in the absence of evidence to support this notion, it has been included along with other fragments of identifiable abalone shell in a food type category.

Similarly chiton is not currently exploited by Tasmanians as a food resource but has been included as a food category because it is commonly present in prehistoric midden sites around Tasmania. Only three pieces of chiton shell were recovered from the site and by weight these represented less than .025% of all shell recovered. Clearly chiton were either not being targeted as a major food resource by people using the shelter, or were not available in any quantity in the area.

The other main shell category apart from 'food type' is 'other shellfish remains'. The latter is subdivided into two categories; shell fragments and other (Table 4.1b). Fragments comprised all broken shell that lacked adequate diagnostic features to enable it to be identified to a species, family level or food type category. It is highly probable that the majority of remains in the fragments category is from shellfish foods as the majority of the total marine remains were shellfish types exploited for food. The second shellfish category apart from food types is 'other'. This other category mainly consisted of a large number of small shells <20 millimetres, predominantly turret shaped gastropod species about 10 millimetres in size. Also included in this category was a very minor component of sea urchin and cuttlefish pieces (<3 grams in total).

It is possible that the cuttlefish and sea urchin fragments were deposited in the shelter by the muttonbirds or other birds roosting in the shelter or inadvertently brought to the site adhering to shellfish or seaweed. As discussed further below, the cultural status of remains from this 'other' category is ambiguous as they may have been collected by people for ornamental purposes.

MNI method

After sorting, shellfish remains from each of the D9, D6 and C6 squares were quantified by weight and MNIs (minimum numbers of individuals) calculated to

species level where possible. To ensure that the optimal minimum number of individuals was obtained for each species, two methods were employed; diagnostic trait counts and representative shell weights. This second method involved dividing the weight of shell recovered from a species by the weight of a whole shell of an average sized, mature shell specimen minus the soft mollusc [Appendix V] Wherever possible shell weights were obtained using reference specimens of similar size to those in the excavated remains (Table 4.2). Where reference material was not available in the ANU and the Museum of Victoria collections shell weights followed Bowdler (1979:227). MNIs obtained using this basic shell weight method were compared with those calculated using the most numerous trait method described below.

SPECIES	EMPTY SHELL weight g
Periwinkles:	
<i>Austrochlea</i> sp.	3
<i>Nerite</i> sp.	3
Whelks:	
<i>Dicathais textilosa</i>	34
<i>Pleuroploca australasia</i>	127
<i>Cabestana spengleri</i>	103
Warrener: shell plus operculum	
<i>Subninella undulata</i>	12
Limpets:	
<i>Cellana solida</i>	11
<i>Patellanax peroni</i>	6
Mussel: both valves	
<i>Mytilus planulatus</i>	14
<i>Hormomya erosa</i>	6.5
Abalone: <70 mm	
<i>Haliotis scalaris</i>	7

Table 4.2: Empty shell weight estimates.

The other more standard method, by counting diagnostic traits method involved recording the frequencies of a number of singular attributes for each species or type, and then calculating the MNI using the combination of mutually exclusive attributes which provided the greatest number. For example, in the case of warrener (*Subninella undulata*) shells the numbers of protoconch and the triangular junctions (the singular junction of the outer lip, posterior canal and the body whorl present on each shell) were recorded. Although, as it happened, no complete warrener shells had been excavated, whole shells could have been present and hence constituted a relevant

category for MNI calculation. Several categories of operculae were also recorded; because an individual may be represented in the remains by both its operculum and one or more main body shell parts, operculum and body shell attributes had to be treated as discrete categories.

Since many of the *Subnivalia* operculae were broken, the MNI represented by this shell part was calculated using the number of whole operculae plus the number of either of the following categories of broken operculae, according to which was the greater; a) broken operculae which contained the junction of the dorsal whorl and the outer edge of the operculum, or b) operculae pieces which represented 50% or more of overall whole operculae.

After recording the frequency of the above attributes in the *Subnivalia* remains, the MNI was calculated for this species by using the greatest of the sums of the following attribute combinations;

- a) the total number of whole shells plus the protoconch,
- b) the total number of whole shells plus the junctions,
- c) the total number of whole operculae plus operculae >50% complete, or
- d) the total number of whole operculae plus those with the peripheral whorl junction present.

For limpets, the MNI was calculated using a combination of the protoconch and whole shell numbers. The number of limpet rims which were more than 50% complete was also recorded; should these have exceeded the number of limpet protoconch present, then this trait would have been used in preference in the MNI calculation. The most numerous attributes, that is those which were used to calculate MNIs represented in each of the shellfish categories are tabled below (Table 4.3).

Except for two sample spits, the minimum number of specimens (NISP) of shell, that is the sum total of individual shell fragments, partial and complete shells, was not recorded [Appendix IV]. Generally the information obtainable from NISP data for shellfish analysis is principally a measure of shell fragmentation, information which in the Beeton Rockshelter remains was ascertained by comparing 3 millimetre and 7 millimetre sieve data (see below).

TYPE	SPECIES	MNI CALCULATED ON
Periwinkle	<i>Austrocochlea constricta</i> , <i>A. concamerata</i> , <i>Nerita atramentosa</i>	no. of protoconch
Limpet	<i>Cellana solida</i> , <i>Patellanax peroni</i>	no. of protoconch plus whole shells
Mussel	<i>Hormomya erosa</i> , <i>Mytilus planulatus</i>	Most numerous handed umbo
Warrener	<i>Subnirrella undulata</i>	no. of whole operculum plus no. of operculum pieces with peripheral whorl junction
Whelk	<i>Cabestana spengleri</i> , <i>Dicathais textilosa</i> , <i>Pleuroploca australasia</i>	no. of protoconch (except <i>Pleuroploca</i> in D9 where anterior columellae were used)
Abalone	<i>Haliotis scalaris</i>	no. of protoconch
Other	<i>Notoacmea</i> sp., <i>Chiton</i> sp., <i>Hipponyx conicus</i> , <i>Bembicium nanum</i> , <i>Phasiantrochus</i> sp, <i>Conus</i> sp. plus other bivalves & g'pods <20 mm identified to family level	no. of protoconch plus whole shells (gastropods) and most numerous handed umbo (bivalves)

Table 4.3: Attributes used to calculate MNIs for shell fish remains from squares D9, D6 and C6.

4.2.2 Shellfish analysis

In most midden sites variation in relative proportions of different types of marine shellfish in the deposits can provide information about variation in site use, both across the site area and through time. Although the disturbed nature of the shell bearing deposit in the Beeton Rockshelter site precluded the investigation of diachronic changes, this was not of particular importance as the C14 shell dates indicated that the shell midden had been deposited over a time span of probably a few hundred years (Figure 3.4). The analysis therefore focused on other aspects of shellfish exploitation and processing patterns.

Density of shellfish remains recovered

A total of 4.715 kilograms of remains of marine origin were excavated from the five squares excavated at the Beeton Rockshelter site. Ninety-five % (4.463 kilograms) of these remains were recovered from the three squares which were located in the shelter of the rock overhang at the site, that is squares D9, D6 and C6 (Table 4.4). The remaining 5% (0.251 kilograms) came from the squares located outside the drip-line, C6 and U7 (Figure 3.1). Remains from the D9, D6 and C6 squares have been used in the shellfish analysis.

The depth of the unit III shell bearing layer varied both within and outside the shelter, and the weight of unit III deposits removed from each square varied commensurately (Table 4.4a). The data was initially corrected for variation in spit volumes by expressing the shell density recovered as grams of shell per ten kilograms of excavated deposit. This is a standard method employed for comparative analysis of shell density and identification of both synchronic and diachronic variation in past human behaviour associated with shellfish exploitation. In the Beeton Rockshelter site however, the variation in the corrected shell density is dependent primarily not on human behaviour, but the depth to which the muttonbirds re-deposited the shell. While the vertical distribution and corrected shell densities were not a product of human behaviour, and thus not used in the shellfish analysis, they are of interest as a measure of site disturbance. For the shellfish analysis, data has not been measured volumetrically as all shell from the disturbed rookery layer, unit III, has been conflated into a single analytical unit.

Square	grams of shell recovered	kg of deposit removed unit III - rookery layer	g shell/kg deposit
D9	2353.30	939	2.5
D6	1244.34	732	1.7
C6	865.76	543	1.6
I6*	136.42	228	0.6
U7*	114.72	247	0.5
TOTAL	4714.54	2689	mean 1.7

Table 4.4a: Weight and volumetrically corrected weight of excavated shell from all squares excavated (* indicates squares located beyond the drip-line).

Square	grams of shell recovered	kg of deposit removed unit III - rookery layer	g shell/kg deposit
Combined D9, D6 & C6	4463.40	2232	2.0

Table 4.4b: Combined weight and corrected weight of excavated shell from D9, D6 and C6.

Table 4.4: Weight of shellfish and other marine remains recovered.

The depositional pattern suggested by the variation in shell weights recovered from the excavated squares indicates that minimal shellfish was consumed or discarded outside the actual main part of the Beeton Shelter. Most shell was discarded in the area of the D9 square, in the centre of the shelter just in from the drip-line but where the head room was 1.8 metres or more. Not unexpectedly, shell deposition rates within the shelter declined as head room decreased toward the sides and back of the shelter, in squares D6 and C6. Almost certainly the vigorous digging of the nesting birds has caused some degree of horizontal displacement of shell. Since the birds dig their burrows with entrances facing out toward the sea, horizontal shell displacement from the digging would have resulted in shell being shifted toward, and possibly beyond the drip-line.

Yet a relatively small quantity of shell was recovered from the U7 square, located immediately in front of the drip-line, suggesting that horizontal shell displacement by bird burrowing was limited (Table 4.4a; Figure 3.1). The overall variation in the density of shellfish remains is therefore interpreted as predominantly reflecting more intense use of areas more suited to human occupation. Areas with increased headroom appear to have been the principal focus for human activity at the site as these had a higher density of shellfish remains.

Range and composition of the marine remains

The bulk of the weight of marine remains comprised shellfish (marine molluscs). Non-mollusc remains made up less than .08% (<3 grams) of the weight of marine remains and consisted of fragments of cuttlefish, sea urchin, and crustacea, all less than one gram in weight. As these latter remains may have been deposited by nesting

seabirds or blown into the site in the case of the cuttlefish, these are not interpreted as cultural remains *per se*, rather their presence and ambiguous cultural status noted.

The range of identified shellfish and other marine remains is tabled below as both raw weights and relative proportions (Tables 4.5a and 4.5b). The vast majority of the weight of the marine remains comprised shellfish food remains although a minor component of smaller shellfish types, too small to have been exploited as food, was present in all squares (Figures 4.1a and 4.1b).

SPECIES/ TYPE	D9 wt g	D6 wt g	C6 wt g	TOTAL wt g D9, D6, C6 combined
<i>Austrochlea concamerata</i>	209.0	144.3	92.4	445.7
<i>Austrochlea constricta</i>	117.3	57.9	37.6	212.8
<i>Nerita atramentosa</i>	1.0	0	0	1.0
<i>Dicathais textilosa</i>	83.8	86.7	28.6	199.1
<i>Pleuroploca australasia</i>	75.0	7.9	3.3	86.2
<i>Cabestana spengleri</i>	5.9	0.8	6.7	13.4
Species unidentifiable whelk shell	97.9	38.2	48.0	184.1
<i>Subnirrella undulata</i> shells & operc.	379.7	239.9	172.1	791.7
<i>Cellana solida</i>	853.7	318.1	249.6	1421.4
<i>Patellanax peroni</i>	17.0	0	2.0	19.0
<i>Mytilus planulatus</i>	0.4	0.1	1.6	2.1
<i>Hormomya erosa</i>	215.0	90.5	103.3	408.8
<i>Haliotis scalaris</i> or sp.	6.2	26.1	1.27	33.6
Fragments	256.7	214.6	118.3	589.6
Chiton	1.1	0	0	1.1
Crustacea (poss. <i>Jasus lalandei</i>)	0.1	0.1	.1	.3
Other (small gastropods, sea-urchin, cuttlefish)	33.5	18.9	7.7	60.1
TOTAL	2353.3	1244.4	865.8	4463.5

Table 4.5a: Shellfish weights from squares D9, D6 and C6 and combined square totals.

SPECIES/ TYPE	D9 % wt	D6 % wt	C6 % wt	TOTAL % wt D9, D6, C6 combined
<i>Austrochlea concamerata</i>	9	12	11	10
<i>Austrochlea constricta</i>	5	5	4	5
<i>Nerita atramentosa</i>	0	0	0	0
<i>Dicathais textilosa</i>	4	7	3	4
<i>Pleuroploca australasia</i>	3	1	0	2
<i>Cabestana spengleri</i>	0	0	1	0
Species unidentifiable whelk shell	4	3	6	4
<i>Subnirrella undulata</i> shells & operc.	16	19	20	18
<i>Cellana solida</i>	36	26	29	32
<i>Patellanax peroni</i>	1	0	0	0
<i>Mytilus planulatus</i>	0	0	0	0
<i>Hormomya erosa</i>	9	7	12	9
<i>Haliotis scalaris</i> or sp.	0	2	0	1
Fragments	11	17	14	13
Chiton	0	0	0	0
Crustacea (poss. <i>Jasus lalandei</i>)	0	0	0	0
Other (small gastropods, sea-urchin, cuttlefish)	1	2	1	1
TOTAL	100	100	100	100

Table 4.5b: Shellfish percentages by weight from squares D9, D6 and C6 and combined square totals.

Table 4.5: Weights and percentages of shellfish and other marine remains from squares D9, D6 and C6 and combined square totals.

Comparison between the relative proportions of marine remains in all categories shows that, except for one limpet type, *Cellana solida*, this varied by less than 5% in the D9, D6 and C6 squares. *Cellana solida* varied by 10% overall, from some 26% of remains in D6 to 36% in the D9 square (Tables 4.5a and 4.5b; Figures 4.1a and 4.1b). The variation in *Cellana solida* shell is not considered to be aberrant given the range in human activity one would expect over time and space in a site such as the Beeton Rockshelter. More notable is the consistency in the relative composition by weight of the remains, particularly in terms of food categories in each of the squares (Figure 4.1b).

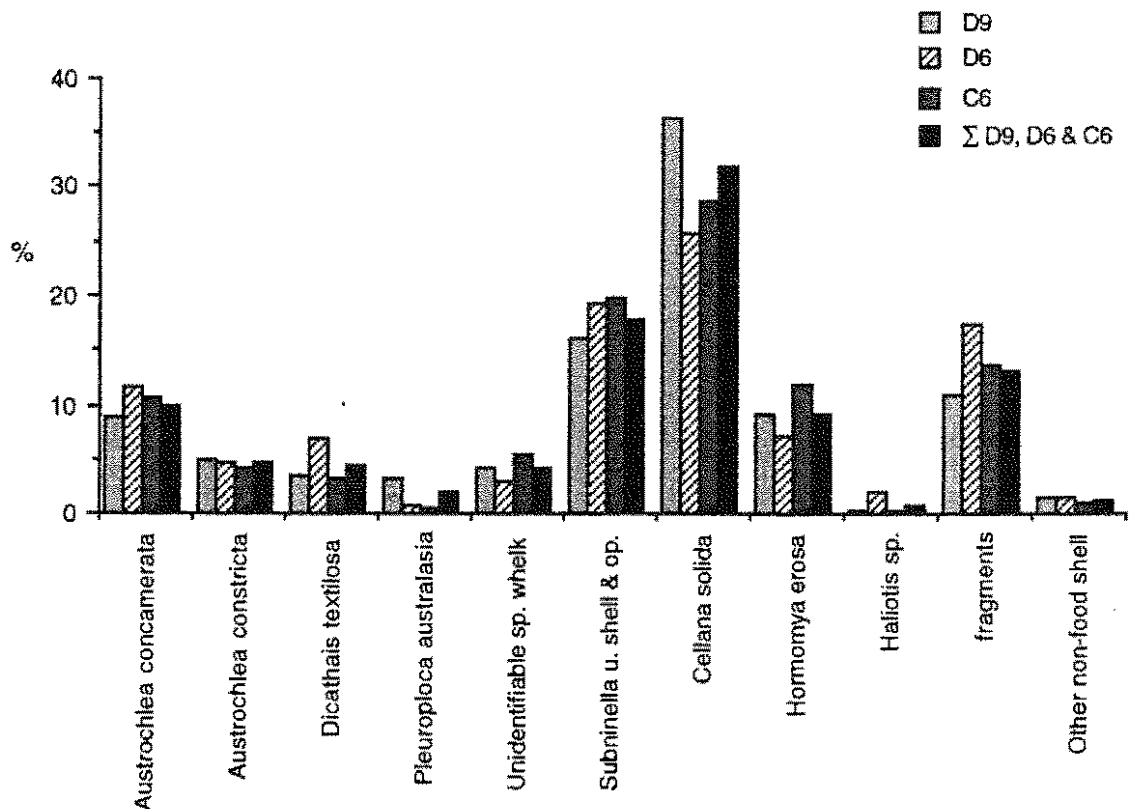


Figure 4.1a: Proportions by weight of shellfish and other marine remains in all categories (categories with < 1% omitted i.e. *Nerita*, *Cabestana*, *Patellanax*, *Mytilus*, *Chiton* and crustacea).

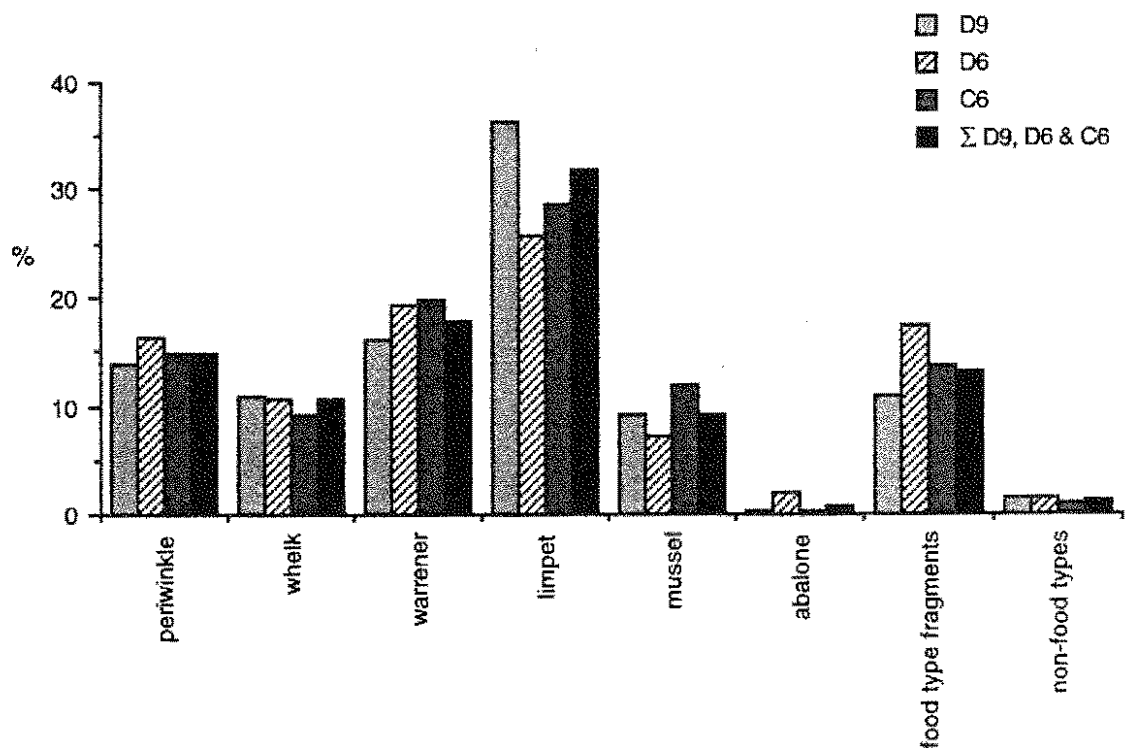


Figure 4.1b: Proportions by weight of shellfish in food and non-food categories.

Figure 4.1: Shellfish remains - percentages by weights from squares D9, D6 and C6.

In summary, horizontal variation in the range and weight of the shellfish and other marine remains in the rockshelter was minimal, although there was slightly more limpet (*Cellana solida*) recovered from the D9 square in the more central position of the shelter, where shellfish remains were also most dense. Overall there was a notable consistency in the range and relative proportions by weight of marine remains recovered from the D9, D6 and C6 squares. Comparisons of shell weights of various shellfish types represented in the site however can be somewhat misleading as to the focus of gathering activities and relative contributions to people's diet.

While limpet shell was most highly represented in the weight of marine remains in all squares, this did not necessarily mean that limpets were most numerous in terms of individual shellfish represented. Nor did the variation in weights of different species being targeted as food necessarily correlate with the amount of mollusc meat weight represented in the remains.

Quantities of food represented by the shellfish - MNIs

In order to investigate what the marine remains may represent in terms of human activity at the site, shellfish were quantified as MNIs and the results used to estimate what these represented in terms of food quantities of different shellfish types. Tables 4.6a and 4.6b list the results of the MNI calculations obtained using the diagnostic trait method described above (in section 4.2.1). For all species the MNI calculated using this method exceeded that obtained by dividing the shell weight recovered for a species by the average weight of a mature shell specimen of that species [Appendix V]. Hence MNIs used in the shellfish analysis are those obtained using the diagnostic trait method.

MNIs of marine remains were also graphed to see if the general homogeneity evident from each of the squares in the weight of shellfish remains was also present in the MNI data (Figures 4.2a and 4.2b).

SPECIES/ TYPE	D9 MNI	D6 MNI	C6 MNI	Σ D9, D6, C6 MNI
<i>Austrochlea concamerata</i>	258	248	74	580
<i>Austrochlea constricta</i>	208	212	102	522
<i>Nerita atramentosa</i>	1	0	0	1
<i>Dicathais textilosa</i>	12	12	7	31
<i>Pleuroploca australasia</i>	2	1	1	4
<i>Cabestana spengleri</i>	1	1	1	3
<i>Subnirrella undulata</i> shells & operc.	376	169	87	632
<i>Cellana solida</i>	369	134	83	586
<i>Patellanax peroni</i>	2	0	2	4
<i>Mytilus planulatus</i>	1	1	1	3
<i>Hormomya erosa</i>	43	28	19	90
<i>Haliotis scalaris</i> or sp.	1	1	1	3
Chiton	1	0	0	1
Crustacea (poss. <i>Jasus lalandei</i>)	1	0	1	2
Other (small gastropods, sea-urchin, cuttlefish)	213	141	60	414
TOTAL	1489	948	439	2876

Table 4.6a: Marine remains MNI counts.

SPECIES/ TYPE	D9 % (MNI)	D6 % (MNI)	C6 % (MNI)	Σ D9, D6, C6 % (MNI)
<i>Austrochlea concamerata</i>	17.3	26.2	16.9	20.2
<i>Austrochlea constricta</i>	13.9	22.4	23.2	18.2
<i>Nerita atramentosa</i>	0.1	0	0	0
<i>Dicathais textilosa</i>	0.8	1.3	1.6	1.1
<i>Pleuroploca australasia</i>	0.1	0.1	0.2	0.1
<i>Cabestana spengleri</i>	0.1	0.1	0.2	0.1
<i>Subnirrella undulata</i> shells & operc.	25.3	17.9	19.8	22.0
<i>Cellana solida</i>	24.8	14.1	18.9	20.4
<i>Patellanax peroni</i>	0.1	0	0.5	0.1
<i>Mytilus planulatus</i>	0.1	0.1	0.2	0.1
<i>Hormomya erosa</i>	2.8	2.9	4.4	3.1
<i>Haliotis scalaris</i> or sp.	0.1	0.1	0.2	0.1
Chiton	0.1	0	0	0.1
Crustacea (poss. <i>Jasus lalandei</i>)	0.1	0	0.2	0.1
Other (small gastropods, sea-urchin, cuttlefish)	14.3	14.8	13.7	14.4
TOTAL	100	100	100	100

Table 4.6b: MNIs of marine remains as percentage.

Table 4.6: Marine remains MNIs as counts and percentages.

The MNI data concurs with the shell weight data in that it indicates that there was a general consistency in the range and proportion of shellfish types being deposited in different areas of the site (Figures 4.1 and 4.2). The MNI analysis highlighted a relatively high number of small shells which did not represent food remains (Figure 4.3). The MNI of these small (non-food) shells totalled 414, representing nearly 15% of the total MNI shells recovered from the three squares excavated inside the shelter.

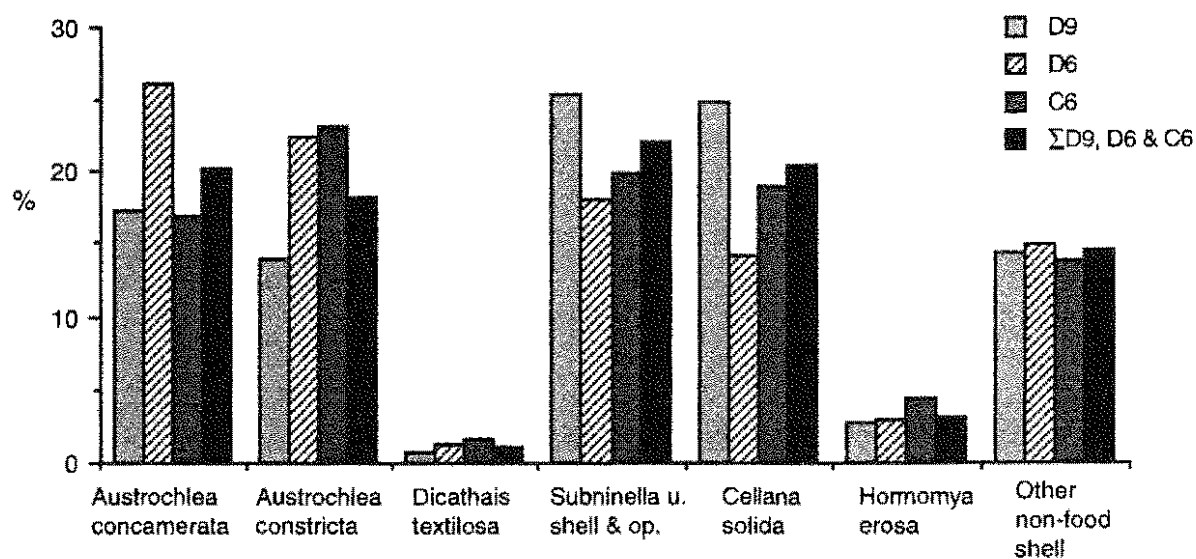


Figure 4.2a: MNIs as % of shellfish and other marine remains in all categories (categories with < 1% omitted i.e. *Nerita*, *Pleuroploca*, *Cabestana*, *Patellanax*, *Mytilus*, *Haliotis*, *Chiton* and crustacea).

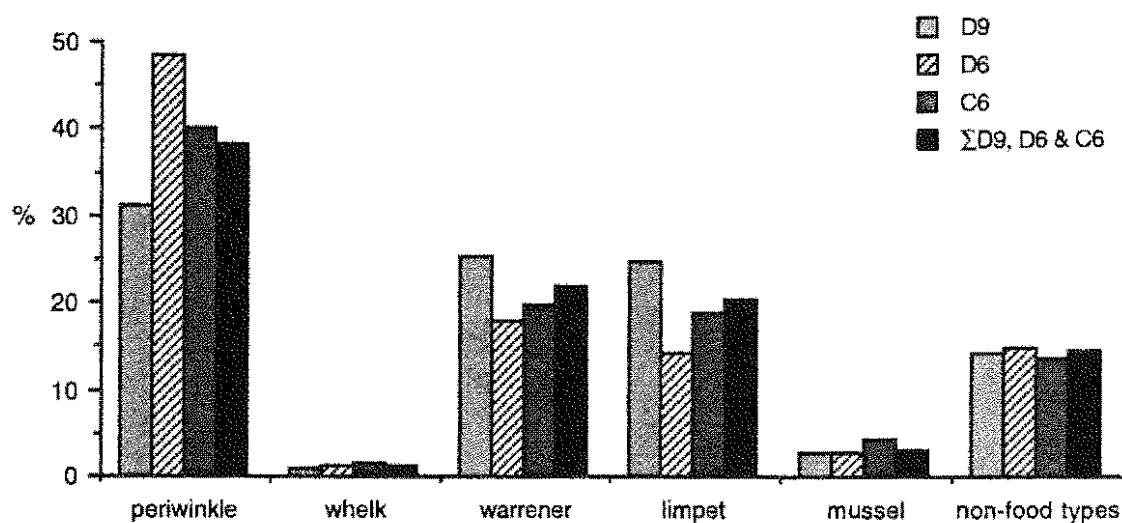


Figure 4.2b: MNIs as % of different food and non-food categories.

Figure 4.2: Shellfish MNIs from D6, D9 and C6.

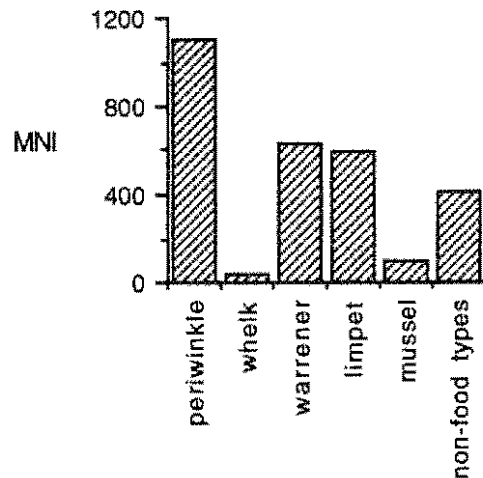


Figure 4.3: MNIs of shellfish in food and non-food categories.

The only natural explanation for the inclusion of such shells in the deposit would be as inclusions with the aeolian sediments in the shelter. If this were the case however it would be expected that such shells would be distributed throughout the deposit, as the sediment analysis indicates a similar source for most of the deposit, and certainly for the sediments in the shell bearing and underlying deposit. The restriction of these shells to the unit also bearing the shellfish food remains however refutes an explanation of natural deposition for their presence. Since there is no other animal behaviour, or natural causes which could account for the inclusion of these small shells in the deposit, they are attributed to human behaviour.

The range of small shells being brought to the site included a number of Trochidae species less than 15 millimetres in length which are commonly known as kelp shells. Several species of Trochidae were used by the Tasmanians in the pre-contact and historic period for making shell necklaces (Norman 1993, Brownrigg in Murray Smith 1987:9). Kelp shells have a distinctive iridescent pearly lustre to the subsurface nacreous layer and there are historic accounts of this being deliberately exposed by smoking the shells over a slow grass fire prior to the shell being pierced and strung on kangaroo sinew (Plomley 1987:226). According to Norman (1993) the Tasmanians in pre-contact times drilled in the whorl of the kelp shells using points made from bone or animal teeth. In more recent times a wider range of small shells was used as the use of steel needles and drills makes it possible to pierce shells other than kelp shells (Norman 1993).

There are contact period accounts of kelp and other seaweed being cooked over a slow fire and eaten (Labillardiere 1800:285,302-306,307-312; Plomley 1966:66-67). Since the kelp shells and other small gastropods attach themselves to kelp and seagrasses, it is highly probable that the discovery of the iridescent under-shell on the Trochidae was a result of the cooking method employed to soften the kelp. Exploitation of seaweed as a food resource could account for the presence of numerous small shells in the deposit at Beeton Rockshelter; both bull kelp (*Durvillea* sp. and other seaweed *Zostera* sp.) mentioned in the historic accounts as food resources are currently found in the waters close to the Beeton Rockshelter site. It is considered that rather than deliberate ornamental shell collecting, seaweed or mussel exploitation is a more likely explanation for the inclusion of small shells in the deposit.

There was only a relatively small proportion of Trochidae species recovered amongst the small shells; 10 of the overall 441 (MNI) small shells were kelp shells. More numerous than Trochidae were Potamididae and Cerithiidae species, several of which are known to inhabit the same marine habitat favoured by seagrasses and mussel beds (Phillips 1984). Moreover, there was no evidence of processing of the small shells recovered, such as piercing or heating, that would be expected if they were being utilised for ornamental purposes. Hence the presence of a relatively high number of small gastropods, which were clearly not being targeted for food, is attributed to their being inadvertently being brought to the site, attached to another food resource such as seaweed or mussels.

Shellfish food remains

Quantities of mollusc meat represented in the various shellfish food categories in the marine remains recovered from all three squares within the shelter were calculated using the MNI counts and mollusc meat weight estimates for each species (Tables 4.7 and 4.8). The latter were obtained by weighing samples of fresh specimens in the case of one whelk (*Pleuroploca australasia*), warrener and the mussels. As samples of one mussel (*Hormomya erosa*) were unobtainable, the mollusc weight for this species was calculated using a size weight ratio based on *Mytilus planulatus*. The mollusc weight for the *Haliotis scalaris* abalone was similarly calculated using the shell size/meat weight ratio obtained from the more common *Haliotis ruber*. Remaining mollusc weights were obtained from Bowdler (1979:227) and Coleman (1966).

The results of the meat weight calculations have been graphed along with the relative proportions of the recovered shell weight and MNIs for each of the shellfish food categories (Table 4.8; Figure 4.4). Despite representing only one quarter of the total MNI count, the warreners (*Subnivalia undulata*) make up more than 50% of the meat weights calculated from the MNI of the various shellfish types. The recovered shell weight distribution is also not reflected in the mollusc meat weight distribution. Shell weight data could suggest that limpets were the shellfish being most intensively targeted, and that warrener and periwinkle were minor secondary items of about the same order; an interpretation clearly refuted by the mollusc meat weight data (Figure 4.4).

SPECIES	MEAT weight g	
Periwinkles:		
<i>Austrochlea</i> sp.	0.3	
<i>Nerita</i> sp.	0.3	
Whelks:		
<i>Dicathais textilosa</i>	15	
<i>Pleuroploca australasia</i>		16
<i>Cabestana spengleri</i>	20	
Warrener:		
<i>Subnivalia undulata</i> shell	7	
Limpets:		
<i>Cellana solida</i>		5
<i>Patellanax peroni</i>	3	
Mussel:		
<i>Mytilus planulatus</i>	3	
<i>Hormomya erosa</i>	1	
Abalone:		
<i>Haliotis scalaris</i> (<70 mm)	10	

Table 4.7: Mollusc meat weights.

In terms of mollusc meat weights, limpet and whelk also represented a relatively higher proportion than the MNI data. The reverse pattern was found in periwinkle and mussel, smaller shellfish types with generally lower meat weight to shell ratios. Whilst most numerous in terms of MNIs, the periwinkles represented less than 4% of the overall meat weight represented by the shellfish remains.

FOOD TYPE	recovered shell		MNI		mollusc meat	
	wt g	%	no.	%	wt g	%
Periwinkle	660	17	1103	44	331	4
Limpet	1440	38	590	24	2942	35
Mussel	411	11	93	4	99	1
Warrener	792	21	632	26	4424	53
Whelk	482	13	38	2	589	7
Abalone	34	1	3	0	340	0
Chiton	1	0	1	0	5	0
TOTAL	3820	100	2460	100	8730	100

Table 4.8: Total shellfish food remains from squares D9, D6 & C6 - mollusc meat weights represented by the MNIs.

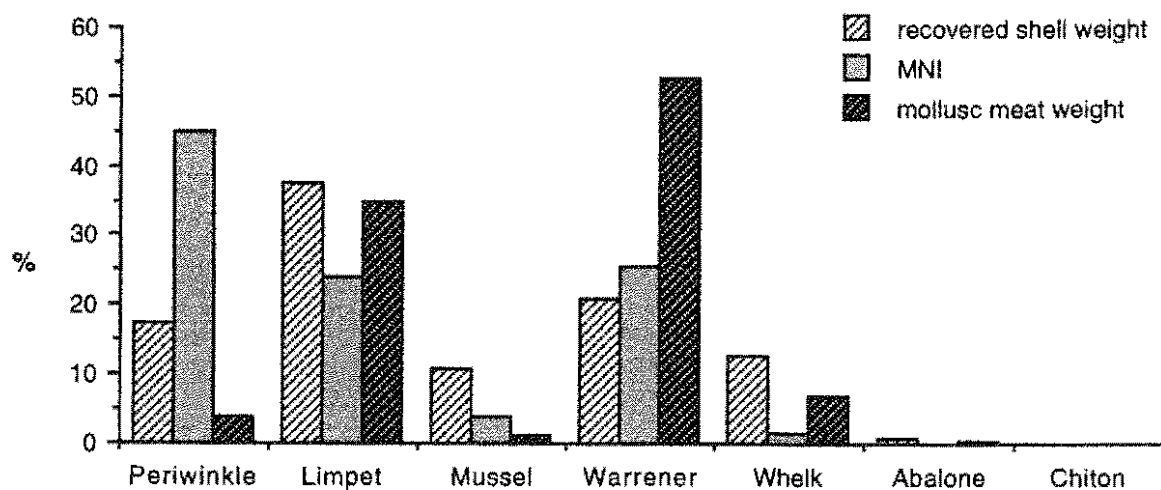


Figure 4.4: Percentages of recovered shell weights, MNIs and mollusc meat weights per food category in remains from Σ D9, D6 and C6.

Today periwinkles are the most widely distributed and abundant shellfish food type available around the Furneaux Islands. Periwinkles are found in all rocky shore habitats around the islands and it is not unexpected therefore that these are the most numerous shellfish in the midden remains. While limpets and warreners yield more meat per individual shell these types are more habitat specific and not always as readily available. A high proportion of these more habitat specific shellfish types could therefore be reflecting local environmental factors as much as shellfish exploitation patterns. Nonetheless, in terms of meat weight represented in the remains from the Beeton Rockshelter, warreners and limpets made up about 88% and the remainder comprised mainly periwinkle, mussel and whelk.

Estimated depth of original shell midden layer

Due to the muttonbird burrowing activity in the rockshelter it is difficult to draw any secure conclusions regarding the original *in situ* vertical distribution of the shellfish. It is possible to estimate the original depth of the shell deposit as represented by the quantity of shellfish remains in the squares excavated in the shelter. The close span of the midden shell dates, in combination with the decrease in sedimentation rate in the shelter in the terminal Pleistocene, suggest that before the mid-Holocene bird turbation, the shell was unlikely to have comprised stratified layers or lenses of shell associated with different occupation periods; the evidence suggests the shell was probably present as a surface layer prior to the bird nesting phase.

To establish the depth of the midden shell represented in the recovered shell, a shell layer was reconstructed in the laboratory using the same shellfish types and in similar proportions to those found in the Beeton Rockshelter (Table 4.5b). The midden reconstruction indicated that about 4 kilograms of combined fragmented and whole shells were required to form a shell layer 2.5 centimetres deep in a 50 centimetre square tray. Hence, it would require about 16 kilograms of excavated shell from one square metre to represent a shell layer about 2.5 centimetres in depth at the site, that is a ratio of 1 kilogram of shell per 1.6 millimetres in midden depth.

To approximate the original depth of the shell deposit at the site, the original weight of the shellfish remains deposited was estimated using the MNIs and individual shell weight data (Table 4.9). Because of the shell survival and recovery rate, this method provides a more accurate estimate than that obtained using solely the shell recovered during excavation. The weight of shellfish remains originally deposited over the three square metres excavated within the shelter is estimated to have been about 23

kilograms (Table 4.9). Assuming this quantity of shell was representative of remains across the entire rockshelter area, and was deposited as a single layer, then it would have formed a surface shell layer about 3.7 centimetres deep prior to the bird disturbance. Given that the mature size of most shellfish types represented in the archaeological remains exceeds 3 centimetres, the remains therefore represent a relatively low density layer of shell, equivalent to a layer about one shell in depth across the site.

Variation in the overall quantity of shellfish recovered from each of the three squares suggests that rather than a thin contiguous layer, the shell was probably deposited as a number of discrete low density scatters varying in size and depth across the shelter surface according to the intensity of occupation in different parts of the site (Table 4.10a).

SPECIES/ TYPE	Σ D9, D6, C6 MNI	estimated wt kg of whole shells	recovered wt g of shells	estimated % of original shell deposit recovered
Periwinkle	1105	3.315	660	20
Whelk		1.562	482	31
<i>Dicathais textilosa</i>	31			
<i>Pleuroploca australasia</i>	4			
<i>Cabestana spengleri</i>	3			
Warrener	632	7.584	792	10
Limpet		6.470	1440	22
<i>Cellana solida</i>	586			
<i>Patellanax peroni</i>	4			
Mussel		3.860	411	11
<i>Mytilus planulatus</i>	4			
<i>Hormomya erosa</i>	586			
Abalone		0.380	34	9
<i>Haliotis scalaris</i>	2			
<i>Haliotis</i> sp.	1			
Chiton	1	0.015	1	7
TOTAL	2876	23.186	3820	16

Table 4.9: Estimated minimum weight of shell originally deposited compared with shell weight recovered during excavation.

In most midden sites, the depositional context of the midden remains can be reconstructed directly from the archaeological and stratigraphic context of the shellfish remains. As the depositional context of the shellfish at the Beeton Rockshelter site had been destroyed by the muttonbird burrowing, the shell layer reconstruction was a useful method of gaining a general impression of the original midden site, albeit limited in precision. In this case the stratigraphic context of the shell was somewhat misleading, and the shell layer reconstruction suggests that the shell remains represent a light scatter of shells across the shelter floor rather than the deep midden suggested by the stratigraphic context.

Preservation and fragmentation

Preservation

In calculating the original quantity of shell represented by the MNIs it became apparent that the bulk of the shell originally deposited in the excavated squares was not recovered during the excavation. From the estimated weight of shell originally deposited in the excavated squares, it appears that about 16% was recovered (Table 4.9). Either the remaining shell had disintegrated over time, or it had been crushed to such an extent that it was not recoverable in the 3 millimetre sieve. Examination of the 3 millimetre sieve residues revealed fine shell fragments but of insufficient quantity to account for the remainder of the estimated quantity of shellfish deposited. Hence a relatively large proportion of the shell appeared to have not survived.

The original shell quantity was estimated from the MNI calculations, data which had been obtained using diagnostic parts of the shells. These diagnostic parts comprised protoconch, junctions and columellae parts; the thicker and structurally stronger parts of the shell. That such diagnostic parts were being preferentially preserved suggested that the bulk of the shell which had not been preserved came from less resilient, non-diagnostic body whorl part of the shells. The main body whorl area is also the portion of the shells that generally comes into direct contact with the heat and hot coals when the shells are cooked on an open fire (McNiven 1992, 1996; Sim 1991:137).

In modern times periwinkles and warrener are boiled in water, causing the soft body to shrink and facilitating the extraction of the cooked meat using a safety pin or wire. Historic and contact accounts however indicate these and other shellfish were

previously cooked directly on a small fire or hot coals (Labillardiere 1800:302-306; Plomley 1983:31-33). The association of hearths and shellfish remains, and the presence of burnt shell in Tasmanian midden sites also supports the prehistoric antiquity of direct fire cooking methods for shellfish (Bowdler 1979; Jones 1971; Lourandos 1970). Much of the warrener shell recovered from the site had ragged, powdery edges rather than clean breaks, and the nacreous and outer shell layers were delaminated: traits consistent with the shell having been exposed to fire heat.

Replication experiments have shown that heating of warrener shell causes a change in shell texture, shell delamination and exposure of the sub-surface nacreous layer, weakening and disintegration of shell areas in direct contact with the coals (Sim 1991). Heat damage occurred predominantly in the main body whorl and, depending upon cooking time and temperature, usually caused this part to disintegrate into fine powdery ash. Cooking also frequently caused the protoconch area to become detached from the main body whorl and aperture part of the shell. Direct cooking on hot coals has also been observed to cause similar destruction to both *Austrocochlea* species, and to the rim area of limpets.

Limpets are usually cooked on the coals by placing them upside down on the fire and allowing the mollusc juices to boil dry. This cooking process tends to weaken the lower portion of the shell, particularly mid-shell, around the base of the protoconch or apex area, where the shell is often thinner. Hence, the apex and rim parts of the limpets often detach as a result of the cooking process. Cooking also causes the rim surrounds to delaminate, and if sufficiently heated, to disintegrate.

Heat contact on the cap or apex of the limpet shell however has a reverse, tempering effect. The cap area is made up of a type of calcite which, when sufficiently heated changes to aragonite, a more durable compound (John Head pers. comm.). Hence, high temperature cooking of limpets can preferentially preserve the protoconch; and in some instances also detach, weaken or destroy the outer rim part of the shell.

The presence of numerous complete, small fragile kelp shells indicated that deposit provided excellent conditions for shell preservation over time. Preservation conditions *per se* therefore do not offer an explanation as to why the majority of the shell from the larger food shellfish species remains appear not to have survived. Differential preservation between the food and other smaller non-edible types could result from the effects of cooking of the larger shellfish over an open fire. The process of cooking shellfish on open fires would have resulted in the destruction of a

substantial proportion of the shell originally brought to the site. It is also highly probable that a proportion of the remaining heat-weakened shell subsequently disintegrated during reworking of the deposit by burrowing muttonbirds. Destruction of shell by both these means would explain the absence of a high proportion of the original shell weight from the estimated weight of shell taken to the site.

Fragmentation

Arguably the use of the rockshelter by stock in more recent times may have caused some damage to the shellfish remains in the Beeton Rockshelter deposit. If so, it would be expected that shellfish recovered from the innermost C6 square would be less fragmented since the reduced thickness of stock excreta in this square attests to less stock activity toward the rear of the shelter. The degree of fragmentation, as measured by the different sieve recovery rates, however does not increase toward the rear of the shelter, suggesting that shell fragmentation has not resulted from historic stock activity (Tables 4.10a and 4.10b).

Furthermore, the shellfish remains recovered were sufficiently robust to withstand without damage the handling involved during excavation, transportation, washing, drying and sorting. The resilience of the shellfish remains and the lack of evidence of breakage from stock activity, indicates that shell fragmentation is most probably reflecting human exploitation behaviour.

Although some whole limpet shells were recovered, the majority of the excavated shell was damaged or broken to some extent. The degree of fragmentation in the recovered shell overall is indicated by the relative quantities retrieved from the 3 millimetre and 7 millimetre sieves (Tables 4.10a and 4.10b). Clearly the shell had not been finely broken or crushed since the majority (74%) did not pass through the 7 millimetre mesh sieve.

Sieve size	D9 wt g	D6 wt g	C6 wt g	Σ D9, D6 & C6
7 mm	1825.19	815.94	650.99	3292.12
3 mm	528.14	428.42	214.86	1171.42
TOTAL	2353.33	1244.36	865.75	4463.54

Table 4.10a: Shell weights recovered.

Sieve size	D9 %	D6 %	C6 %	Σ D9, D6 & C6
7 mm	78	66	75	74
3 mm	22	34	25	26
TOTAL	100	100	100	100

Table 4.10b: Shell weights recovered as percentages.

Table 4.10: Shell weights and percentages - 3 millimetre and 7 millimetre sieves, squares D9, D6 and C6.

As expected, fragment sizes of different shellfish types were generally correlated with shell size (Tables 4.11a and 4.11b). Periwinkles, the smallest shell type had a comparatively high percentage of shell recovered from the 3 millimetre sieve, compared to whelks, the largest shell type (Table 4.11b). The only fragmentation pattern which did not correlate with size was that evident in the limpet remains.

SIEVE	Periwinkle	Mussel	Warrener	Limpet	Whelk
3 mm	271.6	83.9	161.4	51.4	44.9
7 mm	387.9	327.0	630.4	1390.8	431.2
TOTAL	659.5	410.9	791.8	1442.2	476.1

Table 4.11a: Weight in grams of identified shellfish food types per sieve.

SIEVE	Periwinkle	Mussel	Warrener	Limpet	Whelk
3 mm	41	20	20	4	9
7 mm	59	80	80	96	91
TOTAL	100	100	100	100	100

Table 4.11b: Percentage of identified shellfish food types per sieve.

Table 4.11: Weights and percentages of shellfish types from 3 millimetre and 7 millimetre sieves from the combined D9, D6 and C6 samples (shellfish types are listed in size order from the smallest 'periwinkle' on the left to the largest 'whelk' on the right).

Limpet shell, compared with the similar sized warrener species, had a higher than expected proportion of shell recovered from the 7 millimetre sieve, and was the least fragmented of all types. This concurs with the recovery of 107 complete limpet shells (*Cellana solida* and *Patellanax peroni*). These were the only complete shells amongst the excavated shellfish remains, and represented almost 20% of the MNIs recorded for the limpets.

Despite being composed of a more robust shell type, no complete whelk shells were recovered. Complete shells were also absent in the periwinkle and warrener remains [Appendix IV]. Whereas a limpet mollusc can be removed without damaging the shell, it is necessary to smash the shell of periwinkles, warreners and whelks to access the soft mollusc body. This strongly suggests that human behaviour is responsible for the contrasting fragmentation pattern between limpets and other gastropod species present. Furthermore, anthropogenic fragmentation of these latter shell types has been recorded in other Tasmanian midden sites and in ethnographic accounts (McNiven 1992, 1996; Sim 1991). It is most probable therefore that the presence of complete limpet shells in the remains from the Beeton Rockshelter site is due to these shells not having to be smashed to obtain the mollusc meat, and the fragmented state of the periwinkles, warreners and whelks attributable to them being deliberately smashed.

More than 408 grams of the 411 grams of mussel shell recovered comprised the smaller *Hormomya erosa* species which is marginally larger than the periwinkle shells but structurally more fragile. Compared with the periwinkle shell, a relatively high proportion of mussel shell was recovered from the 7 millimetre sieve (Table 4.11a). This was consistent with the observation made during the sorting that damage to mussel shell was minimal compared with the periwinkle remains. Although no complete mussel shell valves were recovered many had sustained only minor damage. This contrasted markedly with the periwinkle shell which was more fragmented despite being a more robust shell type and structure than mussel. There was no consistent fracture pattern observed on the mussel valves which could be attributed to systematic human exploitation behaviour.

No natural or post-depositional process could account for breakage present amongst the mussel or other shellfish remains. It is most probable that the mussels were heated directly on the fire to open the valves and facilitate the removal of the mussel meat. Deleterious effects of heat and post-depositional turbation could account for the relatively minor damage that was present. While neither limpet nor mussel shell

had evidence to suggest deliberate smashing or crushing, the fragmentation pattern evident on the periwinkle, warrener and whelk shell suggested that these latter types had been deliberately broken.

4.2.3 Summary of shellfish analysis

A consistent range of shellfish species was recovered from all squares, the majority of which comprised species recorded elsewhere in Tasmania in midden sites and which are also still commonly exploited by Tasmanian Aborigines. A minor component of the shellfish remains consisted of marine gastropods too small to have been collected for food. While some of these may have been collected for ornamental crafts such as shell necklaces, the majority were too small for piercing and were not species documented as being used for necklace making. It appears that most of the smaller shells were inadvertently brought to the site, most probably adhering to seaweed and larger shells.

With the exception of less than three grams of abalone shell, all shellfish were intertidal species that could be obtained by wading amongst the rocks and on tidal rock platforms. There was no evidence of sub-tidal resource exploitation, such as the intensive abalone and crayfish exploitation evident in late Holocene midden sites around Tasmania and also described in the early European explorers' accounts (Dunnett 1993; Labillardiere 1800; Plomley 1966:79,863, 1983:31-33; Sim 1994).

MNI estimates indicated that periwinkles, warrener and limpet were the common types of shellfish brought to the site, although the meat weight provided by the periwinkles was relatively small. Shellfish remains from the three squares excavated within the shelter indicated that warrener (*Subnirrella undulata*) and limpet (*Cellana solida*) were the major contributors to the mollusc meat weight represented in the samples. By comparison, mussel and whelk were neither numerous nor major contributors to the meat weight represented in the sample; chiton and abalone remains were insignificant.

Although now churned and mixed with underlying Pleistocene deposits, prior to turbation by muttonbirds the shell was most likely a low density scatter across the shelter floor. Shellfish were principally confined to areas within the drip-line, and the greatest density was recovered from areas with most headroom, that is those better suited to human occupation. Human activity associated with cooking and

subsequent removal of the shellfish body from the shell has resulted in the destruction and fragmentation of a substantial quantity of the shell.

Damage to the recovered shellfish remains was consistent with the shell having been cooked or heated on an open fire. This appears to have resulted in the loss of much of the shell originally taken to the shelter, both directly through burning and through subsequent disintegration of heat weakened shell. A relatively low degree of fragmentation and the presence of complete limpet shells suggest that these shells were not deliberately broken. In the case of warrener, whelk and periwinkles however no complete shells were recovered and the fragmentation suggests that exploitation of these involved the shells being purposely smashed.

4.3 Terrestrial vertebrate bone analysis

4.3.1 Aims of the terrestrial vertebrate bone analysis

A total of 11.178 kilograms of bone was recovered from the five squares excavated, of which 10.147 kilograms comprised non-avian faunal remains [Appendix VI]. The latter included mammal, reptile, amphibian and fish bones, although the vast majority of bone recovered was mammal and reptile; amphibian and fish combined represented a very minor component of the bone recovered. Field impressions of the excavated bone suggested that the bulk of the assemblage comprised fragmented mammal bone, although complete elements from smaller mammals such as murids were also observed. These two features are characteristic of bone deposits in caves and rockshelters known to originate from Tasmanian devil (*Sarcophilus harrisii*) scats, and owl and other bird of prey pellets (Dodson and Wexlar 1979; Geering 1990; Hall and Jones 1990; Hamilton-Smith 1965-66; Hayward *et al.* 1993; Hoffman 1988; Marshall 1986; Marshall and Cosgrove 1990).

Apart from evidence of burning and charring on a minor component of the bone remains, there was no immediately apparent evidence of a cultural origin for the bone. One of the main aims of the analysis therefore was to determine if a portion of the non-avian bone was cultural, that is human food debris. A secondary aim was to examine the broader issue of the effects of insulation on mammal populations in the region. For this reason identification to species level where possible was undertaken on remains from all squares, although as explained below only a sample of these was ultimately used for most of the analysis.

Hope (1973) examined the question of insulation effects in the 1970s but at that time the chronology of both human occupation in the region and that of the insulation process was less certain. The possible effects of human predation on the island mammal populations were not considered, as at that time it was thought the Furneaux region had been abandoned prior to insulation. Changes in island mammal distributions over time are of direct relevance to the issue both of human predation patterns and of the viability of mammal populations on isolated islands. The latter issue is also relevant to the problem of the disappearance of the prehistoric human population from the Furneaux region.

Detecting changes over time, particularly in the critical insulation and post-insulation phases in the Beeton Rockshelter remains, however, was problematic given the disturbance of the deposit in the site. Nonetheless, on a gross level three phases of mammal suites can be compared that may be useful;

- 1) the glacial maximum Pleistocene phase represented in deposits from Unit B,
- 2) a more recent prehistoric phase spanning the terminal Pleistocene and Holocene incorporating the insulation period, represented by the disturbed Unit A deposits, and
- 3) the evidence for mammal populations on Badger Island in the historic contact period (Hope 1973).

4.3.2 Method

The strategy employed for the faunal analysis involved a) identifying and eliminating bone typical of that deposited in rockshelters by birds and in predatory mammal scats, and b) investigating the remainder for possible evidence of carnivore or human predation. All bone was washed and dried using the same method described in the shellfish analysis. Bird bone was removed from bone samples in a primary sort and was analysed separately (see section 4.4).

All terrestrial bone recovered from the C6, I6, U7 squares, and 50% of that from D9 square, was sorted, identified and categorised according to the level of identification possible for that bone, ie to species and element where possible. Paired elements were identified as left or right. These data were recorded along with weights and counts for bone in each category. Non-avian bone from the D6 square was also washed and sorted but species identifications not undertaken on this sample. This sample was excluded from the analysis as a portion of the D6 square had been

disturbed by an animal burrow, and hence Unit B possibly contaminated with material from the rookery layer (Figure 3.2b).

Sorting and Identifying

After bird bone had been removed from the spit samples, reptile, frog and fish bone was separated from the mammal bone. Fish bone was found in only one square, I6, and comprised five bones in all. Frog and reptile as detailed below also comprised relatively minor components of the total bone assemblage. The remaining bone from each spit, that is the mammal bone, was divided into burnt and unburnt bone categories and each of these sorted into one of the four following categories;

1. Unidentifiable fragments less than 20 millimetres in maximum dimension.
2. Unidentifiable fragments greater than 20 millimetres in maximum dimension.
3. Unidentified bone other than fragments.
4. Identifiable bone, incomplete and complete elements identifiable to family and/or species level.

The 'unidentified bone' category comprised complete and substantially complete elements such as vertebrae, ribs and other bone which could in some instances be differentiated to mammal size category, but not to family or species level. For analytical purposes all mammals were divided into body size categories, a broader classification level than family (Table 4.12). This body size category enabled the classification of otherwise unidentifiable mammal bones which were not fragmented. Bone identifiable to family and species was also sorted into skeletal element and mammal size categories.

4.3.3 Analysis

Distribution of terrestrial faunal bone

Table 4.13 shows the distribution of the non-avian bone remains across the squares excavated at the Beeton Rockshelter site. While most of the bone excavated came from the D9 square, when volumetrically corrected, the deposits from all three squares inside the shelter contained on average, a similar density of terrestrial faunal bone. In contrast, the two squares located outside the drip-line had a much lower density of bone. The slightly higher density in U7 (compared to I6) is attributed to the recovery of a complete wombat skull which represented more than 25% of the

total bone weight for U7. Overall however both these squares contained similar and relatively low densities of faunal bone compared with squares within the shelter (Table 4.13).

LARGE SIZE MAMMALS (>10 kg mature body weight)

Macropodidae

Eastern Grey Kangaroo (*Macropus giganteus*)

Bennetts Wallaby (*Macropus rufogriseus*)

Vombatidae

Wombat (*Vombatus ursinus*)

MEDIUM SIZE MAMMALS (>500 g <10 kg)

Macropodidae

Tasmanian Pademelon (*Thylogale billardierii*)

Peramelidae

Southern Brown Bandicoot (*Isodon obesulus*)

Eastern Barred Bandicoot (*Perameles gunnii*)

Phalangeridae

Brush-tail Possum (*Trichosurus vulpecula*)

Petauridae

Ring-tail Possum (*Pseudocheirus peregrinus*)

Potoroidae

Potoroo (*Potorous tridactylus*)

Tas. Bettong (*Bettongia gaimardi*)

Dasyuridae

Spotted Quoll (*Dasyurus maculatus*)

Eastern Quoll (*Dasyurus viverrinus*)

Tas. Devil (*Sarcophilus harrisii*)

SMALL SIZE MAMMALS (<500 g)

Burramyidae

Eastern Pygmy Possum (*Cercartetus nanus*)

Little Pygmy Possum (*Cercartetus lepidus*)

Muridae

Eastern Water Rat (*Hydromys chrysogaster*)

Long-tailed Mouse (*Pseudomys higginsii*)

New Holland Mouse (*Pseudomys novaehollandiae*)

Broad-toothed Rat (*Mastacomys fuscus*)

Eastern Swamp Rat (*Rattus lutreolus*)

Petauridae

Sugar Glider (*Petaurus breviceps*)

Vespertilionidae

1 bat species

Dasyuridae

Swamp Antechinus (*Antechinus minimus*)

Dusky Antechinus (*A. swainsonii*)

Table 4.12: The range of mammal species represented in the Beeton Rockshelter faunal bone arranged according to the analysis categories; body size, family and species.

Within the drip-line area C6 and D6, the adjoining outer square, had a minimally higher density of bone recovered than the D9 square. Arguably if the bone were deposited by humans then it would be expected that higher densities would be found in the D6 and D9 squares as these were located in more commodious areas of the

shelter than C6 which was close to the back wall and had less head room. Food refuse discard patterns however do not always accord with human activity areas as illustrated by the clearing of shell from the central habitable space and the mounding of shell debris around the base of the cave walls (Jones 1971:186-188, 1980:162). Furthermore, in the case of bone debris from the Beeton Rockshelter site it appeared that at least some of it was probably deposited by non-anthropogenic agents.

Square	bone (non-avian) wt g	% by wt	density g/kg deposit
D9	4084.9	40	1.7
D6	3268.4	32	1.9
C6	2174.4	22	1.9
I6	171.3	2	0.2
U7	448.6	4	0.6
TOTAL	10147.6	100	Mean 1.3

Table 4.13: Distribution of non-avian vertebrate faunal remains.

The distribution pattern of mammal bone across the site was similar to that of both cultural remains such as stone artefacts and shellfish remains, and also non-cultural remains such as muttonbird bone. Hence while the patterning of bone density across the site may be reflecting human behavioural patterns, it was not possible to differentiate between these and other animal behaviour solely from the distributional evidence across the site.

Bone densities within the depth of the deposit from squares C6 and D9, were also examined for variation over time (Table 4.12). These data indicate that compared with the underlying Pleistocene unit, there was a relatively high density of terrestrial bone remains in the disturbed rookery layer; and little bone in the surface layers of the deposit, most of which consisted of some 10 centimetres or so of sheep and cow dung. Similarly small quantities of shell and other cultural remains were recovered from these upper spits, ie stratigraphic units I and II, which appeared to have been

disturbed from unit III by stock and other animal activity. For this reason bone remains from the uppermost 3 or 4 spits (stratigraphic units I and II) have been combined with the rookery unit as analytical Unit A for analytical purposes (Table 4.14).

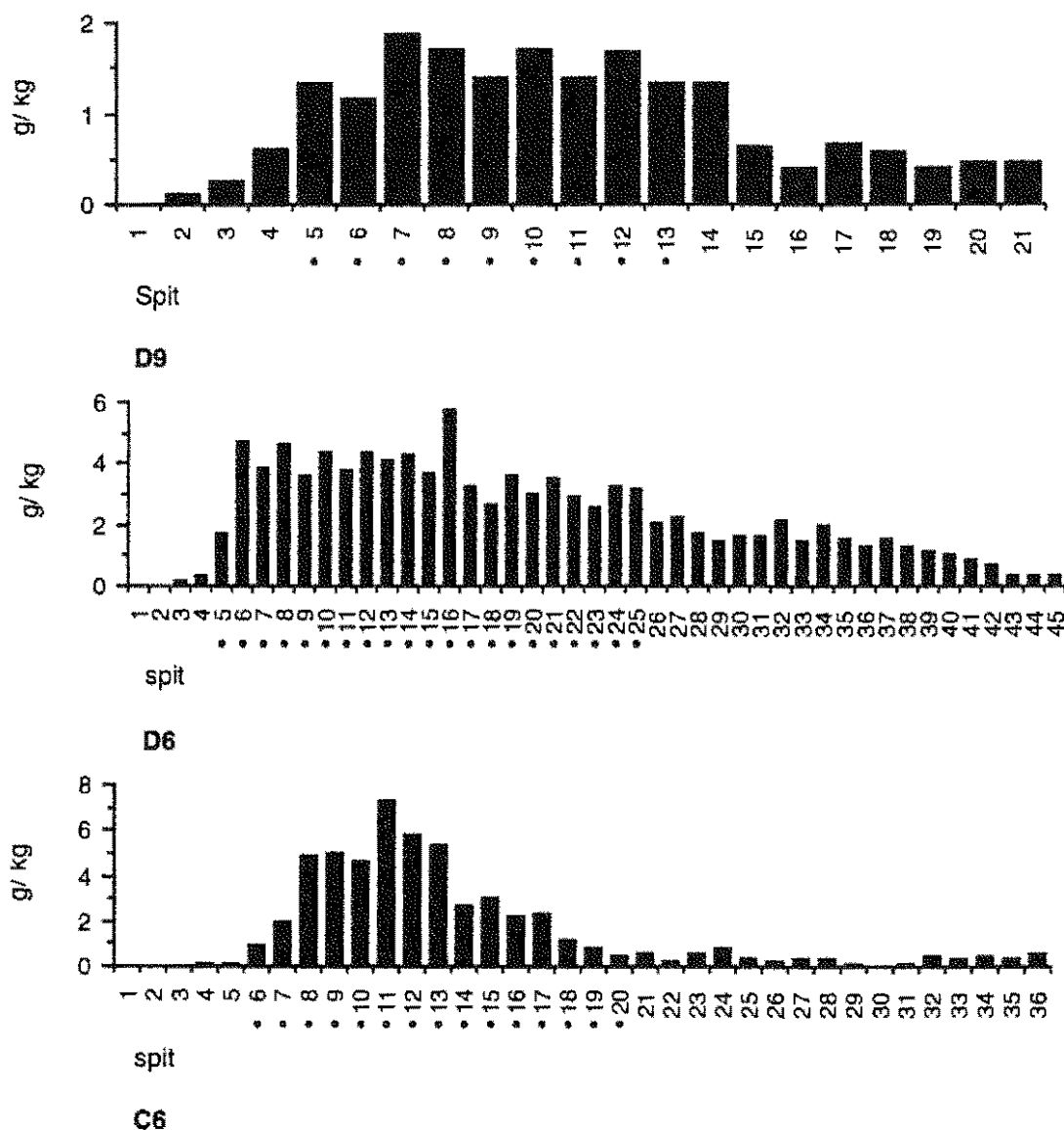


Figure 4.5: Bone density per spit - volumetrically corrected (* denotes spit within stratigraphic unit III - rookery layer).

Analytical Unit	Square D9		Square D6		Square C6	
	wt g	%	wt g	%	wt g	%
Unit A	2563.4	63	2095.0	64	2019.2	93
Unit B	1521.5	37	1173.4	36	155.2	7
TOTAL	4084.9	100	3268.4	100	2174.4	100

Table 4.14a: Terrestrial bone distributions.

Analytical Unit	Square D9	Square D6	Square C6
	g bone/kg deposit	g bone/kg deposit	g bone/kg deposit
Unit A	2.5	2.6	2.7
Unit B	1.2	1.3	0.4

Table 4.14b: Comparative bone densities volumetrically corrected.

Table 4.14: Terrestrial bone distribution and density per analytical unit in squares D9, D6 and C6.

Although a much higher percentage of bone was recovered from Unit A in the C6 square, when corrected volumetrically the density of bone in this unit is very similar to that in Unit A in the D9 and D6 squares (Table 4.14). Only the density of bone in Unit B in the C6 square was inconsistent with the pattern shown in other squares (Table 4.14b). This lower density may be reflecting the location of the square immediately against the rear wall of the shelter in the past when sediment levels in the shelter would have been lower (Figure 3.1). The relative paucity of bone is undoubtedly reflecting preferential use of shelter areas closer to the drip-line; the question is whether this preference was that of humans or other animals which could be responsible for the deposition of bone in the shelter.

There was no clear evidence in the distribution patterns of the bone at the site which would indicate these remains were a product of human predation. Arguably the

increased density of terrestrial bone in the rookery layer, the layer containing the shellfish remains could suggest that these were associated with the midden phase occupation. Nevertheless, there would need to be unequivocal evidence of a cultural association between the animal bone and shellfish remains to support this contention as this disturbed unit also contains deposits spanning the 10,000 years or so prior to the midden phase occupation.

It is also possible therefore that the increase in bone in the rookery layer is associated with increased use of the shelter in the post-glacial period but prior to the most recent midden phase – assuming that the bone is cultural. The critical issue here however is that of the cultural status of the terrestrial vertebrate bones, rather than of their antiquity. This question was further investigated by examining the range of species, bone conditions such as fragmentation and burning and the role of non-anthropogenic agents that may have deposited bone remains in the shelter.

Species range, size and distribution

To investigate the species range, size and distribution evident in the remains terrestrial bone samples from the C6 and D9 squares were analysed. These squares were selected as they provided samples from different areas within the shelter, and apart from the disturbed rookery level were stratigraphically otherwise intact. All terrestrial bone recovered from the C6 square was included in the analysis, whereas a randomly selected 50% sample from D9 was used. This sampling strategy was employed because of the fragmented nature of the bone remains and the quantity of these recovered from the D9 square; the 50% sample comprised 14,494 individual bones or fragments (Table 4.13). Unless otherwise stated, the analysis of the terrestrial vertebrate bone is based on the C6 and D9 samples.

Fish, reptile and frog

In addition to the mammal and avian bone, faunal remains included reptile, amphibian and fish remains. The fish bone which included three vertebrae weighed in total 2.2 grams, and was all found in the I6 square just outside the drip-line. The status of the fish bone as cultural remains is dubious as these were all retrieved from the uppermost spits and could have been deposited by birds or carnivore mammals scavenging from the nearby shoreline (Smith 1984). The location of the remains in the square close to the outer edge of the shelter roof suggests they were probably dropped by birds feeding on prey or scavenged carrion. Raptors known to take and

scavenge fish inhabit the islands, and a brown falcon was frequently observed resting and feeding on the rockshelter ledge during the excavations. White-breasted sea eagles, renowned for their fishing prowess are also sighted around the islands. Given the absence of fish in other squares, an avian origin is considered the most likely explanation for the fish remains recovered.

Of the bone analysed from the D9 and C6 squares less than 0.9% (2.1 grams) was reptile and 0.3 % (0.71 grams) was amphibian (Table 4.15). All the amphibian bone was frog, whereas several skink and lizard species were present in the reptile remains; no snake bone was recovered. The remainder of the non-avian vertebrate remains comprised terrestrial mammal bone, from species the majority of which are now locally extinct on Badger Island.

Square	Reptile		Frog		Mammal	
	wt g	%	wt g	%	wt g	%
D9	1.79	0.08	0.33	0.03	2079.41	99.89
C6	0.34	0.02	0.38	0.02	2170.28	99.96

Table 4.15: Relative distribution of terrestrial faunal bone in squares D9 and C6.

Mammal

Mammal species represented in the Beeton Rockshelter bone remains were compared with the previous records of extant and sub-fossil distributions from the Furneaux Islands [Appendix VII]. More specifically, the range of species from the Beeton Rockshelter deposits were compared with those on Badger and Flinders Islands in historic times (Table 4.16). This comparison is limited to medium and larger sized mammals as no systematic studies have been undertaken on the smaller extant mammal populations on Badger Island, and historic records from Badger Island are unlikely to contain reliable information regarding murid and other small mammal species distributions. Two mammal species, both macropods, were recorded on Badger Island in historic times and while it is possible that medium-sized species

such as possums, quolls or bandicoots were there, these were not recorded (Hope 1973:175; Rounsevell *et al.* 1991:754). These species were however recorded on other remote Furneaux Islands, suggesting that the historic records are most probably accurate at least for medium and large-sized species.

	Extant *	Extant *	BEETON	SHELTER
	Flinders Is.	Badger Is.	Unit A	Unit B
Macropodidae				
Forester Kangaroo (<i>Macropus giganteus</i>)			•	
Bennetts Wallaby (<i>Macropus rufogriseus</i>)	•	•	•	•
Tasmanian Pademelon (<i>Thylogale billardieri</i>)	•	•?	•	•
Vombatidae				
Wombat (<i>Vombatus ursinus</i>)	•		•	
Dasyuridae				
Spotted Quoll (<i>Dasyurus maculatus</i>)	•		•	• <i>D. sp?</i>
Eastern Quoll (<i>Dasyurus viverrinus</i>)			•	• <i>D. sp?</i>
Tasmanian Devil (<i>Sarcophilus harrisii</i>)			•	
Peramelidae				
Southern Brown Bandicoot (<i>Isodon obesulus</i>)	•		•	•
Eastern Barred Bandicoot (<i>Perameles gunnii</i>)			•	•
Petauridae				
Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	•		•	
Phalangeridae				
Brushtail Possum (<i>Trichosurus vulpecula</i>)	•		•	
Potoroidae				
Potoroo (<i>Potorous tridactylus</i>)	•*		•	•
Tasmanian Bettong (<i>Bettongia gaimardi</i>)			•	

* in the early 1800's

Table 4.16: Large and medium-sized mammals recorded in the Beeton Rockshelter compared with historic distributions on Badger and Flinders Islands (Flinders Island and historic data from Hope 1972, Rounsevell *et al.* 1991).

The range of mammal species from the Beeton Rockshelter is consistent with sub-fossil remains from other prehistoric deposits in the Furneaux region (Brown 1993; Hope 1973). Although it was aimed to examine the changes over time in the species range in the deposit, the small number of bones identifiable to species recovered from the Unit B deposit precluded this. The sample size of identifiable bone (i.e. identifiable to family level) from this unit was about one quarter of that recovered from Unit A, and few of these were identifiable to species level (Table 4.17). Hence more species were identified in the Unit A remains, rather than in Unit B as would be expected if the faunal suite was contracting as rising post-glacial seas covered land areas in the region. No species were recorded in the lower unit that were not also present in the upper (Table 4.16). Several species however were not present in Unit B but were recovered from the more recent Unit A deposits.

Those absent from the species identified in Unit B deposits were the wombat, the two possum species, the Tasmanian devil and the Tasmanian Bettong. There is no clear explanation for this, although the absence could be reflecting the comparatively small sample size of species identifiable bone in Unit B. Nevertheless, a genuine absence of these species could suggest that the localised environment was somewhat different and not a favourable habitat for these particular mammals during the last glacial maximum. Given the rapid sedimentation rate during the depositional phase represented by Unit B, this is plausible as the immediate locality may well have been a sandy dune environment with sparse vegetation cover (Hope 1978; Wasson 1986.). From the current evidence available, either explanation is plausible: the absence may be due to either the small sample size, or the unfavourable habitat – or both of these factors may be playing a role.

The sub-fossil records from this and other prehistoric bone assemblages in the Furneaux region indicate that there was a marked reduction in faunal species on the islands and that this was related to the palaeogeographic changes wrought by the post-glacial inundation (Brown 1993; Hope 1973). Hope has clearly demonstrated that there is a direct correlation between the number of the large-sized mammal species an island will support long term and the size of the island (1973:187). Flinders Island which covers about 1,330 square kilometres, had relatively few mammal extinctions in prehistoric times, retaining 11 of its 13 large and medium-sized mammals.

Although the internal comparison of species present in Units A and B in the Beeton Rockshelter assemblage does not follow the expected pattern of reduction, in combination these two data sets show a marked reduction in the number of mammal species on Badger Island in the pre-insulation period, compared to the historic mammal records. On Badger Island which is about ten square kilometres in size, the 13 species of large and medium-sized mammal species present in prehistoric times were reduced to two in the post-insulation phase – a situation consistent with that on other islands of similar size in the region (Hope 1973:187).

Category	D9 Unit A no. of bones/ fragments	D9 Unit A weight g	D9 Unit A % by N	D9 Unit A % by wt g
identifiable (to family)	1728	178.3	19	13
unidentifiable/unidentified	351	60.7	4	5
fragments < 20mm	6749	754.5	72	57
fragments > 20mm	483	325.4	5	25
TOTAL	9311	1318.9	100	100

Category	C6 Unit A no. of bones/ fragments	C6 Unit A weight g	C6 Unit A % by N	C6 Unit A % by wt g
identifiable (to family)	414	123.3	4	6
unidentifiable/unidentified	188	32.2	2	2
fragments < 20mm	9074	1284.2	84	63
fragments > 20mm	1066	578.8	10	29
TOTAL	10742	2018.5	100	100

Table 4.17a: Unit A.

Category	D9 Unit B no. of bones/ fragments	D9 Unit B weight g	D9 Unit B % by N	D9 Unit B % by wt g
identifiable (to family)	1791	264.1	35	35
unidentifiable/unidentified	948	199.2	18	26
fragments < 20mm	2276	224.5	44	30
fragments > 20mm	137	72.6	3	9
TOTAL	5154	760.8	100	100

Category	C6 Unit B no. of bones/ fragments	C6 Unit B weight g	C6 Unit B % by N	C6 Unit B % by wt g
identifiable (to family)	318	25.3	14	17
unidentifiable/unidentified	142	20.1	6	13
fragments < 20mm	1706	91.3	78	60
fragments > 20mm	38	15.1	2	10
TOTAL	2204	151.8	100	100

Table 4.17b: Unit B.

Table 4.17: Percentages by weights and numbers of identifiable mammal bone compared with unidentifiable fragmented and other unidentifiable/unidentified mammal bone.

Fragmentation patterns and carnivore predation

The bulk of the mammal bone from all levels of the deposit in the shelter comprised fragments unidentifiable to skeletal element (Photograph 12, Table 4.18). Only a small percentage of the remains could be identified to family or species level, although a general body-size category could be assigned to some bone in the fragmented and unidentified (species and family) bone categories. The bulk of the bone recovered accorded with criteria used to identify assemblages of bone deposited in caves and rockshelters in owl and raptor pellets, and in Tasmanian devil scats

(Dodson and Wexlar 1979; Douglas *et al.* 1966; Geering 1990; Hall and Jones 1990; Hayward *et al.* 1993; Hope 1969:58; Marshall and Cosgrove 1990). Thus a large percentage of the bone from the Beeton Rockshelter deposit probably does not represent human food debris.

CATEGORY	Square D9 %	Square C6 %
unidentifiable fragments <20 mm	47	63
unidentifiable fragments >20 mm	19	28
unidentified/unidentifiable (non-fragmented)	14	7
species/family identifiable	20	2
TOTAL	100	100

Table 4.18: Percentages of mammal bone in identification categories from squares D9 and C6.

The main criterion for devil scat bone is a high degree of fragmentation with the bulk of the bone fragments being less than 20 millimetres in maximum dimension, and tending toward square in shape rather than elongated (Douglas *et al.* 1979; Marshall and Cosgrove 1990:110). Virtually all of the fragmented bone from the Beeton Rockshelter fitted this criterion as even fragments greater than 20 millimetres were relatively small pieces, broken to such a degree that it could not be determined from which element they originated. Although some bone in the fragments > 20 millimetres category were larger than 39 millimetres, the upper limit identified for bone from devil scats, none were identifiable as to element and in the main, bone from this category fitted the criteria for devil scat remains (Marshall and Cosgrove 1990:110). In devil scat bone about 5% of the scat bone remains consists of fragments > 20 millimetres (Marshall and Cosgrove 1990:107). These data suggest that about 50% or more of the terrestrial bone recovered from the Beeton Rockshelter deposits was probably from Tasmanian Devil scats.

Variation over time in the possible contribution of devil-deposited bone was investigated by comparing remains from Unit A with Unit B (Tables 4.17a and 4.17b; Figure 4.6). The proportion of fragmented bone numbers < 20 millimetres to bone fragments >20 millimetres is generally consistent with the 95% to 5% ratio found by Marshall and Cosgrove (1990:107) in devil scats (Table 4.19).

From these data it is apparent that compared with the D9 square, a higher proportion of bone in the C6 square at the rear of the shelter, is consistent with devil scat remains. Assuming a portion of the bone in the non-scat categories, that is the non-fragmented, identifiable and unidentified bone is attributable to human predation activity, then the distributions indicated in Figure 4.6 suggest that culturally deposited bone is probably densest in the D9 remains. Moreover evidence of devil activity appears to have been more prevalent in Unit A in both squares, and possibly a greater percentage of culturally deposited bone present in the Unit B assemblage.

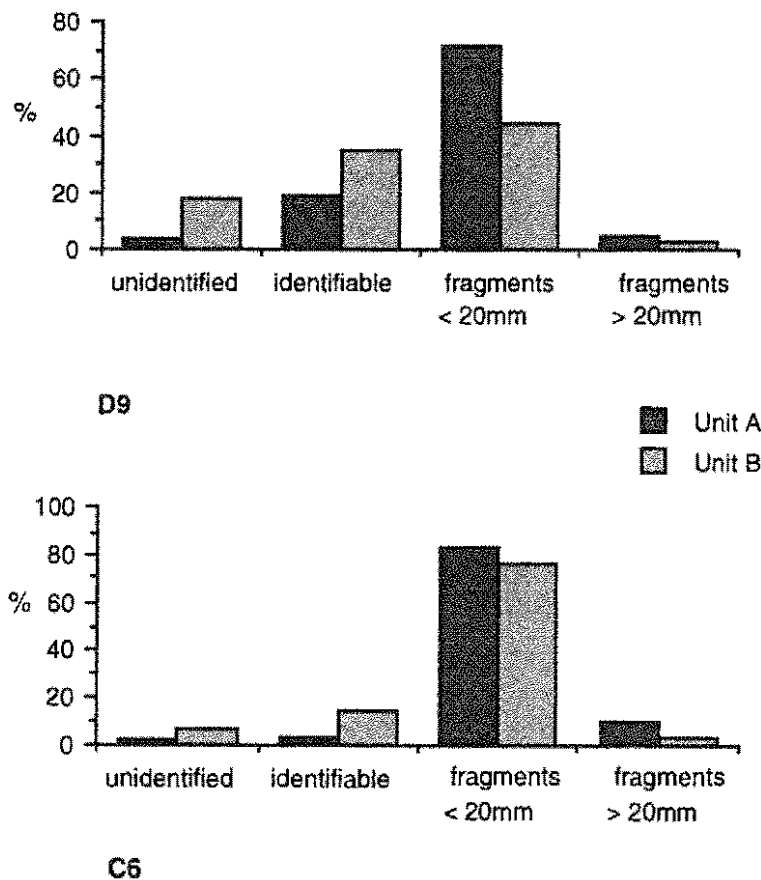


Figure 4.6: Percentage by weight of terrestrial bone categories in Units A and B.

Category	D9 Unit A n	C6 Unit A n	D9 Unit A %	C6 Unit A %
unidentifiable mammal fragments < 20mm	6749	9074	93	89
unidentifiable mammal fragments > 20mm	483	1066	7	11
TOTAL	7232	10140	100	100

Category	D9 Unit B n	C6 Unit B n	D9 Unit B %	C6 Unit B %
unidentifiable mammal fragments < 20mm	2276	1706	94	98
unidentifiable mammal fragments > 20mm	137	38	6	2
TOTAL	2413	1744	100	100

Table 4.19: Percentage of fragmented bone <20 mm compared with that >20 mm in analytical units.

Other non-human predators

While it is acknowledged that thylacines were almost certainly in the region in the past, there are no historic records or sub-fossil evidence of their presence in the Furneaux region. Nor are there any scat studies or other relevant reference material known to exist for this species. For this reason, the role of thylacines as agents of bone deposition in the Beeton Rockshelter site was not investigated. Although it is recognised that they may have been responsible for some of the bone remains in the Beeton Rockshelter deposit, the detection of this is beyond the scope of this thesis. There is however clear evidence of deposition of bone by other carnivores in the remains from the site.

Bone from owls and raptor pellets

The overall assemblage of analysed bone of terrestrial fauna was characterised by a predominance of small mammal bone, and thus was typical of rock-shelter bone assemblages with a component of owl and raptor-deposited bone (Dodson and Wexlar 1979; Geering 1990; Hayward *et al.* 1993) (Table 4.20). Several raptor and owl species which inhabit the region, are known to target murids.

More than 80% of all small mammal bone identifiable to family level from analytical units in both squares D9 and C6 comprised murid bone, most of which was identified by complete long bones and mandibles (Table 4.21). The presence of complete murid long bones is a characteristic trait of owl and raptor pellet bone (Dodson and Wexlar 1979:283; Geering 1990:141). This suggests that the murid and possibly other small mammal bones most probably originate from owls roosting and raptors perching in the shelter, although quolls may also be responsible for a component, as discussed below.

Mammal body size category	Σ D9 N	Σ C6 N	Σ D9 %	Σ C6 %
small	1768	380	67	52
medium	696	162	26	22
medium and large	67	33	3	4
large	93	162	4	22
TOTAL	2624	737	100	100

Table 4.20: Distribution by number of non-fragmented bone identifiable to family level per size category.

Mammal carnivores other than Tasmanian Devils (*Sarcophilus harrisii*).

Terrestrial faunal remains, other than those attributable to devil scats and owl and raptor pellets, were investigated further for evidence of other non-human predation patterns. Apart from devils, several other species of carnivorous mammals also known to inhabit rockshelters were in the past extant in the Furneaux region. These included medium and small-sized dasyurids, the latter of which are two antechinus and a dunnart species, all of which are of small rodent size and prey in the main on small invertebrates (Strahan 1983). Given their size and feeding habits, these small dasyurids are highly unlikely to have contributed significantly to the vertebrate bone remains.

On the other hand, medium-sized carnivores such as the Spotted and Eastern Quolls (*Dasyurus maculatus* and *Dasyurus viverrinus*) prey on a range of murids, bandicoots, smaller macropods, arboreal mammals – that is most of the smaller and medium sized categories of mammals, as well as ground nesting birds and reptiles (Strahan 1983). Like Tasmanian devils, the quolls also scavenge carcasses of larger mammals, but do not hunt or transport such remains to their lairs. Therefore, the presence of large mammal bone in the site (other than as scat fragments) is unlikely to be introduced to the site's deposit by carnivorous marsupials, unless they were scavenging carcasses of large mammals which had died natural deaths in the rockshelter. Hence, the only explanations for the presence of non-fragmented large mammal bone in the rockshelter deposit are human predation or natural deaths.

small mammal bone	Σ D9 wt g	Σ C6 wt g	Σ D9 %	Σ C6 %
murid (4 species)	179.37	24.7	88	90
other (6 species)	25.03	2.71	12	10
TOTAL	204.42	27.41	100	100

small mammal bone	D9 Unit A wt g	C6 Unit A wt g	D9 Unit A %	C6 Unit A %
murid (4 species)	30.12	8.87	82	80
other (6 species)	6.55	2.23	18	20
TOTAL	36.67	11.1	100	100

small mammal bone	D9 Unit B wt g	C6 Unit B wt g	D9 Unit B %	C6 Unit B %
murid (4 species)	149.27	15.83	86	97
other (6 species)	25	.46	14	3
TOTAL	174.27	16.29	100	100

Table 4.21: Percentage by weight of murid bone in the family identifiable remains from the small mammal category.

Natural deaths or human predation

The problem of whether the non-fragmented large mammal bone was a product of human predation or natural deaths was investigated further by examining

- the distribution of non-fragmented large mammal bone within the deposit, and
- the bone for damage consistent with human predation behaviour.

During the sorting process all non-fragmented bone was examined for butchering marks such as those inflicted by stone artefacts, fracture patterns such as 'Z' fractures and other transverse breakage, or other features which are considered to be hallmarks of human exploitation behaviour (Binford 1981; Brain 1981; Colley 1990; Lyman 1987; Rackham 1994:35; Sadek-Kooros 1975).

Only one bone had discernible marks that could possibly have resulted from human exploitation. The distal joint on one unburnt but broken macropod long bone had been removed by what appeared to be chewing but it was not possible to detect damage patterns on the bone which would indicate the predator species. This bone was however recovered from analytical Unit A in the D9 square, where there was a relatively high proportion of large mammal bone compared with other sized mammals in that unit (Tables 4.20 and 4.22).

Mammal body size category	D9 Unit A N	C6 Unit A N	D9 Unit A %	C6 Unit A %
small	465	152	56	36
medium	238	73	28	18
medium and large	39	32	5	8
large	90	160	11	38
TOTAL	832	417	100	100

Mammal body size category	D9 Unit B N	C6 Unit B N	D9 Unit B %	C6 Unit B %
small	1303	228	73	71
medium	458	89	26	27
medium and large	28	1	1	1
large	3	2	0	1
TOTAL	1792	320	100	100

Table 4.22: Numbers and percentages of non-fragmented bone per body size category in analytical Units A and B.

Arguably, if all the non-fragmented large mammal bone were from natural deaths then it could be expected that the proportion of this type of bone would be fairly constant over time. The density per spit of all non-fragmented bone from medium and large mammals – that is all bone that could not be attributed to other predators such as birds or devils – does suggest a fairly consistent presence in the D9 square and a less consistent but nonetheless persistent presence in C6. The latter square also showed an overall increase in the density of bone from medium and large mammals in Unit A, specifically the rookery spits (Figure 4.7). Overall these data suggest that natural deaths were in part contributing to the medium and large-sized mammal bone in the deposit, and that medium-sized mammals formed the majority of these remains (Table 4.22, Figure 4.8). This pattern however was not totally consistent over time as there was a marked disparity in the proportion of large mammal bone found within Unit A compared with that in Unit B, and this disparity was similar in both D9 and C6 samples (Figure 4.8).

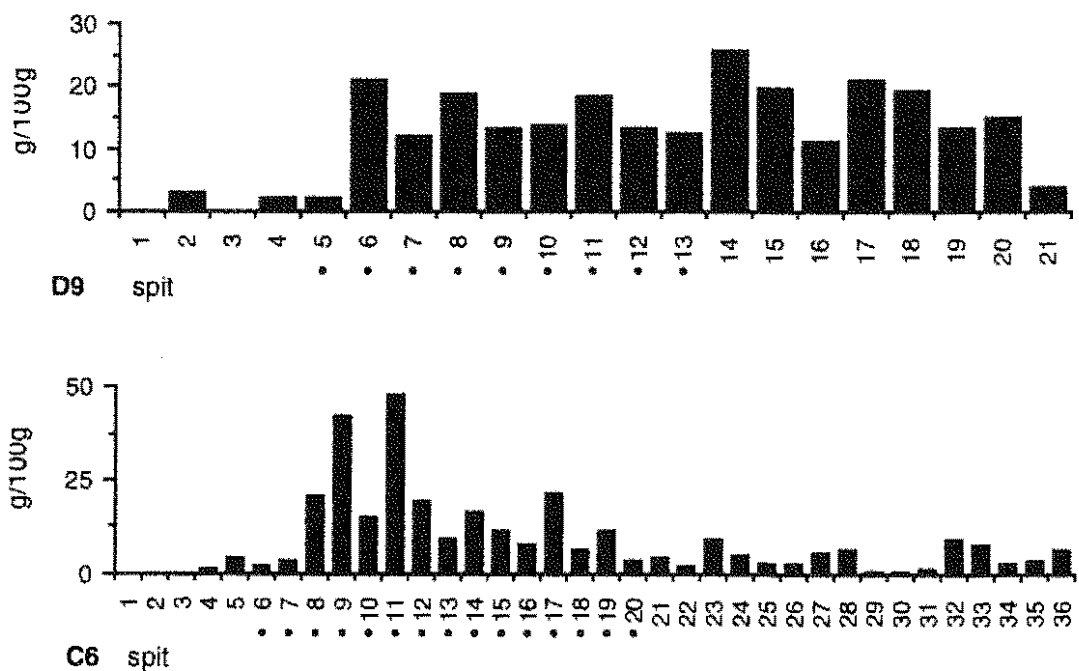


Figure 4.7: Volumetrically corrected density by weight of non-fragmented bone from medium and large-sized mammals (* indicates rookery layer spits).

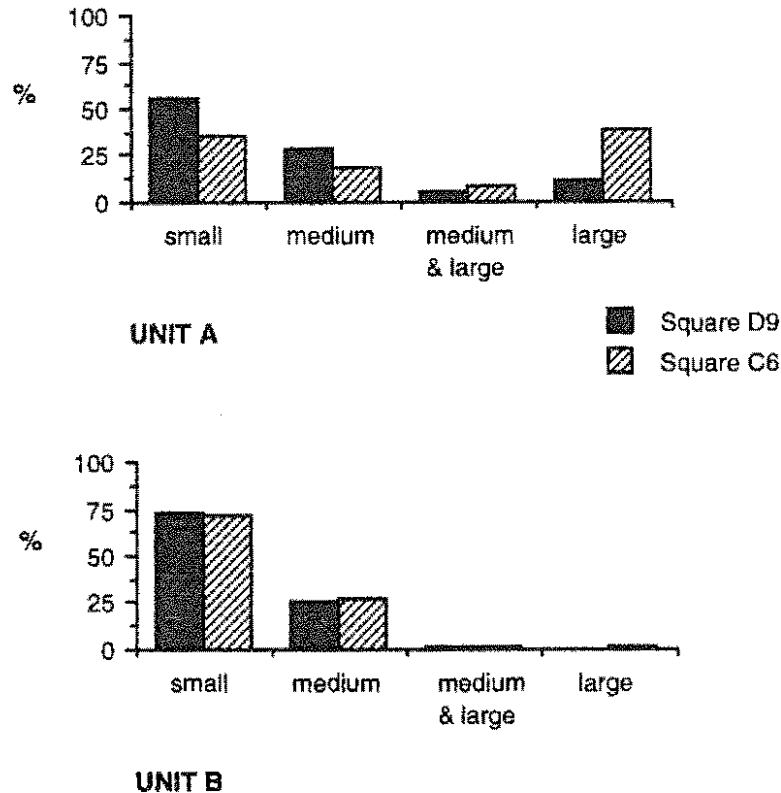


Figure 4.8: Percentage by number of non-fragmented mammal bone in body size categories.

The coincidence of the marked increase in large mammal bone in Unit A, where unequivocal cultural remains appeared to be denser, strongly suggested that human activity was probably responsible at least in part for the deposition of the large mammal bone, and possibly also some of the medium-sized mammal. This proposition was canvassed further in the analysis of the burnt bone distribution.

Burnt bone distribution

In rockshelter deposits, burnt or charred bone is recognised as a relatively reliable indicator of human activity. While acknowledging that some non-cultural bone will be inadvertently heat affected in hearth areas, the majority of burnt bone in cultural

deposits probably results from cooking of animal foods. For the purposes of the analysis, all bone that was calcined, charred, blackened or had other evidence of heat damage was classified as burnt bone. The comparison of the ratio of burnt to unburnt bone in analytical Units A and B indicates that there was a markedly higher percentage of burnt bone recovered from Unit A in both D9 and C6 squares (Table 4.23; Figure 4.9). This accords with the higher incidence of large mammal bone in Unit A deposits, lending further support to the interpretation of mammal remains of this size as human food debris.

Of the burnt bone identifiable to family level, about 80% by number of bones and 92% by weight comprised large mammal bone: wallaby, pademelon and wombat. The large burnt macropod remains also included a molar from an Eastern Grey or Forester kangaroo (*Macropus giganteus*), a species which is now locally extinct in the Furneaux region and restricted in mainland Tasmania to relatively small open grassland areas of the northeast. Between 7% and 11% of the burnt bone was from medium-sized mammals – bandicoot and possums, and the remainder small mammals comprising indigenous rats, mice and a single antechinus (marsupial mouse) bone (Table 4.24). Given the presence of large quantities of other small mammal bone originating from bird pellets, it is probable that the burnt murid and other small mammal bone is similarly non-cultural, and heat-damaged inadvertently by hearths being lit in the shelter. Compared with the unburnt terrestrial bone assemblage, there is a disproportionately high representation of bone from medium and large-sized mammals in the burnt bone sample (Table 4.25). As can be seen by the cumulative frequency graph, the majority of the burnt bone comes from the larger mammal size range, and this is in marked contrast with unburnt bone, the majority of which came from small mammals such as murids (Figure 4.10).

The divergent pattern found in the burnt bone remains suggest that human predation was responsible for a major portion of this bone, and that people were principally targeting large and medium-sized animals. The majority of the burnt bone identifiable to family from this body size range was wallaby, pademelon and wombat, suggesting these may have been the principal species being exploited for food by people inhabiting the Beeton Rockshelter.

D9 Square	Unit A wt g	Unit B wt g	Unit A %	Unit B %
Burnt	230.5	37.8	17	5
Unburnt	1088.4	723.0	83	95
TOTAL	1318.9	760.8	100	100

D9 Square	Unit A n	Unit B n	Unit A %	Unit B %
Burnt	1293	173	14	3
Unburnt	8018	4981	86	97
TOTAL	9311	5154	100	100

Table 4.23a: Square D9.

C6 Square	Unit A wt g	Unit B wt g	Unit A %	Unit B %
Burnt	716.9	18.91	35	12
Unburnt	1301.6	132.89	65	88
TOTAL	2018.5	151.8	100	100

C6 Square	Unit A n	Unit B n	Unit A %	Unit B %
Burnt	5016	299	47	14
Unburnt	5736	1905	53	86
TOTAL	10751	2204	100	100

Table 4.23b: Square C6.

Table 4.23: Percentages of burnt bone to unburnt bone by weight and number in analytical units squares D9 and C6.

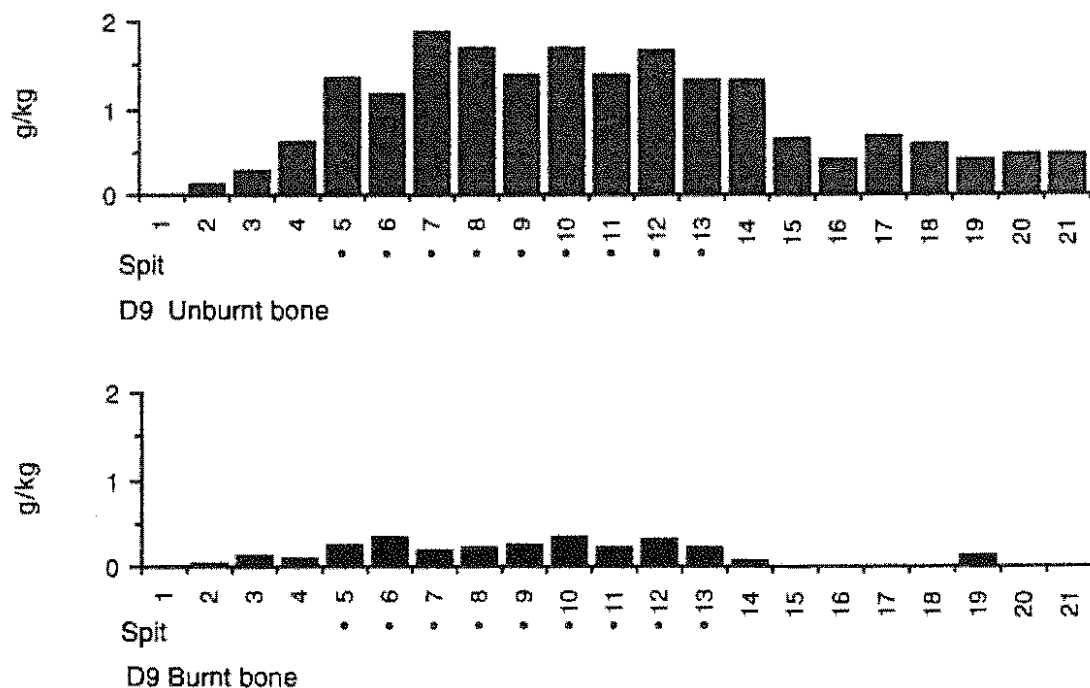


Figure 4.9a: Distribution by spit of burnt and unburnt bone from D9 - by weight and volumetrically corrected (* indicates rookery layer spits).

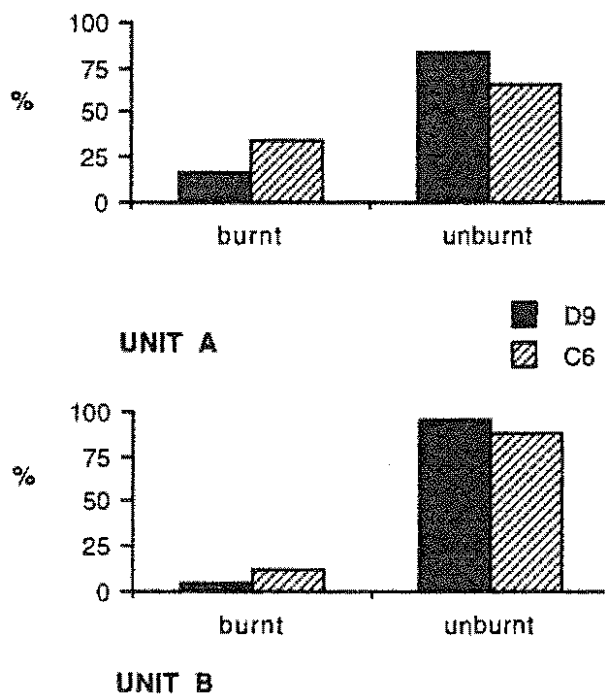


Figure 4.9b: Percentage of burnt to unburnt bone (by weight) per analytical unit.

Figure 4.9: Comparison of burnt and unburnt bone.

FAMILY types represented	wt g	n	% wt	% n
Macropodidae kangaroo, wallaby, pademelon	37.58	81	56	46
Vombatidae wombat	23.74	59	36	33.5
Peramelidae bandicoots	1.36	15	2	9
Petauridae Ringtail possum	3.34	4	5	2
Dasyuridae antechinus	.05	1	0.1	0.5
Muridae rats, mice	.52	15	0.9	9
TOTAL	66.59	175	100	100

Table 4.24: Distribution by weight and number of family identifiable burnt bone from combined D9 and C6 samples.

Mammal body size category	Burnt n	Unburnt n	Burnt %	Unburnt %	Ratio n burnt:unburnt
small	60	3313	12	71	1:55
medium	73	957	14	21	1:13
medium and large	254	189	49	4	1:0.7
large	129	190	25	4	1:1.5
TOTAL	516	4649	100	100	Mean 1:9

Table 4.25: Number and percentage of burnt and unburnt bone in the non-fragmented terrestrial mammal bone recovered which was identifiable to mammal body size category; and the ratio of burnt to unburnt bone per size category.

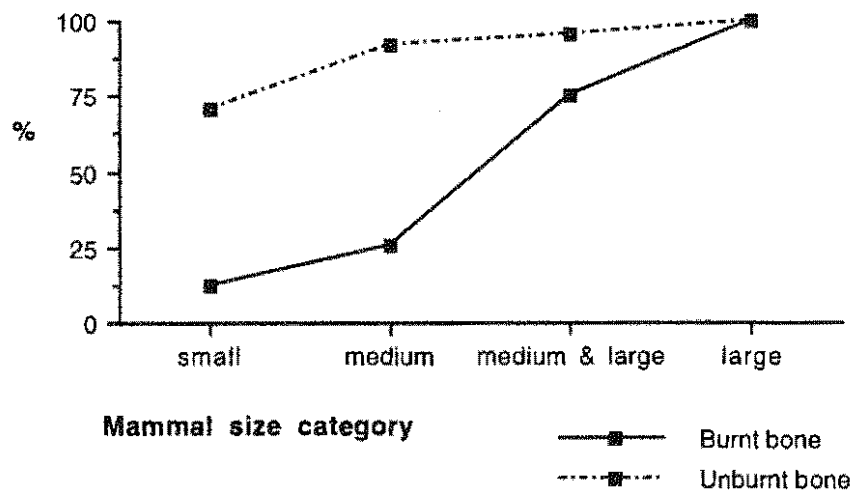


Figure 4.10: Cumulative frequency of burnt and unburnt bone (unfragmented) identifiable to family level from combined D9 and C6 samples.

4.3.4 Summary of the findings from the terrestrial vertebrate bone analysis

Although more than 10 kilograms of terrestrial vertebrate bone was recovered during the excavations, the majority of the bone was unburnt and comprised small mammal remains. The analysis indicates that the bulk of these remains are non-cultural and are attributable to carnivorous mammals, owls and raptor scats. The majority of bone recovered came from Unit A deposits, and about 23% of it had evidence such as discolouration indicating that it was heat affected. The majority of the burnt bone was from larger mammals, and this along with its concentration in Unit A suggested that most of the burnt bone was cultural.

The comparison between the range of mammal species identified in the shelter's prehistoric remains and in historic times indicates that, since insulation, the number of mammal species has declined markedly. This pattern is consistent throughout the smaller outer Furneaux Islands, indicating these remote island environments have a limited long-term carrying capacity for mammal species.

4.4 Seabird bone analysis

4.4.1. Muttonbird and other seabird bones

During excavation the stratigraphic association between the muttonbird bone and the shellfish remains was clearly apparent as both were confined to unit III. While it was obvious the shellfish remains were cultural remains, whether or not the muttonbird bone was food debris was unclear. Although burrow-like features encountered in the unit II deposit and apparent in the sections suggested it was an extinct rookery, the density of the muttonbird bone suggested that these remains were more probably human food debris. Moreover it was clear during excavation that the squares with more dense cultural material were the ones that also contained most muttonbird remains.

Initially it appeared that the origin of the muttonbird bones could be resolved by obtaining conventional radiocarbon dates from muttonbird bone in the site, and comparing the bird bone dates with those obtained from marine shellfish remains from the same midden levels. This however would not solve the problem: using conventional dating methods it would have been necessary to combine a number of the muttonbird bones to obtain the sample size required for C14 dating. If the bones had been excavated from a stratified deposit then this would not have presented so much of a problem, as one could assume there was some sort of chronological association between remains within each layer.

The problem was that the deposit containing the bird bone and shellfish remains had no such stratigraphy, and had to be subdivided artificially in (measured) layers for excavation purposes. If at some stage the site had been a rookery, then it was possible that the muttonbird bones in the midden deposit were a mix of both human food refuse and bird bones from natural rookery deaths. Therefore, dating a combined muttonbird bone sample from this context could potentially provide a date averaged from food refuse bones and considerably younger rookery bones.

It would only be possible to obtain dates useful in determining the origin of the muttonbird bones if a date could be obtained from bones from one individual bird, or else from single bones rather than combined samples. Since it was not possible to distinguish remains belonging to one individual, it was necessary to use AMS dating to obtain individual element dates. As discussed previously in regard to the chronology and depositional history of the site, the results of AMS dating on the

muttonbird bone showed that after people stopped using the shelter it had become a rookery, and the layer containing the shellfish and muttonbird bones had been created by bird and not human activity (Tables 3.2 and 3.5).

However, while eight of the nine dated muttonbird bones were between 5,000 and 6,300 years old, one was considerably older and of similar antiquity to the shellfish remains (Table 3.5). At 9980-9855 BP, the date for this bone falls within the span of dates obtained for the shellfish remains, the implication being that a portion of the muttonbird bone may be human food debris (Table 3.2). Further analysis of the muttonbird was undertaken, the principal aim of which was to determine if it was possible to distinguish culturally deposited muttonbird bones amongst those resulting from natural rookery deaths. Evidence of early Holocene muttonbird exploitation is of interest as the evidence for prehistoric exploitation of muttonbirds is to date scant and confined to late Holocene sites.

Although not dense, muttonbird bones have been previously found in a number of Tasmanian archaeological sites; Cave Bay Cave and other sites on Hunter Island (Bowdler 1979; O'Connor 1982), Prion Beach rockshelter (Dunnnett 1992), the West Point midden (Jones 1966), and the Maatsuyker Island and Louisa River sites (Vanderwal and Horton 1984). The most substantial evidence of prehistoric muttonbirding to date is that from the Prion Beach rockshelter site (Dunnnett 1992). This midden site contained remains from a range of different seabird species, marine shellfish, mammals and terrestrial birds, and charcoal from the midden base was dated to about 2,000 BP (Dunnnett 1992).

On Hunter Island, the only evidence of intensive Aboriginal muttonbird exploitation is from the historic occupation early last century when sealers took women, stolen from their Tasmanian tribes, to the islands (Bowdler 1979; O'Connor 1980:38). There was no evidence of prehistoric muttonbirding on other Bass Strait islands, including the Furneaux Islands, many of which have large muttonbird (*Puffinus tenuirostris*) populations (Sim 1989, 1991). I previously investigated accumulations of muttonbird bones in dune deposits on King Island as it was unclear if these were a product of human predation or natural rookery deaths (Sim 1988). Although natural deaths in muttonbird rookeries are common, as a result of bird and other predators, and also from burrow collapses, it was possible that the muttonbird bone deposits were anthropogenic in origin as there were other accumulations of faunal remains in dunes around King Island, including prehistoric and historic midden sites (Sim 1988).

Element analysis revealed a disproportionately high number of wing bones in dunes and rookeries on King Island. It was subsequently revealed that this pattern was a result of recent exploitation by fishermen who remove the wings when they take the birds for crayfish bait (Sim 1988). This information cast considerable doubt on Vanderwal and Horton's identification of muttonbird bones on Maatsuyker Island sites as being prehistoric human food remains. Wing bones were over-represented in the suite of muttonbird bones from these rookery sites, and they were located close to anchorages used by crayfishermen (Sim 1988; Vanderwal and Horton 1984).

The King Island example demonstrated that human predation patterns, albeit in that case one of recent non-Aboriginal exploitation, could be detected amongst bones found in rookery locations; deposits which would almost certainly also contain bones from natural deaths. While the bulk of the muttonbird bone from the Beeton Rockshelter was almost certainly from natural rookery deaths it appeared nonetheless that some component of it may have been human food debris. The investigation therefore aimed to determine if this were the case by identifying indicators of prehistoric Aboriginal exploitation.

The analysis described is generally confined to the remains retrieved from the Beeton Rockshelter site. I carried out the initial analysis of the seabird bone from the site, and West undertook further analysis comparing the Beeton Rockshelter site muttonbird remains with human-predated muttonbird bone suites from a Tasmanian Aboriginal and a Maori site (Dunnett 1992; Sutton and Marshall 1980; West and Sim 1995). The body of this work was undertaken before any of the muttonbird bone dates were received. Three dates were obtained just prior to the completion of the report and were all about 5,000 years old – that is younger than the shell dates by more than 3,000 years. Subsequent dating results which included one bone of similar antiquity to the shellfish remains at the site lent support to the conclusion from the other analyses that a minor component of the muttonbird bone may have been of anthropogenic origin (Table 3.5).

4.4.2 Method

All seabird bone was sorted, weighed and identified wherever possible by species and element. Other data recorded included the handing of naturally paired elements, age of bird where evident, evidence of burning and degree of fragmentation. Darrell West did all the sorting, primary identifications and entered the data on Filemaker [Appendix VIII and IX]. The late Dr Jerry van Tets did all the other seabird

identifications from the site, checked the *P. tenuirostris* identifications and also identified muttonbird species other than *P. tenuirostris* present in the avian remains.

4.4.3 Results

A total of 4,832 muttonbird (*Puffinus* sp.) bones weighing 994.6 grams were recovered from the five squares excavated (Table 4.26). In contrast, bones from other seabirds were much less common, the excavated remains containing only 262 bones weighing some 36.2 grams (Table 4.27). In terms of volumetrically corrected weights, the muttonbird had an average density 30 times that of all other seabird bone (Tables 4.26 and 4.27). It is estimated that the sample from the three squares inside the shelter represents about 5% of all seabird remains in the deposit as only three of 60 or more square metres of habitable space in the shelter was excavated.

SQUARE	Muttonbird bone no.	Muttonbird bone wt g	kg of deposit excavated	density: g bone /10 kg deposit
D9	2602	447.3	2284.0	1.9
D6	1891	408.4	1726.2	2.4
C6	252	115.2	1159.3	0.9
I6	63	16.3	900.0	0.2
U7	24	7.6	723.0	0.1
TOTAL	4832	994.7	6792.5	Mean 1.5

Table 4.26: Weight, number and density of muttonbird (*Puffinus* sp.) recovered from the Beeton Rockshelter excavations.

SQUARE	other seabird no. bones	other seabird wt g	kg of deposit excavated	other seabird g /10 kg deposit
D9	57	7.28	2284.0	.03
D6	98	10.4	1726.2	.06
C6	106	18.5	1159.3	.15
I6	1	.89	900.0	.01
U7	0	0	723.0	0
TOTAL	262	36.2	6792.5	Mean .05

Table 4.27: Weight, number and density of seabird bone other than muttonbird.

Distribution across the site

The density of muttonbird bone varied considerably across the site with markedly lower densities in the squares outside the shelter, U7 and I6. Lower densities in these latter squares may be reflecting less intensive bird-nesting in these areas. In the case of the I6 square near the drip-line, the deposit was marred by large pieces of rock which had fallen from the receding rim of the shelter. This rock may have been a major deterrent to birds seeking soft deposits in which to make their burrows. Similarly the deposit in the U7 square may have not been well suited to burrowing as the depth of sand deposit in this location was considerably shallower than inside the shelter.

Arguably, the lower densities could be related to human exploitation of muttonbirds and anthropogenic bone discard patterns at the site. The coincidence of high muttonbird bone densities and the squares where burrow features were detected does not support the cultural explanation for the distribution of the bone across the site - rather it strongly suggests that it is directly related to the intensity of bird activity in different areas of the site.

The stratigraphic context of the seabird bone

Nearly all of the muttonbird and other seabird bones were recovered from analytical Unit A, and more specifically from stratigraphic unit III, the darker shell bearing layer overlying the Pleistocene sand unit (Tables 4.28a and 4.28b). A small quantity of remains was recovered from the underlying unit, in squares D9 and D6. In the case of the D9 square all seabird bones in Unit B came from the uppermost level of the Pleistocene unit, from the junction between this basal unit and the overlying rookery layer. Considering the indistinct junction and burrow features at the base of the rookery layer, the inclusion of material from this layer in the uppermost spit of the underlying unit is not unexpected. In D6 however, muttonbird and other seabird bones were recovered from lower spits; one piece of bone was about 20 centimetres below the base of the rookery layer. In this square however there was evidence of an animal burrow passing through the rookery level and intruding some way into the Pleistocene sand unit, resulting in a small quantity of shell and bone being transported down into the underlying deposit.

Overall however, the distribution of the seabird bone was confined to the rookery layer in Unit A, and there was no evidence to suggest that any of the seabird bones

had been deposited prior to the midden phase occupation. Any original depositional stratigraphic context of these remains had been disturbed by the mid-Holocene rookery phase at the shelter.

SQUARE	Unit A no. of bones	Unit A wt g	Unit B no. of bones	Unit B wt g
D9	2542	441.1	30	2.1
D6	1865	406.4	26	2.0
C6	252	115.2	0	0
TOTAL	4659	965.7	56	4.1

Table 4.28a: Number and weight of muttonbird (*Puffinus* sp.).

SQUARE	Unit A no. of bones	Unit A wt g	Unit B no. of bones	Unit B wt g
D9	57	7.3	0	0
D6	93	9.3	5	1.1
C6	106	18.5	0	0
TOTAL	256	35.1	5	1.1

Table 4.28b: Number and weight of all other seabird (apart from *Puffinus*).

Table 4.28: Seabird bone in Units A and B from squares excavated within the shelter, D9, D6, and C6.

Species range and ratios

Five species of muttonbirds (or shearwaters) were identified amongst the remains: the Short-tailed Shearwater or Tasmanian Muttonbird (*Puffinus tenuirostris*), Fluttering Shearwater (*Puffinus huttoni*), Fleshy-footed Shearwater (*Puffinus carneipes*), Wedge-tailed Shearwater (*Puffinus pacificus*), Sooty Shearwater (*Puffinus griseus*). Another as yet unidentified muttonbird (*Puffinus* species) was also recorded along with remains

from other birds in the same family, the Petrels *Procellariidae* (Table 4.29). These latter remains have been categorised as other petrels and included in the other seabird category along with bones from: the Great-winged Petrel (*Pterodroma macroptera*), the Little Penguin (*Eudyptula minor*), the Pacific Gull (*Larus pacificus*), Fairy Prion (*Pachyptila turtur*), and an Oystercatcher (*Haematopus longirostris* or *fuliginosus*).

Relative proportions of bone numbers, weights and minimum numbers of individuals (MNI) for each of the muttonbird (*Puffinus*) species and for other seabird remains together are tabulated and graphed below (Table 4.29, Figure 4.11). Muttonbird bones made up the bulk of the seabird remains, representing more than 95% of the remains by both weight and number. Of these, some 80% comprised the Short-tailed Shearwater (*Puffinus tenuirostris*), the only muttonbird found in the Tasmanian region today. The presence of the other *Puffinus* species is primarily of interest because of the implications for mid-Holocene palaeoclimatic conditions, rather than human activity at the site. While these palaeoclimatic indicators are not necessarily unrelated to past human occupation patterns in the region, they are shed no light on the immediate question concerning the cultural status of the muttonbird bones.

The species range amongst the seabird bones recovered from the Beeton Rockshelter excavations was similar to that from the Prion Beach Shelter midden (Dunnett 1992). The latter site contained midden debris with remains of eight different seabird species. These included muttonbird (*P. tenuirostris*) and other petrels, Fairy Prion, penguins and Pacific Gull; a range of seabirds such as that also found at the Beeton Rockshelter site. The results of Dunnett's investigations suggest that in prehistoric times seabirds generally constituted a valued, albeit minor, component of the Tasmanian Aboriginal diet and were deliberately targeted as a food source (Dunnett 1992). This suggested that other seabird bones (apart from muttonbird) from the Beeton Rockshelter site may similarly have been human food refuse.

The only other explanation for the presence of non-*Puffinus* seabird species in the Beeton Rockshelter deposit would be non-human predators or scavengers such as birds of prey or mammalian carnivores. None of the seabird bones from the Beeton Rockshelter site however bore evidence of either carnivore or bird predation (Jerry van Tets pers. comm.). It is highly probable therefore that muttonbird aside, all other seabird bone is human food debris, most probably from occupation in the coastal phase of the site, when the shellfish remains were also deposited.

The cultural status of *Puffinus* remains on the other hand, is less clear. Given that other seabird bones in the deposit appear to be human food debris, culturally deposited muttonbird bone at the Beeton Rockshelter site would not however appear aberrant.

BIRD sp. /other	wt g	% wt g	No. of bones	% N	MNI	% MNI
<i>P. tenuirostris</i>	838.5	81	4059	80	55	66
<i>P. griseus</i>	70.2	7	136	3	8	9
<i>P. pacificus</i>	27.6	3	159	3	4	5
<i>P. carneipes</i>	10.9	1	61	1	1	1
<i>P. huttoni</i>	1.0	0	3	0	1	1
<i>Puffinus</i> chicks	45.8	4	413	8	7	8
<i>Puffinus</i> (sp. ?)	0.7	0	1	0	1	1
Other seabird	37.1	4	262	5	8	9
TOTAL	1031.7	100	5094	100	85	100

Table 4.29: Proportions of different muttonbird species and other seabird recovered from all squares excavated.

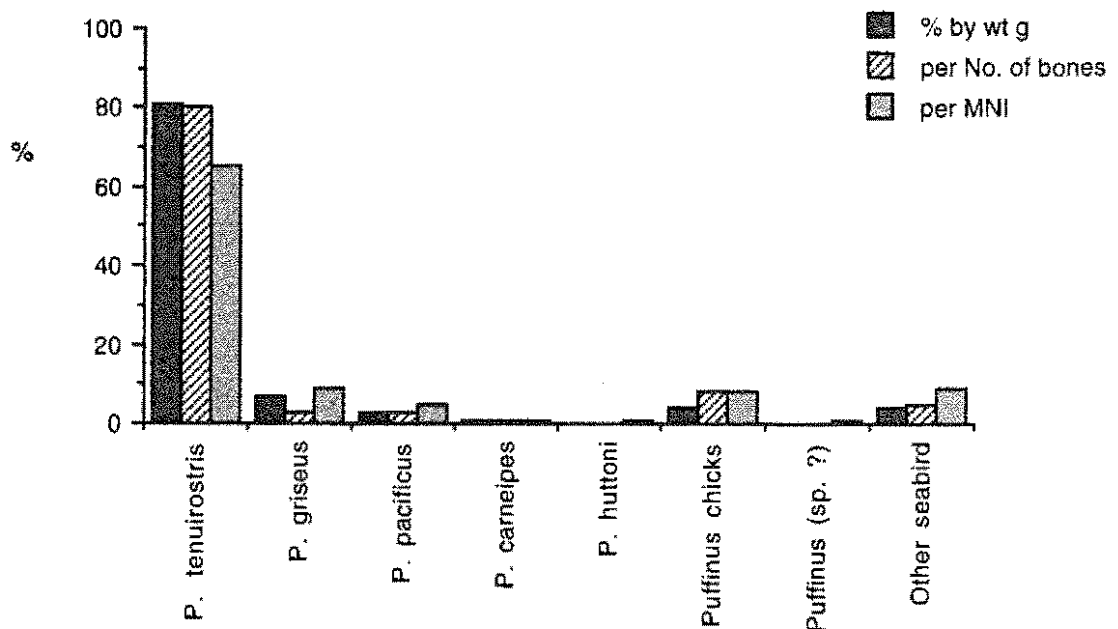


Figure 4.11: Percentage of muttonbird and other seabird recovered from all squares excavated.

Element distribution analysis

Different skeletal elements in the Tasmanian or Short-tailed Shearwater (*Puffinus tenuirostris*) muttonbird remains from Beeton Rockshelter were quantified in order to identify any unnatural bias in elements represented in the sample of muttonbird bones. Relative proportions of different skeletal elements were quantified using total weights of particular elements in the excavated sample. These data were compared with a control sample simulating a rookery sample; that is, the expected pattern from natural bird deaths calculated on the distribution of elements in a complete bird (Figure 4.12).

For this comparison, elements were grouped into body part categories. The elements assigned to body part categories identified in Figure 4.12 include

- a) all wing bones (humerus, radius, ulna and all carpal bones)
- b) all leg and foot bones (femur, tibia and all tarsal bones)
- c) skull and bills (cranium, mandible and premaxillae), and
- d) body elements (vertebrae, ribs, scapulae, furcula, sternum, coracoids and pelvis).

The relative proportions of different muttonbird skeletal elements from the Beeton Rockshelter site were also compared with the muttonbird sample from cultural deposits at the Prion Beach Shelter (Dunnett 1992) (Figure 4.13). It was only possible to compare elements for which there were comparable data in both sites.

The inter-site comparison therefore included only eight elements:

- a) major wing and leg long bones (humerus, ulna, femur and tibia),
- b) upper and lower bills (mandible and premaxillae), and
- c) the sternum and collarbones (coracoids).

The data for these elements from the two sites were each compared to the pattern that would be found in a natural death sample, that is the relative proportions found in a sample of these elements from a complete bird (Figure 4.13). The sample sizes from each of the sites differ considerably, with numbers of these eight elements (graphed as relative percentages) totalling 960 bones in the sample from the Beeton Rockshelter and 95 from the Prion Beach Rockshelter site.

As a control sample, data from a complete bird provides a rather coarse level for comparison, in that the elements being used for the inter-site comparative analysis are present either as single or paired elements, representing 7.7% or 15.4% respectively. A finer comparative level could have been obtained by comparing the

relative proportions of different elements using weights rather than counts (as in Figure 4.12). This was not possible for Figure 4.13 however, as the data from the Prion Beach Rockshelter was expressed as counts rather than weights of particular elements (Dunnett 1992:24).

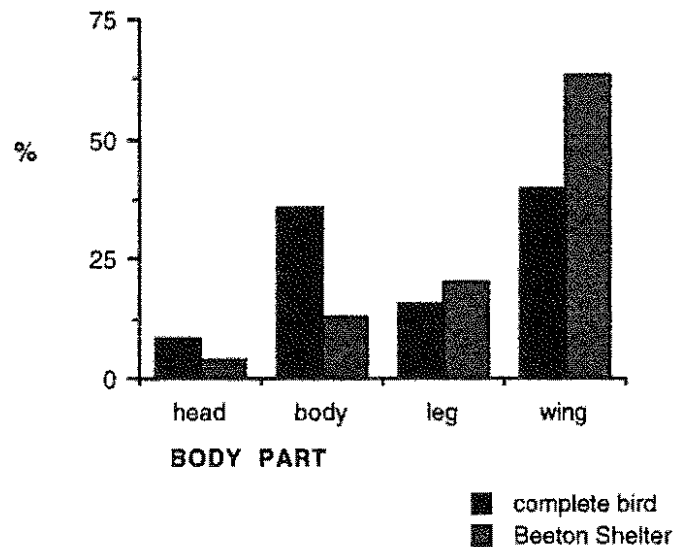


Figure 4.12: Percentage by weight of muttonbird (*P. tenuirostris*) head, body, leg and wing bones from the Beeton Rockshelter site compared to the distribution of these elements in a natural (complete bird) sample.

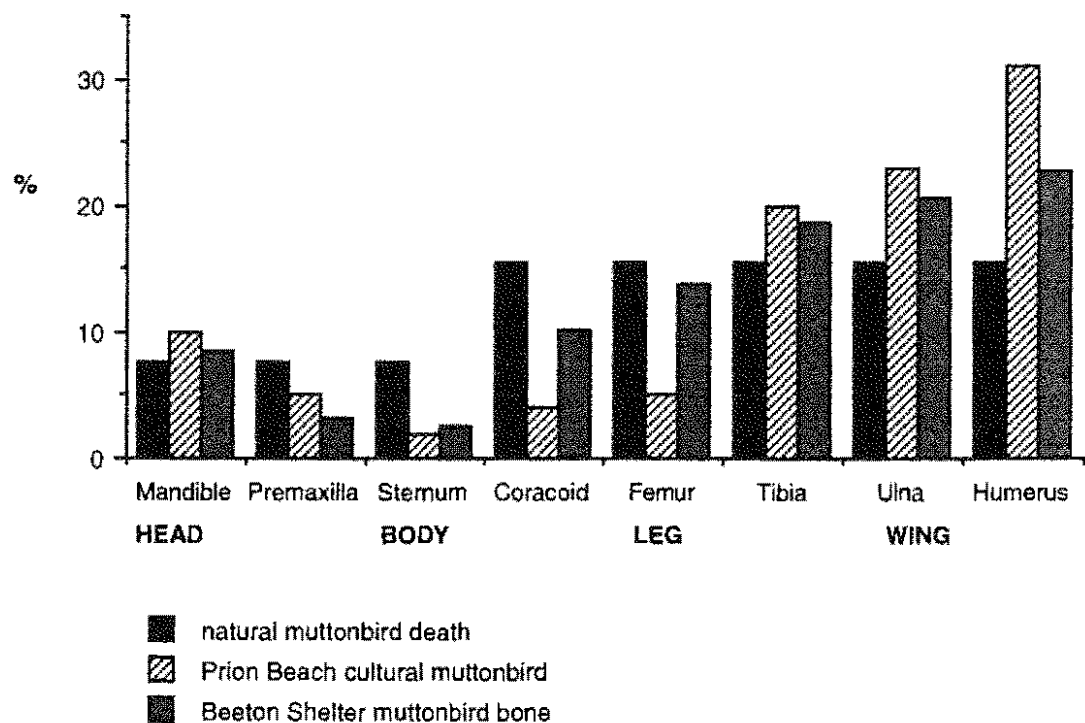


Figure 4.13: Comparative distribution of *Puffinus tenuirostris* body part elements - percentages calculated from bone element numbers in each sample.

Element analysis results

Figure 4.12 indicates that, compared to a natural death (complete bird) sample, there was a higher than expected representation of wing and leg bones present in the Beeton Rockshelter sample, with the disparity being most marked in the wing bones. On the other hand, both head and body elements were under-represented although this pattern was markedly more noticeable in the body bones. If the pattern of bias in the wing and body bones were a product of human predation, then it suggests that wings, which have minimal meat on them, were being discarded on site, and the bird bodies which have substantially more meat on them, were either being thrown out of the shelter or burnt. As none of the seabird bone had evidence of being burnt or charred it does not appear that bird bones were being discarded into hearths. Other implications of the absence of burnt seabird bone are discussed further below.

The possible bias in the wing and body bone in the Beeton Rockshelter sample was examined in light of comparison with the Prion Shelter site (Figure 4.13). From Figure 4.13 it can be seen that the only deviations greater than 10% are all from the Prion Beach cultural bone, with over-representation of humeri at +15%, and under-representation of femora at -11% and coracoid bones at about -12% from the natural death pattern. Otherwise, however, the deviation of the known cultural sample from the Prion Beach site, from the expected, natural element distribution was less than 7%. This suggested that overall the muttonbird element distribution is not very helpful in distinguishing prehistoric rookery samples from human predation sites.

It could be inferred from the under-representation of femurs and coracoids, that as these are found in the fleshiest part of the leg and breast, these were the parts being consumed – and that after consuming the flesh the bones were being thrown out of the main shelter area. And parts of the birds not being consumed, such as the wings, lower legs and bills were removed from the bird and left lying around the shelter floor. Unfortunately, because of the limited sample size recovered from the Prion Beach Shelter conclusions relying solely on the data from this site are somewhat tenuous. Nonetheless, there was a consistent pattern in the over-representation of the tibia, ulna and particularly humerus bones that warranted consideration.

Since these elements are all long bones and appeared to be amongst the more robust of the muttonbird skeletal elements, the question of differential preservation could not be dismissed.

Preservation of muttonbird bone

The muttonbird bone dates indicate that at least some, if not most, are more than 6,000 years old (Table 3.5). Some elements in the muttonbird skeleton are quite fragile, and bird bone in general is relatively light and thin. It is possible therefore that what is present in the deposit now is the surviving remnant, and therefore not a representative sample of what had been originally in the deposit, whether as a result of natural rookery deaths or human exploitation.

To test for differential preservation of elements, the bone elements analysed above were ordered by degree of fragility; with mandibles being the most fragile element and hence least likely to be preserved over time, and coracoids the most robust and thus most likely to survive should sediment conditions be other than optimal for preservation. Figure 4.14 shows the relative representation of elements in the Beeton Rockshelter muttonbird bone sample, ordered (from left to right) according to degree of fragility rather than body category. If preservation was a factor then it would be expected that more fragile elements on the right would be under-represented, with mandibles being most affected.

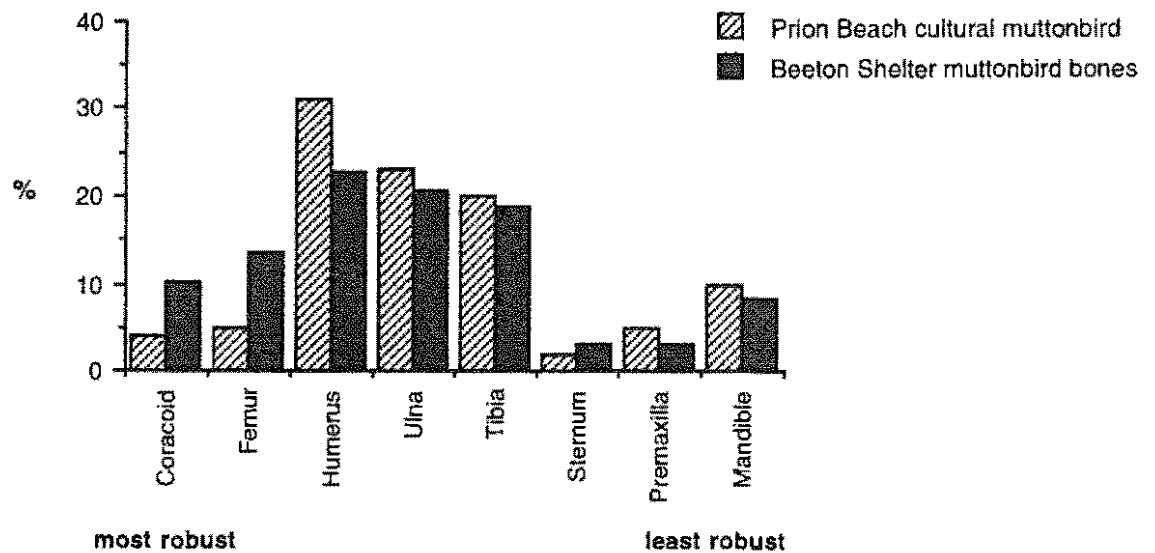


Figure 4.14: Proportion of elements represented in the Beeton Rockshelter muttonbird bone graphed with elements graded from the most robust on the left to the most fragile on the right.

The most interesting result shown in Figure 4.14 is the low proportion of coracoid and femur bones, in both samples of muttonbird, but particularly in the culturally deposited bone from Prion Beach. That these two most robust bones are those relatively poorly represented in the samples indicates that the distribution of bone elements is unlikely to a result of differential natural preservation processes. Rather it suggests that the under-representation of these elements is a product of human predatory behaviour, and particularly so in the sample known to be cultural material from Prion Beach. That a similar pattern, albeit less marked, is consistent in these bone elements from the Beeton Rockshelter site suggests that at least some of the bones from there are probably human food debris.

Age of birds at death

The predominance of adult individuals, in both muttonbird and other seabird cultural remains, from the Prion Beach Rockshelter site suggested that human predation involved targeting adult birds. In light of these findings, the age of the birds in the predominant muttonbird species from the Beeton Rockshelter site were examined, and compared with the Prion Beach site data. The muttonbird age data from the Beeton Rockshelter site included all *Puffinus* species recorded, primarily because it is not generally possible to identify the species of bones from immature birds (i.e. chicks).

The sample from the Beeton Rockshelter site therefore includes all six muttonbird species whereas the Prion Beach Shelter site contained the one muttonbird species (*Puffinus tenuirostris*) found in that site. It is considered unlikely that age predation patterns would differ between muttonbird species; rookery behaviour differs little between species and the size range of species included in the analysis is similar with the exception of one smaller species which was represented by a single individual at the Beeton Rockshelter site. The mix of *Puffinus* species in the Beeton sample is not considered to be a significant factor in terms of the possible age of birds being exploited, if people were consuming muttonbirds at this site.

From the comparative age distributions graphed below, it is evident that the majority of *Puffinus* individuals recovered from both shelters are adult birds and juveniles and chicks represent a relatively minor component (Figure 4.15). Arguably, the similarity in age distributions between the two sites could suggest an anthropogenic origin for most of the *Puffinus* bone from the Beeton Rockshelter deposit. Conversely, the facts that the site was also an extinct rookery and that most of the dates from the

muttonbird bone post-dated human occupation at the site could also indicate that the age distribution in bone from natural rookeries is similar to that found in the Prion Beach site. Without a comparative sample from a rookery in an area known not to have been inhabited by people in the past, no firm conclusions can be drawn in regard to the age distribution of the *Puffinus* remains, despite the apparent match between the Prion Beach and Beeton Rockshelter remains (Figure 4.15).



Figure 4.15 : Age distribution of muttonbird remains using proportions of the *Puffinus* MNIs in the Beeton Rockshelter site compared with the Prion Beach Rockshelter midden (this latter data from Dunnett 1992:25).

Burning

All muttonbird remains were examined for evidence of burning, artificial breakage patterns or other conditions which could be relevant to predation behaviour. No burning or charring was evident on any muttonbird or other seabird bones from the Beeton Rockshelter site. This was inconsistent with the remains from the Prion Beach Rockshelter site. The sample from this latter site contained 381 *Puffinus tenuirostris* bones of which 24 or 6% had evidence of burning or more commonly, light charring. None of the 3,985 *Puffinus tenuirostris* bones from the Beeton Rockshelter deposit were burnt or charred.

The absence of burning or charred marks could possibly be attributed to preservation, that is, bleaching effects of chemicals in the sediments over time. Radiocarbon dates from the Prion Beach Rockshelter site indicate that the midden was deposited more recently than about 2,000 years ago whereas shell from the Beeton Rockshelter midden dates to about 9,600 BP. While it is possible that light scorch marks on bird bones from the midden phase occupation at the Beeton Rockshelter site could have

disappeared with time, this is considered unlikely; numerous burnt and charred mammal bone fragments were recovered from the rookery and shell layer but no muttonbird bone.

Since it is considered that the seabird bone other than the muttonbirds in the Beeton Rockshelter deposit is most probably human food remains, then the absence of burn marks on these suggests that seabirds were being consumed either raw, or were being cooked only minimally before being dismembered and consumed. Nevertheless, there was no positive evidence for burning or cooking on any of the mutton or other seabird bones, and this was at odds with the evidence from the Prion Beach site.

Bone fractures and fragmentation

Nearly 50% of the number of muttonbird bones recovered from the Beeton site were unidentifiable fragments, although by weight these represented only 14% (Table 4.30). Because of the longitudinal nature of the muttonbird bone fragmentation (described below), weight ratios rather than counts provide a more useful method for describing the bone sample.

	wt g	% (wt)	no. n	% (n)
Unidentifiable fragments	134	14%	1802	46%
Element identifiable	788	86%	2183	54%
TOTAL	922	100	3985	100

Table 4.30: Tasmanian muttonbird (*Puffinus tenuirostris*) bones from the Beeton Rockshelter site — weight, number and proportion of unidentifiable fragmented bone, and identifiable whole and broken bone.

Almost all of the unidentifiable bone consisted of narrow splinters, most of which were more than 1 centimetre in length. The remainder of the bone categorised as element identifiable, comprised complete or substantially complete elements. With few exceptions, all broken bone, whether fragments or identifiable elements, displayed longitudinal fracture patterns. The longitudinal splintering of the muttonbird bone is considered to be a product of natural weathering processes; it is

not consistent with the transverse fracture pattern evident on seabird bones in Tasmanian midden sites such as Prion Beach Rockshelter and the West Point site excavated by Jones (pers. obs.).

No transverse fractures were observed on the seabird bone from Beeton Rockshelter, although it was difficult to tell if such a pattern could be detected given the tendency for many of the long bones in particular to disintegrate. Splintering was clearly a product of decay over time as complete muttonbird bones were disintegrating longitudinally into numerous splinters in the process of being excavated from the site. Similar post-depositional, longitudinal splintering of buried muttonbird bone has been observed in other deposits in coastal environments, and is thought to result from a weathering process similar to 'salt wedging' on rock (Jerry van Tets pers. comm.).

Although it is possible that transverse fractures were being masked by subsequent longitudinal weathering patterns, overall the fracture evidence on the seabird bone from the Beeton Rockshelter site was not consistent with patterns known to result from human predation.

4.4.4 Summary of the seabird bone analysis

The bone analysis supports the AMS muttonbird dating in that the bulk of the muttonbird bone appears to be from the extinct rookery phase at the site, post-dating human occupation. The results also suggest however that a minor component of the muttonbird, and all the other seabird bones, are attributable to human exploitation. The direct correlation between one of the muttonbird bone dates and the culturally derived shellfish remains, the differential distribution of bone in the shelter, the similarity between Beeton and Prion Beach element and bird age distribution patterns, along with the presence of other seabird bone, are all consistent with at least a minor component of the bird bones in the Beeton Rockshelter site being from human predation. Rookery deaths alone do not provide a satisfactory explanation for the patterns identified in the muttonbird remains, nor for the presence of other seabird bones in the shelter.

It should be noted however that the conclusions from the muttonbird and other seabird bone analysis are somewhat problematic principally because of the small size of the comparative sample of muttonbird bones from the Prion Beach site, and the absence of comparative data from other prehistoric sites with larger sample sizes. At present there are none, which is partially why the investigation of the evidence for

possible Aboriginal exploitation of muttonbirds in the Beeton Rockshelter remains was undertaken. Further comparative analysis with natural rookery and archaeological site muttonbird bone samples could provide a greater degree of security in the results of the bird bone analysis. This is an avenue for further research, possibly by a specialist zooarchaeologist, that was beyond the scope and main aims of this thesis. Analysis of the present available evidence however led to the conclusion that a small component of the muttonbird remains was probably attributable to human predation.

4.5 Stone analysis

It could be expected that palaeoenvironmental changes over the span of prehistoric occupation of the Beeton Rockshelter site would be reflected to some extent in the cultural remains. Lourandos (1970, 1977) found a marked variation in stone assemblages from the Little Swanport midden site on the east coast of Tasmania and the Crown Lagoon site some 20 kilometres inland. He attributed variation in the assemblages from these two sites to different site functions; differences in resource exploitation behaviours associated with a coastal environment as opposed to an inland hunting site.

Because of the post-glacial marine inundation the Beeton Rockshelter has at various times in the past been both an inland site and a coastal site. It could be expected therefore that changes in site function linked to these palaeoenvironmental changes would be evident in the stone assemblages at this one site. The sea level rise would undoubtedly have affected localised exploitation strategies and also precluded access to stone resources in the lower altitude areas of the Bassian region. Hence, it was probable that there would be some variation evident in the stone artefacts from the most recent early-Holocene (midden phase) occupation and that from the late Pleistocene when sea levels were substantially lower.

As outlined in Chapter Three, muttonbird burrowing which took place several thousand years after people stopped using the shelter, and almost certainly resulted in the mixing of Pleistocene artefacts with more recent stone artefacts, midden shell and other cultural remains in unit III, the rookery layer. However, it can be confidently assumed that cultural remains underlying unit III, that is from unit IV, are all from Pleistocene occupation, pre-dating the early Holocene midden phase about 8,600 years ago.

The unit IV deposit underlying the surface and rookery units is relatively undisturbed and radiocarbon dates from charcoal within unit IV indicate that evidence of human occupation in this remnant Pleistocene layer spans from about 19,000 to 21,000 years ago (Table 3.2). This lower unit therefore can provide a stone artefact sample from the glacial maximum which can be compared with those from more recent occupation phases. It is possible also to use this as a baseline sample to control for possible variation over time in the more recent stone assemblage from overlying units, despite the possibility that overlying units could contain a mix of Pleistocene and Holocene artefacts. If present, major variation between the glacial maximum and the Holocene occupation phases should be detectable despite the possible inclusion of Pleistocene artefacts in the upper rookery deposit.

4.5.1 Aims

Analysis of the stone assemblage recovered from the Beeton Rockshelter excavations aimed principally to investigate the range of artefacts, technology employed in artefact manufacture and types of stone employed. From the antiquity of the cultural remains at the site it could be inferred, *a priori*, that the assemblage would be consistent with the broader Australian core tool and scraper tradition (Bowler *et al.* 1970; Jones 1979:91-92). It is generally accepted that all Australian flaked stone artefacts 'older than about 5,000 years' display 'a very restricted morphological range', the similarities of which 'are so marked that all examples can be treated as part of the coretool and scraper tradition' (White and O'Connell 1982:65). It could therefore be argued that an assemblage belonging to the core tool and scraper tradition is unlikely to contain patterned or behaviourally significant variation. Nevertheless, patterns of variation in the regional and temporal distribution of core tool and scraper artefacts have been identified in Australian Pleistocene assemblages (Hiscock 1983; Lampert 1979; Lorblanchet and Jones 1979). And in Tasmania, specific scraper types have been argued to represent not only chronological markers, but also archaeological signatures of regional economic systems (Cosgrove 1991:104; Jones 1990:279; McNiven 1994:80; Porch and Allen 1995:722).

The core tool and scraper tradition is however defined simply on the broad morphological similarities in Australian Pleistocene and early Holocene assemblages. And while this definition may be justified typologically for some cores and some

scraper tools, it does not include other artefact types that are also present in older Australian sites (Hayden 1979; Hiscock 1980; White and O'Connell 1982:85). For several decades, typological perspectives, stemming from the morphological homogeneity of Pleistocene retouched tools and cores, masked the potential of other avenues for investigating assemblages; and discussion of Pleistocene artefacts focused on the more widespread scraper types and single platform cores. These specific types actually represent a very small percentage of the majority of complete assemblages assigned to the 'core tool and scraper' tradition (Hiscock 1980; White and O'Connell 1982:87).

The advent of 'new' or 'processual archaeology' in the 1960s and 1970s saw a shift in paradigm away from typology and toward more behavioural explanations of the archaeological record and the development of middle range theory (Binford and Binford 1969; Gould 1977). This encouraged a broader approach to lithic studies, including the investigation of stone assemblages complete with the unretouched or debitage flakes which usually form the bulk of stone artefacts at sites. The development of middle range theory included the use of replication and ethnoarchaeological experiments in the analysis of stone assemblages, and highlighted the relevance of stone exploitation behaviour in the patterning of artefacts in sites (Binford 1977, 1983; Jones and White 1988). Implicit in this movement away from typological studies was the analysis of entire assemblages rather than focussing solely on formal implement types. Researchers recognised the potential for evidence of behavioural changes to be investigated using non-morphological traits such as raw material use, discard patterns, use-wear, residue and debitage analyses (Cosgrove 1991; Fullagar 1986; Kamminga 1982; Lampert and Sim 1986; Lourandos 1977).

Hence, while the assemblage recovered from the Beeton Rockshelter falls chronologically under the umbrella of the Australian core tool and scraper tradition, this does not preclude the possibility that behavioural changes had taken place over time in the region, and that such changes would be reflected in the stone assemblage. The fundamental aim of the analysis was to describe the stone artefacts recovered in a manner that would reflect the nature of the assemblage as a whole, and variation within the assemblage. More specifically, the stone analysis aimed to address issues such as how the assemblage may be reflecting changing accessibility of tool-stone sources and the human response to palaeogeographic (sea level) changes in the region.

4.5.2 Terminology

For the purposes of the artefact analysis the following terminology was employed.

Artefacts or artefactual stone:

All stone for which there was no explanation apart from human transportation for its presence in the deposit. Artefactual stone included;
all stone which had been humanly modified, and/or
all stone which was geologically foreign to the immediate site, excluding faunal gastroliths (stomach contents) (cf. Horton 1978:32).

Flakes:

Any piece of stone that had

- a) been detached from a core using a hammer-stone, and
- b) had a percussion bulb present on the ventral surface, and
- c) also had a striking platform, ring crack or point of force application indicating it was struck from a core by force applied to a single impact point.

Other general flake features include bulbar (erailure) scars and radiating force lines and rings centred on the point of force application.

Retouched flakes:

Retouched flakes include all flaked stone which had been deliberately modified by the removal of smaller flakes, evident by negative flake scars generally along the dorsal edge. This category includes all 'scrapers' and other recognisable tool types produced by retouch flaking. All retouched flakes are included in the 'implement' category.

Unmodified flakes:

Unmodified flakes comprised all flaked stone artefacts which did not have evidence of secondary modification resulting from retouch or use-wear. The majority of unmodified flakes are probably knapping debitage, although for those larger than 15 millimetres this should not be an *a priori* assumption (see 'debitage').

Unmodified flaked pieces:

All artefacts in this category were made from quartz. Flaked pieces included stone which had been artificially fractured but lacked a bulb. Evidence of human modification on such stone consisted of angular fractured surfaces in combination with annular and radial force cracks emanating from a point of force application, and/or crushing at this and the opposing end of the piece (described below). Flaked pieces with unequivocal evidence of use-wear were categorised as 'implements' along with retouched and other utilised flaked artefacts.

Implements:

The implements category included any flaked artefactual stone that had been retouched or had evidence of use-wear, i.e. any tool or utilised flaked artefact. Hence, this category included all retouched flakes, plus unretouched flakes and flaked pieces that had evidence of use-wear.

Cores:

Cores were defined as pieces of stone from which flakes had been struck, the desired aim being the production of flakes (as opposed to the removal of flakes from a flake in order to reshape it rather than produce other flakes). All cores had evidence of three or more flakes having been removed from the artefact.

Debitage:

Debitage can be used as a general term to refer to all by-products of the knapping process, and can include all unmodified flakes, flake fragments, flaked pieces and stone chips. For this study, the term debitage is restricted to all unmodified flakes and flaked pieces with a maximum dimension less than 15 millimetres.

Manuports:

Manuports included all stone

- a) that was geologically foreign to the site, and
- b) for which there was no other explanation for its presence in the deposit apart from human transportation, and
- c) that did not have flake features, and
- d) that had not been intentionally modified in the process of producing flakes.

Cortex:

The term cortex has been used in the standard archaeological sense, that is to refer to surfaces of the rock that have not been artificially fractured and retain characteristics of the natural rock surface. The most common cortex types in the Beeton Rockshelter assemblage were water-rounded cobble surfaces, rough vein quartz and crystal facets.

Use-wear

Use-wear was defined by the presence of edge damage on flaked artefacts or cores, resulting from use of the artefact as a tool. Wear on artefacts from the Beeton Rockshelter site took the form of small use-fractures; small hinge, feather, bending and step fractures around utilised flake margins (as per Kamminga 1982:6,7). There were no flaked artefacts identified with other forms of use-wear such as polish or edge bevelling (Kamminga 1977:209, 1982).

4.5.3 Attributes recorded

In keeping with the aims of the stone analysis the following metrical and descriptive attributes were recorded for each category of artefacts:

Flaked implements (retouched and flaked artefacts with use-wear):

- length, width and thickness in millimetres
- weight in grams
- cortex: presence/absence, type and % of surface with cortex
- length of retouched edge or portion of edge with use-wear
- use-wear presence/absence
- stone type
- typological description of artefact

Cores:

- length, width and breadth in millimetres
- weight in grams
- cortex: presence/absence, type and % of overall surface
- stone type
- description of core type (single platform, multi-platform, bipolar)

Manuports:

- length, width and breadth in millimetres
- weight in grams
- cortex: presence/absence, type and % of overall surface

- stone type
- description of manuport
- Unmodified flakes and flaked pieces:
 - stone type
 - maximum dimension
 - weight in grams
 - bulb presence/absence
 - cortex: presence/absence, type and % of surface with cortex
- Unmodified flakes and flaked pieces from each spit were grouped according to stone type and size (Appendix X).

4.5.4 Analytical units

Because of the disturbed nature of the rookery unit, and the lack of stratigraphic definition in the underlying deposit, neither excavated spits nor stratigraphic units were useful for analytical purposes. The few artefacts found in stratigraphic units I and II overlying the unit III rookery layer had clearly been disturbed from the rookery unit by animal activity in relatively recent times. Hence, artefacts excavated from spits within the surface and disturbed rookery deposits, that is stratigraphic units I - III, were conflated into one analytical unit, Unit A. All remaining artefacts, that is those recovered from spits within the stratigraphic unit IV, the remnant of the undisturbed Pleistocene deposit were for the analysis designated as Unit B (Table 3.1)

As detailed in Chapter Three, estimates from radiocarbon dated charcoal and emu eggshell samples suggest the prehistoric occupation span represented by cultural remains in Unit A to be from around 8,000 to 18,000 or so years ago. The occupation span in Unit B appears to be probably in the order of about five thousand years, from about 18,000 to 23,000 ago.

Although data was recorded for stone artefacts from all squares excavated, the analysis focuses on artefacts recovered from D9, D6 and C6, the squares excavated within the rockshelter (Figure 3.1). These three squares contained more than 96% of stone artefacts recovered, and had a consistent ratio of artefacts recovered from the rookery and the underlying Pleistocene unit (Tables 4.31, 4.32a and 4.32b). Artefacts from the squares I6 and U7 were generally excluded because of the small sample sizes obtained from these two squares, and the problem of compatibility when

comparing samples obtained from squares located outside with those from the three squares located within shelter itself.

Square	artefacts wt g	no.	kg of deposit excavated	no. artefacts/ kg deposit
D9	2124.6	1436	2284.0	.62
D6	2305.8	1769	1726.2	1.02
C6	1292.6	791	1159.3	.68
I6*	110.6	70	900.0	.07
U7*	857.1	85	723.0	.11
TOTAL	6690.7	4151	6792.5	.61

Table 4.31: Weight, number and density of stone artefacts recovered from the Beeton Rockshelter excavations (* indicates squares located beyond the drip line).

Square	Unit A no. artefacts	Unit A kg deposit	Unit B no. artefacts	Unit B kg deposit	Unit A artefacts no. /kg	Unit B artefacts no. / kg
D9	1392	1026	44	1258	1.35	.03
D6	1593	817.4	176	908.8	1.95	.19
C6	780	748.8	11	410.5	1.04	.02
I6*	67	347	3	553	.19	.01
U7*	80	442.5	5	280.5	.20	.01
TOTAL	3912	3381.7	239	3410.8	1.18	.07

Table 4.32a: Artefact densities in analytical Unit A (the surface and rookery stratigraphic units I to III) compared with B (the underlying Pleistocene deposit unit IV).

Square	Unit A no. of artefacts	Unit B no. of artefacts	Ratio Unit A : Unit B
D9	1392	44	32:1
D6	1593	176	9:1
C6	780	11	70:1
Σ D9, D6 & C6	3765	231	16:1

Table 4.32b: Comparative artefact numbers from squares D9, D6 and C6 .

Table 4.32: Stone artefact density per analytical unit - squares D9, D6 and C6 .

During the laboratory sorting, numerous animal gastrolith stones were discarded from the stone recovered from the sieves during the excavations. Gastroliths were predominantly milky quartz and readily identifiable by

- a) their unmodified gravel-like appearance in terms of the morphology and rounding of the pebble surface,
- b) the absence of fractured surfaces, and
- b) the relatively small size (i.e. generally less than eight millimetres in diameter) which precluded the possibility that the stone was humanly transported material brought to the site for artefact manufacture.

4.5.5 Residue analysis

Fullagar (pers. comm.) detected microscopic starch grains on four of the artefacts recovered from the shelter, which were of indeterminable origin and not possible to speciate. Loy also examined a number of artefacts that had macroscopic staining, the appearance of which suggested contact with animal remains. On closer examination however these residues appeared to be mineral staining, and the assemblage was assessed as having little potential for residue analysis using the available techniques (Tom Loy pers. comm.).

Subsequent SEM (scanning electron microscope) investigation of the mineral staining on one artefact indicated it to be ochre (Photograph 14) [Appendix XI]. As discussed further below, the red ochre stain on the tested artefact was consistent with the mineral stains on a number of other artefacts recovered.

4.5.6 Density and distribution of stone artefacts

A total of 4,151 stone artefacts weighing 6.69 kilograms were recovered from the five squares excavated at the Beeton Rockshelter site; 3,996 of these were recovered from the three squares excavated within the shelter. The D6 square had the highest number and almost twice the density of stone artefacts compared with the other two squares within the confines of the shelter (Table 4.31). I6, the square immediately outside the drip-line, contained the lowest density of artefacts as here they were about one tenth the density of artefacts in the squares inside the shelter. A slightly higher density of artefacts was found in the U7 square some 16 metres in front of the rockshelter (Table 4.31). This distribution of stone artefacts across the site suggests that stone working and thus also other activities were more concentrated within the confines of the actual shelter. Nonetheless, the recovery of 70 or more artefacts from

the U7 and I6 squares suggests that people were, at times, also using the open spaces around the rockshelter albeit to a lesser degree.

Artefact densities within the deposit were consistently higher in Unit A, the disturbed upper analytical unit, compared with the underlying Unit B Pleistocene deposit (Table 4.32). Given the marked reduction in sedimentation in the terminal Pleistocene period suggested by the radiocarbon dates, a concentration would not be unexpected if use of the shelter had continued at a similar rate as sedimentation declined. Decreased sedimentation alone however could not account for the disparity in artefact densities between Units A and B. The total number of stone artefacts recovered from Unit A in the three squares was more than 16 times the total from Unit B; and yet in terms of human occupation spans, Unit A represents only about double that of Unit B (Table 4.32).

Such a disparity suggests that people were either using the shelter more intensively, or that stone working activity was more common during the occupation span represented by the Unit A deposits. Since the shellfish remains were confined to Unit A, it is possible that the higher density of artefacts was associated with cultural changes in this most recent coastal occupation phase. More intensive occupation or stone working activity may have accompanied the midden phase compared to earlier periods when activities at the shelter were less coastally oriented. Alternatively, occupation may have intensified in the terminal Pleistocene (but pre-midden) period as the marine transgression inundated other lower lying rockshelters or suitable habitation areas in the region.

Because of the disturbance however it is not possible to identify specifically the occupation phase associated with the higher density of stone artefacts in Unit A. The question of variation was investigated further in other aspects of the assemblage in order to obtain a finer degree of chronological resolution than is provided by the analytical units.

4.5.7 Raw stone materials

Changes of raw stone material over time have been noted in assemblages from a number of Tasmanian sites (Allen and Porch 1996; Cosgrove 1991; Jones 1977b, 1990; Lourandos 1983). Several notable stone types such as spongolite and Darwin Glass have been linked to specific source sites, and it has also been suggested that exploitation of these sources is chronologically associated with specific occupation

phases (Cosgrove 1990:58, 1991:125; Jones 1977b:194; Lourandos 1983; Painter 1992:19; Thomas and Van Eckart 1989). It has also been suggested that exploitation of some stone sources is directly linked to changing palaeoenvironmental conditions as these affected access to some source areas (Bowdler 1988; Cosgrove 1991; Jones 1971; Lourandos 1983). Since the inundation of the Bassian region would have undoubtedly cut access to some sources of stone suited to artefact manufacture, the range and distribution of stone types was examined to see if changes were reflected in the Beeton assemblage.

The distribution of raw material types in the assemblage excavated from the D9, D6 and C6 squares is tabulated and graphed below (Table 4.33, Figure 4.16). No additional types of stone were present in the artefacts recovered from I6 or U7, the two squares excavated outside the shelter.

STONE TYPE	Unit A n	Unit B n	Σ A & B n	Unit A %	Unit B %	Σ A & B %
quartz	3190	171	3361	84.7	74.0	84.0
crystal quartz	465	42	507	12.4	18.2	12.6
quartzite	54	14	68	1.4	6.1	1.7
local slaty hornfels	32	3	35	0.9	1.3	0.9
chert	9	0	9	0.2	0.0	0.3
cherty hornfels	5	1	6	0.1	0.4	0.2
indurated limestone	6	0	6	0.2	0.0	0.2
silcrete	3	0	3	0.08	0.0	0.08
granite	1	0	1	0.02	0.0	0.02
TOTAL	3765	231	3996	100	100	100

Table 4.33: Stone type frequency from squares D9, D6 and C6.

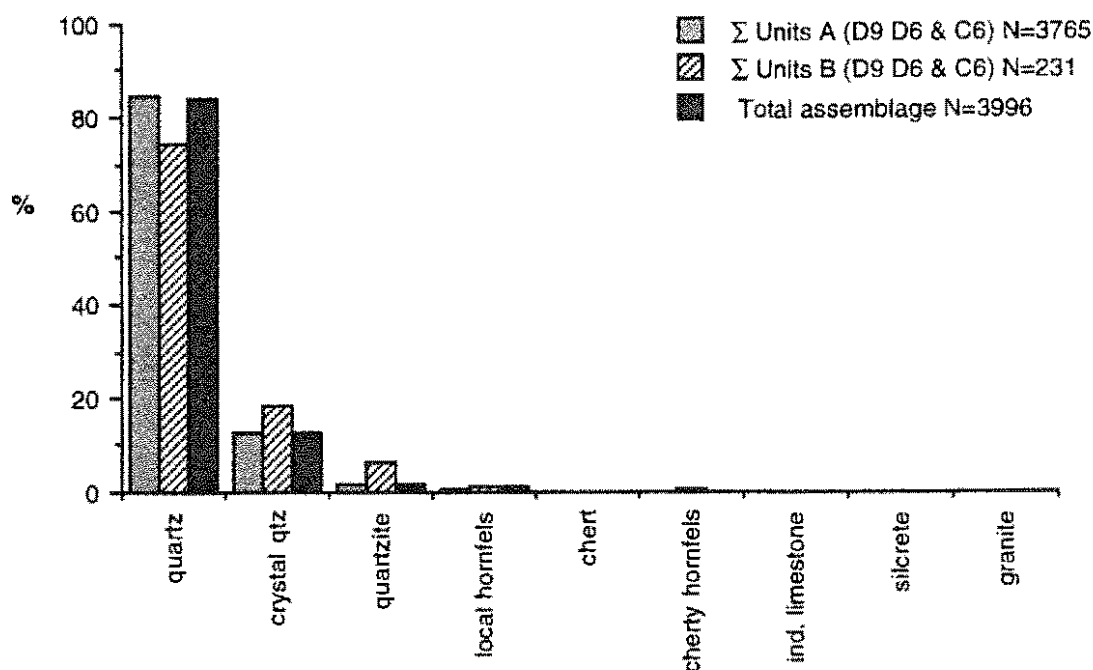


Figure 4.16: Stone type distribution in Units A and B from squares D9, D6 and C6.

Stone types and potential sources

Quartz and crystal quartz

The most common stone type in the artefact assemblage was quartz; both reef (or vein) and crystal forms. Together crystal and reef quartz represented more than 96% of all artefacts recovered (Table 4.33, Figure 4.16). The clear crystal quartz was of exceptionally high quality and included a component of the distinctive 'smoky' (grey tinted) quartz crystal variety (Photographs 13 and 14). The remainder of the quartz artefacts were made from glassy quartz, a low grade form of clear crystal quartz, and white and grey 'milky' reef quartz.

Quartz is commonly found in geological association with intrusive granites and contact zone sequences and is common over extensive areas of Tasmania and south east Australia, including the Furneaux region (Mayer 1976:160; Sutherland 1972:9). Although less common than reef quartz, clear or glassy crystal quartz is abundant in

several areas around Flinders Island. Smoky quartz is less common and there is only one known source in the Furneaux region. Local gem fossickers collect it from the Tanners Bay area on Flinders Island; one of six locations in Tasmania where it is known to occur (Mayer 1976:164; Thelma Shaik pers. comm.).

The predominance of quartz artefacts in the Beeton Rockshelter assemblage is in keeping with the surface sites recorded on other Furneaux Islands and the assemblage excavated by Brown from Mannalargenna Cave on Prime Seal Island (Brown 1993; Sim 1989:33-34; Sim and Gait 1992; Sim and Stuart 1991). Quartz-dominated assemblages are also common in geologically similar areas across much of northeastern Tasmania (Cosgrove 1991; Kee 1987, 1991; Moore 1997; Sim 1996; Smith 1995; Sutherland 1972:12; Thomas 1992).

Quartzite

Quartzite was the second most common raw material after quartz. Quartzite was also the second most numerous stone type recorded during surface site surveys on Flinders Island and the Outer Furneaux Islands (Sim 1989:31; Sim and Gait 1992; Sim and Stuart 1991:21). Compared with the crystal and milky quartz however quartzite artefacts were relatively scant and made up only 1.7% (i.e. 68 artefacts) of the Beeton Rockshelter assemblage (Table 4.33).

The variety of colours and grain sizes evident in the quartzite artefacts recovered from the Beeton Rockshelter site suggested a range of quartzite sources were being exploited. Nevertheless, all quartzites observed were consistent with quartzites from contact zones associated with the Devonian-Carboniferous granite intrusions in the Furneaux region. Several of these quartzites sources have been documented on Flinders Island although there is no direct evidence of Aboriginal quarrying at the observed sources (Sim 1989:8,33).

Other stone types present

Raw stone materials apart from quartz and quartzite made up less than 2% of the assemblage, with no other single stone type representing more than 1% (Table 4.33). Other stone types which made up this very small component are described below.

Slaty hornfels

This is a distinctive dark grey contact rock which is found in the immediate area of the site. This rock naturally occurs as sharp rocky outcrops adjacent to the intrusive granite band at the western end of Badger Island, and as waterworn rounded pebbles

and cobbles around the shores. Most of this local slaty hornfels does not fracture conchoidally and is not suited to percussion flaking. Nonetheless, several cobbles of fine-grained slaty hornfels which appeared to have a higher degree of metamorphism were observed in raised pebble beaches on the islands. Hence although not common, slaty hornfels from which flaked artefacts could be made was available in the immediate site environs.

Cherts and silcretes

Nine chert and three silcrete artefacts were recovered which, like the quartzite, were made from a variety of different coloured stone. This suggested exploitation of a number of different chert and silcrete sources, and transport of the material as there are no known present day sources for either in the Furneaux region. Nevertheless, both chert and silcrete are geologically associated with Tertiary basalts, and since these are known to exist in submarine contexts in the Bass Strait, it is possible that in the past there were sources of this stone available relatively close to the Furneaux area (Simon Stephens and Lin Sutherland pers. comm.).

Chert can also occur in limestone although none has been recorded in the few formations that occur on several of the Furneaux Islands. Sources of both chert and silcrete however are known in the northwest region, and along the north coast of Tasmania. Chert in particular is a significant component amongst artefact assemblages recorded in many coastal sites in northern Tasmania (Jones 1971:254,263; Sutherland 1972:16-17). The chert artefacts recovered from the Beeton Rockshelter included a small red jasper debitage flake. No other jasper was recovered from the site and nor has jasper been recorded in any other sites in the Furneaux region. The nearest known jasper source is in northeast Tasmania around Gladstone (Simon Stephens pers. comm.).

Cherty hornfels

Less than 0.2%, of the artefacts recovered were made from cherty hornfels for which there is no known source on the Furneaux islands. While the regional geology does not preclude cherty hornfels from occurring in the region, none has been observed during the extensive archaeological surveys undertaken on the islands. Sources now inundated by rising seas may have been available in the past although the scant number of cherty hornfels artefacts in both the Beeton Rockshelter and other sites in the region does not suggest this is the case. It is most probable that this type of stone was transported from eastern or northeastern Tasmanian hinterland areas where there are numerous cherty hornfels sources and there is a predominance of this

material in surface artefact scatters (Cosgrove 1990; Moore 1997; Sutherland 1972:10).

Indurated limestone

Another 0.2% of the artefacts were made from a dolomitic, indurated limestone, a rock type found in beds within limestone. Limestone formations are found on Badger, Cape Barren, Flinders, Prime Seal and Kangaroo Islands in the Furneaux region, and indurated limestone has been observed on the last three islands.

Granite

One granite artefact was recovered. The stone was consistent with the granites found within several hundred metres of the site, on the western-most end of the island.

Summary of stone types

Although a minor component of the artefacts in Unit A was made from chert, indurated limestone silcrete and granite, stone types not represented in Unit B, little importance can be attached to this due to the small sample size in the latter unit (Table 4.33, Figure 4.16). The absence of these stone types is not anomalous in that the expected representation of these in Unit B — a sample size of less than one sixteenth that of Unit A — would in all cases be less than one artefact.

There is however a slightly higher representation of vein or reef quartz in the Unit A assemblage which could be reflecting a greater emphasis on stone sources in the immediate environs of the rock shelter after other stone sources were drowned in the post-glacial inundation. None of the stone materials present in the excavated deposit are geologically foreign to the northwest Tasmanian region although sources for some, such as chert and quartzite were probably more accessible in the past when sea levels were lower.

4.5.8 Artefact types

Artefacts from each square were initially sorted into four categories:

- a) unmodified flakes and flaked pieces,
- b) implements (i.e. scrapers, other retouched artefacts and flakes with use-wear edge damage),
- c) cores, and
- d) manuports.

The implements included retouched and utilised flakes and flaked pieces, and a range of scraper types (Tables 4.34a, 4.34b and 4.34c). Thumbnail scrapers were identified by their morphology and size (cf. Bowdler 1984:122; Cosgrove 1991:145; McNiven 1994:77).

Square /spit	Implement description	l x b x t mm	retouch mm	stone type - colour	cortex	wt g	use-wear
D9/4	small round 'thumbnail' scraper	14 16 6	21	quartz - glassy translucent	—	1.94	present
D6/12	small round 'thumbnail' scraper	18 16 5	22	quartz - glassy white	—	1.87	present
D6/16	small rounded 'thumbnail' scraper	21 18 9	24	quartz - grey	—	4.33	present

Table 4.34a: Thumbnail scrapers.

Square /spit	Implement description	l x b x t mm	retouch mm	stone type - colour	cortex	wt g	use-wear
D9/9	small round steep-edge scraper	21 20 9	29	quartz - white	w'worn 20%	3.9	present
D9/10	steep edge scraper	36 24 13	39	quartzite - cream/grey	other 5%	13.11	present
D9/10	small rounded steep edge scraper	18 12 5	12	crystal quartz clear	facet 20%	1.13	—
D6/6	end scraper	37 15 12	16	quartz - white	—	4.89	present
D6/8	round scraper	33 31 6	32	quartz - white	—	2.58	present
U7/9	steep edge end scraper	20 11 7	13	crystal qtz - clear smoky	—	1.75	present
D6/12	small end scraper	29 16 8	12	quartz - white	vein 50%	4.31	—
C6/5	small steep edge scraper	12 10 6	19	crystal quartz clear	—	1.05	present
D6/14	steep edge scraper	29 24 9	22	quartz - white	vein 30%	3.87	—
D6/33	small scraper	20 16 5	21	quartz - white	—	1.92	present
D6/17	large steep edge scraper	46 31 14	59	quartzite	—	28.93	present

Table 4.34b: Other scrapers.

Square / spit	Implement description	l x b x t mm	retouch mm	stone type - colour	cortex	wt g	use-wear
D6/5	retouched flake	31 18 10	14	quartzite - rust brown	—	4.17	—
C6/8	retouched flake	12 18 4	11	crystal quartz - smoky	—	.76	yes
C6/14	retouched flake	15 21 3	11	quartz - glassy t'slucent	—	3.43	yes
D6/16	retouched flake	24 19 5	17	quartzite brown	—	1.95	yes
C6/7	retouched flake	16 10 3	16	quartz - glassy	w'worn facet	0.69	yes
C6/10	retouched flake	21 16 4	8	crystal quartz clear	—	1.51	yes
C6/11	retouched flake	26 29 8	28	quartzite-grey	—	8.35	—
C6/11	retouched flake	21 16 5	27	crystal quartz clear	w'worn facets	1.8	yes
C6/12	retouched flake	20 14 7	17	quartz - white	—	1.94	yes
C6/12	utilised flaked piece	44 31 9	—	crystal quartz - clear	—	17.25	yes
C6/7	utilised flake	32 18 7	—	crystal quartz clear	facets 15%	4.45	yes
C6/15	utilised flaked piece	29 11 4	—	crystal quartz - clear	—	1.17	yes
D6/14	utilised broken flake	24 12 4	—	crystal quartz clear	—	1.33	yes

Table 4.34c: Retouched flakes and flaked pieces with use-wear.

Table 4.34: Implements recovered from all squares excavated.

Cores

Types of cores identified in the Beeton Rockshelter assemblage included:

Bipolar cores, all of which were quartz (crystal and vein) and were defined by the presence of negative flake scars in combination with evidence of impact or force application on opposing ends. The impact evidence included annular and radial cracking and point crushing.

Single platform cores where all flakes removed had been struck from a single face of the stone.

Multi-platform or revolved cores which had negative flake scars oriented in a number of different directions on the core piece.

Square /spit	core type	stone type	l x b x t mm	wt g	cortex
D6/23	single platform	quartzite - ochre residue	66 41 38	101.9	outcrop
D9/9	multi-platform	silcrete	51 43 41	125.6	—
D6/10	single platform	quartz - grey	47 45 28	93.20	vein
D9/9	bipolar	quartz	54 42 29	76.06	—
D9/11	bipolar	crystal qtz	33 11 8	2.45	—
D9/12	bipolar	quartz	26 24 16	9.18	—
D6/12	bipolar	crystal quartz	23 9 5	1.61	facet
D6/14	bipolar	quartz	72 25 29	39.67	vein
D9/4	bipolar	quartz grey	64 41 35	45.86	vein
C6/15	bipolar	crystal quartz	39 23 18	15.46	2 facets
C6/17	bipolar	quartz	36 30 19	27.25	w/worn pebble

Table 4.35: Cores recovered from all squares excavated.

Manuports

Thirty-nine manuports in total were recovered and five of these had use damage in the form of pitting (Table 4.36). As discussed further below the cortex and stone type for most of the manuports suggested a local fluvial source was being exploited for the majority of these artefacts.

Square /spit	rock type	manuport description	wt g	l x b x t mm
D6/10	local contact rock	cobble with fracture and pitting 80% water worn cortex	120.48	57 34 51
D6/21	local contact rock	possibly pitted (very weathered) hammer-stone water worn cobble	213.63	51 24 20
D6/22	quartz	water worn cobble with minor pitting	157.42	59 54 44
C6/8	local contact rock	pitted piece of grindstone	87.22	89 38 22
C6/11	local contact rock	elongated cobble with minor pit marks	263.37	129 45 32

Table 4.36: Manuports with pitted use-wear.

Distribution of different artefact types

The numbers and relative proportions of artefacts in each of these categories from all five excavated squares are tabulated and graphed below (Table 4.37, Figure 4.17). In four of the five squares more than 97% of the artefacts comprised unmodified flakes and flaked pieces, and in the other square these represented more than 89%. In all squares artefacts in each of the other three categories, that is implements, cores and manuports represented less than 1% of the stone assemblage. The relatively high proportion of unmodified flakes and flaked pieces is typical of other rockshelter and surface site assemblages recorded in Tasmania (Bowdler 1984:109; Brown 1993:267; Cosgrove 1991:150; Jones 1971; Lourandos 1970; Moore 1997; Stern and Allen 1996:175; Vanderwal and Horton 1984:124).

ARTEFACT CATEGORY	D9		D6		C6		I6		U7	
	No.	%	No.	%	No.	%	No.	%	No.	%
Unmodified flakes & flaked pieces	1413	98.4	1744	98.6	773	97.7	68	97.1	76	89.4
Implements	4	0.3	11	0.6	11	1.4	0	0	1	1.2
Cores	5	0.3	4	0.2	2	0.3	0	0	0	0
Manuports	14	1	10	0.6	5	0.6	2	2.9	8	9.4
TOTAL	1436	100	1769	100	791	100	70	100	85	100

Table 4.37a: Frequency of artefacts in each category from all spits combined - all excavated squares.

ARTEFACT CATEGORY	Σ all squares n	Σ all squares %
Unmodified flake/flaked piece	4074	98.2
Implement	27	0.6
Core	11	0.3
Manuport	39	0.9
TOTAL	4151	100

Table 4.37b: Frequency of artefacts per category.

Table 4.37: Frequency of artefacts per category from all excavated squares.

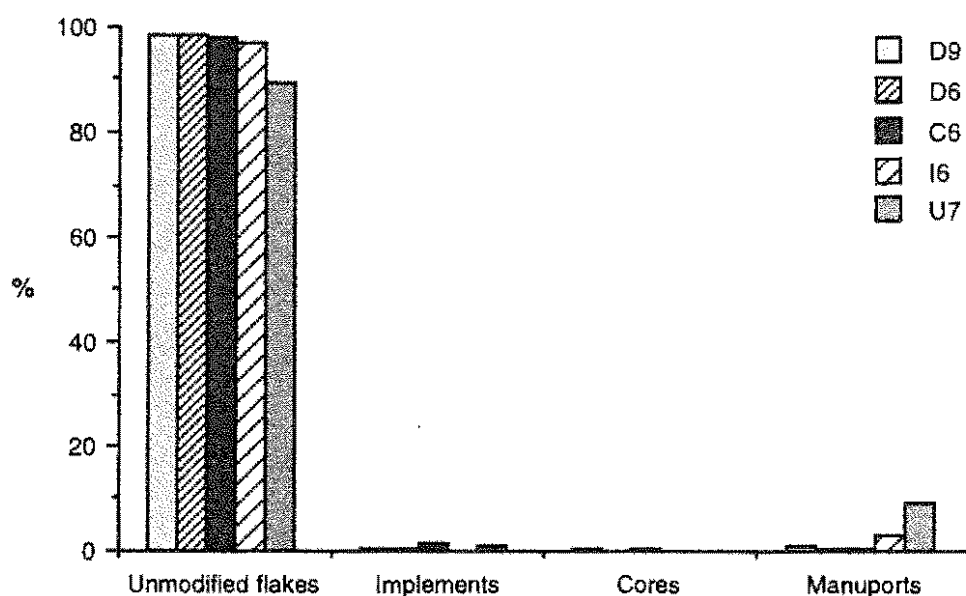


Figure 4.17: Frequency of artefacts in each category from all squares excavated.

Tables 4.38a, 4.38b and Figure 4.18 compare artefacts from analytical Unit A, the surface and rookery deposits, with those recovered from analytical Unit B, the lower Pleistocene B deposit. The representation of different artefact categories was markedly similar in both analytical Units A and B. These results conform with Lourandos's (1977:223-4) stone assemblage model for a hinterland hunting site rather than a coastal midden (Table 4.39). Lourandos found markedly different stone assemblages at the coastal midden and inland hunting sites he investigated. He

concluded that these sites, while part of a single economic system, represented two complementary sets of resource exploitation behaviour linked to varying resources available in the hinterland and coastal environments. More than 95% of the stone assemblage in the Little Swanport midden site comprised implements (i.e. retouched artefacts and artefacts with use-wear) compared to less than 3% at the Crown Lagoon inland hunting site (Lourandos 1970:43,45, 1977:222) (Table 4.39).

ARTEFACT CATEGORY	UNIT A surface & rookery layers				UNIT B Pleistocene lower deposit			
	D9	D6	C6	Σ D9, D6, C6	D9	D6	C6	Σ D9, D6, C6
Unmodified flakes & flaked pieces	1369	1570	762	3701	44	174	11	229
Implements	4	10	11	25	0	1	0	1
Cores	5	4	2	11	0	0	0	0
Manuports	14	9	5	28	0	1	0	1
TOTAL	1392	1593	780	3765	44	176	11	231

Table 4.38a: Artefact category frequencies in Unit A compared with Unit B.

ARTEFACT CATEGORY	UNIT A Σ D9, D6, C6		UNIT B Σ D9, D6, C6	
	no.	%	no.	%
Unmodified flakes & flaked pieces	3701	98.3	229	99.1
Implements	25	.7	1	.4
Cores	11	.3	0	0
Manuports	28	.7	1	.6
TOTAL	3765	100	231	100

Table 4.38b: Frequency and percentage of artefacts in squares D9, D6 and C6.

Table 4.38: Distribution of artefacts in analytical Units A and B.

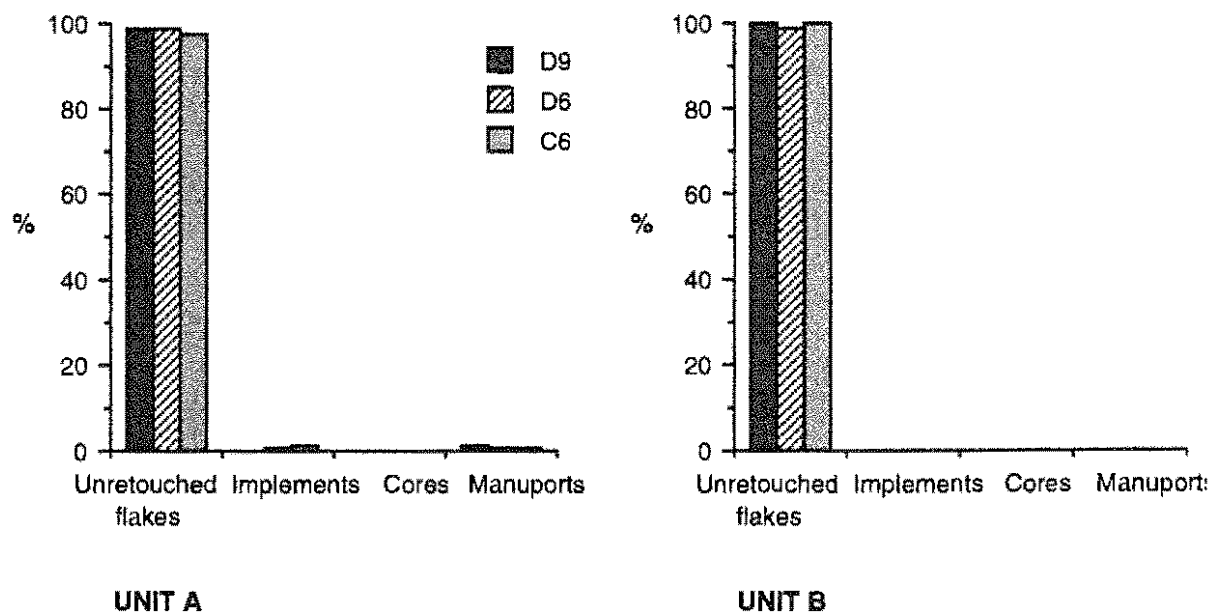


Figure 4.18: Percentage of artefacts per category in analytical Units A and B.

SITE	Sample size N	Implements - as % of total assemblage	Debitage * - as % of total assemblage
LS Little Swanport (coastal midden)	176	93.0	6.8
CL Crown Lagoon (hinterland site)	7802	2.5	90.5
Unit A Beeton Shelter (midden & hinterland)	3765	0.7	80.6
Unit B Beeton Shelter (hinterland site)	231	0.4	80

* LS & CL = unmodified flaked stone & pieces < half inch (12.5 mm) (after Lourandos 1977:222)

Beeton Rockshelter = unmodified flaked stone & pieces <15 mm

Table 4.39: Proportion of flaked stone implements (retouched and utilised artefacts) anddebitage in assemblages from two eastern Tasmanian sites and the Beeton Rockshelter site.

The artefact suites from both Units A and B in the Beeton Rockshelter site match more closely with that found by Lourandos at Crown Lagoon, the inland hunting site rather than the midden site. Although Unit A at Beeton Rockshelter contained shellfish remains, there was a relatively low percentage of implements, unlike the findings from the Little Swanport site. There was also little variation in the proportion of debitage in the Unit A and B assemblages (Table 4.39). Insofar as Lourandos's model is applicable to this site, the results from the Beeton Rockshelter suggest that the bulk of the stone artefact assemblage originate from use of the shelter prior to the midden phase, that is when the shelter would have been a hinterland rather than coastal site.

It should be noted that Lourandos's findings pertained to sites occupied in much more recent times, and in different environmental settings. And while artefact analyses from other Tasmanian non-coastal sites generally concur with Lourandos's findings from Crown Lagoon regarding the high percentage of waste flakes, the ratio of artefact types on midden sites varies considerably and appears to relate to local availabilities of stone as much as to subsistence activities at the sites; stone artefacts are absent from some middens, while they are prolific and include high percentages of debitage at others (Brown 1986, 1991; Jones 1971; Kee 1987; Vanderwal 1977; Vanderwal and Horton 1984). Hence while Lourandos's artefact ratios are useful for investigating site activities in hunting camps, some caution is required in using the artefact data from his midden findings.

The low ratio of implements to other artefacts in both analytical units in the Beeton Rockshelter suggests a continuity of site activities over time. This does not negate the possibility that post-depositional disturbance is masking differences between stone suites from the midden and those from earlier occupation in Unit A. Radiocarbon dating of the shellfish remains indicates that occupation associated with deposition of the midden material took place over a relatively short span of several hundred years or so. Furthermore, the sparse nature of the shellfish remains suggests that use of the shelter in the midden phase was probably ephemeral and thus unlikely to be evidenced by significant numbers of stone artefacts. Given the low level of habitation during the coastal phase, it is possible that any change in artefact discard patterns is now masked by the post-depositional mixing of these with more intense late Pleistocene occupation. It cannot be assumed therefore that either the seeming lack of variation in the stone assemblage in Unit A, or the similarity between artefact ratios in Units A and B, is a reflection of behavioural or cultural continuity from earliest habitation through to the midden phase occupation at the site.

Quite disparate discard patterns may have taken place at the site over time, changes now undetectable due to disturbance and lower discard rates. Nonetheless, the gross discard pattern from the disturbed Unit A does concur with that in the underlying Unit B, and this pattern is consistent with an assemblage predominantly resulting from tool maintenance and hunting activities (Table 4.39). Moreover it could be argued that in the most recent occupation phase, hunting activities were merely supplemented, rather than replaced by shellfish gathering, and hence no major changes are evident in the artefact assemblage.

The similarly low ratio of implements in both Units A and B at the Beeton Rockshelter therefore could be equally attributable to

- a) post-depositional disturbance in combination with low discard rates during the midden phase occupation rendering variation within Unit A undetectable, or
- b) terrestrial hunting activities continuing and possibly predominating throughout the coastal (midden) occupation phase, or
- c) the stone assemblage being predominantly associated with a more intense pre-midden occupation phase post-dating 18,000 BP, stratified evidence of which has been destroyed by the muttonbird burrowing.

4.5.9 Cortex

Cortex was divided into two categories:

Outcrop cortex which comprised all natural rock surface originating from a natural terrestrial outcrop context and had no evidence of water-rounding. Outcrop cortex included unmodified reef or vein surfaces on quartz, crystal facets on both milky and clear (crystal) quartz. Some artefacts made from chert, quartzite and the local slaty hornfels also had natural outcrop cortex which had no sign of fluvial rounding.

Pebble and cobble cortex which included all cortex surfaces which had evidence of smoothing or rounding by fluvial processes.

About 12% of all artefacts recovered had cortex present, and there were almost twice as many artefacts with outcrop cortex compared with cobble or pebble cortex (Table 4.40a). Both types of cortex were found in similar proportions in artefacts in both Units A and B (Tables 4.40b, 4.40c). The predominance of outcrop cortex (as opposed to water-rounded cobble or pebble cortex) suggests that artefactual stone was mainly being obtained from sources other than watercourses, fluvial deposits or coastal zones. Nevertheless, the presence of a lesser component of artefacts with

water-rounded cortex does indicate that some stone was being transported from fluvial environments.

In the present day environment, the only water-rounded stones naturally occurring on Badger Island are slaty hornfels, quartz and granite pebbles and cobbles around the shorelines. Nevertheless, the submarine bathymetry suggests that at times of lower sea levels when the shelter was being used, there would almost certainly have been a drainage channel from the western watershed of the Strzelecki Ranges. In the late Pleistocene therefore it is probable that a river or stream-bed source of water-worn material would have located within several kilometres of the site. In the most recent midden phase of past occupation, this drainage channel would undoubtedly have been inundated by rising seas with run-off from the Strzelecki Ranges draining into the sea at the western foothills of the range.

A minor component of manuports comprised quartz and quartzite cobbles and one piece of unworked indurated limestone, known sources for all of which are known in the region. The majority however comprised the local slaty hornfels rock most of which had water-rounded cortex. This suggests that there was a source of cobbles or pebbles of this stone type close to the site. As discussed above, the slaty hornfels forms the local outcrop stone and bedrock in the immediate area of the shelter, and the present-day shoreline in front of the site is fringed by a bank of hornfels cobbles. The high proportion of unmodified manuports made from this material supports the notion that, at least in the more recent midden phase occupation, people were transporting slaty hornfels cobbles from the nearby coast (Tables 4.41a, 4.41b and 4.41c; Figure 4.19).

Amongst quartz, crystal quartz and quartzite, the most common artefact materials, there was a similar ratio of cortex, although crystal quartz had a markedly higher proportion of outcrop cortex present. On crystal quartz this non-cobble cortex comprised crystal facets in all instances. Given the limited size of most quartz crystals obtainable in the region, the presence of facets on crystal quartz artefacts would be expected. And the lower representation of water-rounded cortex on crystal quartz artefacts indicates the material was being obtained *in situ* from the granites, rather than from river or stream beds.

STONE TYPE	Σ artefacts n	% with outcrop cortex	% with pebble or cobble cortex	TOTAL % with cortex
quartz	3361	7	5	12
crystal quartz	507	14	1	15
quartzite	68	3	9	12
local slaty hornfels	35	57	37	94
chert	9	11	11	22
cherty hornfels	6	0	0	0
indurated limestone	6	0	0	0
silcrete	3	0	33	33
granite	1	0	100	100
Σ all stone types	3996	8	5	13

Table 4.40a: Proportion of artefacts from Σ D9, D6 & C6 with outcrop cortex and water worn pebble or cobble surfaces.

STONE TYPE	Σ artefacts n	% with outcrop cortex	% with pebble or cobble cortex	TOTAL % with cortex
quartz	3190	7	5	12
crystal quartz	465	15	1	16
quartzite	54	4	9	13
local slaty hornfels	32	59	38	87
chert	9	11	11	22
cherty hornfels	5	0	0	0
indurated limestone	6	0	0	0
silcrete	3	0	33	33
granite	1	0	100	100
Σ all stone types	3765	8	5	13

Table 4.40b: Proportion of all artefacts from Unit A with outcrop cortex and water worn pebble or cobble surfaces.

STONE TYPE	Σ artefacts n	% with outcrop cortex	% with pebble or cobble cortex	TOTAL % with cortex
quartz	171	8	4	12
crystal quartz	42	19	2	21
quartzite	14	0	7	7
local slaty hornfels	3	0	33	33
cherty hornfels	1	0	0	0
Σ all stone types	231	10	4	14

Table 4.40c: Percentages of artefacts from Unit B with cortex.

Table 4.40: Proportion of artefacts with cortex types from squares D9, D6 and C6.

STONE TYPE	Unmodified flake / flaked piece		Implement		Core		Manuport		Σ all artefacts	
	%	no.	%	no.	%	no.	%	no.	%	no.
quartz	85	3340	46	12	55	6	11	3	84	3358
crystal quartz	12.3	495	35	9	27	3	0	0	12.8	510
quartzite	1.5	60	19	5	9	1	7	2	1.7	68
slaty hornfels	0.4	13	0	0	0	0	78.4	22	.9	35
other	0.6	22	0	0	9	1	3.6	1	.6	25
TOTAL	100	3701	100	26	100	11	100	28	100	3996

Table 4.41a: Frequency and percentages of raw materials and artefact types Σ squares D9, D6 and C6.

STONE TYPE	Unmodified flake / flaked piece		Implement		Core		Manuport	
	%	no.	%	no.	%	no.	%	no.
quartz	85.6	3170	44	11	54	6	11.1	3
crystal quartz	12.3	453	36	9	27	3	0	0
quartzite	1.2	46	20	5	9.5	1	7.4	2
slaty hornfels	0.3	11	0	0	0	0	78	21
other	0.6	21	0	0	9.5	1	3.7	1
TOTAL	100	3701	100	25	100	11	100	27

Table 4.41b: Unit A raw material and artefact types.

STONE TYPE	Unmodified flake / flaked piece		Implement		Core		Manuport	
	%	no.	%	no.	%	no.	%	no.
quartz	74.2	170	100	1	0	0	0	0
crystal quartz	18.3	42	0	0	0	0	0	0
quartzite	6.1	14	0	0	0	0	0	0
slaty hornfels	.9	2	0	0	0	0	100	1
other	.5	1	0	0	0	0	0	0
TOTAL	100	229	100	1	0	0	100	1

Table 4.41c: Unit B raw materials and artefact types.

Table 4.41: Raw materials and artefact types.

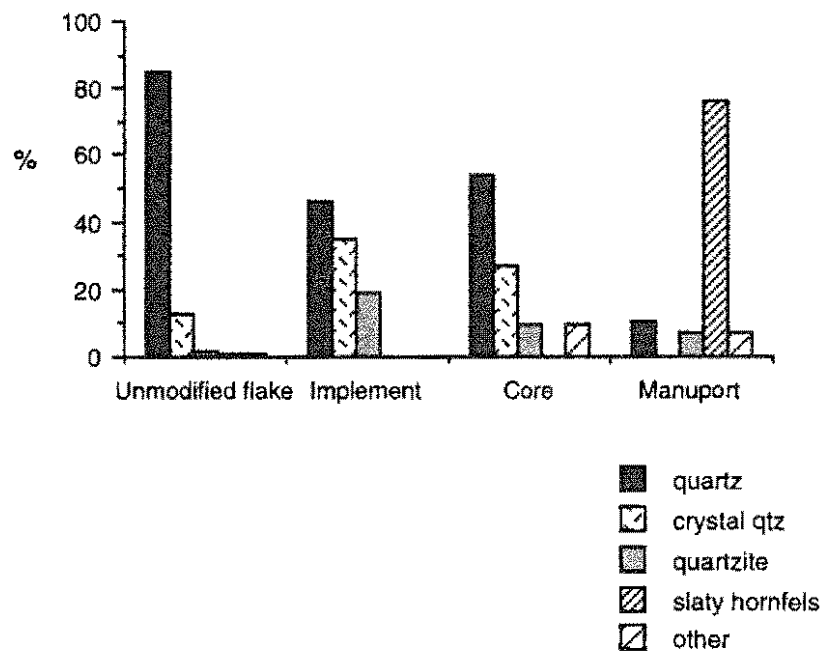


Figure 4.19a: Raw materials used for artefact types - Σ D9, D6 & C6.

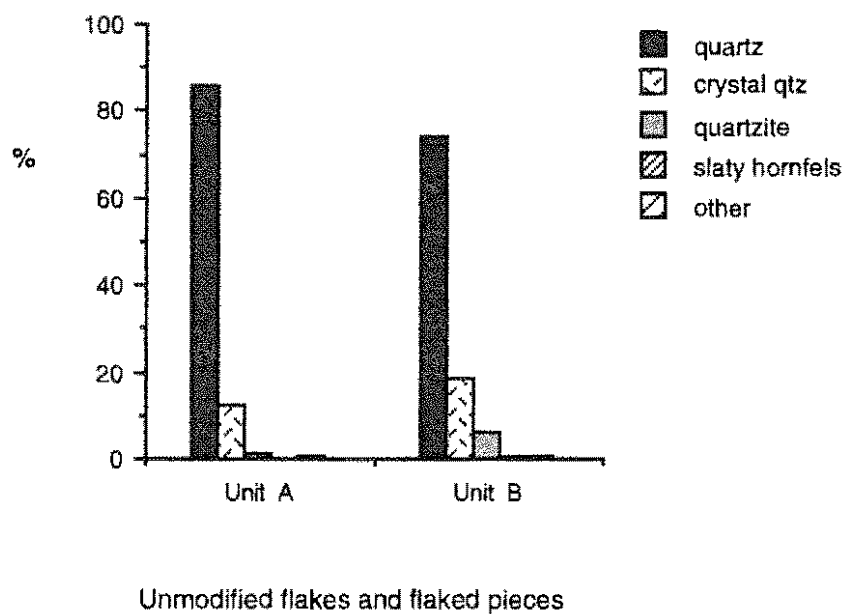


Figure 4.19b: Raw materials - unmodified flakes and flaked pieces - Units A & B.

Figure 4.19: Raw materials used for artefact types and unmodified flakes and flaked pieces.

Cortex types on milky quartz and quartzite artefacts indicate that both fluvial and outcrop sources were being targeted for these stone types. While reef or vein quartz is readily obtainable from granites to the east of the site, there are no river or stream bed sources of quartz in the present day environment. Shoreline sources are also uncommon as pebble banks do not occur along the granite coastal areas around the island. The presence of water-rounded cortex on quartz and quartzites therefore suggests that at least some of this stone was being obtained from more distant sources such as river or stream beds.

The seemingly high ratio of cortex on both chert and silcrete artefacts is an anomaly attributed to the small sample size of these stone types (Table 4.40a).

If river or stream beds were being targeted for stone for flake production, it would be expected that this would be reflected in a predominance water-rounded cortex amongst the unmodified flakes and flaked pieces recovered. This was not the case as outcrop cortex was slightly more common than cobble or pebble cortex in unmodified flakes and flaked pieces from both Units A and B (Table 4.42). The cortex distribution suggests that both fluvial and outcrop sources were being exploited although the latter were more common, and that this pattern may have been consistent over time.

CORTEX	Unit A		Unit B		Σ Unit A & B	
	%	no.	%	no.	%	no.
outcrop	6	226	9	21	6	247
cobble or pebble	5	172	4	9	5	181
none	89	3303	87	199	89	3502
TOTAL	100	3701	100	229	100	3930

Table 4.42: Unmodified flakes and flaked pieces from squares D9, D6 and C6 - cortex type frequency per analytical unit.

The analysis shows a similar pattern in the frequency of both outcrop and water-rounded cortex found on different stone types, indicating a consistent exploitation pattern incorporating local outcrop stone sources and to a slightly lesser extent, more distant river or stream beds. The mixed Unit A deposit makes conclusions concerning change over time somewhat problematic; nonetheless, there is no evidence to suggest that stone exploitation patterns changed markedly over time, as the types and frequency of cortex on artefacts in Unit A is consistent with that in Unit B

(Tables 4.40 and 4.42). Despite the undoubted constriction of stone sources with the inundation of the Bassian region, there is no evidence of this reflected in the cortex distribution although it is possibly evident in the relative decrease in quartzite and crystal quartz in Unit A discussed previously.

4.5.10 Artefact size

The possibility of changing site activities was investigated further by examining evidence for variation in stone reduction activities. One of the main indicators of on-site stone working is a high proportion of unmodified flakes of artefactual stone, particularly those smaller than 15 millimetres. Combined, unmodified flakes and flaked pieces made up more than 98% of the total assemblage excavated from the Beeton Rockshelter (Table 4.37b). As documented in the data base, these artefacts were initially sorted into size categories of 5 millimetre gradations (Appendix X). For analytical purposes artefacts larger than 20 millimetres were subsequently combined into size categories of ten millimetres plus gradations, and these have been used to table and graph the size distribution of all unmodified flaked stone (Table 4.43; Figure 4.20a).

The process of stone reduction, that is percussion removal of flakes from cores, and resharpening and other edge modification of utilised tools, results in the production of large numbers of waste flakes or debitage (Hayden 1989; Hiscock 1981; Lourandos 1977:219; Moore 1997:250). For this analysis, debitage was arbitrarily defined as any unmodified flaked stone less than 15 millimetres in maximum dimension. The maximum size for debitage is the estimated minimum size for either intentionally produced flake blanks or primary flakes suitable for use in their unmodified form, and was determined in light of the general size range of utilised and retouched artefacts in Tasmanian assemblages (Cosgrove 1991:112; Dickson 1977:100-101; Jones 1971:214, 1990; Lourandos 1977:223).

The presence of debitage in an assemblage suggests that core reduction, flake retouch and/or tool resharpening had taken place at the site, and further can provide a useful measure of the intensity of these activities (Hiscock 1981). While unmodified flaked stone larger than 15 millimetres could also be waste from the flaking process, the status of this larger material as 'debitage' is ambiguous since arguably it could also have been produced with the intention that it be used — either in its primary form or as a tool blank. Thus unmodified flaked stone larger than about 15 millimetres could well have been transported to the site in that form, rather than

produced by on-site stone-working. While restricting 'debitage' to unmodified flaked stone less than 15 millimetres in size almost certainly excluded some portion of the waste material, it is useful in that it removes any ambiguity and thus enables the delineation of a category of stone which is unequivocally a product of on-site stone working.

SIZE CATEGORY	UNIT A no.				UNIT B no.			
	D9	D6	C6	Σ D9, D6, C6	D9	D6	C6	Σ D9, D6, C6
<10 mm	732	1010	347	2089	20	110	6	136
10 - <15 mm	415	315	216	946	13	33	3	49
15 - <20 mm	135	120	96	351	7	14	1	22
20 - <30 mm	75	100	87	262	4	11	1	16
30 - <40 mm	8	17	15	40	0	6	0	6
40 - <50 mm	2	6	1	9	0	0	0	0
50 - <75 mm	1	2	0	4	0	0	0	0
75 - <100 mm	1	0	0	0	0	0	0	0
TOTAL	1369	1570	762	3701	44	174	11	229

Table 4.43a: Size category frequencies.

SIZE CATEGORY	UNIT A %				UNIT B %			
	D9	D6	C6	Σ D9, D6, C6	D9	D6	C6	Σ D9, D6, C6
<10 mm	54	65	46	56	45	63	55	60
10 - <15 mm	30	20	28	28	30	19	27	21
15 - <20 mm	10	8	13	8	15	8	9	10
20 - <30 mm	5	6	11	7	10	6	9	7
30 - <40 mm	0	1	2	1	0	4	0	2
40 - <50 mm	0	0	0	0	0	0	0	0
50 - <75 mm	0	0	0	0	0	0	0	0
75 - <100 mm	0	0	0	0	0	0	0	0
TOTAL	100	100	100	100	100	100	100	100

Table 4.43b: Size category percentage by number.

Table 4.43: Size of unmodified flakes and flaked pieces from D9, D6 and C6.

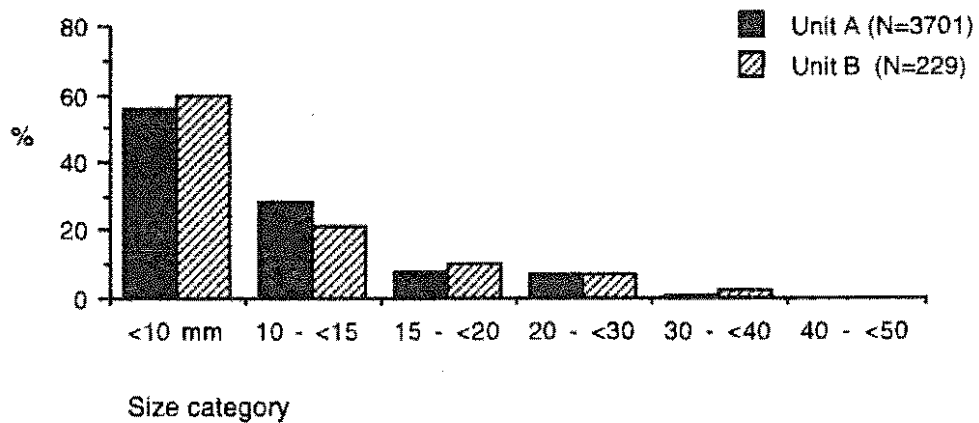


Figure 4.20a: Unmodified flakes and flaked pieces - size distribution Unit A and Unit B.

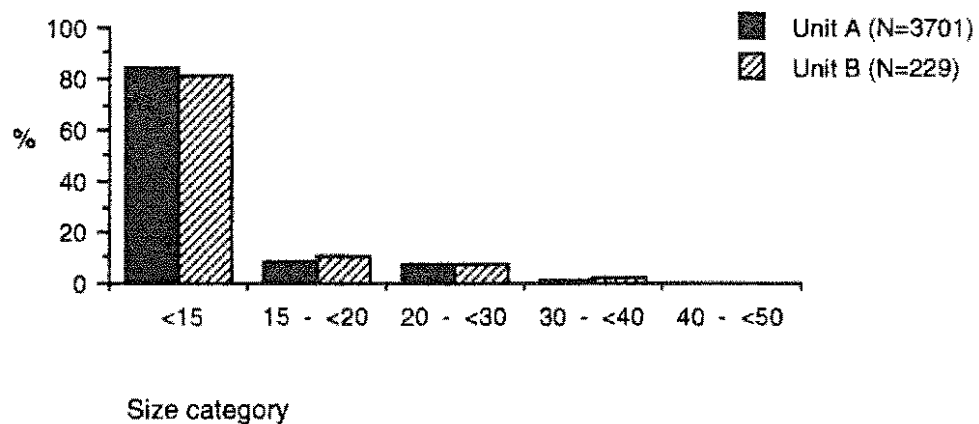


Figure 4.20b: Percentage of debitage (<15 mm) compared to other sized unmodified flakes and flaked pieces in Unit A and Unit B.

Figure 4.20: Size of unmodified flakes and flaked pieces.

The high proportion of debitage and the general size distribution overall of unmodified flaked stone in the Beeton Rockshelter assemblage indicates clearly that stone working was carried out at the site (Figures 4.18, 4.20a and 4.20b). Furthermore, the similar proportion of debitage in Units A and B in all three squares

suggests that stone working activities had taken place across both time and space within the shelter.

However this did not negate the possibility that stone working activity at the site decreased or ceased during the midden phase occupation; as outlined above in regard to other aspects of the assemblage investigated, it is possible that variation is not being detected due to varying sample sizes from different occupation phases, remains of which are now intermixed in Unit A. Moreover, it is possible that while some aspects of the assemblage continued through time, others may have changed. For example, while the knapping technology and some implement types may have had a long term continuity, types of stone may have varied over time with changes in social alliances and demographics, and the environment.

4.5.11 Artefact types and raw materials employed

It is highly unlikely that unmodified manuports would have been transported any considerable distance, particularly since cobbles and loose outcrop rocks would have been readily available in the immediate environs of the site. That the vast majority of the manuports were slaty hornfels, a material unsuited to flaking, suggests local rock was being transported to the site for purposes other than raw material for flaking (Tables 4.41b and 4.41c; Figure 4.19a). Pitting on the cortex of some manuports indicated the use of these as hammer-stones, possibly either for stone working or smashing shellfish. None had pitted depressions typical of bipolar anvil stones, although bipolar artefacts were present amongst the assemblage.

Cobble manuports are commonly associated with midden sites and there are ethnographic accounts of Tasmanians using such rocks as hammer-stones and anvils to open shellfish (Roth 1899:76-77, 94). That manuports are associated with midden sites is further supported by the archaeological remains from Cave Bay Cave; all manuports at this site recovered were found within midden layers (Bowdler 1979:280). This supports the interpretation of the manuports from Unit A as being originally associated with the final late Holocene phase of prehistoric use of the site.

The disturbance in Unit A and the small sample sizes however made it difficult to draw conclusions concerning variation between stone types employed for implements and cores (Tables 4.41b and 4.41c). Nonetheless, as discussed further below, raw material distributions across these categories can provide insights into the stone working activities that have taken place at the site in the past.

Larger sample sizes amongst unmodified flakes and flaked pieces suggested that this category of artefacts had the most potential for further analysis, comparing the two analytical units. The pattern of raw material use however varied little between the two units; in both units the unmodified flakes and flaked pieces were predominantly quartz, with a secondary crystal quartz and lesser quartzite component, and both units had less than 1% being made from other stone types (Figure 4.19b). This pattern suggests that stone working was in the main using locally available rather than transported materials, as the most readily available artefactual stone in the vicinity of the site is crystal and milky quartz. Furthermore, while not present on the island today, quartzites would not be geologically foreign along the local granite contact zone that passes north-south within 100 metres or so west of the Beeton Rockshelter site (Lin Sutherland pers. comm.). The evidence suggests that at times of lower sea level, sources of quartzites along this contact zone were relatively close to the site and were being exploited. Hence the reduction in unmodified quartzite flakes could be a result of decreased access to these sources with rising seas.

In total, the composition of the assemblage in terms of artefact types and raw materials indicates that quartz was the most abundant worked stone at the site (Table 4.41a, Figure 4.19a). Quartz dominated the unmodified flake, implement and core categories. The quartz component in the implement category is probably an under-representation - although retouch on quartz is readily detectable, use-wear edge damage is not. Because of the physical properties and structure of milky quartz, edge chattering tends to replicate natural fracture and weathering patterns (Moore 1997). This makes use-wear more difficult to detect than on other highly siliceous stone types such as crystal quartz or cherts, where use-wear forms a variety of recognisable step-like fracture patterns (Kamminga 1982).

Hence a proportion of unmodified quartz flakes or flaked pieces may have been used and were therefore implements, but were not identifiable as such. Conversely, on crystal quartz, a stone type on which use-wear is readily identifiable, a comparatively high percentage of implements were identified which, except for use-wear edge damage were otherwise unmodified (Table 4.44). This indicates that some percentage at least of unretouched flaked stone was being used for processing food resources, or manufacturing and maintaining wooden and other utilitarian items.

UNIT A	quartz		crystal quartz		quartzite		TOTAL	
	%	no.	%	no.	%	no.	%	no.
scrapers	32	8	8	2	8	2	48	12
retouched flakes	12	3	12	3	12	3	36	9
use-wear only	0	0	16	4	0	0	16	4
TOTAL	44	11	36	9	20	5	100	25
UNIT B								
scraper	100	1	0	0	0	0	100	1

Table 4.44: Raw materials used for implement manufacture.

All formal tool types recorded comprised scrapers: thumbnail, round and steep-edged types (Jones 1971; White and O'Connell 1982:163). All retouched flakes, scrapers and flaked stone with use-wear were made from quartz, crystal quartz or quartzite (Table 4.44). The majority of formal tool types including the three thumbnail scrapers recorded were also made from quartz. The predominance of quartz in both implements and cores suggests that ease of stone procurement took priority over conchoidal flaking properties. Bipolar quartz and crystal quartz cores indicate that people using the shelter had stone working techniques that enabled them to utilise the materials at hand for the majority of their stone artefact needs (Photograph 13).

The small sample sizes (i.e. single implement) from Unit B precluded comparisons with Unit A to examine changing patterns of both implement and core stone types over time (Tables 4.41b and 4.41c).

4.5.12 Summary of findings from the stone analysis

Various aspects of the stone assemblage were examined in order both to describe the assemblage as a whole, and where possible to investigate variation over time. In light of previous interpretations of cultural change in the mainland Tasmanian context and the suggestion that Flinders Island represented a microcosm of this process (Jones 1977b), the issue of changes in the assemblage was of particular relevance to the problem of the fate of the prehistoric Furneaux population. Unfortunately

muttonbird disturbance of the uppermost cultural deposits, those spanning the last 10,000 years or so of prehistoric use of the shelter, greatly impeded the investigation of change within the artefact assemblage. Moreover the bulk of the assemblage was recovered from this disturbed unit, and sample size provided by the suite of artefacts recovered from the underlying unit was relatively scant.

Despite this major impediment, some useful observations can be made both from the overall stone assemblage and concerning variation between the two analytical units represented in the deposit. In summary, the distribution of artefacts across the site indicated that stone working activities appear to have been in general restricted to the confines of the shelter although a few artefacts were also present in the areas excavated outside the shelter itself. The density of artefacts within the shelter varied in accordance with comfort factors, that is more sheltered areas toward the front where there was increased headroom were being used preferentially.

The density of artefacts in the undisturbed lower Pleistocene unit was markedly less than that in the overlying unit which contained the disturbed rookery deposits. This pattern of greater artefact concentrations in the upper analytical unit was consistent in all squares excavated. Alternative explanations for this increase include a) more intensive stone working associated with the midden phase of occupation, or b) more intensive use of the shelter from about 18,000 years ago for a period, but prior to the midden phase.

It is also possible that artefact discard rates declined and the nature of the assemblage changed significantly during the midden phase as site activities changed, but that this small sample is now undetectable in the mixed deposit.

The range of artefact types, and composition of the assemblage is consistent with other Tasmanian rockshelter and hunting camp sites. Quartz, both milky and crystal varieties, dominated all categories of the assemblage except for manuports. The latter in the main comprised slaty hornfels, like the outcrop and bedrock found in the immediate area of the rockshelter. Knapping activities employed the locally available materials except for the slaty hornfels which is generally unsuited to percussion flaking. A small proportion of exotic material was recovered but in total this comprised less than 1% of all artefacts excavated. Furthermore although sources of these stone types are not found on the islands, such stone may have come from the region at times of lower sea level. In keeping with other Pleistocene Tasmanian rockshelter sites, implements formed a minor component of the total assemblage but

included thumbnail and other scrapers, retouched flakes and flakes with evidence of use-wear. Most implements and cores were made from rock types presently available in the region: vein quartz, crystal quartz or quartzite.

Overall the stone assemblage gave an impression of very low-intensity use of the shelter for most of the earliest occupation phase until discard rates increased markedly about 18,000 years ago with the late glacial maximum. The occupation pattern from this time until the site was abandoned about 8,600 BP is unclear owing to the rookery disturbance. A pattern of greater use of local quartz in Unit A could suggest changing access to other stone sources as a result of post-glacial inundation. However some caution is required in placing too much emphasis on such variation due to the small sample size in Unit B and the post-depositional disturbance of the late Pleistocene and early Holocene deposits in the rookery layer. The one possible exception to this is the presence of rounded manuport rocks which can more certainly be attributed to the shell midden occupation phase.

4.6 Fossil bivalve shell artefacts

In addition to the shellfish food remains in the deposit, a number of pieces of other marine mollusc shell was recovered amongst the cultural remains. This other marine shell comprised two types of large bivalves: a robust fossil cockle shell (*Eucrassatella kingicola*) and scallop (*Pecten alba*) which is discussed in the following section. Both fossil bivalve and scallop shell have also been recovered from Pleistocene cultural deposits at Mannalargenna Cave and recorded on an open site on nearby Prime Seal Island (Brown 1991, 1993; Sim 1994) (Photographs 16 to 20). Although the shells were clearly cultural remains neither of these shellfish types are documented prehistoric food resources in Tasmania or elsewhere in southeastern Australia. Both these shellfish types are found in water of eight fathoms or more in depth although the shells do get washed up on high energy shores.

One hundred and eight pieces of fossil shell were recovered in total from the five squares excavated at Beeton Rockshelter [Appendix XI] (Tables 4.45 and 4.46). Pieces of the fossil shell were recovered from all squares excavated at the site in both the rookery layer and underlying Pleistocene deposits, indicating that at least some of these shells were being used prior to the occupation phase associated with the shell midden (Tables 4.45 and 4.46). Eleven of the 108 fossil cockle shell pieces recovered had umbones intact, enabling these to be identified as *Eucrassatella kingicola*. The remainder of the fossil shell without diagnostic traits such as the umbo was

consistent in size and shape with *Eucrassatella*, although this identification cannot be verified.

Square	excavated fossil shell		kg of deposit excavated	density no./10kg deposit	density g/10kg deposit
	no.	g			
D9	61	109.8	2284.0	.27	0.5
D6	21	116.7	1726.2	.12	0.7
C6	24	86.9	1159.3	.21	0.7
I6*	1	33.9	900.0	.01	0.4
U7	1	7.2	723.0	.01	0.1
TOTAL	108	354.5	6792.5	Mean 0.16	Mean 0.5

* includes a substantially complete valve with umbo

Table 4.45: Fossil shell - density and weight of shell recovered from squares D9, D6, C6, U7 and I6.

Shell type	Unit A		Unit B		TOTAL	
	no.	%	no.	%	no.	%
Fossil shell	104	96	4	4	108	100

Table 4.46: Numbers and percentages of fossil shell recovered in analytical Units A and B from squares D9, D6 and C6.

The robust fossil cockle shell was to some degree silicified, and consequently had a conchoidal fracture pattern typical of siliceous fine-grained stone such as chert. Fourteen, or 13%, of the 108 pieces of fossil shell had been shaped into tools using standard percussion knapping techniques normally used on stone material. These artefacts had unequivocal retouch (negative flake) scars and some also had use-wear edge damage (Table 4.47; Photographs 17, 18 and 19). Retouched shell artefacts

were fairly evenly distributed across the three squares excavated within the shelter, as was the volumetrically corrected density of fossil shell recovered, when calculated by weight. However, as with stone artefacts, fossil shell densities based on numbers are probably a more useful measure as they may relate directly to the intensity of on-site shell working. In this instance the density of shell artefacts by number was almost three fold in the D9 square despite the apparent similarity in density by weight (Tables 4.45 and 4.47).

Square /spit	artefact type	l x b x w mm	wt g	retouch &/or use-wear length mm & description
D9 /5	scraper	45 x 31 x 9	9.69	37 mm retouch on the shell margin edge
D9 /6	scraper	33 x 25 x 8	10.3	32 mm retouch with use wear on the shell margin edge
D9 /6	utilised flaked piece	26 x 14 x 5	1.77	9 mm neg. flake scars and use-wear on the shell margin edge
D9 /7	utilised flaked piece	39 x 29 x 8	6.12	18 mm edge damage (use-wear/retouch?) on the shell margin edge
D9 /7	round scraper	32 x 29 x 7	5.70	52 mm retouch with some use-wear damage on the shell margin edge
D6/6	round scraper	37 x 29 x 7	8.78	57 mm retouch on the margin edge with use-wear damage
D6/14	retouched piece	22 x 9 x 4	0.55	21 mm retouch on the margin edge (broken edge piece of larger tool)
D6/16	round scraper	38 x 22 x 7	4.03	36 mm retouch on the shell margin edge
D6/33	retouched piece	41 x 18 x 7	4.82	36 mm retouch on the margin edge with use-wear damage
C6/7	round scraper	31 x 29 x 6	4.95	35 mm retouch on the margin edge with use-wear damage
C6/8	round scraper	44x x25 x 6	10.3	33 mm retouch on the shell margin edge-umbo portion on dorsal end
C6/12	scraper slug	30 x 11 x 8	2.17	28 mm retouch/use wear on blunted 'expended' edge
C6/14	end scraper	32 x 21 x 5	4.25	21 mm retouch on the edge
C6/14	scraper	45 x 24 x 10	7.05	36 mm retouch on the edge

Table 4.47: Retouched fossil shell artefacts.

Three of the retouched fossil shell (*Eucrassatella*) pieces from the Beeton Rockshelter site had been retouched around the margins, shaping them into round and ovoid scraper tools (Table 4.47; Photographs 18 and 19). The round fossil shell scrapers were metrically and morphologically consistent with Jones' round-edge stone scraper type identified in the Rocky Cape assemblage, which are also not uncommon in other Tasmanian sites (Jones 1971:431, 450). In all cases the retouched edge of the shell tools incorporated the thinner, flared margin area of the shell valve, and the thicker umbo area had been removed in all but one. This latter artefact had a minor portion of the umbo present on the end opposing the worked edge.

Most unretouched edges on the broken fossil shell had fractured along straight planes, and bulbs or percussive impact points were absent. This fracture pattern suggests that the shell valves were being initially broken and then shaped into tool blanks using cleavage techniques other than freehand percussive knapping techniques. The valves were probably reduced on an anvil stone with a hammer-stone, using the natural concavity of the shell to assist in its fracture, resulting in the non-conchoidal fracture pattern evident on the broken shell edges. Suitably sized and shaped pieces of shell from the thinner ventral edge opposite the umbo appear to have been selected for tool-making purposes.

Unlike unmodified pieces, distinct negative flake scars were evident on the worked edges of retouched shell artefacts. Standard percussive flaking techniques were employed in the production of the working edge on the scraper blanks, and all retouched edges had been unifacially flaked from the ventral (inner, concave) surface of the shell. Umbones and the attached portion of shell appear to have been generally discarded, probably due to the morphology of this part of the shell not being suited to the making of scrapers. The umbo-bearing piece of shell is the equivalent of an expended stone core, the portion left after all potentially useful, margin pieces had been removed (Photograph 17).

The minimum number of individual valves represented in the fossil shell from the excavated squares was 11 (Table 4.48). The total weight of fossil shell represented by the 11 individual umbones, would be about 506 grams or so. This was estimated using a weight of 46 grams for a complete *Eucrassatella* valve, calculated from an unbroken *Eucrassatella* valve weighing 48.3 grams which was found in a dune on Prime Seal Island, and the 75% complete valve recovered from the I6 square which weighed of 33.9 grams. Using this weight estimate, the 354 grams of fossil shell recovered represents about 70% of 506 grams, the estimated total MNI fossil shell weight. This

implies that about 30% of the shell was being removed from the shelter, and that this shell comprised pieces from the thinner marginal parts of the valve opposite the umbo — the part from which the scrapers were made.

	sample size no.	weight g	Mean wt g
unretouched fossil shell pieces - umbo absent	84	111.1	1.3
unretouched pieces with umbo	10	163.1	16.3
retouched shell tools	14*	80.4	5.7

* includes one tool with umbo partially intact

Table 4.48: Comparative weight of fossil shell pieces with and without umbones, and retouched tools.

Production of shell scraper blanks, or finished scraper tools, which were being taken away from the site for future use could explain the absence of a quantity of the thinner shell margin fragments. Waste shell pieces had a relatively low mean weight when compared with either the retouched shell implements and the umbo (core) pieces (Table 4.48). This pattern is also consistent with secondary reduction of the marginal (non-umbo) shell pieces to produce shell blanks or tools at the site. On-site discard of the heavier large umbo part of the shells further indicates that complete valves were being brought to the site for the purpose of tool manufacture. That the shells were not being reduced at their source and were probably transported to the site as complete valves suggests that the source of the fossil shell was fairly close to the site. Since *Eucrassatella* fossil shell artefacts have also been found in sites on Prime Seal Island some 23 kilometres north of Badger Island, it is most probable that the fossil shell source is located somewhere between these two islands or to the west, and is now submarine.

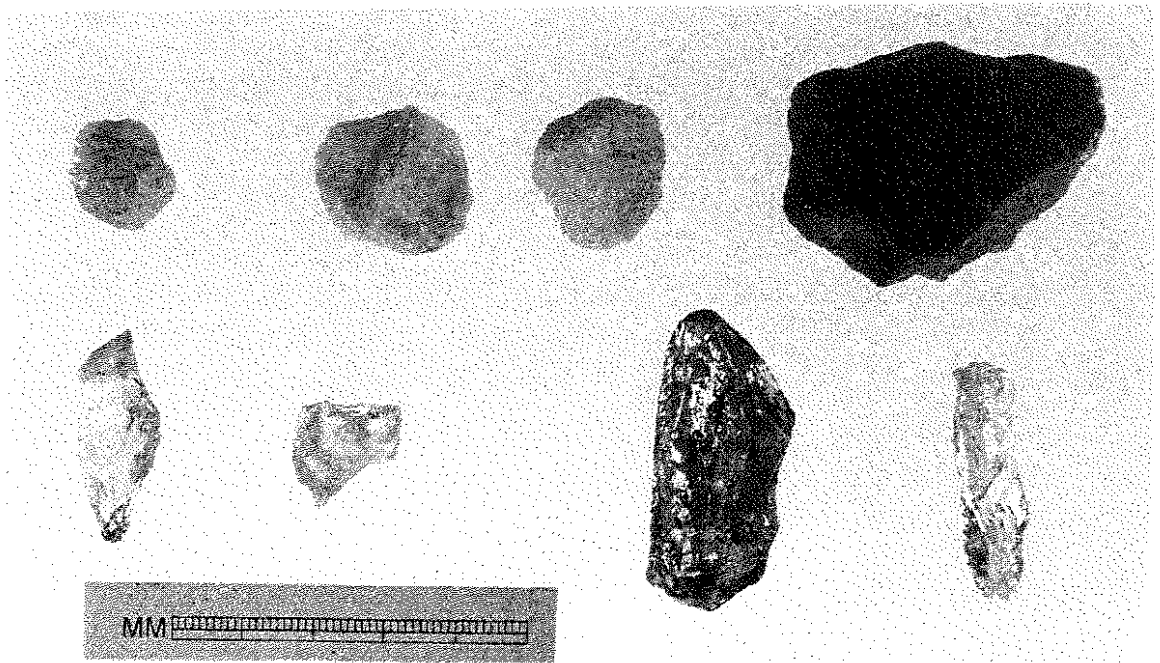
In many respects the fossil shell artefacts could be regarded as another category of stone flaking material, and analysed using similar methods. Accordingly, a sample of seven fossil shell artefacts was examined by Barton (1994) for organic residues and use-wear patterns using a low power stereo microscope with oblique lighting (x6-x40)

and a high power metallographic microscope with vertical incident light (x100, x200, x500 and x1000). Five retouched artefacts were found to have poorly preserved traces of plant and/or animal residues, none of which were clearly associated with the use of the artefact. Moreover the presence of a feather barbule amongst the residue traces raised the possibility of residue contamination, an issue of some concern considering the artefacts had been in immediate contact with nesting muttonbirds and buried for several thousand years or more in rookery sediments.

Use-wear analysis was not as problematic and microscopic edge-damage was identified patterns on four retouched artefacts. Damage comprised combinations of polish, striations and rounding, and on all four tools indicated the primary function of the tool had been for scraping - a common use for shell tools found in archaeological sites in northern Australia and other regions elsewhere (Barton 1991; Barton and White 1993; Cooper 1988; O'Connor 1996:33; Schrire 1982).

Apart from two sites on Prime Seal Island, no other sites containing fossil shell artefacts, or flaked shell artefacts have been recorded in Tasmania or the broader southeast Australian region (Brown 1993; Sim 1994). While the use of shell as scraper tools has been documented ethnographically and in archaeological contexts in northern Australia, there are no records of percussive stone working techniques being applied to shell (O'Connor 1996; Schrire 1982). The use of fossil shell for making scrapers suggests that people adapted the technology in accordance with available resources; why they chose to do this rather than transport or trade stone is the salient question.

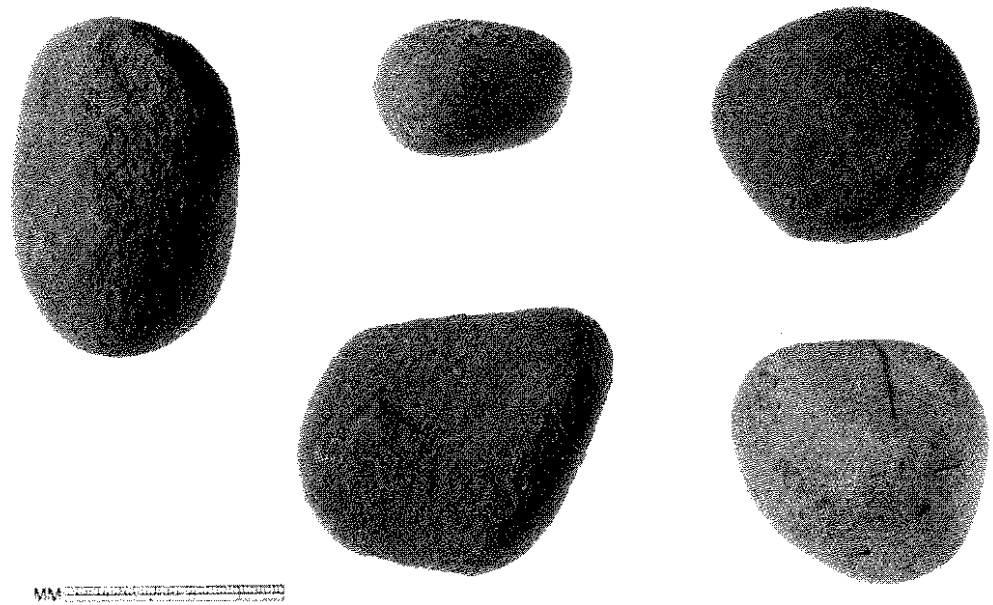
Unfortunately due to the muttonbird burrowing in Unit A it is not possible to obtain a finer scale resolution of the depositional context or chronology of the exploitation of fossil shell at this site. The problem concerning the antiquity of the fossil shell artefacts, and the association of these with human occupation phases at the site, is examined further below in the discussion section concerning the analysis of the excavated finds.



Photograph 13: Beeton Rockshelter stone artefacts: (top from left) D9/4 thumbnail scraper, D6/16 thumbnail scraper, D9/9 small round steep edge scraper, D6/17 large steep edge scraper (bottom from left) C6/11 flaked piece, D6/33 flake, C6/17 bipolar core, D9/11 bipolar core.



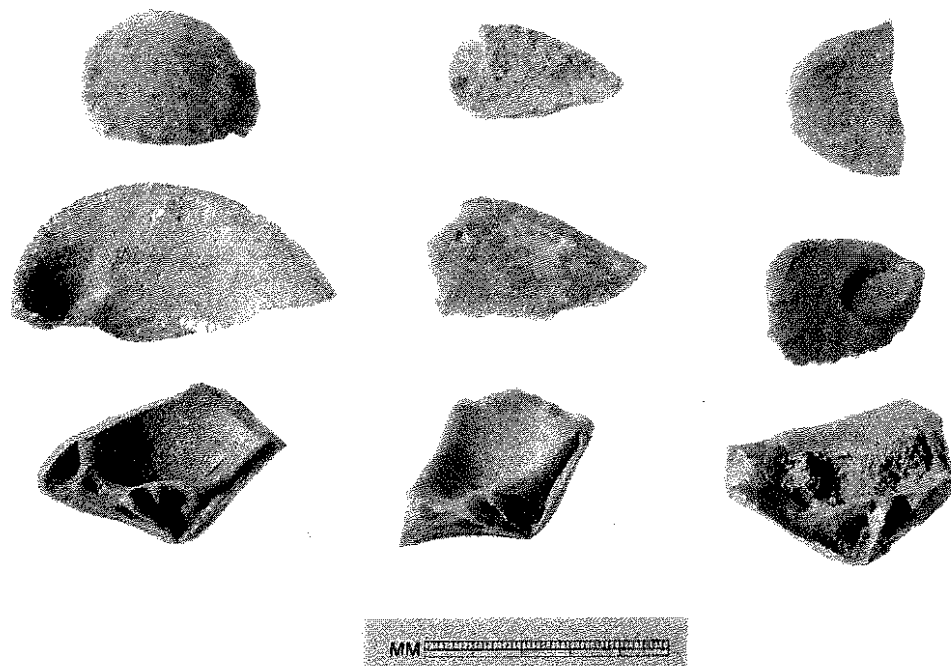
Photograph 14: Beeton Rockshelter artefacts: (from left) C6/12 ochre-stained quartz crystal flaked piece, D6/12 orange ochre nodule, C6/15 red ochre lump, C6/9 red ochre nodule, D6/23 single platform quartzite core with evidence of more recent re-use.



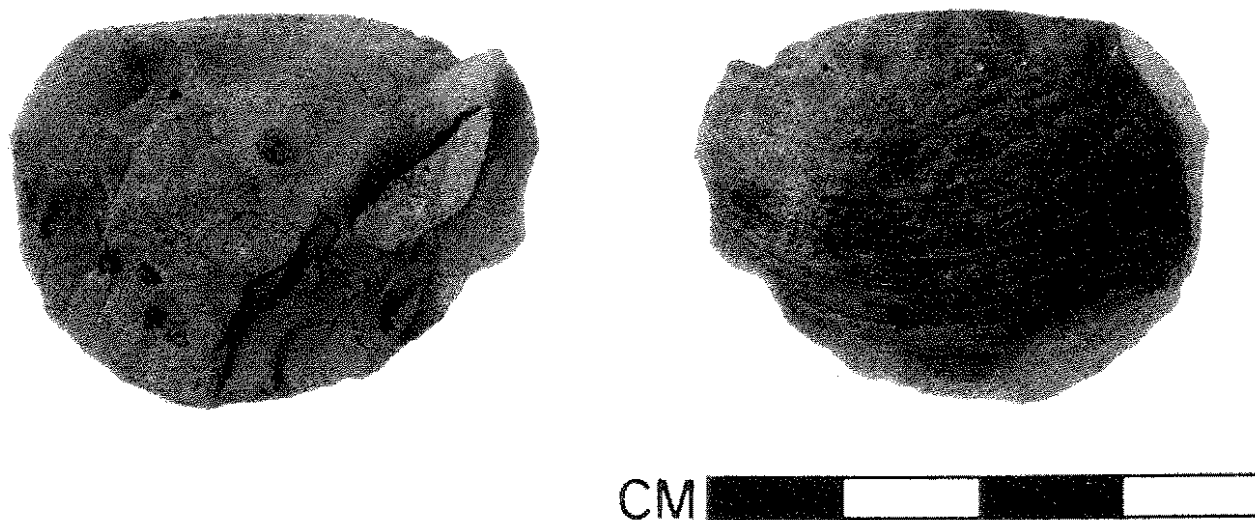
Photograph 15: Beeton Rockshelter stone artefacts: manuports from Unit A rookery layer.



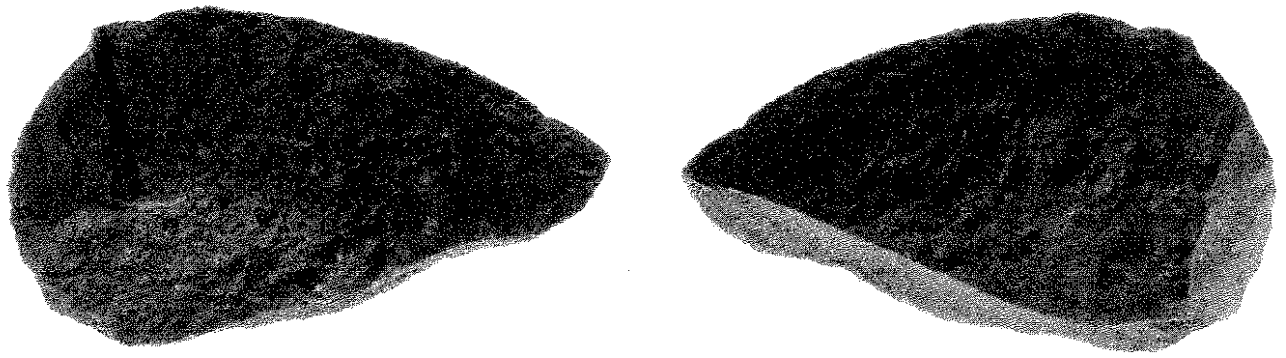
Photograph 16: Fossil shell (*Eucrassatella kingicola*) scraper from South Bay site on Prime Seal Island.



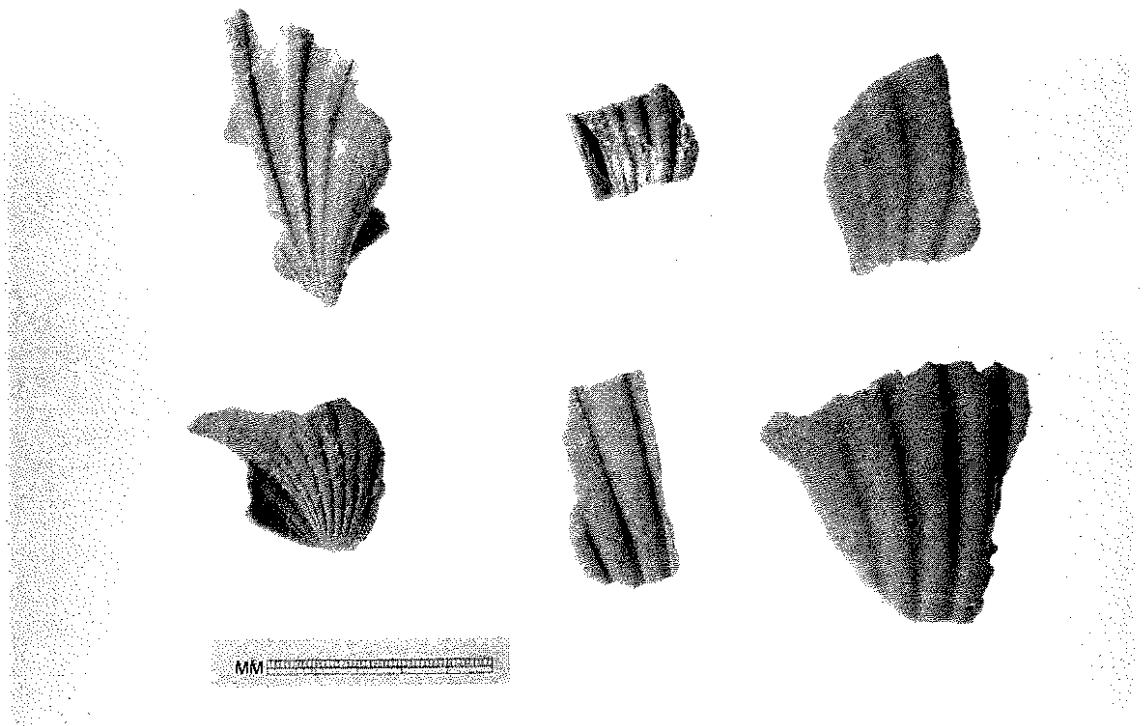
Photograph 17: Fossil shell (*Eucrassatella kingicola*) artefacts from Beeton Rockshelter: (bottom row to top row) umbo discards ('core slugs'), scraper blanks, retouched round and end scraper types.



Photograph 18: Fossil shell (*Eucrassatella kingicola*) round edge scraper from Beeton Rockshelter D6/6: (left) ventral, (right) dorsal.



Photograph 19: Fossil shell (*Eucrassatella kingicola*) end scraper from Beeton Rockshelter C6/14: (left) ventral, (right) dorsal.



Photograph 20: Scallop shell (*Pecten alba*) manuports from Beeton Shelter (BS) and Mannalargenna Cave (MC): (top from left) BS-D9/13, BS-D9/4, BS-D9/8, and (below) MC-F1/23, BS-D9/7 and MC-F1/27.

4.7 Scallop shell

In total 18 pieces of scallop shell (*Pecten* sp.) were recovered from the five squares excavated at Beeton Rockshelter [Appendix XII]. Like the fossil shell, scallop was found in both the Unit A rookery layer and the underlying Pleistocene Unit B deposit (Tables 4.49 and 4.50).

Square	excavated scallop shell		kg of deposit excavated	density no./10kg deposit	density g/10kg deposit
	no.	g			
D9	4	5.2	2284.0	.02	0.02
D6	2	8.0	1726.2	.01	0.05
C6	11	20.3	1159.3	.09	0.18
I6	1	1.7	900.0	.01	0.02
U7	0	0	723.0	0	0.00
TOTAL	18	35.2	6792.5	Mean 0.01	Mean 0.05

Table 4.49: Scallop shell - density and weight of shell recovered from squares D9, D6, C6, U7 and I6.

Shell type	Unit A		Unit B		TOTAL	
	no.	%	no.	%	no.	%
Scallop shell	17	94	1	6	18	100

Table 4.50: Numbers and percentages of scallop shell recovered in analytical Units A and B from squares D9, D6 and C6.

Four pieces of scallop shell had diagnostic elements which enabled them to be identified as *Pecten alba*. The sculpture and dimensions of ribbing on the remaining scallop shell pieces were also consistent with *Pecten alba* (Photograph 20). As there is no other described scallop (Pectinidae) species of similar size, it is highly probable that all the scallop shell recovered is from this one deepwater marine species (Macpherson and Gabriel 1962).

Although there was no evidence of deliberate shaping or use-wear on the scallop shell, there is no explanation other than human behaviour for the inclusion of this shell in the shelter's aeolian deposit. The absence of use-wear on the scallop shell suggests it was probably collected for non-utilitarian purposes such as body ornamentation, although none of the shell was pierced or incised. During the Furneaux Island surveys, scallop shells were commonly observed around the shores of several southern islands in the Furneaux Group, in areas where there are scallop beds which have been commercially dredged in recent times. It is possible therefore that scallop shells in the past were collected from more distant shorelines and carried to the shelter. Since the coast would have been up to 40 kilometres or so distant in late Pleistocene times, the portage of the scallop shell suggests that it was of particular significance to the people in the region.

It is also possible that at times of lower sea levels, deposits of natural shell beds were exposed, thus providing a source for the scallop shell. Quaternary beds of mud oyster shells, and older, upper Pliocene fossil shell deposits containing a variety of species have been recorded on Flinders Island (correspondence from D. Merrilees to D. Smith, Flinders Island 1969). One of these natural shell beds has been exposed by the shifting course of Northeast River near its mouth and others in excavated agricultural drains on the northeast flats of Flinders Island (pers. obs.).

Unlike the bleached shell observed in natural shell beds on Flinders Island however, the scallop shell excavated in the Beeton Rockshelter site had retained its purplish-red colour. The state of preservation of the scallop shell suggests that it is of much more recent antiquity than shell observed in natural shell beds in the region, supporting the explanation of transportation from a beach wash source rather than fossil shell bed exploitation.

Pieces of scallop shell were found in all squares except I6, and more than half of those recovered came from the C6 square toward the rear of the shelter (Table 4.49). This distribution pattern across the site contrasts with that of most other cultural remains as these tended to be more prolific in the D9 and D6 squares. Scallop shell was evident in both the disturbed rookery layer (Unit A) and the underlying Pleistocene deposit (Unit B) although only one piece was recovered from the latter (Table 4.50). This piece was retrieved from the upper levels of Unit B in the D6 square where the junction between the rookery layer and underlying deposit was indistinct in places due to animal disturbance.

Overall the concentration of the scallop shell in Unit A suggests that it was deposited sometime after about 19,000 years ago or so. Human deposited scallop shell has also been recorded in Pleistocene deposits at Mannalargenna Cave on nearby Prime Seal Island, although this does not exclude the possibility that the use of scallop shell continued through the more recent midden phase at the Beeton Rockshelter deposit (Brown 1993:265).

4.8 Avian eggshell

Eggshell fragments were recovered from most levels of the deposit in the Beeton Rockshelter excavations. A reference collection consisting of extant and extinct ratite shell, and eggshell of the Cape Barren Goose (*Cereopsis novaehollandiae*), short-tailed shearwater (*Puffinus tenuirostris*) and black swan (*Cygnus atratus*), was used to identify the eggshell found in the shelter deposit. The eggshell recovered from the shelter deposit fell into two categories:

- a) that which was readily identifiable as emu eggshell because of its granulated surface, thickness, and in most instances colour, and
- b) other eggshell which had a smooth surface and was also too thin to be emu or swan eggshell.

The latter shell was all consistent with the muttonbird and Cape Barren Goose eggshell in the reference material, although it was not possible to differentiate between goose and muttonbird egg due to the similarities in thickness, colour and texture. Similarly, muttonbird eggshell could have come from any one of the five species of muttonbirds identified in the bird bone remains. Thus, for analytical purposes, the avian eggshell was divided into two categories, emu and other eggshell.

4.8.1 Emu eggshell

At the time of first European contact, emus were observed on both King Island and mainland Tasmania although both these populations were extirpated by early white settlers within a few decades (Barnard 1826-1827; Dove 1926; Jouanin 1959). There are no historic records of emus on the Furneaux Islands at the time of European arrival although its distribution across southeast Australia, Tasmania and King Island would suggest that it was almost certainly present in the Furneaux region during past landbridge periods. Which emu species (or subspecies) was present in the Furneaux region is unknown as the only remains found there to date are eggshell (Brown 1993; Hope 1973). Although the taxonomic relationship between the King

Island species (*Dromaius ater*), the Tasmanian emu (*D. diemenensis*), the Kangaroo Island emu (*D. peroni*) and the extant mainland Australian species (*D. novaehollandiae*) is somewhat unclear, it is generally accepted that there are at least 'two forms' of emu (Jouanin 1959:199; Pizzey 1980). The presence of emu eggshell in the Beeton Rockshelter deposit certainly indicates that at least one *Dromaius* species was there in the prehistoric past, and this bird and its eggs may have been exploited by people living in the region in prehistoric times.

Emu eggshell was found in all squares excavated within the shelter (Table 4.51) [Appendix XIII].

Square	Total no. of pieces	Total wt g	Mean wt g per fragment	Density no./10 kg deposit
C6	97	21.06	.217	.836
D6	126	19.79	.157	.731
D9	70	11.31	.161	.306
Σ C6, D6 & D9	293	52.16	.178	.624

Table 4.51: Numbers and weights of emu eggshell from squares C6, D6 and D9.

A total of 52.16 grams of emu eggshell was recovered from squares C6, D6 and D9, within the shelter proper, and an additional 0.67 grams (three pieces) was found in the I6 square outside the drip-line. Cultural remains were generally scant in this latter square and also in U7, the square further outside the shelter where no emu eggshell was recovered.

Stratigraphic distribution of the emu eggshell

The vertical distribution of the emu eggshell (tabled in Appendix XIII) is graphed below (Figure 4.21). These data are presented as raw numbers of pieces of eggshell found per spit rather than in a rationalised form. Raw data have been used because the vast majority of emu eggshell pieces were recovered from the bird-disturbed unit and the question of relative density within the rookery unit was not relevant. It

was the presence or absence *per se* and quantity that was of greater interest. In Figure 4.21 spits excavated from the disturbed rookery layer, i.e. unit III, are indicated by a dot preceding the spit number.

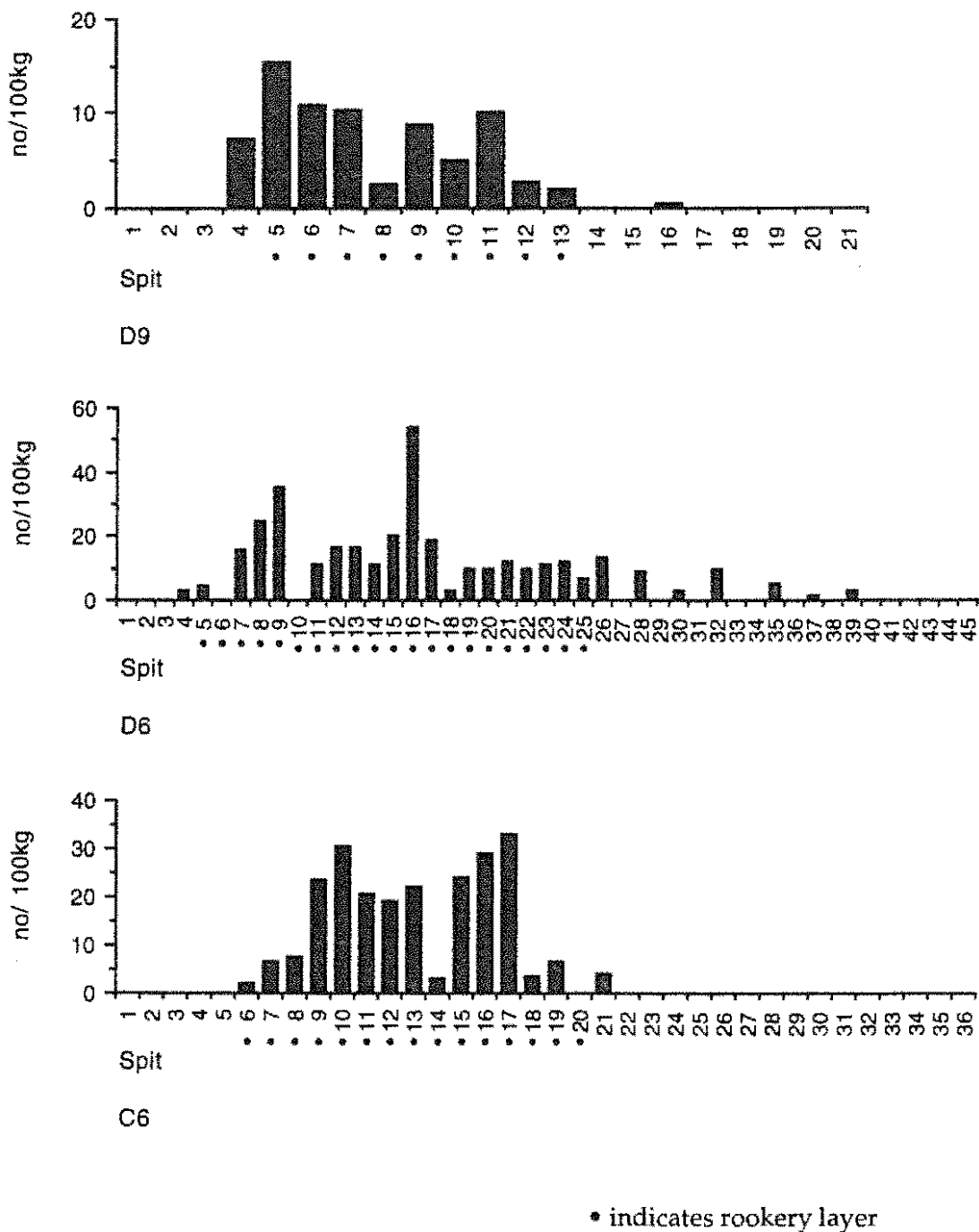


Figure 4.21: Volumetrically corrected density of emu eggshell in squares D9, D6 and C6.

In squares C6 and D9 there is a marked correlation between the distribution of the emu eggshell in the deposit and the rookery layer disturbed by birds, unit III. Of the 167 pieces of emu eggshell recovered from the C6 and D9 squares only two were found in the deposits beneath the rookery layer. A similar pattern was also evident in the D6 square although 25 pieces in this square were recovered from the underlying unit IV deposit. These have almost certainly been transported downwards by a wombat burrowing through unit III and into the unit IV deposit. As described in the taphonomy and depositional history of the site in Chapter Three, the D6 square contained a wombat burrow, and rookery layer deposits intruded from above into the underlying unit IV deposit. Considering the distribution pattern of emu eggshell in the other two squares, and the presence of the burrow in D6, it is highly probable that the emu eggshell recovered from the lower unit IV in the D6 square resulted from the wombat burrowing activities.

Overall the increased density of emu eggshell in the rookery layer indicates that it was originally mainly confined to the upper levels of the Pleistocene deposit (i.e. post 18,000 BP), before the deposit was disturbed by burrowing muttonbirds and the rookery layer formed. Even though two samples in the D/L ratio analysis were almost certainly heat affected, there were three samples that had ratios consistent with the piece AMS dated to about 23,000 years old (uncalibrated), and one younger piece the D/L ratio of which suggested it was about 19,000 years old [Appendix II]. The accumulation of a number of pieces of this antiquity in the rookery level which overlies the undisturbed remnant of the Pleistocene unit IV deposit further supports a rapid accumulation of sediments in the rock-shelter at the height of the last glacial. It is also possible that the emu eggshell was originally present in a cultural horizon in the upper level of the Pleistocene deposit, some depth below the shellfish remains.

Fragmentation

During sorting the emu eggshell pieces were assigned to various size categories according to the maximum dimension of piece (Table 4.52). The largest piece weighed 0.98 grams and had a maximum dimension of 63 millimetres. A consistent pattern in the size distribution was present in all three squares within the rock-shelter (Figure 4.22). The majority of the pieces however were relatively small, falling within the 10 - 15 millimetres maximum dimension category.

Despite its fragile appearance, emu eggshell is resilient and does not naturally break into fragments less than 20 millimetres in size, either in the hatching process or when

deliberately broken to obtain the raw egg white and yolk (Jerry van Tets pers. comm.). A higher degree of fragmentation occurs when the shell is trodden on, or deliberately reduced in size by hammering, and also when the shell has become more brittle as a result of heat effects. Hence the degree of fragmentation evident in the Beeton Rockshelter emu eggshell is not consistent with natural breakage patterns, suggesting it has been reduced to relatively small pieces as a result of trampling of larger pieces and/or heating of the eggshell.

Size Category max. dimension	no.	%
5 - 10 mm	62	22
10 - 15 mm	164	55
15 - 25 mm	43	15
25 - 75 mm	24	8
TOTAL	293	100

Table 4.52: Size distribution of emu eggshell from squares C6, D6 and D9.

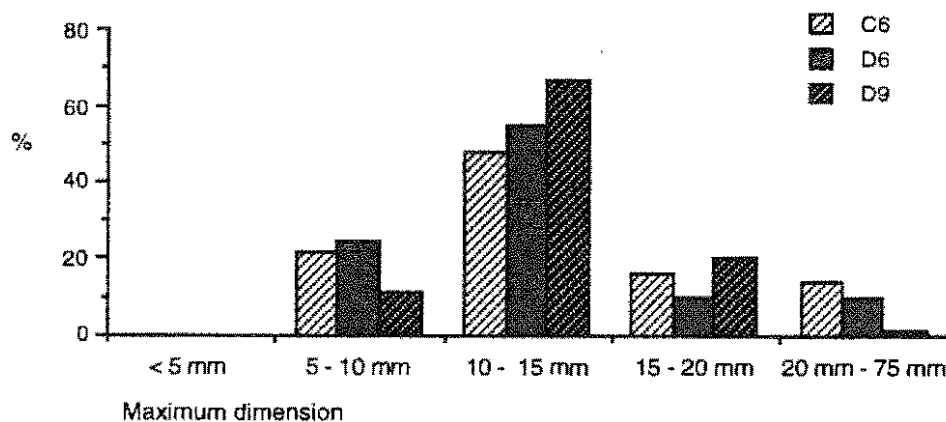


Figure 4.22: Size distribution of the emu eggshell from squares D9, D6 and C6.

Emu eggshell: cultural or non-cultural remains?

An average-sized 'blown' egg from the extant mainland Australian emu weighs between about 75 and 85 grams (Campbell 1974:1064, and weights from ANU reference collection eggs). Using this as a comparative basis, the overall amount of emu eggshell recovered from the three squares within the shelter represents less than one complete emu egg. Nonetheless, it is highly improbable that the remains are from a single egg as the excavated deposit represents only somewhere in the order of 5% of the total deposit in the shelter. Assuming the density of emu eggshell in these three excavated squares is representative of the overall deposit within the shelter, then estimated the quantity of emu eggshell in the entire deposit would be about 15 eggs. This is equivalent to what would be found in two to three clutches of eggs in a typical southeast Australian emu habitat.

Emus generally choose more open locations than rockshelters for nesting although ornithologists cannot be certain of the behaviours of the extinct Tasmanian and Furneaux region emus. Nonetheless, it is unlikely that the emu eggshell is naturally occurring in the deposit as much of it is burnt, a phenomenon that is not observed in non-anthropogenic contexts elsewhere in Australia. Nor is it possible that the eggshell was transported by winds into the cave with the sediments, as such transport is readily identifiable in the abraded nature of the edges of eggshell pieces (John Magee pers. comm.). No such evidence was observed on any of the emu eggshell recovered from Beeton Rockshelter. The trait most diagnostic of its association with human activity however is evidence of charring or burning.

Burnt or charred eggshell

Forty-two percent of the pieces of emu eggshell had some evidence of burning (Table 4.53). Eggshell categorised as burnt varied from partially charred pieces to others which had been totally blackened.

The shell curvature of some pieces which had been completely blackened or heavily charred had been totally reversed as a result of firing. Similar heat effects had been observed on emu eggshell found in the prehistoric Seton Shelter site on Kangaroo Island (Jerry van Tets pers. comm.). Pieces displaying such heat effects were, along with the majority of the burnt pieces, relatively small in size (Table 4.54).

Square	burnt pieces no.	unburnt pieces no.	burnt %	unburnt %
C6	54	43	56	44
D6	52	74	41	59
D9	17	53	24	76
TOTAL	123	170	42	58

Table 4.53: Numbers and percentages of burnt and unburnt emu eggshell pieces from squares D9, D6 and C6.

Size Category max. dimension	no.	% burnt	% unburnt
5 - 10 mm	62	61	39
10 - 15 mm	164	39	61
15 - 25 mm	43	30	70
25 - 75 mm	24	33	67

Table 4.54: Size distribution of burnt emu eggshell.

Due to the chemical composition of emu eggshell, heating or firing will significantly increase the fragility of the shell (John Head pers. comm.). It would be expected therefore that burnt pieces of shell would be more vulnerable to further fragmentation, and thus explain the increased percentage of burnt pieces in the smaller size range.

Antiquity of the emu eggshell: depositional and occupational implications

As outlined in the section on chronology in Chapter Three, an AMS date of about 23,000 BP was obtained on a piece of emu eggshell recovered from the rookery deposit in the D9 square (Table 3.2). While there is possibly younger emu eggshell in the deposit, the results of D/L analysis on pieces which did not appear to have been heat affected gave ages between about 19,000 and 23,000 years [Appendix III]. The possible absence of younger emu eggshell is interesting in light of the prehistoric extinction of emus in the Furneaux region.

Early historic Tasmanian accounts document emu sightings on King Island and in a range of open woodland and plains habitats on mainland Tasmania (Dove 1926; Jouanin 1959; Micco 1971). There were no emus however on any of the islands in the Furneaux Group when Europeans first arrived in the late 1790s. Since there is both evidence of prehistoric human occupation and exploitation of emu resources in the Furneaux region, it seems plausible that the extinction of emus in the region is related to past human predation. As demonstrated by the sealers rapid extirpation of the King Island emu, and the similar extinction of mainland Tasmanian emu populations by early settlers, the emu appears vulnerable to human predation. Nevertheless, other factors such as habitat requirements and palaeoenvironmental changes could also account for changes in emu distributions and, as noted below, the variation in density of emu eggshell in the cultural deposit at Beeton Rockshelter may to some degree be a reflection of non-cultural factors.

Although the extant Australian species is noted for its adaptability to a wide range of environments, Cosgrove (1991:252) suggests that open woodland and grasslands are preferred Tasmanian emu habitats. If this is the case the presence of emus in the late Pleistocene on the Bassian plains concurs with Hope's (1978) vegetational history of the region, based on pollen sequences from Cave Bay Cave on Hunter Island. These pollen sequences show that the regional vegetation from around 28,000 BP to 16,000 BP would have been open shrub-dominated heath, possibly with woodland patches in more sheltered areas, and that this increasingly became open grasslands as climatic conditions became more arid as the glacial maximum peaked (Hope 1978). Environmental conditions alone however cannot account for the absence of emu eggshell in the undisturbed Pleistocene cultural deposit or the absence of emus on the Furneaux Islands in early historic times.

That no emu eggshell was recorded from the unit IV deposits could suggest that people using the shelter in the earlier period were either not exploiting emu eggs or alternatively not transporting them to the shelter. A wide range of behavioural as well as environmental explanations could account for the absence of emu eggshell in the lower deposit (e.g. changing patterns in site use and activities undertaken at the site, changes in emu habitat over time, changes in human exploitation strategies etc.). It is considered more probable however that people were not using the shelter for the same range of activities evident in the upper levels of the deposit where the emu eggshell was found, and that the absence of emu eggshell in the lower deposit is reflecting human behavioural rather than environmental changes.

As outlined in the chronology and depositional history of the shelter in Chapter Three, the evidence suggests that the deposit accumulated rapidly, probably as the result of a short period of intense aeolian activity around the last glacial maximum. The greater density of emu eggshell in the upper levels of this deposit probably are reflecting a greater use of the shelter by people as the phase of high wind regime and sedimentation declined. This interpretation is certainly supported by the evidence at Mannalargenna Cave on nearby Prime Seal Island, where the vertical distribution of emu eggshell matched the pattern evident in other cultural remains (Brown 1993:265). A similar case can be argued for Beeton Rockshelter although the disturbed nature of the upper level of the cultural deposit, and the shellfish phase make the interpretation of this site somewhat more complex.

In summary, the presence of emu eggshell in unit III, the rookery layer, suggests a more intensive occupation phase at the site probably as sedimentation rates at this site declined. The AMS date obtained from one piece of eggshell suggests that this increase in shelter use commenced around or after about 23,000 or so years ago. It should also be noted that due to the greater stability of carbon in eggshell compared with charcoal, a discrepancy between radiocarbon dates from emu eggshell and from charcoal samples of similar antiquity is to be expected, and the charcoal dates younger. The disturbed nature of the rookery layer containing the eggshell make it difficult to ascertain more precisely the chronology of this occupation phase. For the same reason, it was not possible to ascertain from the stratigraphy whether any of the emu eggshell is associated with the occupation evident in the shellfish remains. The results of dating and analysis of D/L ratio suggest that the emu eggshell deposition pre-dated the midden phase, possibly by 10,000 years or more. It is possible however that the AMS and D/L dated pieces are not a representative sample and that more recent emu eggshell is present in the deposit. The question of the antiquity of the emu eggshell is addressed further in Chapter Five.

4.8.2 Other eggshell

As described above, all other eggshell was consistent with that of muttonbirds or Cape Barren Geese. The latter birds breed on Badger Island and eggs are seasonally available around the shelter, and while muttonbirds are now extinct on the island, the presence of numerous muttonbird bones in the rookery layer attests to their presence there in the past. It is common for muttonbird eggshell to be included and preserved in rookery sediments as the eggs hatch in the burrows and are often buried and preserved when burrows collapse (Jerry van Tets and Darrell West pers. comm.).

Hence, the strong correlation between the eggshell distribution and the rookery layer is not unexpected (Figure 4.23). Nonetheless, a similar correlation was evident in the distribution of culturally derived eggshell, that is the emu eggshell, and the other eggshell arguably could also be cultural remains. Brown's (1993) findings from Mannalargenna Cave showed a strong correlation between the same category of other avian eggshell and all other cultural remains including emu eggshell. This latter site however had not been a muttonbird rookery and was therefore less likely to have eggshell included in the deposit by non-human agents.

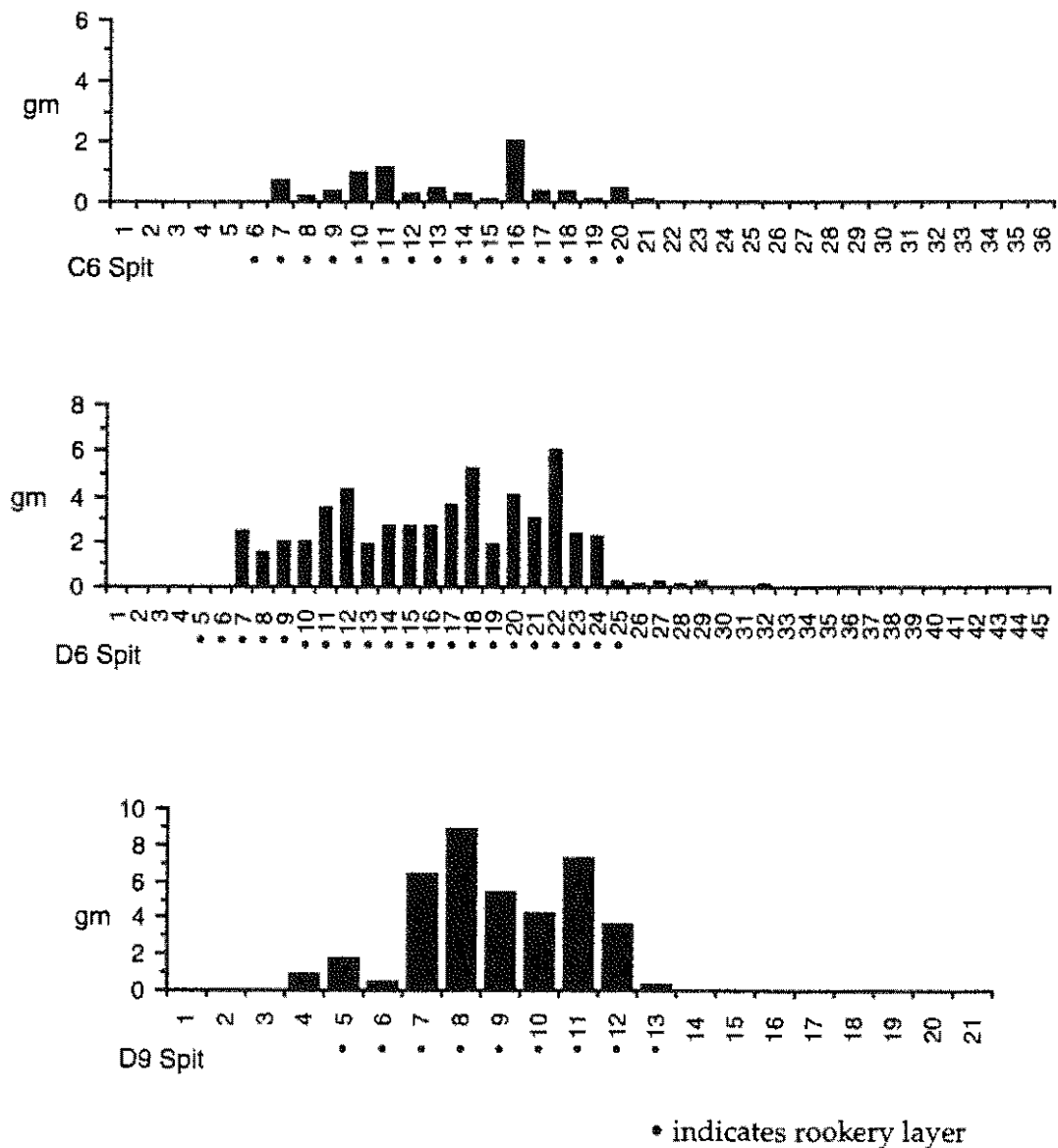


Figure 4.23: Distribution of avian eggshell (other than emu eggshell) in squares D9, D6 and C6.

As Beeton Rockshelter is an extinct rookery, it would therefore be expected that eggshell would accumulate in the deposit as a result of nesting birds. Since it was not possible to detect which of the eggshell apart from emu was deposited by humans, and which attributable to the muttonbirds, this eggshell was not accorded cultural status — even though a small component of the eggshell apart from emu egg is possibly cultural. What is clear however is that the rookery deposit contains relatively dense quantities of both emu and other types of avian eggshell, whereas eggshell of any type is scant and emu absent in the deposit underlying the rookery layer.

4.9 Charcoal

A total of 130 grams of charcoal was recovered from the C6, D6 and D9 squares, and 1.43 grams from I6 and U7, the squares located outside the shelter (Table 4.55a). It could be argued that some component of the charcoal recovered is a product of natural prehistoric fire events in the vicinity of the rockshelter, although the disparity between the charcoal found in the squares outside the shelter and those within does not suggest this is the case. Almost certainly the charcoal found in the deposit inside the shelter is a product of human activity and has come from hearths as several were excavated from squares within the shelter. There was also a corresponding increase in charcoal in spits excavated from identifiable hearth levels in the undisturbed deposits. There is no evidence to suggest that the charcoal has any origin other than human activity in the shelter. Moreover, the small quantities of charcoal recovered from squares outside the shelter do not suggest that wildfires have been a feature in the region in the past.

Charcoal was both most frequent and densest in the D6 deposit (Table 4.55a). The D6 and the D9 squares are in the main habitable sheltered area whereas C6 is located close to the back wall. The comparatively low amount of charcoal found in C6 is probably due to human activity being more intense in the more commodious parts of the shelter. This does not explain however the disproportionately low quantity of charcoal recovered from the rookery layer in the D9 square. While it is possible that fewer hearths originally existed in this area of the shelter, it could equally be a result of relatively poor preservation of charcoal in this square. The majority of charcoal excavated from the deposit was very fragile and some smaller pieces disintegrated into flecks too small for sieve recovery on site. Given the fragile nature of the charcoal it is highly probable that bird activity at the site has broken down a substantial portion of the charcoal to particles too fine for sieve retrieval. This could

explain the lesser charcoal recovered from the rookery unit in the D9 square as this square also contained much more muttonbird bone.

Overall there was a consistent pattern of relatively high densities of charcoal in Unit A (surface and rookery deposits) compared with the underlying Unit B (Pleistocene sand deposits) in squares inside the shelter (Table 4.55b). The increased density of charcoal in the rookery layer strongly suggests that there was more intense use of the shelter sometime in the period represented by the intermixed rookery. Moreover because of the extremely friable nature of most of the charcoal and the intense bird activity, the quantities of charcoal recovered from the rookery unit are probably an under-representation of the charcoal originally present. Nonetheless although much lower in density, the presence of charcoal and hearths in the underlying Unit B deposit attests to sporadic use of the shelter by people in the earlier phase of sediment deposition (Figure 4.24).

Square	Charcoal wt g	g/100 kg of deposit removed
C6	21.47	1.85
D6	70.10	4.06
D9	38.42	1.68
I6	0.41	.05
U7	1.02	.15

Table 4.55a: Charcoal weight and density per square.

Square	Unit A wt g	Unit B wt g	Unit A g/100 kg	Unit B g/100 kg
C6	20.76	0.71	3.63	0.17
D6	66.05	4.05	9.55	0.45
D9	27.95	9.19	3.70	0.73

Table 4.55b: Charcoal weight and density - Units A and B .

Table 4.55: Charcoal recovered from squares D9, D6 and C6 .

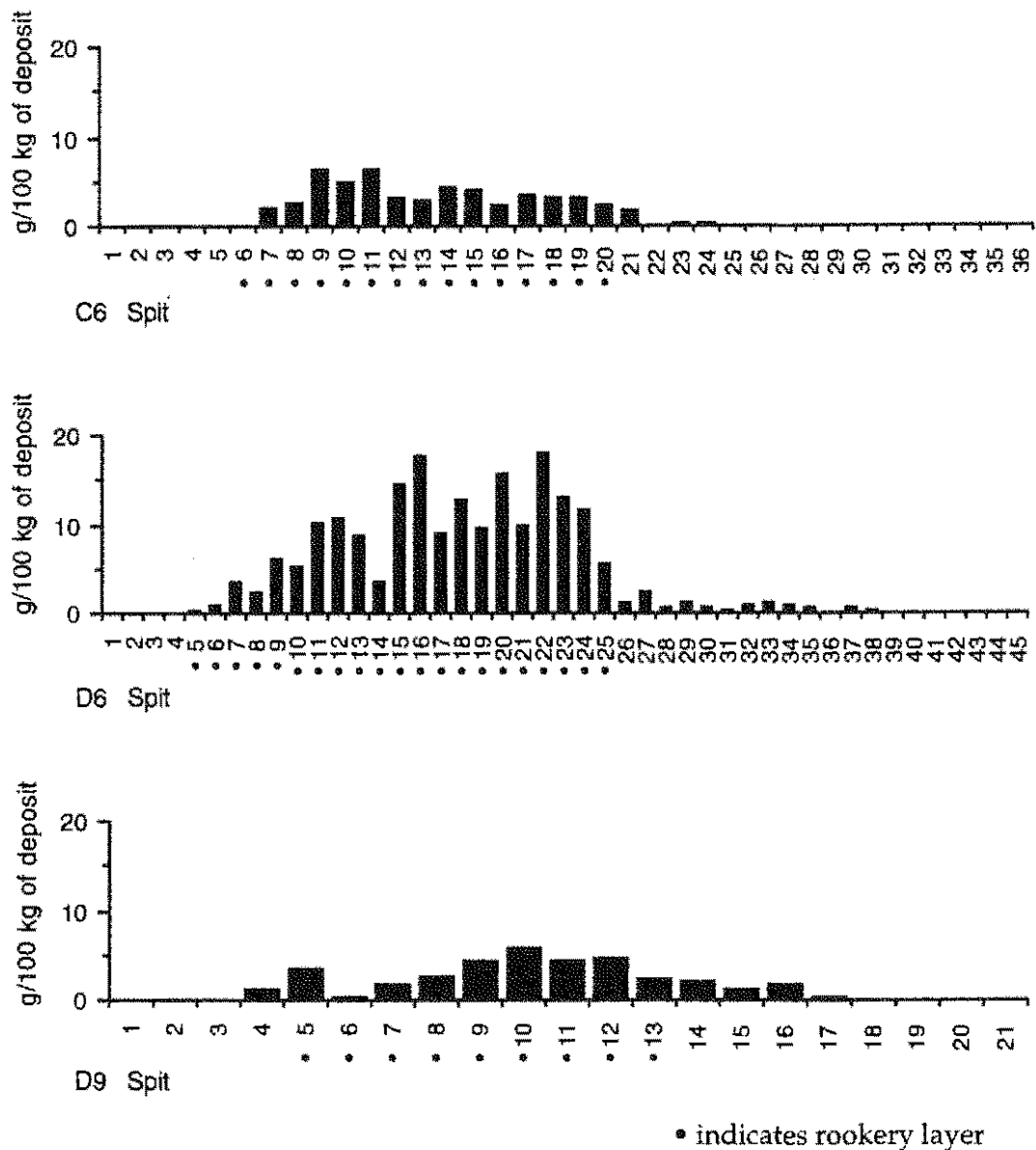


Figure 4.24: Charcoal distribution in squares D9, D6 and C6.

4.10 Ochre

Eight small nodules of ochre were retrieved from the five squares excavated (Table 4.56, Photograph 14). All the ochre was found in Unit A deposits, within the rookery layer. Although no pure haematite deposits are found in the Furneaux region, poor quality ochre can currently be obtained from iron rich horizons exposed in eroding aeolianite formations along the west coast of Flinders Island (Sim pers. obs.;

Sutherland and Kershaw 1972:8). There are no known sources in close proximity to the site and nor does the local geology suggest that haematite would occur on Badger Island.

Square	spit	ochre g
C6	7	.22
C6	9	.23
C6	11	.34
C6	12	.37
C6	15	.72
D6	11	2.2
D6	12	.04
D9	11	.17

Table 4.56: Ochre weights and provenance.

Red staining which appeared to be ochre was observed on a number of stone artefacts. SEM analysis of one stained artefact confirmed that the red staining on it is ochre (Photograph 14) [Appendix XI]. The similarity between staining identified as ochre and that on other artefacts strongly suggests that the red stains on these are also ochre stains. Ochre hand-stencils have been found in several southwest Tasmanian Pleistocene cave sites and there is clearly a long tradition of ochre exploitation for hair grooming, body ornamentation and other artistic purposes in Tasmania (Loy *et al.* 1990; Plomley 1966; Sagona 1994). The presence in the Beeton Rockshelter deposit therefore suggests that activities other than utilitarian tasks were being undertaken there in the past.

4.11 Beeton Rockshelter: summary of analyses and interpretation

Five squares, each one metre square, were excavated at the Beeton Rockshelter site. Three of these were located within the rockshelter and two beyond the drip-line (Figure 3.1). The range of cultural remains recovered included marine shellfish, stone artefacts, flaked fossil shell artefacts, bird and mammal bone, emu eggshell fragments, scallop shell and ochre nodules.

The stratigraphy was consistent in all squares excavated although more vertically compact in the U7 square which was located 16 metres seaward of the rockshelter.

Four stratigraphic units were present in the rockshelter :

- I. a modern sheep and cow dung layer about 10 centimetres thick,
- II. a culturally sterile thin band of medium pale sand (present only in some areas) up to two centimetres thick,
- III. a darker medium to coarse sand unit intermixed with bird and animal bone, shellfish remains, stone artefacts and other cultural remains, 45 to 50 centimetres in depth,
- IV. a paler medium coarse sand basal unit containing a lower density of cultural remains. The basal sand unit varied in depth between about 80 centimetres and 1.1 metres according to the lie of the bedrock.

The unit III was not a depositional unit *per se* but a post-depositional feature — an extinct muttonbird rookery deposit. Sediments in both the rookery layer and the underlying unit were aeolian in origin, typical of those currently found in sand sheets and coastal dunes in the region. The finer sand present in some places between the dung capping and the rookery layer appeared to have been from more localised weathering of the rockshelter walls, deposited during the period of stability at the site, after the aeolian deposition ceased.

Radiocarbon dates obtained from samples of shellfish, charcoal and emu eggshell indicate that deposition of the bulk of the rookery layer and underlying sediments in the Beeton Rockshelter probably occurred very rapidly just prior to and during the peak of the last glacial maximum. A case could be put for a slower rate of deposition in the rockshelter although the presence of emu eggshell pieces almost certainly more than 19,000 years old, and one piece radiocarbon dated to about 23,000 BP, support the case for rapid deposition at the last glacial maximum rather than a long term accumulation of deposit over some ten or more thousand years.

While some remains recovered during the excavations were unequivocally of cultural origin, the derivation and cultural status of others was ambiguous. Cultural remains included stone artefacts, shellfish debris, worked and unworked fossil shell, charcoal found in association with hearth areas, scallop shell; of less certain cultural derivation were scattered charcoal, emu eggshell, muttonbird bone and mammal bone. Since there were hearth areas evident in the deposit and no other evidence to suggest that wildfires were responsible for the deposition of charcoal in the rockshelter, the scattered charcoal was accorded the same cultural status as that recovered from

hearth areas. Similarly, there was no natural explanation for the presence of emu eggshell as it clearly had not been transported by aeolian means to the rockshelter. Furthermore some 42% of the eggshell had evidence of charring or burning which suggested the eggs had been cooked or heated and thus were human food debris.

Muttonbird bone was more difficult to assess. Initial field observations during the excavations and the absence of rookeries on Badger Island suggested the muttonbird bone may have been food debris associated with the shellfish midden occupation phase. Subsequent analysis however did not support these observations and indicates that the vast majority of the bone results from muttonbirds nesting in the rockshelter several thousand years after people had ceased visiting it. Five species of shearwaters were identified in the muttonbird bone although the main species represented was the Short-Tailed Shearwater, the species commonly found in the Furneaux region today. The results of analyses of other muttonbird bone accorded with the bone dating; both indicated that probably only a very minor component of the assemblage was a result of human predation.

The AMS radiocarbon dating results indicated that the majority of the muttonbird bones resulted from natural rookery deaths about 5,000 years ago, and demonstrate that rather than an intact midden deposit, the stratigraphic unit III is the product of widespread disturbance created by birds burrowing in the rockshelter.

It is probable that the colonisation of the rockshelter by the muttonbirds was related to the extinction of quolls or devils in the post-insulation period, as extant populations of these are known to deter muttonbirds from establishing rookeries on larger islands. Why muttonbird rookeries appear to have been relatively short lived on Badger Island may be related to carnivore populations waning on other islands as a result of the insulation process (Skira 1993). Compared with present-day rookery habitats on the Outer Furneaux Islands, Badger Island has few dune or alluvial areas suitable for burrows, and represents a minimal environment in terms of rookery habitat (Jerry van Tets and Irynej Skira pers. comm).

The analysis did not suggest that muttonbirds were being targeted as a food resource, although the occasional one may have been eaten. As the relative proportion of bone resulting from human predation was minimal, the muttonbird bone has been generally regarded as non-cultural.

The mammal bone remains were more problematic as a number of agents including natural deaths of animals in the rockshelter could account for these remains. Much of the bone analysis focused on differentiating remains derived from human activity from those for which there is a natural explanation for their presence in the deposit. Using rockshelter bone assemblages deposited by non-human agents, criteria have been developed by which it is possible to identify scat bone attributable to Tasmanian devils and predatory birds in rockshelter deposits. A major component of the bone met these criteria and while this does not exclude the possibility that some was human food debris, the majority did not appear to be so. The bone distributions illustrated in Figure 4.9 show the distribution of the component of unburnt bone that was possibly food refuse and the burnt bone. The latter is considered to be related to human activity in that it was either direct evidence of cooking or alternatively indirect evidence of human activity at the site in that it results from the building of hearths in the rockshelter.

Since there is a greater probability that the burnt bone is human food debris, it provides a comparative basis for assessing the mode of deposition of other bone not attributable to bird or devil scats. The analysis indicated that while some of this bone is undoubtedly attributable to human predation, the rockshelter deposits also contain a fairly consistent component of medium, and to a lesser extent, large mammal bone probably resulting from natural animal deaths within the rockshelter.

Cultural remains were consistently denser and more numerous in the Unit A deposit in all pits excavated. In terms of human occupation at the site this suggests that the rockshelter was visited more often during the period in which the sediments which now comprise the rookery layer were deposited.

The presence of shellfish throughout the rookery layer could suggest that the increased use of the site was associated with the sea level rise and availability of marine resources in close proximity to the site. The only evidence to support this however is the stratigraphic association between the shellfish remains and the other cultural remains in the disturbed rookery layer — an association resulting not from the depositional context of these remains but from the muttonbirds' burrowing activity. The antiquity of the emu eggshell and the hearth dated to about 18,000 BP at the junction of the rookery layer and underlying unit indicate that the rookery layer remains could date between about 8,500 and 18,000 or more years ago.

There is no reason therefore to suppose that the bulk of the other cultural remains such as stone artefacts, fossil shell and burnt bone also found in the rookery layer are of the same antiquity as the shellfish remains. Because of the disturbed nature of the rookery level the depositional chronology of most remains from this layer remains unresolved. From the present evidence all that can be stated is that, apart from the shellfish remains, other cultural remains in the rookery deposit could date from anywhere between about 8,500 and 18,000 years or more in age.

Despite the problematic stratigraphy, it is clear that the distribution pattern of the cultural remains within Unit A was produced by muttonbird burrowing reworking the deposit rather than by human deposition. It is highly improbable therefore that the sudden increase in cultural remains appearing in the rookery layer is directly transposable to human occupation intensities in measured spits within this unit. While clearly the increase in cultural remains in the rookery layer does indicate more intensive use of the rockshelter at some point, it is more probable that this increase was more gradual in nature than the sudden increase in cultural remains found at the base of the rookery layer would suggest. This is further supported by the findings from Mannalargenna Cave on Prime Seal Island, which are discussed in more detail in the following chapter.

In summary the evidence from the Beeton Rockshelter indicates that there was consistent, but low intensity use of the rockshelter from at least 20,000 years ago and possibly about 23,000 years or more ago (the latter date based on the emu eggshell date). Cultural evidence from the basal deposits of the rockshelter included hearths, stone artefacts and burnt bone. In some instances these were found several spits above the lowest spits excavated. Nonetheless in relation to bedrock these were in some cases basal deposits as the bedrock was very uneven in most areas, and the lower spits were decreasing in area and volume as exposed bedrock areas within each square increased. In squares D9, D6 and C6 stone artefacts and burnt bone were found in sediments adjoining exposed bedrock areas — that is in pockets of deeper sediments in the undulating bedrock, although none were found resting directly on the bedrock itself.

The undulating morphology of the bedrock suggests that prior to sedimentation the rockshelter would not have been suited to human habitation. That older deposits are absent further suggests that wind regimes were not conducive to the transport and deposition of sediments in the rockshelter, and that vegetation and dunes in the region were probably more stable before about 25,000 years ago (Colhoun 1983:10,

1977; Colhoun and van der Geer 1987:69; Wasson 1986). Thus the evidence indicates that people began inhabiting the rockshelter, at least sporadically, as the peak of the last glacial approached and increasing winds and aridity caused sediments to begin accumulating in the rockshelter (Bowden 1983; Wasson 1986). It is also possible that sediments deposited in the rockshelter prior to the last glacial maximum were scoured out with increased wind regimes but prior to dune mobilisation.

During the sediment deposition phase prior to about 18,000 BP, between 85 centimetres and 1.1 metres of aeolian sediment was deposited in the rockshelter, along with cultural remains from human visitations to the site. Evidence from this earliest occupation phase recovered from D9 and C6, the two squares within the rockshelter with undisturbed lower (Unit B) deposits, included stone artefacts, a few fragments of emu eggshell, hearth charcoal and burnt bone.

Aeolian sedimentation and low level human occupation continued in the rockshelter until sometime around the height of the last glacial maximum, after which sedimentation rates slowed and people began using the rockshelter more frequently. Unfortunately due to disturbance in the upper 40 centimetres or so of the deposit, the rate of sedimentation for the upper portion of the deposit is unclear, although it had certainly stabilised by about 10,000 years ago, and most probably earlier. It is also clear that during the phase of occupation spanned by what is now the rookery layer there was a marked increase in cultural remains compared with the earlier period prior to about 18,000 BP.

Not only does the density of cultural remains in the rookery layer increase, but the range is augmented by the appearance of flaked fossil shell artefacts, pieces of scallop shell, small ochre nodules and shellfish food debris. Radiocarbon dates obtained from six samples of midden shell indicate that all of the shellfish food debris was deposited around 8,500 years ago, and represents the period when the post-glacial marine transgression brought marine resources within easy access of the rockshelter.

Unfortunately the rookery disturbance effectively means that the chronology of the more intense phase of human occupation within this span cannot be resolved to a finer level from the evidence at this site. Seeking other evidence from the occupation period spanned by the rookery layer, I undertook excavations at Mannalargenna Cave on nearby Prime Seal Island. Excavations had previously been carried out at

the Mannalargenna Cave site by Brown (1993) and although he had not reached the base of sterile deposits or bedrock, he had established that this site contained a relatively undisturbed evidence of human occupation of similar antiquity to that in the Beeton Rockshelter site. Furthermore evidence from this site also indicated a more intensive occupation phase following the glacial maximum, in a more secure stratigraphic context compared with the Beeton Rockshelter (Brown 1993:265; Sim 1994:367).

CHAPTER FIVE

MANNALARGENNA CAVE, PRIME SEAL ISLAND EXCAVATION

5.1 Site description and background to the excavation

Mannalargenna Cave is a small cave located in a coastal limestone ridge about 50 metres above sea level on the eastern side of Prime Seal Island, the largest of the Outer Furneaux Islands (Figures 1.2 and 5.1; Photographs 21 and 22). Prime Seal Island is situated six kilometres west of Flinders Island and is about 8.9 square kilometres in area, only slightly smaller than Badger Island. Mannalargenna Cave has views directly across the sea to Flinders Island and several smaller offshore islands in the Furneaux Group. In exceptionally fair weather the limestone ridge containing Beeton Rockshelter can be sighted on Badger Island, 28 kilometres to the southeast.

A large aeolian relict dune deposit abuts the side of Target Hill, where the limestone ridge containing Mannalargenna Cave is located. In contrast to the white siliceous quartzose sands of the present coastal zone, the sediments of the relict dune banked against the eastern slope of Target Hill are medium to coarse grained calcareous sands. This relict dune, which at a time of lower sea level migrated more than 60 metres up the hill slope, contains similar aeolian sediments to those in the Mannalargenna Cave.

Present day vegetation in the area of the rockshelter is dominated by introduced pasture grasses although patches of boobialla (*Acacia sophorae*) and she-oak (*Casuarina stricta*) dominated scrub, typical of the islands' coastal heath are located along the ridges and on the slopes above Mannalargenna Cave (Harris 1988; Kirkpatrick and Dickenson 1984). Historic terrestrial indigenous fauna include murids and one macropod (*Thylogale billardierii*). Active muttonbird rookeries are found at various locations around the island but tend to be concentrated on the western and southwestern areas where prevailing winds assist the birds' launching from the nests.

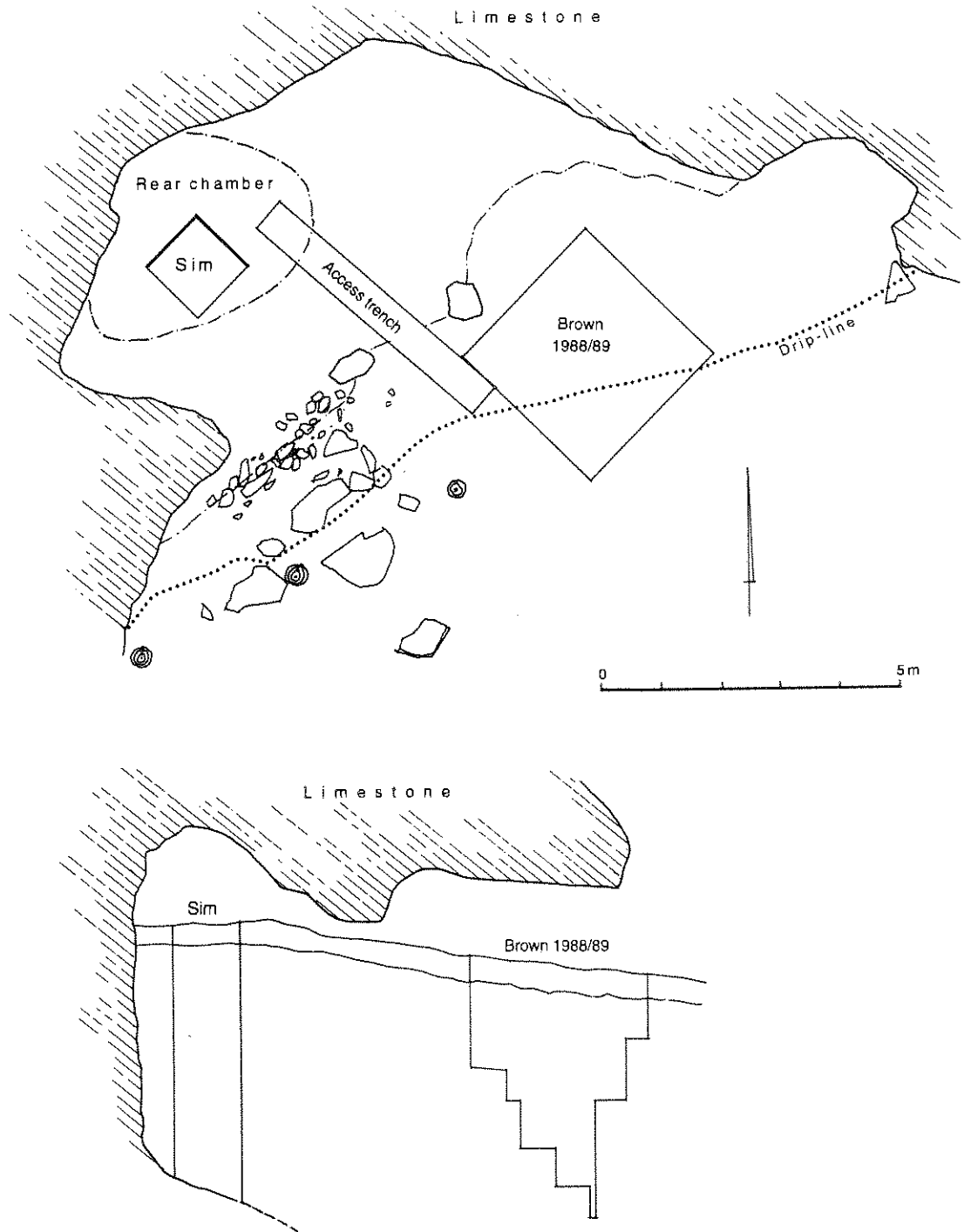


Figure 5.1: Mannalargenna Cave - site plan and section.

Mannalargenna Cave consists of an outer overhang area and a larger inner chamber of about 20 square metres. At present the inner chamber is inaccessible unless one crawls in through a small opening in the rear wall of the outer overhang area. In the inner chamber there is generally less than half a metre between the deposit surface and the ceiling, except for a small domed area of about five square metres at the rear of the cave where there is a ceiling height of between 1.2 and 1.8 metres (Figure 5.1). Despite the difficulty of access this area was selected for the inner chamber excavation as to excavate elsewhere in the inner chamber would have caused unwarranted disturbance to the deposit.

5.1.1 Background

Previous excavations at the site were undertaken by Steve Brown in 1988 and 1989. These excavations were located in the open outer overhang area of the cave extending across the drip-line. Prior to the most recent investigation, no exploration of the deposit in the less accessible inner chamber had been undertaken (Brown 1993:258) (Figure 5.1). Brown found the deposit in the outer part of the cave was more than 3.8 metres in depth, with stone artefacts in the lowest excavated level. Although maintaining an ongoing interest in the site, Brown subsequently left archaeology for a career in the circus and encouraged me to pursue further excavations at the site in order to resolve the question of the basal occupation date.

Dates from charcoal in the deposit in the outer area of the rockshelter indicated that the inner chamber would have been readily accessible in the late Pleistocene when the surface level in the shelter was lower. It would also have been more suited to human habitation, being light and spacious yet well sheltered. Hence the inner chamber appeared to have greater archaeological potential than the outer cave area. It also seemed likely that archaeological remains would probably be denser and better preserved in the inner chamber than in the outer cave area under the drip-line. Moreover, the morphology of the rockshelter suggested that there was a greater chance of reaching bedrock in the inner chamber than in the outer drip-line area.

5.1.2 The excavation

Two pits were opened in the cave; a long narrow access trench running from the outer rockshelter to the inner chamber, and a deep square pit in the centre of the inner chamber (Figure 5.1). The access trench not only facilitated entry to the inner

chamber but also provided a stratigraphic link enabling comparison to be made between the inner chamber pit and Brown's previous pit in the outer cave area.

The access trench was 66 centimetres wide and varied in depth according to the slope of the deposit surface, from 10 centimetres along the eastern (outer) end to 70 centimetres in the inner chamber. In order to reduce disturbance to the deposit, the access trench was kept to a minimum size. Consequently one had to crawl through the squeeze space, which was less than 60 centimetres in height, for about two metres to gain entry to the inner chamber. This access trench was lined with plywood. A trolley was used to carry buckets of excavated deposit from the inner chamber to the sieves and spoil heap area in the outer chamber — and to return these deposits to the pit for back filling (Photographs 22 and 23).

The inner chamber pit was 1.2 metres by 1.2 metres at the top and due to the plywood shoring materials, was stepped in to a 98 centimetre square at the base (Photograph 24). It was 4.05 metres in depth from the surface level to bedrock. A telescoping box system was employed for shoring because of the loose nature of the cave deposit sediments which caused a section collapse for Brown in his first season. The shoring system comprised a series of 60 centimetre high, 19 millimetre thick plywood boxes which were lowered and pushed progressively into the pit as the excavation proceeded. I developed this shoring method for use in similar aeolian sand deposits in caves on King Island, after being told of a concentric concrete ring system used by local farmers to dig wells in the sand dune country there.

Section drawings were made while the excavation proceeded, with about 50 centimetres of section being exposed and recorded before the box was pushed down and excavation re-commenced. The boxes were used in pairs, as two 60 centimetre high boxes could be travelled down together to a total depth of 1.2 metres before frictional forces prevented them from being sunk any deeper. At this stage, the first of the next two slightly smaller boxes was placed inside the existing ones, decreasing the size of the hole to the internal size of the next set of boxes. In total six boxes (three pairs) were required to shore up the pit in the Mannalargenna site. Due to the small size of the access tunnel these were assembled in the confined space of the inner chamber (Photographs 25 to 30).

The telescopic shoring system was simple but very effective. The only difficulties encountered with it were: having only a portion of the section exposed at one time, the expense of purchasing the 19 millimetre ply required to ensure safety at depths of

four metres or more, and the problem of transporting the materials to this remote location. Of lesser but not inconsiderable importance was the reaction of the crew as the sieving benches, recording tables, wind breaks, seats and eventually the all important 'tea trolley' were repossessed and disappeared down the pit.

Excavation methods and recording procedures

Excavation and recording procedures employed generally followed those employed at the Beeton Rockshelter site, described in Chapter Three. The only exceptions were:

- a) the removal of each spit as a single unit rather than using quadrant sub-divisions, and
- b) the depth of spits used.

Spit depths followed Brown's methodology with the uppermost 9 spits being 5 centimetres in depth, and the lower ones generally 10 centimetres.

The access trench deposit was initially removed in 5 centimetre spits, but due to the limited headroom shoring could not be installed until some depth was achieved and consequently two sections collapsed. Installation of temporary shoring at this stage caused further disturbance and the remainder of the deposit was removed in a single spit as the stratigraphic integrity of this remaining deposit, 28 centimetres in depth, had effectively been destroyed. All access trench deposit was nevertheless sieved and finds recorded. Due to the collapse, finds from the access trench were excluded from the analysis.

Absence of space and natural light made taking levels toward the base of the pit extremely difficult. Therefore, dumpy level readings for the 11 lowest spits were taken every 20 centimetres rather than every 10 centimetres, although these 20 centimetre spits were subdivided during excavation into upper and lower units and sieved and sorted accordingly. The density of cultural remains in these lower deposits was very low and became increasingly scant with depth. A total of 34 measured spits was excavated. Remains from the upper 23 measured spits are included in the following analyses; provenance of remains from the bottom 11 spits is documented as 'upper' or 'lower' in the excavation records.

Four cubic metres of deposit weighing 5.58 tonnes were removed, comprising sediment, cultural and other remains, and four rocks, each of which weighed < 2 kilograms. The weight (tonne) to volume (cubic metre) ratio for deposit from this pit

was 1.395, which not unexpectedly was similar to that in the Beeton Rockshelter deposit. Both sites contained medium to coarse calcareous aeolian sediments.

5.1.3 Stratigraphy and chronology

Both the access trench and inner chamber pit deposits accorded with the stratigraphy previously recorded in the outer area of the rockshelter (Brown 1993:259). A dark brown consolidated silty-sand surface deposit capped a looser, paler medium to coarse sand unit. This paler sand unit continued almost to bedrock with no distinct stratigraphic breaks but subtle gradual changes in colour. Cultural and natural features including hearths and animal burrows were encountered in the paler sand unit. A modern mouse (*Mus musculus*) burrow found in the upper 50 centimetres of the deposit contained three desiccated young specimens along with grasses and other nest material. The only distinct change in the sand deposit was at the base where the sediments became noticeably lighter and coarser just above bedrock (Figure 5.2).

There was no direct evidence indicating that the deposit was disturbed apart from the mice burrows in the upper levels. For the purposes of the analysis it was therefore assumed that the cultural remains were in their original depositional contexts within the deposit. It is acknowledged however that it is highly probable that animal disturbance similar to that evident in the upper levels has been an ongoing process, but due to the more rapid deposition of the underlying deposit and post-depositional changes, evidence of past disturbance is now undetectable in the stratigraphy. The presence of several intact hearths does suggest that at least some portions of the deposit are undisturbed.

Stratigraphic units

The deposit has three major stratigraphic units, with a subdivision in the sand unit which comprised the bulk of the deposit:

Unit I [Spits 1 to 5]

This unit was the uppermost dark brown consolidated (10YR 2/3) silty sand layer. It was between five and ten centimetres thick and capped the entire surface of the rockshelter deposits. It contained humic material and pockets and bands of secondary deposits of white lime in damper places inside the cave. Deposits from this layer contained modern material including a match and a piece of woven cotton fabric, along with rotting animal remains and faecal matter.

0 100 cm

Units

- I Dark silty surface layer
- II Brown/yellow sand
- Ila Mottled brown/yellow sand
- III Paler brown/yellow sand
- IV Coarser paler sand

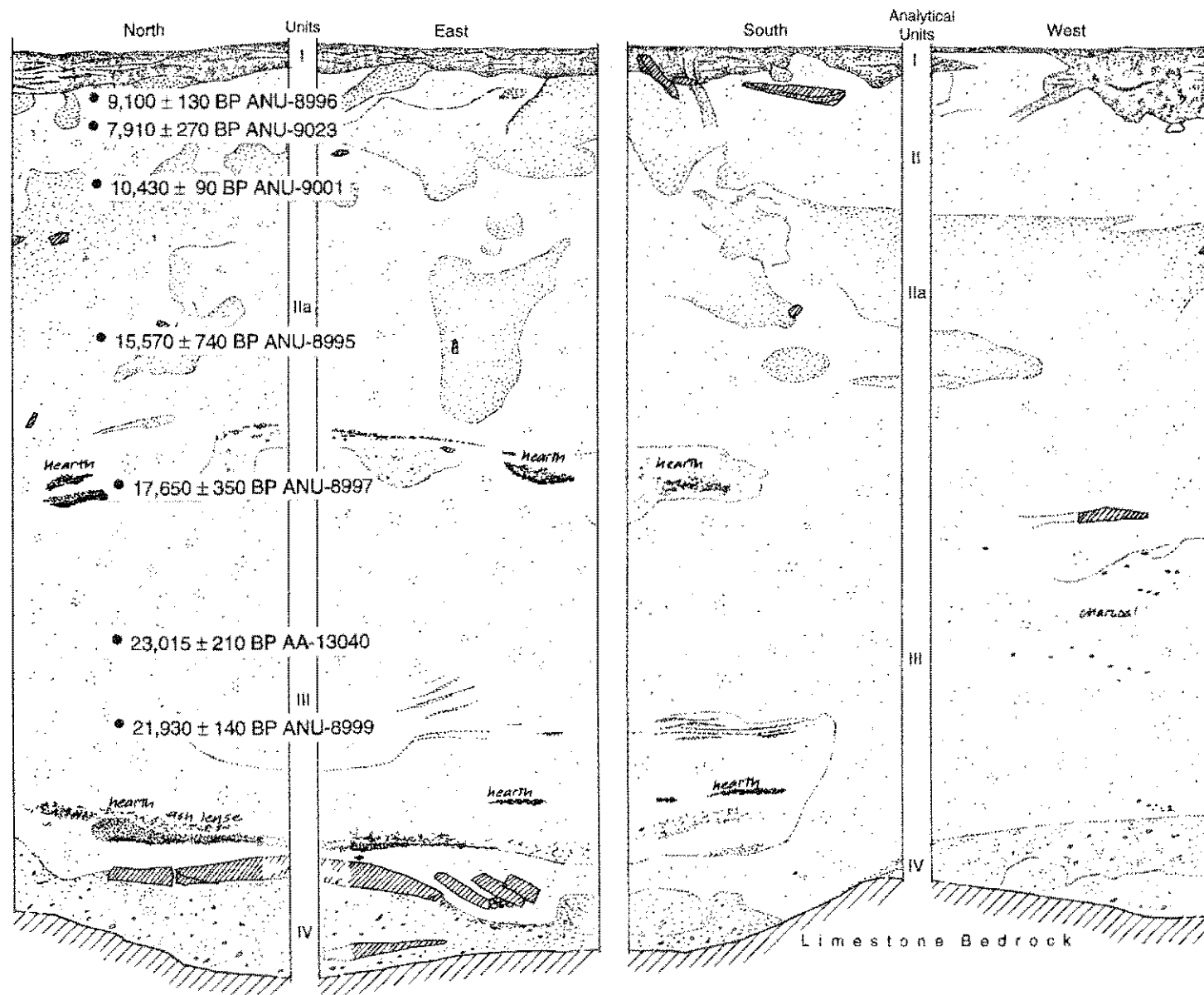


Figure 5.2:
Section drawings square F1
Mammalargenna Cave.

Unit II [Spits 6 to 31]

This medium to coarse pale orange brown (10YR 6/4) loose sand unit comprised the vast majority of the deposit sediments. Two live roots up to 10 millimetres in diameter intruded in this unit in spits 20 and 22. Some slightly lighter areas could be distinguished within this unit and these have been designated as a sub unit IIA (10YR 7/4A). This distinction has been made solely on the basis of a gradual colour change and no stratigraphic break or change in sediment texture was evident to suggest it represented a separate depositional event. The overall depth of unit II was about 3.65 metres.

Unit III [Spits 32 to 34]

This unit comprised about 30 centimetres of very consolidated sand lighter in colour (2.5Y8/4) and coarser than the overlying unit. This unit was resting on bedrock. The consolidation of this unit increased slightly with depth. A live root about 15 millimetres in diameter was encountered adjacent to the bedrock. It appears that roots from trees outside the drip-line were following the bedrock to obtain moisture.

Bedrock

Beneath unit III was a sloping coarse limestone bedrock floor. This had furrows which appeared to be drainage channels following the easterly slope toward the cave opening (Photograph 30). These may have resulted from the period of wave erosion of the limestone at times of higher sea levels.

Sediments

As with the Beeton Rockshelter, textural analysis of sediments was undertaken in order to examine possible sources for the vast amount of sediments that have accumulated in the cave. It seemed highly improbable that such a deposit could have originated from weathering of the immediate cave environment; karst column formations along the back wall of the outer overhang area suggested that at least in recent times water was the principal weathering agent and unlikely to be responsible for significant quantities of loose sediment in the cave. Furthermore the rockshelter itself appears to be a wave cut notch formed during a higher sea level stand (Bowden and Colhoun 1984:330; Murray-Wallace and Goede 1990). That a body of sediments could have subsequently weathered from the rockshelter walls while retaining the original wave notch formation is extremely improbable.

The most likely source for the sediments appeared to aeolian sediments, from a time of intense dune mobility in the region such as that evident in the presence of the immense dune deposit against the eastern face of the hill slope below Mannalargenna Cave. As described in Chapter 3, sediment samples were collected from the dune for comparison with those in both the Beeton Rockshelter site and the Mannalargenna Cave deposits.

While upper-level samples from both the dune and the cave displayed a similar sand component, the silt and clay proportions in these samples varied (Figure 5.3). This is not unexpected given that localised silts have undoubtedly contributed to the upper levels of these deposits in the long period since the sands were originally deposited. Given that one sample is from an internal cave environment and the other an open coastal context, the variation in the silt and clay components therefore is not surprising. Of more interest is the marked similarity between sediments from the lower deposits in the cave and those from the dune samples, both of which have been buried for thousands of years in contexts where more modern sediments are unlikely to have been incorporated. The marked similarity between the lower dune and cave sediments suggests that these almost certainly came from the same source, and that the deposition of the dune and cave deposits is probably of similar antiquity (John Magee pers. comm.).

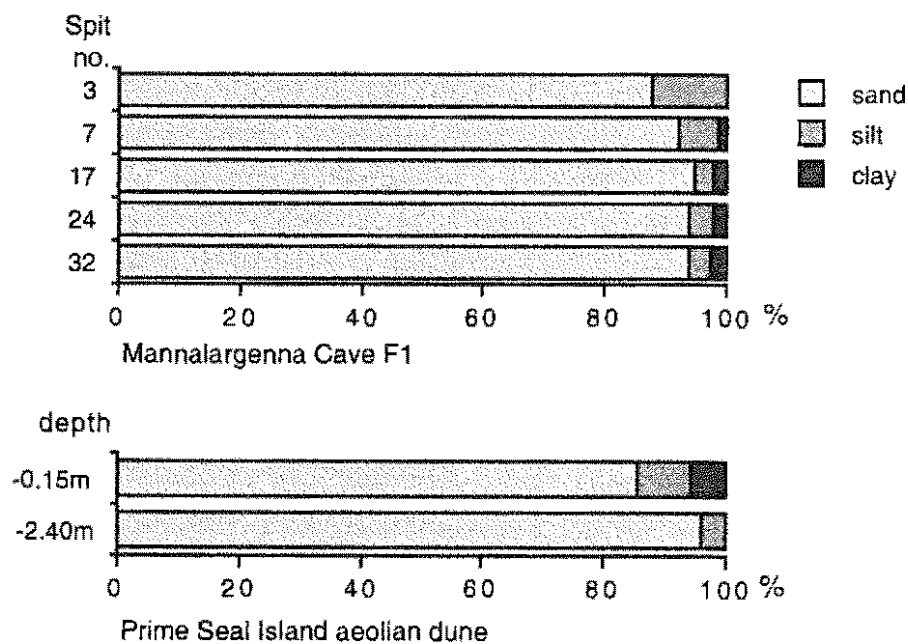
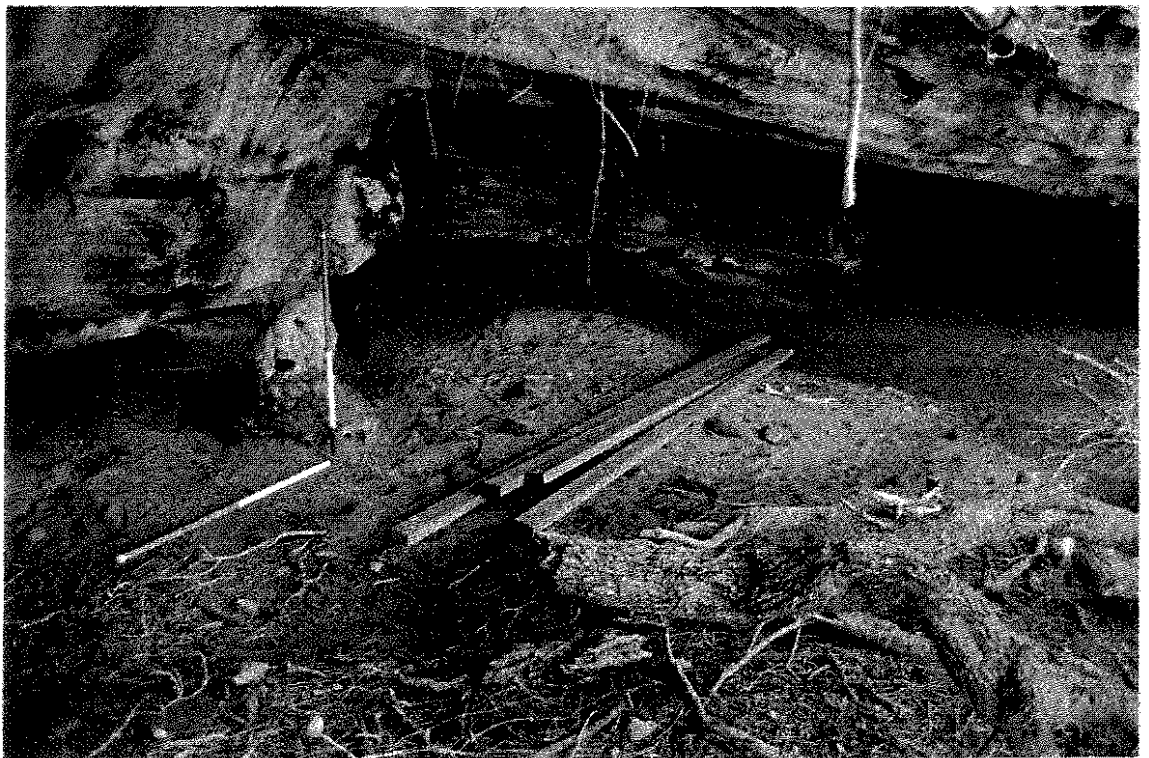


Figure 5.3: Sediment analysis Mannalargenna Cave and dune samples.



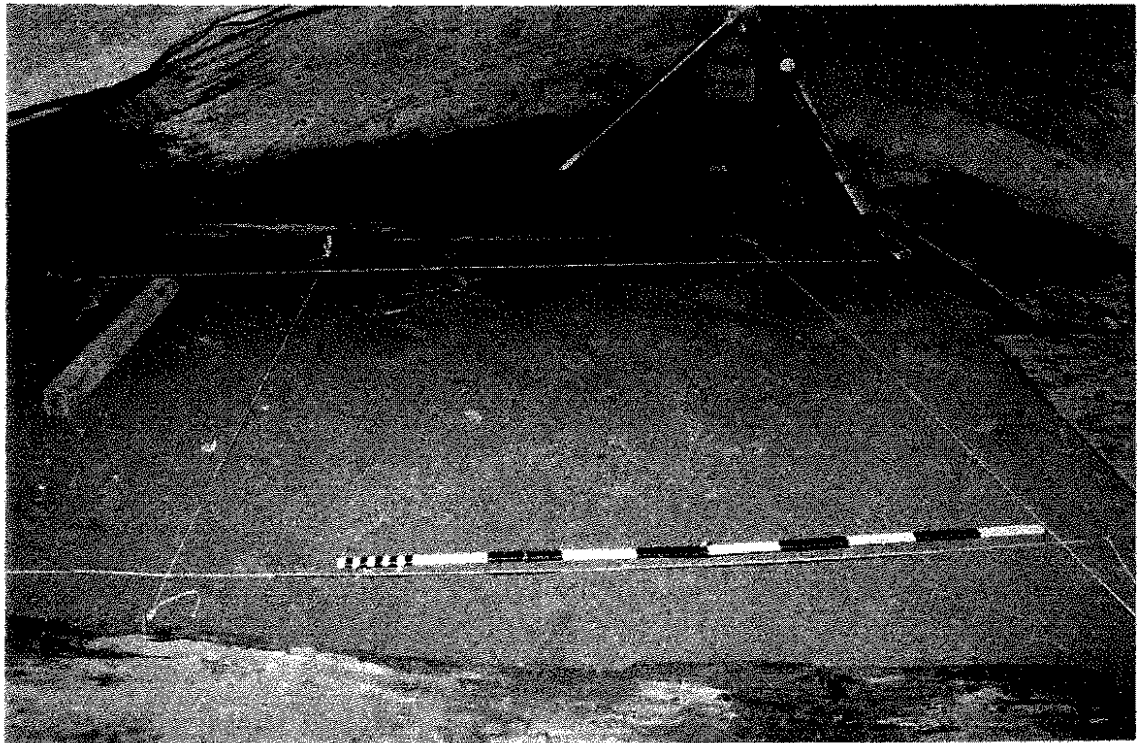
Photograph 21: Mannalargenna Cave, Prime Seal Island - from left D. West, J. Clarke and R. Heron.



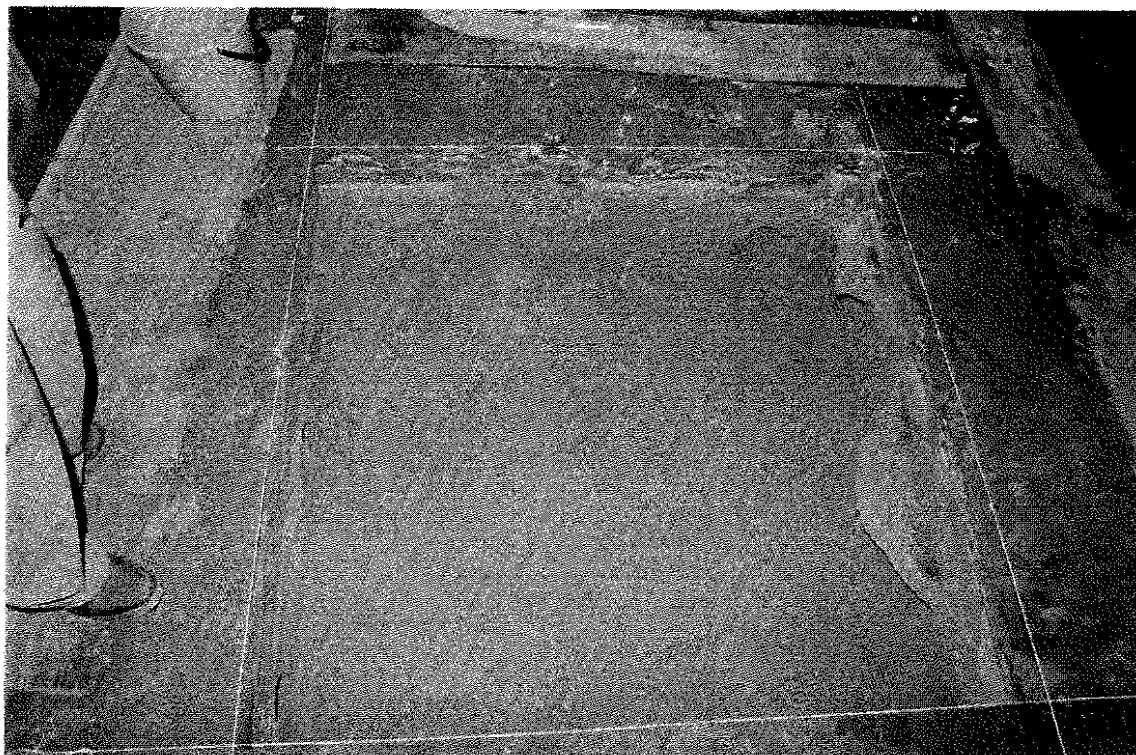
Photograph 22: Mannalargenna Cave showing outer overhang where Brown excavated (1990) and site of access trench in from ranging pole on the left.



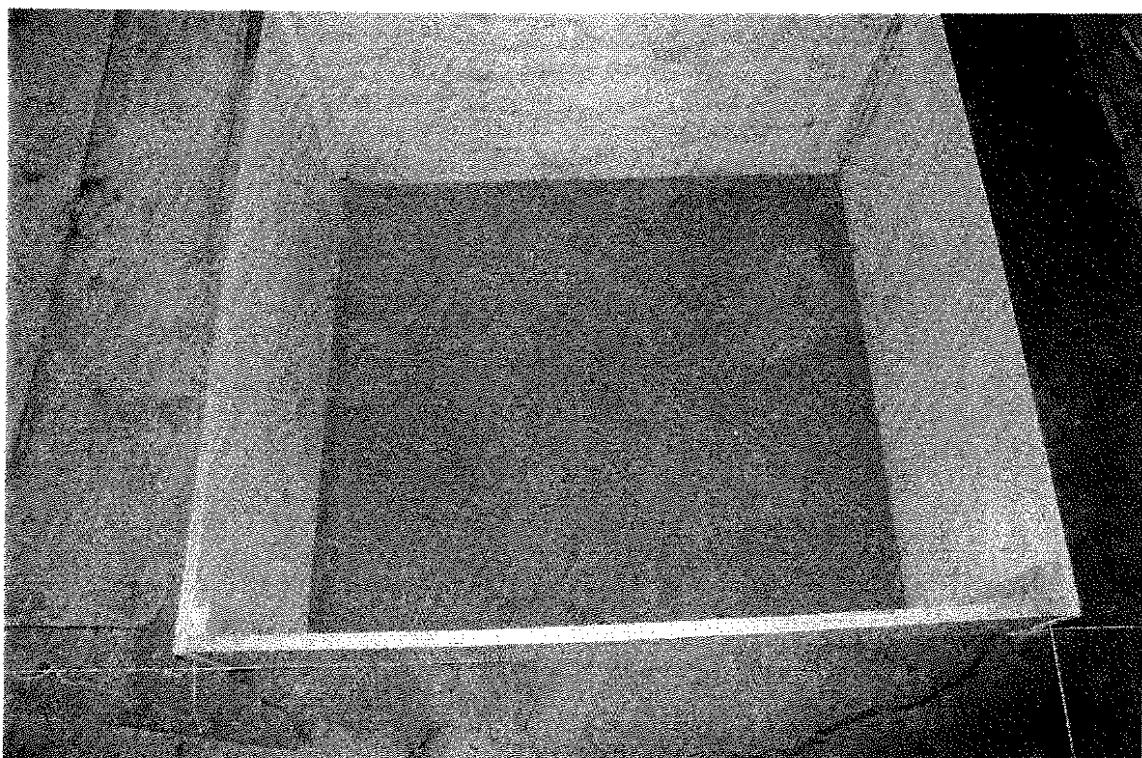
Photograph 23: Mannalargenna Cave showing entrance to inner chamber access trench with bucket trolley - J. Clarke foreground.



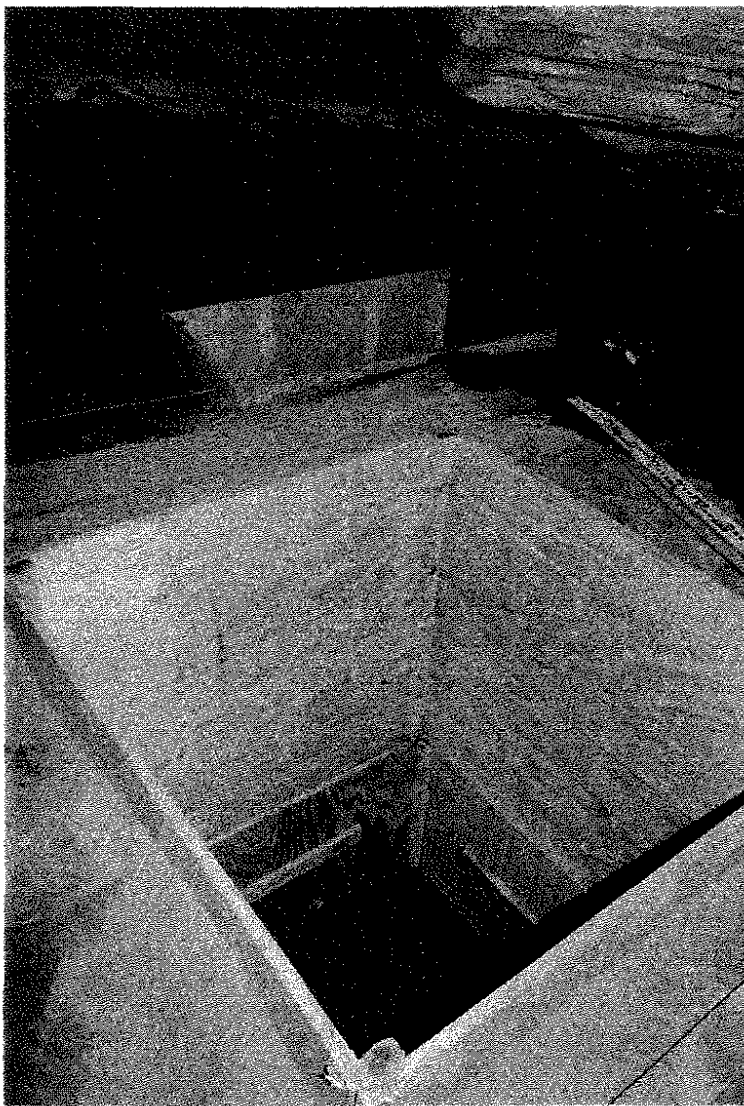
Photograph 24: Mannalargenna Cave inner chamber square F1 prior to excavation.



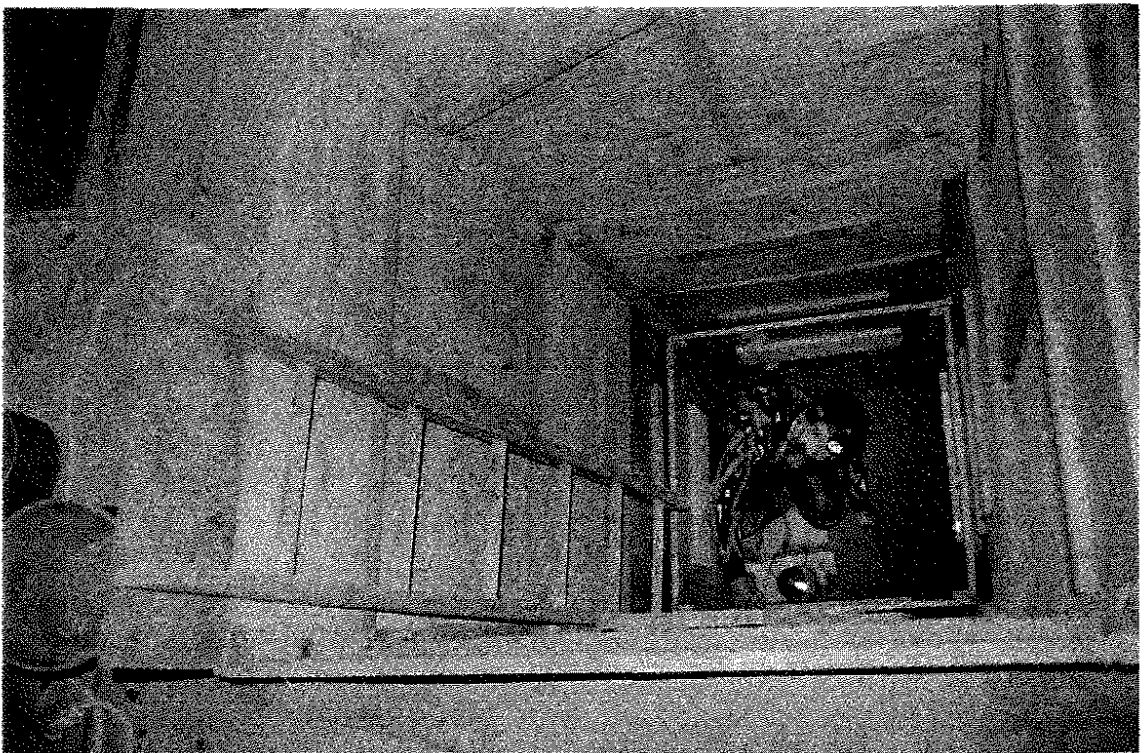
Photograph 25: Mannalargenna Cave F1, base of spit 6.



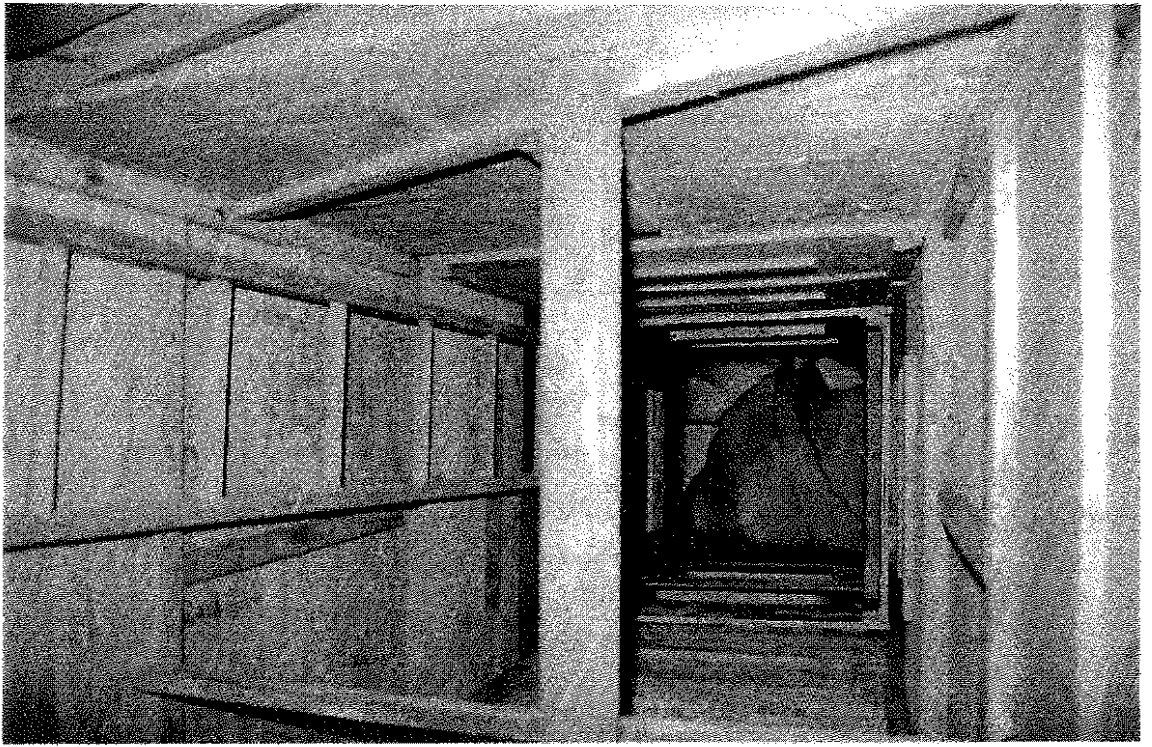
Photograph 26: Mannalargenna Cave F1, base of spit 12.



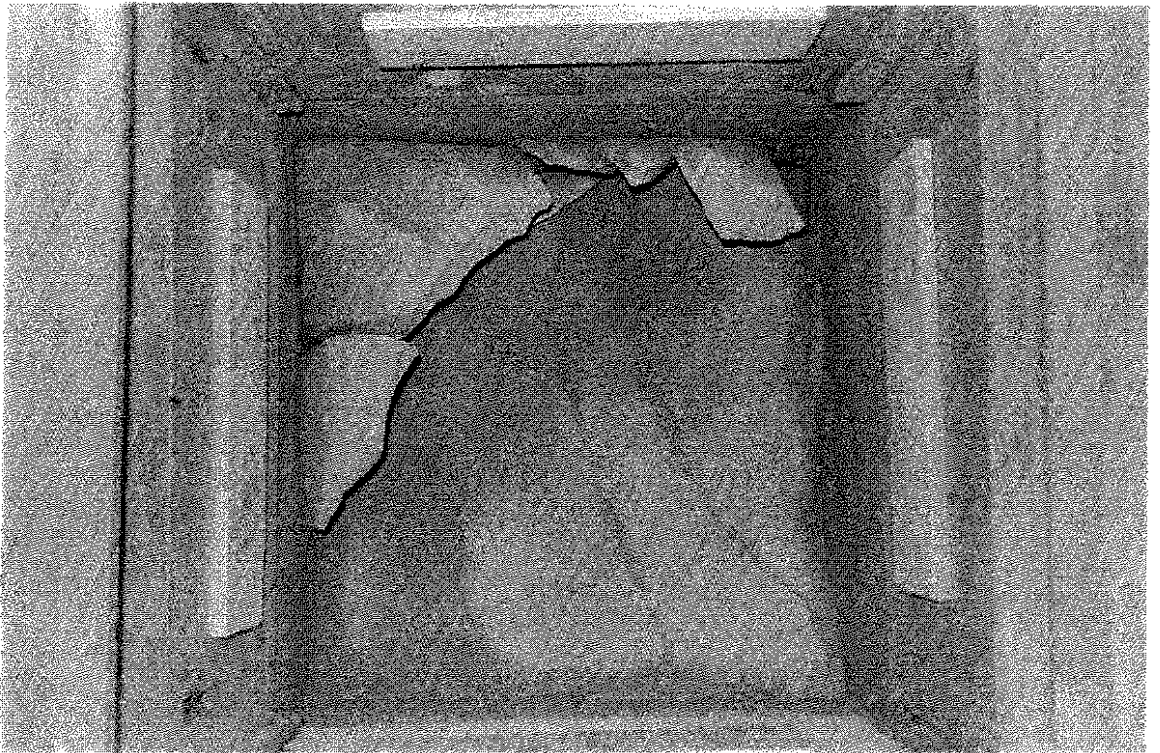
Photograph 27:
Mannalargenna Cave F1,
base of spit 22 view
toward the northeast
corner with access trench
shoring behind.



Photograph 28: Mannalargenna Cave F1, base of spit 28 with D. West in the pit.



Photograph 29: Mannalargenna Cave F1, excavated down to bedrock.



Photograph 30: Mannalargenna Cave F1 close up of bedrock with roof-fall rock in sections just above - note channel formations on bedrock.

Chronology and depositional history

Nine charcoal samples were dated using conventional radiocarbon methods, and one AMS date was obtained from a piece of emu eggshell (Table 5.1). Four of the dated samples were lump charcoal collected from dense clusters of charcoal which in some cases were underlain by compacted earth and ash, and were clearly hearth areas.

Five samples comprised a compilation of scattered charcoal collected during excavation of that spit, but were not from discrete hearth areas (Photographs 31 to 34). As discussed further below, the uppermost of the five scattered dates, that is the date of 4,830 BP from spit 4, is not associated with human occupation.

Spit	material dated	C ₁₄ date & lab. no.	Calibrated date
4	scattered small lump charc.	4,830 ± 110 BP ANU-9024	5300 - 5760
6	scattered lump charcoal	9,100 ± 130 BP ANU-8996	9850 - 10380
8	scattered lump charcoal	7,910 ± 270 BP ANU-9023	8180 - 8240
12	charcoal hearth lumps	10,430 ± 90 BP ANU-9001	11960 - 12590
20	charcoal hearth lumps	15,570 ± 740 BP ANU-8995	16810 - 20300
24u	charcoal hearth lumps	17,650 ± 350 BP ANU-8997	20020 - 21940
27	emu eggshell	23,015 ± 210 BP AA-13040	beyond calib'n
28l	scattered charcoal	12,510 ± 630 BP ANU-8998	13240 - 16420
30l	charcoal hearth lumps	21,930 ± 140 BP ANU-8999	beyond calib'n
33l	scattered charcoal flecks	13,280 ± 600 BP ANU-9000	14140 - 17290

Table 5.1: Radiocarbon dates obtained from square F1, in the inner chamber of Mannalargenna Cave.

The dating results clearly indicate that there is a contamination problem with the combined charcoal samples from lower spits in this deposit (Table 5.2). The 12,510 BP and 13,280 BP dates from spits 28l and 33l respectively are both aberrantly young by about 6,000 years or so. This younger anomaly is typical of fragmented samples contaminated during the dating process (Steve Robertson pers. comm.). Brown also

had problems using conventional dates for the lower deposits in the outer cave test pit and in some instances had to use AMS dating instead (Brown 1993:261 and pers. comm.). The dating inconsistencies suggest that in this site the only secure dates for human occupation are those obtained from lumps of hearth charcoal and possible emu eggshell. As outlined in Chapter Three however, the emu eggshell will almost certainly provide a radiocarbon age in excess of, but more accurate than charcoal from the same depositional context due to the more stable nature of the material.

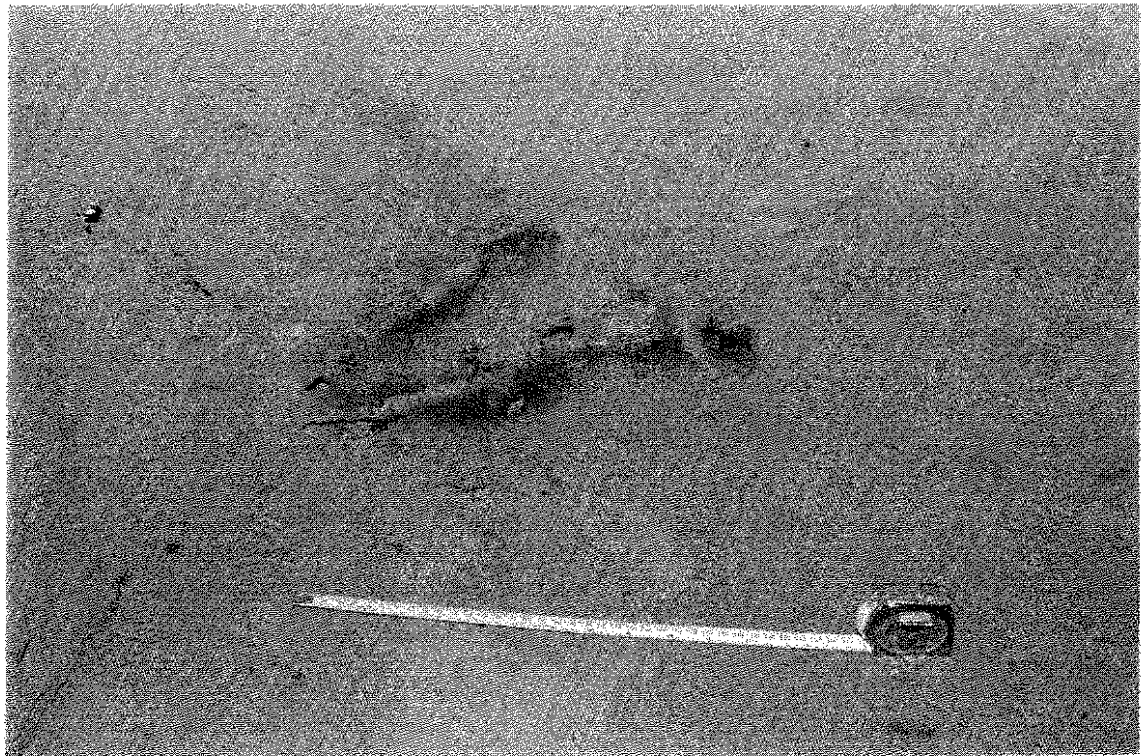
That the 23,000^{BP}_A date for the emu eggshell from spit 27 is slightly older than that obtained from underlying hearth charcoal in spit 30 is therefore not considered anomalous. The only aberrant dates are those from combined charcoal samples in spits 28 and 33. The similarity in these dates further suggests the same source of contamination is probably responsible for the anomaly in both these instances and probably also Brown's date of 13,900^{BP}_A (John Head pers. comm.).

The two combined samples from spits 28 and 33 were submitted for dating as I wished to obtain occupation dates in these levels for two reasons. In the case of ANU-8998, this sample was the closest charcoal found in any quantity in close proximity to the level from which the dated emu eggshell was obtained, and it was anticipated that these two dates would be useful for comparative purposes. From the same level as the charcoal, a large quartzite pitted cobble was recovered from its original depositional context. As it eventuated, the date for the ANU-8998 sample in this case is anomalous, although in terms of the depth/age distribution, the emu eggshell is consistent with both older and younger hearth charcoal.

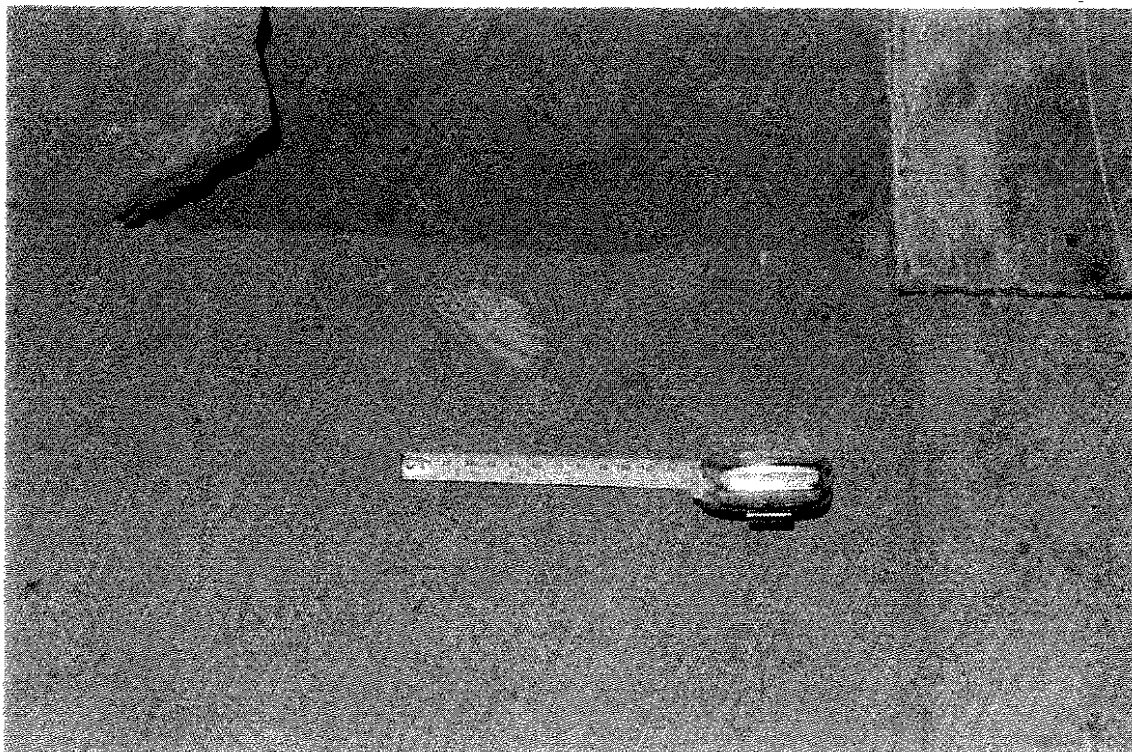
Similarly the ANU-9000 sample was a scattered sample rather than hearth charcoal but was submitted for dating as it was stratigraphically the lowest charcoal recovered. This sample came from 15 centimetres above bedrock, in the same spit as the lowest stone artefact recovered. In retrospect it would have been wiser also to date a smaller charcoal sample from this spit using AMS rather than conventional methods. At the time, however, conventional dates were being provided by the Quaternary Dating Centre at ANU and it was believed that this and the ANU-8998 samples were suitable for dating using conventional methods despite the fragmented nature of the charcoal (John Head pers. comm.).



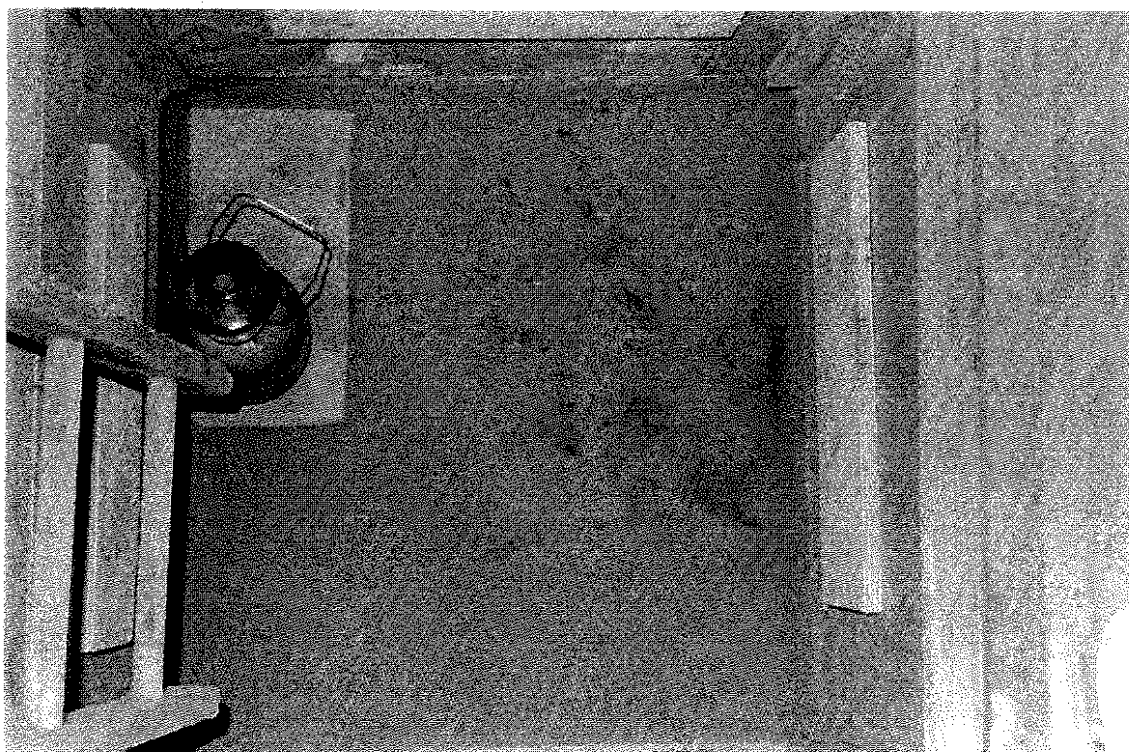
Photograph 31: East section showing hearth in wall and floor, Mannalargenna Cave F1 at the base of spit 23.



Photograph 32: North section showing hearth in wall in spit 23, photo taken at the base of spit 24, Mannalargenna Cave F1.



Photograph 33: Scallop shell *in situ* in the upper level of spit 24 from the same level as the dated hearth charcoal, Mannalargenna Cave F1.



Photograph 34: Charcoal flecking at the base of spit 24/top of spit 25, Mannalargenna Cave F1.

Spit	material dated	C ₁₄ date & lab. no.	Calibrated date
6	scattered lump charcoal	9,100 ± 130 BP ANU-8996	9850 - 10380
8	scattered lump charcoal	7,910 ± 270 BP ANU-9023	8180 - 8240
12	charcoal hearth lumps	10,430 ± 90 BP ANU-9001	11960 - 12590
20	charcoal hearth lumps	15,570 ± 740 BP ANU-8995	16810 - 20300
24u	charcoal hearth lumps	17,650 ± 350 BP ANU-8997	20020 - 21940
27	emu eggshell	23,015 ± 210 BP AA-13040	beyond calib'n
30l	charcoal hearth lumps	21,930 ± 140 BP ANU-8999	beyond calib'n

Table 5.2: Dates associated with human activity from square F1, Mannalargenna Cave.

One implication of the dating results is that dates obtained from lump hearth charcoal almost certainly provide a more reliable method of dating human occupation in a specific level than combined samples from non-hearth contexts.

Depositional history

The radiocarbon dates indicate that the four metres or more of sediment in the Mannalargenna Cave built up steadily between about 23,000 or so years ago and 8,000 years ago (Table 5.2, Figures 5.2 and 5.4.). That four metres of aeolian sediments were deposited in the cave, attests to the intensity of increased wind regimes and dune mobility in this region during the last glacial maximum (Bowden 1983:163). The deposit stabilised around 8,000 BP although a minor component of silt continued to accumulate in the upper levels.

The hearth charcoal dates are consistent with a steady accumulation of the four metres of deposit in the cave between about 25,000 or so years ago and about 8,000 or so years ago. This latter date represents the time when the sea level rise would have both inundated the aeolian sediment source and cut overland access between Prime Seal Island and greater Furneaux Island. It also coincides with charcoal dates obtained by Brown for the uppermost cultural levels in the outer chamber and possibly the most recent date for prehistoric use in the inner chamber (Table 5.1). The current bathymetry suggests that the sea was probably about 20 metres or so below its present level when insulation occurred (Figure 1.2).

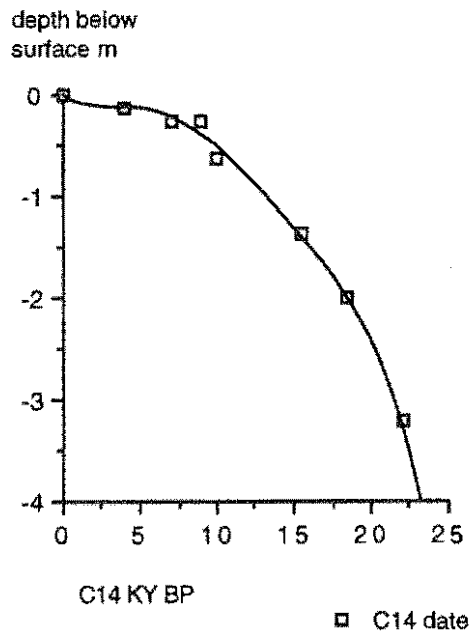


Figure 5.4: Mannalargenna Cave: depth-age curve based on charcoal dates from F1.

There is no evidence to suggest that the 4,800 BP date relates to human activity at the site. Moreover this date coincides with extensive evidence of natural firing episodes in dated charcoal-rich palaeosols across Flinders Island, and increased carbonised particles in a core from a swamp on Flinders Island (Ladd *et al.* 1992). Fire and wind activity are considered the most likely depositional agents for charcoal in the uppermost deposit.

In summary, the radiocarbon dates indicate that people were using the rockshelter possibly as recently as 8,000 and certainly between about 10,000 and 23,000 years ago, spanning from the peak of the last glacial maximum to the time of insulation of Prime Seal Island.

5.1.4 Analysis of excavated remains

It had been anticipated that a much higher density of remains would be recovered from the inner chamber excavation than was found in the squares previously excavated near the drip-line in the outer shelter area. However, cultural remains

were more scant in the inner chamber deposit. Nevertheless, the excavation quite clearly reached bedrock, resolving the question of early occupation dates for this site, and several intact hearths were excavated which have provided more secure occupation chronology for the site.

A range of cultural and potentially cultural remains was recovered from the square F1 in the inner chamber. These included stone and fossil shell artefacts, burnt bone, bone points, manuports, emu and other avian eggshell, charcoal, terrestrial faunal remains and a few fragments of scallop shell. Apart from the absence of marine shellfish food debris, the suite of remains was markedly similar to that recovered from the Beeton Rockshelter deposit. The analysis of these remains focused on the question of habitation intensity in the region between about 20,000 and 10,000 years ago, that is, in the period for which the remains in the Beeton Rockshelter were disturbed. Other aspects of the remains which are interesting but not directly relevant to the problem are identified but not investigated in depth.

Unless otherwise stated, terminologies and methods of analysis follow those employed in the analysis of remains from the Beeton Rockshelter site (described in Chapter Four). The principal aim of all the analysis was to examine the occupation intensity over time, as measured by the variation in densities of cultural remains recovered from the deposit.

5.2 Bone analysis

A total of 75.2 grams of burnt and 2510.8 grams of unburnt bone of terrestrial mammal, frog, reptile and bird was excavated from the inner chamber pit (MCF1). The overall bone assemblage comprised: 2533 grams of mammal bone, 39.4 grams of reptile, 12.3 grams of bird bone and five frog bones weighing 1.2 grams (Table 5.3) [Appendix XIII].

Category	weight g	%
mammal	2533.4	97.95
reptile	39.4	1.50
bird bone	12.3	.50
frog	1.2	.05
TOTAL	2586.3	100

Table 5.3: Weights and percentages of types of bone remains in square MCF1.

Less than 4% of the total bone recovered was burnt, and the distribution of this compared with that of the unburnt bone is graphed in Figure 5.5. While small quantities of burnt bone were found at various depths throughout the deposit, it was most concentrated between spits 19 and 24 where hearths were also more concentrated (Figure 5.5; Photographs 31 and 32). Since the burnt bone is almost certainly a by-product of people lighting fires at the site, the correlation between burnt bone and spits containing hearths is not unexpected. There is also a dramatic increase in the density of unburnt bone in spit 31, immediately underlying the lowest hearth spit.

Whereas the burning of bone is almost certainly a product of human activity, the origin of unburnt bone in such deposits is more problematic. As outlined in Chapter Four in reference to the bone remains from the Beeton Rockshelter site, criteria have been identified for bone remains from Tasmanian Devil scats, and raptor and owl pellets in assemblages from cave deposits (Dodson and Wexlar 1979; Douglas *et al.* 1966; Hayward *et al.* 1993; Hoffman 1988; Marshall 1986; Marshall and Cosgrove 1990). One of the main characteristics of devil scat bone is that it is extremely fragmented and unidentifiable to skeletal element, with very few pieces longer than

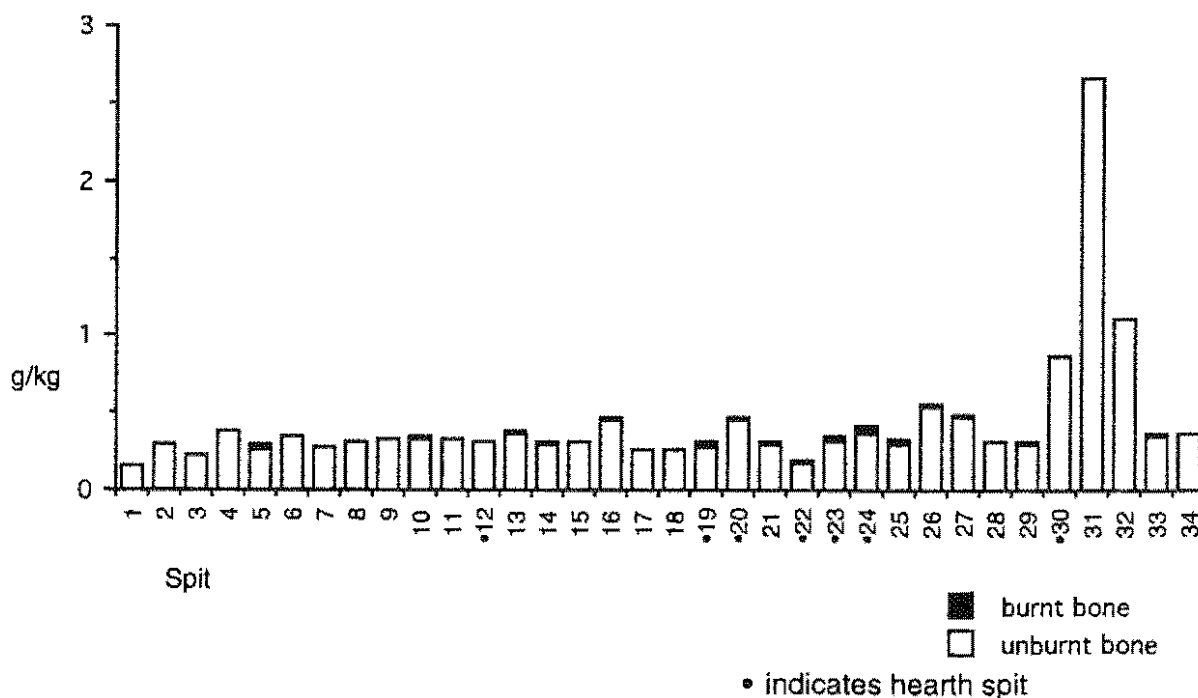


Figure 5.5: Burnt and unburnt bone distributions from MCF1 (volumetrically corrected).

39 millimetres and more than 94% less than 20 millimetres (Marshall & Cosgrove 1990:107). Although a wide range of other mammals were sometimes present, high representations of medium and large sized macropod and wombat bone were a common characteristic of devil scats (Marshall and Cosgrove 1990:110).

There was a relatively high representation of medium and large sized mammal bone fragments amongst the unburnt bone assemblage from Mannalargenna Cave which was consistent with their being devil scat bone. Furthermore, the majority of these bones were unidentifiable to element level and less than 20 millimetres in length (Tables 5.4 and 5.5). All these factors suggest that Tasmanian Devils are probably responsible for much of the bone in the deposit. In addition to the fragmented bone, there was a relatively high representation, by both weight and number, of murid bones in the bone remains identifiable to family (Table 5.4). Since murid bones, along with skink and other lizard remains are common in pellets from birds known to inhabit rockshelters and caves, this portion of the bone assemblage is probably attributable to owls and raptors (Dodson and Wexlar 1979; Hayward *et al.* 1993; Hoffman 1988; Marshall 1988; Jerry van Tets pers. comm.).

In spit 31 there is a high incidence of murid and reptile bone which has almost certainly originated from bird pellets. There is also a marked increase in unidentifiable fragmented bone characteristic of devil scats in this spit (Figure 5.6); both suggest that the marked increase in unburnt bone in this level is attributable to non-human predators. The increased use of the site by predators in this and possibly the uppermost levels of the deposit suggests that human use of the site was probably less frequent during these periods.

There is no clear correlation between hearth levels and increases in specific types of unburnt bone (Figure 5.6). This further supports the notion that the bulk of the unburnt bone from the deposit is not associated with human activity at the site. Nonetheless, the bone remains do provide useful information concerning past distributions of species and the implications for palaeoenvironmental conditions. Unfortunately the fragmented nature of the bone assemblage impeded the identification of most of the remains to species level although some 16% of the bone (by weight) was identifiable to family level. Families and species identified in the remains are tabled below (Table 5.6). Bone distributions and densities can also provide information about patterns of site use by non-human predators, patterns often linked to human occupation levels.

Category	weight g	%
MEDIUM & LARGE:		
Macropodidae	174.79	6.9
Potoroidae (potoroo)	0.71	0.0
Vombatidae	12.46	0.5
Peramelidae (bandicoots)	16.31	0.6
Phalangeridae (possum)	0.38	0.0
Dasyuridae (quolls)	1.59	0.1
unidentified	66.19	2.6
fragmented bone	1446.38	57.1
SMALL MAMMALS:		
Dasyuridae (marsupial mice)	3.26	0.1
Muridae	197.37	7.8
unidentified	311.06	12.3
fragmented bone	302.89	12.0
TOTAL	2533.4	100

Table 5.4: Mammal bone categories: weights and percentages from MCF1.

Size	weight g	%
fragmented bone <20 mm	1617.18	92.4
fragmented bone >20 mm	132.09	6.6
TOTAL	1749.27	100

Table 5.5: Fragmented bone sizes MCF1.

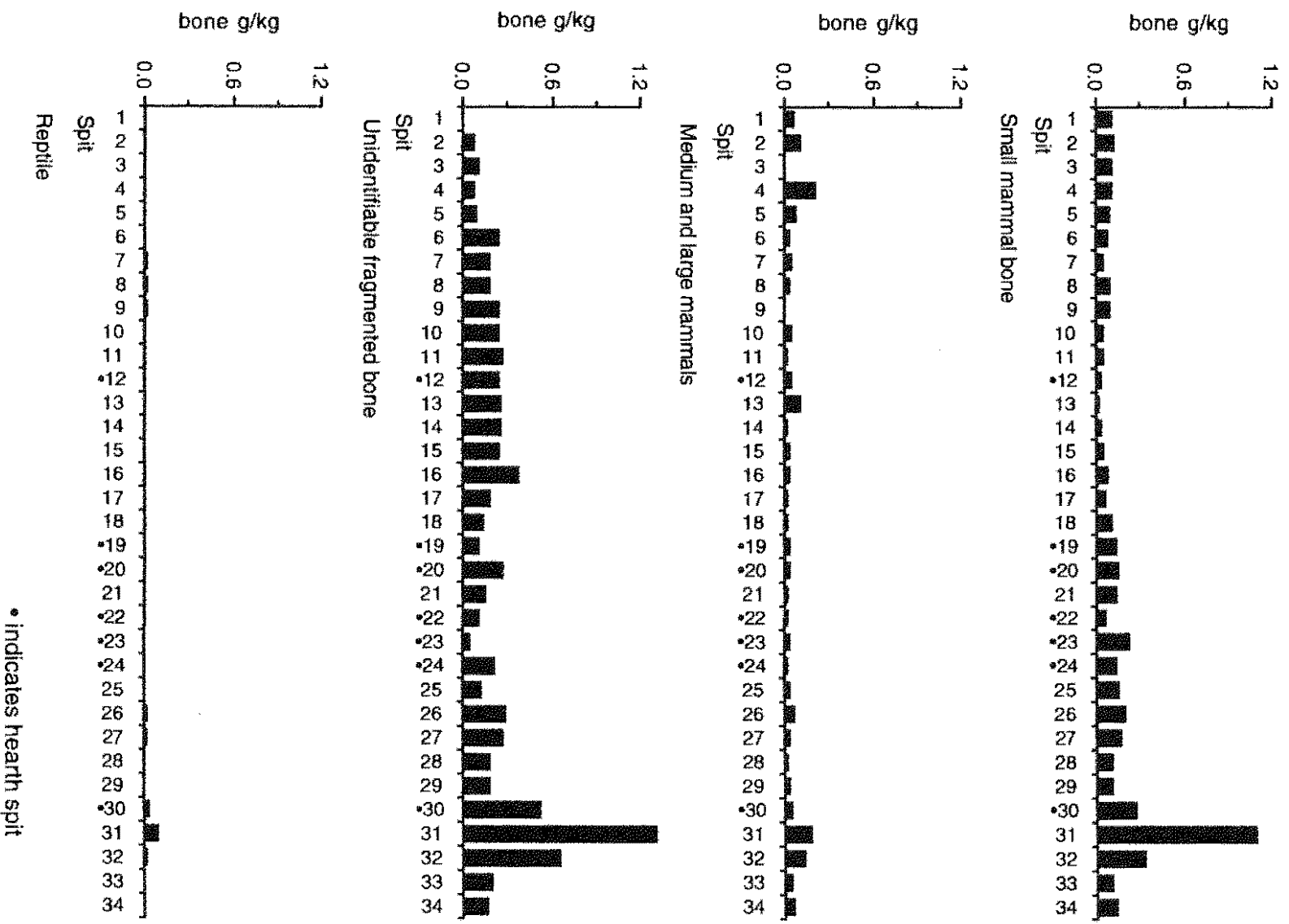


Figure 5.6: Distribution by spit of unburnt mammal and reptile bone - MCF1.

LARGE SIZE MAMMALS (>10 kg mature body weight)

Macropodidae

Eastern Grey Kangaroo (*Macropus giganteus*)

Bennetts Wallaby (*Macropus rufogriseus*)

Vombatidae

Wombat (*Vombatus ursinus*)

MEDIUM SIZE MAMMALS (>500 g <10 kg)

Macropodidae

Tasmanian Pademelon (*Thylogale billardieri*)

Peramelidae

Bandicoot sp.? (*Isoodon obesulus*

and/or *Perameles gunnii*)

maculatus)

Phalangeridae

viverrinus)

Brushtail Possum (*Trichosurus vulpecula*)

Potoroidae

Potoroo (*Potorous tridactylus*)

Tas. Bettong (*Bettongia gaimardi*)

Dasyuridae

Spotted Quoll? (*Dasyurus*

Eastern Quoll (*Dasyurus*

Tas. Devil (*Sarcophilus harrisii*)

SMALL SIZE MAMMALS (<500 g)

Muridae

Eastern Swamp Rat (*Rattus lutreolus*)

Long-tailed Mouse (*Pseudomys higginsii*)

New Holland Mouse (*Pseudomys novaehollandiae*)

Broad-toothed Rat (*Mastacomys fuscus*)

Vespertilionidae

Dasyuridae

Antechinus (*A. minimus* and/

or *A. swainsonii*)

Table 5.6: Families and species represented in the mammal bone from square F1, Mannalargenna Cave.

The densities of various categories of unburnt bone remain fairly constant with the exception of spit 31 and the immediately adjacent spits (Figure 5.6). Apart from this sudden increase which, as described above, is almost certainly attributable to carnivore predators and birds, the only marked variation is a slight decrease in the unidentifiable bone fragments between spits 18 and 25, that is the levels where hearths were most frequently encountered. This pattern is consistent with less intensive use of the cave by devils and other carnivore predators such as quolls. The slight increase in small mammal bone in the deposit from spit 19 down is not considered to be related to human occupation at the site as it continues to the basal spit, in relative proportion to fragmented bone which is clearly non-cultural (Figure 5.6).

Burnt Bone

The small quantity of burnt bone recovered precluded detailed analysis although some patterns were evident in the sample. The majority of the burnt bone was fragmented medium and large mammal bone; burnt bone from small mammals was relatively scarce. This pattern is at odds with unburnt bone remains where fragmented small mammal bone is more common (Figure 5.7). Overall there was a relatively high proportion of burnt bone of medium and large sized mammals compared with the unburnt bone assemblage. Of the identifiable burnt bone, wombat and macropod bone were represented; and murid and peramelid (bandicoot) bone were absent despite the latter being present in the unburnt bone (Figure 5.7). If, as the Beeton Rockshelter remains suggest, people were targeting medium and large mammals and particularly wombat and macropod, then the burnt bone from the Mannalargenna site is consistent with remains from human food debris.

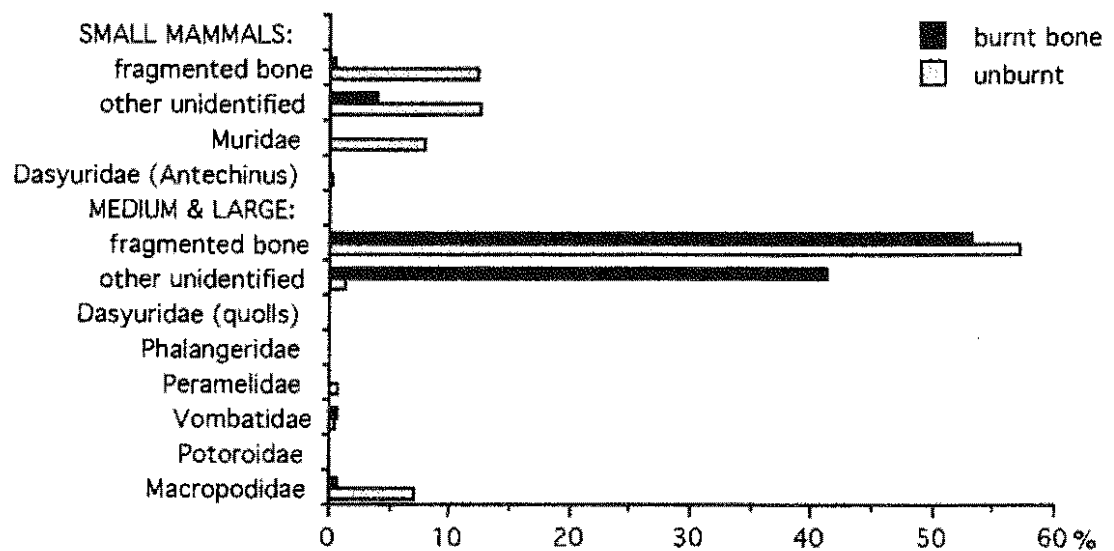


Figure 5. 7: Burnt and unburnt bone from different mammal categories MCF1.

In summary, the majority of the bone recovered does not appear to be a product of human activity at the site, and most is attributable to faecal matter from birds of prey, Tasmanian Devils and possibly quolls. Moreover there is no evidence to suggest that any of the unburnt bone is associated with human activities at the site. On the other hand the analysis indicates that the burnt bone is human food debris, reflecting in the main preparation and consumption of medium and large mammals. Thus, burnt bone is considered to be a fairly reliable indicator of human occupation at this and the Beeton Rockshelter site.

5.2.1 Bone points

One bone point 89 millimetres long was recovered from deposit removed from below spit 3 in the collapsed section in the access trench, and two smaller broken points from spit 23 in the inner chamber pit (Photograph 35). All three points had evidence of use-wear. The large point had been made from a wallaby (*Macropus rufogriseus*) fibula and had use polish and striations evident along the shaft. Because of the disturbed context from which it was recovered the antiquity of the bone tool remains uncertain, although it is unlikely to be more recent than about 10,000 years old as it came from deposits 35 centimetres or more below the surface. There is no secure evidence of cultural remains of a lesser antiquity than this at a similar depth in the controlled excavations in both the outer and inner cave deposits (Brown 1993). Both the small broken points from the inner chamber came from deposits between 15,500 and 18,000 years old.

5.3 Stone artefacts

A total of 102 stone artefacts was recovered from the inner chamber pit. These artefacts comprised four cores, two retouched scrapers, one utilised flake, one pitted anvil stone, and 94 unmodified flakes or flaked pieces [Appendix XIV]. Compared with the stone assemblages from Beeton Rockshelter and that recovered from the outer area at Mannalargenna, the inner chamber pit contained a higher percentage of implements and cores (Table 5.7). Little emphasis is placed on this finding however because of the relatively small sample size from the inner chamber pit and the somewhat atypical location of the pit against the back wall of the shelter (as explained above there was little choice regarding the placement of the pit as it was the only accessible space in the inner chamber).

	Beeton Shelter Σall squares N = 4151	Mannalargenna Outer N = 632	Mannalargenna Inner N = 102
Unmodified flakes/pieces	98	98*	94
Cores	0	1	4
Implements	1	1	4
Manuports	1	0	0
TOTAL	100	100	100

* includes Brown's 'fragment' types (1993:264,265)

Table 5.7: Percentages of artefact types - Mannalargenna Cave and Beeton Rockshelter.

All four cores recovered were bipolar worked quartz, and one of these was recovered from spit 28 along with a large pitted anvil cobble and a quartz flake. Bipolar worked quartz pieces were evident in a number of spits between spit 16 and spit 28, which according to the C14 dating results, span occupation between about 10,000 and 23,000 years ago. The range of stone artefacts was similar to that in the Beeton Rockshelter in that it included bipolar worked pieces and cores, retouched scrapers and flakes with use-wear (Table 5.8). Although platform cores and thumbnail scrapers were absent in the inner chamber deposits, Brown recovered examples of these artefact types from the outer shelter area at Mannalargenna (Brown 1993:264-265).

The only artefact type not found at Mannalargenna Cave was unmodified manuports; the one cobble recovered had unequivocal evidence of use as an anvil stone and two flake scars which may have been deliberate flake removal scars. The absence of unmodified cobbles or other manuports could suggest that there was either no source of such rocks in the immediate area, or that the activities at the site did not involve the use of unmodified pieces of rock and cobbles. Since, as discussed below, quartz artefacts with water-rounded cortex were recovered from the inner chamber pit, the occupants did have access at least to fluvial quartz sources. This lends support to the notion that the absence of manuports relates to site activities, and more specifically shellfish exploitation behaviour; neither shellfish food debris nor manuports were present in the Mannalargenna Cave deposits and yet both were evident in the Beeton Rockshelter remains.

SPIT	Artefact description	Stone type	wt g	l x b x w mm	retouch mm	cortex	use-wear
7	notched flake	quartz glassy white	4.4	26 30 5	12	absent	edge-damage
20	bipolar core	quartz glassy white	5.6	33 18 10	—	<15% water-worn cobble	absent
20	bipolar core	quartz glassy white	15.2	52 21 17	—	absent	absent
22	bipolar core	quartz white	22.7	49 32 9	—	vein	absent
27	utilised flake	quartz glassy white	1.7	22 18 5	18	15% facet	edge-damage
28	bipolar core	quartz white	29.1	39 27 30	—	<20% water-worn cobble	absent
33	small steep-edge scraper	quartz white	6.6	21 22 11	15	absent	edge-damage
28	cobble anvil	quartzite cream	1128.9	117 120 77	—	>80% water-worn cobble	pitting & 2 flake scars

Table 5.8: Retouched and utilised artefacts and cores from F1.

Stone types and sources

Stone types present included crystal and milky quartz, indurated limestone and quartzite (Table 5.9). As with the Beeton Rockshelter artefacts, quartz was the dominant stone type being utilised for artefact manufacture at the site, and there was a relatively high percentage also of high quality clear and smoky crystal quartz. There are known sources for both varieties of crystal quartz and for quartzite on the nearby east coast of Flinders Island. Milky quartz is abundant amongst the granites in both hillside outcrops and coastal boulders on both Prime Seal and other islands in the Furneaux Group. Indurated limestones are common around the northeast Marshalls Bay area on Flinders Island, and to a lesser extent in the limestone formations on Prime Seal Island. All stone types excavated have known sources within 25 kilometres of the site.

STONE TYPE	no.	%
quartz	88	86
crystal quartz	10	9
quartzite	4	4
indurated limestone	1	1
TOTAL	102	100

Table 5.9: Stone types represented in the artefact assemblage from F1.

Nearly 10% of the 102 artefacts recovered had water-rounded pebble or cobble cortex present. Apart from the present day coastal zone, there are no creek beds or other sources of water rounded stones on Prime Seal Island. At times of lower sea level however water courses on the greater Furneaux land mass would have been readily accessible. Water-rounded quartz pebbles would have been obtainable from drainage channels near Settlement Point about 10 kilometres to the east and possibly from closer sources which have since been inundated. Quartzite however is geologically foreign to the localised area and the nearest area where it could occur is in a contact zone near Pats River, over 20 kilometres to the east of the site on Flinders Island. If the quartzite cobble anvil had been transported from the Pats River area to the site, it would suggest there was an absence of large cobble stones suitable for anvil use in the area of the site.

Given that the large quartzite anvil cobble weighed more than 1 kilogram, it is more probable however that it was transported to the site from a closer, and now submerged source. The Pats River contact zone extends seaward toward Prime Seal Island, and the geology of small islands in the area indicates the zone passes about five kilometres to the east of Mannalargenna Cave. If, as the presence of the quartzite cobble suggests, there was a closer quartzite source, then the predominance of quartz rather than quartzite in the assemblage may be reflecting a genuine preference for quartz, rather than its mere expedient use, because of local abundance. Nonetheless, the three other quartzite artefacts do not have cortex present and this in combination with the overall low representation of quartzite does not suggest there was a source of this stone type in close proximity to the site. Hence, the work involved in transporting the quartzite cobble could reflect both the utility of this artefact type and the absence of sources of large cobbles close to the site.

Artefact density and distribution

As can be seen in Figure 5.8 the cluster of higher artefact densities between spits 21 and 24 corresponds with an increase in hearths in those levels. That stratified hearths have been preserved suggests a high degree of stratigraphic integrity, and that the artefacts in the deposit, at least within hearth levels, are probably in their original depositional contexts. While the one artefact in unit I, a quartz flake weighing less than 0.15 grams, was probably churned up from lower deposits by murid burrowing, it is less probable that those present in spits 6, 7 and 8 are similarly disturbed. This suggests that occupation at the shelter continued until sometime after the hearth date of 10,500 BP.

Artefact discard rates however suggest that human occupation in the Mannalargenna Cave was considerably less intense in the more recent phase than earlier, and that human use of the shelter was most intense between about 15,000 BP and 18,000 BP.

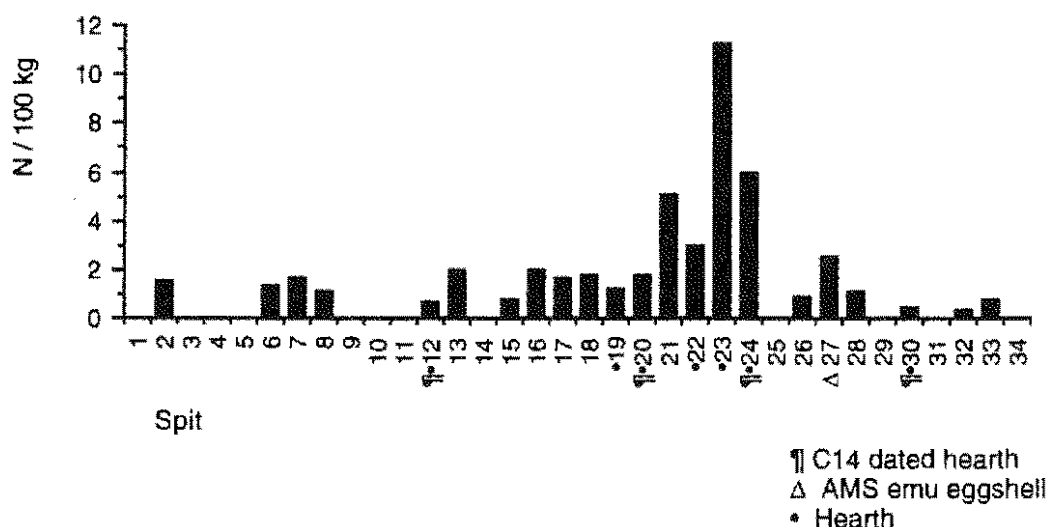


Figure 5.8: Stone artefact density, MCF1 - volumetrically corrected.

That less use was made of the shelter before the last glacial maximum is shown in artefact densities from both inner and outer shelter areas, although stone artefacts in the inner pit continued to be found in very low densities to the second lowest spit, several centimetres above bedrock. These lowest artefacts were found in spit 33,

below the hearth dated to about 22,000 BP in spit 30 and the emu eggshell dated to 23,000 BP in spit 27.

Although the stone artefacts were rarer than anticipated in the inner chamber deposit, the analysis results generally concurred with findings from the outer squares excavated by Brown (1993). There was also a marked similarity between the types of artefacts and stone types, with the exception of manuports, represented in the Mannalargenna assemblage and from the Beeton Rockshelter deposit. No manuports were recovered from the Mannalargenna Cave deposit whereas 39 were found in the squares excavated at the Beeton Rockshelter site. The chronological distribution of the stone artefacts also concurred with Brown's findings which suggested a more intense phase of site use between about 15,000 and 18,000 or so years ago (Brown 1993:269).

5.4 Shell artefacts

Although no shellfish food debris was present in the Mannalargenna Cave deposit, small quantities of fossil (*Eucrassatella* sp.) and scallop shell were recovered from the inner chamber pit. These finds were in keeping with remains previously excavated from the outer Mannalargenna Cave deposit and from Beeton Rockshelter (Brown 1993). A retouched fossil shell scraper was also observed on a deflated open site at the southern end of Prime Seal Island (Photograph 16).

5.4.1 Fossil shell artefacts

Sixteen pieces of fossil shell were recovered from the inner chamber pit, all of which appeared to be consistent with the identified *Eucrassatella kingicola* shell excavated by Brown (1993) in the outer chamber, and also present in Beeton Rockshelter remains (Table 5.10) Nine fragments were less than one gram in weight and the largest was 2.16 grams. No pieces with umbones were in the excavated sample and none had evidence of deliberate shaping, retouch or use-wear of any kind. Ten pieces of the fossil shell recovered were charred, and in the case of fragments recovered from spit 23, heat effects had clearly contributed to the shell fragmentation. The charred shell had a distinctly 'crumbly' texture as opposed to the hardness and resilience of the unburnt silicified shell.

The volumetrically corrected density of fossil shell fragments in the inner chamber pit was less than one twelfth that in the excavated deposit in the outer cave (Brown

1993:265,268). The absence of worked pieces in the inner chamber deposit is almost certainly due to the lower density and small sample size (16) compared with that (135) recovered from the outer cave excavation. Although there was no direct evidence recovered from the inner chamber pit to indicate the fossil shell was being worked on site, flaked and retouched pieces were recovered by Brown in the outer cave excavations (Brown 1993:265). The fossil shell artefacts in the inner chamber are therefore interpreted as debitage pieces from shell-working activities at the site, despite the absence of flaked shell implements or discarded umbo portions in the inner chamber pit.

SPTT	fragments no.	weight g	charred no.
22	1	1.54	0
23	9	13.13	9
23	1	1.17	0
24	3	0.58	0
24	1	.42	1
28	1	2.16	0
TOTAL	16	19.00	10

Table 5.10: Fossil shell artefacts from F1.

5.4.2 Scallop shell artefacts

Four pieces of scallop shell similar to those found in the Beeton Rockshelter and in the outer chamber by Brown (1993) were recovered from the inner chamber (Table 5.11, Photographs 20 and 33). None of the pieces had diagnostic elements enabling a secure species identification although the similarity in rib contour and edge contour where present suggested it was most probably of the same family (Pectenidae) if not species (*Pecten alba*) as the scallop shell previously recorded at Mannalargenna and Beeton Rockshelter. Whereas the fossil shell artefacts were clearly a result of shell working, there was no evidence from this or the Beeton Rockshelter site to suggest that the scallop shell was being employed for utilitarian tasks. The absence of use wear or polish suggests the shell was probably being used for ornamental purposes.

SPIT	weight g	fragments no.
19	7.20	1
23	5.06	1
24	9.74	1
27	7.69	1
TOTAL	29.69	4

Table 5.11: Scallop shell manuports from F1.

5.5 Avian eggshell

Avian eggshell weighing 29.89 grams was recovered from the inner chamber pit. The eggshell was similar to that recovered from the Beeton Rockshelter site in that it comprised emu and other types of avian eggshell. As described in Chapter Four, the emu eggshell was easily identifiable by its distinctive texture, thickness and colour whereas the other avian shell could have come from a range of birds. In the case of the Beeton Rockshelter about one third (by weight) of the eggshell was emu eggshell whereas more than half of the eggshell from the Mannalargenna Cave F1 pit comprised emu eggshell. Undoubtedly the lower representation of other avian (non-emu) eggshell in Mannalargenna is due to the fact that unlike the Beeton Rockshelter this site is not an extinct muttonbird rookery. The avian eggshell from this site afforded the possibility of investigating the question of the cultural origins of these remains, as unlike the Beeton Rockshelter, the deposit at the Mannalargenna Cave was relatively undisturbed, and contained discrete hearth levels and no rookery remains.

5.5.1 Emu eggshell

Seventy pieces of emu eggshell weighing nearly 17 grams were recovered from the inner chamber pit (Table 5.12; Figure 5.9). More than half of this eggshell came from spit 23, a spit rich in cultural remains and where a charcoal-rich hearth overlying an ash deposit was excavated. The association of the emu eggshell with the hearth layers suggested that the emu eggs may have been deliberately heated or cooked; and

since about 35% of the pieces of emu eggshell were burnt, charred or heat discoloured, this appears to have been the case (Table 5.13, Photograph 36).

Total no. of pieces no.	Total wt g	Mean wt g per fragment g	Density no/100 kg deposit
70	16.87	0.24	1.25

Table 5.12: Number and weight of emu eggshell pieces from F1.

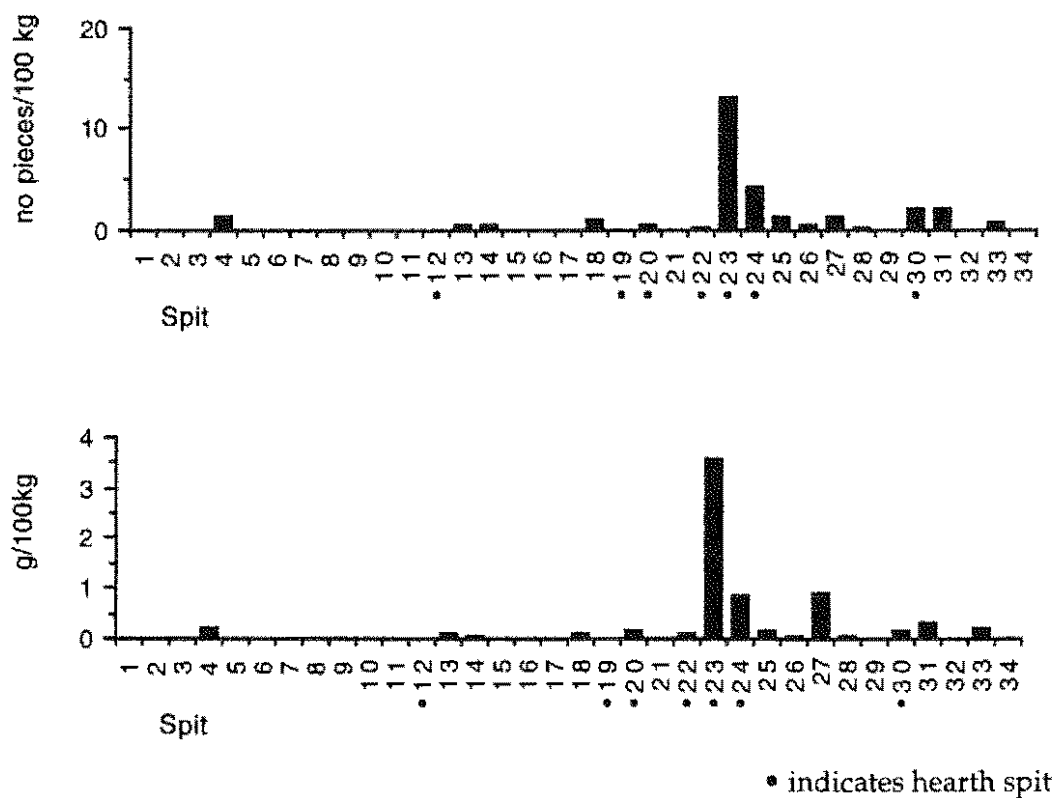


Figure 5.9: Emu eggshell from MCF1 - volumetrically corrected density by number (top) and weight (below).

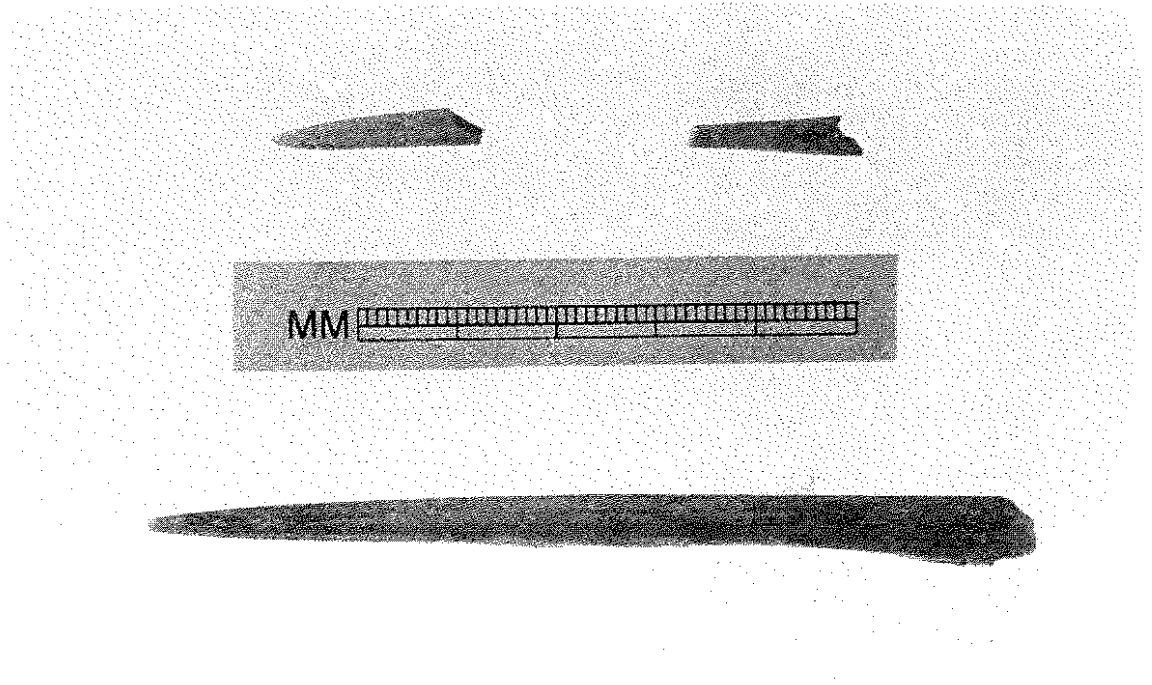
Spit	burnt pieces no.	unburnt pieces no.
4	0	1
13	0	1
14	0	1
18	0	2
20	0	1
22	0	1
23	10	25
24	6	4
25	3	0
26	1	0
27	0	3
28	1	0
30	2	3
31	1	2
33	1	1
TOTAL	25 (35%)	45 (65%)

Table 5.13: Burnt and unburnt emu eggshell numbers and percentages.

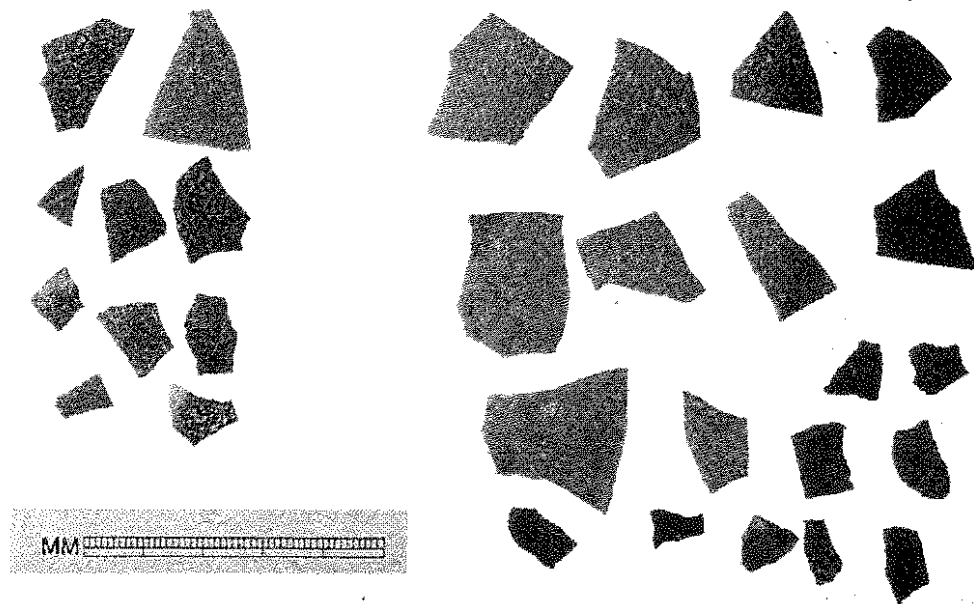
Both weight and number show that emu eggshell was less frequent in the upper levels of the deposit, that is in deposits more recent than about 15,000 BP (Table 5.13; Figure 5.9). Nonetheless, it was still present albeit in small quantities in the uppermost level of stratigraphic unit II, that dates from the time of the stabilisation of the deposit about 9,000 years or so ago. Overall the distribution accorded generally with that of cultural remains such as stone and fossil shell artefacts, scallop shell manuports and burnt bone — further supporting a cultural origin for the emu eggshell in the deposit.

5.5.2 Other avian eggshell

Slightly more than 13 grams of avian eggshell other than emu was recovered from the F1 pit (Table 5.14). While this eggshell weighed only a few grams less than the emu eggshell recovered, the number of individual specimens was more than seven-fold that of the emu eggshell, and hence the density by number in the deposit of similarly increased magnitude. At a density of 8.8 pieces per 100 kilograms of excavated deposit, and with an average weight of 0.03 grams per fragment, these eggshell remains are clearly both small and scarce in the deposit overall.



Photograph 35: Bone points from Mannalargenna Cave: one broken point and point shaft from F1 spit 23 (above) and large point with tip damage, use polish and striations from the access trench E2 below spit 3 (below).



Photograph 36: Burnt and unburnt emu eggshell from Mannalargenna Cave F1, spit 23; eggshell from hearth area on right and the remainder from spit 23 non-hearth contexts.

Total no. of pieces no.	Total wt g	Mean wt g per fragment g	Density no/100 kg deposit
492	13.02	0.03	8.82

Table 5.14: Number, weight and density of other avian (non-emu) eggshell from F1.

The distribution of the other eggshell did not concur closely with that of the emu eggshell, suggesting that at least some of these remains may have been non-cultural (Figures 5.9 and 5.10). Furthermore, there was a marked increase in the non-emu

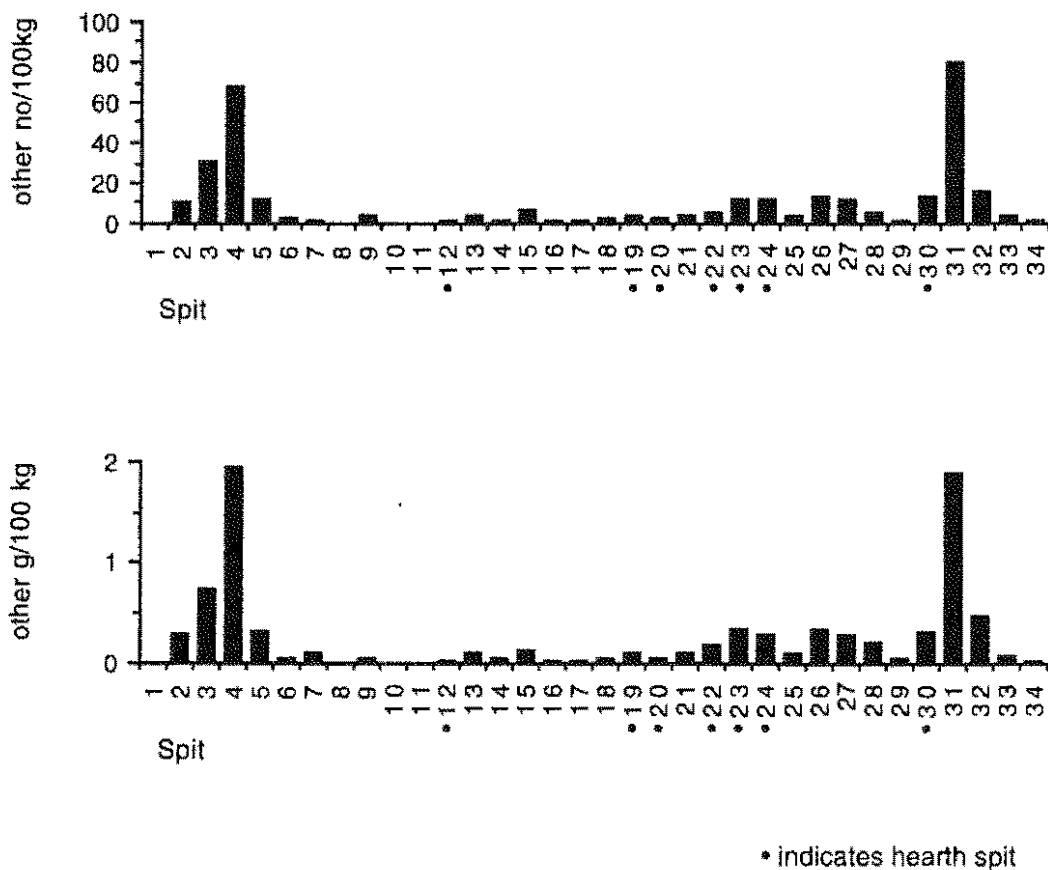


Figure 5.10: Other eggshell from MCF1 - volumetrically corrected density by number (top) and weight (below).

eggshell in spit 31, which corresponded directly with a dramatic increase in other non-cultural bone remains in the same spit (Figure 5.6). This raises the problem of what non-human agent could explain the presence of the eggshell in the deposit. It is possible that the eggshell accumulated as a result of either birds nesting within the rock crevices, or in scats or droppings from animals that rob bird nests. A number of Australian bird species have been documented as nesting in caves, most notably the Welcome Swallow (*Hirundo neoxena*) (Hamilton-Smith 1966) and in the absence of a more persuasive explanation, shell from *in situ* nests in the cave appears the most likely source of avian eggshell (other than emu) found in the deposit.

5.6 Charcoal

A total of 136 grams of charcoal was recovered from the pit (Table 5.15). [Appendix XV]

	charcoal wt g	charcoal wt %
7 hearth Spits (12, 19, 20, 22,23,24,30)	65.79	52
27 non-hearth spits (all others)	70.41	48
TOTAL	136.20	100

Table 5.15: Proportion of charcoal recovered from hearth and non-hearth spits.

Charcoal was most dense in spits 7, 23 and 30, the last two of which contained large hearths containing ash, charcoal and burnt earth (Figure 5.11). There was no hearth feature evident in spit 7 although the relatively high charcoal content in this spit was noted during excavation along with small animal burrows in the deposit. Spit 12 contained the first evidence of a hearth feature although charcoal in this spit was not as dense as in spit 7. The presence of charcoal lumps greater than one centimetre and stone artefacts in spits overlying spit 12 suggested that people had been visiting the inner chamber, possibly using fire sticks to light the cavern in times more recent than about 10,000 years ago. That hearths were not present in the uppermost spits could be due to the cessation of sedimentation in the very early Holocene. Rather than being buried and thus preserved by ongoing aeolian sedimentation, hearths in the

early Holocene occupation period would have remained on or close to the surface and thus been prone to disturbance by people and other animals using the shelter.

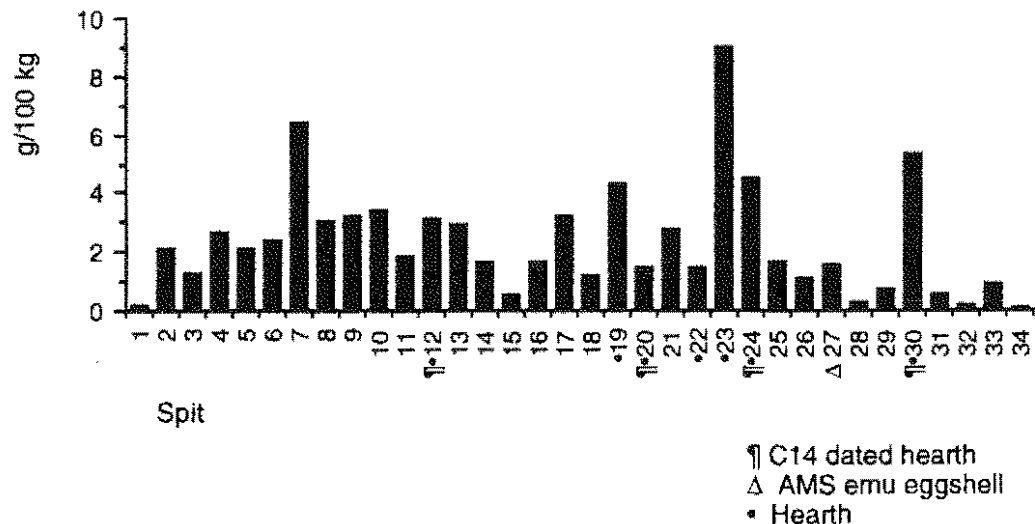


Figure 5.11: Recovered charcoal: (volumetrically corrected) density per spit MCF1.

Thus the stratigraphic integrity of early Holocene hearths in the uppermost levels of the deposit may have been destroyed by people subsequently using the shelter, causing the charcoal to be dispersed throughout the upper levels of the deposit. It is also possible that hearths were not being made in the shelter in the early Holocene as by this time the inner shelter deposit level would have been fairly similar to today with limited headroom and thus hardly suitable for habitation or for fires. The evidence does suggest however that people were still visiting the inner chamber albeit to a lesser degree, and it is therefore also possible that charcoal in the upper levels originates from torches as the small openings to the inner chamber block almost all natural light.

Equally, there may be some charcoal in the surface deposits from natural mid-Holocene fire episodes in the region. Extensive charcoal-rich palaeosol horizons are found across the northern end of Flinders Island, including one dated to $4,660 \pm 70$ (ANU-7403) at Caves Beach near Settlement Point about 5 kilometres to the east of Prime Seal Island (Sim 1991:89). There is also further evidence of increased natural firing in the region in the increase in carbonised particles from about 4,500 years ago in a swamp core from eastern Flinders Island (Ladd *et al.* 1992). Given the extensive

evidence of intense natural firing episodes in the mid-Holocene on Flinders Island, it would be expected that at least some of the charcoal in the surface deposits in Mannalargenna Cave would be a product of these natural fire events. There is no evidence of earlier episodes of similar natural fire activity in the late Pleistocene or early Holocene.

Charcoal from the subsurface levels deposited during the period of dune mobility, therefore, is most probably related directly to human activity at the site. There was a marked increase in the charcoal deposition rate between spit 22 and 25, again toward the base of the deposit at spit 30 (Figures 5.11 and 5.12). These increases coincide with spits where hearths were excavated, and in both cases where two or more discrete hearth layers were present within the spits. Hearths were readily identifiable as these were underlain by a layer of compacted, burnt earth and in some instances an ash lens (Photograph 31). That the integrity of hearth features was retained toward the rear of the cave suggests that this area of the cave was less frequented — and this is further supported by the increased density of cultural remains in the outer cave deposit. As Brown (1993:261) suggests, past human activity at the site has almost certainly destroyed the integrity of hearth features in the area where he excavated.



Figure 5.12: Cumulative weight of charcoal.

Charcoal collected from identified hearth deposits accounted for 51% of all charcoal collected (Table 5.15). Most of the dispersed charcoal also probably originates from hearths, from the scattering of peripheral charcoal around the hearth edges, or the disturbance of complete hearth areas. As described above, fire sticks and torches too may have contributed to the charcoal, particularly in the upper spits. The scattered charcoal provides a background level of charcoal which is clearly augmented in at least four spits by the presence of hearths. Less explicable is the high concentration of charcoal in spit 7, although the concomitant increase in stone artefacts in spits 6, 7 and 8 further supports the interpretation of the charcoal outlined above as being of human origin.

5.7 Ochre

Although Brown recovered 60 nodules of ochre from the excavation in the outer cave, only one nodule was found in the deposit in the inner chamber. This small nodule which weighed .09 grams was found in spit 18. Seven quartz artefacts, none of which were retouched or had evidence of use-wear, had reddish stains evident on them consistent with the ochre staining on the artefact from Beeton Rockshelter (Table 5.16) [Appendix XI].

Spit No.	no.
13	1
15	1
20	1
22	2
24	1
27	1
Total	7

Table 5.16: Ochre-stained stone artefacts from F1.

These artefacts were recovered from deposits between about 10,500 and 22,000 years old. None of the stained artefacts had striations or other evidence to indicate they

had been used for grinding ochre although whether evidence would be apparent on the quartz artefacts is equivocal. Nonetheless, the evidence from this and the outer cave excavations does suggest that ochre was in continuous use and being probably being prepared at the site.

5.8 Summary of findings from the Mannalargenna Cave site

Although cultural evidence recovered from the inner chamber excavation was much rarer than anticipated, intact hearths found at various levels within the deposit provide a secure chronology for late Pleistocene occupation at the site. A distinctive suite of archaeological remains was recovered which included flaked fossil shell and stone artefacts, pieces of manuport scallop shell, emu eggshell, burnt bone, bone points, ochre stained artefacts and a small nodule of ochre. The range of cultural materials accorded not only with Brown's finds from the outer cave excavation but also with those from the Beeton Rockshelter deposit. The only difference between the suites of remains in the two sites was the absence of bone points and presence of marine shellfish midden remains in Beeton Rockshelter. The implications of the midden shell are discussed further in the following chapter.

Remains in the inner chamber had a similar distribution pattern to that evident in the outer cave deposit, a pattern which Brown interpreted as indicating more intensive site use between about 18,500 and 15,000 years ago (Brown 1993:269).

The analysis of remains from the inner chamber generally supports the occurrence of a more intense glacial maximum to late Pleistocene occupation phase. The increased sample size from the earliest occupation phase at the site adds a degree of confidence to Brown's interpretation, which was based on a relatively small sample of deposit (Brown 1993). The larger sample has also facilitated a resolution of the question of the origins of unburnt bone. The analysis of the unburnt bone implies that the bulk of the bone assemblage is not a product of human activity at the site. Similarly the analysis further indicates that it is highly improbable that avian eggshell other than emu eggshell is of cultural origin.

Unfortunately, the scant cultural remains and absence of intact hearths in the uppermost levels of the deposit impeded a finer scale resolution of the chronology of the more recent occupation phase and of site abandonment. Nonetheless, the charcoal dates from both the inner chamber pit and Brown's earlier excavations in the

outer cave, and the presence of a range of cultural materials in the upper levels, do support overall an interpretation of intermittent site use in the terminal Pleistocene until between about eight to ten thousand years ago, when the site was abandoned as rising seas cut overland access to the area that is now Prime Seal Island.

CHAPTER SIX

DISCUSSION AND CONCLUSIONS

6.1 Introduction

This chapter discusses the results from the Beeton Rockshelter and Mannalargenna Cave excavations and the implications of these findings in light of

- a) the changing palaeogeography and environment in the Bassian region during the span of past occupation,
- b) past human occupation patterns in the broader Tasmanian and southeast Australian contexts and
- c) biogeographical models concerning the viability of human populations on remote islands.

The more specific questions concerning the ultimate fate of the population of Flinders Island and why island habitation ceased are addressed. The interplay of chronological, cultural and environmental factors is examined with reference to the viability of human populations in remote island environments, and conclusions are drawn from the research that are relevant to both regional archaeology and wider biogeographical research. The discussion focuses on archaeological and palaeoenvironmental data from various phases:

- a) from about 35,000 years ago, the time of earliest known human occupation in Tasmania, through to the end of the last glacial maximum,
- b) the terminal Pleistocene to mid-Holocene, and
- c) the mid- to late Holocene.

For each of these phases a summary of the regional conditions is presented along with a discussion of the archaeological data from the Mannalargenna and Beeton Rockshelter sites and other relevant regional data.

Reconstructing past sea levels

Until 1994, sea level reconstructions for the Bassian region were based upon data which suggested that during the possible span of human occupation in Tasmania, the land bridge to the Australian mainland was breached several times (Cosgrove 1989:1708). More recent research has shown this not to be the case, and it now appears that for some 40,000 or so years, between about 50,000 and 10,000 years ago, sea levels were more than 60 metres lower than at present (Chappell 1994:831). Thus

for the duration of known Pleistocene human occupation in mainland Australia and in Tasmania there has been a continuous land connection between these two land masses (Cosgrove 1995:95; O'Connell and Allen 1998:142) (Figures 6.1 and 6.2)

It should be noted that much of the following discussion relates directly to reconstructions of the palaeogeography and chronology of marine transgressions which have been extrapolated from

- a) a generalised sea level curve constructed principally from data from broader Australian and New Guinea contexts (Belpiero *et al.* 1983; Chappell 1994; Chappell *et al.* 1982; Chappell and Shackleton 1986), and
- b) critical sill depths from present day bathymetric and naval charts.

Both of these sources have inherent limitations. Due to past variation in localised environments such as shifting sand barriers, river mouth migration, uplift and the like, the sea level curve can only provide an approximation of past sea levels for a specific locality (John Chappell pers. comm.). Furthermore, while bathymetric charts are very accurate in the present day context, it is highly unlikely that they reflect the submarine (or terrestrial) topography of the Bass Strait area in past times (Jennings 1959a). Oceanographic sediment surveys indicate that there has been mass movement of submarine sediments throughout the Bassian region and particularly in critical sill areas where superficial sediments have been scoured away to bedrock in places (Blom 1988; Jones and Davies 1983). Inundation straits such as Banks Strait and that to the north between Flinders and Deal Island would almost certainly have become deeper over time with the removal of sediments by tidal currents.

Critical sill depths therefore were probably somewhat higher in the past than the present-day bathymetry indicates, and the use of present sill depths to predict the chronology of past insulation events will not be precise. Furthermore, with sediment scouring in strait areas, sediment deposition has occurred commensurately in other areas less affected by currents, effectively reducing the relative depth over time of areas within Bass Strait. Overall reconstructions of past sea levels produced using the sea level curve and present-day bathymetric data can provide only an approximation of past coastlines and the chronology of their formation. It should be recognised therefore that predictions concerning past sea levels in a specific region can be accurate probably within only a few hundred years at best (John Chappell pers. comm.). Nonetheless for the Bass Strait region it is at present the best available method, although computer simulated models for predicting past sea levels are being developed and refined (Lambeck and Nakada 1990).

For the discussion of sea level changes on this time scale it has been necessary to graph past sea depths using a curve, although as discussed above, this would probably be more accurately expressed as an envelope encompassing a span of both time and depth rather than specific intersection points. Nevertheless, while such envelope graphs work well for smaller time scales it is impractical to employ such a graph for the 40,000 year time span archaeologically relevant to Tasmania and the Bass Strait region. It should be noted therefore that any specific point of intersection of the depth curve and time axis provides a general depth-age approximation with an estimated tolerance in the order of ± 500 years or so.

6.2 Bassian environments and human occupation in Tasmania and Bass Strait 35,000 to 15,000 years ago

6.2.1 Palaeoenvironment

Although there is no direct evidence of human habitation older than about 23,000 BP in the Bassian region, evidence of human occupation 35,000 years ago in more southerly mainland Tasmanian sites indicates that people traversed parts of the Bassian plain area in earlier times (Cosgrove 1991, 1995:96; Jones 1995; Porch and Allen 1995). From about 35,000 BP to 25,000 BP or so the climate in southeast Australia was relatively stable although somewhat colder than today (Colhoun 1983:10; Colhoun and van de Geer 1987). From around 40,000 BP to 28,000 BP sea levels fluctuated between 80 and 90 metres lower than at present and the Bassian region would have been a broad peninsula some 300 to 400 kilometres wide (Figures 6.1 and 6.2).

There may have been a large swampland or marsh in the central Bassian depression known as the Bass Basin, although seabed cores from this area indicate that the waters would always have been saline to some degree and never fully fresh (Blom 1988:96). The core sequence could equally be interpreted as evidence of a late Pleistocene palaeoestuary and/or drainage channel from the Tamar River, cutting across the Bassian plains in a northwesterly direction and discharging into the ocean to the north of King Island for much of the last glacial period. Whether an estuarine or brackish swamp environment in the pre- and post-glacial phases, however, this would have contracted and possibly completely dried out in the arid conditions of the last Glacial maximum. This is supported by the presence of calcareous dune sediments dating to this phase in Bassian seabed cores (Blom 1988:96).

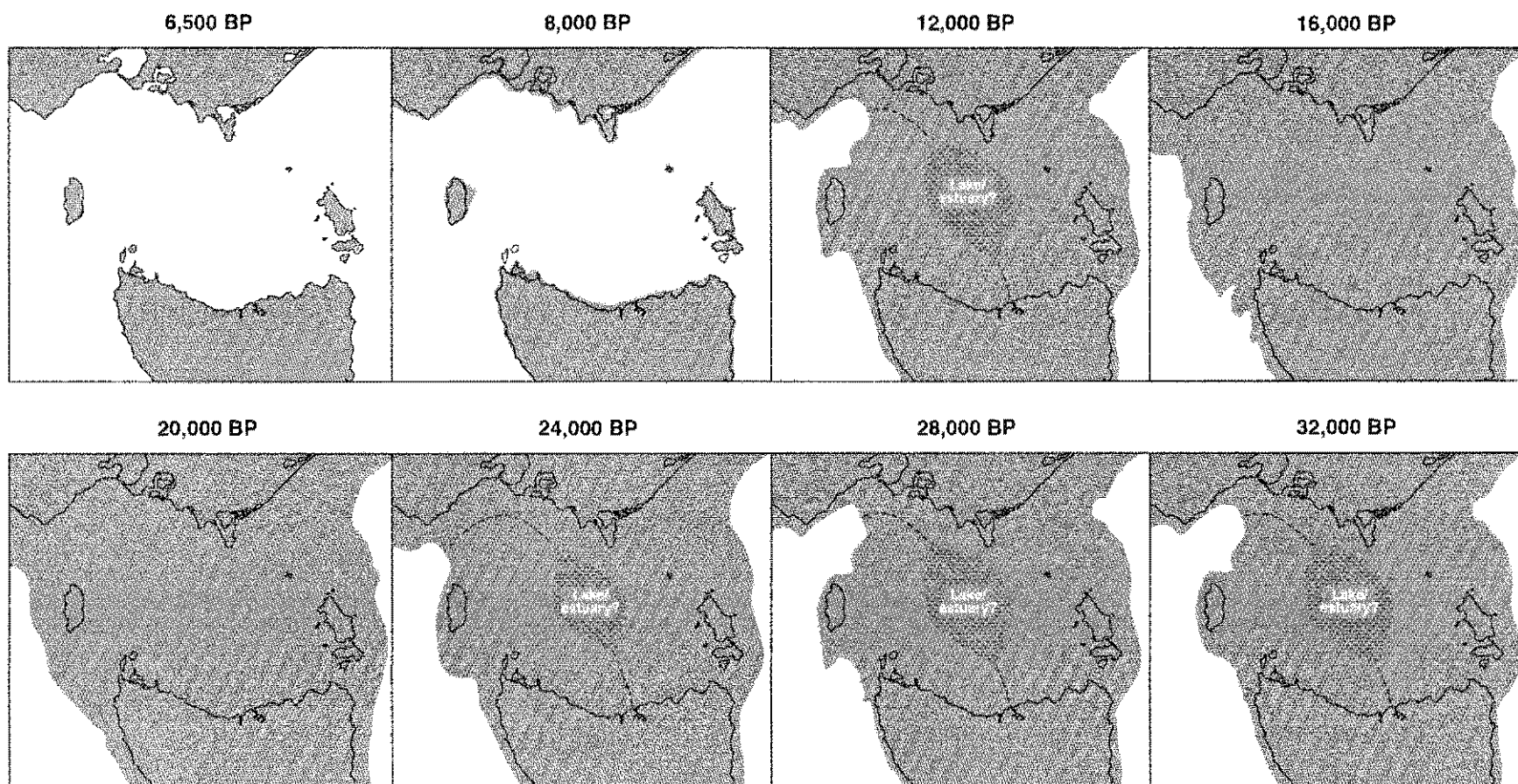


Figure 6.1: Palaeogeographic changes in the Bass Strait region showing the variation in land exposure with sea level variations in 4,000 year intervals from 32,000 BP until the sea reached its present position (ca. 6,500 years ago).

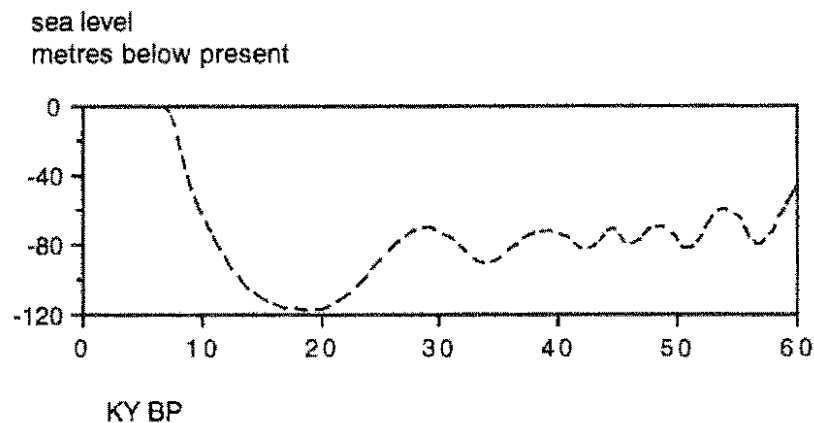


Figure 6.2: Past sea levels (after Chappell 1994:831).

Data from pollen cores from mainland western and northwestern Tasmania, and from King and Hunter Islands generally agree that vegetation regimes in the region were dominated by shrub and woodland taxa prior to about 25,000 years ago (Colhoun 1983:10-11; Colhoun and van de Geer 1986 in Cosgrove 1991:326; Hope 1978; van de Geer *et al.* 1996). Evidence from Cave Bay Cave also suggests that some eucalypt forest was present in the Bassian region although probably confined to more sheltered areas (Hope 1978:505).

Heralding the onset of the glacial maximum, around 28,000 years ago the sea began to drop to low levels unprecedented since people first colonised Australia more than 40,000 years ago (Chappell 1994:831; O'Connell and Allen 1998:141,144). By 23,000 years ago the sea was more than 100 metres below its present-day level. At this time Bass Strait would have been a broad peninsula with Beeton Rockshelter and Mannalargenna Cave sites over 100 metres above sea level, perched in the foothills of the southern tail of the Great Dividing Range. Both sites would have been some 70 kilometres or more from the nearest coast along the eastern seaboard of the continent. (Figure 6.1). On the western side of the Bassian plains at 23,000 years ago, Cave Bay Cave would also have been on the upper slope of a small 100 metre rise about 50 kilometres inland from the coast (Bowdler 1984:51). Over the next five thousand

years, the sea level dropped another 20 metres or so until it reached its lowest level of about -120 metres, about 18,500 years ago (Chappell 1994:831) (Figure 6.2). Although quite dramatic the sea level changes between about 32,000 and 16,000 did not however translate to vast palaeogeographic changes in the Bassian region because of the topography of the continental shelf (Figure 6.1). The major palaeoenvironmental changes related to climate and vegetation.

With the onset of the last glacial maximum, steppe-like grassland vegetation began to replace open woodlands in the Bassian region and forest contracted to more sheltered areas as climates became colder and wind regimes and aridity increased. Declining temperatures and increased wind regimes would have rendered the Bassian plains a somewhat bleak although dynamic environment throughout the glacial maximum. Vast dunefields mobilised, stretching from the core of the continent and across southeast Australia and northern Tasmania, probably as a result of denudation of much of the drought-sensitive grassland vegetation (Ash and Wasson 1983; Kershaw 1995:664; Wasson 1986, 1989).

Kershaw (1995:673) has suggested that there was high seasonality in the glacial phase which 'appears to have excluded extensive tree survival over much of southern Australia' and this combined with lower precipitation 'to produce a very unstable landscape'. It is clear from relict dune formations and aeolian cave deposits on King Island, the Furneaux Islands and northeast Tasmania that during the last glacial maximum extensive tracts of the Bassian plains would have been drifting dune fields, most active from about 24,000 years ago until about 15,000 (Bowden 1983; Bowler 1976; Hope 1978:505, 1989; Jennings 1959b; Kershaw 1995; Lampert 1979:28; Wasson 1986). Dune building may also have increased during this phase due to salinity and increased loose sediments in the system, as the sea level drop exposed vast areas of unvegetated sands (Jennings 1959a, 1959b).

In more protected areas of the Bassian region however, pockets of forest managed to survive through the peak of the last glacial, despite the arid conditions (Hope 1978:505, 511). Extant patches of relict forest and temperate rainforest in the sheltered gullies around Mt Strzelecki on Flinders Island, and in the gullies around the City of Melbourne Bay area of King Island, attest the resilience and diversity of previous vegetation regimes on the Bassian landbridge in the past (Hope 1978, pers. comm.). At the glacial maximum, the areas of surviving forest would almost certainly have been more widespread along the eastern seaboard of the Bassian landbridge, in the

more sheltered foothills and gullies of the mountain ranges— the peaks of which now form a chain of islands between Wilsons Promontory in Victoria and northeast Tasmania.

After the peak of the last glacial about 18,000 years ago the climate began to ameliorate rapidly, and by about 15,000 years ago dunes had basically stabilised in the Bassian region, and shrub and forest vegetation began to expand again to areas it previously occupied. Although the sea began to rise from about 18,000 years ago, because of the relatively steep decline below about -80 metres toward the edge of the continental shelf, compared with the flatter profile of the shelf area itself, the sea level rise initially made little impact on the overall area of territory in the Bassian region (Figures 6.1 and 6.2).

The Bassian region would have been relatively flat with mountainous upland areas rising rather incongruously out of the plains down the eastern side. In the western Bassian area a plateau of lower altitude would have existed in the area that now comprises King Island. Pollen and faunal evidence from King and Hunter Islands suggest that in the past the flatter shelf area of the Bassian plains was probably open heath and grassland, not unlike the present 'flats' areas on both King and Flinders Islands (Bowdler 1984; Hope 1978; Sim 1991). These existing flats have poor drainage and feature numerous permanent fresh water lagoon environs which attract abundant waterfowl and terrestrial faunal resources. With the climatic amelioration, and particularly increased precipitation, it could be expected that similar environs were to be found across the coastal plains that fringed the Furneaux peninsula in the terminal Pleistocene. The area of these plains environments however would have been decreasing rapidly as post-glacial sea levels continued to rise (Jennings 1957, 1959a, 1959b; Kershaw 1995:665).

In summary, the Bassian region from about 35,000 BP to 15,000 BP saw vast changes in terms of climate, vegetation and dune mobility, although the actual land mass varied little over time (Figure 6.1). This period saw a climatic change from conditions slightly colder than at present about 35,000 years ago to the full glacial maximum about 18,000 BP when conditions became colder and drier. The major manifestation of the glacial maximum in the Bassian region appears to have been changes in vegetation and the associated mobilisation of massive dune fields across the Bassian land bridge area and northeast Tasmania. Climatic amelioration toward the end of the Pleistocene brought increased precipitation, dune stabilisation and the return of

climatic and vegetation regimes similar to those in the pre-glacial maximum phase. The sea level also began to rise although by 15,000 BP it was still well below -100 metres.

6.2.2 Human occupation in Tasmania and Bass Strait 35,000 to 15,000 years ago

Although the first evidence of human occupation in the Bassian region does not occur until about 23,000 BP, indirect evidence of occupation there comes from the presence of people in southwest Tasmania from about 35,000 BP (Cosgrove 1995). To reach Tasmania from further north, people would at least have had to traverse the Bassian region which at that time would have been a large southeast Australian peninsula. Palaeoenvironmental data suggest there may have been a river channel or estuary dissecting the northwestern region of the Bassian plains, so that the initial occupation of the Bassian region was probably down the eastern side.

The earliest evidence of occupation in Tasmania comes from southwest cave sites first occupied between c. 36,000 BP and 25,000 BP: Nunamira, Pallawa Trounta, Warreen and Bone Caves (Allen 1996a, 1996b; Cosgrove 1991; Stern and Allen 1996). Two other sites, ORS 7 and Parmerpar Meethaner, have been found in Tasmania with evidence of greater antiquity than 30,000 BP—Parmerpar Meethaner which has cultural deposits dated to at least 35,000 BP and is located inland in the Forth River valley in northwest Tasmania, and ORS 7 in the Shannon River Valley in the Central Plateau area (Cosgrove 1991, 1995). This suite of Pleistocene sites suggests that Tasmania was probably first colonised sometime around or shortly after 40,000 years ago when Tasmania was the southernmost region of a broad southeast Australian peninsula (Figures 6.1 and 6.3).

Cosgrove argues that there are distinctive archaeological signatures showing commonalities in technology and resource exploitation behaviour within the southwest sites, and that these are diagnostic of the sites representing a bounded archaeological system (1991:354, 1995:97). Nonetheless he acknowledges links between the sites of the southwest 'system' and the more northerly Parmerpar Meethaner site in the antiquity of initial occupation, the dominance of locally available quartz in stone assemblages, thumbnail scrapers and increased artefact discard rates between 30,000 BP and 25,000 BP — all archaeological signatures of the southwest system identified by Cosgrove (1995:100). ORS 7, the other site of similar antiquity of initial occupation, also shows a predominance of locally procurable stone

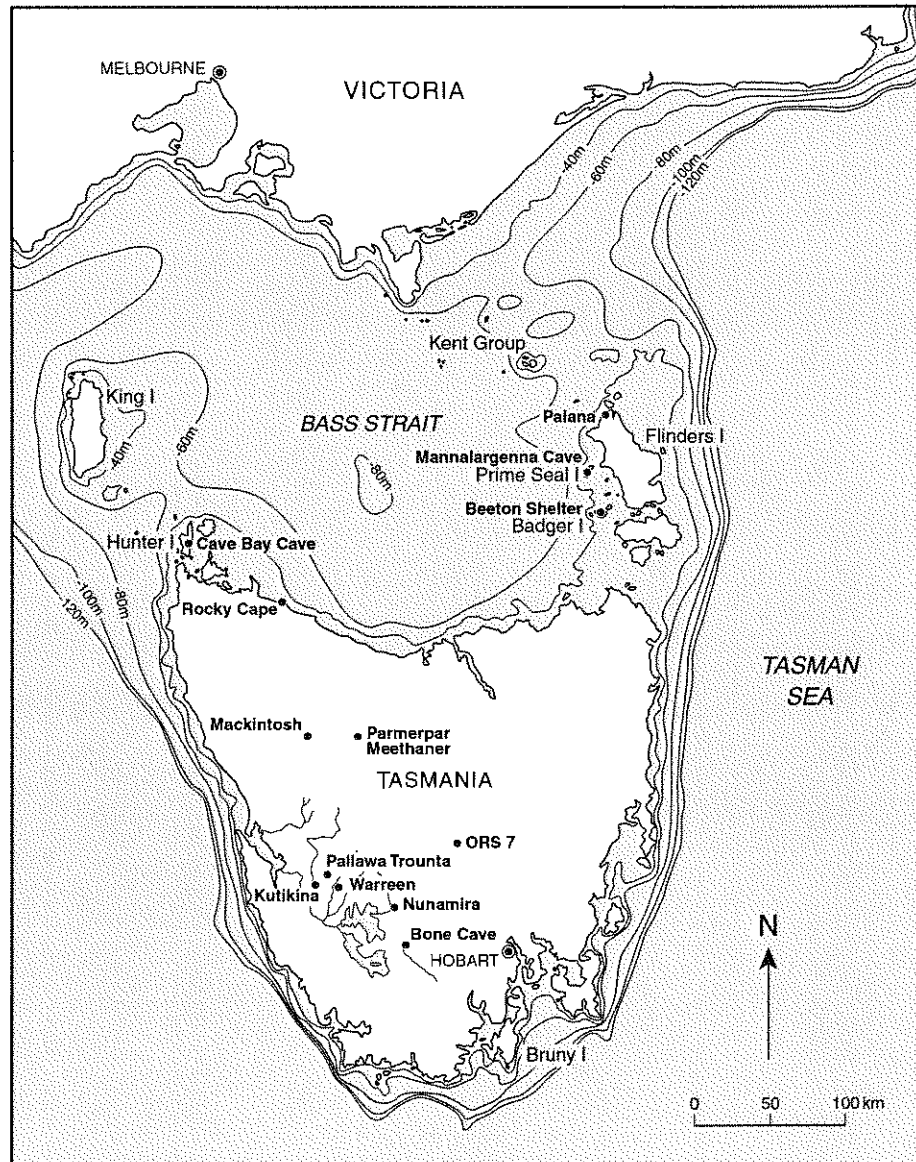


Figure 6.3 Map showing bathymetric contours relevant to the insulation of the Bass Strait islands and Tasmania, and archaeological sites mentioned in the text.

and a period of higher discard rates around 30,000 BP, although thumbnail scrapers were not recovered from this site (Cosgrove 1991, 1995:99). Cosgrove argues that variation in artefact assemblages, stone procurement and faunal exploitation patterns is a reflection of 'very distinct site functions' — an attribute he views 'as a measure of a more closed network of social interaction' during the occupation of the southwest (Cosgrove 1995:98). Contradictions in using both variation and commonalities of the same attributes to support the notion of a bounded southwest system are recognised by Cosgrove who explains such contradictions as reflecting 'the scale of analysis and the way in which human behaviour is characterised' (1995:99).

Nonetheless, it is clear that variation in cultural remains in sites of this antiquity are reflecting exploitation strategies on one scale finely tuned to local conditions. Hence it is to be expected that palaeoecologically and geographically distant sites such as ORS 7 and Parmerpar Meethaner would vary in terms of specific types of raw materials, faunal remains and even artefact types — while at the same time displaying similar broad trends in site occupation intensities. Clearly the southwest sites are a manifestation of a late Pleistocene system, and possibly the first archaeological system operating in Tasmania. To identify sites of similar antiquity as culturally peripheral to, or outside this system on the basis of geographic distance or palaeoecological differences however is problematic, and particularly so in the case of Parmerpar Meethaner where there are acknowledged cultural links with the southwest sites (Cosgrove 1995; McNiven 1994). More useful is the identification and recognition of common behavioural patterns in these early Tasmanian sites; patterns demonstrating rapid cultural adaptation to a range of changing late Pleistocene environments.

To date, evidence of human occupation in the pre-glacial maximum phase in Tasmania suggests that habitation was predominantly focused in the southwest region, where grassland areas appear to have been more extensive. People in these and other sites with evidence of occupation at this time appear to have had a well developed technology and strategy of exploitation, the principal feature of which was adaptability to a range of relatively diverse environments and local resources. The most marked broad scale change over time in this period is an increase in intensity of occupation at the sites, as measured by artefact discard rates, between about 25,000 BP and 30,000 BP. The subsequent decline in discard rates in the southwest sites, after 25,000 BP, continues through to 16,000 BP and coincides with the onset and peak of the last glacial maximum (Cosgrove 1995; Porch and Allen 1995:719). With climatic amelioration, discard rates increase again in most sites for several thousand

years until the southwest sites are abandoned in the last few millennia of the Pleistocene. Interestingly, as discard rates in the southwest begin to wane with the onset of the last glacial maximum, evidence of human occupation begins to appear in caves in the Bassian region to the north.

6.3 The last Glacial Maximum

In the late Pleistocene, people continued to occupy the southwest Tasmanian caves although to a lesser extent through the peak of the glacial phase. Discard rates decline significantly in the early southwest sites from about 25,000 BP until about 15,000 BP, and cave site use declined significantly in the southwest as climatic conditions deteriorated. Conversely, in the Bassian region sites begin to appear in the archaeological record as the glacial maximum approaches its peak. Radiocarbon dates from emu eggshell and hearth charcoal suggest that Beeton Rockshelter and Mannalargenna Cave in the Bassian region of northeastern Tasmania, and Cave Bay Cave in the northwest, were all first occupied by at least 23,000 years ago (Bowdler 1979; Brown 1993; Sim 1991, 1994) (Figure 6.3).

Evidence from each of these three sites reflects a relatively low level of site use during the late Pleistocene, although there is a marked increase in remains in Mannalargenna Cave and probably the Beeton Rockshelter remains between about 19,000 BP and 15,000 BP. The evidence from Beeton Rockshelter shows a pattern of markedly higher discard rates after about 19,000 years ago although when this more intense occupation phase ceases is unclear due to disturbance. Stone artefact discard rates at Cave Bay Cave followed a similar overall pattern with Pleistocene occupation being most intense albeit rather low level throughout the glacial peak until about 15,000 years ago when the site was effectively abandoned until mid-Holocene times (Bowdler 1984:110).

Pleistocene artefact and faunal assemblages in each of these three sites share a number of characteristics. Stone artefacts were predominantly made from locally available quartz and included bipolar worked pieces. Although there was a low percentage of retouched or utilised flaked artefacts, implement types from both the Mannalargenna Cave and Beeton Rockshelter sites included steep-edged scrapers and end scrapers. Single thumbnail scrapers were recovered from Cave Bay and Mannalargenna Caves, and three from Beeton Rockshelter (Bowdler 1984:122; Brown 1993:265). Faunal remains from all these sites also suggested that larger mammals and particularly macropods were being targeted. Ochre nodules and ochre stained

artefacts were recovered from all three sites and bone tools from the Mannalargenna and Cave Bay Cave deposits. These traits are also shared by the southwest sites and are thus regarded as reflecting larger scale behavioural trends on a regional and possibly wider scale. More localised regional variations within this general pattern are evident however, and as in the southwest, distinct cultural traits appear to cluster both chronologically and geographically.

As discussed above, Cosgrove (1991, 1995) suggests that closed or bounded regional systems can be identified by the geographical distribution of specific cultural traits or archaeological signatures such as Darwin Glass, and that these systems are bounded geographically and chronologically by palaeoecological conditions. Despite the obvious potential for circularity in this framework, Cosgrove (1991, 1995) has demonstrated a coincidence between cultural and palaeoecological boundaries in the southwest, boundaries independently validated by the palaeoecological and archaeological data. Arguably, a similarly bounded archaeological system may have existed in the Bassian region in the late Pleistocene. However, unlike most of the southwest sites where the richness of cultural remains indicates the sites were well frequented and thus represent the core territory of a system, the sites in the Furneaux region contained much lower densities of cultural remains and appear to be peripheral rather than core territory sites. At the time of most frequent occupation between about 20,000 and 15,000 years ago, the Furneaux sites would have been located in cold, windy and arid environs, on rises surrounded by plains with mobile dunes, sand blowouts and sparse patches of grassland vegetation — and hence the low intensity of visitation reflected in the remains is not unexpected.

By interpreting increased artefact discard rates in the southwest between 30,000 and 25,000 BP, and later between 16,000 BP and 10,000 BP, as evidence of 'greater spatial use' in better climes, Cosgrove (1995:100) implies that in the less clement conditions of the glacial maximum, between these two periods, people were more constricted geographically. McNiven (1994) has also argued that people in the southwest became more mobile with post-glacial climatic amelioration after about 16,000 BP. His argument however hinges on the geographical and chronological distributions of thumbnail scrapers, distributions which themselves are not agreed upon (Jones 1995). While the model of Pleistocene refugia may work well for flora in some specific regions, its extension to the faunal sphere, and more particularly the cultural sphere is problematic (Sauer 1977:321). A more cogent human behavioural explanation is that increased discard rates were in fact reflecting the reverse — a more geographically confined land-use pattern in better climes. Under this model, discard

rates decreased in times of climatic stress as local resources became less locally abundant and human activity became more dispersed with people ranging further to obtain resources. Archaeologically this would be reflected not only in a decrease in site use in the core territory in times of climatic stress such as the last glacial maximum, but also a concomitant increase in site use in geographically peripheral territories.

In the Bassian region, the broad chronological pattern of occupation—as measured by artefact discard rates—is the reverse of the southwest sites: rather than waning during the peak of the glacial phase, occupation in these sites intensifies (Brown 1993; Bowdler 1984). These Bassian sites could therefore represent the peripheral facet of the dispersal model, that is, sites being visited in forays to outlying territories in times of climatic stress. This would explain the apparently ephemeral nature of human occupation in these sites, suggested by the relatively low density of cultural remains, and the chronology of occupation. The latter indicates that all three of the Bassian sites were used more frequently during the most intense phase of the last glacial and use tapered off with increasing climatic and palaeoenvironmental amelioration about 15,000 years ago. This notion concurs with the suggestion of Porch and Allen, that *the* ‘available archaeological record reflects behavioural shifts in landscape use and subsistence procurement which correlate well with large-scale climatic changes’ (1995:729).

Whether the sites in the Bassian region are outliers of the southwest system or of a more localised northeast regional system however is unclear. These sites have broad commonalities with Pleistocene evidence from Cave Bay Cave and the southwestern and other Tasmanian sites, while at the same time having very distinctive evidence demonstrating a high degree of adaptation to very localised resources. Evidence from the Beeton Rockshelter and Mannalargenna Cave sites demonstrates an intimate knowledge of local stone sources and other resources such as fossil shell beds. The systematic fossil shell-working technology evident in both the Mannalargenna and Beeton Rockshelter sites is far from opportunistic. Fossil shell-working may well be the archaeological signature of a regionalised system, the northeast equivalent of the southwest Darwin Glass.

Gamble suggests such geographically restricted patterning of raw material distribution reflects discrete systems operating on a smaller regional scale, and that such ‘closure in the social unit will most probably occur under conditions where spatial areas it occupies are small and the food supply predictable’ (1983:204,

1986:338). Under this model, groups colonising Tasmania possibly at various times may have settled different regions such as the southwest and the northeast, adapting and evolving social networks, technological and subsistence strategies to the specific (and changing) palaeoecological conditions of their environs possibly over tens of thousands of years. While Porch and Allen (1995:728-9) have suggested that it was logistically possible that 'terminal Pleistocene hunter-gatherers in Tasmania ranged as far north as present-day Victoria', the high degree of local adaptation evident in the remains from the Mannalargenna Cave and Beeton Rockshelter sites does not suggest intermittent use of the sites by people traversing between Tasmania and Victoria; rather it displays a high degree of adaptation to local resources with evidence from at least 23,000 BP to about 16,000 BP.

The hallmark or archaeological signature of sites in this region appears to be the unique shell-working technology, evidence of which was present in both Mannalargenna Cave and Beeton Rockshelter deposits and on a deflated open site six kilometres south of Mannalargenna Cave on Prime Seal Island. Clearly a shell-working technology had been adapted from stone-working reduction methods and enabled consistent scraper blanks and scraper forms to be produced from the shell material. Such specialised use of local materials is evident not only in the exploitation of fossil shell beds and the development of a shell-working technology, but also in the apparent knowledge of smoky and clear crystal quartz sources in the Furneaux region.

Although the Furneaux region is known for producing fine quality and large quartz crystals, the locations where these occur *in situ* are extremely rare (Thelma Shaik pers. comm.). Most crystal quartz is recovered from fluvial sources and is of relatively poor quality tending toward glassy quartz rather than well-formed clear crystals. A commercial gem dealer and fossicker who has lived on Flinders Island for more than 60 years says sources of large crystals such as those from which the larger artefacts would have been fashioned are rare; with few exceptions local islanders would be unaware of the whereabouts of such sources (Thelma Shaik pers. comm.).

That the Mannalargenna and Beeton assemblages contain a significant component of fine quality clear and smoky crystal quartz, and that this is a consistent pattern over time for the duration of Pleistocene occupation further supports long-term knowledge of local resources, possibly supporting permanent Pleistocene habitation centred in the northeast region. If as the evidence suggests these sites represent

outlier camps, this raises the question as to where the core territory may have been and evidence of this could be expected to be found in the archaeological record from the region.

Palaeoenvironmental data indicate that prior to and during the height of the last glacial, the Furneaux rise would have provided comparatively resource-rich environs with fresh water sources in the catchments of the mountains and ranges. Arguably therefore, people may have been focusing habitation in this region and extending further into the surrounding plains as resources became less abundant. If this were the case then it would be expected that the archaeological record of the Furneaux region would show a concentration of sites, particularly Pleistocene sites, in the areas of the major islands, the areas of greater topographical relief that in the past would have comprised the Furneaux rise. To date however there is no archaeological evidence supporting the concept of the Furneaux rise as the focus of human habitation in the region during the last glacial maximum, despite extensive site surveys and numerous rockshelter, cave and open site excavations being undertaken there (Hope 1969; Mackay 1946; Orchiston and Glenie 1978; Sim 1989, 1991, 1994).

An alternative explanation is that Pleistocene habitation in the Bassian region focused around the Bassian Plains rather than upland areas, and that people were making forays into the more upland areas including sites such Beeton Rockshelter, Mannalargenna and Cave Bay Cave during more arid times associated with the glacial maximum. Palaeoenvironmental data suggests that apart from the more arid glacial maximum phase, the plains of the Bassian region in the late Pleistocene were probably resource-rich heath environs with fresh water lagoons. The coastal plains east of the Furneaux rise extended some 40 kilometres to the coast, probably providing a habitat of rich terrestrial, avian and marine resources. The presence of transported marine scallop shell in Pleistocene deposits in both the Mannalargenna and Beeton Rockshelter sites, dating from a time when the sea was distant, possibly indicates a strong link with the coast at this time. Whether the Bassian plains region constituted the territorial focus of a specific northeastern group in the Pleistocene however is unclear.

Testing this proposition has obvious difficulties as only the peripheral sites associated with the last glacial maximum will probably have survived, and plains sites will now be well below present sea level. Clearly more data are required before any firm conclusions can be reached as to the nature of Pleistocene occupation in the Furneaux region. As it stands however the evidence from the Beeton Rockshelter and

Mannalargenna Cave does not demonstrate direct links with the southwest system. Commonalities evident in sites from the Bassian and southwest region are of a nature typical of all sites of this antiquity across the broader southeast Australian region. Nonetheless, the Pleistocene evidence from the Furneaux sites does indicate a very distinct pattern of adaptation unique to the local region; and until either Darwin Glass is discovered in the Bassian region, or fossil shell artefacts in the southwest, I would suggest that there may have been two independent Pleistocene systems in operation, one in the southwest and one in the Bassian region.

6.3.1 Post glacial amelioration and sea level rise

After about 15,000 BP, temperatures and precipitation increased, dunes stabilised, and heath and forest vegetation expanded across the southeastern region of the continent (Hope 1978; Kershaw 1995). While for most of southern Australia this amelioration saw a return toward more stable climatic and vegetation regimes, the marine transgression began transforming the palaeogeography of the Bassian region at a rate unprecedented in the period of human occupation in southeast Australia. Although the palaeoenvironment had undergone dramatic transformations with dune mobility in the glacial maximum, until about 12,000 years ago the overall size of the Bassian land mass had been relatively constant (Figure 6.1). In the terminal Pleistocene and early Holocene however the Bassian plains were transformed; a large embayment formed from the western side of the strait encompassing the entire central Bassian basin. The Bassian landmass contracted rapidly as the embayment expanded to what is now the -60 metre bathymetric contour, and coastal plains fringing the eastern and western seaboards became inundated (Figure 6.3).

Ultimately, when the sea level rose to about -55 metres or so the connection between the Furneaux region and Victoria was breached, isolating Tasmania and the adjoining Furneaux region from mainland Australia. According to current sea level data and the timing of the first post-glacial appearance of fully marine organisms in seabed cores from the Bass basin, the severance of Tasmania from mainland Australia appears to have occurred between about 10,500 and 11,000 years ago (Blom 1988:95; Chappell 1994; Cosgrove 1995:96).

Because of the massive quantities of water moving with tidal changes in the Bassian Basin, once a north-south oriented land barrier in this region was severed it would have widened rapidly. Rising seas meant that ever increasing quantities of water were being channelled by tidal currents through straits once they had been formed.

It is also likely that the infamous tidal rips observable today in the Bass Strait were more treacherous in the past when outflow areas were more restricted. Thus, alternating phases of isthmus building and breaching, as suggested by Bowdler for Hunter Island (1984) are highly improbable in the Bass Strait area even in the initial formative phase (Kerry Black pers. comm.).

About 10,500 or 11,000 years ago, when the land connection between Tasmania and the Australian mainland was first severed, the Hunter Islands on the western side of the Bassian region would still have been part of the Tasmanian mainland. A strait probably formed between Tasmania and King Island only a short time after, if not at the same time as the initial formation of Bass Strait (Figure 6.3). Hence within a span of a few generations, people in the Bassian region would have witnessed both the formation of Bass Strait with the sundering of the landbridge between Tasmania and mainland Australia, and the severance of King Island from northwest Tasmania.

There is less than 15 metres variation in the present day depth of Banks Strait, between northwest Tasmania and the Furneaux region, at about -35 metres, and the slightly shallower critical sill depths between most of the outer Furneaux Islands and Flinders Island. Because of inherent imprecision in past sea level reconstructions (as discussed above) it is not possible to establish a precise chronology or even sequence for the severance of the Furneaux peninsula and subsequent fragmentation of the Greater Furneaux Island. Nonetheless the available data do suggest that the first major impact on the Furneaux Peninsula was probably the formation of Banks Strait probably within the first centuries of the early Holocene when the sea reached between about -35 and -40 metres (Figures 6.2 and 1.2).

This was rapidly followed by the inundation of the coastal plains surrounding the greater Furneaux Rise with hills and small rises on the plains becoming isolated as satellite islands. Around 9,000 years ago the sea had reached about -20 m, bringing the shoreline to within 500 metres or less of Beeton Rockshelter. A further rise of a few metres would have severed overland access between Beeton Rockshelter and the ever diminishing greater Furneaux Island. About this time Prime Seal Island too would have separated from the adjoining Flinders Island (Figure 1.2).

Although the sea level continued to rise until about 6,500 BP when it peaked at a level slightly higher than today, the insulation of the Furneaux Islands in their present day form had largely occurred by about 8,000 years ago (Belpiero 1989; Belpiero *et al.*

1983; Chappell *et al.* 1982; Hails *et al.* 1983). By about 8,000 BP the Furneaux Group, comprising the three main islands Flinders, Cape Barren and Clarke Islands and more than forty outer islands and islets dominated the eastern side of Bass Strait, and King and the Hunter Islands the western side (Figure 6.1).

Throughout the early to mid-Holocene, during the last phase of the post-glacial sea level rise, the climate was becoming warmer and wetter across the broader southeast Australian region (Dodson *et al.* 1992; Kershaw 1995; Kershaw *et al.* 1983:101; Macphail 1983a:103, 1983b:105-6; Markgraf *et al.* 1992). Within the Beeton Rockshelter deposits, the presence of bones from two muttonbird species, the Flesh-footed shearwater (*Puffinus carneipes*) and the Wedge-tailed shearwater (*Puffinus pacificus*), provide evidence of a warmer phase around 5,000 BP. The current range of these species at present is restricted to warmer climates north of the Bass Strait region (Anderson *et al.* 1996; Harper and Kinsky 1978; Pratt *et al.* 1987).

6.3.2 Human responses to the changing palaeoenvironments of the late Pleistocene to mid-Holocene

From about 15,500 BP, use of the Bassian region sites declined markedly, and in fact ceased entirely in Cave Bay Cave until the mid-Holocene (Bowdler 1979:428).

Human skeletal remains dating to 14,500 BP have been found in a cave on King Island, which would then have been the western region of the Bassian landbridge (Sim and Thorne 1990). No cultural remains were found with the human remains in the King Island site and nor has other secure evidence of human occupation of Pleistocene or early to mid-Holocene antiquity been recovered from the western Bassian region, despite extensive investigations there (Jones 1979; Sim 1988, 1990, 1991).

Interestingly, the occupation pattern suggested by the Bassian region sites in the post 15,500 BP period is once again contrary to that found in southwest Tasmania.

Whereas evidence of human occupation in the southwest cave sites intensifies for several thousand years from about 16,000 BP prior to their abandonment about 12,000 years ago, in the Furneaux region it decreases markedly and remains at a very low level until the early Holocene when these sites too are abandoned (Brown 1993; Cosgrove 1995:98,100; Kiernan *et al.* 1983; Porch and Allen 1995). By the end of the Pleistocene, evidence at Mannalargenna and possibly the Beeton Rockshelter site suggests that use of these was becoming very infrequent, and both sites are abandoned before about 8,000 BP. Precise dating of the abandonment of

Mannalargenna Cave site is not possible as charcoal unequivocally attributable to human occupation (i.e. hearth charcoal) does not appear in the uppermost levels of the deposit. Dated samples of loose charcoal from the upper cultural levels nonetheless do suggest that people had possibly abandoned the site by 10,000 BP and almost certainly by 8,000 BP (see also Brown 1993:261).

A more precise abandonment chronology for the Beeton Rockshelter site was obtainable despite disturbance of the deposit. Tightly clustered radiocarbon dates obtained from the shellfish midden remains clearly indicate that people were using this shelter as recently as about 8,300 (C14) years ago, after which the site was abandoned. The clustering is the more striking since, by virtue of the muttonbird disturbance, the shell dates were obtained from a totally random sample.

The abandonment of both these sites coincides with the insulation phase occurring in the region as rising seas steadily fragmented the greater Furneaux Island. The chronology of these site abandonments tracks the insulation process — abandonments marking the point at which rising seas cut overland access to peripheral coastal areas of the greater Furneaux Island. With rising seas people were retracting to the greater landmass of the Furneaux uplands, the area that ultimately became the three major islands of the group, Flinders, Cape Barren and Clarke Islands— and ultimately to Flinders Island itself. Arguably, people using the Beeton Rockshelter in the last occupation phase when the shell midden material was deposited, may still have been able to travel overland to northeast Tasmania when they retreated from the Beeton Rockshelter area.

Nonetheless, the presence of mid-Holocene midden sites on Flinders Island clearly indicates that some people did retreat to or remain in the Furneaux region, as the survey results and dates from the Beeton Rockshelter midden remains indicate that people in Furneaux region in the past were not using watercraft (Orchiston and Glenie 1978; Sim 1991, 1994). That no prehistoric middens are found around the shores of the smaller Cape Barren or Clarke Islands further supports a pattern of people retreating to the larger and the more ecologically diverse landmass, as rising seas inundated the greater Furneaux coastal plains and foothills.

The discovery of shell midden sites on Flinders Island in the late 1970s was considered interesting principally because it was viewed *a priori* as supporting evidence for Jones' model of cultural decline in Holocene Tasmania, rather than as a problem in its own right (Jones 1977a, 1977b, 1979; Orchiston 1979, 1984; Orchiston

and Glenie 1978). Subsequent radiocarbon dating of shell from five Flinders Island midden sites plus advances in both Tasmanian archaeology and palaeoenvironmental research now enables the evidence to be assessed from an archaeologically independent perspective. Radiocarbon dates from the midden sites and outer island excavations indicate that people were in the Furneaux region throughout the insulation phase and until at least 4,700 BP (Sim 1994). Clearly the people on Flinders Island constituted a numerically and culturally viable population, as they survived in isolation in the Furneaux region for some 4,500 to 5,000 years (Sim 1991, 1994).

6.4 Flinders Island - abandonment or extinction?

The absence of mid-Holocene midden sites on outer Furneaux islands and northeast Tasmanian stop-over islands, and the contracting land-use pattern shown by the regional chronology of human abandonments indicate that people in the region did not have watercraft. Evidence from the Beeton Rockshelter and Mannalargenna sites indicates that as rising seas inundated the peripheral coastal areas of the greater Furneaux Island people retracted to the more upland area that now constitutes Flinders Island. There was no evidence to suggest that people had visited any of the islands outside Flinders Island in the period since insulation, despite there being abundant seasonally available resources on many of the Outer Furneaux Islands.

The archaeological record moreover shows a consistent pattern of people contracting to the upland area of the Furneaux region, from sites such as Beeton Rockshelter and Mannalargenna Cave on the peripheral fringes, abandoned as insulation became imminent. It is unlikely however that people moved toward the Furneaux rise from areas of what is now mainland Tasmania, as rising seas threatened to sever the Furneaux Peninsula from mainland Tasmania. Archaeological evidence from sites in the Furneaux region indicated that people were already inhabiting the region in the early Holocene albeit possibly in low numbers. It is most probable therefore that the people initially stranded on Flinders Island in the mid-Holocene were already occupying the region and were unaware of the long term implications of their insulation. It is even possible that they welcomed the impending isolation as it afforded them a degree of protection that only island environments offer.

Since there is no evidence in the archaeological record for the use of watercraft in this region in the prehistoric past, people on the Greater Furneaux Island in the post-insulation phase were clearly isolated from mainland Tasmania. Furthermore since any abandonment or recolonisation of Flinders Island must depend upon the

presence of watercraft in the region in the mid-Holocene, such explanations are at odds with the presence of midden evidence on Flinders Island or subsequent habitation cessation after 4,700 BP. Clearly we are dealing here with a case of extinction not abandonment; a small group of people, separated from greater Tasmania around 9,000 years ago in the post-glacial inundation of the Bassian region, survive for some 5,000 years and then die out.

Discounting the possibility of island abandonment raises the more complex question as to why the Flinders Island population eventually died. Do other models of the cessation of habitation on islands provide analogues for or even clues to the factors or process involved in the extinction of the Flinders population? Is the answer to be found in a combination of cultural and environmental factors or are we dealing with a singular natural catastrophe?

6.5 Extinction - analogues and explanations

From the case studies outlined in the first chapter, a number of factors emerged that were common to island habitation cessations, and near-cessations in the case of islands such as St Kilda, Easter Island, Mangareva and Tikopia. These factors included environmental degradation, resource depletion, environmental factors and particularly unpredictable climatic shifts, changes in patterns of ocean voyaging and external contact. With the exception of catastrophic disasters such as tsunami and volcanic activity, habitation cessation is most often attributable to an interplay of these cultural and environmental factors rather than a single cause *per se*. Where prime movers are identifiable these tend to be merely catalysts for a train of interrelated cultural responses and environmental feedbacks, which ultimately led to the demise of the population. In some instances the initiating factor was itself a long term consequence of human activity whereas in others it was due to naturally induced environmental changes such as climatic shifts.

Before the habitation cessation on Flinders Island is explicitly addressed in light of these factors, the issue of the purported cultural effects of physical isolation in small island populations needs consideration. This notion, commonly referred to as the 'slow strangulation of the mind' theory, was posited by Jones (1997b:200) and has been the source of much debate in the Tasmanian context (Allen 1979; Bowdler 1982; Jones 1978; Thorne and Raymond 1989; Vanderwal 1978; Walters 1981). It should be noted that Jones' idea, although now clearly problematic, was in fact rooted in new developments in island biogeographic theory in the 1970s and reflects a general

search for new paradigms in archaeology at that time. Nonetheless Jones' theory is of direct relevance to the question of why habitation ceased on Flinders Island, as it has been implied that the cessation of habitation of that island represents a microcosm of the cultural devolution model posited by Jones for mainland Tasmania (Diamond 1993, 1994; Gorman 1979; Orchiston 1984). Despite the debate that Jones' ideas engendered, the interpretation of the Flinders Island habitation cessation as a microcosm of the dubious Tasmanian degeneration model has gone virtually unchallenged. Could the extinction of this population be, as suggested, a consequence of decreasing cultural choices stemming from the deleterious effects of long term isolation (Diamond 1998:312, 313)?

Isolation effects and population size

Diamond (1994:332) has suggested that a model for these island extinctions is to be found in the Norse of Greenland who

became hopelessly conservative, refused to adopt the successful subsistence methods of their Eskimo neighbours, failed to invent equivalent methods themselves, and died out within a few generations of the visit of the last ship from Norway.

Diamond (1994) further extends this model to the Tasmanian mainland, uncritically accepting the model of cultural devolution posited by Jones (1977b), and implies that the Aboriginal population there would also have eventually become extinct but for European intervention. The fundamental problem with Diamond's theory is that it is based on the *a priori* assumption that Jones' (1977b) model of cultural devolution is sound.

The evidence Diamond uses to support his trajectory of doom for the Tasmanians is Kangaroo and the Bass Strait Islands:

human populations stranded in the midst of plenty on Flinders, King and Kangaroo Islands show that even a society of several hundred people is insufficient to propel human culture indefinitely (1994:332).

Diamond then goes on to paraphrase Jones (1976) by stating that such societies died out not for want of food but 'from lack of people' that is, the lack of cultural diversity (Diamond 1978, 1994:332). Underpinning this model are the firm assumptions

- a) that the Tasmanians were on a trajectory of extinction
- b) that this was due to isolation and cultural conservatism, and
- b) that Kangaroo and the Bass Strait Islands represent microcosms of the cultural devolutionary process played out to its ultimate conclusion.

There is however no archaeological or other evidence to support this theory and arguments based on mutually reinforcing notions borrowed by archaeologists from biogeographers and vice versa, are somewhat circular (cf. Gorman 1979).

Diamond uses models from bird behaviour such as 'niche contraction' in insular environments, to provide explanations for differences in material culture between Tasmanian and mainland Australian Aboriginal populations (1978, 1993, 1994). Circularity arises however as Diamond uses Jones' interpretation of the Tasmanian material culture as depauperate — an interpretation itself prompted by the florescence of island biogeographical theory in the early 1970s. Diamond (1978) further uses Jones' data to support his contention that the demise of the Flinders and Kangaroo Island populations is attributable to these islands being too small to support populations of more than several hundred people — too few to provide the cultural diversity Jones (1977b) deemed necessary to circumvent the longer term trajectory of cultural degeneration.

Furthermore, to suggest that viability is dependent on large populations is clearly at odds with situations such as Easter Island, Mangareva and Tikopia where excessive population growth at times clearly threatened the long term viability of these populations. Would more Norse in Greenland have resulted in anything other than more deaths? Although population levels were specifically addressed in the 1970s by equilibrium theory of island biogeography, this body of theory has not proved rigorous or useful for human and many other animal and plant populations (Boecklen and Simberloff 1986:249-50; Gilbert 1980:229-30; Shaffer 1981, 1987). The major criticism of equilibrium theory is that while it is well recognised that each species has a minimum viable population size, and that generally very small populations are at greater risk of extinction, there are a number of unquantifiable variables which will affect that degree of risk in an unpredictable manner (Boecklen and Simberloff 1986:252-3).

In the case of human populations these unquantifiable variables include both cultural and environmental factors. One of the major cultural factors affecting optimum population levels in island environments is subsistence method. Clearly the same environment will have a carrying capacity for a hunter-gatherer population different from that of an agricultural one. Moreover an island environment that may support a hunter-gatherer population may not be able to sustain an agricultural one and vice versa. Climatic shifts also require cultural responses which can involve the shifting of subsistence strategies between these two modes. Furthermore it can be seen with

the Norse and the St Kildans that these populations failed through sheer persistence with subsistence strategies that were no longer viable. And Easter Island was probably following the same course. The survival of the Tasmanians and the Eskimo populations of Greenland however serves to demonstrate how the hunter-gatherer subsistence mode is more adaptable to the sorts of environmental changes that have sounded the death knell for agriculturalists. By being able more readily to re-focus and broaden their resource base to accommodate fluctuations in resource availabilities, hunter-gatherers can be at an advantage when faced with climatic shifts, natural hazards and staple resource failures. Hunter-gather subsistence modes appear to be more flexible by nature and thus can adapt rapidly to circumstances which have brought about the demise of agricultural based societies.

Cultural adaptability

While it is now evident that the Flinders Island population did die out, there is no evidence to suggest that a 'maladaptive' cultural decline such as that posited by Jones (1977b, 1978:46) and Diamond (1976, 1994) occurred in this, the broader Tasmanian or any other cultural context. Rather, as Bowdler (1982:43) has pointed out, there is no such thing as cultural 'maladaptation' as culture is quintessentially adaptive in nature. As the example of the Eskimo and Norse populations in Greenland demonstrates, it was not an absence of cultural interaction but a lack of cultural *adaptability* that occasioned the demise of the Norse. A range of other island examples from the historic St Kildans to prehistoric Pacific contexts such as Necker and Nihoa further suggest that the lack of adaptability or cultural flexibility to meet changing social and environmental conditions was a critical factor in extinction of or abandonment by island populations. Archaeological and historical evidence indicate that where subsistence strategies and social structures did not adapt to maintain populations and natural resources at sustainable levels, habitation ceased.

That the Aboriginal population of Tasmania has survived for some 35,000 years or more since colonising Tasmania, and in total isolation from mainland Australia for the last 11,000 years, is testament to the adaptability and ultimate *success* of that island population. Despite the presence of the Bassian land connection for much of the Pleistocene, the Tasmanians were possibly equally isolated in Pleistocene and Holocene times, and yet managed to adapt to diverse and changing palaeoenvironments from 35,000 years ago to historic times (Cosgrove 1995; Porch and Allen 1995).

The extinction of the Flinders Island population is then all the more puzzling given the demonstrated adaptability of the Tasmanians. It suggests that their demise may have been due to some circumstance outside the cultural realm. That habitation ceased on Kangaroo Island also around 4,000 years ago further suggests that the principal factors involved in the death of these islander populations are not cultural. Moreover there is a strong chronological coincidence of other major changes in the archaeological records not only of these islands but across the broader context of Tasmania and the Australian continent about 4,000 years ago (Beaton 1985; Bird and Frankel 1991; Lourandos 1997:312-317; Ross 1985; Rowland 1983).

One of the main features of the change evident in the archaeological record from 4,000 BP is a greater focus on coastal resources on the eastern Australian seaboard and the florescence of island use, and by implication watercraft, around Australia (Beaton 1985; Bowdler 1995; Stockton 1982). If as the archaeological record indicates, people were not using watercraft prior to about 4,000 BP in the Holocene, then a stranded island population in the mid-Holocene would clearly have fewer choices open to them. In dealing with irreparable environmental degradation, natural disaster or unsustainable population levels in an isolated island environment, migration or abandonment were clearly not short term choices available to populations without watercraft — or the materials or technology to construct them. Moreover the development of watercraft suited to open ocean voyaging and the requisite handling and navigational skills would require time.

Interestingly, it is from about 4,000 years ago that the west coast of Tasmania begins to be occupied and there is a general increase in focus on marine resources both in Tasmania and on the southeastern and eastern seaboard of mainland Australia. It is also shortly after this time that fish ceases to be a dietary component of the Tasmanians and evidence of intensive exploitation of subtidal resources such as abalone and crayfish appears in the archaeological record (Bowdler 1988; Dunnett 1993; Sim 1994; Stockton 1982). It is also in the mid- to late Holocene that the first evidence of watercraft use in Tasmania appears in the archaeological record, as people begin to exploit seasonal resources on offshore islands (Vanderwal 1978; Vanderwal and Horton 1984).

Explanations invoking social change are clearly unsatisfactory to account for mid- to late Holocene changes occurring at the same time in the archaeological record not only in Tasmania but across more distant and physically isolated areas of eastern and northern Australia. Only a broad scale climatic shift could have impacted on people

living in both Tasmania and mainland Australia and set in train independently the broad scale changes in the archaeological record in both contexts around 4,000 years ago. The chronological coincidence of these changes and the disappearance of human populations from Flinders and Kangaroo Islands around this time further support the notion that palaeoclimatic factors underlie the changes in the mid- to late Holocene archaeological record. What then is the evidence for climatic changes at this time, and what sort of change could have effected both the extinction of island populations such as those on Flinders and Kangaroo Islands on one hand, and the florescence of coastal exploitation with the advent of new technologies and exploitation strategies on the other?

6.7 Palaeoenvironmental evidence

Surveys of a wide range of palaeoenvironmental data from Tasmania and southeastern Australia show a remarkably consistent pattern of significant changes, including increased seasonality occurring between about 4,000 BP and 3,000 BP (Baynes 1989:86; Bowdler 1984:49; Bowler and Hamada 1971:5; Hope 1978:507; Macphail 1983:104; Markgraf *et al.* 1992:196; Wasson 1986:59). Recent research into palaeoclimates and the evolution of the El Niño-Southern Oscillation (ENSO) links these changes with the onset of the influence of ENSO cycles (Markgraf *et al.* 1992; McGlone *et al.* 1992).

It is unlikely that typical ENSO cycles were a major factor in Australasian ... climates before about 7,000 BP, and they only began to exercise their present strong influence beginning at 5000 and fully developed by 3000 BP (McGlone *et al.* 1992:435-6).

It has been suggested that replacement of the warmer and wetter phase in the early-middle Holocene by 'colder climates with drier summers similar to present' between 5,000 BP to 3,000 BP was a consequence of the establishment of ENSO cycles (McGlone *et al.* 1992:435-6). And there is ever-increasing consensus that El Niño has played the dominant role in late Holocene climatic and palaeoenvironmental change, throughout southern Australia, South America, the southern Pacific and New Zealand (Anderson *et al.* 1996; Harrison and Dodson 1993; Markgraf *et al.* 1992; McGlone *et al.* 1993; McGlone *et al.* 1992; Thom 1992:12). There is now a persuasive range of evidence from a broad spectrum of palaeoclimatic and palaeoenvironmental sources which supports major climatic change around 4,000 years ago being associated with the onset of ENSO cycles in Australia and elsewhere in southern Pacific regions.

In Tasmania and southeastern Australia the principal manifestations of the onset of ENSO cycles were lower temperatures, cooling of ocean waters, less precipitation and increased seasonality (Harrison and Dodson 1993:276; McGlone *et al.* 1992:446). Both increased annual seasonality in combination with less frequent but more intense El Niño episodes from around 4,000 years ago are manifest in the palaeoenvironmental record as variability in hydrological, vegetation, climatic, wind and dune building regimes. And these may vary regionally, dependant upon local environmental factors. In the effort to rationalise seemingly conflicting inter-regional palaeoenvironmental data, the salient point is often overlooked; variation *per se* is the expected outcome of ENSO onset — and lack of correlation in lake levels, tree line migrations and vegetation regimes on an inter-regional scale is not necessarily anomalous, but rather an indicator of ENSO-induced changes (Harrison and Dodson 1993:276-279; McGlone *et al.* 1992:446).

For the northern Tasmanian and Bassian region the late Holocene evidence is consistent, and there are a number of changes in vegetation regimes, sedimentation evidence and fire regimes between 4,000 and 3,000 that support the onset of a new climatic regime consistent with ENSO (Bowdler 1979; Hope 1978, in press; Kershaw 1995:673; Ladd *et al.* 1992; Macphail 1980; Sim 1991; Thomas 1992). The disappearance of warm water taxa of muttonbirds from the Bass Straits region from about 4,500 BP is further evidence of palaeoenvironmental changes possibly relating to water temperatures and ocean currents in the mid- to late Holocene (Anderson *et al.* 1996). A significant increase in sedimentation rates in Cave Bay Cave on Hunter Island between 4,000 BP and 2,500 BP indicates changes in palaeoenvironmental conditions in the Bassian Region from this time (Bowdler 1984:49). Although the cave sediments are not of aeolian origin, and thus provide no evidence of dune mobility, the increased sedimentation rate nonetheless indicates that a significant change in palaeoenvironmental conditions must have occurred to bring about such a marked increase in the chemical weathering of the cave walls from about 4,000 BP (Bowdler 1984:49,50).

Most consistent is the evidence of increased natural firing associated with increased frequencies of summer droughts, not only in the Bassian region but across southeast Australia and including Kangaroo Island (Hope in press; Lampert 1979; Macphail 1980). In the immediate Bassian region the evidence for intense fire episodes from 4,000 BP is compelling; pollen cores from Hunter Island show 'a distinct phase of high carbonised particle accumulation from about 4000 to about 2500 BP' (Hope in press); charcoal from non-cultural contexts in extensive dune palaeosols at Palana on

Flinders Island and the Cataragui Monument site on King Island shows a consistent pattern of firing between about 4,000 BP and 2,500 BP; and dates from buried palaeosols exposed in coastal dunes also indicate periods of dune mobility on a vast scale from at least 3,500 BP (Jennings 1959b; Sim 1991:89,162).

The chronological coincidence of dune mobility and increased fire regimes suggests that the dune building is not a product of increased wind regimes but rather is related to firing and associated vegetation disturbance (Hope in press). That widespread evidence of firing is predominant in periods on both King and Hunter Islands when these islands were unoccupied demonstrates that fires were occurring naturally, almost certainly from lightning strikes (Hope 1978:507). Furthermore the increased firing is not necessarily an indicator of increased storm activity and higher seasonal precipitation. More frequent and prolonged droughts could *per se* produce conditions more susceptible to ignition from lightning strikes.

6.8 ENSO as a prime mover for changes in the mid-Holocene archaeological record

If, as seems likely, ENSO is responsible at least as a prime mover for the changes that occur in the archaeological record about 4,000 BP, then this raises the question as to how the onset of ENSO cycles could have effected such a disparate set of changes. On Flinders and Kangaroo Islands the populations became extinct, whereas in Tasmania the consequence of the climatic shift was an expansion of resource subsistence strategies, territorial boundaries and broader changes in socioeconomic structures (Bowdler 1982; Dunnett 1993). Why should it be that such different outcomes arose in response to the same environmental stress? Is it that the size of the smaller island populations on Flinders and Kangaroo, like the Norse of Greenland, clung steadfastly to subsistence strategies that in changing climes were increasingly less productive and ultimately failed to meet their needs? While clearly the model Jones posited of cultural degeneration in Tasmania is untenable, is it possible that this model is valid at smaller scale where in fact the populations did become extinct? Or was the nature of environmental degradation on these islands such that the only course for survival would have been abandonment?

To examine these propositions it is useful first to examine the successful response to the climatic shift that occurred in the Tasmanian mainland, and to investigate why a similar response did not, or could not, occur in the Flinders Island context. It is interesting to note that there are remarkably similar chronological and cultural

parallels to Tasmanian mid-Holocene cultural change to be found amongst the Yaghan and Alakaluf of Tierra del Fuego—a region where models of cultural devolution have also been posited to explain these changes (Yesner 1990). In Tierra del Fuego there is palaeoenvironmental evidence of colder and drier conditions there and a major shift in wind regimes in the mid-Holocene, along with changes in the archaeological record about 4,000 BP indicating a broadening of the resource base to include

deep water fish and shellfish species, and, in general, a more catholic utilization of the environment as a whole ... it no longer seems tenable that the Fuegians can be considered simply as having 'devolved' from more complex groups to the north; they clearly evolved *in situ* ... (Yesner 1990:18).

Like the Tasmanians, the Tierra del Fuegians responded to the mid-Holocene climatic shift by broadening their resource base to include subtidal shellfish species such as abalone which provide greater protein returns than smaller intertidal species. As Lischka points out deeper water species such as abalone have a higher protein content than other classes of shellfish such as mussels and clams. Moreover to meet the 40 gram daily protein requirement an adult would need to consume 40 clams (*Chione* spp.) whereas one green abalone (of equivalent size to the Tasmanian *Haliotis laevis*) 'has over four days worth of protein' (Lischka 1983:22). Abalone therefore present a reliable protein staple that would be available year round in most coastal regions in Bass Strait and Tasmania. Cosgrove has argued that as a result of unpredictable variability in precipitation, game and in particular macropod populations will also vary unpredictably, although not in direct synchrony (Cosgrove 1991:343).

The increased frequency of drought brought on by the ENSO cycle therefore probably brought about shortages from time to time in what previously had been reliable staple mammal protein sources. Changes in ocean currents from about this time, and particularly the advent of upwelling of colder nutrient-rich waters from the Southern Australian Current may have also favoured the proliferation of the larger, green-lipped abalone species (*Haliotis laevis*) which prefers water temperatures colder than the black lipped (*Haliotis ruber*). It should be noted however that the latter species at least has probably always been part of the molluscan fauna as, like crayfish, it tolerates relatively warm waters and is found today off the coast of NSW. Both crayfish and abalone were therefore probably present in Tasmanian waters in the early to mid-Holocene when waters appear to have been much warmer than today (Anderson *et al.* 1996).

Overall the evidence suggests that as precipitation became less predictable and drought more frequent with the onset of the ENSO cycles, people in Tasmania, at least in coastal regions, responded by broadening their resource base to include sources of protein such as abalone and crayfish which were reliable all year round . This entailed expansion down the west coast into areas previously not incorporated into the economic cycles of the Tasmanians. It appears also to have brought about a more sedentary lifestyle at least for the winter months, when people congregated in base camps along the west and southwest coasts. These base camps or 'villages' as Robinson referred to them were located on river mouths and comprised groups of substantial huts each about three to four metres in diameter and over two metres high and holding up to ten people (Plomley 1966:142, 721, 859). In times of seasonal scarcity and inclement weather people could rely on marine resources in close proximity to the camps.

The influence of the el Niño on the archaeological record of the Peruvian coast in the Cotton Preceramic period (from ca. 4,500 BP) has been recognised for some time (Lischka 1983; Osborn 1977; Wilson 1981; Yesner 1980). The interpretation of cultural and population changes evident from this time have been the cause of debate not dissimilar to that surrounding the interpretation of changes in the archaeological record in Australia at the same time (Beaton 1985; Lourandos 1997:311-313; Osborn 1977; Wilson 1981). Nonetheless there is a general recognition that climatic changes and specifically the onset of pervasive el Niño events had a fundamental role in 'shaping preceramic cultural developments on the Peruvian coast' (Lischka 1983:52). Lischka (1983:33) maintains that, rather than viewing the el Niño onset as a natural disaster, it is better described as a natural hazard to which people respond in various ways depending both on the cultural context and the nature of the hazard:

response may vary from acceptance of losses to a complete avoidance of the event by permanently migrating out of the area affected ... The type of response depends, to an extent, on the nature of the event..... (Lischka 1983:33).

According to Lischka natural hazards fall into two categories; pervasive hazards such as recurring droughts to which a society can adapt, and less frequent and more intensive hazards such as tornadoes and other major catastrophes most of which few people experience in a lifetime. That people would respond to hitherto unknown variability in the availability of staple resources by broadening their resource base, and particularly supplementing it with shellfish, is a well documented response in hunter-gatherer economies (Bray 1976:90,91; Gamble 86:44,45; Perlman 1980:286-80).

Such a shift in resource exploitation strategies is however unlikely to eventuate from an isolated environmental event or disaster such as one flood or drought, but rather demonstrates a permanent shift in climatic regime albeit to one fundamentally episodic in nature.

Why then did the Flinders Island population not respond to the resource stress brought about by increased drought episodes by broadening their resource base or other means to ensure their survival? I would suggest that the evidence points to one explanation: that in the island environment where water is less readily available, increased frequencies of prolonged drought took a greater toll on animal populations, including humans. In mainland Tasmania people and other animals could initially have moved to areas of greater food and water abundance as a short term response to single episodes of drought.

Models of human response to natural hazards indicate that, as frequency and possibly intensity increase, a longer-term response emerges as society adapts to the changed environmental circumstance (Lischka 1983:53). This will be evident in changes in resource scheduling or exploitation strategies, and associated social mechanisms to maintain and reinforce these changes also will occur. In the Tasmanian mainland context people obviously survived the initial ENSO onset phase and by about 4,000 to 3,500 BP their cultural systems had adapted and possibly continued to do so; thus climatic variability such as increased seasonality and drought occurrences could be accommodated in the normal economic scheduling.

In the island environments however it appears that the initiating drought events were probably more devastating, and furthermore the short term options were limited for people without watercraft as they could not move to areas with more reliable water sources. That the island society failed was not for want of people, external ideas or cultural diversity - it was for want of water. The stress of drought was too severe for the islanders and they did not have the luxury of time to adapt (i.e. develop watercraft technology and navigational skills). A marked feature of both Flinders and Kangaroo Islands is the scarcity of freshwater sources. Kangaroo Island has no rivers and even streams there dry out seasonally. Only two permanent lagoons are on the island and Lampert questions whether these too would not dry out or become too saline to be potable in drought years (Lampert 1979:11). Flinders Island also has limited water sources, the most dependable being the freshwater lagoons. In times of lower rainfall, levels in these lagoons drop although the major ones have not totally dried out in historic times deep (Derek Smith pers. comm.).

None of these however are more than a few metres in depth and given extended periods of precipitation levels lower than at present, it is certainly plausible that these too would have dried out.

Depletion of food resources associated with the drought conditions, and the added stress of increased natural wild fires put too great a burden on the Flinders Island population. The archaeological evidence from Flinders and Kangaroo Islands suggests a similar scenario, as both these relict island populations were probably close to a critical threshold despite surviving for several thousand years. The resource depletion during mid-Holocene droughts initiated by the ENSO cycle, possibly in the space of several prolonged episodes, was sufficient to take these populations below the critical threshold — and what had been viable populations for thousands of years died out.

Was it a case then of cultural failure on the part of the Flinders Islanders? I would argue not; rather it is a case of environmental failure. What we are dealing with is not an example of an unsustainable human population, it is an example of an environment that in the long term was incapable of sustaining a human population. Flinders and Kangaroo Islands thus represent environments below the threshold for successful long-term isolated human populations.

6.9 Biogeographical implications of the extinction of the Flinders Islanders

Biogeographers and others have attempted to use island biogeographical theory to produce models of colonisation and the maintenance of human populations on islands and also to explain evidence of habitation cessation on islands such as the 'mystery islands' of the Pacific (Birdsell 1977; Black 1980; Jones 1977a; Keegan and Diamond 1987; Diamond 1976; Sauer 1969, 1977; Terrell 1976, 1977). Most of these models have been based around island size, founding population numbers and the like; and while these types of studies have been useful in the heuristic sense, the conclusions that can be drawn from them are very general, i.e. the larger the island area, the greater the chance of successful colonisation, the larger the founding population the greater the chance of survival and the like.

Perhaps this research too may be taken to be congruent with these general notions and therefore to add little to island biogeographic theory. This is not the case. What has been demonstrated here is that Flinders and Kangaroo Islands are clearly below the threshold for the long term survival of an isolated human population. This is

significant because it demonstrates that Tasmania represents the minimum environment where it is known that a human population has survived in isolation since Pleistocene times. No island smaller than this has been sufficient to support such a population in the long term. In the face of the mid-Holocene climatic shift, people in mainland Australia and Tasmania survived whereas those on the islands such as Flinders and Kangaroo Islands did not. Thus the minimum environment for long term survival of an isolated human population lies somewhere between Tasmania and Flinders or Kangaroo Islands.

Tasmania is about 67,900 square kilometres in area, Kangaroo Island 4,400 and Flinders 1,300. This suggests that islands sufficiently large to provide the diversity required for long term isolated human populations to avoid or adapt to natural hazards are probably somewhere between 5,000 and 70,000 square kilometres in size. Moreover, the evidence suggests that the factor most critical for short term response to natural hazard is the ability to avoid or migrate, and in the longer term to adapt. In small isolated island environments the short term options are decreased, increasing the risk of extinction. In order to avoid the consequences of drought in the short term, people would either have had to be able to move to areas of increased precipitation or more reliable water sources, or to leave the island. If, as seems highly likely, there were no reliable water sources, and people had no watercraft then the consequences would have been, and clearly were, fatal. Greater land area and ecological diversity such as that offered by Tasmania provided more short term options and hence facilitated the subsequent long term adaptive cultural response on a systemic scale.

The archaeological evidence from mainland Tasmania further suggests that similar processes of short term and long term responses to palaeoenvironmental changes, and the natural hazards that accompany such changes, have been occurring since Pleistocene times. Despite the existence of the Bassian plains connecting southeast Australia and Tasmania, at the peak of the last glacial maximum, southwest Tasmania represented an isolated environment. That changes in Pleistocene land-use patterns also generally accord with climatic shifts is evidence not only of the adaptable nature of human culture, but attests also the changing suitabilities of environments for human occupation. As can be seen by the terminal Pleistocene abandonment of the southwest, when an environment becomes unsuited to human habitation, people leave.

This is not environmental determinism; environmental determinism would be indicated if people were not to leave, and as a consequence died out. The point here is that islands are unique in that there is a scale on which environment *does* determine the viability of a human population. A group of people abandoned on a small remote oceanic island with no food, water, watercraft or means to construct them and no contact with the outside world, will inevitably perish. A population stranded on Flinders Island in prehistoric times would clearly have had a greater chance of survival, and in Tasmania a better chance still. This is what island biogeographic theory is fundamentally about, not the role of or processes involved in cultural adaptation. The common misconception that biogeographic theory can provide explanatory models for processes of cultural change, and *vice versa*, underpins not only Jones' devolutionary theory but also Diamond's (1994, 1998) interpretation of the evidence from Flinders and Kangaroo Islands. Cultural explanations such as these are being used to answer a question that is quintessentially a biogeographical problem. The explanation for the extinction of the Flinders Island population is not to be found in cultural theory.

6.10 Directions for future research

It has now been demonstrated that the Flinders Island population died out, and that this was a consequence of the ENSO induced mid-Holocene climatic shift and the physical isolation of the island population. All Bass Strait islands with archaeological potential have now been surveyed and archaeologically assessed. At the present time there are no sites known in the region that are considered to offer the potential to provide any further information about prehistoric use of the region. This does not preclude other sites with archaeological potential being found there in the future; it would be interesting if they were. At present however there are no obviously identifiable avenues for further prehistoric archaeological research in the Furneaux Group or King Island. Nonetheless there are islands in northern Australia where this issue of viability of island environments for isolated human populations is paramount and which to date have not been archaeologically investigated.

Melville Island which is about 30 kilometres off the coast of northern Australia to the north of Darwin is over 5,000 square kilometres and is the only Australian island intermediate in size between Kangaroo and Tasmania. Immediately adjacent to Melville Island is Bathurst Island and a channel of less than one kilometre's width separates the two. Together these islands cover an area of 7,800 square kilometres.

At the time of first European contact these islands were inhabited by the indigenous Tiwi population. The degree of isolation of this population is hard to ascertain as there had been contact with Macassans for several hundred years or more in recent times. Nonetheless it has been suggested that prior to this, the Tiwi lived in isolation from mainland groups, and were possibly a relict population from a time of lower sea level, and certainly they have a quite distinct culture from adjacent mainland groups (Hart and Pilling 1960; Jones 1976:260; Mulvaney 1975:25,47). No archaeological research has yet been undertaken on either Bathurst or Melville Islands, despite the question of the antiquity of occupation on these islands being raised over twenty years ago (Jones 1976).

Should the Tiwi population have been in continuous occupation from the time of sea level rise and in isolation from the mainland, then the Tiwi would certainly represent the smallest isolated relict population to survive long term. Bathurst and Melville islands are about one twelfth the size of Tasmania and located in a very different climate. A relict population in the north of Australia would provide a comparative sample in terms of both cultural responses and palaeoclimatic change.

These islands are of further interest in light of O'Connor's (1992) suggestion that watercraft were in use several thousands of years earlier in northern Australia than in more southerly regions. I would suggest the apparent evidence she has suggested for island occupation actually represents occupation just prior to insulation, as the occupation dates are uncalibrated and the sea level data she has used are in calendar years. Investigations of Melville and Bathurst Island have the potential therefore to address not only the issue of island viability for relict populations in environments outside the southeast Australian region, but also questions concerning the chronology of watercraft in the region and Macassan contact.

Further afield, a comparative study of Holocene cultural and palaeoenvironmental changes in Tasmania and Tierra del Fuego would be useful in terms of examining parallel processes and manifestations of cultural responses to the onset of the ENSO cycles in high latitude environments. This project would require an interdisciplinary team including palaeoenvironmental as well as archaeological expertise.

6.11 Conclusions

The aim of the research was to investigate why it should be that evidence of human occupation on Flinders Island disappears from the archaeological record about 4,500 years ago. The primary step in this investigation was to determine whether the habitation ceased due to the island being abandoned, or whether it was a case of *in situ* extinction of the population. Lampert (1979) had investigated a similar mid-Holocene habitation cessation on Kangaroo Island, and while suggesting that the population probably died out *in situ* there he could not dismiss the alternative possibility that people had left the island. Of island abandonment he says

...I think the odds are weighted against it, but the judgement is a fine one since the evidence is probabilistic rather than conclusive (1979:228).

In the Flinders Island instance it was possible to investigate archaeologically the watercraft issue because of the presence of numerous outer islands and stop-over islands en-route between Flinders Island and the Tasmanian mainland. There was no evidence for watercraft use in the region and it can therefore be concluded that the Flinders Island population was an isolated relict population which died out sometime after about 4,500 BP.

It can further be concluded that the demise of this population was not induced by cultural factors and is directly related to the environmental stress brought about by increased droughts and fire regimes associated with the onset of the ENSO cycle in the mid-Holocene. The same climactic shift also brought about the demise of the Kangaroo Island population in a similar fashion. Lampert (1979:229) had opted for this explanation some twenty years ago, although acknowledging the limitations of the archaeological and palaeoenvironmental data base at that time. This subsequent research now demonstrates that Lampert (1979) was correct and that a similar scenario ensued on Flinders Island. The recognition of the role of ENSO cycles in shaping cultural environments in Australia has lagged behind south American research where el Niño events were archaeologically identified as early as the late 1970s (Lischka 1983; Osborne 1977).

This study has shown that the mid-Holocene populations of Flinders and Kangaroo Islands became extinct, and related this to ENSO-associated environmental stress. Is it possible then that another climatic shift could see these and possibly other island population extinctions? Given that it was fundamentally the lack of means to move that prevented the island populations from migrating and thus sealed their fate, this

seems highly improbable. Nevertheless the productivity and population trajectories over a mere century and a half on Flinders Island suggest that the prognosis for long term occupation is poor.

Once-flourishing enterprises are on the wane and social problems are on the rise; increasingly people are leaving the island in seek of better employment opportunities and the present population has dwindled to almost half that of 40 years ago. Over-fishing has reached the point where several fish and shellfish species are no longer commercially viable, and crayfish and abalone stocks are severely depleted. Erosion and salination are major problems. Soil fertility can only be maintained by the application of vast amounts of chemicals. The Flinders Island dairy and abattoir have closed down.

If this island is to be viable for human habitation by future generations then certainly the present day trajectory of resource depletion is going to have to change. Whether this historic population level continues to decline or not, one thing is certain: eventually, be it another 4,000, 40,000, 400,000 or 4 million years, at some time in the future the human population will disappear from the island once more. To suggest, like Bahn and Flenley (1992), that we can use culture to delay the inevitable fate of the human species *Homo sapiens sapiens*, its extinction seems a somewhat anthropocentric notion in light of the palaeontological record of extinctions. While island environments may well provide interesting study capsules for population dynamics, it has to be borne in mind that there is a quantum leap between the extinction of a population and that of a species.

BIBLIOGRAPHY

- Abbie, A.A. 1951. The Australian Aborigine. *Oceania* 22:91-100.
- Alland, A. 1972. Cultural evolution: The Darwinian Model. *Social Biology* 19:227-239.
- Allen, H. 1979. Left out in the cold: Why the Tasmanians stopped eating fish. *The Artefact* 4:1-10.
- Allen, J. 1996a. Bone Cave. In J. Allen (ed.) *Report of the Southern Forests Archaeological Project. Volume 1: Site descriptions, stratigraphies and chronologies*. Bundoora: School of Archaeology, La Trobe University. pp 91-122.
- Allen, J. 1996b. Warreen Cave. In J. Allen (ed.) *Report of the Southern Forests Archaeological Project. Volume 1: Site descriptions, stratigraphies and chronologies*. Bundoora: School of Archaeology, La Trobe University. pp 135-167.
- Allen, J. and N. Porch. 1996. Warragarra Rockshelter. In J. Allen (ed.) *Report of the Southern Forests Archaeological Project. Volume 1: Site descriptions, stratigraphies and chronologies*. Bundoora: School of Archaeology, La Trobe University. pp 195-217.
- Anderson, A. 1980. The archaeology of Raoul Island (Kermadecs) and its place in the settlement of Polynesia. *Archaeology and Physical Anthropology in Oceania* 15:131-141.
- Anderson, A. 1981. The value of high latitude models in South Pacific archaeology: A critique. *New Zealand Journal of Archaeology* 3:143-160.
- Anderson, A. 1991. The chronology of colonization in New Zealand. *Antiquity* 65:767-795.
- Anderson, A. 1995. Current approaches in East Polynesian colonisation research. *The Journal of the Polynesian Society* 104(1):110-132.
- Anderson, A. 1996. Discovery of a prehistoric habitation site on Norfolk Island. *The Journal of the Polynesian Society* 105:479-486
- Anderson, A., W. Ambrose, F. Leach and M. Weisler. 1997. Material sources of basalt and obsidian artefacts from a prehistoric settlement site on Norfolk Island, South Pacific. *Archaeology in Oceania* 32:39-46.
- Anderson, A., J. Head, R. Sim and D. West. 1996. Radiocarbon dates on shearwater bones from Beeton Shelter, Badger Island, Bass Strait. *Australian Archaeology* 42:17-19.
- Ash, J.E. and R.J. Wasson. 1983. Vegetation and sand mobility in the Australian desert dunefield. *Annals of Geomorphology Supplement* 45:7-26.
- Bahn, P. and J. Flenley. 1992. *Easter Island, Earth Island*. London: Thames and Hudson.

- Bailey, G.N. 1983. Concepts of time in Quaternary prehistory. *Annual Review of Anthropology* 12:165-192.
- Barker, B. 1989. Nara Inlet 1: A Holocene sequence from the Whitsunday Islands, Central Queensland Coast. *Queensland Archaeological Research* 6:53-76.
- Barker, B. 1991. Nara Inlet 1: coastal resource use and the Holocene marine transgression in the Whitsunday Islands, central Queensland. *Archaeology in Oceania* 26:102-109.
- Barnard, G. 1826-1827. A descriptive map of rocks, timber and soil on King's Island. *Lt. Gov. Arthur's Despatch* 73. Governor's despatches, October to December 1827. London: Colonial Records Office.
- Barton, H. 1991. *Raw material and tool function: A residue and use wear analysis of artefacts from a Melanesian rockshelter*. Unpublished BA (Hons) Thesis, University of Sydney, Sydney.
- Barton, H. 1994. *Badger and Prime Seal Shell Report*. Unpublished report prepared for Robin Sim.
- Barton, H. and J.P. White. 1993. Use of stone and shell artefacts at Balof 2, New Ireland, Papua New Guinea. *Asian Perspectives* 32:169-181.
- Baudin, N.T. 1803. *The Journal of Post Captain Nicolas Baudin*. (1974 translation). Adelaide: Libraries Board of South Australia.
- Baynes, A. 1989. Clines and climates: reading rainfall from rats? In T.H. Donnelly and R.J. Wasson (eds) *CLIMANZ 3: Proceedings of the third symposium on the late Quaternary climatic history of Australasia*. Canberra: CSIRO. pp 86-90.
- Beaton, J.M. 1985. Evidence for a coastal occupation time-lag at Princess Charlotte Bay (North Queensland) and implications for coastal colonisation and population growth theories for Aboriginal Australia. *Archaeology in Oceania* 20:1-20.
- Bellwood, P.S. 1978. *Man's Conquest of the Pacific*. Auckland: Collins.
- Bellwood, P.S. 1985. *Prehistory of the Indo-Malaysian Archipelago*. Sydney: Academic Press.
- Belpiero, A.P. 1989. The greenhouse debate and rising sea-levels. *Search* 20(2):48-50.
- Belpiero, A.P., J.R. Hails and V.A. Gostin. 1983. A review of Holocene sea levels in South Australia. In D. Hopley (ed.) *Australian sea levels in the last 15,000 years: A review*. Monograph Series, Occasional Paper 3. Townsville: Department of Geography, James Cook University of Northern Queensland. pp 37-47.
- Bender, B. and R. Caillaud. 1986. *The archaeology of Brittany, Normandy and the Channel Islands: An introduction and guide*. London: Faber and Faber.

- Binford, L.R. 1977. Forty-seven trips: A case study in the character of archaeological formation processes. In R.V.S. Wright (ed.) *Stone tools as cultural markers: Change, evolution, complexity*. Canberra: Australian Institute of Aboriginal Studies. pp 24-36.
- Binford, L.R. 1981. *Bones: Ancient men and modern myths*. New York: Academic Press.
- Binford, L.R., J.F. Cherry and R. Torrence. 1983. *In pursuit of the past: Decoding the archaeological record*. London: Thames and Hudson.
- Binford, S.R. and L.R. Binford. 1969. Stone tools and human behaviour. *Scientific American* 220(5):70-84.
- Bird, C.F.M. and Frankel, D. 1991. Chronology and explanation in western Victoria and south-east Australia. *Archaeology in Oceania* 26:1-16.
- Birdsell, J.B. 1977. The recalibration of a paradigm for the first peopling of Greater Australia. In J. Allen, J. Golson and R. Jones (eds) *Sunda and Sahul: Prehistoric studies in Southeast Asia, Melanesia and Australia*. London: Academic Press. pp 113-167.
- Black, R.F. 1974. Late-Quaternary sea level changes, Umnak Island, Aleutians: Their effects on ancient Aleuts and their causes. *Quaternary Research* 4(3):264-281.
- Black, S. 1980. Demographic models and island colonisation in the Pacific. *New Zealand Journal of Archaeology* 2:51-64.
- Blom, W.M. 1988. Late Quaternary sediments and sea-levels in Bass Basin, southeast Australia — A preliminary report. *Search* 19(2):94-96.
- Bodmer, W.F. and L.L. Cavalli-Sforza. 1976. *Genetics, Evolution and Man*. San Francisco: W.H. Freeman.
- Boecklen, W.J. and D. Simberloff. 1986. Area-based extinction models in conservation. D.K. Elliott (ed.) *Dynamics of Extinction*. New York: John Wiley and Sons.
- Bowden, A.R. 1983. Relict terrestrial dunes: Legacies of a former climate in coastal northeastern Tasmania. *Zeitschrift für Geomorphologie Supplementband* 45:153-174.
- Bowden, A.R. and E.A. Colhoun. 1984. Quaternary emergent shorelines of Tasmania. In B.G. Thom (ed.) *Coastal Geomorphology in Australia*. North Ryde: Academic Press. pp 313-342.
- Bowdler, S. 1974. Pleistocene date for man in Tasmania. *Nature* 252:697-8.
- Bowdler, S. 1979. *Hunter Hill, Hunter Island*. Unpublished PhD Thesis, Australian National University, Canberra.
- Bowdler, S. 1980b. Hunters and Farmers in the Hunter Islands: Aboriginal and European land-use of north-west Tasmanian islands in the historic period. *Records of the Queen Victorian Museum* 70:1-17.

- Bowdler, S. 1982. Prehistoric Archaeology in Tasmania. *Advances in World Archaeology* 1:1-49.
- Bowdler, S. 1984. *Hunter Hill, Hunter Island*. Terra Australis 8. Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University.
- Bowdler, S. 1988. Tasmanian Aborigines in the Hunter Islands in the Holocene: Island resource use and seasonality. In G. Bailey and J. Parkington (eds) *The archaeology of prehistoric coastlines*. Cambridge: Cambridge University Press. pp 42-52.
- Bowdler, S. 1995. Offshore islands and maritime exploration in Australian prehistory. *Antiquity* 69:945-958.
- Bowler, J.M. 1976. Aridity in Australia: age, origin and expression in aeolian landforms and sediments. *Earth Sciences Review* 12:279-310.
- Bowler, J.M. 1982. Aridity in the late Tertiary and Quaternary of Australia. In W.R. Barker and P.J.M. Greenslade (eds) *Evolution of the flora and fauna of arid Australia*. Adelaide: Peacock Publishing. pp 35-46.
- Bowler, J.M. and T. Hamada. 1971. Late Quaternary stratigraphy and radiocarbon chronology of water level fluctuations in Lake Keilambete, Victoria. *Nature* 232:330-332. (reprint pp 1-6)
- Bowler, J.M., R. Jones, H. Allen and A.G. Thorne. 1970. Pleistocene human remains from Australia: A living site and human cremation from Lake Mungo, western New South Wales. *World Archaeology* 2:39-60.
- Brain, C.K. 1981. *The hunters or the hunted? An introduction to African cave taphonomy*. Chicago: University of Chicago Press.
- Bray, W. 1976. From predation to production: The nature of agricultural evolution in Mexico and Peru. In G. de G. Sieveking, I.H. Longworth and K.E Wilson (eds) *Problems in Economic and Social Archaeology*. London: Duckworth. pp 73-95.
- Brooks, A.S., P.E. Hare, J.E. Kokis, G.H. Miller, R.D. Ernst and F. Wendorf. 1990. Dating Pleistocene archaeological sites by Protein Diagenesis in ostrich shell. *Science* 248:60-64.
- Brown, S. 1986. *Aboriginal archaeological resources in south east Tasmania: an overview of the nature and management of Aboriginal sites*. Occasional Paper No. 12. Hobart: Tasmanian National Parks and Wildlife Service.
- Brown, S. 1988. *A preliminary report of archaeological investigations on Prime Seal Island, Furneaux Island Group*. Unpublished report, Tasmanian Department of Lands, Parks and Wildlife, Hobart.
- Brown, S. 1990. Archaeological investigations on Prime Seal Island, news update. Unpublished manuscript.
- Brown, S. 1991. *Aboriginal archaeological sites in eastern Tasmania: A cultural resource management statement*. Occasional Paper No. 31. Hobart: Tasmanian Department of Parks, Wildlife and Heritage.

- Brown, S. 1993. Mannalargenna Cave: A Pleistocene site in Bass Strait. In M.A. Smith, M. Spriggs and B. Fankhauser (eds) *Sahul in Review: Pleistocene archaeology in Australia, New Guinea and Island Melanesia*. Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University. pp 258-271.
- Callow, P. and J.M. Cornford (eds) 1986. *La Cotte de St. Brelade, 1961-1978: Excavations by C.B.M. McBurney*. Geo: Norwich.
- Cameron, C.M. and S.A. Tomka (eds) 1993. *Abandonment and settlement of regions: Ethnoarchaeological and archaeological approaches*. Cambridge, New York: Cambridge University Press.
- Campbell, A.J. 1974. *Nests and eggs of Australian birds*. Melbourne: Wren.
- Campbell, R.N. 1974. St Kilda and its sheep. In P.A. Jewell, C. Milner and J. Morton Boyd (eds) *Island survivors: The ecology of the Soay sheep of St Kilda*. London: The Athlone Press of the University of London. pp 8-35.
- Casey, D.A. 1940. The present state of our knowledge of the archaeology of Australia. In F.N. Chasen and M.W.F. Tweedie (eds) *Proceedings of the Third Congress of Prehistorians of the Far East, Singapore, 1938*. pp 22-29.
- Cavalli-Sforza, L.L., P. Menozzi and A. Piazza. 1994. *The history and geography of human genes*. Princeton, New Jersey: Princeton University Press.
- Chappell, J. 1994. Upper Quaternary Sea Levels, Coral Terraces, Oxygen Isotopes and Deep-sea Temperatures. *Journal of Geography* 103(7):828-840.
- Chappell, J., E.G. Rhodes, B.G. Thom and E. Wallensky. 1982. Hydro-isostasy and the sea level isobase of 5500 BP in north Queensland. *Marine Geology* 49:81-90.
- Chappell, J. and N.J. Shackleton. 1986. Oxygen isotopes and sea levels. *Nature* 324:137-140.
- Cherry, J.F. 1990. The first colonisation of the Mediterranean Islands: A review of recent research. *Journal of Mediterranean Archaeology* 3:145-221.
- Cipriani, L. 1966. *The Andaman Islanders*. London: Weidenfeld and Nicolson.
- Clarke, A.F. 1994. *Winds of change: An archaeology of contact in the Groote Eylandt archipelago, Northern Australia*. Unpublished PhD Thesis, Australian National University, Canberra.
- Cleghorn, P. 1986. The settlement and abandonment of two Hawaiian outposts: Nihoa and Necker Islands. *Bishop Museum Occasional Papers* 28:35-49.
- Coleman, E. 1966. *An analysis of small samples from the West Point shell midden*. Unpublished BA (Hons) Thesis, University of Sydney, Sydney.
- Colhoun, E.A. 1978. The late Quaternary environment of Tasmania as a backdrop to Man's occupancy. *Records of the Queen Victoria Museum* 61:1-12.

- Colhoun, E.A. 1983. The climate of Tasmania 32+/- 5 KA. In J. Chappell and A. Grindrod (eds) *Proceedings of the First CLIMANZ Conference*. Canberra: Department of Biogeography and Geomorphology, Research School of Pacific Studies, Australian National University. pp 10-11.
- Colhoun, E.A. and G. van de Geer. 1987. Vegetation history and climate before the maximum of the last glaciation at Crotty, Western Tasmania. *Papers and Proceedings of the Royal Society of Tasmania* 121:69-74.
- Colhoun, E.A., G. van de Geer and W.G. Mook. 1982. Stratigraphy, pollen analysis and palaeoclimatic interpretation of Pulbeena Swamp, Northwestern Tasmania. *Quaternary Research* 18:108-126.
- Collcutt, S.N. 1979. The analysis of Quaternary cave sediments. *World Archaeology* 10(3):290-301.
- Colley, S.M. 1990. Humans as taphonomic agents. In S. Solomon, I. Davidson and D. Watson (eds) *Problem solving in taphonomy: Archaeological and palaeontological studies from Europe, Africa and Oceania*. Tempus Volume 2. St Lucia: Anthropology Museum, University of Queensland. pp 50-64.
- Cooper, Z. 1988. Shell artefacts from the Andaman Islands. *Australian Archaeology* 26:24-42.
- Cosgrove, R. 1989. Thirty thousand years of human colonization in Tasmania: New Pleistocene dates. *Science* 243:1706-1708.
- Cosgrove, R. 1990. *The archaeological resources of Tasmanian forests: past Aboriginal use of forested environments*. Occasional Paper No. 27. Hobart: Tasmanian Department of Parks, Wildlife and Heritage.
- Cosgrove, R. 1991. *The Illusion of Riches*. Unpublished PhD Thesis, La Trobe University, Bundoora.
- Cosgrove, R. 1995. Late Pleistocene behavioural variation and time trends: The case from Tasmania. *Archaeology in Oceania* 30:83-104.
- Crosby, A.W. 1986. *Ecological Imperialism: The biological invasion of Europe, 900 - 1900*. Cambridge: Cambridge University Press.
- Cumpston, J.S. 1973. *First visitors to Bass Strait*. Canberra: Roebuck.
- Damas, D. (ed.) 1984. *Handbook of North American Indians. Volume 5, Arctic*. Washington D.C.: Smithsonian Institute.
- Davidson, D.S. 1935. The chronology of Australian watercraft. *Journal of the Polynesian Society* 44:1-16.
- Diamond, J.M. 1976. Colonization cycles in man and beast. *World Archaeology* 8(3):249-261.
- Diamond, J.M. 1978. The Tasmanians: the longest isolation, the simplest technology. *Nature* 273:185-6.
- Diamond, J.M. 1985. Why did the Polynesians abandon their mystery islands? *Nature* 317:764.

- Diamond, J.M. 1994. The last people alive. *Nature* 370:331-332.
- Diamond, J.M. 1998. *Guns, Germs and Steel: A short history of everybody for the last 13,000 years*. London: Vintage.
- Dickson, F.P. 1977. Quartz flaking. In R.V.S. Wright (ed.) *Stone Tools as Cultural Markers: Change, evolution and complexity*. Canberra: Australian Institute of Aboriginal Studies. pp 97-103.
- Dodson, J., R. Fullagar and L. Head. 1992. Dynamics of environment and people in the forested crescents of temperate Australia. In J. Dodson (ed.) *The Native Lands*. pp 115-159. Melbourne: Longman Cheshire.
- Dodson, P. and D. Wexlar. 1979. Taphonomic investigations of owl-pellets. *Paleobiology* 5:275-284.
- Dortch, C.E. and K. Morse. 1984. Prehistoric stone artefacts on some offshore islands in Western Australia. *Australian Archaeology* 19:31-47.
- Dortch, C.E. 1991. Rottnest and Garden Island prehistory and the archaeological potential of the adjacent continental shelf, Western Australia. *Australian Archaeology* 33:38-43.
- Douglas, A.M., G.W. Kendrick and D. Merrilees. 1966. A fossil bone deposit near Perth, Western Australia, interpreted as a carnivore's den after feeding tests on living *Sarcophilus* (Marsupialia, Dasyuridae). *Journal of the Royal Society of Western Australia* 49:88-90.
- Dove, H.S. 1926. The Tasmanian Emu. *The Emu* 25:213, 290-291.
- Dunnett, G. 1992. Prion Beach Rockshelter: Seabirds and offshore islands in southwest Tasmania. *Australian Archaeology* 34:22-28.
- Dunnett, G. 1993. Diving for dinner: Some implications from Holocene middens for the role of coasts in the late Pleistocene of Tasmania. In M.A. Smith, M. Spriggs and B. Fankhauser (eds) *Sahul in Review: Pleistocene archaeology in Australia, New Guinea and Island Melanesia*. Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University. pp 247-257.
- Edgecombe, J. 1986. *Flinders Island and Eastern Bass Strait*. Sydney: Edgekirk.
- Elkin, A.P. 1943. *The Australian Aborigines*. 2nd Edition. Sydney: Angus and Robertson.
- Flannery, T.F. 1994. *The Future Eaters: An ecological history of the Australasian lands and people*. Melbourne: Reed.
- Fleming, A. 1995. St Kilda: Stone tools, dolerite quarries and long-term survival. *Antiquity* 69:25-35.
- Flinders, M. 1801. *Observations on the coasts of Van Diemen's Land, on Bass's Strait and its islands, and on part of the coasts of New South Wales*. London: Nicol.

- Flinders, M. 1814. *A voyage to Terra Australis*. 2 volumes plus atlas. London: Nicol.
- Frankel, D. 1993. Pleistocene chronological structures and explanation: A challenge. In M.A. Smith, M. Spriggs and B. Fankhauser (eds) *Sahul in Review: Pleistocene archaeology in Australia, New Guinea and Island Melanesia*. Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University. pp 24-33.
- Fullagar, R.L.K. 1986. *Use-wear and residues on stone tools: Functional analysis and its application to two southeastern Australian archaeological assemblages*. Unpublished PhD Thesis, La Trobe University, Melbourne.
- Gad, F. 1970. *The history of Greenland: Earliest times to 1700*. London: C. Hurst.
- Gaughwin, D. and R. Fullagar. 1995. Victorian offshore islands in a mainland coastal economy. *Australian Archaeology* 40:38-50.
- Geering, K. 1990. A taphonomic analysis of recent masked owl pellets from Tasmania. In S. Solomon, I. Davidson and D. Watson (eds) *Problem solving in taphonomy: Archaeological and palaeontological studies from Europe, Africa and Oceania*. Tempus Volume 2. St Lucia: Anthropology Museum, University of Queensland. pp 135-143.
- Gilbert, F.S. 1980. The equilibrium theory of island biogeography: Fact or fiction? *Journal of Biogeography* 7:209-235.
- Gillespie, R. and H.A. Polach. 1979. The suitability of marine shells for radiocarbon dating of Australian prehistory. In R. Berger and H. Suess (eds) *Radiocarbon Dating: Proceedings of the Ninth International Conference, 1976*. Berkeley: University of California Press. pp 404-421.
- Glover, J.E. and R. Lee. 1984. Geochemistry and provenance of Eocene chert artefacts, southwestern Australia. *Archaeology in Oceania* 19:16-20.
- Gorman, M. 1979. *Island Ecology*. London: Chapman and Hall.
- Gould, R.A. 1977. Ethno-archaeology: Or, where do models come from? In R.V.S. Wright (ed.) *Stone tools as cultural markers: Change, evolution, complexity*. Canberra: Australian Institute of Aboriginal Studies. pp 162-168.
- Gamble, C.S. 1983. Culture and society in the Upper Palaeolithic of Europe. In G.N. Bailey (ed.) *Hunter-Gatherer Economy in Prehistory*. Cambridge: Cambridge University Press. pp 201-211.
- Gamble, C.S. 1986. *The Palaeolithic settlement of Europe*. Cambridge: Cambridge University Press.
- Graham-Campbell, J. and D. Kidd. 1980. *The Vikings*. London: British Museum Press.
- Graves, M.W. and D.J. Addison. 1995. The Polynesian settlement of the Hawaiian Archipelago: Integrating models and methods in archaeological interpretation. *World Archaeology* 26(3):380-399.

- Hails, J.R., A.P. Belpiero and V.A. Gostin. 1983. Holocene sea levels of upper Spencer Gulf, South Australia. In D. Hopely (ed.) *Australian sea levels in the last 15000 years: A review*. (Monograph series 3). Townsville: Department of Geography, James Cook University. pp 48-53.
- Hall, J. and R. Jones. 1990. Palaeoscatology and taphonomic implications at Rocky Cape, northwestern Tasmania. In S. Solomon, I. Davidson and D. Watson (eds) *Problem solving in taphonomy: Archaeological and palaeontological studies from Europe, Africa and Oceania*. Tempus Volume 2. St Lucia: Anthropology Museum, University of Queensland. pp 219-229.
- Hamilton-Smith, E. 1965-66. Birds in Australian caves. *The Emu* 65:152-155.
- Harper, P.C. and F.C. Kinsky. 1978. Southern albatrosses and petrels: An identification guide. Wellington: Victoria University Press.
- Harris, S. 1988. *A catalogue of some cultural relics in the outer Furneaux Islands*. Unpublished report to the Australian National Parks and Wildlife Service.
- Harrison, S.P. and J. Dodson. 1993. Climates of Australia and New Guinea since 18,000 yr B.P. In H.E. Wright Jr, J.E. Kutzbach, T. Webb III, W.F. Ruddiman, F.A. Street-Perrott and P.J. Bartlein (eds) *Global Climates since the Last Glacial Maximum*. Minneapolis: University of Minnesota Press. pp 265-293.
- Hart, C.W.M. and A.R. Pilling. 1960. *Tiwi of North Australia*. New York: Holt, Rinehart and Winston.
- Hayden, B. 1979. *Palaeolithic Reflections*. Canberra: Australian Institute of Aboriginal Studies.
- Hayden, B. 1989. From Chopper to Celt: The evolution of resharpening techniques. In R. Torrence (ed.) *Time, Energy and Stone Tools*. Cambridge: Cambridge University Press. pp 7-16.
- Hayward, J.L., J.G. Galusha and G. Frias. 1993. Analysis of Great Horned Owl pellets with Rhinoceros auklet remains. *The Auk* 110:133-135.
- Head, J., R. Jones and J. Allen. 1983. Calculation of the 'marine reservoir effect' from the dating of shell-charcoal paired samples from an Aboriginal midden on Great Glennie Island, Bass Strait. *Australian Archaeology* 17:99-112.
- Heyerdahl, T. and A. Skjolsvold. 1965. Notes on the archaeology of Pitcairn. In T. Heyerdahl and C.N. Ferndon (eds) *Reports of the Norwegian archaeological expedition to Easter Island and the East Pacific, Volume 2: Miscellaneous papers*. Monograph 24, Part 2. Stockholm: School of American Research and Kon-Tiki Museum. pp 3-8.
- Higham, T. and L. Johnson. 1996. The prehistoric chronology of Raoul Island, the Kermadec Group. *Archaeology in Oceania* 31:207-213.
- Hiscock, P. 1980. Review of R.V.S. Wright (ed.), "Stone tools as cultural markers: Change, evolution, complexity". *Archaeology and Physical Anthropology in Oceania* 15:172-176.
- Hiscock, P. 1981. Comments on the use of chipped stone artefacts as a measure of "intensity of site usage". *Australian Archaeology* 13:30-34.

- Hiscock, P. 1983. Stone tools as cultural markers? The last two decades of stone artefact analysis in Australian archaeology. *Australian Archaeology* 16:48-56.
- Hiscock, P. 1989. Artefact recording in the field. In J. Flood, I. Johnson and S. Sullivan (eds) *Sites and Bytes: Recording Aboriginal places in Australia*. Special Australian Heritage Publications Series No. 8. Canberra: Australian Heritage Commission. pp 20-38.
- Hoffman Jr., C.A. 1967. *Bahama Prehistory: Cultural adaptation to an island environment*. Unpublished PhD Thesis, University of Arizona.
- Hoffman, R. 1988. The contribution of raptorial birds to patterning in small mammal assemblages. *Paleobiology* 14:81-90.
- Hope, G.S. in press. Vegetation and fire response to late Holocene human occupation in island and mainland north west Tasmania. *Quaternary International*
- Hope, G.S. 1978. The Late Pleistocene and Holocene vegetational history of Hunter Island, north-western Tasmania. *Australian Journal of Botany* 26:493-514.
- Hope, G.S. 1989. Climatic implications of timberline changes in Australasia from 30,000 yr BP to present. In T.H. Donnelly and R.J. Wasson (eds) *CLIMANZ 3: Proceedings of the third symposium on the late Quaternary climatic history of Australasia*. Canberra: CSIRO. pp 91-99.
- Hope, J.H. 1969. Biogeography of the mammals on the islands of Bass Strait with an account of variation in the genus *Potorous*. Unpublished PhD Thesis, Monash University, Melbourne.
- Hope, J.H. 1973. Mammals of the Bass Strait Islands. *Proceedings of the Royal Society of Victoria* 85:163-195.
- Horton, D.R. 1978. Preliminary notes on the analysis of Australian coastal middens. *Australian Institute of Aboriginal Studies Newsletter* 10:30-33.
- Irwin, G. 1989. Against, across and down the wind: a case for the systematic exploration of the remote Pacific Islands. *Journal of the Polynesian Society* 98:167-206.
- Irwin, G. 1990. Human colonisation and change in the remote Pacific. *Current Anthropology* 31:90-4.
- Irwin, G. 1992. *The Prehistoric Exploration and Colonisation of the Pacific*. Cambridge: Cambridge University Press.
- Jennings, J.N. 1957. Coastal dune lakes as exemplified from King Island, Tasmania. *Geographical Journal* 123:59-70.
- Jennings, J.N. 1959a. The submarine topography of the Bass Strait. *Proceedings of the Royal Society of Victoria* 71:49-72.
- Jennings, J.N. 1959b. The coastal geomorphology of King Island, Bass Strait, in relation to changes in the relative level of land and sea. *Records of the Queen Victoria Museum* 11:1-39.

- Jones, G. 1984. *The Norse Atlantic Saga: Being the Norse voyagers of discovery, and settlement of Iceland, Greenland, America*. London: Oxford University Press.
- Jones, H.A. and P.J. Davies. 1983. Superficial sediments of the Tasmanian continental shelf and part of Bass Strait. *Bureau of Mineral Resources: Geology and Geophysics Bulletin* 18:1-23.
- Jones, R. 1966. A speculative sequence for northwest Tasmania. *Records of the Queen Victoria Museum* 25:1-12.
- Jones, R. 1968. The geographical background to the arrival of man in Australia and Tasmania. *Archaeology and Physical Anthropology in Oceania* 3:186-215.
- Jones, R. 1971. *Rocky Cape and the problem of the Tasmanians*. Unpublished PhD Thesis, University of Sydney, Sydney.
- Jones, R. 1976. Tasmania: aquatic machines and off-shore islands. In G. de G. Sieveking, I.H. Longworth and K.E Wilson (eds) *Problems in Economic and Social Archaeology*. London: Duckworth. pp 235-263.
- Jones, R. 1977a. Man as an element of a continental fauna: The case of the sundering of the Bassian bridge. In J. Allen, J. Golson and R. Jones (eds) *Sunda and Sahul: Prehistoric studies in Southeast Asia, Melanesia and Australia*. London: Academic Press. pp 317-386.
- Jones, R. 1977b. The Tasmanian Paradox. In R.V.S. Wright (ed.) *Stone Tools as Cultural Markers: Change, evolution and complexity*. Canberra: Australian Institute of Aboriginal Studies. pp 189-204.
- Jones, R. 1978. Why did the Tasmanians stop eating fish? In R. Gould (ed.) *Explorations in Ethnoarchaeology*. Albuquerque: University of New Mexico Press. pp 11-47.
- Jones, R. 1979. A note on the discovery of stone tools and a stratified prehistoric site on King Island, Bass Strait. *Australian Archaeology* 9:87-94.
- Jones, R. 1980. Different strokes for different folks: sites, scale and strategy. In I. Johnson (ed.) *Holier than Thou. Proceedings of the 1978 Kioloa Conference on Australian Prehistory*. Canberra: Department of Prehistory, Australian National University. pp 151-171.
- Jones, R. 1987. Hunting Forbears. In M. Roe (ed.) *The flow of culture: Tasmanian studies*. Occasional Paper No. 4. Canberra: Australian Academy of the Humanities. pp 14-49.
- Jones, R. 1990. From Kakadu to Kutikina: The Southern Continent at 18,000 years ago. In C. Gamble and O. Soffer (eds) *The world at 18,000 BP, Low Latitudes, Volume 2*. London: Unwin Hyman. pp 264-295.
- Jones, R. 1995. Tasmanian archaeology: Establishing the sequences. *Annual Review of Anthropology* 24:423-446.

- Jones, R. and N. White. 1988. Point blank: Stone tool manufacture at the Ngilipitji Quarry, Arnhem Land, 1981. In B. Meehan and R. Jones (eds) *Archaeology with ethnography: An Australian perspective*. Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University. pp 51-87.
- Jouanin, C. 1959. Les emeus de l'expedition Baudin. *L'Oiseau et la Revue Francaise D'Ornithologie* V.XXIX:169-203.
- Kamminga, J. 1977. A functional study of use-polished eloueras. In R.V.S. Wright (ed.) *Stone tools as cultural markers: Change, evolution, complexity*. Canberra: Australian Institute of Aboriginal Studies. pp 205-212.
- Kamminga, J. 1982. *Over the edge: Functional analysis of Australian stone tools*. Occasional Papers in Anthropology No. 12. Brisbane: University of Queensland.
- Kee, S. 1987. *North east Tasmanian archaeological survey: A regional study*. Unpublished report to the Department of Lands, Parks and Wildlife, Tasmania.
- Kee, S. 1991. *Aboriginal archaeological sites in northeast Tasmania*. Occasional Paper No. 28. Hobart: Department of Parks, Wildlife and Heritage.
- Keegan, W.F. and J.M. Diamond. 1987. Colonization of islands by humans: A biogeographical perspective. In M. Schiffer (ed.) *Advances in Archaeological Method and Theory*, Volume 10. New York: Academic Press. pp 49-92.
- Kemp, T.B. 1963. The prehistory of the Tasmanian Aborigines. *Australian Natural History* 14(8):242-247.
- Kershaw, A.P. 1995. Environmental change in Greater Australia. *Antiquity* 69 (Special number 265):656-675.
- Kershaw, A.P., W. Southern, J.M. Williams and L.J. Joyce. 1983. The vegetation record of the Southeastern Highlands of mainland Australia. In J. Chappell and A. Grindrod (eds) *Proceedings of the First CLIMANZ Conference*. Canberra: Department of Biogeography and Geomorphology, Research School of Pacific Studies, Australian National University. p 110.
- Kershaw, R.C. and F.L. Sutherland. 1972. Quaternary geomorphology of Flinders Island. *Records of the Queen Victoria Museum* 43:1-27.
- Kiernan, K., R. Jones and D. Ranson. 1983. New evidence from Fraser Cave for glacial age man in Southwest Tasmania. *Nature* 301:112-113.
- Kirch, P.V. 1984. The Polynesian Outliers: Continuity, change and replacement. In R. Kirk and E. Szathmary (eds.) *Out of Asia: Peopling the Americas and the Pacific*. Canberra: *Journal of Pacific History*. pp 206-221.
- Kirch, P.V. 1997a. Introduction: The environmental history of Oceanic Islands. In P.V. Kirch and T.L. Hunt (eds) *Historical ecology in the Pacific islands: Prehistoric environmental and landscape change*. New Haven: Yale University Press. pp 1-21.

- Kirch, P.V. 1997b. Microcosmic histories: Island perspectives on "global" change. *American Anthropologist* 99:30-42.
- Kirkpatrick, J.B. and K.J.M. Dickinson. 1984. *Tasmanian Vegetation Map, 1:500,000*. Hobart: Forestry Commission.
- Labillardière, J.J.H. 1800. *Voyage in search of La Perouse performed by Order of the Constituent Assembly during the years 1791, 1792, 1793 and 1794*. London: John Stockdale.
- Ladd, P.G., D.W. Orchiston and E.B. Joyce. 1991. Holocene vegetation history of Flinders Island. *New Phytologist* 122:757-767.
- Lambeck, K. and M. Nakada. 1990. Late Pleistocene and Holocene sea level change along the Australian coastline. *Palaeogeography, Palaeoclimatology, Palaeoecology* 89:143-176.
- Lampert, R.J. 1979. *The Great Kartan Mystery*. Unpublished PhD Thesis, Australian National University, Canberra.
- Lampert, R.J. and R. Sim. 1986. Residues on stone tools: Implications for handling and storage. *Australian Archaeology* 22:157-159.
- Laughlin, W.S. and W.G. Reeder (eds.) 1966. Studies in Aleutian-Kodiak prehistory, ecology and anthropology. *Arctic Anthropology* 3(2):1-240.
- Lischka, J.J. 1983. *The Niño as a natural hazard; its role in the development of cultural complexity on the Peruvian coast*. Natural Hazards Research Working Paper 48. Boulder: Department of Anthropology, University of Colorado.
- Lourandos, H. 1970. *Coast and hinterland: The archaeological sites of eastern Tasmania*. Unpublished MA Thesis, Australian National University, Canberra.
- Lourandos, H. 1977. Stone tools, settlement, adaptation: A Tasmanian example. In R.V.S. Wright (ed.) *Stone Tools as Cultural Markers: Change, evolution and complexity*. Canberra: Australian Institute of Aboriginal Studies. pp 219-224.
- Lourandos, H. 1983. 10,000 years in the Tasmanian highlands. *Australian Archaeology* 16:39-47.
- Lourandos, H. 1997. *Continent of Hunter-Gatherers: New Perspectives in Australian Prehistory*. Cambridge: Cambridge University Press.
- Loy, T.H., R. Jones, D.E. Nelson, B. Meehan, J. Vogel, J. Southon and R. Cosgrove. 1990. Accelerator radiocarbon dating of human blood proteins in pigments from late Pleistocene art sites in Australia. *Antiquity* 64:100-116.
- Lyman, R.L. Archaeofaunas and butchery studies: A taphonomic perspective. In M. Schiffer (ed.) *Advances in Archaeological Method and Theory*, Volume 10. New York: Academic Press. 249-338
- MacArthur, R.H. and E.O. Wilson. 1967. *The Theory of Island Biogeography*. Princeton: Princeton University Press.
- Macauley, K. 1764. *The History of St Kilda*. London: T. Becket.

- McCartney, A.P. 1971. A proposed western Aleutian phase in the Near Islands. *Arctic Anthropology* 8(2):92-142.
- McCartney, A.P. 1984. Prehistory of the Aleutian region. In D. Damas (ed.) *Handbook of North American Indians. Volume 5, Arctic*. Washington D.C.: Smithsonian Institute. pp 119-135.
- McCoy, P.C. 1979. Easter Island. In J.D. Jennings (ed.) *The Prehistory of Polynesia*. Cambridge, Mass.: Harvard University Press. pp 135-166.
- McGlone, M.S., A.P. Kershaw and V. Markgraf. 1992. El Niño/Southern Oscillation climatic variability in Australasian and South American paleoenvironmental records. In H.F. Diaz and V. Markgraf (eds) *El Niño: Historical and Paleoclimatic Aspects of the Southern Oscillation*. Cambridge, Cambridge University Press. pp 435-62.
- McGlone, M.S., M.J. Salinger and N.T. Taylor. 1993. Paleovegetation studies of New Zealand's climate since the last glacial maximum. In H.E. Wright, Jr, J.E. Kutzbach, T. Webb III, W.F. Ruddiman, F.A. Street-Perrott and P.J. Bartlein (eds) *Global Climates since the Last Glacial Maximum*. Minneapolis: University of Minnesota Press. pp 294-317.
- Macgregor, D.R. 1960. The island of St Kilda: A survey of its character and occupance. *Scottish Studies* 4:1-48.
- Macintosh, N.W.G. 1949. A survey of possible sea routes available to the Tasmanian Aborigines. *Records of the Queen Victoria Museum* 2:123-144.
- Mackay, D. 1946. The prehistory of Flinders Island. *Present Opinion* (Melbourne University) 1:48-50.
- McNiven, I. 1992. *Excavation of Aboriginal Shell Middens at Hibbs Bay, SW Tasmania*. Unpublished Community Report No. 1, Southern Forests Archaeological Project.
- McNiven, I. 1994. Technological organization and settlement in southwest Tasmania after the glacial maximum. *Antiquity* 68:75-82.
- McNiven, I. 1996. Mid to late Holocene shell deposits at Hibbs Bay, Southwest Tasmania: Implications for Aboriginal occupation and marine resource exploitation. In J. Allen (ed.) *Report of the Southern Forests Archaeological Project. Volume 1: Site descriptions, stratigraphies and chronologies*. Bundoora: School of Archaeology, La Trobe University. pp 219-247.
- Macphail, M.K. 1983a. Structural changes in the highland vegetation of Southeastern Australia during the early to middle Pleistocene. In J. Chappell and A. Grindrod (eds) *Proceedings of the First CLIMANZ Conference*. Canberra: Department of Biogeography and Geomorphology, Research School of Pacific Studies, Australian National University. pp 103-5.
- Macphail, M.K. 1983b. The early to middle Holocene Pomaderris maximum in southeastern Australia. In J. Chappell and A. Grindrod (eds) *Proceedings of the First CLIMANZ Conference*. Canberra: Department of Biogeography and Geomorphology, Research School of Pacific Studies, Australian National University. pp 105-6.

- Macpherson, J.H. and C.J. Gabriel. 1962. *Marine Molluscs of Victoria*. Parkville: Melbourne University Press.
- Major, R.H. (eds) 1872. *Conquest and conversion of the Canarians*. London: The Hakluyt Society.
- Markgraf, V., J.R. Dodson, A.P. Kershaw, M.S. McGlone and N. Nicholls. 1992. Evolution of late Pleistocene and Holocene climates in the circum-South Pacific land areas. *Climate Dynamics* 6: 193-211.
- Marshall, B. 1986. An experimental evaluation of the criteria used to distinguish owl-deposited bone in archaeological cave deposits in Australia. *Australian Archaeology* 22:104-121.
- Marshall, B. and R. Cosgrove. 1990. Tasmanian Devil (*Sarcophilus harrisii*) scat bone: Signature criteria and archaeological implications. *Archaeology in Oceania* 25:102-113.
- Martin, P.S. 1984. Normal extinctions of isolated populations. In M.H. Nitecki (ed.) *Extinctions*. Field Museum of Natural History, Spring Systematic Symposium 1983. Chicago: University of Chicago Press. pp 153-189.
- Mayer, W. 1976. *A field guide to Australian rocks, minerals and gemstones*. Adelaide: Rigby.
- Meston, A.L. 1936. Observations on visits of the Tasmanian Aborigines to the Hunter Islands. *Papers of the Proceedings of the Royal Society of Tasmania* 1935:155-162.
- Micco, H.M. 1971. *King Island and the Sealing Trade 1802*. Canberra: Roebuck.
- Miller, G.H., J.W. Magee and A.J.T. Jull. 1997. Low-latitude glacial cooling in the Southern Hemisphere from amino-acid racemization in emu eggshells. *Nature* 385:241-244.
- Mitchell, S.R. 1949. *Stone-age craftsmen*. Melbourne: Tait.
- Mizutani, H., Y. Kabaya, P.J. Moors, T.W. Spier and G.L. Lyon. 1991. Nitrogen isotope ratios identify deserted seabird colonies. *Auk* 108:960-964.
- Moore, M.W. 1997. *Aboriginal archaeology of dry sclerophyll forest conservation reserves in Eastern Tasmania: A study of Tasmanian lithic technology. Volume 2, Research design and results*. Unpublished report to Forestry Tasmania.
- Morton Boyd, J. 1974. Introduction. In P.A. Jewell, C. Milner and J. Morton Boyd (eds) *Island survivors: The ecology of the Soay sheep of St Kilda*. London: The Athlone Press of the University of London. pp 1-7.
- Mulvaney, D.J. 1975. *The Prehistory of Australia*. Ringwood: Penguin Books.
- Murray-Smith, S. 1987. Bass Strait: Discovery and exploration. In S. Murray-Smith (ed.) *Bass Strait: Australia's Last Frontier*. Sydney: Australian Broadcasting Commission. pp 9-18.

- Murray-Smith, S. 1987. *Mission to the Islands: The missionary voyages of Canon Marcus Brownrigg, 1872 - 1885*. Launceston: Foot and Playsted.
- Murray-Wallace, C.V. and A. Goede. 1990. Aminostratigraphy and electron spin resonance studies of late Quaternary sea level change and coastal neotectonics in Tasmania (Abstract). *Geological Society of Australia* 25:67-68.
- Nakada, M. and K. Lambeck. 1989. Late Pleistocene and Holocene sea-level change in the Australian region and mantle rheology. *Geophysical Journal* 96:497-517.
- Noetling, F. 1911. The antiquity of man in Tasmania. *Papers of the Proceedings of the Royal Society of Tasmania* 102:41-46.
- Norman, R. 1993 *Jewellery and Cultural Identity: A Tasmanian perspective*. Unpublished MA Thesis, Monash University, Melbourne.
- O'Connell, J.F. and J. Allen. 1998. When did humans first arrive in greater Australia and why is it important to know? *Evolutionary Anthropology* 6(4):132-46.
- O'Connor, S. 1980. *Bringing it all back home: Analysis of the vertebrate faunal remains from the Stockyard Site, Hunter Island, Northwest Tasmania*. Unpublished BA (Hons) Thesis, University of New England, Armidale.
- O'Connor, S. 1982. Bi-coastal: An interpretation of a Hunter Island midden. In S. Bowdler (ed.) *Coastal Archaeology in Eastern Australia*. Canberra: Department of Prehistory, Australian National University. pp 133-140.
- O'Connor, S. 1992. The timing and nature of prehistoric island use in northern Australia. *Archaeology in Oceania* 27:49-60.
- O'Connor, S. 1994. A 6,700 BP date for island use in the West Kimberley, Western Australia: New evidence from High Cliffy Island. *Australian Archaeology* 39:102-107.
- O'Connor, S. 1996. Thirty thousand years in the Kimberley: Results of excavation of three rockshelters in the coastal West Kimberley, W.A. In P. Veth and P. Hiscock (eds) *Archaeology of Northern Australia: Regional perspectives*. Tempus Volume 4. St Lucia: Anthropology Museum University of Queensland. pp 26-49.
- Orchiston, D.W. 1979. Prehistoric man in the Bass Strait region. *See Australia* 2:130-135.
- Orchiston, D.W. 1984. Quaternary environmental changes and Aboriginal man in Bass Strait, Australia. *Man and Environment* 8:49-60.
- Orchiston, D.W. and R.C. Glenie. 1978. Residual Holocene populations in Bassaria: Aboriginal man at Palana, northern Flinders Island. *Australian Archaeology* 8:127-141.
- Osborn, A.J. 1977. Strandloopers, mermaids and other fairy tales: Ecological determinants of marine resource utilization - the Peruvian case. In L.R. Binford (ed.) *For Theory Building in Archaeology*. New York: Academic Press. pp 157-205.

- Painter, R. 1992. *A story of decay: The dispersal of spongolite in north-west Tasmania*. Unpublished BA (Hons) Thesis, University of Sydney, Sydney.
- Perlman, S.M. 1980. An optimum diet model, coastal variability and hunter-gatherer behaviour. In M.B. Schiffer (ed.) *Advances in Archaeological Method and Theory* Volume 3. New York: Academic Press. pp 257-310.
- Phillips, D.A.B. (Convenor, Editorial Committee). 1984. *Coastal Invertebrates of Victoria: An atlas of selected species*. Melbourne: Marine Research Group of Victoria in Association with the Museum of Victoria.
- Pinkard, G.T. and L.R. Richley. 1982. *Land systems of Tasmania Region 2*. Hobart: Department of Agriculture.
- Pirazzoli, P.A. 1991. *World atlas of Holocene sea-level changes*. Amsterdam: Elsevier.
- Pizzey, G. 1980. *A field guide to the birds of Australia*. Sydney: William Collins.
- Playford, P.E. 1988. *Guidebook to the geology of Rottnest Island*. Perth: Geological Society of Australia, Western Australian Division.
- Plomley, N.J.B. (ed.) 1966. *Friendly Mission: The Tasmanian journals and papers of George Augustus Robinson 1829 - 34*. Hobart: Tasmanian Historical Research Association.
- Plomley, N.J.B. 1983. *The Baudin expedition and the Tasmanian Aborigines, 1802*. Hobart: Blubber Head Press.
- Plomley, N.J. B. 1987. *Weep in Silence: A history of the Flinders Island Aboriginal settlement*. Hobart: Blubber Head Press.
- Porch, N. and J. Allen. 1995. Tasmania: Archaeological and palaeo-ecological perspectives. *Antiquity* 69 (Special Number 265):714-732.
- Pratt, H.D., P.L. Bruner and D.G. Berrett. 1987. *A Field Guide to the Birds of Hawaii and the Tropical Pacific*. Princeton: Princeton University Press.
- Rackham, J. 1994. *Animal Bones*. London: British Museum Press.
- Richards, R. 1972. A population distribution map of the Morioris of the Chatham Islands, circa 1790. *Journal of the Polynesian Society* 81:350-374.
- Ross, A. 1985. Archaeological evidence for population change in the middle to late Holocene in southeastern Australia. *Archaeology in Oceania* 16:145-155.
- Ross, A., T. Donnelly and R. Wasson. 1992. The peopling of the arid zone: Human-environment interactions. In J. Dodson (ed.) *The naive lands: Prehistory and environmental change in Australia and the Southwest Pacific*. Melbourne: Longman Cheshire. pp 76-114.
- Roth, H.L. 1899. *The Aborigines of Tasmania*. London: Halifax.
- Rounsevell, D.E., R.J. Taylor and G.J. Hocking. 1991. Distribution records of native terrestrial mammals in Tasmania. *Australian Wildlife Research* 18:699-717.

- Rowland, M.J. 1980. The Keppel Islands - preliminary investigations. *Australian Archaeology* 11:1-17.
- Rowland, M.J. 1981. Radiocarbon dates for a shell fish hook and disc from Mazie Bay, North Keppel Island. *Australian Archaeology* 12:63-69.
- Rowland, M.J. 1982. Further radiocarbon dates from the Keppel Islands. *Australian Archaeology* 15:43-48.
- Rowland, M.J. 1983. Aborigines and environment in Holocene Australia: changing paradigms. *Australian Aboriginal Studies* (2):39-50.
- Rowland, M.J. 1985. Further radiocarbon dates from Mazie Bay, North Keppel Island. *Australian Archaeology* 2:62-67.
- Rowland, M.J. 1986. The Whitsunday Islands: Initial historical and archaeological observations and implications for future research. *Queensland Archaeological Research* 3:72-87.
- Rowland, M.J. 1996. Prehistoric archaeology of the Great Barrier Reef Province - Retrospect and Prospect. In P. Veth and P. Hiscock (eds) *Archaeology of Northern Australia: Regional perspectives*. Tempus Volume 4. St Lucia: Anthropology Museum, The University of Queensland. pp 191-212.
- Ryan, L. 1996. *The Aboriginal Tasmanians*. St Leonards, NSW: Allen and Unwin.
- Sadek-Kooros, H. 1975. Intentional fracturing of bone: Description of criteria. In A.T. Classon (ed.) *Archaeozoological Studies*. New York: North Holland Publishing Company. pp 139-150.
- Sagona, A.G. (ed). 1994. *Bruising the Red Earth: Ochre Mining and Ritual in Aboriginal Tasmania*. Melbourne: Melbourne University Press.
- Sauer, J.D. 1969. Oceanic Islands and biogeographical theory: A review. *The Geographical Review* 59:582-593.
- Sauer, J.D. 1977. Biogeographical theory and cultural analogies. *World Archaeology* 8:320-331.
- Schrire, C. 1982. *The Alligator Rivers: Prehistory and ecology in Western Arnhem Land*. Terra Australis 7. Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University.
- Shaffer, M. 1981. Minimum population sizes for species conservation. *BioScience* 31:131-134.
- Shaffer, M. 1987. Minimum viable populations: Coping with uncertainties. In M.E. Soule (ed.) *Viable populations for conservation*. Cambridge: Cambridge University Press. pp 69-86.
- Sigleo, W.R. and E.A. Colhoun. 1975. Glacial age Man in Southeastern Tasmania: Evidence from the Old Beach Site. *Search* 6(7):300-302.
- Sim, R. 1988. *King Island visited: An archaeological survey*. Unpublished BA (Hons) Thesis, La Trobe University, Melbourne.

- Sim, R. 1989. *Flinders Island prehistoric land use survey*. Unpublished report to the National Estate Grants Programme on behalf of the Tasmanian Archaeological Society.
- Sim, R. 1990. Prehistoric sites on King Island in the Bass Strait: Results of an archaeological survey. *Australian Archaeology* 31:34-43.
- Sim, R. 1991. *Prehistoric archaeological investigations on King and Flinders Island, Bass Strait, Tasmania*. Unpublished MA Thesis, Australian National University, Canberra.
- Sim, R. 1994. Prehistoric human occupation in the King and Furneaux Island regions, Bass Strait. In M. Sullivan, S. Brockwell and A. Webb (eds) *Archaeology in the North. Proceedings of the 1993 Australian Archaeological Association Conference*. Darwin: NARU Publications, Australian National University. pp 358-374.
- Sim, R. 1996. *Archaeological potential zoning testing project*. Unpublished report to Forestry Tasmania.
- Sim, R. and P. Gait. 1992. *Southern Furneaux Islands archaeological survey: Stage Two of the prehistoric and historic site recording project in the Furneaux Group, Bass Strait, Tasmania*. Unpublished Tasmanian Environmental Centre report for the National Estate Grants Programme.
- Sim, R. and I. Stuart. 1991. *Outer Furneaux Islands archaeological survey: A prehistoric and historic archaeological site recording project in the Furneaux Group, Bass Strait, Tasmania, 1991*. Unpublished Tasmanian Environmental Centre report for the National Estate Grants Programme.
- Sim, R. and A.G. Thorne. 1990. Pleistocene human remains from King Island, Bass Strait. *Australian Archaeology* 31:44-51.
- Simmons, A.H. 1991. Humans, island colonisation and Pleistocene extinctions in the Mediterranean: The view from Akrotiri Aetokremnos, Cyprus. *Antiquity* 65:857-869.
- Skinner, H.D. 1923. *The Morioris of Chatham Islands*. Memoirs of the Bernice P. Bishop Museum 9(1).
- Skinner, H.D. 1974. *Comparatively speaking: Studies in Pacific material cultural 1921 - 1972*. Dunedin: University of Otago Press.
- Skinner, H.D. and W. Baucke. 1928. *The Morioris*. Memoirs of the Bernice P. Bishop Museum 9(5).
- Skira, I.J. 1993. *Tasmanian Aborigines and Muttonbirding: A Historical Examination*. Unpublished PhD Thesis, University of Tasmania, Hobart.
- Skira, I.J. and G. David. 1987. The short-tailed shearwater colonies of King Island. *The Tasmanian Naturalist* 90:1-6.
- Smith, A. 1995. *Archaeological survey methods for forested environments: An assessment*. Unpublished report to Forestry Tasmania and the Australian Heritage Commission.

- Smith, G.C. 1984. An analysis of prey remnants from osprey *Pandion haliaetus* and white-bellied sea-eagle *Haliaetus leucogaster* feeding roosts. *The Emu* 85:198-200.
- Specht, J. 1984. *The prehistoric archaeology of Norfolk Island*. Pacific Anthropological Records 34. Honolulu: BP Bishop Museum.
- Steadman, D.W. 1989. Extinction of birds in eastern Polynesia: A review of the record and comparisons with other Pacific Island groups. *Journal of Archaeological Research* 16:177-205.
- Steadman, D.W. 1995. Prehistoric extinctions of Pacific Island birds: Biodiversity meets zooarchaeology. *Science* 267:1123-1131.
- Steadman, D.W. 1997. Extinction of Polynesian birds: Reciprocal impacts of birds and people. In P.V. Kirch and T.L. Hunt (eds) *Historical ecology in the Pacific Islands: Prehistoric environmental and landscape change*. New Haven: Yale University Press. pp 51-79.
- Stern, N. and J. Allen. 1996. Pallawa Trounta Shelter. In J. Allen (ed.) *Report of the Southern Forests Archaeological Project. Volume 1: Site descriptions, stratigraphies and chronologies*. Bundoora: School of Archaeology, La Trobe University. pp 169-193.
- Steel, T. 1975. *The life and death of St Kilda*. Glasgow: Fontana/Collins.
- Stockton, J. 1982. *The prehistoric geography of north-west Tasmania*. Unpublished PhD Thesis, Australian National University, Canberra.
- Strahan, R. 1983. *The Australian Museum complete book of Australian Mammals*. Sydney: Angus and Robertson.
- Stuiver, M. and G.W. Pearson. 1993. *Radiocarbon* 35:1-23.
- Stuiver, M. and P.J. Reimer. 1993a. *Radiocarbon* 35:215-230.
- Stuiver, M. and P.J. Reimer. 1993b. University of Washington Quaternary Isotope Laboratory Radiocarbon Calibration Program Rev 3.0.3
- Sullivan, M.E. 1982. Exploitation of offshore islands along the New South Wales coastline. *Australian Archaeology* 15:8-19.
- Sutherland, F.L. 1972. The classification, distribution, analysis and source of materials in flaked stone implements of Tasmanian Aborigines. *Records of the Queen Victoria Museum* 42:1-46.
- Sutton, D.G. 1982. The Chatham Islands. In N.J. Prickett (ed.) *The first thousand years: Regional perspectives in New Zealand archaeology*. Palmerston North: Dunmore Press. pp 160-178.
- Sutton, D.G. and Y.M. Marshall. 1980. Coastal hunting in the Subantarctic zone. *New Zealand Journal of Archaeology* 2:25-49.
- Terrell, J. 1976. Island biogeography and man in Melanesia. *Archaeology and Physical Anthropology in Oceania* 11:1-17.

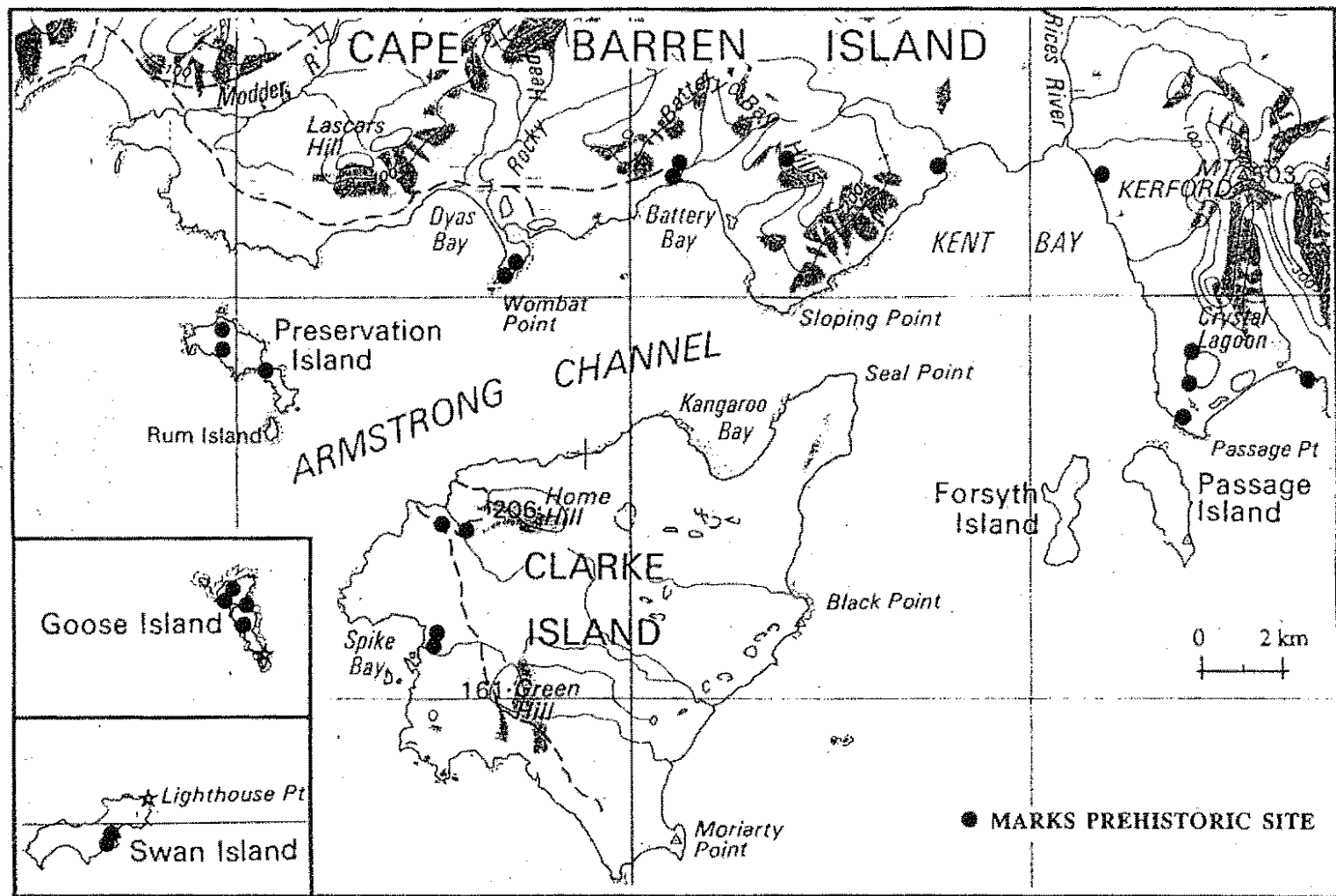
- Terrell, J. 1977. Biology, biogeography and man. *World Archaeology* 8:237-248.
- Terrell, J.E. 1986. *Prehistory in the Pacific Islands*. Cambridge: Cambridge University Press.
- Thorne, A.G. and R. Raymond. 1989. *Man on the Rim: the Peopling of the Pacific*. North Ryde: Angus and Robertson.
- Thom, B.G. 1992. Dynamics of environment and people in the forested crescents of temperate Australia. In J. Dodson (ed.) *The Naïve Lands*. Melbourne: Longman Cheshire. pp 9-12.
- Thomas, I. 1992. *The Holocene archaeology and palaeoecology of northeastern Tasmania*. Unpublished PhD Thesis, University of Tasmania, Hobart.
- Thomas, I. and D. Van Eckart. 1989. *A survey for Aboriginal sites in the Rebecca Creek State Forest, Northwestern Tasmania*. Unpublished report to Tasmanian Forestry Commission.
- Tindale, N.B. 1941. The antiquity of man in Australia. *Australian Journal of Science* 3:144-147.
- Tindale, N.B. 1977. Further report on the Kaiadilt people of Bentinck Island, Gulf of Carpentaria Queensland. In J. Allen, J. Golson and R. Jones (eds) *Sunda and Sahul: Prehistoric studies in Southeast Asia, Melanesia and Australia*. London: Academic Press. pp 247-273.
- van de Geer, G., E.A. Colhoun and W.G. Mook. 1986. Stratigraphy, pollen analysis and palaeoclimatic interpretation of Mowbray and Broadmeadows swamps, north western Tasmania. *Australian Geographer* 17:121-33.
- Vanderwal, R.L. 1977. The Shag Bay Rockshelter, Tasmania. *The Artefact* 2:161-170.
- Vanderwal, R.L. 1978. Adaptive technology in South West Tasmania. *Australian Archaeology* 8:107-127.
- Vanderwal, R.L. and D. Horton. 1984. *Coastal southwest Tasmania: The prehistory of Louisa Bay and Maatsuyker Island*. Terra Australis 9. Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University.
- Van Tilburg, J.A. 1994. *Easter Island: Archaeology, ecology and culture*. London: British Museum Press.
- Veth, P. 1993. The Aboriginal occupation of the Montebello Islands, northwest Australia. *Australian Aboriginal Studies* 2:39-50.
- Walters, I. 1981. Why did the Tasmanians stop eating fish: a theoretical consideration. *The Artefact* 6:71-7.
- Wasson, R.J. 1986. Geomorphology and Quaternary history of the Australian continental dunefields. *Geographical Review of Japan* 59:55-67.

- Weisler, M.I. 1993. *Long distance interaction in prehistoric Polynesia: Three case studies*. Unpublished PhD Thesis, University of California, Berkeley.
- Weisler, M.I. 1994. The settlement of marginal Polynesia: New evidence from Henderson Island. *Journal of Field Archaeology* 21:83-102.
- Weisler, M.I. and R.H. Gargett. 1993. Pacific island avian extinctions: The taphonomy of human predation. *Archaeology in Oceania* 28:85-93.
- West, D. and R. Sim. 1995. Aboriginal muttonbird exploitation: An analysis of muttonbird (yolla) bone from the Beeton rockshelter site, Badger Island, Bass Strait. *Australian Aboriginal Studies* 2:15-33.
- White, J.P. and J.F. O'Connell. 1982. *A prehistory of Australia, New Guinea and Sahul*. Sydney: Academic Press.
- Wilson, D.J. 1981. Of maize and men: A critique of the maritime hypothesis of state origins on the coast of Peru. *American Anthropologist* 83:93-120.
- Williamson, K. and J.M. Boyd. 1960. *St Kilda summer*. London: Hutchinson.
- Wood-Jones, F. 1934. *Australia's vanishing race*. Sydney: Angus and Robertson.
- Wragg, G.M. and M.I. Weisler 1994. Extinctions and new records of birds from Henderson Island, Pitcairn Group, South Pacific Ocean. *Notornis* 41:61-70.
- Yesner, D.R. 1980. Maritime Hunter-gatherers: Ecology and prehistory. *Current Anthropology* 21:727-750.
- Yesner, D.R. 1990. Fuegians and other hunter-gatherers of the Subantarctic region. In B. Meehan and N. White (eds) *Hunter-gatherer Demography Past and Present*. Oceania Monograph 39. Sydney: University of Sydney. pp 1-22.

APPENDIX I

Survey island maps with sites





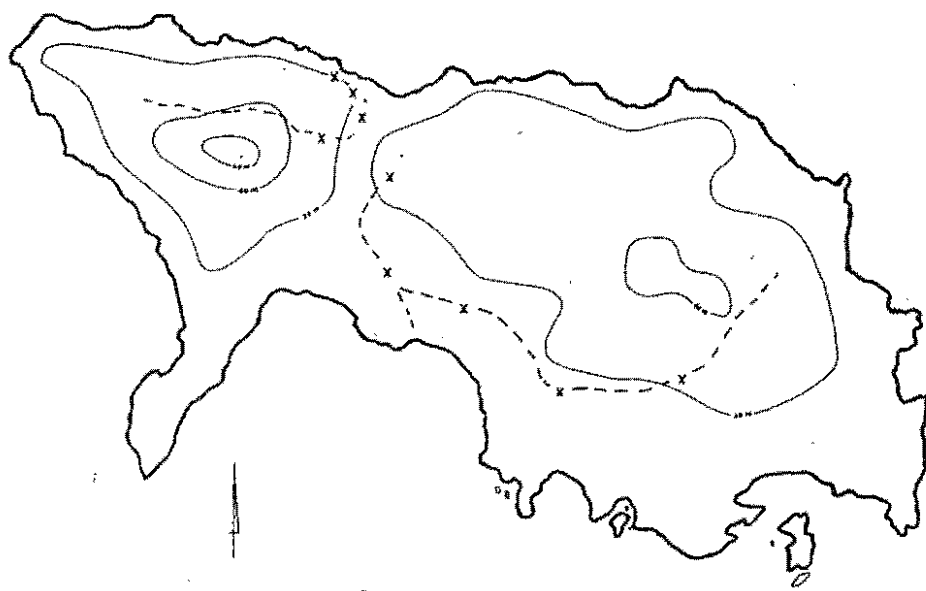
Prehistoric Site Locations



VANSITTART (GUN CARRIAGE) IS.
 X PREHISTORIC SITE (STONE ARTEFACTS)

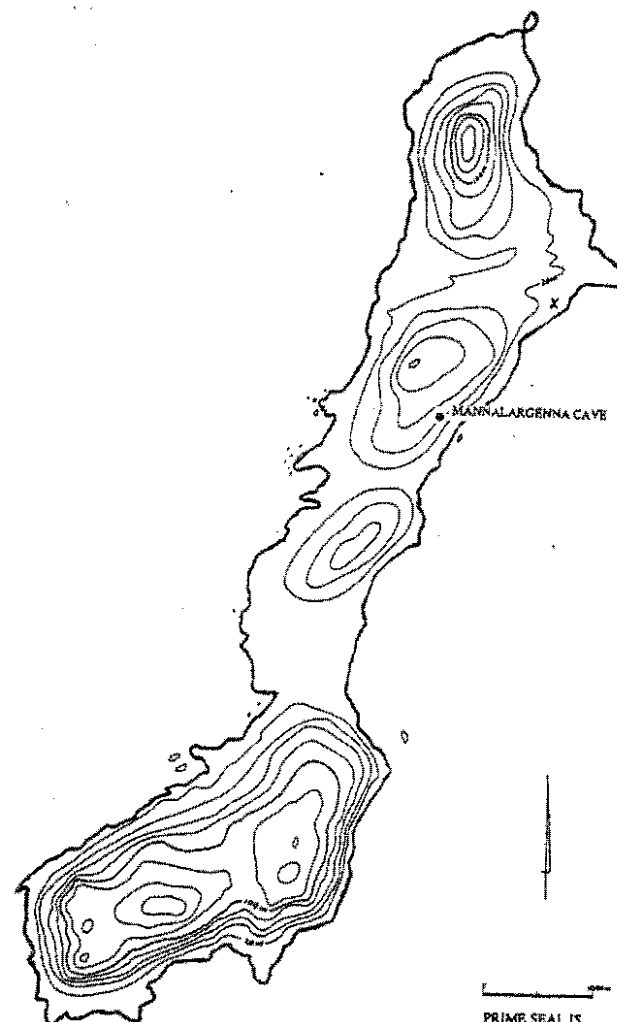


ANDERSON (WOODY) IS.
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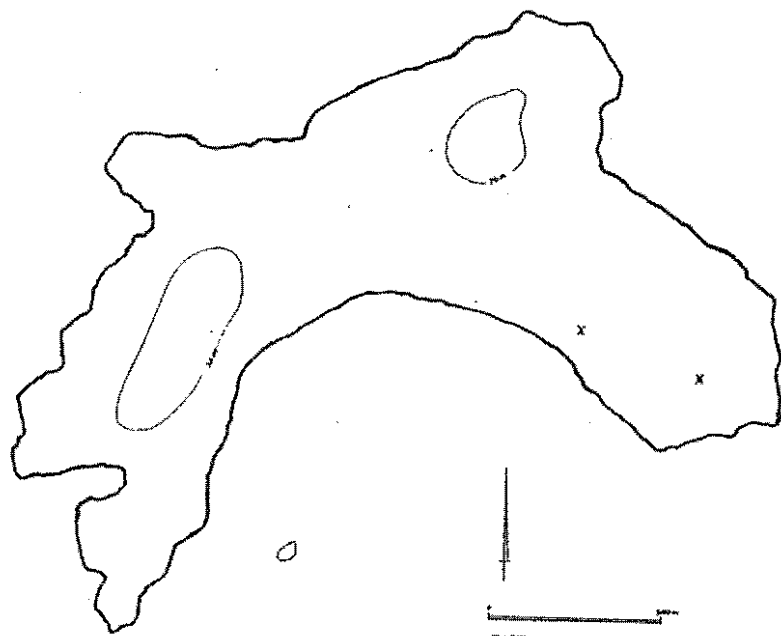
BIG INOO IS.

X PREHISTORIC SITE (STONE ARTEFACT/S)

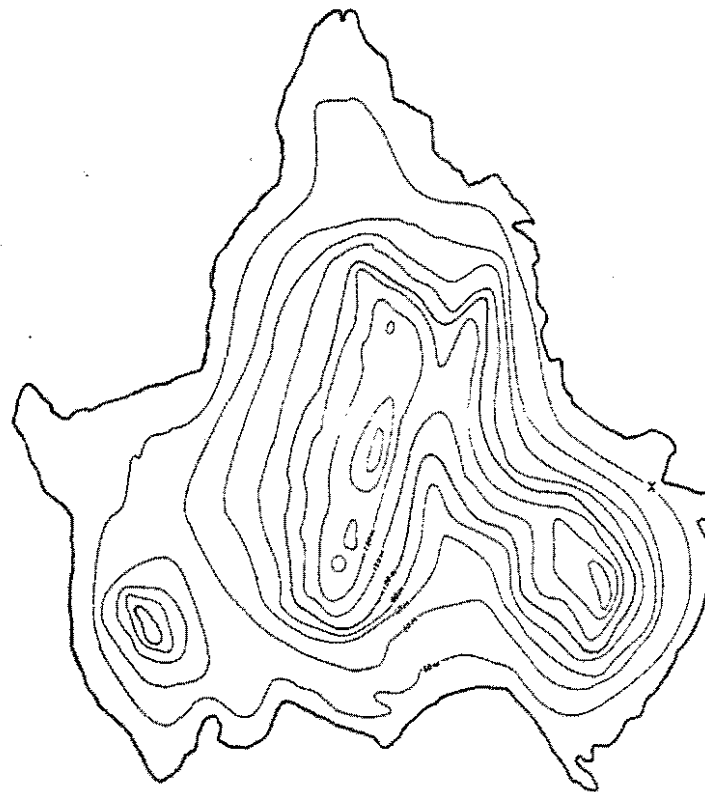


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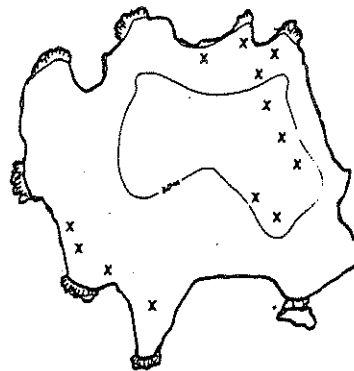
X PREHISTORIC SITE (STONE ARTEFACT/S)



EAST KANOAROO IS.
X PREHISTORIC SITE (STONE ARTEFACTS)



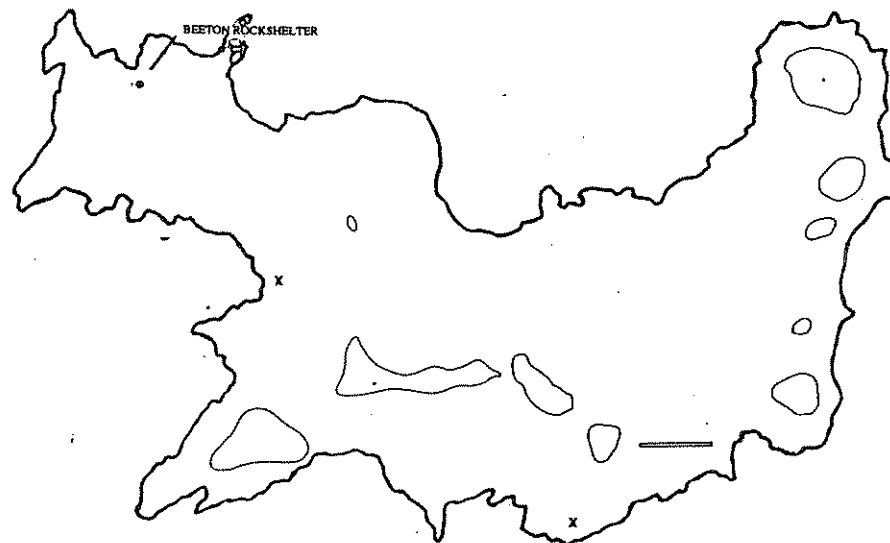
BABEL IS.
X PREHISTORIC SITE (STONE ARTEFACTS)



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

LITTLE DOG IS.

X PREHISTORIC SITE (STONE ARTEFACT/S)



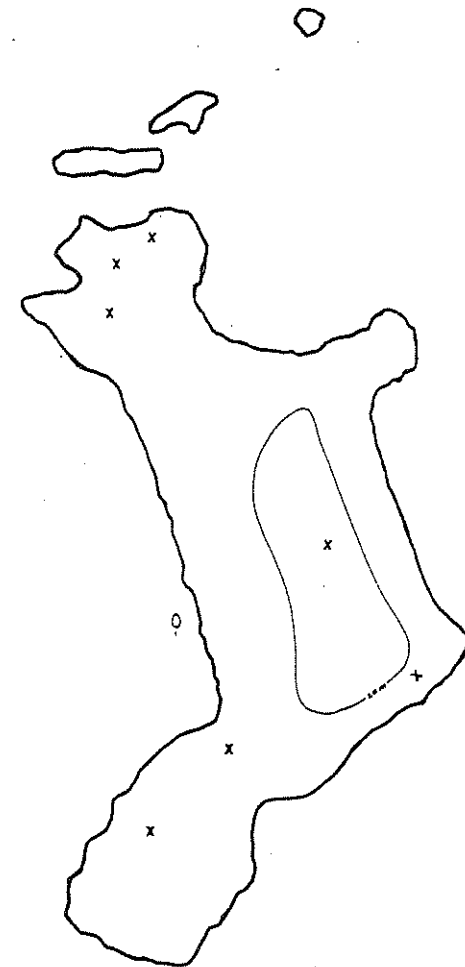
BETON ROCKSHELTER

X PREHISTORIC SITE (STONE ARTEFACT/S)

• PREHISTORIC SITE (ROCKSHELTER)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

BADGER IS.



BIG GREEN IS.

X PREHISTORIC SITE (STONE ARTEFACT/S)

APPENDIX II

Beeton Rockshelter: Emu egg D/L

Dates emu eggshell

MC-F1-SP27	Emu	AAL-6727	0.086	23,015±1210	AA-13040
BSD9-10	Emu	AAL-7478	0.103	23,340±1280	AA-15143

The 13C values have not been run for these, but the average in about 40 other eggshell is -10 per mil with a std dev of about 2 per mil, so the correction is about 160 yr with a 40 yr uncertainty. The given date is too old as the lab assumed the delta 13C was 0 per mil.

Sample ID	Lab-ID				
BI-D9-SP6	AAL-6717	All burnt			
BI-D9-SP7	AAL-6718	0.088			
BSD9-10	AAL-7478	0.103	(23,340±1280 BP AA-15143)		
BSD9-9	AAL-7507	0.101	0.102		
BSD9-6	AAL-7510	0.109	0.124	0.102	<u>0.122</u>
MC-F1-SP23SE	AAL-6724	0.080	0.078		
MC-F1-SP33	AAL-6725	0.091	0.089		
MC-F1-SP23NE	AAL-6726	0.081			
MC-F1-SP27	AAL-6727	0.084	0.086	(23,015±1210 BP AA-13040)	
MC-F1-SP23NW	AAL-6728	0.342			
MC-F1-SP31	AAL-6729	0.081			
MC-F1-SP23SE	AAL-6730	0.128	0.191		

From the BS D9 series: 0.102 ± 0.01 should be about 23 ka. 0.123 or so should be about 29 ka.

From the MC series, all of the samples at about 0.09 should be about 23 ka.

The one sample at 0.32 should be about 100 ka, but I think this one has been burned. The sample at 0.128 works out to be 35 ka, and the 0.191 sample is about 60 ka, assuming that there has been no burning. The fact that none of these samples have the same ratio suggests to me that all three have been burnt.

APPENDIX III

Beeton Rockshelter: sediment analysis procedure

Sediment analysis.

Textural analysis procedure

1. Select representative sub-sample ^a 60 gm
2. Add sample to 800 ml distilled water + dispersant (10 mls 10% Na-Tripoly-phosphate + 5 mls 5% NaOH)
3. Mix for 60 mins with a paddle stirrer
4. Wet sieve whole sample through 63 μm sieve
 - Sand fraction ($>63 \mu\text{m}$) in tared beaker to oven to dry
 - Mud fraction ($<63 \mu\text{m}$) returned to paddle stirrer mixer
5. Sub-sample aliquot of mud fraction was analysed in the HORIBA CAPA-300 Particle analyser.
6. Mud fraction acidified, and placed in tared beaker in oven to dry.
7. Sands were dry sieved for 12 minutes on a sieve shaker in a nest of sieves at 0.5 phi intervals from -1.5 phi to 4 phi (2.8mm to 63 μm) .
8. Sand and Mud fractions were weighed and total sample weight calculated. The pan fraction (less than 63 μm) weight, from the nest of sieves, was added to the mud.
9. Percentage weights for gravel, sand, silt and clay grades calculated.
10. Results plotted on Sand-Silt-Clay triangular diagram of Folk (1968) and sediment textural types determined.

APPENDIX IV

Beeton Rockshelter: Shellfish database - filemaker

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-U7	1	3	all shell			0.00						
BS-U7	1	7	all shell			0.00						
BS-U7	2	3	all shell			0.00						
BS-U7	2	7	all shell			0.00						
BS-U7	3	3	all shell			0.44						
BS-U7	3	7	all shell			0.00						
BS-U7	4	3	all shell			0.00						
BS-U7	4	7	all shell			0.00						
BS-U7	5	3	all shell			2.65						
BS-U7	5	7	all shell			2.23						
BS-U7	6	3	all shell			2.92						
BS-U7	6	7	all shell			6.52						
BS-U7	7	3	all shell			1.60						
BS-U7	7	7	all shell			11.69						
BS-U7	8	3	all shell			2.34						
BS-U7	8	7	all shell			32.67						
BS-U7	9	3	all shell			0.00						
BS-U7	9	7	all shell			4.40						
BS-U7	10	3	all shell			0.76						
BS-U7	10	7	all shell			16.01						
BS-U7	11	3	all shell			1.29						
BS-U7	11	7	all shell			14.51						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-U7	12	3	all shell			1.01						
BS-U7	12	7	all shell			10.92						
BS-U7	13	3	all shell			1.58						
BS-U7	13	7	all shell			0.00						
BS-U7	14	3	all shell			1.18						
BS-U7	14	7	all shell			0.00						
BS-U7	15	3	all shell			0.00						
BS-U7	15	7	all shell			0.00						
BS-l6	1	3	all shell			0.00						
BS-l6	1	7	all shell			0.00						
BS-l6	2	3	all shell			0.57						
BS-l6	2	7	all shell			0.00						
BS-l6	3	3	all shell			0.24						
BS-l6	3	7	all shell			2.39						
BS-l6	4	3	all shell			3.66						
BS-l6	4	7	all shell			3.72						
BS-l6	5	3	all shell			2.66						
BS-l6	5	7	all shell			1.96						
BS-l6	6	3	all shell			2.00						
BS-l6	6	7	all shell			9.29						
BS-l6	7	3	all shell			1.55						
BS-l6	7	7	all shell			1.16						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-16	8	3	all shell			1.93						
BS-16	8	7	all shell			48.01						
BS-16	9	3	all shell			2.05						
BS-16	9	7	all shell			21.92						
BS-16	10	3	all shell			1.43						
BS-16	10	7	all shell			8.61						
BS-16	11	3	all shell			0.56						
BS-16	11	7	all shell			12.93						
BS-16	12	3	all shell			0.84						
BS-16	12	7	all shell			0.00						
BS-16	13	3	all shell			0.49						
BS-16	13	7	all shell			0.00						
BS-16	14	3	all shell			1.50						
BS-16	14	7	all shell			1.37						
BS-16	15	3	all shell			1.20						
BS-16	15	7	all shell			0.90						
BS-16	16	3	all shell			1.01						
BS-16	16	7	all shell			0.41						
BS-16	17	3	all shell			0.32						
BS-16	17	7	all shell			0.66						
BS-16	18	3	all shell			0.64						
BS-16	18	7	all shell			0.44						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-I6	19	3	all shell			0.00						
BS-I6	19	7	all shell			0.00						
BS-D9	1	3	UNIDENTIFIABLE			0.02						
BS-D9	2	3	OTHER	Potamididae		0.02	1					
BS-D9	2	3	MUSSEL		<i>Hormomya erosa</i>	0.42						
BS-D9	2	3	UNIDENTIFIABLE			1.71						
BS-D9	2	3	WHELK			0.72						
BS-D9	2	7	WARRENER		<i>Subninfella undulata</i>	0.11						
BS-D9	3	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.15	3					
BS-D9	3	3	PERIWINKLE		<i>A. concamerata</i>	0.34	2					
BS-D9	3	3	OTHER	Cerithiidae		0.01			1			
BS-D9	3	3	MUSSEL		<i>Hormomya erosa</i>	0.49						
BS-D9	3	3	WARRENER		<i>Subninfella undulata</i>	0.33		3				
BS-D9	3	3	UNIDENTIFIABLE			4.61						
BS-D9	3	7	LIMPET		<i>Cellana solida</i>	1.08	2					
BS-D9	3	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.12	1					
BS-D9	3	7	MUSSEL		<i>Hormomya erosa</i>	0.48						
BS-D9	3	7	WHELK			0.54						
BS-D9	4	3	WHELK			4.26				1		
BS-D9	4	3	LIMPET		<i>Cellana solida</i>	6.12						
BS-D9	4	3	OTHER		sea urchin	0.01						
BS-D9	4	3	OTHER	Cerithiidae		1.11			20			

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	4	3	MUSSEL		<i>Hormomya erosa</i>	7.13					3	
BS-D9	4	3	UNIDENTIFIABLE			51.45						
BS-D9	4	3	WARRENER		<i>Subninella undulata</i>	7.34		30				
BS-D9	4	3	WARRENER		<i>Subninella undulata</i>	4.57	5					
BS-D9	4	3	PERIWINKLE		<i>A. concamerata</i>	10.55	29	12				
BS-D9	4	3	PERIWINKLE		<i>Austrocochlea constricta</i>	6.13	26	2				
BS-D9	4	7	WHELK		<i>Dicathais textilosa</i>	14.89	3					
BS-D9	4	7	WHELK		<i>Pleuroploca australasia</i>	9.21						
BS-D9	4	7	WHELK			5.09				1		
BS-D9	4	7	LIMPET		<i>Cellana solida</i>	63.02	40	6	2			
BS-D9	4	7	OTHER	Hipponyx		0.51			2			
BS-D9	4	7	OTHER	Gastropod		0.35			1			
BS-D9	4	7	OTHER	Bivalves		1.85			2		1	
BS-D9	4	7	OTHER	Gastropod		0.60			3			
BS-D9	4	7	MUSSEL		<i>Hormomya erosa</i>	18.54						3
BS-D9	4	7	UNIDENTIFIABLE			5.37						
BS-D9	4	7	WARRENER		<i>Subninella undulata</i>	4.58		13				
BS-D9	4	7	WARRENER		<i>Subninella undulata</i>	12.62	7					
BS-D9	4	7	OTHER		<i>Bembicium nanum</i>	0.91			1			
BS-D9	4	7	PERIWINKLE		<i>A. concamerata</i>	5.98	3	5				
BS-D9	4	7	PERIWINKLE		<i>Austrocochlea constricta</i>	3.00	5	3				
BS-D9	5	3	PERIWINKLE		<i>A. concamerata</i>	20.04	77	17				

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	5	3	PERIWINKLE		<i>Austrocochlea constricta</i>	4.31	19	9				
BS-D9	5	3	MUSSEL		<i>Hormomya erosa</i>	7.10					1	
BS-D9	5	3	OTHER	Potamididae		0.19	6					
BS-D9	5	3	OTHER	Littorinidae		0.02	1					
BS-D9	5	3	OTHER	Cerithiidae		0.78			15			
BS-D9	5	3	ABALONE		<i>Haliotis spp.</i>	0.04						
BS-D9	5	3	UNIDENTIFIABLE			53.92						
BS-D9	5	3	WARRENER		<i>Subnivalia undulata</i>	5.08	8					
BS-D9	5	3	WARRENER		<i>Subnivalia undulata</i>	8.66		45				
BS-D9	5	3	WHELK			1.58						
BS-D9	5	3	LIMPET		<i>Cellana solida</i>	4.41						
BS-D9	5	7	PERIWINKLE		<i>A. concamerata</i>	12.54	5	14				
BS-D9	5	7	PERIWINKLE		<i>Austrocochlea constricta</i>	6.82	7	6				
BS-D9	5	7	MUSSEL		<i>Hormomya erosa</i>	25.63					10	10
BS-D9	5	7	ABALONE		<i>Haliotis spp.</i>	0.60						
BS-D9	5	7	OTHER	Sepiidae	cuttle-fish	0.05						
BS-D9	5	7	UNIDENTIFIABLE			3.63						
BS-D9	5	7	OTHER	Cerithiidae		0.30			2			
BS-D9	5	7	OTHER	Bivalves		0.12	3					
BS-D9	5	7	OTHER	Limpet <10mm		0.05	1					
BS-D9	5	7	OTHER	Gastropod		0.02						
BS-D9	5	7	OTHER	Muricidae		0.02	1					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	5	7	OTHER	Littorinidae		0.03	1					
BS-D9	5	7	WARRENER		<i>Subnirrella undulata</i>	13.72		41				
BS-D9	5	7	WARRENER		<i>Subnirrella undulata</i>	19.60	14					
BS-D9	5	7	WHELK		<i>Dicathais textilosa</i>	25.31	3			6		
BS-D9	5	7	WHELK			8.05						
BS-D9	5	7	LIMPET		<i>Patellanax peroni</i>	6.89			1			
BS-D9	5	7	LIMPET		<i>Cellana solida</i>	174.23	55	18	10			
BS-D9	6	3	PERIWINKLE		<i>Austrocochlea constricta</i>	6.88	6	7				
BS-D9	6	3	PERIWINKLE		<i>A. concamerata</i>	3.90	14	11				
BS-D9	6	3	UNIDENTIFIABLE			17.52						
BS-D9	6	3	LIMPET		<i>Cellana solida</i>	4.80						
BS-D9	6	3	WHELK			12.86						
BS-D9	6	3	WARRENER		<i>Subnirrella undulata</i>	4.35		18				
BS-D9	6	3	WARRENER		<i>Subnirrella undulata</i>	4.81	7					
BS-D9	6	3	MUSSEL		<i>Hormomya erosa</i>	4.29					1	1
BS-D9	6	3	CHITON		<i>Chiton</i>	0.31						
BS-D9	6	3	OTHER	Cerithiidae		0.95			15			
BS-D9	6	7	PERIWINKLE		<i>A. concamerata</i>	20.02	3	23				
BS-D9	6	7	PERIWINKLE		<i>Austrocochlea constricta</i>	7.92	12	5				
BS-D9	6	7	UNIDENTIFIABLE			1.44						
BS-D9	6	7	LIMPET		<i>Cellana solida</i>	91.87	37	8	6			
BS-D9	6	7	WHELK			0.86						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	6	7	WHELK		<i>Pleuroploca australasia</i>	1.23						
BS-D9	6	7	WARRENER		<i>Subninella undulata</i>	12.17		32				
BS-D9	6	7	WARRENER		<i>Subninella undulata</i>	24.17	10					
BS-D9	6	7	MUSSEL		<i>Mytilus planulatus</i>	0.04						
BS-D9	6	7	MUSSEL		<i>Hormomya erosa</i>	21.31					4	7
BS-D9	6	7	OTHER	Sepiidae	cuttle-fish	0.24				1		
BS-D9	6	7	OTHER	Cerithiidae		0.13			2			
BS-D9	6	7	OTHER	Hipponyx		1.26	1					
BS-D9	6	7	OTHER	Bivalves		0.15	1					
BS-D9	6	7	OTHER	Limpet <10mm		0.08	1					
BS-D9	6	7	OTHER	Gastropod		0.09	1					
BS-D9	7	3	OTHER	Cerithiidae		0.95			18			
BS-D9	7	3	MUSSEL		<i>Hormomya erosa</i>	4.67					1	
BS-D9	7	3	LIMPET		<i>Cellana solida</i>	4.81	2					
BS-D9	7	3	PERIWINKLE		<i>Austrocochlea constricta</i>	4.04	10	3				
BS-D9	7	3	PERIWINKLE		<i>A. concamerata</i>	8.12	16	6				
BS-D9	7	3	WHELK			2.86						
BS-D9	7	3	WARRENER		<i>Subninella undulata</i>	6.64	6					
BS-D9	7	3	WARRENER		<i>Subninella undulata</i>	5.13		18				
BS-D9	7	3	OTHER	Limpet<10mm		0.13	2					
BS-D9	7	3	OTHER	Gastropod		0.23	3					
BS-D9	7	3	UNIDENTIFIABLE			21.33						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	7	7	ABALONE		<i>Notohaliotis ruber</i>	0.08						
BS-D9	7	7	OTHER	Trochidae		0.44			4			
BS-D9	7	7	MUSSEL		<i>Hormomya erosa</i>	21.89					4	3
BS-D9	7	7	LIMPET		<i>Celiana solida</i>	111.92	36		13			
BS-D9	7	7	PERIWINKLE		<i>Nerita atramentosa</i>	0.93	1					
BS-D9	7	7	PERIWINKLE		<i>Austrocochlea constricta</i>	7.02	8	11				
BS-D9	7	7	PERIWINKLE		<i>A. concamerata</i>	19.67	3	15				
BS-D9	7	7	WHELK		<i>Pleuroploca australasia</i>	7.55						
BS-D9	7	7	WHELK		<i>Dicathais textilosa</i>	9.59	4					
BS-D9	7	7	WHELK			16.07	3			2		
BS-D9	7	7	UNIDENTIFIABLE			4.20						
BS-D9	7	7	WARRENER		<i>Subnirrella undulata</i>	11.74		31				
BS-D9	7	7	WARRENER		<i>Subnirrella undulata</i>	20.23	12					
BS-D9	7	7	OTHER	Bivalves		1.53						
BS-D9	7	7	OTHER	Hippomyx		1.49	3					
BS-D9	7	7	OTHER	Limpet<10mm		0.10						
BS-D9	8	3	LIMPET		<i>Celiana solida</i>	1.89						
BS-D9	8	3	WARRENER		<i>Subnirrella undulata</i>	5.54		25				
BS-D9	8	3	WARRENER		<i>Subnirrella undulata</i>	5.09	5					
BS-D9	8	3	MUSSEL		<i>Hormomya erosa</i>	6.20					1	2
BS-D9	8	3	UNIDENTIFIABLE			26.70						
BS-D9	8	3	OTHER	Cerithiidae		1.27			15			

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	8	3	OTHER	Potamididae		0.13	2					
BS-D9	8	3	OTHER	Limpet<10mm		0.11	2					
BS-D9	8	3	PERIWINKLE		<i>A. concamerata</i>	9.78	32	14				
BS-D9	8	3	PERIWINKLE		<i>Austrocochlea constricta</i>	4.90	20	7				
BS-D9	8	3	WHELK			1.28						
BS-D9	8	7	LIMPET		<i>Cellana solida</i>	130.26	34	5	15			
BS-D9	8	7	LIMPET		<i>Patellanax peroni</i>	10.07			1			
BS-D9	8	7	WARRENER		<i>Subnirrella undulata</i>	55.81	29					
BS-D9	8	7	WARRENER		<i>Subnirrella undulata</i>	8.98		23				
BS-D9	8	7	MUSSEL		<i>Mytilus planulatus</i>	0.39						
BS-D9	8	7	MUSSEL		<i>Hormomya erosa</i>	30.49					4	7
BS-D9	8	7	PERIWINKLE		<i>Austrocochlea constricta</i>	23.25	11	32				
BS-D9	8	7	PERIWINKLE		<i>A. concamerata</i>	11.41	12	8				
BS-D9	8	7	UNIDENTIFIABLE			1.51						
BS-D9	8	7	WHELK			16.93						
BS-D9	8	7	WHELK		<i>Cabestana spengleri</i>	1.27				1		
BS-D9	8	7	WHELK		<i>Dicathais textilosa</i>	10.70				3		
BS-D9	8	7	OTHER	Limpet<10mm		0.03	1					
BS-D9	8	7	OTHER	Hipponyx		2.10	3					
BS-D9	8	7	OTHER	Bivalves		0.03						
BS-D9	8	7	OTHER	Littorinidae		1.10	3					
BS-D9	8	7	OTHER	Potamididae		0.08	1					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	8	7	OTHER	Littorinidae	<i>Bembicium nanum</i>	1.21	2					
BS-D9	9	3	OTHER	Gastropod		0.33	5					
BS-D9	9	3	OTHER		sea urchin	0.18						
BS-D9	9	3	OTHER	Cerithiidae		0.76			9			
BS-D9	9	3	PERIWINKLE		<i>A. concamerata</i>	9.39	15	11				
BS-D9	9	3	PERIWINKLE		<i>Austrocochlea constricta</i>	5.26	25	8				
BS-D9	9	3	UNIDENTIFIABLE			20.11						
BS-D9	9	3	WARRENER		<i>Subninfella undulata</i>	5.15		22				
BS-D9	9	3	MUSSEL		<i>Hormomya erosa</i>	4.43						
BS-D9	9	3	WARRENER		<i>Subninfella undulata</i>	5.36	6					
BS-D9	9	7	LIMPET		<i>Cellana solida</i>	101.09	40	4	9			
BS-D9	9	7	WHELK		<i>Pleuroploca australasia</i>	34.76				1		
BS-D9	9	3	WHELK			1.94						
BS-D9	9	7	WHELK		<i>Dicathais textifosa</i>	8.20				1		
BS-D9	9	7	ABALONE		<i>Haliotis scalaris</i>	6.21			1			
BS-D9	9	7	CHITON		<i>Chiton</i>	0.47						
BS-D9	9	7	OTHER	Sepiidae	cuttle-fish	0.78						
BS-D9	9	7	OTHER	Littorinidae		1.21	3					
BS-D9	9	7	OTHER	Hippomyx		0.92	2					
BS-D9	9	7	OTHER	Limpet<10mm		0.09	2					
BS-D9	9	7	OTHER	Bivalves		0.07						
BS-D9	9	7	OTHER	Cerithiidae		0.11			2			

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	9	7	UNIDENTIFIABLE			6.60						
BS-D9	9	7	MUSSEL		<i>Hormomya erosa</i>	21.54					5	
BS-D9	9	7	WHELK			13.18				3		
BS-D9	9	7	WARRENER		<i>Subninella undulata</i>	28.44	23					
BS-D9	9	7	WARRENER		<i>Subninella undulata</i>	7.22		25				
BS-D9	9	7	PERIWINKLE		<i>A. concamerata</i>	22.13	6	30				
BS-D9	9	7	PERIWINKLE		<i>Austrocochlea constricta</i>	11.45	9	14				
BS-D9	10	3	WHELK			1.62				1		
BS-D9	10	3	PERIWINKLE		<i>A. concamerata</i>	7.94	12	11				
BS-D9	10	3	PERIWINKLE		<i>Austrocochlea constricta</i>	4.71	12	10				
BS-D9	10	3	WARRENER		<i>Subninella undulata</i>	4.67	9					
BS-D9	10	3	WARRENER		<i>Subninella undulata</i>	3.02		12				
BS-D9	10	3	MUSSEL		<i>Hormomya erosa</i>	2.61					3	2
BS-D9	10	3	UNIDENTIFIABLE			14.09						
BS-D9	10	3	LIMPET			1.83						
BS-D9	10	3	OTHER	Cerithiidae		0.96			10			
BS-D9	10	3	OTHER	Gastropod		0.19	5					
BS-D9	10	3	OTHER	Muricidae		0.05	3					
BS-D9	10	3	OTHER	Hipponyx		0.11	2					
BS-D9	10	3	OTHER	Trochidae		0.05	1					
BS-D9	10	7	PERIWINKLE		<i>A. concamerata</i>	20.85	7	17				
BS-D9	10	7	PERIWINKLE		<i>Austrocochlea constricta</i>	5.49	4	9				

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	10	7	WHELK		<i>Cabestana spengleri</i>	4.61						
BS-D9	10	7	WHELK		<i>Dicathais textilosa</i>	4.66				2		
BS-D9	10	7	WHELK			6.19	1					
BS-D9	10	7	MUSSEL		<i>Hormomya erosa</i>	17.40					4	4
BS-D9	10	7	WARRENER		<i>Subninella undulata</i>	33.70	20					
BS-D9	10	7	WARRENER		<i>Subninella undulata</i>	6.33		15				
BS-D9	10	7	LIMPET		<i>Cellana solida</i>	72.76	19	4	9			
BS-D9	10	7	OTHER	Cymatidae		0.52	2					
BS-D9	10	7	OTHER	Muricidae		0.11	1					
BS-D9	10	7	OTHER	Potamididae		0.46	1					
BS-D9	10	7	OTHER	Trochidae	<i>Phasantrochus</i> sp.	0.78	1					
BS-D9	10	7	UNIDENTIFIABLE			6.11						
BS-D9	11	3	PERIWINKLE		<i>A. concamerata</i>	4.46	7	8				
BS-D9	11	3	PERIWINKLE		<i>Austrocochlea constricta</i>	4.06	9	5				
BS-D9	11	3	UNIDENTIFIABLE			6.71						
BS-D9	11	3	OTHER	Trochidae	<i>Phasantrochus</i> sp.	0.04	1					
BS-D9	11	3	OTHER	Gastropod		0.18	4					
BS-D9	11	3	OTHER	Cerithiidae		0.59			8			
BS-D9	11	3	WARRENER		<i>Subninella undulata</i>	1.96	4					
BS-D9	11	3	WARRENER		<i>Subninella undulata</i>	0.92		5				
BS-D9	11	3	MUSSEL		<i>Hormomya erosa</i>	1.47					1	1
BS-D9	11	3	LIMPET		<i>Cellana solida</i>	1.20	2					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	11	7	PERIWINKLE		<i>A. concamerata</i>	13.63	8	18				
BS-D9	11	7	PERIWINKLE		<i>Austrocochlea constricta</i>	9.59	11	8				
BS-D9	11	7	UNIDENTIFIABLE			3.95						
BS-D9	11	7	OTHER	Sepiidae	cuttle-fish	0.39						
BS-D9	11	7	OTHER		<i>Conus anemone</i>	1.23						
BS-D9	11	7	CHITON		<i>Chiton</i>	0.36						
BS-D9	11	7	OTHER	Bivalves		0.22						
BS-D9	11	7	OTHER	Gastropod		0.55	1					
BS-D9	11	7	OTHER	Cerithiidae		0.13			1			
BS-D9	11	7	MUSSEL		<i>Hormomya erosa</i>	9.83						
BS-D9	11	7	WHELK			2.83						
BS-D9	11	7	WHELK		<i>Dicathais textilosa</i>	1.20						
BS-D9	11	7	WARRENER		<i>Subninelia undulata</i>	3.86		10				
BS-D9	11	7	WARRENER		<i>Subninelia undulata</i>	26.36	20					
BS-D9	11	7	LIMPET		<i>Cellana solida</i>	56.79	23	2	5			
BS-D9	11	7	CRUSTACEA		<i>Jasus lalandei?</i>	0.13						
BS-D9	12	3	OTHER	Cerithiidae		0.28			4			
BS-D9	12	3	OTHER	Potamididae		0.11	2					
BS-D9	12	3	OTHER	Hipponyx		0.50	1					
BS-D9	12	3	OTHER	Littorinidae		0.23	1					
BS-D9	12	3	UNIDENTIFIABLE			4.89						
BS-D9	12	3	WHELK			0.41						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	12	3	PERIWINKLE		<i>A. concamerata</i>	3.49	5	5				
BS-D9	12	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.84	6	2				
BS-D9	12	3	LIMPET		<i>Cellana solida</i>	0.59						
BS-D9	12	3	MUSSEL		<i>Hormomya erosa</i>	1.40						1
BS-D9	12	3	WARRENER		<i>Subninella undulata</i>	2.03		8				
BS-D9	12	3	WARRENER		<i>Subninella undulata</i>	0.47						
BS-D9	12	7	OTHER	Sepiidae	cuttle-fish	0.62						
BS-D9	12	7	UNIDENTIFIABLE			0.37						
BS-D9	12	7	WHELK			0.67						
BS-D9	12	7	WHELK		<i>Dicathais textilosa</i>	9.20	1					
BS-D9	12	7	WHELK		<i>Pleuroploca australasia</i>	22.29				1		
BS-D9	12	7	PERIWINKLE		<i>A. concamerata</i>	3.71	2	3				
BS-D9	12	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.40	4	3				
BS-D9	12	7	MUSSEL		<i>Hormomya erosa</i>	5.02					1	2
BS-D9	12	7	WARRENER		<i>Subninella undulata</i>	7.74	8					
BS-D9	12	7	LIMPET		<i>Cellana solida</i>	26.68	6	1	3			
BS-D9	13	3	UNIDENTIFIABLE			0.30						
BS-D9	13	3	WARRENER		<i>Subninella undulata</i>	0.69	1					
BS-D9	13	3	PERIWINKLE		<i>A. concamerata</i>	0.30		1				
BS-D9	13	7	LIMPET		<i>Cellana solida</i>	0.20	1					
BS-D9	13	7	WARRENER		<i>Subninella undulata</i>	0.55	2					
BS-D9	13	7	PERIWINKLE		<i>A. concamerata</i>	0.71		3				

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protocench	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D9	13	7	MUSSEL		<i>Hormomya erosa</i>	2.63						
BS-D9	14	3	UNIDENTIFIABLE			0.17						2
BS-D6	1	3				0.00						
BS-D6	1	7				0.00						
BS-D6	2	3	WARRENER		<i>Subninella undulata</i>	0.11						
BS-D6	2	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.16						
BS-D6	2	7				0.00						
BS-D6	3	3	LIMPET		<i>Cellana solida</i>	0.09						
BS-D6	3	3	UNIDENTIFIABLE			1.78						
BS-D6	3	3	WHELK			0.34						
BS-D6	3	3	MUSSEL		<i>Hormomya erosa</i>	0.45						
BS-D6	3	3	PERIWINKLE		<i>A. concamerata</i>	0.16						
BS-D6	3	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.11						
BS-D6	3	3	OTHER	Cerithiidae		0.16			1			
BS-D6	3	7	WARRENER		<i>Subninella undulata</i>	0.28		2				
BS-D6	3	7	LIMPET		<i>Cellana solida</i>	0.50						
BS-D6	3	7	WHELK			5.21						
BS-D6	3	7	MUSSEL		<i>Hormomya erosa</i>	0.36						
BS-D6	4	3	WHELK			0.29						
BS-D6	4	3	OTHER	Cerithiidae		0.19			2			
BS-D6	4	3	PERIWINKLE		<i>A. concamerata</i>	1.17	3					
BS-D6	4	3	MUSSEL		<i>Hormomya erosa</i>	1.42						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	4	3	LIMPET		<i>Cellana solida</i>	1.82						
BS-D6	4	3	WARRENER		<i>Subnirrella undulata</i>	0.45		1				
BS-D6	4	3	UNIDENTIFIABLE			7.88						
BS-D6	4	7	WHELK		<i>Pleuroploca australasia</i>	4.66				1		
BS-D6	4	7	OTHER	Conidae	<i>Conus</i>	0.63						
BS-D6	4	7	LIMPET		<i>Cellana solida</i>	1.37	4					
BS-D6	4	7	MUSSEL		<i>Hormomya erosa</i>	0.77						
BS-D6	4	7	WARRENER		<i>Subnirrella undulata</i>	0.22						
BS-D6	5	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.92	4					
BS-D6	5	3	PERIWINKLE		<i>A. concamerata</i>	4.00	9	3				
BS-D6	5	3	MUSSEL		<i>Hormomya erosa</i>	1.98					1	1
BS-D6	5	3	WARRENER		<i>Subnirrella undulata</i>	1.69		5				
BS-D6	5	3	LIMPET		<i>Cellana solida</i>	1.43	1					
BS-D6	5	3	UNIDENTIFIABLE			9.54						
BS-D6	5	3	WHELK			1.10	1					
BS-D6	5	3	WARRENER		<i>Subnirrella undulata</i>	2.14	3					
BS-D6	5	3	OTHER	Cerithiidae		0.21			5			
BS-D6	5	7	OTHER	Trochidae		0.09			1			
BS-D6	5	7	OTHER	Limpet<10mm		0.87	1					
BS-D6	5	7	OTHER	Bivalves		0.68	2					
BS-D6	5	7	OTHER	Muricidae		0.42	1					
BS-D6	5	7	WHELK		<i>Dicathais textilosa</i>	9.11	1					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	5	7	MUSSEL		<i>Hormomya erosa</i>	2.37						1
BS-D6	5	7	WARRENER		<i>Subninella undulata</i>	0.87		2				
BS-D6	5	7	WHELK		<i>Cabestana spengleri</i>	0.80	1					
BS-D6	5	7	WHELK			2.07						
BS-D6	5	7	WARRENER		<i>Subninella undulata</i>	8.85	4					
BS-D6	5	7	PERIWINKLE		<i>A. concamerata</i>	1.19		2				
BS-D6	5	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.20	1	1				
BS-D6	5	7	LIMPET		<i>Cellana solida</i>	7.17	10					
BS-D6	6	3	WHELK			0.35						
BS-D6	6	3	WARRENER		<i>Subninella undulata</i>	1.09		7				
BS-D6	6	3	PERIWINKLE		<i>A. concamerata</i>	3.90	16	6				
BS-D6	6	3	UNIDENTIFIABLE			12.80						
BS-D6	6	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.20	10	1				
BS-D6	6	3	MUSSEL		<i>Hormomya erosa</i>	0.90						1
BS-D6	6	3	WARRENER		<i>Subninella undulata</i>	0.77	1					
BS-D6	6	3	OTHER	Cerithiidae		0.60			8			
BS-D6	6	7	WARRENER		<i>Subninella undulata</i>	4.53	4					
BS-D6	6	7	WHELK		<i>Dicathais textilosa</i>	2.20						
BS-D6	6	7	LIMPET		<i>Cellana solida</i>	13.47	4	3	1			
BS-D6	6	7	WHELK		<i>Pleuroploca australasia</i>	3.26						
BS-D6	6	7	MUSSEL		<i>Hormomya erosa</i>	5.26					2	2
BS-D6	6	7	WARRENER		<i>Subninella undulata</i>	1.01		4				

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	6	7	PERIWINKLE		<i>A. concamerata</i>	2.35	1	6				
BS-D6	6	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.35	3	1				
BS-D6	6	7	UNIDENTIFIABLE			0.96						
BS-D6	6	7	OTHER	Hipponyx		1.02	1					
BS-D6	6	7	OTHER	Bivalves		0.41						
BS-D6	6	7	OTHER	Gastropod		0.19						
BS-D6	7	3	PERIWINKLE		<i>Austrocochlea constricta</i>	2.18	14	2				
BS-D6	7	3	LIMPET		<i>Cellana solida</i>	1.79						
BS-D6	7	3	OTHER	Cerithiidae		0.27			6			
BS-D6	7	3	MUSSEL		<i>Hormomya erosa</i>	1.05						
BS-D6	7	3	WHELK			0.25						
BS-D6	7	3	WARRENER		<i>Subnirrella undulata</i>	1.25	1					
BS-D6	7	3	WARRENER		<i>Subnirrella undulata</i>	1.82		5				
BS-D6	7	3	PERIWINKLE		<i>A. concamerata</i>	4.51	13	7				
BS-D6	7	3	UNIDENTIFIABLE			16.07						
BS-D6	7	7	WHELK		<i>Dicathais textilosa</i>	9.67	3					
BS-D6	7	7	PERIWINKLE		<i>A. concamerata</i>	2.68	1	2				
BS-D6	7	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.47	3					
BS-D6	7	7	UNIDENTIFIABLE			2.00						
BS-D6	7	7	WARRENER		<i>Subnirrella undulata</i>	3.07		8				
BS-D6	7	7	WARRENER		<i>Subnirrella undulata</i>	2.03	1					
BS-D6	7	7	MUSSEL		<i>Hormomya erosa</i>	4.37					3	

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	7	7	WHELK			2.29						
BS-D6	7	7	LIMPET		<i>Cellana solida</i>	34.97	9	5	1			
BS-D6	8	3	WHELK			0.91						
BS-D6	8	3	MUSSEL		<i>Homomya erosa</i>	1.57						1
BS-D6	8	3	WARRENER		<i>Subninella undulata</i>	1.13	1					
BS-D6	8	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.39	10	1				
BS-D6	8	3	PERIWINKLE		<i>A. concamerata</i>	4.32	10	7				
BS-D6	8	3	OTHER	Cerithiidae		0.61			11			
BS-D6	8	3	WARRENER		<i>Subninella undulata</i>	1.63		7				
BS-D6	8	3	LIMPET		<i>Cellana solida</i>	0.85						
BS-D6	8	7	OTHER	Cerithiidae		0.04			1			
BS-D6	8	7	WARRENER		<i>Subninella undulata</i>	2.19	1					
BS-D6	8	7	LIMPET		<i>Cellana solida</i>	15.06	7	1	1			
BS-D6	8	7	PERIWINKLE		<i>A. concamerata</i>	3.83	2	3				
BS-D6	8	7	MUSSEL		<i>Homomya erosa</i>	6.63					2	1
BS-D6	8	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.84	7	2				
BS-D6	8	7	WARRENER		<i>Subninella undulata</i>	2.36		8				
BS-D6	8	7	WHELK			8.14						
BS-D6	8	7	CRUSTACEA		<i>Jasus lalandei?</i>	0.03						
BS-D6	9	3	UNIDENTIFIABLE			16.15						
BS-D6	9	3	WARRENER		<i>Subninella undulata</i>	1.89		7				
BS-D6	9	3	LIMPET		<i>Cellana solida</i>	1.65						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	9	3	WHELK			1.91						
BS-D6	9	3	PERIWINKLE		<i>A. concamerata</i>	7.39	11	7				
BS-D6	9	3	PERIWINKLE		<i>Austrocochlea constricta</i>	2.46	11	1				
BS-D6	9	3	WARRENER		<i>Subnirrella undulata</i>	2.05	2					
BS-D6	9	3	OTHER	Cerithiidae		0.37			3			
BS-D6	9	3	MUSSEL		<i>Homomya erosa</i>	2.75					3	2
BS-D6	9	7	WHELK		<i>Dicathais textilosa</i>	17.12	1			1		
BS-D6	9	7	LIMPET		<i>Cellana solida</i>	37.09	12	2				
BS-D6	9	7	WARRENER		<i>Subnirrella undulata</i>	2.03		3				
BS-D6	9	7	WARRENER		<i>Subnirrella undulata</i>	6.28	4					
BS-D6	9	7	MUSSEL		<i>Homomya erosa</i>	8.70						4
BS-D6	9	7	PERIWINKLE		<i>Austrocochlea constricta</i>	4.02	5	2				
BS-D6	9	7	OTHER		sea urchin	0.35						
BS-D6	9	7	PERIWINKLE		<i>A. concamerata</i>	5.34	1	10				
BS-D6	9	7	UNIDENTIFIABLE			2.57						
BS-D6	9	7	OTHER	Cerithiidae		0.22			2			
BS-D6	9	7	OTHER	Bivalves		0.63	2					
BS-D6	10	3	WARRENER		<i>Subnirrella undulata</i>	1.25						
BS-D6	10	3	MUSSEL		<i>Homomya erosa</i>	1.98						
BS-D6	10	3	WHELK			0.71						
BS-D6	10	3	UNIDENTIFIABLE			15.01						
BS-D6	10	3	LIMPET		<i>Cellana solida</i>	1.93	2					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	10	3	WARRENER		<i>Subninella undulata</i>	2.62		11				
BS-D6	10	3	PERIWINKLE		<i>A. concamerata</i>	5.16	17	4				
BS-D6	10	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.81	13	2				
BS-D6	10	3	OTHER	Cerithiidae		0.49			7			
BS-D6	10	3	OTHER	Bivalves		0.12						
BS-D6	10	7	PERIWINKLE		<i>A. concamerata</i>	6.49	2	6				
BS-D6	10	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.44		4				
BS-D6	10	7	LIMPET		<i>Cellana solida</i>	34.70	5	13				
BS-D6	10	7	WHELK		<i>Dicathais textilosa</i>	15.84	1			2		
BS-D6	10	7	OTHER	Hippomyx		0.45	3					
BS-D6	10	7	MUSSEL		<i>Hormomya erosa</i>	2.64					1	1
BS-D6	10	7	WARRENER		<i>Subninella undulata</i>	3.30		5				
BS-D6	10	7	WARRENER		<i>Subninella undulata</i>	7.21	3					
BS-D6	11	3	UNIDENTIFIABLE			11.71						
BS-D6	11	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.14	10	2				
BS-D6	11	3	PERIWINKLE		<i>A. concamerata</i>	2.53	18	4				
BS-D6	11	3	MUSSEL		<i>Hormomya erosa</i>	1.12					2	
BS-D6	11	3	OTHER	Cerithiidae		0.36			6			
BS-D6	11	3	OTHER	Littorinidae		0.13	2					
BS-D6	11	3	WARRENER		<i>Subninella undulata</i>	1.31	1					
BS-D6	11	3	WARRENER		<i>Subninella undulata</i>	2.01		11				
BS-D6	11	3	WHELK			1.04						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	11	7	WARRENER		<i>Subnirrella undulata</i>	2.13		7				
BS-D6	11	7	PERIWINKLE		<i>Austrocochlea constricta</i>	2.23	5	1				
BS-D6	11	7	UNIDENTIFIABLE			2.04						
BS-D6	11	7	WHELK			0.82						
BS-D6	11	7	WHELK		<i>Dicathais textilosa</i>	3.12	2					
BS-D6	11	7	WARRENER		<i>Subnirrella undulata</i>	10.28	4					
BS-D6	11	7	MUSSEL		<i>Hormomya erosa</i>	6.33					2	1
BS-D6	11	7	OTHER	Bivalves		0.56					1	
BS-D6	11	7	OTHER		sea urchin	0.12						
BS-D6	11	7	LIMPET		<i>Cellana solida</i>	20.37	10	2	1			
BS-D6	11	7	PERIWINKLE		<i>A. concamerata</i>	6.21	4	9				
BS-D6	12	3	UNIDENTIFIABLE			12.19						
BS-D6	12	3	LIMPET		<i>Cellana solida</i>	1.25						
BS-D6	12	3	PERIWINKLE		<i>A. concamerata</i>	4.71	15	7				
BS-D6	12	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.43	10					
BS-D6	12	3	WARRENER		<i>Subnirrella undulata</i>	2.02		9				
BS-D6	12	3	OTHER		sea urchin	0.07						
BS-D6	12	3	OTHER	Cerithiidae		0.14			2			
BS-D6	12	3	WHELK			0.42						
BS-D6	12	3	WARRENER		<i>Subnirrella undulata</i>	2.94	2					
BS-D6	12	3	MUSSEL		<i>Hormomya erosa</i>	0.96						
BS-D6	12	7	ABALONE		<i>Haliotis scalaris</i>	26.08	1					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	12	7	PERIWINKLE		<i>A. concamerata</i>	5.57	2	4				
BS-D6	12	7	LIMPET		<i>Cellana solida</i>	14.30	10	1				
BS-D6	12	7	UNIDENTIFIABLE			2.84						
BS-D6	12	7	WARRENER		<i>Subnirrella undulata</i>	17.17	5					
BS-D6	12	7	MUSSEL		<i>Hormomya erosa</i>	1.67						1
BS-D6	12	7	WARRENER		<i>Subnirrella undulata</i>	2.39		5				
BS-D6	12	7	OTHER	Hipponyx		0.22	1					
BS-D6	12	7	OTHER	Cerithiidae		0.11			1			
BS-D6	12	7	PERIWINKLE		<i>Austrocochlea constricta</i>	3.96	2	5				
BS-D6	12	7	WHELK		<i>Dicathais textilosa</i>	6.97	1			1		
BS-D6	13	3	WHELK			1.08						
BS-D6	13	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.63	11	1				
BS-D6	13	3	PERIWINKLE		<i>A. concamerata</i>	3.98	13	4				
BS-D6	13	3	OTHER	Cerithiidae		0.44			5			
BS-D6	13	3	WARRENER		<i>Subnirrella undulata</i>	1.75		8				
BS-D6	13	3	WARRENER		<i>Subnirrella undulata</i>	1.21						
BS-D6	13	3	MUSSEL		<i>Hormomya erosa</i>	1.77						1
BS-D6	13	3	UNIDENTIFIABLE			9.32						
BS-D6	13	3	MUSSEL		<i>Mytilus planulatus</i>	0.12						
BS-D6	13	3	LIMPET		<i>Cellana solida</i>	1.15						
BS-D6	13	7	WARRENER		<i>Subnirrella undulata</i>	7.06	2					
BS-D6	13	7	WHELK			0.36						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	13	7	MUSSEL		<i>Hormomya erosa</i>	0.57						
BS-D6	13	7	WARRENER		<i>Subninella undulata</i>	0.37		1				
BS-D6	13	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.16	1					
BS-D6	13	7	PERIWINKLE		<i>A. concamerata</i>	2.74	2					
BS-D6	13	7	LIMPET		<i>Cellana solida</i>	14.61	5		2			
BS-D6	13	7	OTHER	Hipponyx		0.32	1					
BS-D6	13	7	OTHER	limpet<10mm		0.14	1					
BS-D6	14	3	WARRENER		<i>Subninella undulata</i>	1.05	1					
BS-D6	14	3	PERIWINKLE		<i>A. concamerata</i>	4.91	11	6				
BS-D6	14	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.88	8	1				
BS-D6	14	3	MUSSEL		<i>Hormomya erosa</i>	1.61					1	1
BS-D6	14	3	UNIDENTIFIABLE			10.66						
BS-D6	14	3	WARRENER		<i>Subninella undulata</i>	0.99		5				
BS-D6	14	3	OTHER	Cerithiidae		0.29			7			
BS-D6	14	3	WHELK			0.56						
BS-D6	14	3	LIMPET		<i>Cellana solida</i>	0.58						
BS-D6	14	7	OTHER		sea urchin	0.22						
BS-D6	14	7	MUSSEL		<i>Hormomya erosa</i>	0.72						
BS-D6	14	7	WARRENER		<i>Subninella undulata</i>	15.97	4					
BS-D6	14	7	LIMPET		<i>Cellana solida</i>	14.09	3	1	1			
BS-D6	14	7	WHELK			1.17						
BS-D6	14	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.35	2	1				

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	14	7	PERIWINKLE		<i>A. concamerata</i>	2.60	1	4				
BS-D6	15	3	WHELK			0.33						
BS-D6	15	3	LIMPET		<i>Cellana solida</i>	0.34						
BS-D6	15	3	UNIDENTIFIABLE			3.33						
BS-D6	15	3	PERIWINKLE		<i>A. concamerata</i>	2.51	6	2				
BS-D6	15	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.63	7					
BS-D6	15	3	MUSSEL		<i>Hormomya erosa</i>	0.47						
BS-D6	15	3	WARRENER		<i>Subnirrella undulata</i>	1.33	1					
BS-D6	15	3	WARRENER		<i>Subnirrella undulata</i>	0.50		3				
BS-D6	15	3	OTHER	Cerithiidae		0.13			3			
BS-D6	15	7	WARRENER		<i>Subnirrella undulata</i>	8.77	2					
BS-D6	15	7	LIMPET		<i>Cellana solida</i>	21.34	5		3			
BS-D6	15	7	MUSSEL		<i>Hormomya erosa</i>	6.63					1	2
BS-D6	15	7	WARRENER		<i>Subnirrella undulata</i>	2.38		5				
BS-D6	15	7	PERIWINKLE		<i>A. concamerata</i>	1.75	1	2				
BS-D6	15	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.23		1				
BS-D6	15	7	WHELK		<i>Dicathais textilosa</i>	2.35				1		
BS-D6	16	3	PERIWINKLE		<i>A. concamerata</i>	3.48	12	8				
BS-D6	16	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.49	6	1				
BS-D6	16	3	WHELK			0.87						
BS-D6	16	3	WARRENER		<i>Subnirrella undulata</i>	2.45	2					
BS-D6	16	3	OTHER	Cerithiidae		0.36			8			

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	16	3	MUSSEL		<i>Homomya erosa</i>	1.55					1	1
BS-D6	16	3	WARRENER		<i>Subninella undulata</i>	1.80		5				
BS-D6	16	3	LIMPET		<i>Cellana solida</i>	0.47						
BS-D6	16	3	UNIDENTIFIABLE			9.88						
BS-D6	16	7	PERIWINKLE		<i>A. concamerata</i>	3.72	1	3				
BS-D6	16	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.59		2				
BS-D6	16	7	MUSSEL		<i>Homomya erosa</i>	2.58					2	
BS-D6	16	7	LIMPET		<i>Cellana solida</i>	8.93	2	3				
BS-D6	16	7	WHELK			2.42	1					
BS-D6	16	7	WARRENER		<i>Subninella undulata</i>	2.92	3					
BS-D6	16	7	OTHER	Bivalves		1.45						
BS-D6	17	3	WHELK			0.37						
BS-D6	17	3	OTHER	Hipponyx		0.14			1			
BS-D6	17	3	OTHER	Cerithiidae		0.16	2		2			
BS-D6	17	3	OTHER		sea urchin	0.03						
BS-D6	17	3	WARRENER		<i>Subninella undulata</i>	2.02	2					
BS-D6	17	3	WARRENER		<i>Subninella undulata</i>	0.39		1				
BS-D6	17	3	MUSSEL		<i>Homomya erosa</i>	1.13						
BS-D6	17	3	LIMPET		<i>Cellana solida</i>	0.58	1					
BS-D6	17	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.37	9	2				
BS-D6	17	3	PERIWINKLE		<i>A. concamerata</i>	2.55	16	5				
BS-D6	17	3	UNIDENTIFIABLE			14.47						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	17	7	LIMPET		<i>Cellana solida</i>	13.69	4	2				
BS-D6	17	7	MUSSEL		<i>Homomya erosa</i>	0.49						
BS-D6	17	7	WARRENER		<i>Subninella undulata</i>	0.22						
BS-D6	17	7	WARRENER		<i>Subninella undulata</i>	0.89		2				
BS-D6	17	7	WHELK			1.12						
BS-D6	17	7	PERIWINKLE		<i>A. concamerata</i>	2.64	1	4				
BS-D6	17	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.28						
BS-D6	18	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.71	9					
BS-D6	18	3	PERIWINKLE		<i>A. concamerata</i>	4.29	2	15				
BS-D6	18	3	OTHER	Cerithiidae		0.28	2		4			
BS-D6	18	3	UNIDENTIFIABLE			10.71						
BS-D6	18	3	LIMPET		<i>Cellana solida</i>	0.87	1					
BS-D6	18	3	WARRENER		<i>Subninella undulata</i>	0.61						
BS-D6	18	3	MUSSEL		<i>Homomya erosa</i>	1.82						1
BS-D6	18	3	WARRENER		<i>Subninella undulata</i>	1.09		6				
BS-D6	18	7	OTHER	Cerithiidae		0.09			2			
BS-D6	18	7	OTHER	Trochidae	<i>Phasantrochus</i> sp.	1.22			1			
BS-D6	18	7	WHELK		<i>Dicathais textilosa</i>	10.60				1		
BS-D6	18	7	PERIWINKLE		<i>A. concamerata</i>	4.36	1	8				
BS-D6	18	7	PERIWINKLE		<i>Austrocochlea constricta</i>	3.02	1	3				
BS-D6	18	7	WARRENER		<i>Subninella undulata</i>	6.30	3					
BS-D6	18	7	LIMPET		<i>Cellana solida</i>	13.99	5	1	1			

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	18	7	WARRENER		<i>Subninella undulata</i>	0.66		1				
BS-D6	18	7	MUSSEL		<i>Hormomya erosa</i>	2.70					1	
BS-D6	19	3	OTHER	Hipponyx		0.05			1			
BS-D6	19	3	OTHER	limpet<10mm		0.03			1			
BS-D6	19	3	OTHER	Cerithiidae		0.07	1					
BS-D6	19	3	UNIDENTIFIABLE			6.87						
BS-D6	19	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.90	8					
BS-D6	19	3	PERIWINKLE		<i>A. concamerata</i>	2.70	9	4				
BS-D6	19	3	MUSSEL		<i>Hormomya erosa</i>	0.65					1	
BS-D6	19	3	WHELK			0.62						
BS-D6	19	3	LIMPET		<i>Cellana solida</i>	0.40	1					
BS-D6	19	3	WARRENER		<i>Subninella undulata</i>	1.18	2					
BS-D6	19	3	WARRENER		<i>Subninella undulata</i>	0.45		2				
BS-D6	19	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.52		1				
BS-D6	19	7	PERIWINKLE		<i>A. concamerata</i>	2.67		4				
BS-D6	19	7	WHELK			0.48						
BS-D6	19	7	WARRENER		<i>Subninella undulata</i>	0.55						
BS-D6	19	7	WARRENER		<i>Subninella undulata</i>	0.54		2				
BS-D6	19	7	MUSSEL		<i>Hormomya erosa</i>	1.08						
BS-D6	19	7	LIMPET		<i>Cellana solida</i>	12.32	3		1			
BS-D6	19	7	OTHER	Cerithiidae		0.11			1			
BS-D6	19	7	OTHER	limpet<10mm		0.10			1			

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	19	7	OTHER		sea urchin	0.06						
BS-D6	20	3	PERIWINKLE		<i>Austrocochlea constricta</i>	2.02	12	1				
BS-D6	20	3	PERIWINKLE		<i>A. concamerata</i>	4.45	9	8				
BS-D6	20	3	LIMPET		<i>Cellana solida</i>	1.25						
BS-D6	20	3	MUSSEL		<i>Hormomya erosa</i>	1.71					2	
BS-D6	20	3	WHELK			0.93						
BS-D6	20	3	WARRENER		<i>Subnirrella undulata</i>	1.40	3					
BS-D6	20	3	UNIDENTIFIABLE			14.43						
BS-D6	20	3	WARRENER		<i>Subnirrella undulata</i>	1.56		7				
BS-D6	20	3	OTHER	Cerithiidae		0.47	3		4			
BS-D6	20	3	OTHER	limpet<10mm		0.07			1			
BS-D6	20	7	LIMPET		<i>Cellana solida</i>	9.76	5	2	1			
BS-D6	20	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.62	1	1				
BS-D6	20	7	PERIWINKLE		<i>A. concamerata</i>	3.52		5				
BS-D6	20	7	MUSSEL		<i>Hormomya erosa</i>	3.82						1
BS-D6	20	7	WARRENER		<i>Subnirrella undulata</i>	12.61	3					
BS-D6	20	7	WARRENER		<i>Subnirrella undulata</i>	0.73		1				
BS-D6	20	7	WHELK		<i>Dicathais textilosa</i>	2.24	1					
BS-D6	21	3	MUSSEL		<i>Hormomya erosa</i>	1.22					1	
BS-D6	21	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.21	7					
BS-D6	21	3	PERIWINKLE		<i>A. concamerata</i>	4.47	16	4				
BS-D6	21	3	OTHER	Cerithiidae		0.37	1		4			

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	21	3	OTHER	Hipponyx		0.04			1			
BS-D6	21	3	OTHER	Trochidae		0.06			1			
BS-D6	21	3	WARRENER		<i>Subninella undulata</i>	1.10	1					
BS-D6	21	3	WHELK			0.71						
BS-D6	21	3	LIMPET		<i>Cellana solida</i>	1.01	2					
BS-D6	21	3	UNIDENTIFIABLE			6.40						
BS-D6	21	3	WARRENER		<i>Subninella undulata</i>	0.53		4				
BS-D6	21	7	MUSSEL		<i>Hormomya erosa</i>	3.19						2
BS-D6	21	7	OTHER	Bivalve		0.66					1	
BS-D6	21	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.34						
BS-D6	21	7	WHELK		<i>Dicathais textilosa</i>	5.03	1			1		
BS-D6	21	7	PERIWINKLE		<i>A. concamerata</i>	3.10	2	3				
BS-D6	21	7	WARRENER		<i>Subninella undulata</i>	6.33	3					
BS-D6	21	7	LIMPET		<i>Cellana solida</i>	7.19	5					
BS-D6	22	3	PERIWINKLE		<i>A. concamerata</i>	4.05	13	4				
BS-D6	22	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.61	9	1				
BS-D6	22	3	MUSSEL		<i>Hormomya erosa</i>	1.19						1
BS-D6	22	3	WARRENER		<i>Subninella undulata</i>	1.01		3				
BS-D6	22	3	WARRENER		<i>Subninella undulata</i>	0.61						
BS-D6	22	3	UNIDENTIFIABLE			9.56						
BS-D6	22	3	OTHER	Cerithiidae		0.41			7			
BS-D6	22	3	LIMPET		<i>Cellana solida</i>	1.01						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	22	7	PERIWINKLE		<i>A. concamerata</i>	3.46		2				
BS-D6	22	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.80	2	2				
BS-D6	22	7	OTHER	Hipponyx		0.21			1			
BS-D6	22	7	LIMPET		<i>Cellana solida</i>	2.12	1					
BS-D6	22	7	WHELK			1.19						
BS-D6	22	7	ABALONE		<i>Haliotis</i>	0.21						
BS-D6	22	7	MUSSEL		<i>Hormomya erosa</i>	1.35						1
BS-D6	22	7	WARRENER		<i>Subnirrella undulata</i>	20.69	5					
BS-D6	23	3	UNIDENTIFIABLE			3.56						
BS-D6	23	3	OTHER	Cerithiidae		0.14	2		2			
BS-D6	23	3	WARRENER		<i>Subnirrella undulata</i>	0.27						
BS-D6	23	3	PERIWINKLE		<i>A. concamerata</i>	1.30	2	2				
BS-D6	23	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.53	5					
BS-D6	23	3	WHELK			0.10						
BS-D6	23	3	WARRENER		<i>Subnirrella undulata</i>	0.53		5				
BS-D6	23	3	MUSSEL		<i>Hormomya erosa</i>	0.48						1
BS-D6	23	7	LIMPET		<i>Cellana solida</i>	1.32	2					
BS-D6	23	7	PERIWINKLE		<i>A. concamerata</i>	0.83	1	3				
BS-D6	23	7	WHELK		<i>Dicathais textilosa</i>	2.47	1					
BS-D6	23	7	PERIWINKLE		<i>Austrocochlea constricta</i>	2.91		2				
BS-D6	23	7	WARRENER		<i>Subnirrella undulata</i>	23.12	6					
BS-D6	24	3	OTHER	Cerithiidae		0.01	1					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-D6	24	3	WARRENER		<i>Subninella undulata</i>	0.15	1					
BS-D6	24	3	MUSSEL		<i>Hormomya erosa</i>	0.28					1	
BS-D6	24	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.35	4					
BS-D6	24	3	PERIWINKLE		<i>A. concamerata</i>	0.80	4					
BS-D6	24	3	UNIDENTIFIABLE			1.56						
BS-D6	24	7	WARRENER		<i>Subninella undulata</i>	0.10		1				
BS-D6	24	7	LIMPET		<i>Cellana solida</i>	0.11	1					
BS-D6	24	7	WARRENER		<i>Subninella undulata</i>	0.91						
BS-D6	24	7	PERIWINKLE		<i>A. concamerata</i>	1.00		2				
BS-D6	25	3	OTHER	Cerithiidae		0.01	1					
BS-D6	25	3	PERIWINKLE		<i>A. concamerata</i>	0.22						
BS-D6	25	3	MUSSEL		<i>Hormomya erosa</i>	0.07						
BS-D6	25	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.25	2					
BS-D6	25	3	UNIDENTIFIABLE			0.34						
BS-D6	25	7	MUSSEL		<i>Hormomya erosa</i>	0.15						
BS-D6	25	7	LIMPET		<i>Cellana solida</i>	0.20						
BS-D6	25	7	PERIWINKLE		<i>A. concamerata</i>	0.70		1				
BS-D6	25	7	WARRENER		<i>Subninella undulata</i>	0.48						
BS-D6	26	3				0.00						
BS-D6	26	7				0.00						
BS-D6	27	3				0.00						
BS-D6	27	7	LIMPET		<i>Cellana solida</i>	0.94	1					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tall	No. umbo L	No. umbo R
BS-D6	28	3				0.00						
BS-D6	28	7				0.00						
BS-C6	1	3										
BS-C6	1	7										
BS-C6	2	3										
BS-C6	2	7										
BS-C6	3	3										
BS-C6	3	7										
BS-C6	4	3	MUSSEL		<i>Hormomya erosa</i>	0.18						
BS-C6	4	3	LIMPET		<i>Cellana solida</i>	0.38						
BS-C6	4	3	WARRENER		<i>Subnirrella undulata</i>	0.33		1				
BS-C6	4	3	UNIDENTIFIABLE			0.98						
BS-C6	4	3	WHELK			0.32						
BS-C6	4	3	PERIWINKLE		<i>A. concamerata</i>	0.08						
BS-C6	4	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.04	1					
BS-C6	4	7	WHELK			0.52						
BS-C6	5	3	OTHER		sea urchin	0.07						
BS-C6	5	3	MUSSEL		<i>Hormomya erosa</i>	0.19						
BS-C6	5	3	PERIWINKLE		<i>A. concamerata</i>	0.15		1				
BS-C6	5	3	UNIDENTIFIABLE			0.73						
BS-C6	5	3	WHELK			0.09						
BS-C6	5	3	WARRENER		<i>Subnirrella undulata</i>	0.34						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	5	3	WARRENER		<i>Subnirrella undulata</i>	0.10		1				
BS-C6	5	7	MUSSEL		<i>Mytilus planulatus</i>	1.59						
BS-C6	5	7	PERIWINKLE		<i>A. concamerata</i>	0.26	1					
BS-C6	5	7	LIMPET		<i>Cellana solida</i>	1.99	3					
BS-C6	5	7	WHELK			2.40	1					
BS-C6	6	3	UNIDENTIFIABLE			8.41						
BS-C6	6	3	MUSSEL		<i>Hormomya erosa</i>	1.02						1
BS-C6	6	3	LIMPET		<i>Cellana solida</i>	1.03						
BS-C6	6	3	WARRENER		<i>Subnirrella undulata</i>	0.55		2				
BS-C6	6	3	WARRENER		<i>Subnirrella undulata</i>	0.96						
BS-C6	6	3	WHELK			0.19						
BS-C6	6	3	OTHER	Gastropod	<i>Conus sp.</i>	0.21	1					
BS-C6	6	3	OTHER	Turritellidae <		0.07			1			
BS-C6	6	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.63	6					
BS-C6	6	3	PERIWINKLE		<i>A. concamerata</i>	2.98	4	4				
BS-C6	6	7	LIMPET		<i>Cellana solida</i>	16.47	1	1				
BS-C6	6	7	MUSSEL		<i>Hormomya erosa</i>	6.79						2
BS-C6	6	7	PERIWINKLE		<i>A. concamerata</i>	4.82	2	4				
BS-C6	6	7	OTHER	Cerithiidae		0.58			4			
BS-C6	6	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.13	1	1				
BS-C6	6	7	WHELK		<i>Dicathais textilosa</i>	2.73						
BS-C6	6	7	WARRENER		<i>Subnirrella undulata</i>	1.09		3				

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	6	7	WARRENER		<i>Subnirrella undulata</i>	2.39	2					
BS-C6	6	7	UNIDENTIFIABLE			0.91						
BS-C6	7	3	PERIWINKLE		<i>Austrocochlea constricta</i>	2.13	15	1				
BS-C6	7	3	PERIWINKLE		<i>A. concamerata</i>	5.40	8	5				
BS-C6	7	3	LIMPET		<i>Cellana solida</i>	1.68	2					
BS-C6	7	3	MUSSEL		<i>Hormomya erosa</i>	2.66					2	1
BS-C6	7	3	WARRENER		<i>Subnirrella undulata</i>	2.13	6					
BS-C6	7	3	WHELK			1.16						
BS-C6	7	3	WARRENER		<i>Subnirrella undulata</i>	3.51		11				
BS-C6	7	3	UNIDENTIFIABLE			23.58						
BS-C6	7	3	OTHER	Cerithiidae		0.37	2		3			
BS-C6	7	7	PERIWINKLE		<i>A. concamerata</i>	6.60		8				
BS-C6	7	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.95	2	4				
BS-C6	7	7	MUSSEL		<i>Hormomya erosa</i>	11.53					2	2
BS-C6	7	7	LIMPET		<i>Cellana solida</i>	42.95	14	6	2			
BS-C6	7	7	WHELK			7.12						
BS-C6	7	7	WHELK		<i>Dicathais textilosa</i>	3.60	2			1		
BS-C6	7	7	WARRENER		<i>Subnirrella undulata</i>	1.64		3				
BS-C6	7	7	OTHER	Cerithiidae		0.26			2			
BS-C6	7	7	WARRENER		<i>Subnirrella undulata</i>	9.70	5					
BS-C6	7	7	OTHER	limpet<10mm		0.19			2			
BS-C6	7	7	OTHER	Hippomyx		0.45			2			

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	7	7	OTHER	Bivalves		0.12			1			
BS-C6	7	7	OTHER	Muricidae		0.15	1					
BS-C6	8	3	PERIWINKLE		<i>A. concamerata</i>	4.05	9	4				
BS-C6	8	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.95	13	2				
BS-C6	8	3	WARRENER		<i>Subrinella undulata</i>	0.91	1					
BS-C6	8	3	WARRENER		<i>Subrinella undulata</i>	1.37		6				
BS-C6	8	3	MUSSEL		<i>Hormomya erosa</i>	1.98						1
BS-C6	8	3	WHELK			0.32						
BS-C6	8	3	UNIDENTIFIABLE			15.72						
BS-C6	8	3	OTHER	Cerithiidae		0.42	2		3			
BS-C6	8	7	PERIWINKLE		<i>A. concamerata</i>	5.85	1	6				
BS-C6	8	7	PERIWINKLE		<i>Austrocochlea constricta</i>	2.39	2	3				
BS-C6	8	7	WARRENER		<i>Subrinella undulata</i>	37.01	6					
BS-C6	8	7	WARRENER		<i>Subrinella undulata</i>	0.84		2				
BS-C6	8	7	WHELK			2.51	1					
BS-C6	8	7	MUSSEL		<i>Hormomya erosa</i>	9.26						
BS-C6	8	7	UNIDENTIFIABLE			4.32						
BS-C6	8	7	OTHER		sea urchin	0.24						
BS-C6	8	7	LIMPET		<i>Cellana solida</i>	38.21	6	2	3			
BS-C6	9	3	PERIWINKLE		<i>A. concamerata</i>	3.08	5	5				
BS-C6	9	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.41	7	2				
BS-C8	9	3	UNIDENTIFIABLE			7.34						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	9	3	WARRENER		<i>Subninella undulata</i>	1.91		10				
BS-C6	9	3	WARRENER		<i>Subninella undulata</i>	0.62						
BS-C6	9	3	LIMPET		<i>Cellana solida</i>	0.48						
BS-C6	9	3	OTHER	Cerithiidae		0.27	3		4			
BS-C6	9	3	MUSSEL		<i>Hormomya erosa</i>	1.68						
BS-C6	9	7	PERIWINKLE		<i>A. concamerata</i>	4.09	4	4				
BS-C6	9	7	PERIWINKLE		<i>Austrocochlea constricta</i>	2.48	2	5				
BS-C6	9	7	MUSSEL		<i>Hormomya erosa</i>	6.49					3	
BS-C6	9	7	WARRENER		<i>Subninella undulata</i>	2.62	2					
BS-C6	9	7	WARRENER		<i>Subninella undulata</i>	0.79		3				
BS-C6	9	7	WHELK			0.81						
BS-C6	9	7	LIMPET		<i>Cellana solida</i>	12.43	5	1	2			
BS-C6	10	3	PERIWINKLE		<i>A. concamerata</i>	3.84	7	7				
BS-C6	10	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.89	5	3				
BS-C6	10	3	WARRENER		<i>Subninella undulata</i>	0.66		3				
BS-C6	10	3	WARRENER		<i>Subninella undulata</i>	1.36	3					
BS-C6	10	3	OTHER		sea urchin	0.07						
BS-C6	10	3	UNIDENTIFIABLE			8.60						
BS-C6	10	3	MUSSEL		<i>Hormomya erosa</i>	1.19					1	
BS-C6	10	3	LIMPET		<i>Cellana solida</i>	1.12	2					
BS-C6	10	3	OTHER	Cerithiidae		0.08	1		1			
BS-C6	10	7	PERIWINKLE		<i>A. concamerata</i>	3.89		5				

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	10	7	PERIWINKLE		<i>Austrocochlea constricta</i>	1.31	2	1				
BS-C6	10	7	WHELK			2.17						
BS-C6	10	7	WHELK		<i>Dicathais textilosa</i>	2.61	2					
BS-C6	10	7	WARRENER		<i>Subninella undulata</i>	10.31	3					
BS-C6	10	7	WARRENER		<i>Subninella undulata</i>	0.36		1				
BS-C6	10	7	MUSSEL		<i>Hormomya erosa</i>	9.02					2	1
BS-C6	10	7	LIMPET		<i>Cellana solida</i>	24.09	4	2	1			
BS-C6	10	7	OTHER	Gastropod		0.38	1		2			
BS-C6	11	3	PERIWINKLE		<i>A. concamerata</i>	3.45	6	3				
BS-C6	11	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.99	4	1				
BS-C6	11	3	WHELK		<i>Pleuroploca australasia</i>	0.19						
BS-C6	11	3	WHELK			0.62						
BS-C6	11	3	UNIDENTIFIABLE			11.39						
BS-C6	11	3	CRUSTACEA		<i>Jasus lalandei?</i>	0.08					1	
BS-C6	11	3	LIMPET		<i>Cellana solida</i>	0.31	1					
BS-C6	11	3	WARRENER		<i>Subninella undulata</i>	1.04	3					
BS-C6	11	3	WARRENER		<i>Subninella undulata</i>	1.35		6				
BS-C6	11	3	MUSSEL		<i>Hormomya erosa</i>	1.76						
BS-C6	11	3	OTHER	Cerithiidae		0.45	2		4			
BS-C6	11	7	PERIWINKLE		<i>A. concamerata</i>	6.68		5				
BS-C6	11	7	PERIWINKLE		<i>Austrocochlea constricta</i>	2.77	3	1				
BS-C6	11	7	WHELK		<i>Dicathais textilosa</i>	2.67						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	11	7	WHELK			6.21						
BS-C6	11	7	WARRENER		<i>Subnirrella undulata</i>	10.01	6					
BS-C6	11	7	WARRENER		<i>Subnirrella undulata</i>	0.84		2				
BS-C6	11	7	MUSSEL		<i>Homomya erosa</i>	11.54					2	1
BS-C6	11	7	LIMPET		<i>Cellana solida</i>	17.51	3		2			
BS-C6	12	3	WARRENER		<i>Subnirrella undulata</i>	1.68		9				
BS-C6	12	3	WARRENER		<i>Subnirrella undulata</i>	1.34	3					
BS-C6	12	3	LIMPET		<i>Cellana solida</i>	0.09						
BS-C6	12	3	OTHER	Cerithiidae		0.01	1					
BS-C6	12	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.94	9	1				
BS-C6	12	3	PERIWINKLE		<i>A. concamerata</i>	2.40	6	2				
BS-C6	12	3	MUSSEL		<i>Homomya erosa</i>	0.16						
BS-C6	12	3	UNIDENTIFIABLE			4.69						
BS-C6	12	7	WHELK		<i>Pleuroploca australasia</i>	3.10				1		
BS-C6	12	7	PERIWINKLE		<i>Austrocochlea constricta</i>	2.88	2	3				
BS-C6	12	7	PERIWINKLE		<i>A. concamerata</i>	5.98	1	6				
BS-C6	12	7	OTHER	Bivalves		0.13						
BS-C6	12	7	WARRENER		<i>Subnirrella undulata</i>	1.51		5				
BS-C6	12	7	WHELK			3.01	1					
BS-C6	12	7	WHELK		<i>Dicathais textilosa</i>	3.42	2	2				
BS-C6	12	7	MUSSEL		<i>Homomya erosa</i>	5.37						1
BS-C6	12	7	WARRENER		<i>Subnirrella undulata</i>	6.11	3					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	12	7	LIMPET		<i>Cellana solida</i>	17.32	3	1	2			
BS-C6	13	3	OTHER	Cerithiidae		0.27	1		3			
BS-C6	13	3	MUSSEL		<i>Homomya erosa</i>	1.79						
BS-C6	13	3	LIMPET		<i>Cellana solida</i>	0.32						
BS-C6	13	3	PERIWINKLE		<i>A. concamerata</i>	2.52	5	4				
BS-C6	13	3	PERIWINKLE		<i>Austrocochlea constricta</i>	1.01	4	2				
BS-C6	13	3	WHELK			0.27						
BS-C6	13	3	WARRENER		<i>Subninella undulata</i>	1.19	2					
BS-C6	13	3	WARRENER		<i>Subninella undulata</i>	0.52		3				
BS-C6	13	3	UNIDENTIFIABLE			3.77						
BS-C6	13	7	MUSSEL		<i>Homomya erosa</i>	3.14						2
BS-C6	13	7	PERIWINKLE		<i>A. concamerata</i>	0.96		2				
BS-C6	13	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.45	1	1				
BS-C6	13	7	UNIDENTIFIABLE			0.55						
BS-C6	13	7	WARRENER		<i>Subninella undulata</i>	3.21	1					
BS-C6	13	7	WARRENER		<i>Subninella undulata</i>	1.25		3				
BS-C6	13	7	WHELK		<i>Dicathais textilosa</i>	4.14				1		
BS-C6	13	7	LIMPET		<i>Patellanax peroni</i>	0.75			1			
BS-C6	13	7	LIMPET		<i>Cellana solida</i>	8.58	3		1			
BS-C6	14	3	OTHER		sea urchin	0.03						
BS-C6	14	3	OTHER	Littorinidae		0.16						
BS-C6	14	3	UNIDENTIFIABLE			5.04						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	14	3	LIMPET		<i>Cellana solida</i>	0.47						
BS-C6	14	3	WHELK			0.62						
BS-C6	14	3	WARRENER		<i>Subninella undulata</i>	0.85	4					
BS-C6	14	3	PERIWINKLE		<i>A. concamerata</i>	0.84	2	1				
BS-C6	14	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.86	3	2				
BS-C6	14	3	OTHER	Cerithiidae		0.54			3			
BS-C6	14	7	WARRENER		<i>Subninella undulata</i>	0.21	5					
BS-C6	14	7	LIMPET		<i>Cellana solida</i>	11.79	4	1	2			
BS-C6	14	7	WHELK			18.06						
BS-C6	14	7	LIMPET		<i>Patellanax peroni</i>	1.22			1			
BS-C6	14	7	OTHER	limpet<10mm		0.41			1			
BS-C6	14	7	OTHER	Bivalves		0.80						
BS-C6	14	7	PERIWINKLE		<i>A. concamerata</i>	2.51	1	4				
BS-C6	14	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.90						
BS-C6	14	7	MUSSEL		<i>Homomya erosa</i>	2.73					1	1
BS-C6	15	3	OTHER	limpet<10mm		0.06			1			
BS-C6	15	3	OTHER	Muricidae		0.09			1			
BS-C6	15	3	PERIWINKLE		<i>A. concamerata</i>	0.91	3					
BS-C6	15	3	OTHER	Cerithiidae		0.11			1			
BS-C6	15	3	WHELK			0.18						
BS-C6	15	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.55	4					
BS-C6	15	3	WARRENER		<i>Subninella undulata</i>	0.36		1				

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	15	3	WARRENER		<i>Subninella undulata</i>	1.05	1					
BS-C6	15	3	MUSSEL		<i>Homomya erosa</i>	0.76						
BS-C6	15	3	UNIDENTIFIABLE			2.71						
BS-C6	15	7	MUSSEL		<i>Homomya erosa</i>	3.29						
BS-C6	15	7	PERIWINKLE		<i>Austrocochlea constricta</i>	2.31	1	1				
BS-C6	15	7	PERIWINKLE		<i>A. concamerata</i>	4.46	2	6				
BS-C6	15	7	WARRENER		<i>Subninella undulata</i>	0.43		1				
BS-C6	15	7	WARRENER		<i>Subninella undulata</i>	16.90	6					
BS-C6	15	7	LIMPET		<i>Cellana solida</i>	11.66	2		1			
BS-C6	16	3	WARRENER		<i>Subninella undulata</i>	0.93		3				
BS-C6	16	3	MUSSEL		<i>Homomya erosa</i>	0.67						1
BS-C6	16	3	LIMPET		<i>Cellana solida</i>	0.53						
BS-C6	16	3	OTHER	Gastropod		0.18			3			
BS-C6	16	3	UNIDENTIFIABLE			4.41						
BS-C6	16	3	PERIWINKLE		<i>A. concamerata</i>	1.37	2	2				
BS-C6	16	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.69	6					
BS-C6	18	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.60						
BS-C6	16	7	PERIWINKLE		<i>A. concamerata</i>	4.31		4				
BS-C6	16	7	WARRENER		<i>Subninella undulata</i>	0.86		2				
BS-C6	16	7	MUSSEL		<i>Homomya erosa</i>	7.42					3	2
BS-C6	16	7	WHELK		<i>Dicathais textilosa</i>	2.32	1					
BS-C6	16	7	WARRENER		<i>Subninella undulata</i>	14.32	6					

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	16	7	LIMPET		<i>Cellana solida</i>	12.06	3	2				
BS-C6	17	3	UNIDENTIFIABLE			6.45						
BS-C6	17	3	MUSSEL		<i>Hormomya erosa</i>	1.16						
BS-C6	17	3	WARRENER		<i>Subninella undulata</i>	0.60		2				
BS-C6	17	3	WARRENER		<i>Subninella undulata</i>	0.62						
BS-C6	17	3	WHELK			0.58						
BS-C6	17	3	LIMPET		<i>Cellana solida</i>	0.84						
BS-C6	17	3	PERIWINKLE		<i>A. concamerata</i>	0.87	1	2				
BS-C6	17	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.94	5					
BS-C6	17	7	MUSSEL		<i>Hormomya erosa</i>	8.58					3	2
BS-C6	17	7	ABALONE		<i>Haliotis</i>	1.27						
BS-C6	17	7	WHELK		<i>Dicathais textilosa</i>	4.91						
BS-C6	17	7	PERIWINKLE		<i>A. concamerata</i>	4.99	1	5				
BS-C6	17	7	UNIDENTIFIABLE			1.53						
BS-C6	17	7	LIMPET		<i>Cellana solida</i>	16.41	6	1	2			
BS-C6	17	7	OTHER	limpet<10mm		0.45			1			
BS-C6	17	7	PERIWINKLE		<i>Austrocochlea constricta</i>	3.92		6				
BS-C6	17	7	WARRENER		<i>Subninella undulata</i>	13.98	6					
BS-C6	17	7	WARRENER		<i>Subninella undulata</i>	0.63		1				
BS-C6	18	3	PERIWINKLE		<i>A. concamerata</i>	0.18	1	1				
BS-C6	18	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.49	3					
BS-C6	18	3	WARRENER		<i>Subninella undulata</i>	0.46		2				

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	18	3	OTHER	limpet<10mm		0.03			1			
BS-C6	18	3	OTHER	Muricidae		0.04			1			
BS-C6	18	3	MUSSEL		<i>Homomya erosa</i>	0.21						
BS-C6	18	3	WARRENER		<i>Subninella undulata</i>	0.51	2					
BS-C6	18	3	UNIDENTIFIABLE			3.62						
BS-C6	18	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.08						
BS-C6	18	7	PERIWINKLE		<i>A. concamerata</i>	1.81		1				
BS-C6	18	7	UNIDENTIFIABLE			1.26						
BS-C6	18	7	WARRENER		<i>Subninella undulata</i>	4.19	3					
BS-C6	18	7	WARRENER		<i>Subninella undulata</i>	0.09		1				
BS-C6	18	7	WHELK		<i>Dicathais textilosa</i>	2.25						
BS-C6	18	7	MUSSEL		<i>Homomya erosa</i>	1.57						
BS-C6	18	7	LIMPET		<i>Cellana solida</i>	2.77	1	1				
BS-C6	19	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.16						
BS-C6	19	3	PERIWINKLE		<i>A. concamerata</i>	0.37						
BS-C6	19	3	WARRENER		<i>Subninella undulata</i>	0.10						
BS-C6	19	3	UNIDENTIFIABLE			1.75						
BS-C6	19	7	MUSSEL		<i>Homomya erosa</i>	0.85						
BS-C6	19	7	WHELK			0.84						
BS-C6	19	7	LIMPET		<i>Cellana solida</i>	2.17						
BS-C6	19	7	WARRENER		<i>Subninella undulata</i>	0.38						
BS-C6	19	7	WARRENER		<i>Subninella undulata</i>	2.95						

SQUARE	SPIT	SIEVE SIZE	TYPE CATEGORY	FAMILY	SPECIES	Wt gm	No. protoconch	No. rims operculum	No. whole	No. columella tail	No. umbo L	No. umbo R
BS-C6	19	7	PERIWINKLE		<i>A. concamerata</i>	0.82						
BS-C6	19	7	PERIWINKLE		<i>Austrocochlea constricta</i>	0.51						
BS-C6	20	3	UNIDENTIFIABLE			0.31						
BS-C6	20	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.18		1				
BS-C6	20	3	PERIWINKLE		<i>A. concamerata</i>	0.41						
BS-C6	20	3	WARRENER		<i>Subninella undulata</i>	0.14						
BS-C6	20	7	PERIWINKLE		<i>A. concamerata</i>	1.11	2	2				
BS-C6	20	7	LIMPET		<i>Cellana solida</i>	3.27			1			
BS-C6	21	3	PERIWINKLE		<i>Austrocochlea constricta</i>	0.07	1					
BS-C6	21	3	UNIDENTIFIABLE			0.23						
BS-C6	21	7	MUSSEL		<i>Hormomya erosa</i>	0.29						
BS-C6	21	7	LIMPET		<i>Cellana solida</i>	0.65	1					
BS-C6	22	3				0.00						
BS-C6	22	7				0.00						
BS-C6	23	3				0.00						
BS-C6	23	7	PERIWINKLE		<i>A. concamerata</i>	0.16						
BS-C6	24	3				0.00						
BS-C6	24	7				0.00						

APPENDIX V

Beeton Rockshelter: Comparative results of shell MNIs using
shell weight and diagnostic trait methods

APPENDIX V

Comparative results of shell MNIs using shell weight and diagnostic trait methods

SPECIES	MNI by shell weight	MNI by diagnostic trait
<i>Austrochlea cocanmerata</i>	148	580
<i>Austrochlea constricta</i>	71	522
<i>Nerita atramentosa</i>	1	1
<i>Dicathais textilosa</i>	6	31
<i>Pleuroploca australasia</i>	1	4
<i>Cabestana spengleri</i>	1	3
<i>Subninella undulata</i>	66	632
<i>Cellana solida</i>	129	586
<i>Patellanax peroni</i>	3	4
<i>Mytilus planulatus</i>	1	3
<i>Hormomya erosa</i>	63	90
<i>Haliotis</i> sp.	1	3

APPENDIX VI

Beeton Rockshelter: Data base bone - unburnt and burnt

Faunal Database Element Key

1	maxilla
2	mandible
3	cranium
4	teeth
5	vertebrae
6	ribs
7	clavicle
8	scapula
9	humerus
10	radius
11	ulna
12	femur
13	tibia
14	fibula
15	pelvis
16	carpals/metacarpals/tarsals/ metatarsals/phalanges/claws
17	unidentifiable (fragmented bone)

Beeton Rockshelter - squares D9 and C6

Burnt Bone

Square	Spit	Size	Family	Species other	element no.	left no.	right	Total no.	Wt gm
BS C6	30	medium	Macropodidae		16	0	0	1	0.21
BS C6	29	medium	unidentifiable	fragments <20mm	17	0	0	3	0.12
BS C6	28	medium	Peramelidae		04	0	0	3	0.07
BS C6	28	small	not identified			0	0	1	0.26
BS C6	28	small	unidentifiable	fragments <20mm	17	0	0	25	0.39
BS C6	28	medium	unidentifiable	fragments <20mm	17	0	0	13	1.41
BS C6	27	small	Muridae		16	0	0	1	0.02
BS C6	27	medium	not identified			0	0	1	0.31
BS C6	27	medium	unidentifiable	fragments <20mm	17	0	0	2	0.24
BS C6	27	small	unidentifiable	fragments <20mm	17	0	0	17	0.47
BS C6	26	small	Muridae		04	0	0	3	0.01
BS C6	26	medium	not identified		16	0	0	1	0.03
BS C6	26	small	Muridae		16	0	0	2	0.02
BS C6	26	medium	Macropodidae		16	0	0	2	0.02
BS C6	26	small	unidentifiable	fragments <20mm	17	0	0	15	0.36
BS C6	26	med. & large	unidentifiable	fragments <20mm	17	0	0	13	0.58
BS C6	25	small & medium	Murid. & Peram.		05	0	0	3	0.03
BS C6	25	medium	Peramelidae		16	0	0	1	0.02
BS C6	25	small	unidentifiable	fragments <20mm	17	0	0	37	1.04

Square	Spit	Size	Family	Species other	element no.	left no.	right	Total no.	Wt gm
BS C6	25	medium	unidentifiable	fragments <20mm	17	0	0	6	0.36
BS C6	24	small	Muridae		01	0	0	1	0.05
BS C6	24	small	Muridae		04	0	0	3	0.08
BS C6	24	medium	not identified		1	0	0	1	0.15
BS C6	24	small	not identified		1	0	0	1	0.13
BS C6	24	large	Macropodidae		16	0	0	1	0.58
BS C6	24	small	unidentifiable	fragments <20mm	17	0	0	13	0.38
BS C6	24	med. & large	unidentifiable	fragments <20mm	17	0	0	24	2.99
BS C6	23	small	Muridae		01	0	0	2	0.15
BS C6	23	medium	Peramelidae		04	0	0	1	0.01
BS C6	23	small & medium	Murid. & Peram.		05	0	0	1	0.01
BS C6	23	medium	Peramelidae		16	0	0	2	0.14
BS C6	23	small	unidentifiable	fragments <20mm	17	0	0	16	0.27
BS C6	23	med. & large	unidentifiable	fragments <20mm	17	0	0	21	1.97
BS C6	23	med. & large	unidentifiable	fragments >20 mm	17	0	0	1	0.72
BS C6	22	small	Muridae		12	0	0	1	0.08
BS C6	22	small	Muridae		11	0	0	1	0.06
BS C6	22	medium	Peramelidae		04	0	0	1	0.06
BS C6	22	medium	Macropodidae		16	0	0	1	0.09

Square	Spit	Size	Family	Species	other	element no.	left no.	right	Total no.	Wt gm
BS C6	22	small	unidentifiable	fragments <20mm		17	0	0	7	0.19
BS C6	22	med. & large	unidentifiable	fragments <20mm		17	0	0	10	0.81
BS C6	22	med. & large	unidentifiable	fragments >20 mm		17	0	0	1	0.80
BS C6	21	med. & large	unidentifiable	fragments <20mm		17	0	0	39	3.22
BS C6	20	large	Vombatidae			04	0	0	1	0.19
BS C6	20	med. & large	unidentifiable	fragments <20mm		17	0	0	27	3.41
BS C6	20	med. & large	Petauridae	Pseudocheirus peregrinus		17	0	0	4	3.34
BS C6	19	large	unidentifiable	fragments <20mm		17	0	0	2	3.15
BS C6	19	med. & large	unidentifiable	fragments <20mm		17	0	0	4	0.37
BS C6	19	small	unidentifiable	fragments <20mm		17	0	0	9	0.32
BS C6	18	large	Macropodidae	Macropus rufogriseus		04	0	0	1	0.20
BS C6	18	medium	Macropodidae			16	0	0	1	0.14
BS C6	18	small	unidentifiable	fragments <20mm		17	0	0	5	0.07
BS C6	18	med. & large	unidentifiable	fragments <20mm		17	0	0	62	8.33
BS C6	17	medium	Macropodidae			04	0	0	3	0.23
BS C6	17	large	Vombatidae			04	0	0	2	0.51
BS C6	17	medium	Macropodidae			16	0	0	2	0.25
BS C6	17	small	unidentifiable	fragments <20mm		17	0	0	8	0.29
BS C6	17	med. & large	unidentifiable	fragments <20mm		17	0	0	179	20.41

Square	Spit	Size	Family	Species	other	element no.	left no.	right	Total no.	Wt gm
BS C6	17	med. & large	unidentifiable	fragments >20 mm		17	0	0	4	2.33
BS C6	16	large	Macropodidae			04	0	0	1	0.25
BS C6	16	medium	Macropodidae			04	0	0	1	0.04
BS C6	16	large	Vombatidae			04	0	0	4	0.55
BS C6	16	medium	Macropodidae			16	0	0	2	0.34
BS C6	16	med. & large	Macropodidae			16	0	0	3	0.73
BS C6	16	small	unidentifiable	fragments <20mm		17	0	0	14	0.36
BS C6	16	med. & large	unidentifiable	fragments <20mm		17	0	0	298	37.55
BS C6	16	med. & large	unidentifiable	fragments >20 mm		17	0	0	3	0.84
BS C6	15	large	Macropodidae			04	0	0	1	0.24
BS C6	15	large	Vombatidae			04	0	0	6	0.79
BS C6	15	med. & large	Macropodidae			16	0	0	2	0.13
BS C6	15	small	unidentifiable	fragments <20mm		17	0	0	26	1.33
BS C6	15	med. & large	unidentifiable	fragments <20mm		17	0	0	412	50.32
BS C6	15	med. & large	unidentifiable	fragments >20 mm		17	0	0	2	0.86
BS C6	14	large	unidentifiable	fragments <20mm		17	0	0	2	2.86
BS C6	14	medium	Macropodidae	Thylogale billardieri		04	0	0	2	0.17
BS C6	14	large	Vombatidae			04	0	0	7	2.52
BS C6	14	med. & large	not identified				0	0	5	1.27

Square	Spit	Size	Family	Species other	element no.	left no.	right	Total no.	Wt gm
BS C6	14	small	unidentifiable	fragments <20mm	17	0	0	13	0.61
BS C6	14	med. & large	unidentifiable	fragments <20mm	17	0	0	6	4.55
BS C6	14	med. & large	unidentifiable	fragments >20 mm	17	0	0	480	28.30
BS C6	13	med. & large	Macropodidae		16	0	0	4	1.19
BS C6	13	large	Macropodidae		16	0	0	1	1.01
BS C6	13	medium	not identified	all other		0	0	1	0.43
BS C6	13	small	unidentifiable	fragments <20mm	17	0	0	4	0.20
BS C6	13	medium	Peramelidae		02	1	0	1	0.28
BS C6	13	medium	Macropodidae	Thylogale billardierii	04	0	0	1	0.07
BS C6	13	med. & large	Macropodidae		04	0	0	10	1.07
BS C6	13	large	Vombatidae		04	0	0	32	12.73
BS C6	13	large	unidentifiable	fragments <20mm	17	0	0	9	6.02
BS C6	13	large	unidentifiable	fragments >20 mm	17	0	0	3	4.95
BS C6	13	med. & large	unidentifiable	fragments <20mm	17	0	0	827	100.12
BS C6	13	med. & large	unidentifiable	fragments >20 mm	17	0	0	3	2.48
BS C6	12	medium	Peramelidae		02	0	0	1	0.17
BS C6	12	medium	Macropodidae		16	0	0	2	0.22
BS C6	12	small	unidentifiable	fragments <20mm	17	0	0	4	0.21
BS C6	12	large	unidentifiable	fragments >20 mm	17	0	0	2	3.71

Square	Spit	Size	Family	Species	other	element no.	left	no. right	Total no.	Wt gm
BS C6	12	med. & large	unidentifiable	fragments <20mm		17	0	0	900	131.20
BS C6	12	med. & large	unidentifiable	fragments >20 mm		17	0	0	15	12.20
BS C6	11	medium	Peramelidae			12	0	0	1	0.17
BS C6	11	medium	Macropodidae	Thylogale billardieri		04	0	0	2	0.16
BS C6	11	med. & large	Macropodidae			04	0	0	8	1.22
BS C6	11	med. & large	unidentifiable	fragments >20 mm		17	0	0	10	7.87
BS C6	11	med. & large	unidentifiable	fragments <20mm		17	0	0	666	84.82
BS C6	12	med. & large	unidentifiable	fragments >20 mm		17	0	0	15	12.20
BS C6	10	medium	Peramelidae			01	1	0	1	0.12
BS C6	10	large	Vombatidae			04	0	0	5	1.87
BS C6	10	medium	not identified			04	0	0	2	0.11
BS C6	10	large	Macropodidae	Macropus rufogriseus		04	0	0	2	0.57
BS C6	10	large	Macropodidae	Macropus rufogriseus		04	0	0	2	0.57
BS C6	10	med. & large	unidentifiable	fragments <20mm		17	0	0	367	51.62
BS C6	10	med. & large	unidentifiable	fragments >20 mm		17	0	0	4	3.58
BS C6	9	medium	Macropodidae			04	0	0	1	0.11
BS C6	9	med. & large	unidentifiable	fragments <20mm		17	0	0	218	29.61
BS C6	9	med. & large	unidentifiable	fragments >20 mm		17	0	0	3	4.76
BS C6	7	large	Macropodidae	Macropus giganteus		04	0	0	1	0.41

Square	Spit	Size	Family	Species other	element no.	left	no. right	Total no.	Wt gm
BS C6	8	med. & large	unidentifiable	fragments <20mm	17	0	0	5	6.42
BS C6	8	med. & large	unidentifiable	fragments >20 mm	17	0	0	115	22.77
BS C6	8	large	Vombatidae		04	0	0	1	0.21
BS C6	7	med. & large	Macropodidae		16	0	0	3	0.29
BS C6	7	med. & large	unidentifiable	fragments <20mm	17	0	0	124	19.58
BS C6	7	large	Macropodidae	fragments >20 mm	13	0	0	1	5.69
BS C6	6	med. & large	unidentifiable	fragments <20mm	17	0	0	29	5.17
BS C6	5	med. & large	unidentifiable	fragments <20mm	17	0	0	2	0.30
BS C6	4	med. & large	unidentifiable	fragments <20mm	17	0	0	4	0.32
BS D9	2	med. & large	unidentifiable	fragments <20mm	17			13	1.6
BS D9	3	med. & large	unidentifiable	fragments <20mm	17			9	1.83
BS D9	4	med. & large	unidentifiable	fragments >20mm	17			60	8.4
BS D9	5	med. & large	unidentifiable	fragments >20 mm	17			107	18.8
BS D9	6	med. & large	Macropodidae		13			1	3.8
BS D9	6	large	Vombatidae		4			1	4.37
BS D9	6	med. & large	Macropodidae		3			1	1.92
BS D9	6	small & medium	not identified		16			2	2.78
BS D9	6	med. & large	unidentifiable	fragments <20mm	17			98	17.95
BS D9	6	med. & large	unidentifiable	fragments >20 mm	17			1	1.97

Square	Spit	Size	Family	Species	other	element no.	left	no. right	Total no.	Wt gm
BS D9	7	med. & large	unidentifiable	fragments <20mm		17			107	15.2
BS D9	8	large	Macropodidae			4			1	0.5
BS D9	8	small	Reptile			5			1	0.3
BS D9	8	med. & large	unidentifiable			17			121	17.1
BS D9	9	med. & large	unidentifiable	fragments <20mm		17			111	16.06
BS D9	9	med. & large	unidentifiable	fragments >20 mm		17			5	4.57
BS D9	10	large	Macropodidae	fragments >20 mm		16			1	10.60
BS D9	10	med. & large	unidentifiable	fragments <20mm		17			193	23.32
BS D9	11	med. & large	unidentifiable	fragments <20mm		17			170	23.45
BS D9	11	med. & large	unidentifiable	fragments >20 mm		17			4	1.30
BS D9	12	large	Macropodidae			3			2	1.02
BS D9	12	med. & large	unidentifiable	fragments <20mm		17			202	27.60
BS D9	12	med. & large	unidentifiable	fragments >20 mm		17			4	5.03
BS D9	13	medium	Peramelidae			2		1	1	0.08
BS D9	13	medium	not identified			10			1	0.25
BS D9	13	med. & large	not identified			16			1	0.10
BS D9	13	med. & large	Macropodidae			3			3	0.85
BS D9	13	small	Muridae			12	1		1	0.05
BS D9	13	med. & large	not identified			17			71	19.72

Square	Spit	Size	Family	Species	other	element no.	left no.	right no.	Total no.	Wt gm
BS D9	14	small	Dasyuridae			2		1	1	.05
BS D9	14	med. & large	Macropodidae			3			3	.47
BS D9	14	medium	Peramelidae			16		1	1	.14
BS D9	14	medium	Macropodidae			26			2	.11
BS D9	14	large	unidentifiable	fragments <20mm		17			52	6.38
BS D9	14	medium	Macropodidae	Thylogale billardieri		1		1	1	2.01
BS D9	15	med. & large	unidentifiable	fragments <20mm		17			15	1.10
BS D9	16	med. & large	unidentifiable	fragments <20mm		17			8	1.91
BS D9	17	med. & large	unidentifiable	fragments <20mm		17			9	0.82
BS D9	18	medium	Peramelidae			8	1		1	0.1
BS D9	18	med. & large	not identified			17			8	1.0
BS D9	19	med. & large	unidentifiable	fragments >20 mm		17			4	0.6
BS D9	19	med. & large	Macropodidae			17			4	0.1
BS D9	19	small	not identified	all other					32	3.6
BS D9	19	medium	not identified	all other					20	15.77
BS D9	19	large	not identified	all other		16			3	1.81
BS D9	20	med. & large	unidentifiable	fragments <20mm		17			6	0.9
BS D9	21	medium	not identified			16			1	0.09
BS D9	21	med. & large	not identified			17			2	0.82

Beeton Rockshelter - squares D9 and C6

Unburnt Bone

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	4	small	Muridae	Rattus lutreolus	02	0	1	1	0.17
BS C6	4	small	Muridae		01	2	1	3	0.11
BS C6	4	small	Dasyuridae		02	0	1	1	0.03
BS C6	4	small	Muridae		12	1	0	1	0.07
BS C6	4	small	Muridae		09	1	2	4	0.10
BS C6	4	small	unidentifiable	fragments <20mm	17	0	0	4	0.11
BS C6	4	med. & large	unidentifiable	fragments <20mm	17	0	0	4	0.31
BS C6	4	small	not identified			0	0		0.22
BS C6	4	med. & large	Macropodidae		16	0	0	1	0.23
BS C6	4	small	not identified		12	0	0	1	0.08
BS C6	5	small	Muridae		09	0	0	4	0.06
BS C6	5	small	Muridae		12	2	3	5	0.55
BS C6	5	small	Muridae		04	0	0	2	0.02
BS C6	5	small	Dasyuridae		02	1	1	2	0.03
BS C6	5	small	Dasyuridae		09	0	0	3	0.03
BS C6	5	small	Muridae		01	0	1	1	0.01
BS C6	5	large	Macropodidae	Macropus giganteus	04	0	0	1	0.32
BS C6	5	small	not identified			0	0		1.02
BS C6	5	medium	not identified			0	0		0.52
BS C6	5	small	unidentifiable		17	0	0	33	0.47

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	5	small	not identified			0	0		0.02
BS C6	6	small	Dasyuridae		12	0	1	1	0.17
BS C6	6	small	Muridae		01	0	1	2	0.10
BS C6	6	small	Muridae		09	3	4	8	0.32
BS C6	6	medium	Macropodidae		04	0	0	2	0.11
BS C6	6	large	Vombatidae		04	0	0	1	0.38
BS C6	6	small	Muridae		02	2	1	3	0.25
BS C6	6	small	Muridae		04	0	0	2	0.01
BS C6	6	small	Muridae		12	0	2	4	0.24
BS C6	6	small	Dasyuridae		09	2	4	6	0.25
BS C6	6	small	not identified		0				0.01
BS C6	6	small	Frog		15	0	0	1	0.08
BS C6	6	small	not identified		17	0	0	33	0.63
BS C6	6	small	not identified		00	0	0	0	1.17
BS C6	6	med. & large	Macropodidae		03	0	0	1	0.52
BS C6	6	large	unidentifiable	fragments >20 mm	17	0	0	5	16.10
BS C6	6	large	unidentifiable	fragments <20mm	17	0	0	4	2.55
BS C6	6	med. & large	unidentifiable	fragments <20mm	17	0	0	121	19.20
BS C6	6	med. & large	unidentifiable	fragments >20 mm	17	0	0	6	3.46
BS C6	7	small	Frog		00			1	.17

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total	no.	Wt gm
BS C6	7	large	Macropodidae	Macropus giganteus	04	0	0	1		0.35
BS C6	7	large	Macropodidae		04	0	0	2		0.16
BS C6	7	large	Macropodidae	Macropus rufogriseus	04	0	0	3		0.51
BS C6	7	medium	Macropodidae	Bettongia gaimardi	04	0	0	1		0.08
BS C6	7	large	Vombatidae		14	0	0	3		0.48
BS C6	7	medium	Peramelidae		04	0	0	5		0.19
BS C6	7	medium	Peramelidae		01	1	0	1		0.09
BS C6	7	small	Muridae		01	3	2	5		0.40
BS C6	7	small	Muridae		02	2	1	3		0.59
BS C6	7	small	Muridae		09	2	2	4		0.15
BS C6	7	small	Muridae		12	1	1	2		0.12
BS C6	7	small	Reptile		3/5	0	0	2		0.15
BS C6	7	small	unidentifiable	fragments <20mm	17	0	0	150		4.45
BS C6	7	med. & large	unidentifiable	fragments <20mm	17	0	0	349		52.56
BS C6	7	med. & large	unidentifiable	fragments >20 mm	17	0	0	31		35.41
BS C6	7	medium	not identified			0	0			0.35
BS C6	7	small	not identified			0	0			0.40
BS C6	8	small	Muridae		01	2	3	5		0.55
BS C6	8	small	Muridae		02	0	1	1		0.21
BS C6	8	medium	Macropodidae	Thylogale billardierii	02	1	0	1		1.40

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	8	large	Macropodidae	Macropus giganteus	04	0	0	2	0.88
BS C6	8	large	Vombatidae		04	0	0	4	1.67
BS C6	8	large	Macropodidae	Macropus giganteus	04	0	0	1	0.17
BS C6	8	large	Macropodidae		04	0	0	2	0.35
BS C6	8	large	Macropodidae	Macropus giganteus	04	0	0	1	0.02
BS C6	8	medium	Macropodidae		09		1	1	0.92
BS C6	8	small	Muridae		12	0	2	4	0.22
BS C6	8	small	Muridae		09	0	0	3	0.05
BS C6	8	small	Reptile		??	0	0	1	0.02
BS C6	8	small	Dasyuridae		02	1	1	2	0.01
BS C6	8	small	unidentifiable	fragments <20mm	17	0	0	65	2.21
BS C6	8	small	not identified			0	0		0.25
BS C6	8	medium	not identified			0	0		0.35
BS C6	8	large	not identified			0	0		2.35
BS C6	8	med. & large	unidentifiable	fragments <20mm	17	0	0	362	73.26
BS C6	8	med. & large	unidentifiable	fragments >20 mm	17	0	0	35	27.66
BS C6	8	large	unidentifiable	fragments <20mm	17	0	0	11	49.57
BS C6	9	small	Muridae		01	1	0	1	0.01
BS C6	9	small	Muridae		12	0	2	2	0.16
BS C6	9	small	Muridae		09	2	1	3	0.15

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	9	small	Dasyuridae		09	3	0	3	0.19
BS C6	9	small	Muridae		02	2	0	2	0.18
BS C6	9	large	Vombatidae		04	0	0	4	2.84
BS C6	9	medium	Peramelidae		02	0	1	1	0.12
BS C6	9	large	Macropodidae	Macropus rufogriseus	02	1	0	1	4.04
BS C6	9	large	Macropodidae	Macropus giganteus	04	0	0	5	3.29
BS C6	9	small	not identified		17	0	0	46	1.28
BS C6	9	large	unidentifiable	fragments <20mm	17	0	0	2	2.48
BS C6	9	large	unidentifiable	fragments >20 mm	17	0	0	5	20.08
BS C6	9	small	not identified			0	0		0.10
BS C6	9	medium	not identified			0	0		1.32
BS C6	9	large	not identified			0	0		2.80
BS C6	9	med. & large	unidentifiable	fragments <20mm	17	0	0	423	71.86
BS C6	9	med. & large	unidentifiable	fragments >20 mm	17	0	0	28	23.28
BS C6	10	large	Macropodidae		02	1	0	1	2.67
BS C6	10	large	Macropodidae	Macropus rufogriseus	04	0	0	2	0.33
BS C6	10	large	Vombatidae		04	0	0	3	0.58
BS C6	10	medium	Macropodidae	Potorous tridactylus	04	0	0	1	0.08
BS C6	10	small	Muridae		02	2	0	2	0.14
BS C6	10	small	Muridae		12	1	2	4	0.27

Square	Split	Size	Family	Species	other	element	no. left	no. right	Total no.	Wt gm
BS C6	10	small	Dasyuridae			09	0	0	1	0.03
BS C6	10	small	Dasyuridae			02	0	0	1	1.03
BS C6	10	small	not identified							2.68
BS C6	10	medium	not identified							0.62
BS C6	10	med. & large	unidentifiable	fragments <20mm		17	0	0	593	77.37
BS C6	10	medium	Peramelidae			04	0	0	1	0.03
BS C6	10	med. & large	unidentifiable	fragments >20 mm		17	0	0	20	13.52
BS C6	10	large	unidentifiable	fragments >20 mm		17	0	0	32	67.25
BS C6	10	large	unidentifiable	fragments <20mm		17	0	0	6	4.60
BS C6	11	large	Vombatidae			04	0	0	8	6.31
BS C6	11	small	Muridae			02	0	1	1	0.18
BS C6	11	small	Muridae			12	0	1	3	0.17
BS C6	11	large	Macropodidae	Macropus rufogriseus		02	1	0	1	6.38
BS C6	11	medium	Macropodidae			04	0	0	1	0.23
BS C6	11	small	Muridae			09	1	0	1	0.02
BS C6	11	small	Reptile			02	0	0	1	0.10
BS C6	11	medium	Macropodidae	Potorous tridactylus		01	1	0	1	0.43
BS C6	11	medium	Peramelidae			01	0	0	1	0.10
BS C6	11	medium	Macropodidae	Thylogale billardieri		04	0	0	1	0.11
BS C6	11	large	Macropodidae			04	0	0	2	0.47

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	11	medium	Peramelidae		02	1	0	1	2.23
BS C6	11	small	not identified			0	0		1.00
BS C6	11	medium	not identified			0	0		2.40
BS C6	11	small	unidentifiable	fragments <20mm	17	0	0	44	1.38
BS C6	11	large	unidentifiable	fragments <20mm	17	0	0	6	7.61
BS C6	11	large	unidentifiable	fragments >20 mm	17	0	0	12	54.73
BS C6	11	med. & large	unidentifiable	fragments <20mm	17	0	0	663	80.50
BS C6	11	med. & large	unidentifiable	fragments >20 mm	17	0	0	38	24.48
BS C6	12	medium	Macropodidae	Potorous tridactylus	04	0	0	1	0.31
BS C6	12	medium	Macropodidae	Thylogale billardieri	04	0	0	1	0.12
BS C6	12	large	Macropodidae	Macropus rufogriseus	04	0	0	1	0.09
BS C6	12	large	Macropodidae	Macropus giganteus	04	0	0	4	1.24
BS C6	12	large	Vombatidae		04	0	0	11	2.62
BS C6	12	small	Muridae		01	2	0	2	0.07
BS C6	12	small	Dasyuridae		01	0	1	1	0.04
BS C6	12	large	Vombatidae		01	1	0	1	0.20
BS C6	12	small	Muridae		02	1	2	3	0.33
BS C6	12	small	Muridae		09	1	0	1	0.02
BS C6	12	small	not identified						0.75
BS C6	12	medium	not identified						0.18

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	12	med. & large	unidentifiable	fragments <20mm	17			344	57.77
BS C6	12	med. & large	unidentifiable	fragments >20 mm	17			18	13.20
BS C6	12	large	unidentifiable	fragments >20 mm	17			10	35.63
BS C6	12	large	not identified						2.73
BS C6	12	medium	Phalangeridae		01	1	1	2	1.68
BS C6	13	small	Muridae		09	1	1	3	0.19
BS C6	13	small	Muridae		12	0	1	1	0.14
BS C6	13	medium	Macropodidae	Potorous tridactylus	02	1		1	0.15
BS C6	13	small	Muridae		01	2		2	0.10
BS C6	13	small	Muridae		02	1		1	0.07
BS C6	13	medium	Macropodidae	Macropus rufogriseus	02	1	0	1	0.45
BS C6	13	medium	Peramelidae		04	0	0	2	0.01
BS C6	13	medium	Macropodidae	Thylogale billardieri	04	0	0	4	0.24
BS C6	13	large	Macropodidae	Macropus rufogriseus	04	0	0	8	2.88
BS C6	13	medium	Peramelidae		01	1	0	1	0.01
BS C6	13	large	unidentifiable	fragments >20 mm	17	0	0	4	11.94
BS C6	13	large	unidentifiable	fragments <20mm	17	0	0	1	0.51
BS C6	13	small & medium	not identified			0	0		0.54
BS C6	13	small	not identified			0	0		0.30
BS C6	13	med. & large	unidentifiable	fragments <20mm	17	0	0	388	58.22

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	13	med. & large	unidentifiable	fragments >20 mm	17	0	0	18	13.29
BS C6	14	large	Vombatidae		03	0	0	2	3.54
BS C6	14	medium	Peramelidae		02	0	0	1	0.05
BS C6	14	large	Macropodidae	Macropus rufogriseus	04	0	0	1	1.19
BS C6	14	small	Muridae		12	2	0	2	0.31
BS C6	14	small	Muridae		09	0	0	1	0.05
BS C6	14	small	unidentifiable	fragments <20mm	17	0	0	15	0.51
BS C6	14	large	unidentifiable	fragments >20 mm	17	0	0	9	11.43
BS C6	14	large	unidentifiable	fragments <20mm	17	0	0	1	1.23
BS C6	14	small	not identified			0	0		0.06
BS C6	14	medium	not identified			0	0		1.05
BS C6	14	med. & large	unidentifiable	fragments <20mm	17	0	0	220	32.44
BS C6	14	med. & large	unidentifiable	fragments >20 mm	17	0	0	6	2.64
BS C6	15	medium	Macropodidae		9	0	0	1	1.14
BS C6	15	large	Vombatidae		04	0	0	3	3.67
BS C6	15	large	Macropodidae	Macropus rufogriseus	04	0	0	1	0.15
BS C6	15	small	Muridae		09				0.01
BS C6	15	medium	Peramelidae		02	0	0	1	0.04
BS C6	15	small	Dasyuridae		02	2	0	2	0.03
BS C6	15	small	Muridae		01	1	2	4	0.36

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	15	small	Reptile		2+ 3	0	0	1	0.05
BS C6	15	small	not identified			0	0		0.19
BS C6	15	medium	not identified			0	0		1.20
BS C6	15	small	unidentifiable	fragments <20mm	17	0	0	27	1.25
BS C6	15	large	unidentifiable	fragments >20 mm	17	0	0	7	22.83
BS C6	15	large	unidentifiable	fragments <20mm	17	0	0	5	2.35
BS C6	15	med. & large	unidentifiable	fragments >20 mm	17	0	0	11	5.45
BS C6	15	med. & large	unidentifiable	fragments <20mm	17	0	0	323	22.10
BS C6	16	small	Muridae		02	0	1	1	0.06
BS C6	16	small	Muridae		04	0	0	2	0.06
BS C6	16	large	Vombatidae		04	0	0	2	1.83
BS C6	16	large	Macropodidae		04	0	0	1	0.05
BS C6	16	small	Frog		9+12	0	0	1	0.01
BS C6	16	small	Muridae		09	1	1	2	0.13
BS C6	16	small	Muridae		12	0	2	2	0.20
BS C6	16	small	unidentifiable	fragments <20mm	17	0	0	18	0.50
BS C6	16	small	unidentifiable	fragments <20mm	17	0	0	4	0.82
BS C6	16	large	unidentifiable	fragments >20 mm	17	0	0	14	14.93
BS C6	16	large	unidentifiable	fragments <20mm	17	0	0	206	33.42
BS C6	16	med. & large	unidentifiable	fragments >20 mm	17	0	0	7	4.12

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	16	small	not identified						0.17
BS C6	16	medium	not identified						1.70
BS C6	17	medium	Peramelidae		02	0	1	1	0.13
BS C6	17	medium	Peramelidae		04	0	0	1	0.11
BS C6	17	large	Vombatidae		04	0	0	2	0.26
BS C6	17	small	Phalangeridae	Cercartetus sp.	02	0	1	1	0.01
BS C6	17	small	Muridae		12	2	0	2	0.39
BS C6	17	medium	Dasyuridae	Sarcophilus harrisii	02	0	1	1	1.57
BS C6	17	small & medium	Peramelidae		01	0	1	1	0.25
BS C6	17	large	Macropodidae		02	1	0	1	3.86
BS C6	17	small	Muridae		01	2	0	2	0.10
BS C6	17	small	Frog		15	0	0	1	0.05
BS C6	17	small	not identified			0	0		0.02
BS C6	17	medium	not identified						1.90
BS C6	17	small	unidentifiable	fragments <20mm	17	0	0	27	1.03
BS C6	17	large	unidentifiable	fragments <20mm	17	0	0	1	0.52
BS C6	17	large	unidentifiable	fragments >20 mm	17	0	0	9	22.65
BS C6	17	med. & large	unidentifiable	fragments <20mm	17	0	0	165	22.23
BS C6	17	med. & large	unidentifiable	fragments >20 mm	17	0	0	9	6.86
BS C6	18	large	unidentifiable	fragments >20 mm	17	0	0	6	9.47

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	18	med. & large	unidentifiable	fragments <20mm	17	0	0	99	8.98
BS C6	18	med. & large	unidentifiable	fragments <20mm	17	0	0	3	1.64
BS C6	18	small	unidentifiable	fragments <20mm	17	0	0	5	0.25
BS C6	18	large	Vombatidae		04	0	0	2	0.17
BS C6	18	medium	Peramelidae		02	0	1	1	0.50
BS C6	18	large	Macropodidae	Macropus rufogriseus	16	0	0	1	0.67
BS C6	18	small	Dasyuridae		02	1	0	1	0.07
BS C6	18	small	Muridae		02	0	1	1	0.04
BS C6	18	large	Macropodidae	Macropus rufogriseus	04	1	0	1	0.16
BS C6	18	medium	Peramelidae		04	0	0	1	0.02
BS C6	18	small	not identified			0	0		0.06
BS C6	18	medium	not identified			0	0		0.12
BS C6	19	small	Muridae		02	0	1	1	0.03
BS C6	19	medium	Macropodidae	Thylogale billardieri	04	0	0	1	0.02
BS C6	19	medium	Peramelidae		01	0	1	1	0.13
BS C6	19	small	unidentifiable	fragments <20mm	17	0	0	11	0.35
BS C6	19	large	unidentifiable	fragments >20 mm	17	0	0	4	7.20
BS C6	19	large	Macropodidae		07	0	0	1	3.95
BS C6	19	small	not identified						0.10
BS C6	19	medium	not identified						0.78

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	19	med. & large	unidentifiable	fragments >20 mm	17	0	0	3	2.05
BS C6	19	med. & large	unidentifiable	fragments <20mm	17	0	0	143	15.00
BS C6	19	medium	Peramelidae		02	1	0	1	0.17
BS C6	20	small	Muridae		01	0	1	1	0.33
BS C6	20	medium	Peramelidae		16	0	0	2	0.35
BS C6	20	medium	Peramelidae		02	1	0	1	0.03
BS C6	20	med. & large	Macropodidae		04	0	0	1	0.11
BS C6	20	small	Muridae		12	0	1	1	0.13
BS C6	20	medium	Macropodidae		16	0	0	1	0.03
BS C6	20	large	Macropodidae		16	0	0	1	0.61
BS C6	20	small	unidentifiable	fragments <20mm	17	0	0	12	0.52
BS C6	20	med. & large	unidentifiable	fragments >20 mm	17	0	0	2	0.81
BS C6	20	med. & large	unidentifiable	fragments <20mm	17	0	0	23	2.98
BS C6	21	small	Muridae		12	0	0	1	0.03
BS C6	21	medium	Peramelidae		09	0	0	1	0.21
BS C6	21	small	Frog		15	0	0	1	0.07
BS C6	21	medium	Peramelidae		04	0	0	1	0.05
BS C6	21	small	Muridae		15	0	0	1	0.16
BS C6	21	medium	not identified			0	0		0.83
BS C6	21	small	unidentifiable	fragments <20mm	17	0	0	16	0.81

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	21	med. & large	unidentifiable	fragments >20 mm	17	0	0	2	5.96
BS C6	21	med. & large	unidentifiable	fragments <20mm	17	0	0	48	4.32
BS C6	22	small	Muridae		02	1	0	1	0.27
BS C6	22	small	Muridae		01	0	1	1	0.31
BS C6	22	small	Muridae		04	0	0	6	0.20
BS C6	22	medium	Peramelidae		16	0	0	1	0.36
BS C6	22	medium	not identified						0.23
BS C6	22	small	not identified						0.19
BS C6	22	small	unidentifiable	fragments <20mm	17	0	0	24	0.77
BS C6	22	med. & large	unidentifiable	fragments <20mm	17	0	0	18	2.92
BS C6	23	medium	Peramelidae		09	0	1	1	1.20
BS C6	23	small	Muridae		04	0	0	13	0.38
BS C6	23	small	Dasyuridae		02	1	0	1	0.05
BS C6	23	small	Muridae		09	0	0	1	0.08
BS C6	23	small	Muridae		02	2	2	4	0.36
BS C6	23	small	Muridae		01	0	0	1	0.12
BS C6	23	medium	Peramelidae		02	0	0	2	0.55
BS C6	23	medium	Peramelidae		16	0	0	1	0.16
BS C6	23	small	Muridae		12	1	0	1	0.32
BS C6	23	medium	Peramelidae		04	0	0	5	0.20

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	23	small	not identified						0.37
BS C6	23	medium	not identified						0.44
BS C6	23	small	unidentifiable	fragments <20mm	17	0	0	69	1.66
BS C6	23	med. & large	unidentifiable	fragments <20mm	17	0	0	43	4.85
BS C6	23	med. & large	unidentifiable	fragments >20 mm	17	0	0	3	1.56
BS C6	24	small	Muridae		04	0	0	20	0.63
BS C6	24	small	Muridae		09	1	0	7	0.20
BS C6	24	small	Muridae		12	0	0	4	0.32
BS C6	24	medium	Peramelidae		02	0	0	2	0.11
BS C6	24	medium	Macropodidae	Potorous tridactylus	04	0	0	1	0.07
BS C6	24	small	Muridae		02	1	0	1	0.48
BS C6	24	small	Muridae		01	1	1	5	0.70
BS C6	24	medium	Peramelidae		04	0	0	13	0.37
BS C6	24	medium	Macropodidae		04	0	0	1	0.13
BS C6	24	small	not identified			0	0		1.82
BS C6	24	medium	not identified						1.68
BS C6	24	small	unidentifiable	fragments <20mm	17	0	0	281	7.49
BS C6	24	med. & large	unidentifiable	fragments <20mm	17	0	0	117	18.04
BS C6	24	med. & large	unidentifiable	fragments >20 mm	17	0	0	5	3.82
BS C6	24	large	Macropodidae		04	0	0	1	0.30

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	25	medium	Peramelidae		04	0	0	12	0.22
BS C6	25	small	Muridae		04	0	0	12	0.33
BS C6	25	small	Muridae		09	0	1	5	0.19
BS C6	25	small	Muridae		12	1	0	1	0.01
BS C6	25	small	Muridae		02	1	1	2	0.18
BS C6	25	small	Muridae		01	1	0	1	0.08
BS C6	25	small	not identified						0.78
BS C6	25	medium	not identified						1.19
BS C6	25	small	unidentifiable	fragments <20mm	0	0	0	207	6.76
BS C6	25	med. & large	unidentifiable	fragments <20mm	0	0	0	42	4.66
BS C6	26	small	Muridae		01	0	1	3	0.26
BS C6	26	small	Muridae		12	0	1	1	0.04
BS C6	26	small	Muridae		09	0	0	9	0.22
BS C6	26	medium	Peramelidae		02	0	1	1	0.07
BS C6	26	small	Reptile		02	0	0	1	0.02
BS C6	26	small	Muridae		02	1	1	2	0.66
BS C6	26	small	Muridae		04	0	0	9	0.33
BS C6	26	medium	Peramelidae		04	0	0	4	0.05
BS C6	26	small	not identified			0	0		0.88
BS C6	26	medium	not identified						1.05

Square	Split	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	26	small	unidentifiable	fragments <20mm	17	0	0	96	1.14
BS C6	26	med. & large	unidentifiable	fragments <20mm	17	0	0	26	2.60
BS C6	27	small	Muridae		09	0	0	6	0.18
BS C6	27	small	Muridae		12	2	3	5	0.41
BS C6	27	small	Muridae		02	0	1	3	0.19
BS C6	27	small	Muridae		01	2	1	3	0.68
BS C6	27	small	Muridae		04	0	0	9	0.22
BS C6	27	medium	not identified			0	0		1.79
BS C6	27	small	not identified			0	0		1.63
BS C6	27	small	unidentifiable	fragments <20mm	17	0	0	149	2.91
BS C6	27	med. & large	unidentifiable	fragments <20mm	17	0	0	30	2.65
BS C6	27	med. & large	unidentifiable	fragments <20mm	17	0	0	1	0.33
BS C6	28	medium	Peramelidae		09	0	0	1	0.34
BS C6	28	small	Dasyuridae		12	0	1	1	0.25
BS C6	28	small	Muridae		04	0	0	10	0.39
BS C6	28	small	Muridae		01	1	1	2	0.48
BS C6	28	medium	Peramelidae		04	0	0	6	0.13
BS C6	28	small	Muridae		12	1	1	2	0.18
BS C6	28	small	Muridae		02	1	2	4	1.08
BS C6	28	medium	Peramelidae		02	0	1	1	0.13

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	28	small	Muridae		12	0	0	2	0.32
BS C6	28	small	not identified			0	0		1.12
BS C6	28	medium	not identified						1.41
BS C6	28	small	unidentifiable	fragments <20mm	17	0	0	69	1.38
BS C6	28	medium	unidentifiable	fragments <20mm	17	0	0	20	2.21
BS C6	29	small	Muridae		01	0	1	2	0.15
BS C6	29	medium	Peramelidae		04	0	0	1	0.05
BS C6	29	medium	Peramelidae		09	0	0	1	0.02
BS C6	29	small	not identified						0.40
BS C6	29	medium	not identified						0.12
BS C6	29	small	unidentifiable	fragments <20mm	17	0	0	9	0.18
BS C6	29	small	unidentifiable	fragments >20 mm	17	0	0	26	2.21
BS C6	30	medium	Macropodidae		16	0	0	2	0.10
BS C6	30	medium	unidentifiable	fragments <20mm	17	0	0	11	0.73
BS C6	31	medium	Peramelidae		16	0	0	2	0.16
BS C6	31	small	Muridae		13	0	0	1	0.11
BS C6	31	small	Muridae		11	0	0	1	0.05
BS C6	31	medium	Peramelidae		04	0	0	3	0.15
BS C6	31	small	Muridae		04	0	0	4	0.15
BS C6	31	small	Muridae		09	0	0	2	0.10

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	31	small	Muridae		16	0	0	1	0.04
BS C6	31	small & medium	not identified			0	0		0.72
BS C6	31	small & medium	unidentifiable	fragments <20mm	17	0	0	37	1.40
BS C6	32	small	Muridae		09	1	0	3	0.10
BS C6	32	small	Muridae		02	1	1	2	0.86
BS C6	32	large	not identified		17	0	0		1.28
BS C6	32	small	Dasyuridae		09	0	0	1	0.05
BS C6	32	small	Muridae		01	1	0	4	0.46
BS C6	32	medium	Macropodidae		16	0	0	1	0.13
BS C6	32	small	Muridae		16	0	0	4	0.06
BS C6	32	medium	Peramelidae		11	0	0	1	0.08
BS C6	32	small	Muridae		11	0	0	1	0.01
BS C6	32	medium	Macropodidae		16	0	0	1	0.02
BS C6	32	small & medium	unidentifiable	fragments <20mm	17	0	0	55	2.06
BS C6	33	small	Muridae		01	1	2	3	.32
BS C6	33	small	Muridae		02		2	2	.37
BS C6	33	small	Muridae		04			4	.17
BS C6	33	small	Muridae		15			1	.01
BS C6	33	small	Muridae		09			1	.03
BS C6	33	medium	Peramelidae		12			1	.41

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	33	medium	Macropodidae		16			1	.5
BS C6	33	medium	unidentifiable	fragments <20mm	17			4	1.34
BS C6	33	small & medium	unidentifiable	fragments <20mm	17			22	1.29
BS C6	34	small	Muridae		01	1	3	5	1.14
BS C6	34	small	Muridae		02	1	0	1	0.03
BS C6	34	small	Muridae		15	0	0	1	0.05
BS C6	34	medium	Peramelidae		04	0	0	1	0.03
BS C6	34	medium	Macropodidae		16	0	0	4	0.13
BS C6	34	small	not identified			0	0		0.16
BS C6	34	medium	unidentifiable	fragments <20mm	17	0	0	4	1.75
BS C6	34	small & medium	unidentifiable	fragments <20mm	17	0	0	12	0.79
BS C6	35	medium	Peramelidae		11			1	.23
BS C6	35	medium	Peramelidae		16			1	.24
BS C6	35	medium	Peramelidae		09			1	.38
BS C6	35	small	Muridae		04			4	.16
BS C6	35	medium	not identified						.5
BS C6	35	small	not identified						.18
BS C6	35	small & medium	unidentifiable	fragments <20mm	17			6	.33
BS C6	36	medium	Peramelidae		02	1	0	1	0.35
BS C6	36	medium	Peramelidae		11	0	0	1	0.28

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS C6	36	medium	not identified			0	0		0.45
BS C6	36	medium	unidentifiable	fragments <20mm	17	0	0	29	5.17
BS D9	1	med. & large	unidentifiable	fragments <20mm	17	0	0	1	0.08
BS D9	2	small	Dasyuridae		02	4	2	7	0.4
BS D9	2	small	Dasyuridae		01	0	1	1	0.1
BS D9	2	small	Muridae	Pseudocheirus peregrinus	01	2	3	8	0.4
BS D9	2	small	Muridae	Pseudocheirus peregrinus	02	1	0	1	0.2
BS D9	2	large	Intro'd stock		04	0	0	1	0.6
BS D9	2	large	Macropodidae		04	0	0	1	0.6
BS D9	2	small	Muridae		09	2	3	5	0.2
BS D9	2	small	Dasyuridae		12	1	0	1	0.2
BS D9	2	small	Muridae		12	3	4	7	0.6
BS D9	2	med. & large	unidentifiable	fragments <20mm	17	0	0	18	1.4
BS D9	2	small	unidentifiable	fragments <20mm	17	0	0	8	0.2
BS D9	3	small	Dasyuridae		12	0	2	2	0.2
BS D9	3	small	Muridae	Pseudomys sp.	02	3	0	3	0.4
BS D9	3	small	Muridae	Pseudomys sp.	01	0	1	1	0.2
BS D9	3	small	Muridae		12	0	2	2	0.2
BS D9	3	small	Muridae		09	0	0	3	0.2
BS D9	3	small	Dasyuridae	Antechinus sp.	09	3	0	3	0.2

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	3	small	Reptile		09	0	0	1	0.1
BS D9	3	small	unidentifiable	fragments <20mm	17	0	0	4	0.1
BS D9	3	med. & large	unidentifiable	fragments <20mm	17	0	0	7	0.4
BS D9	4	small	Dasyuridae		12	1	3	4	0.2
BS D9	4	large	Vombatidae		04	0	0	4	0.2
BS D9	4	small	Reptile		2	0	0	1	0.1
BS D9	4	small	Muridae	Rattus lutreolus	01	0	0	1	0.1
BS D9	4	small	Muridae		02	3	8	11	0.8
BS D9	4	small	Muridae		01	2	5	7	0.4
BS D9	4	large	Macropodidae	Thylogale billardieri	01	1	0	1	0.2
BS D9	4	medium	Phalangeridae	Trichosurus vulpecula	04	0	0	12	1.7
BS D9	4	small	Dasyuridae		09	3	6	11	0.7
BS D9	4	small	Dasyuridae		02	6	7	13	0.6
BS D9	4	small	Dasyuridae		01	1	1	3	0.1
BS D9	4	small	Muridae		09	6	5	17	0.7
BS D9	4	small	Muridae		12	3	4	10	0.6
BS D9	4	small	unidentifiable	fragments <20mm	17	0	0	52	0.9
BS D9	4	med. & large	unidentifiable	fragments <20mm	17	0	0	268	30.5
BS D9	4	med. & large	unidentifiable	fragments >20 mm	17	0	0	30	19.9
BS D9	5	large	Vombatidae		04	0	0	8	0.9

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	5	small	Muridae		09	1	0	3	0.1
BS D9	5	small	Muridae		12	0	1	1	0.2
BS D9	5	small	Muridae	Mastacomys fuscus	01	0	1	1	0.1
BS D9	5	small	Muridae	Pseudomys sp.	01	1	0	1	0.1
BS D9	5	small	Muridae	Pseudomys sp.	02	1	3	4	0.4
BS D9	5	small	Burramyidae	Cercartetus sp.	09	0	1	1	0.1
BS D9	5	small	unidentifiable	fragments <20mm	17	0	0	40	0.7
BS D9	5	med. & large	unidentifiable	fragments <20mm	17	0	0	346	61.9
BS D9	5	med. & large	unidentifiable	fragments >20 mm	17	0	0	40	19.8
BS D9	5	small	not identified						0.7
BS D9	5	medium	not identified						0.8
BS D9	6	medium	Reptile		09	1	1	2	0.1
BS D9	6	med. & large	unidentifiable	fragments <20mm	17	0	0	256	37.78
BS D9	6	large	Macropodidae		03	0	0	2	3.49
BS D9	6	medium	Peramelidae		01	0	1	1	0.09
BS D9	6	small	unidentifiable	fragments <20mm	17	0	0	58	1.06
BS D9	6	medium	Peramelidae		13	0	1	1	0.16
BS D9	6	med. & large	Macropodidae		04	0	0	2	1.91
BS D9	6	med. & large	unidentifiable	fragments >20 mm	17	0	0	47	17.87
BS D9	6	small	not identified						1.33

Square	Split	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	6	medium	not identified						0.81
BS D9	6	large	not identified						1.35
BS D9	7	small	Muridae		12	2	2	7	0.5
BS D9	7	medium	Macropodidae		09	0	0	1	0.1
BS D9	7	small	Muridae		09	1	0	2	0.1
BS D9	7	small	Phalangeridae	Trichosurus vulpecula	09	0	0	1	0.1
BS D9	7	small	Dasyuridae		12	2	0	2	0.2
BS D9	7	small	Dasyuridae		02	0	1	1	0.1
BS D9	7	medium	Macropodidae		01	0	0	2	0.7
BS D9	7	medium	Macropodidae		02	0	0	1	0.2
BS D9	7	large	Vombatidae		04	0	0	7	2.5
BS D9	7	small	Muridae	Mastacomys fuscus	02	0	02	2	0.2
BS D9	7	small	Muridae	Pseudomys sp.	02	0	1	1	0.1
BS D9	7	small	Muridae	Pseudomys sp.	01	2	0	2	0.1
BS D9	7	small	unidentifiable	fragments <20mm	17	0	0	230	4.5
BS D9	7	med. & large	unidentifiable	fragments <20mm	17	0	0	524	64.5
BS D9	7	med. & large	unidentifiable	fragments >20 mm	17	0	0	57	47.0
BS D9	7	small	not identified						1.88
BS D9	7	medium	not identified						5.68
BS D9	8	small	Muridae		09	2	5	8	0.4

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	8	small	Dasyuridae		09	1	0	1	0.1
BS D9	8	small	Frog		09	0	0	2	0.1
BS D9	8	small	Muridae		09	3	2	6	0.4
BS D9	8	small	Muridae	Pseudocheirus peregrinus	02	1	0	1	0.1
BS D9	8	small	Muridae	Pseudocheirus peregrinus	01	1	1	2	0.2
BS D9	8	med. & large	Macropodidae		04	0	0	7	0.7
BS D9	8	large	Macropodidae	Macropus giganteus	04	1	0	1	0.3
BS D9	8	medium	Macropodidae	Bettongia gaimardi	04	1	0	1	0.2
BS D9	8	medium	Macropodidae	Thylogale billardieri	02	1	0	1	1.4
BS D9	8	large	Vombatidae		04	0	0	5	0.6
BS D9	8	medium	Peramelidae		04	0	0	1	0.1
BS D9	8	small	Dasyuridae		02	1	1	2	0.1
BS D9	8	small	unidentifiable	fragments <20mm	17	0	0	247	5.6
BS D9	8	med. & large	unidentifiable	fragments <20mm	17	0	0	325	46.2
BS D9	8	med. & large	unidentifiable	fragments >20 mm	17	0	0	58	49.4
BS D9	8	small	not identified						1.36
BS D9	8	med. & large	not identified						11.86
BS D9	6	medium	not identified		5	0	0	5	.1
BS D9	6	medium	Peramelidae		2	2	0	2	0.76
BS D9	6	small	Muridae		1	3	3	6	0.52

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	6	small	Dasyuridae		2	0	1	1	1.23
BS D9	6	med. & large	Macropodidae		16	0	0	3	1.42
BS D9	6	small	Muridae		2	1	3	4	.53
BS D9	6	med. & large	Macropodidae		4	0	0	5	.32
BS D9	6	large	Vombatidae		4	0	0	1	1.24
BS D9	6	medium	Macropodidae	Potorous tridactylus	1	0	1	1	2.71
BS D9	6	medium	Phalangeridae	Trichosurus vulpecula	2	1	0	1	.83
BS D9	6	small	not identified		16	0	0	1	.02
BS D9	6	small	Muridae		9	2	1	3	0.22
BS D9	6	small	Muridae		12	1	1	2	0.37
BS D9	6	small	Muridae		15	0	1	1	.01
BS D9	6	small	Reptile		5	0	0	1	.01
BS D9	6	medium	Reptile		5	0	0	1	.01
BS D9	6	medium	Peramelidae		11	1	0	1	.47
BS D9	6	medium	Peramelidae		16	0	0	1	.67
BS D9	6	medium	Peramelidae		16	0	2	2	.96
BS D9	6	small	Dasyuridae		12	1	0	1	0.11
BS D9	6	small	Dasyuridae		9	1	0	1	0.11
BS D9	6	small	Dasyuridae		11	1	0	1	0.11
BS D9	6	small	Muridae		13	0	0	1	0.07

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	6	small	Dasyuridae		13	0	1	1	0.55
BS D9	6	medium	Peramelidae		10	0	2	2	3.75
BS D9	6	small	Muridae		16	0	0	5	0.13
BS D9	9	small	Muridae		1	0	1	1	0.21
BS D9	9	small	Dasyuridae		2	1	0	1	.08
BS D9	9	small	Dasyuridae		2	1	0	1	.06
BS D9	9	small	Reptile		2	1	0	1	.04
BS D9	9	medium	Peramelidae		1	0	1	1	0.25
BS D9	9	medium	Macropodidae	Thylogale billardieri	3	0	0	4	3.5
BS D9	9	small	Muridae	Pseudomys sp.	1	1	0	1	.03
BS D9	9	small	Muridae	Pseudomys sp.	2	2	2	4	.31
BS D9	9	small	Muridae	Pseudomys sp.	2	0	1	1	.03
BS D9	9	small	Muridae	Rattus lutreolus	1	1	0	1	.05
BS D9	9	small	Muridae	Rattus lutreolus	2	1	0	1	.05
BS D9	9	medium	Macropodidae		4	0	0	2	0.12
BS D9	9	large	Macropodidae		4	0	0	7	1.98
BS D9	9	large	Vombatidae		4	0	0	1	0.09
BS D9	9	small	Muridae		12	2	1	3	0.54
BS D9	9	small	Muridae		9	0	2	2	0.11
BS D9	9	medium	Macropodidae		9	0	0	2	.29

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	9	small	unidentifiable	fragments <20mm	17	0	0	206	4.60
BS D9	9	med. & large	unidentifiable	fragments <20mm	17	0	0	403	54.92
BS D9	9	med. & large	unidentifiable	fragments >20 mm	17	0	0	32	15.72
BS D9	9	small	not identified		16	0	0		.22
BS D9	9	med. & large	not identified		16	0	0		1.2
BS D9	9	small	Muridae		4	0	0	4	.2
BS D9	9	medium	not identified		11	0	0		.42
BS D9	9	large	not identified		5	0	0	1	1.6
BS D9	9	medium	not identified		8	0	0	1	.22
BS D9	9	small	not identified		11	0	0	1	.12
BS D9	9	small	Muridae		15	0	0	1	.41
BS D9	9	small	Muridae		13	0	0	1	.69
BS D9	9	large	not identified		5	0	0	1	1.17
BS D9	9	small	not identified		5	0	0	1	.48
BS D9	10	small	Muridae		15			2	.06
BS D9	10	medium	Reptile		5			1	.17
BS D9	10	medium	not identified		16			5	.25
BS D9	10	large	Macropodidae		16			3	.83
BS D9	10	medium	not identified		5			13	.42
BS D9	10	small	Muridae		16			3	.14

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	10	medium	Macropodidae		15			1	1.04
BS D9	10	small	Dasyuridae		8			1	.1
BS D9	10	medium	Peramelidae		16		3	3	.57
BS D9	10	medium	not identified		16			1	.04
BS D9	10	medium	Peramelidae		8			1	.18
BS D9	10	small	Muridae		12			3	.2
BS D9	10	small	Muridae		9		2	3	.13
BS D9	10	small	not identified		13			3	.2
BS D9	10	small	Muridae		13			6	.49
BS D9	10	medium	Peramelidae		9			2	.99
BS D9	10	large	Vombatidae		4			12	2.9
BS D9	10	small	Muridae		1			4	.35
BS D9	10	medium	Macropodidae		4			7	.69
BS D9	10	medium	Macropodidae		1			1	.52
BS D9	10	large	Macropodidae		4			2	1.15
BS D9	10	small	Muridae		2			4	.51
BS D9	10	small	Reptile		2			2	.02
BS D9	10	medium	Peramelidae		2			1	.17
BS D9	10	small	not identified		11			1	.05
BS D9	10	med. & large	Macropodidae		3			1	.33

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	10	small	not identified		17			102	2.52
BS D9	10	small	not identified		3			2	.06
BS D9	10	med. & large	unidentifiable	fragments <20mm	17			632	75.55
BS D9	10	large	not identified		3			2	.47
BS D9	10	large	not identified		8			1	.22
BS D9	10	large	Macropodidae		16			6	2.34
BS D9	10	med. & large	unidentifiable	fragments >20 mm	17			32	39.8
BS D9	11	small	Dasyuridae		10			1	.08
BS D9	11	small	Muridae		9	3	3	6	.22
BS D9	11	small	Muridae		15			3	.14
BS D9	11	small	Muridae		11			2	.07
BS D9	11	medium	not identified		11			2	.32
BS D9	11	small	Muridae		12		4	4	.44
BS D9	11	medium	Peramelidae		12	1	1	2	.95
BS D9	11	small	Muridae		13			6	.51
BS D9	11	medium	not identified		9			1	.16
BS D9	11	small	not identified		5			17	.46
BS D9	11	medium	not identified		5			8	.93
BS D9	11	medium	Peramelidae		8			1	.17
BS D9	11	medium	Macropodidae		16			4	.32

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	11	medium	not identified		16			2	.16
BS D9	11	large	Macropodidae		16			1	1.44
BS D9	11	small	Muridae		16			3	.05
BS D9	11	medium	Peramelidae		16			3	.41
BS D9	11	medium	Peramelidae		1			4	.45
BS D9	11	medium	Peramelidae		2			1	.06
BS D9	11	medium	Macropodidae		4			7	.51
BS D9	11	medium	Peramelidae		4			4	.08
BS D9	11	medium	Macropodidae	Thylogale billardieri	1			1	.97
BS D9	11	med. & large	Macropodidae		4			5	.58
BS D9	11	small	Muridae		1	1	4	5	.52
BS D9	11	small	Muridae		2	1		1	.05
BS D9	11	large	Vombatidae		4			3	1.28
BS D9	11	small	Frog					2	.02
BS D9	11	small	Reptile	Dragon lizard	2			2	.06
BS D9	11	medium	not identified		6			1	.13
BS D9	11	small	Reptile		5			3	.32
BS D9	11	medium	not identified		5			1	.05
BS D9	11	small	Dasyuridae		2			2	.11
BS D9	11	medium	Macropodidae		2			1	.37

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	11	small	not identified		17			212	6.37
BS D9	11	med. & large	unidentifiable	fragments <20mm	17			513	70.11
BS D9	11	large	Macropodidae		12		1	1	6.3
BS D9	11	large	Macropodidae		16			3	2.09
BS D9	11	large	Macropodidae		16			4	1.31
BS D9	11	medium	not identified		3			1	0.06
BS D9	11	med. & large	unidentifiable	fragments >20 mm	17			22	28.98
BS D9	11	medium	Peramelidae		2		1	1	1.3
BS D9	12	small	Frog		9		1	1	0.11
BS D9	12	small	Muridae		12	3	4	7	0.90
BS D9	12	small	Muridae		9	5	3	8	0.37
BS D9	12	medium	Peramelidae		13			2	0.09
BS D9	12	medium	Peramelidae		12			3	0.60
BS D9	12	medium	not identified		11			3	0.42
BS D9	12	large	Vombatidae		4			8	2.33
BS D9	12	large	Macropodidae		4			2	0.28
BS D9	12	medium	Macropodidae		4			8	0.47
BS D9	12	small	Dasyuridae		2			1	0.04
BS D9	12	small	Muridae		2	6	4	10	1.92
BS D9	12	small	Muridae		1	2	3	5	0.54

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total	no.	Wt gm
BS D9	12	small	Dasyuridae		1		1	1		0.06
BS D9	12	medium	Peramelidae		2	1	2	8		0.81
BS D9	12	medium	Peramelidae		4			6		0.18
BS D9	12	large	Macropodidae		16			1		1.20
BS D9	12	medium	not indentified		16			3		0.13
BS D9	12	medium	not indentified		16			6		0.32
BS D9	12	medium	Peramelidae		16			1		0.20
BS D9	12	medium	not indentified		16			4		0.45
BS D9	12	medium	not indentified		16			1		0.03
BS D9	12	med. & large	Macropodidae		16			5		1.20
BS D9	12	medium	Peramelidae		8			2		0.20
BS D9	12	small	Muridae		15					0.21
BS D9	12	small	not indentified		8			1		0.05
BS D9	12	small	Muridae		16			3		0.11
BS D9	12	large	not indentified		5			1		1.41
BS D9	12	medium	Reptile		5			1		0.23
BS D9	12	medium	not indentified		5			1		0.21
BS D9	12	small	not indentified		5			25		0.51
BS D9	12	small	not indentified		17			339		10.15
BS D9	12	medium	not indentified		3			4		0.30

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	12	large	unidentifiable	fragments <20mm	17			651	76.72
BS D9	12	large	unidentifiable	fragments >20 mm	17			26	37.44
BS D9	12	medium	Macropodidae		2	0	1	1	1.6
BS D9	12	medium	Macropodidae		2	0	1	1	1.6
BS D9	13	medium	Peramelidae		12	1		1	0.45
BS D9	13	medium	Peramelidae		9	2	1	3	0.53
BS D9	13	small	Reptile		2	1		1	0.08
BS D9	13	small	Muridae		16			23	0.41
BS D9	13	medium	Peramelidae		16			8	0.76
BS D9	13	medium	Peramelidae		16			11	1.35
BS D9	13	small	Muridae		16			9	0.30
BS D9	13	small	not indentified		5			20	0.52
BS D9	13	medium	Macropodidae		16			9	0.50
BS D9	13	medium	Macropodidae		16			27	1.45
BS D9	13	medium	Macropodidae		16			1	0.36
BS D9	13	small	Muridae		15			6	0.30
BS D9	13	small	not indentified		15			4	0.12
BS D9	13	medium	Macropodidae		16			6	0.16
BS D9	13	medium	Peramelidae		10			1	0.21
BS D9	13	small	Dasyuridae		12	1		1	0.14

Square	Split	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	13	small	Reptile		12/9			1	0.01
BS D9	13	small	Muridae		12	12	7	19	1.75
BS D9	13	medium	Macropodidae		12			2	0.40
BS D9	13	small	Reptile		5			2	0.07
BS D9	13	medium	Macropodidae		11	6	1	7	1.27
BS D9	13	small	Muridae		11			6	0.14
BS D9	13	small	Muridae		10			4	0.10
BS D9	13	small	Muridae		13			31	1.80
BS D9	13	medium	Peramelidae		13			5	0.33
BS D9	13	small	Dasyuridae		13			1	0.07
BS D9	13	small	Muridae		9	8	10	26	0.86
BS D9	13	medium	Peramelidae		4			6	0.18
BS D9	13	medium	Macropodidae		4			2	0.16
BS D9	13	medium	Macropodidae	Thylogale billardieri	4	1		1	0.02
BS D9	13	medium	Peramelidae		16			3	0.11
BS D9	13	medium	Peramelidae		1			4	0.25
BS D9	13	medium	Peramelidae		2			2	0.10
BS D9	13	small	Muridae		1			16	2.13
BS D9	13	small	Muridae		2	5		7	2.77
BS D9	13	medium	Dasyuridae		4			1	0.03

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	13	medium	Peramelidae		4			1	0.02
BS D9	13	large	Macropodidae		16			1	0.32
BS D9	13	small	Dasyuridae		2		2	2	0.07
BS D9	13	large	Vombatidae		4			1	0.10
BS D9	13	med. & large	not identified		5			5	0.42
BS D9	13	med. & large	Macropodidae		4			6	1.15
BS D9	13	medium	Macropodidae	Potorous tridactylus	2			1	0.14
BS D9	13	large	Macropodidae		16			1	1.55
BS D9	13	small	unidentifiable	fragments >20 mm	17			483	13.66
BS D9	13	medium	Murid. & Peram.		3			6	0.16
BS D9	13	med. & large	unidentifiable	fragments <20mm	17			665	68.49
BS D9	13	med. & large	unidentifiable	fragments >20 mm	17			17	7.18
BS D9	13	small	Frog		9			3	0.1
BS D9	14	small	Muridae		2	10	5	15	3.18
BS D9	14	med. & large	Macropodidae		4			6	1.00
BS D9	14	small	Muridae		1	17	14	31	4.82
BS D9	14	medium	Peramelidae		1	1	3	4	0.40
BS D9	14	large	Macropodidae		16	2	0	2	10.15
BS D9	14	small	Muridae		16	1	1	2	.02
BS D9	14	small	Muridae		9	8	22	30	1.77

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	14	medium	Peramelidae		16				1.07
BS D9	14	med. & large	Macropodidae		16			1	0.24
BS D9	14	medium	Murid. & Peram.		11	8	3	11	1.89
BS D9	14	small	Muridae		12	28	21	49	5.58
BS D9	14	medium	Murid. & Peram.		9	6	4	10	2.16
BS D9	14	small	Burramyidae		9	1	0	1	.05
BS D9	14	medium	Macropodidae		16			42	2.34
BS D9	14	medium	Peramelidae		16			6	.58
BS D9	14	small	Muridae		13	10	9	42	3.24
BS D9	14	medium	Peramelidae		13	?	?	7	1.57
BS D9	14	medium	Peramelidae		10	?	?	8	1.18
BS D9	14	small	Muridae		11	3	1	4	.11
BS D9	14	medium	Peramelidae		8	3	2	5	.55
BS D9	14	small	Muridae		10			1	.05
BS D9	14	small	Muridae		16			9	0.14
BS D9	14	medium	Macropodidae		6	1		1	1.63
BS D9	14	medium	Murid. & Peram.		16			17	2.63
BS D9	14	medium	Macropodidae		15	4	3	8	1.17
BS D9	14	small	Muridae		15	12	11	23	1.24
BS D9	14	small	Reptile		5			1	.17

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	14	small	not identified		5			11	.23
BS D9	14	medium	Macropodidae		5			22	1.98
BS D9	14	medium	Macropodidae		12	3		3	0.75
BS D9	14	small	Dasyuridae		12	1	1	2	.06
BS D9	14	medium	not indentified		11	2		2	.07
BS D9	14	medium	not identified		9	1	1	2	0.33
BS D9	14	medium	Peramelidae		2	5	7	12	1.76
BS D9	14	medium	not identified		17			10	2.56
BS D9	14	small	not identified		17			30	1.69
BS D9	14	small	not identified		17			212	5.69
BS D9	14	medium	Macropodidae		3			2	.1
BS D9	14	med. & large	Macropodidae		3			7	2.88
BS D9	14	medium	Macropodidae		13			1	0.37
BS D9	14	med. & large	unidentifiable	fragments <20mm	17			324	52.27
BS D9	14	small	Muridae		4			10	-
BS D9	14	medium	unidentifiable	other					16.21
BS D9	14	large	unidentifiable	other					14.25
BS D9	14	small	unidentifiable	other					5.55
BS D9	14	med. & large	unidentifiable	fragments >20 mm	17			17	12.36
BS D9	15	small	Muridae		1	17	30	47	9.43

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	15	small	Muridae		2	25	23	48	8.85
BS D9	15	small	Muridae		12	33	36	69	8.29
BS D9	15	small	Muridae		9	17	29	46	3.04
BS D9	15	small	Dasyuridae		9	1		1	0.02
BS D9	15	medium	Peramelidae		1	4	6	10	1.03
BS D9	15	medium	Dasyuridae		1		1	1	0.06
BS D9	15	medium	Peramelidae		2	11	9	20	2.70
BS D9	15	medium	Peramelidae		12	8	6	14	3.81
BS D9	15	medium	Peramelidae		9	15	13	28	4.39
BS D9	15	small	Dasyuridae		2	1	1	2	0.05
BS D9	15	small	not indentified		17			201	5.00
BS D9	15	med. & large	unidentifiable	fragments <20mm	17			211	28.53
BS D9	15	med. & large	unidentifiable	fragments >20 mm	17			21	12.45
BS D9	15	small	unidentifiable	other					13.32
BS D9	15	medium	unidentifiable	other					22.65
BS D9	15	med. & large	unidentifiable	other					5.72
BS D9	16	small	Muridae		1	19	11	30	6.06
BS D9	16	small	Muridae		2	11	10	31	4.67
BS D9	16	small	Muridae		9	18	19	37	2.09
BS D9	16	small	Muridae		12	23	19	42	4.42

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	16	medium	Peramelidae		1	1		1	0.05
BS D9	16	medium	Peramelidae		2	4	8	12	2.11
BS D9	16	medium	Peramelidae	Isoodon obesulus	2	1		1	0.99
BS D9	16	medium	Peramelidae		12	4	2	6	1.62
BS D9	16	medium	Peramelidae		9	6	5	11	2.11
BS D9	16	small	Dasyuridae		2	1	0	1	0.02
BS D9	16	small	Dasyuridae		1			1	0.05
BS D9	16	small	unidentifiable	fragments <20mm	17			303	6.88
BS D9	16	med. & large	unidentifiable	fragments <20mm	17			147	19.12
BS D9	16	med. & large	unidentifiable	fragments >20 mm	17			11	6.37
BS D9	16	small	unidentifiable	other					5.65
BS D9	16	medium	unidentifiable	other					14.45
BS D9	17	small	Muridae		2	17	11	28	5.68
BS D9	17	small	Dasyuridae		2	1		1	0.06
BS D9	17	medium	Peramelidae		2	11	6	17	2.49
BS D9	17	medium	Peramelidae		1	1	2	3	0.51
BS D9	17	small	Muridae		1	15	18	33	5.64
BS D9	17	medium	Peramelidae		12	3	2	5	1.61
BS D9	17	medium	Peramelidae		9	9	8	17	2.41
BS D9	17	small	Muridae		9	22	20	42	2.34

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	17	small	Dasyuridae		9	1	1	2	0.20
BS D9	17	small	Muridae		12	22	19	41	5.12
BS D9	17	small	Dasyuridae		12		1	1	0.16
BS D9	17	small	unidentifiable	fragments <20mm	17			137	4.98
BS D9	17	med. & large	unidentifiable	fragments <20mm	17			141	17.54
BS D9	17	med. & large	unidentifiable	fragments >20 mm	17			9	2.56
BS D9	17	small	not indentified	other					8.99
BS D9	17	medium	not indentified	other					18.01
BS D9	18	small	Dasyuridae		12	1	1	2	0.2
BS D9	18	small	Muridae		12	27	27	65	7.9
BS D9	18	medium	Peramelidae		12	3	2		1.5
BS D9	18	small	Muridae		9	28	22	60	3.7
BS D9	18	small	Dasyuridae		9	1	0	1	0.1
BS D9	18	small	Dasyuridae		9		1	1	0.1
BS D9	18	medium	Peramelidae		9	9	8	14	4.0
BS D9	18	large	Macropodidae		2	1	0	1	4.2
BS D9	18	small	Dasyuridae		2	2	0	2	0.1
BS D9	18	medium	Peramelidae		2	7	5	16	2.0
BS D9	18	medium	Peramelidae		1	1	1	2	0.2
BS D9	18	small	Muridae		2	13	15	28	6.2

Square	Split	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	18	small	Muridae		1	13	20	33	7.6
BS D9	18	small	Muridae	Rattus lutreolus	2	0	2	4	0.5
BS D9	18	small	Muridae		2	0	1	1	0.1
BS D9	18	small	Muridae	Pseudomys sp.	2	7	7	15	1.2
BS D9	18	small	Muridae	Pseudomys sp.	1	1	1	2	0.2
BS D9	18	med. & large	unidentifiable	fragments <20mm	17			172	23.3
BS D9	18	med. & large	unidentifiable	fragments >20 mm	17			10	4.8
BS D9	18	small	unidentifiable	fragments <20mm	17			105	3.7
BS D9	18	small	not indentified						7.52
BS D9	18	medium	not indentified						22.05
BS D9	19	medium	Macropodidae		2	20	26	46	9.7
BS D9	19	medium	Macropodidae		1	18	20	38	7.3
BS D9	19	small	Muridae		2	0	1	2	0.1
BS D9	19	small	Muridae		2	1	0	1	0.1
BS D9	19	small	Muridae		1	3	4	7	0.7
BS D9	19	small	Muridae		12	13	17	42	4.2
BS D9	19	small	Dasyuridae	Antechinus sp.	2	1	0	1	0.1
BS D9	19	medium	Peramelidae		9	4	5	9	1.4
BS D9	19	small	Muridae		9	3	5	9	0.4
BS D9	19	medium	Peramelidae		1	3	1	4	0.3

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	19	medium	Peramelidae	Isoodon obesulus	1	1	0	1	0.1
BS D9	19	medium	Peramelidae		2	11	3	19	3.4
BS D9	19	medium	Peramelidae		12	3	0	8	1.1
BS D9	19	medium	not indentified		12	0	1	1	0.5
BS D9	19	small	unidentifiable	fragments <20mm	17			79	2.9
BS D9	19	med. & large	unidentifiable	fragments <20mm	17			85	13.2
BS D9	19	med. & large	unidentifiable	fragments >20 mm	17			9	5.8
BS D9	20	small	Muridae		2	19	26	54	10.9
BS D9	20	small	Muridae		1	18	14	32	6.7
BS D9	20	small	Muridae		2	1	5	6	0.6
BS D9	20	small	Muridae		2	1	1	2	0.3
BS D9	20	small	Muridae		1	2	1	3	0.4
BS D9	20	medium	Peramelidae		2	5	5	12	1.5
BS D9	20	medium	Peramelidae		1	0	1	1	0.1
BS D9	20	med. & large	Macropodidae		4			3	0.5
BS D9	20	medium	Peramelidae		9			14	1.8
BS D9	20	medium	Peramelidae		12	6	4	17	5.9
BS D9	20	small	Muridae		9	2	6	15	0.7
BS D9	20	small	Muridae		12	17	21	49	4.3
BS D9	20	small	unidentifiable	fragments <20mm	17			123	3.4

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	20	med. & large	unidentifiable	fragments <20mm	17			135	17.4
BS D9	20	med. & large	unidentifiable	fragments >20 mm	17			6	4.7
BS D9	20	small	not indentified						5.84
BS D9	20	medium	not indentified						15.31
BS D9	20	med. & large	not indentified						0.37
BS D9	21	small	Muridae		13	3	2	5	0.4
BS D9	21	small	not indentified		13	4	1	5	0.3
BS D9	21	small	Muridae		1	7	2	9	1.56
BS D9	21	med. & large	Macropodidae		4		1		0.16
BS D9	21	med. & large	Macropodidae		4			1	0.11
BS D9	21	small	Muridae		15			2	0.14
BS D9	21	medium	Macropodidae		15			1	0.09
BS D9	21	medium	Macropodidae		16			3	0.1
BS D9	21	small	Muridae		16			1	0.01
BS D9	21	medium	Peramelidae		16			1	0.08
BS D9	21	medium	Macropodidae		16			2	0.33
BS D9	21	medium	Peramelidae		16			2	0.29
BS D9	21	medium	Macropodidae		11			4	0.44
BS D9	21	small	Muridae		9	5	4	9	0.4
BS D9	21	small	Muridae		12	6	5	11	0.83

Square	Spit	Size	Family	Species other	element	no. left	no. right	Total no.	Wt gm
BS D9	21	small	not indentified		11		1	1	0.04
BS D9	21	medium	Peramelidae		12			1	0.07
BS D9	21	medium	Peramelidae		2		1	1	0.06
BS D9	21	medium	Peramelidae		1	1		1	0.02
BS D9	21	medium	Macropodidae		9	1	2	3	0.39
BS D9	21	medium	Macropodidae		16			3	0.43
BS D9	21	small	Muridae		2	11	5	16	3.34
BS D9	21	small	unidentifiable	fragments <20mm	17			97	2.10
BS D9	21	med. & large	Macropodidae	fragments <20mm	17			128	18.26
BS D9	21	medium	Macropodidae		13			2	0.74
BS D9	21	med. & large	unidentifiable	fragments >20 mm	17			14	6.74

APPENDIX VII

Beeton Rockshelter: Mammal species in the Furneaux region
historic and fossil records

APPENDIX VII Mammal species in the Furneaux region historic and fossil records

	Extant (1800s) Furneaux Is.	Sub-fossil Furneaux Is. (pre 8,000 BP)	BEETON Unit A	SHELTER Unit B
Macropodidae				
Forester Kangaroo (<i>Macropus giganteus</i>)		•	•	
Bennetts Wallaby (<i>Macropus rufogriseus</i>)	•*	•	•	•
Tasmanian Pademelon (<i>Thylogale billardierii</i>)	•*	•	•	•
Vombatidae				
Wombat (<i>Vombatus ursinus</i>)	•**	•	•	
Dasyuridae				
Spotted Quoll (<i>Dasyurus maculatus</i>)	•*	•	•	• <i>D. sp?</i>
Eastern Quoll (<i>Dasyurus viverrinus</i>)		•	•	• <i>D. sp?</i>
Dusky Antechinus (<i>Antechinus swainsonii</i>)		•	• <i>A. sp?</i>	• <i>A. sp?</i>
Swamp Antechinus (<i>Antechinus minimus</i>)	•	•	• <i>A. sp?</i>	• <i>A. sp?</i>
White-footed Dunnart (<i>Sminthopsis leucopus</i>)	•	•		
Tasmanian Devil (<i>Sarcophilus harrisii</i>)		•	•	
Peramelidae				
Southern Brown Bandicoot (<i>Isodon obesulus</i>)	•*	•	•	•
Eastern Barred Bandicoot (<i>Perameles gunnii</i>)		•	•?	•?
Petauridae				
Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	•*	•	•	
Phalangeridae				
Brush-tail Possum (<i>Trichosurus vulpecula</i>)	•**	•	•	
Potoroidae				
Potoroo (<i>Potorous tridactylus</i>)	•*	•	•	•
Tasmanian Bettong (<i>Bettongia gaimardi</i>)			•	
Burramyidae				
Eastern Pygmy Possum (<i>Cercartetus nanus</i>)	•**		• <i>C. sp?</i>	
Little Pygmy Possum (<i>Cercartetus lepidus</i>)			• <i>C. sp?</i>	
Vespertilionidae				
8 extant Tas. bat species	•3 sp. *		•1 sp.	

	Extant (1800s) Furneaux Is.	Sub-fossil Furneaux Is. (pre 8,000 BP)	BEETON Unit A	SHELTER Unit B
Muridae				
Eastern Water Rat (<i>Hydromys chrysogaster</i>)	•			
Long-tailed mouse (<i>Pseudomys higginsii</i>)		•	•	•
New Holland Mouse (<i>Pseudomys novaeollandiae</i>)	•**	•	•	
Broad-toothed Rat (<i>Mastacomys fuscus</i>)		•	•	•
Eastern Swamp Rat (<i>Rattus lutreolus</i>)	•*	•	•	•

* Flinders and larger outer islands

** Flinders Is only

Tasmanian mammal species distribution records (Furneaux data from Hope 1969, Rounsevell *et al* 1991, Brown 1993).

APPENDIX VIII

Beeton Rockshelter: Muttonbird bone

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-C6	7	P. pacificus	wing bones			2	0.19
BS-C6	7	P. pacificus	radius			1	0.06
BS-C6	7	P. pacificus	unidentifiable			1	0.07
BS-C6	8	P. pacificus	unidentifiable			1	0.06
BS-C6	10	P. pacificus	unidentifiable			1	0.74
BS-C6	10	P. pacificus	wing bones			2	0.24
BS-C6	15	P. pacificus	unidentifiable			2	1.16
BS-C6	15	P. pacificus	ulna		1	1	0.25
BS-C6	15	P. pacificus	wing bones			2	0.11
BS-C6	17	P. pacificus	leg bones other			1	0.33
BS-C6	5	P. tenuirostris	wing bones			2	0.33
BS-C6	5	P. tenuirostris	leg bones other			2	0.09
BS-C6	5	P. tenuirostris	unidentifiable			1	0.04
BS-C6	6	P. tenuirostris	vertebrae & ribs			4	0.48
BS-C6	6	P. tenuirostris	humerus	1	1	2	1.08
BS-C6	6	P. tenuirostris	ulna		1	1	1.77
BS-C6	6	P. tenuirostris	leg bones other			3	0.17
BS-C6	6	P. tenuirostris	unidentifiable			1	0.90
BS-C6	7	P. tenuirostris	wing bones			1	0.72
BS-C6	7	P. tenuirostris	ulna	1	2	3	4.92
BS-C6	7	P. tenuirostris	humerus	2	4	6	7.49
BS-C6	7	P. tenuirostris	cranium		1	1	0.64

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-C6	7	P. tenuirostris	leg bones other			7	0.58
BS-C6	7	P. tenuirostris	vertebrae & ribs			2	0.16
BS-C6	7	P. tenuirostris	wishbone			3	0.54
BS-C6	7	P. tenuirostris	upper bill			1	0.05
BS-C6	7	P. tenuirostris	collarbone		1	1	0.56
BS-C6	7	P. tenuirostris	femur	1	1	2	0.58
BS-C6	7	P. tenuirostris	scapula		1	1	0.30
BS-C6	7	P. tenuirostris	radius			2	0.40
BS-C6	7	P. tenuirostris	tibia		1	1	0.25
BS-C6	7	P. tenuirostris	unidentifiable			5	0.86
BS-C6	8	P. tenuirostris	scapula			4	0.40
BS-C6	8	P. tenuirostris	radius			1	0.41
BS-C6	8	P. tenuirostris	ulna		1	1	1.70
BS-C6	8	P. tenuirostris	leg bones other			7	1.07
BS-C6	8	P. tenuirostris	collarbone	2	1	3	1.97
BS-C6	8	P. tenuirostris	femur		1	1	0.31
BS-C6	8	P. tenuirostris	unidentifiable			3	0.14
BS-C6	9	P. tenuirostris	radius			1	0.29
BS-C6	9	P. tenuirostris	lower bill	1	1	4	0.76
BS-C6	9	P. tenuirostris	leg bones other			3	0.18
BS-C6	9	P. tenuirostris	humerus			1	0.35
BS-C6	9	P. tenuirostris	tibia	1		1	0.48

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-C6	10	P. tenuirostris	ulna	1	1	2	2.95
BS-C6	10	P. tenuirostris	tibia	1	1	2	0.87
BS-C6	10	P. tenuirostris	sternum			1	0.29
BS-C6	10	P. tenuirostris	leg bones other			7	1.13
BS-C6	10	P. tenuirostris	lower bill	1	1	2	0.31
BS-C6	10	P. tenuirostris	femur	1		1	0.32
BS-C6	10	P. tenuirostris	scapula	1	1	2	0.23
BS-C6	10	P. tenuirostris	wing bones			3	0.34
BS-C6	10	P. tenuirostris	humerus	1		1	2.58
BS-C6	14	P. tenuirostris	humerus	1		2	2.01
BS-C6	14	P. tenuirostris	lower bill		1	1	0.26
BS-C6	14	P. tenuirostris	wing bones			3	0.03
BS-C6	14	P. tenuirostris	leg bones other			1	0.06
BS-C6	15	P. tenuirostris	femur		1	1	0.49
BS-C6	15	P. tenuirostris	tibia			1	0.96
BS-C6	15	P. tenuirostris	ulna	1		1	1.21
BS-C6	15	P. tenuirostris	humerus	1	1	2	2.80
BS-C6	15	P. tenuirostris	wing bones			2	1.34
BS-C6	15	P. tenuirostris	leg bones other			2	0.58
BS-C6	15	P. tenuirostris	vertebrae & ribs			1	0.03
BS-C6	12	P. tenuirostris	wishbone			1	0.14
BS-C6	17	P. tenuirostris	upper bill			1	0.10

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-C6	17	<i>P. tenuirostris</i>	scapula			1	0.28
BS-C6	17	<i>P. tenuirostris</i>	pelvis			1	0.22
BS-C6	17	<i>P. tenuirostris</i>	lower bill	1		1	0.16
BS-C6	17	<i>P. tenuirostris</i>	humerus	2	1	5	13.71
BS-C6	17	<i>P. tenuirostris</i>	wing bones			5	2.39
BS-C6	17	<i>P. tenuirostris</i>	ulna			2	2.32
BS-C6	17	<i>P. tenuirostris</i>	collarbone			1	0.05
BS-C6	17	<i>P. tenuirostris</i>	leg bones other			1	0.07
BS-C6	17	<i>P. tenuirostris</i>	femur	1	1	2	1.05
BS-C6	17	<i>P. tenuirostris</i>	radius		1	1	0.11
BS-C6	19	<i>P. tenuirostris</i>	vertebrae & ribs			2	0.24
BS-C6	19	<i>P. tenuirostris</i>	tibia	1		1	0.20
BS-C6	19	<i>P. tenuirostris</i>	leg bones other			2	0.09
BS-C6	20	<i>P. tenuirostris</i>	ulna		1	1	1.69
BS-C6	20	<i>P. tenuirostris</i>	vertebrae & ribs			1	0.14
BS-C6	11	<i>P. tenuirostris</i>	lower bill		1	1	0.26
BS-C6	11	<i>P. tenuirostris</i>	pelvis		1	1	0.17
BS-C6	11	<i>P. tenuirostris</i>	humerus		1	1	0.25
BS-C6	11	<i>P. tenuirostris</i>	ulna		1	1	1.60
BS-C6	11	<i>P. tenuirostris</i>	tibia		1	1	0.27
BS-C6	11	<i>P. tenuirostris</i>	leg bones other			4	0.86
BS-C6	11	<i>P. tenuirostris</i>	vertebrae & ribs			4	0.35

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-C6	11	P. tenuirostris	radius	1		2	0.78
BS-C6	11	P. tenuirostris	femur	1		1	0.33
BS-C6	11	P. tenuirostris	wishbone			1	0.05
BS-C6	12	P. tenuirostris	vertebrae & ribs			1	0.16
BS-C6	12	P. tenuirostris	leg bones other			3	1.54
BS-C6	12	P. tenuirostris	scapula	1	1	2	0.43
BS-C6	12	P. tenuirostris	radius	1	1	3	1.67
BS-C6	12	P. tenuirostris	wing bones			2	0.33
BS-C6	12	P. tenuirostris	humerus		1	1	2.93
BS-C6	13	P. tenuirostris	humerus		1	1	1.15
BS-C6	13	P. tenuirostris	tibia	1	1	2	0.50
BS-C6	13	P. tenuirostris	leg bones other			1	0.09
BS-C6	13	P. tenuirostris	wing bones			2	0.70
BS-C6	13	P. tenuirostris	scapula		3	3	0.66
BS-C6	13	P. tenuirostris	wishbone			2	0.30
BS-C6	13	P. tenuirostris	radius	1		1	1.82
BS-C6	13	P. tenuirostris	upper bill			1	0.12
BS-C6	13	P. tenuirostris	vertebrae & ribs			5	0.28
BS-C6	16	P. tenuirostris	humerus	1	2	5	10.33
BS-C6	16	P. tenuirostris	vertebrae & ribs			4	0.28
BS-C6	16	P. tenuirostris	leg bones other			3	1.25
BS-C6	16	P. tenuirostris	lower bill		1	1	0.07

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-C6	16	P. tenuirostris	pelvis		1	1	0.10
BS-C6	16	P. tenuirostris	collarbone	1	3	4	2.02
BS-C6	16	P. tenuirostris	ulna	2		3	2.32
BS-C6	16	P. tenuirostris	radius			1	0.34
BS-C6	16	P. tenuirostris	tibia	2	1	3	2.83
BS-C6	8	P. tenuirostris	unidentifiable			17	2.08
BS-D6	4	P. tenuirostris	leg bones other			1	0.58
BS-D6	4	P. tenuirostris	unidentifiable			5	0.46
BS-D6	5	P. tenuirostris	leg bones other			3	0.47
BS-D6	5	P. tenuirostris	scapula		2	2	0.48
BS-D6	5	P. tenuirostris	upper bill		1	3	2.25
BS-D6	5	P. tenuirostris	vertebrae & ribs			4	0.32
BS-D6	5	P. tenuirostris	leg bones other			21	3.53
BS-D6	5	P. tenuirostris	tibia		1	1	0.85
BS-D6	5	P. tenuirostris	unidentifiable			17	1.03
BS-D6	6	P. tenuirostris	vertebrae & ribs			6	1.15
BS-D6	6	P. tenuirostris	humerus		1	2	1.70
BS-D6	6	P. tenuirostris	wing bones			5	0.30
BS-D6	6	P. tenuirostris	unidentifiable			32	2.51
BS-D6	6	P. tenuirostris	wishbone			1	0.08
BS-D6	6	P. tenuirostris	cranium			1	0.03

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	6	<i>P. tenuirostris</i>	leg bones other			6	2.64
BS-D6	6	<i>P. tenuirostris</i>	wing bones			9	2.86
BS-D6	6	<i>P. tenuirostris</i>	pelvis			1	0.35
BS-D6	7	<i>P. tenuirostris</i>	collarbone	1	2	3	1.50
BS-D6	7	<i>P. tenuirostris</i>	scapula	1	1	2	0.46
BS-D6	7	<i>P. tenuirostris</i>	upper bill			2	0.65
BS-D6	7	<i>P. tenuirostris</i>	lower bill	1	1	2	0.37
BS-D6	7	<i>P. tenuirostris</i>	wishbone			1	0.20
BS-D6	7	<i>P. tenuirostris</i>	wing bones			9	1.45
BS-D6	7	<i>P. tenuirostris</i>	humerus		3	5	4.53
BS-D6	7	<i>P. tenuirostris</i>	ulna	1	3	6	5.03
BS-D6	7	<i>P. tenuirostris</i>	vertebrae & ribs			3	0.55
BS-D6	7	<i>P. tenuirostris</i>	radius			1	0.47
BS-D6	7	<i>P. tenuirostris</i>	femur	2	3	5	2.67
BS-D6	7	<i>P. tenuirostris</i>	leg bones other			15	3.35
BS-D6	7	<i>P. tenuirostris</i>	unidentifiable			35	3.75
BS-D6	8	<i>P. tenuirostris</i>	collarbone	2	1	6	2.00
BS-D6	8	<i>P. tenuirostris</i>	scapula		1	1	0.29
BS-D6	8	<i>P. tenuirostris</i>	humerus		2	3	3.49
BS-D6	8	<i>P. tenuirostris</i>	wing bones			9	2.22
BS-D6	8	<i>P. tenuirostris</i>	ulna	1	2	5	5.01
BS-D6	8	<i>P. tenuirostris</i>	radius			3	0.82

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	8	P. tenuirostris	femur	1	4	5	2.35
BS-D6	8	P. tenuirostris	leg bones other			14	1.13
BS-D6	8	P. tenuirostris	tibia	1	2	3	2.74
BS-D6	8	P. tenuirostris	vertebrae & ribs			2	0.13
BS-D6	8	P. tenuirostris	lower bill		1	1	0.25
BS-D6	8	P. tenuirostris	wishbone			1	0.22
BS-D6	8	P. tenuirostris	unidentifiable			44	3.04
BS-D6	8	P. tenuirostris	cranium		1	1	0.06
BS-D6	9	P. tenuirostris	lower bill		1	2	0.36
BS-D6	9	P. tenuirostris	upper bill			1	0.17
BS-D6	9	P. tenuirostris	cranium			1	0.02
BS-D6	9	P. tenuirostris	vertebrae & ribs			9	1.20
BS-D6	9	P. tenuirostris	humerus	1		1	0.32
BS-D6	9	P. tenuirostris	ulna	1	1	2	2.30
BS-D6	9	P. tenuirostris	wing bones			7	1.70
BS-D6	9	P. tenuirostris	pelvis			2	0.36
BS-D6	9	P. tenuirostris	wishbone			1	0.18
BS-D6	9	P. tenuirostris	scapula		1	1	0.31
BS-D6	9	P. tenuirostris	leg bones other			10	2.12
BS-D6	9	P. tenuirostris	femur	1		1	0.45
BS-D6	9	P. tenuirostris	tibia	1	2	5	2.45
BS-D6	9	P. tenuirostris	unidentifiable			30	3.46

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	10	P. tenuirostris	vertebrae & ribs			10	1.11
BS-D6	10	P. tenuirostris	humerus		2	2	3.24
BS-D6	10	P. tenuirostris	radius	1	1	6	1.96
BS-D6	10	P. tenuirostris	ulna	1	2	7	5.63
BS-D6	10	P. tenuirostris	wing bones			6	2.12
BS-D6	10	P. tenuirostris	pelvis	1	1	2	0.45
BS-D6	10	P. tenuirostris	collarbone	1	2	3	1.39
BS-D6	10	P. tenuirostris	femur	1		1	0.42
BS-D6	10	P. tenuirostris	leg bones other			14	3.16
BS-D6	10	P. tenuirostris	wishbone			2	0.35
BS-D6	10	P. tenuirostris	lower bill		1		0.14
BS-D6	10	P. tenuirostris	unidentifiable			29	2.56
BS-D6	11	P. tenuirostris	cranium			3	0.90
BS-D6	11	P. tenuirostris	wishbone			1	0.09
BS-D6	11	P. tenuirostris	radius			2	0.13
BS-D6	11	P. tenuirostris	humerus			3	1.30
BS-D6	11	P. tenuirostris	ulna	2	1	3	5.18
BS-D6	11	P. tenuirostris	leg bones other			12	0.83
BS-D6	11	P. tenuirostris	femur	1	1	2	0.43
BS-D6	11	P. tenuirostris	tibia	1		1	0.90
BS-D6	11	P. tenuirostris	pelvis			1	0.12
BS-D6	11	P. tenuirostris	collarbone	1	1	3	0.82

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	11	P. tenuirostris	scapula	1	1	2	0.48
BS-D6	11	P. tenuirostris	vertebrae & ribs			6	0.85
BS-D6	11	P. tenuirostris	unidentifiable			18	1.30
BS-D6	12	P. tenuirostris	unidentifiable			28	2.32
BS-D6	12	P. tenuirostris	vertebrae & ribs			3	0.39
BS-D6	12	P. tenuirostris	wing bones			11	2.04
BS-D6	12	P. tenuirostris	humerus		2	3	4.18
BS-D6	12	P. tenuirostris	radius			5	2.13
BS-D6	12	P. tenuirostris	ulna	3		3	4.38
BS-D6	12	P. tenuirostris	pelvis			1	0.35
BS-D6	12	P. tenuirostris	lower bill	1		1	0.20
BS-D6	12	P. tenuirostris	wishbone			1	0.12
BS-D6	12	P. tenuirostris	scapula			1	0.25
BS-D6	12	P. tenuirostris	leg bones other			5	0.53
BS-D6	12	P. tenuirostris	femur	2		2	0.70
BS-D6	13	P. tenuirostris	lower bill			1	0.15
BS-D6	13	P. tenuirostris	humerus		1	2	3.65
BS-D6	13	P. tenuirostris	ulna	1		1	1.68
BS-D6	13	P. tenuirostris	radius			1	0.71
BS-D6	13	P. tenuirostris	tibia		1	1	0.70
BS-D6	13	P. tenuirostris	leg bones other			10	0.45
BS-D6	13	P. tenuirostris	unidentifiable			30	2.90

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	14	P. tenuirostris	tibia			3	1.37
BS-D6	14	P. tenuirostris	leg bones other			5	0.27
BS-D6	14	P. tenuirostris	femur	1		1	0.35
BS-D6	14	P. tenuirostris	scapula	1	1	2	0.48
BS-D6	14	P. tenuirostris	lower bill	1		3	0.27
BS-D6	14	P. tenuirostris	vertebrae & ribs			14	1.15
BS-D6	14	P. tenuirostris	humerus	1		1	2.42
BS-D6	14	P. tenuirostris	ulna	1	3	4	5.31
BS-D6	14	P. tenuirostris	unidentifiable			4	0.70
BS-D6	15	P. tenuirostris	collarbone	1		1	0.35
BS-D6	15	P. tenuirostris	radius			1	0.16
BS-D6	15	P. tenuirostris	leg bones other			11	0.60
BS-D6	15	P. tenuirostris	vertebrae & ribs			6	0.72
BS-D6	15	P. tenuirostris	ulna	1	1	2	3.26
BS-D6	15	P. tenuirostris	radius			1	0.80
BS-D6	15	P. tenuirostris	wing bones			6	1.30
BS-D6	15	P. tenuirostris	upper bill			2	0.41
BS-D6	15	P. tenuirostris	lower bill			4	0.32
BS-D6	15	P. tenuirostris	unidentifiable			64	6.67
BS-D6	16	P. tenuirostris	cranium			1	0.03
BS-D6	16	P. tenuirostris	humerus		1	1	3.18
BS-D6	16	P. tenuirostris	ulna		1	1	1.69

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	16	<i>P. tenuirostris</i>	wing bones			2	0.39
BS-D6	16	<i>P. tenuirostris</i>	pelvis			2	0.38
BS-D6	16	<i>P. tenuirostris</i>	collarbone			1	0.55
BS-D6	16	<i>P. tenuirostris</i>	leg bones other			8	1.98
BS-D6	16	<i>P. tenuirostris</i>	lower bill	1		1	0.14
BS-D6	16	<i>P. tenuirostris</i>	sternum			1	0.12
BS-D6	16	<i>P. tenuirostris</i>	vertebrae & ribs			1	0.18
BS-D6	16	<i>P. tenuirostris</i>	unidentifiable			63	7.50
BS-D6	17	<i>P. tenuirostris</i>	leg bones other			10	1.60
BS-D6	17	<i>P. tenuirostris</i>	sternum			1	2.28
BS-D6	17	<i>P. tenuirostris</i>	wing bones			2	0.86
BS-D6	17	<i>P. tenuirostris</i>	ulna	1		4	2.14
BS-D6	17	<i>P. tenuirostris</i>	radius			3	1.58
BS-D6	17	<i>P. tenuirostris</i>	humerus	1	2	3	8.30
BS-D6	17	<i>P. tenuirostris</i>	lower bill			1	0.15
BS-D6	17	<i>P. tenuirostris</i>	upper bill			1	0.41
BS-D6	17	<i>P. tenuirostris</i>	vertebrae & ribs			1	0.10
BS-D6	17	<i>P. tenuirostris</i>	collarbone		3	3	1.52
BS-D6	17	<i>P. tenuirostris</i>	scapula			2	0.35
BS-D6	17	<i>P. tenuirostris</i>	wishbone			1	0.20
BS-D6	17	<i>P. tenuirostris</i>	unidentifiable			59	3.55
BS-D6	5	<i>P. pacificus</i>	leg bones other			1	0.15

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	5	P. pacificus	vertebrae & ribs			1	0.02
BS-D6	5	P. pacificus	humerus		1	1	0.63
BS-D6	5	P. pacificus	wing bones			4	1.58
BS-D6	6	P. pacificus	pelvis			1	0.13
BS-D6	6	P. pacificus	leg bones other			4	0.38
BS-D6	7	P. pacificus	leg bones other			5	0.75
BS-D6	7	P. pacificus	wing bones			8	1.60
BS-D6	8	P. pacificus	lower bill		1	1	0.10
BS-D6	11	P. pacificus	wing bones			1	0.57
BS-D6	12	P. pacificus	vertebrae & ribs			5	0.22
BS-D6	12	P. pacificus	wishbone			1	0.32
BS-D6	13	P. pacificus	vertebrae & ribs			8	0.23
BS-D6	15	P. pacificus	vertebrae & ribs			4	0.32
BS-D6	15	P. pacificus	wing bones			2	0.24
BS-D6	16	P. pacificus	leg bones other			4	0.35
BS-D6	17	P. pacificus	leg bones other			3	0.36
BS-D6	8	juvenile P. t	humerus			1	0.65
BS-D6	8	juvenile P. t	vertebrae & ribs			1	0.11
BS-D6	8	juvenile P. t	wing bones			3	0.40
BS-D6	9	juvenile P. t	wing bones			5	0.94
BS-D6	9	juvenile P. t	vertebrae & ribs				0.71
BS-D6	10	juvenile P. t	wishbone			2	0.20

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	10	juvenile P. t	leg bones other			8	2.05
BS-D6	11	juvenile P. t	vertebrae & ribs			4	0.39
BS-D6	11	juvenile P. t	pelvis			1	0.22
BS-D6	11	juvenile P. t	leg bones other			8	0.79
BS-D6	11	juvenile P. t	tibia	1	2	4	1.21
BS-D6	11	juvenile P. t	wing bones			3	0.48
BS-D6	11	juvenile P.p	tibia		1	1	0.54
BS-D6	12	juvenile P. t	sternum		1	1	0.24
BS-D6	12	juvenile P. t	tibia			1	0.32
BS-D6	12	juvenile P. t	vertebrae & ribs			2	0.10
BS-D6	12	juvenile P. t	leg bones other			5	0.20
BS-D6	13	juvenile P. g	ulna	1	1	2	2.40
BS-D6	13	juvenile P. g	wing bones			1	0.63
BS-D6	14	juvenile P. g	humerus	1		1	3.07
BS-D6	14	juvenile P. t	wishbone			1	0.13
BS-D6	14	juvenile P. t	ulna		1	1	1.91
BS-D6	14	juvenile P.p	wishbone			1	0.06
BS-D6	14	juvenile P.p	radius			3	0.28
BS-D6	15	juvenile P.p	leg bones other			2	0.78
BS-D6	15	juvenile P.p	wing bones			4	0.50
BS-D6	16	juvenile P. t	leg bones other			5	0.90
BS-D6	16	juvenile P. t	wing bones			1	0.15

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	17	juvenile P. t	leg bones other			1	0.10
BS-D6	6	juvenile P. t	wing bones			1	0.12
BS-D6	6	juvenile P. t	leg bones other			7	0.75
BS-D6	7	P.griseus	collarbone			1	0.78
BS-D6	7	P.griseus	wishbone			1	0.25
BS-D6	7	P.griseus	lower bill	1	1	2	0.52
BS-D6	7	P.griseus	vertebrae & ribs			1	0.11
BS-D6	8	P.griseus	wing bones				0.58
BS-D6	8	P.griseus	pelvis			1	0.58
BS-D6	8	P.griseus	leg bones other			2	0.23
BS-D6	8	P.griseus	vertebrae & ribs			1	0.15
BS-D6	8	P.griseus	ulna	1	1	2	3.97
BS-D6	8	P.griseus	radius			2	1.36
BS-D6	9	P.griseus	humerus		1	2	1.04
BS-D6	9	P.griseus	wing bones			1	0.25
BS-D6	9	P.griseus	collarbone			1	0.55
BS-D6	9	P.griseus	upper bill			1	0.08
BS-D6	12	P.griseus	humerus	1		2	3.96
BS-D6	12	P.griseus	wing bones			1	0.70
BS-D6	12	P.griseus	vertebrae & ribs			5	1.18
BS-D6	13	P.griseus	vertebrae & ribs			2	0.38
BS-D6	13	P.griseus	pelvis			2	0.27

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	14	P.griseus	humerus		2	2	6.02
BS-D6	14	P.griseus	wing bones			1	0.72
BS-D6	14	P.griseus	femur	1		1	0.35
BS-D6	15	P.griseus	wishbone			1	0.27
BS-D6	15	P.griseus	collarbone			3	0.96
BS-D6	15	P.griseus	sternum			1	0.37
BS-D6	15	P.griseus	pelvis			1	0.13
BS-D6	15	P.griseus	wishbone			2	0.37
BS-D6	16	P.griseus	leg bones other			4	0.38
BS-D6	16	P.griseus	wing bones			2	0.52
BS-D6	16	P.griseus	lower bill		1	1	0.31
BS-D6	17	P.griseus	humerus		1	1	3.08
BS-D6	6	P.griseus	humerus	1		1	3.17
BS-D6	6	P.griseus	tibia		1	1	0.40
BS-D6	6	P.griseus	cranium			1	0.06
BS-D6	6	chick Puffinus	leg bones other			4	0.68
BS-D6	6	chick Puffinus	vertebrae & ribs			1	0.04
BS-D6	7	chick Puffinus	radius			1	0.25
BS-D6	7	chick Puffinus	leg bones other			12	1.56
BS-D6	7	chick Puffinus	sternum			1	0.04
BS-D6	7	chick Puffinus	wing bones			3	0.13
BS-D6	8	chick Puffinus	leg bones other			7	0.65

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	8	chick Puffinus	femur	2	1	3	0.63
BS-D6	8	chick Puffinus	tibia			4	1.13
BS-D6	8	chick Puffinus	vertebrae & ribs			6	0.14
BS-D6	8	chick Puffinus	sternum			1	0.06
BS-D6	8	chick Puffinus	scapula			1	0.06
BS-D6	10	chick Puffinus	wing bones			15	0.98
BS-D6	10	chick Puffinus	wishbone			1	0.08
BS-D6	10	chick Puffinus	femur			2	0.21
BS-D6	10	chick Puffinus	vertebrae & ribs			1	0.04
BS-D6	10	chick Puffinus	lower bill			1	0.02
BS-D6	10	chick Puffinus	ulna		1	1	0.52
BS-D6	10	chick Puffinus	radius			1	0.33
BS-D6	10	chick Puffinus	humerus			2	0.46
BS-D6	11	chick Puffinus	vertebrae & ribs			4	0.14
BS-D6	12	chick Puffinus	leg bones other			14	1.04
BS-D6	12	chick Puffinus	tibia			3	0.40
BS-D6	12	chick Puffinus	vertebrae & ribs			1	0.05
BS-D6	12	chick Puffinus	wing bones			1	0.31
BS-D6	13	chick Puffinus	tibia			2	0.39
BS-D6	13	chick Puffinus	leg bones other			7	0.32
BS-D6	14	chick Puffinus	wishbone			2	0.50
BS-D6	14	chick Puffinus	femur	1		1	0.15

Square	Spit	Species	Element	No. left	No. right	Total	No.	Wt gm
BS-D6	14	chick Puffinus	leg bones other			11		1.11
BS-D6	14	chick Puffinus	vertebrae & ribs			4		0.09
BS-D6	14	chick Puffinus	wing bones			2		0.20
BS-D6	14	chick Puffinus	humerus		1	3		0.70
BS-D6	14	chick Puffinus	femur	1		1		0.13
BS-D6	14	chick Puffinus	leg bones other			8		0.72
BS-D6	15	chick Puffinus	tibia			3		0.28
BS-D6	15	chick Puffinus	wing bones			6		0.40
BS-D6	16	chick Puffinus	humerus			1		0.31
BS-D6	16	chick Puffinus	leg bones other			6		0.30
BS-D6	17	chick Puffinus	leg bones other			3		0.04
BS-D6	17	chick Puffinus	wing bones			2		0.28
BS-D6	17	chick Puffinus	ulna			1		0.41
BS-D6	16	P. small sp.	lower bill		1	1		0.04
BS-D6	17	P. carneipes	vertebrae & ribs			4		0.50
BS-D6	17	P. huttoni	tibia			1		0.97
BS-D6	18	P. carneipes	vertebrae & ribs			4		0.55
BS-D6	18	P. carneipes	collarbone			1		0.65
BS-D6	19	P. carneipes	vertebrae & ribs			5		0.43
BS-D6	18	P. tenuirostris	ulna		2	2		3.25
BS-D6	18	P. tenuirostris	humerus	1		3		2.75
BS-D6	18	P. tenuirostris	wing bones			12		1.44

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	18	<i>P. tenuirostris</i>	sternum			1	0.16
BS-D6	18	<i>P. tenuirostris</i>	leg bones other			13	1.74
BS-D6	18	<i>P. tenuirostris</i>	tibia	1		2	0.70
BS-D6	18	<i>P. tenuirostris</i>	femur			1	0.24
BS-D6	18	<i>P. tenuirostris</i>	wishbone			2	0.36
BS-D6	18	<i>P. tenuirostris</i>	unidentifiable			80	6.40
BS-D6	19	<i>P. tenuirostris</i>	unidentifiable			21	1.40
BS-D6	19	<i>P. tenuirostris</i>	humerus	1	1	3	4.00
BS-D6	19	<i>P. tenuirostris</i>	ulna	1	2	3	4.88
BS-D6	19	<i>P. tenuirostris</i>	upper bill			4	0.25
BS-D6	19	<i>P. tenuirostris</i>	wishbone			3	0.48
BS-D6	19	<i>P. tenuirostris</i>	collarbone	1	1	2	1.13
BS-D6	19	<i>P. tenuirostris</i>	leg bones other			10	1.70
BS-D6	20	<i>P. tenuirostris</i>	femur	1		1	0.30
BS-D6	20	<i>P. tenuirostris</i>	unidentifiable			42	2.78
BS-D6	20	<i>P. tenuirostris</i>	wishbone			3	0.94
BS-D6	20	<i>P. tenuirostris</i>	collarbone	1	1	2	1.14
BS-D6	20	<i>P. tenuirostris</i>	humerus		1	1	2.81
BS-D6	20	<i>P. tenuirostris</i>	ulna	1	1	3	3.10
BS-D6	20	<i>P. tenuirostris</i>	wing bones			12	1.35
BS-D6	20	<i>P. tenuirostris</i>	leg bones other			20	1.57
BS-D6	20	<i>P. tenuirostris</i>	tibia	1		1	1.03

Square	Spit	Species	Element	No. left	No. right	Total	No.	Wt gm
BS-D6	20	P. tenuirostris	vertebrae & ribs			8		0.72
BS-D6	18	juvenile P.p	leg bones other			1		0.10
BS-D6	18	juvenile P. t	wing bones			1		0.02
BS-D6	19	juvenile P.p	wing bones			2		0.17
BS-D6	19	juvenile P. t	vertebrae & ribs			1		0.07
BS-D6	19	juvenile P. t	tibia	2	1	3		2.60
BS-D6	20	juvenile P. t	upper bill			1		0.05
BS-D6	18	chick Puffinus	leg bones other			9		0.44
BS-D6	18	chick Puffinus	femur		1	1		0.18
BS-D6	18	chick Puffinus	ulna			1		0.45
BS-D6	19	chick Puffinus	leg bones other			4		0.22
BS-D6	20	chick Puffinus	leg bones other			7		0.58
BS-D6	18	P.griseus	wishbone			1		0.46
BS-D6	18	P.griseus	leg bones other			1		0.08
BS-D6	18	P.griseus	cranium			1		0.04
BS-D6	19	P.griseus	pelvis			3		0.44
BS-D6	19	P.griseus	humerus		1	1		0.36
BS-D6	18	P. pacificus	wing bones			3		0.24
BS-D6	18	P. pacificus	pelvis			1		0.02
BS-D6	19	P. pacificus	cranium			1		0.06
BS-D6	20	P. tenuirostris	cranium			7		0.70
BS-D6	21	P. tenuirostris	leg bones other			12		3.16

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	21	P. tenuirostris	tibia	1	1	2	1.30
BS-D6	21	P. tenuirostris	wishbone			2	0.24
BS-D6	21	P. tenuirostris	collarbone	1	2	4	1.31
BS-D6	21	P. tenuirostris	scapula			1	0.25
BS-D6	21	P. tenuirostris	vertebrae & ribs			7	1.00
BS-D6	21	P. tenuirostris	cranium			1	1.20
BS-D6	21	P. tenuirostris	upper bill			1	0.55
BS-D6	21	P. tenuirostris	humerus	1	2	6	5.70
BS-D6	21	P. tenuirostris	wing bones			3	0.93
BS-D6	21	P. tenuirostris	pelvis			2	0.18
BS-D6	21	P. tenuirostris	unidentifiable			53	3.51
BS-D6	21	P. tenuirostris	ulna	1		1	1.76
BS-D6	22	P. tenuirostris	leg bones other			12	1.42
BS-D6	22	P. tenuirostris	tibia	1		2	1.16
BS-D6	22	P. tenuirostris	femur	1	1	3	0.91
BS-D6	22	P. tenuirostris	vertebrae & ribs			10	1.05
BS-D6	22	P. tenuirostris	humerus	1		1	1.92
BS-D6	22	P. tenuirostris	ulna	1		2	0.73
BS-D6	22	P. tenuirostris	radius			2	0.86
BS-D6	22	P. tenuirostris	wing bones			7	1.84
BS-D6	22	P. tenuirostris	unidentifiable			53	2.70
BS-D6	22	P. tenuirostris	collarbone			1	0.48

Square	Spit	Species	Element	No. left	No. right	Total	No.	Wt gm
BS-D6	22	<i>P. tenuirostris</i>	upper bill			1		0.12
BS-D6	23	<i>P. tenuirostris</i>	unidentifiable			23		1.56
BS-D6	23	<i>P. tenuirostris</i>	humerus		2	2		4.25
BS-D6	23	<i>P. tenuirostris</i>	wing bones			1		0.10
BS-D6	23	<i>P. tenuirostris</i>	tibia		2	4		2.61
BS-D6	23	<i>P. tenuirostris</i>	femur	1	1	2		1.02
BS-D6	23	<i>P. tenuirostris</i>	leg bones other					0.12
BS-D6	23	<i>P. tenuirostris</i>	lower bill					0.22
BS-D6	23	<i>P. tenuirostris</i>	sternum			1		0.08
BS-D6	23	<i>P. tenuirostris</i>	vertebrae & ribs			3		0.30
BS-D6	21	juvenile <i>P. t</i>	wing bones			1		0.10
BS-D6	22	juvenile <i>P. t</i>	tibia	1	1	2		1.43
BS-D6	22	juvenile <i>P. t</i>	vertebrae & ribs			1		0.08
BS-D6	22	juvenile <i>P. t</i>	pelvis			1		0.63
BS-D6	23	juvenile <i>P. t</i>	leg bones other			1		0.13
BS-D6	2	juvenile <i>P.p</i>	vertebrae & ribs			1		0.04
BS-D6	2	juvenile <i>P.p</i>	radius			1		0.10
BS-D6	2	juvenile <i>P.p</i>	pelvis			1		0.44
BS-D6	21	chick <i>Puffinus</i>	humerus			2		0.44
BS-D6	21	chick <i>Puffinus</i>	wing bones			1		0.12
BS-D6	21	chick <i>Puffinus</i>	leg bones other			3		0.36
BS-D6	22	chick <i>Puffinus</i>	leg bones other			4		0.40

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D6	22	chick Puffinus	vertebrae & ribs			1	0.08
BS-D6	23	chick Puffinus	tibia			5	1.13
BS-D6	22	P. carneipes	vertebrae & ribs			2	0.30
BS-D6	22	P. carneipes	pelvis			2	0.22
BS-D6	22	P.griseus	cranium			1	0.45
BS-D6	21	P. pacificus	leg bones other			3	0.69
BS-D6	21	P. pacificus	vertebrae & ribs			2	0.18
BS-D6	21	P. pacificus	wing bones			1	0.50
BS-D6	21	P. pacificus	ulna			1	0.76
BS-D6	22	P. pacificus	leg bones other			1	0.36
BS-D6	24	chick Puffinus	humerus			1	0.66
BS-D6	24	chick Puffinus	vertebrae & ribs			1	0.08
BS-D6	24	chick Puffinus	leg bones other			3	0.12
BS-D6	26	P. tenuirostris	tibia			1	0.05
BS-D6	26	P. tenuirostris	leg bones other			1	0.08
BS-D6	27	P. tenuirostris	sternum			1	0.10
BS-D6	30	P. tenuirostris	leg bones other			1	0.08
BS-D6	26	P. tenuirostris	unidentifiable			16	1.25
BS-D6	26	P.griseus	radius			1	0.35
BS-D6	26	P. carneipes	vertebrae & ribs			2	0.03
BS-D9	4	P. tenuirostris	wing bones			6	2.30
BS-D9	4	P. tenuirostris	leg bones other			16	0.42

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	4	P. tenuirostris	ulna	1	3	6	8.48
BS-D9	4	P. tenuirostris	radius			3	1.72
BS-D9	4	P. tenuirostris	humerus	3	1	8	8.44
BS-D9	4	P. tenuirostris	pelvis			2	0.28
BS-D9	4	P. tenuirostris	cranium			3	1.72
BS-D9	4	P. tenuirostris	lower bill			4	0.46
BS-D9	4	P. tenuirostris	tibia	1		2	0.46
BS-D9	4	P. tenuirostris	femur	1		3	0.62
BS-D9	4	P. tenuirostris	unidentifiable			127	11.65
BS-D9	5	P. tenuirostris	tibia	6	1	7	4.85
BS-D9	5	P. tenuirostris	ulna	4	3	9	9.05
BS-D9	5	P. tenuirostris	sternum			4	0.44
BS-D9	5	P. tenuirostris	upper bill			1	0.20
BS-D9	5	P. tenuirostris	lower bill			7	0.50
BS-D9	5	P. tenuirostris	radius			9	3.67
BS-D9	5	P. tenuirostris	wishbone			4	0.73
BS-D9	5	P. tenuirostris	leg bones other			52	7.46
BS-D9	5	P. tenuirostris	collarbone	2	1	5	2.13
BS-D9	5	P. tenuirostris	femur	1	1	2	0.67
BS-D9	5	P. tenuirostris	unidentifiable			205	11.61
BS-D9	5	P. tenuirostris	pelvis			4	1.28
BS-D9	5	P. tenuirostris	humerus	2		3	1.46

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	6	P. tenuirostris	humerus	2	2	10	9.42
BS-D9	6	P. tenuirostris	femur	2	1	5	1.16
BS-D9	6	P. tenuirostris	tibia	2	5	10	4.52
BS-D9	6	P. tenuirostris	lower bill	2	1	6	0.72
BS-D9	6	P. tenuirostris	wishbone			2	0.34
BS-D9	6	P. tenuirostris	ulna	4	2	9	9.28
BS-D9	6	P. tenuirostris	radius			11	2.51
BS-D9	6	P. tenuirostris	sternum			4	2.06
BS-D9	6	P. tenuirostris	pelvis			1	0.42
BS-D9	6	P. tenuirostris	vertebrae & ribs			12	1.42
BS-D9	6	P. tenuirostris	wing bones			11	2.06
BS-D9	6	P. tenuirostris	leg bones other			41	3.52
BS-D9	6	P. tenuirostris	unidentifiable			132	8.81
BS-D9	7	P. tenuirostris	unidentifiable			187	13.52
BS-D9	7	P. tenuirostris	lower bill			8	0.51
BS-D9	7	P. tenuirostris	upper bill			2	0.54
BS-D9	7	P. tenuirostris	wing bones			8	2.44
BS-D9	7	P. tenuirostris	ulna	1	1	3	2.40
BS-D9	7	P. tenuirostris	tibia	2	2	5	2.05
BS-D9	7	P. tenuirostris	humerus	2	1	8	8.18
BS-D9	7	P. tenuirostris	femur	1		2	0.41
BS-D9	7	P. tenuirostris	pelvis			1	0.25

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	7	P. tenuirostris	sternum			1	0.19
BS-D9	7	P. tenuirostris	wishbone			2	0.21
BS-D9	7	P. tenuirostris	vertebrae & ribs			20	2.39
BS-D9	7	P. tenuirostris	leg bones other			34	5.15
BS-D9	7	P. tenuirostris	radius			10	2.30
BS-D9	8	P. tenuirostris	unidentifiable			117	7.12
BS-D9	8	P. tenuirostris	upper bill			1	0.10
BS-D9	8	P. tenuirostris	lower bill	2	1	5	0.59
BS-D9	8	P. tenuirostris	radius			13	4.20
BS-D9	8	P. tenuirostris	vertebrae & ribs			60	4.98
BS-D9	8	P. tenuirostris	sternum			5	2.03
BS-D9	8	P. tenuirostris	wishbone			3	1.57
BS-D9	8	P. tenuirostris	humerus	2	1	9	9.11
BS-D9	8	P. tenuirostris	ulna	2	3	8	7.10
BS-D9	8	P. tenuirostris	femur	3	3	8	1.88
BS-D9	8	P. tenuirostris	wing bones			21	3.20
BS-D9	8	P. tenuirostris	leg bones other			74	7.46
BS-D9	9	P. tenuirostris	leg bones other			41	5.40
BS-D9	9	P. tenuirostris	femur	2	1	4	1.63
BS-D9	9	P. tenuirostris	radius			2	1.48
BS-D9	9	P. tenuirostris	vertebrae & ribs			36	1.95
BS-D9	9	P. tenuirostris	wishbone			3	0.51

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	9	<i>P. tenuirostris</i>	sternum			22	0.23
BS-D9	9	<i>P. tenuirostris</i>	wing bones			7	2.60
BS-D9	9	<i>P. tenuirostris</i>	humerus	1		1	2.93
BS-D9	9	<i>P. tenuirostris</i>	pelvis			5	1.60
BS-D9	9	<i>P. tenuirostris</i>	lower bill			7	0.90
BS-D9	9	<i>P. tenuirostris</i>	cranium			1	1.37
BS-D9	9	<i>P. tenuirostris</i>	upper bill			4	1.56
BS-D9	9	<i>P. tenuirostris</i>	collarbone	2	1	5	2.13
BS-D9	9	<i>P. tenuirostris</i>	ulna		1	7	4.04
BS-D9	9	<i>P. tenuirostris</i>	tibia	3	2	7	2.36
BS-D9	9	<i>P. tenuirostris</i>	unidentifiable			104	6.88
BS-D9	4	<i>P. carneipes</i>	femur			1	0.08
BS-D9	5	<i>P. carneipes</i>	collarbone			1	0.45
BS-D9	6	<i>P. carneipes</i>	tibia	1	1	2	1.54
BS-D9	7	<i>P. carneipes</i>	femur	1		1	0.30
BS-D9	8	<i>P. carneipes</i>	wishbone			1	0.07
BS-D9	9	<i>P. carneipes</i>	wing bones			2	0.15
BS-D9	9	<i>P. carneipes</i>	wishbone			2	0.68
BS-D9	9	<i>P. carneipes</i>	collarbone			2	0.59
BS-D9	9	<i>P. carneipes</i>	pelvis			3	0.44
BS-D9	9	<i>P. carneipes</i>	humerus			1	0.56
BS-D9	9	<i>P. carneipes</i>	vertebrae & ribs			16	2.09

Square	Spit	Species	Element	No. left	No. right	Total	No.	Wt gm
BS-D9	4	P. pacificus	ulna			1		0.19
BS-D9	4	P. pacificus	leg bones other			1		0.05
BS-D9	5	P. pacificus	wing bones			6		2.90
BS-D9	5	P. pacificus	leg bones other			2		0.12
BS-D9	6	P. pacificus	leg bones other			6		0.26
BS-D9	6	P. pacificus	wishbone			2		0.14
BS-D9	6	P. pacificus	sternum			1		0.09
BS-D9	6	P. pacificus	cranium			1		0.42
BS-D9	6	P. pacificus	vertebrae & ribs			1		0.06
BS-D9	6	P. pacificus	wing bones			4		0.24
BS-D9	7	P. pacificus	ulna	1		2		0.82
BS-D9	8	P. pacificus	humerus			1		0.13
BS-D9	8	P. pacificus	lower bill			2		0.30
BS-D9	8	P. pacificus	radius			1		0.10
BS-D9	8	P. pacificus	wishbone			1		0.04
BS-D9	9	P. pacificus	leg bones other			3		0.39
BS-D9	4	juvenile P. t	vertebrae & ribs			1		0.16
BS-D9	4	juvenile P. t	ulna			2		1.64
BS-D9	4	juvenile P. t	radius			3		0.48
BS-D9	4	juvenile P. t	wishbone			2		0.30
BS-D9	4	juvenile P. t	scapula			2		0.28
BS-D9	4	juvenile P. t	pelvis			2		0.20

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	4	juvenile P. t	leg bones other			4	0.19
BS-D9	4	juvenile P. t	sternum			1	0.10
BS-D9	4	juvenile P. t	humerus			1	0.39
BS-D9	5	juvenile P. t	leg bones other			10	0.95
BS-D9	5	juvenile P. t	ulna	2		6	2.17
BS-D9	5	juvenile P. t	pelvis			1	0.13
BS-D9	5	juvenile P. t	sternum			3	0.37
BS-D9	5	juvenile P. t	wing bones			3	0.90
BS-D9	5	juvenile P. t	tibia	2		3	0.55
BS-D9	5	juvenile P. t	scapula	1	1	2	0.36
BS-D9	5	juvenile P. t	humerus	2		4	2.89
BS-D9	5	juvenile P.p	femur	1		1	0.23
BS-D9	5	juvenile P.p	wing bones			2	0.24
BS-D9	5	juvenile P.p	humerus			1	0.11
BS-D9	6	juvenile P.p	femur			1	0.24
BS-D9	6	juvenile P.p	tibia			2	0.44
BS-D9	6	juvenile P.p	wing bones			2	0.38
BS-D9	6	juvenile P. t	leg bones other			4	0.35
BS-D9	6	juvenile P. t	ulna		1	1	0.76
BS-D9	6	juvenile P. t	collarbone			1	0.31
BS-D9	7	juvenile P.p	leg bones other			2	0.56
BS-D9	7	juvenile P.p	wing bones			1	0.18

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	7	juvenile P.p	vertebrae & ribs			1	0.08
BS-D9	7	juvenile P. t	wing bones			3	0.55
BS-D9	7	juvenile P. t	vertebrae & ribs			1	0.10
BS-D9	7	juvenile P. t	humerus	1		2	1.08
BS-D9	7	juvenile P. g	sternum			1	0.38
BS-D9	7	juvenile P. g	pelvis			1	0.42
BS-D9	8	juvenile P. t	humerus	1		2	1.43
BS-D9	8	juvenile P. t	ulna			2	0.56
BS-D9	9	juvenile P.p	vertebrae & ribs			1	0.05
BS-D9	9	juvenile P. t	vertebrae & ribs			8	0.54
BS-D9	9	juvenile P. t	scapula			2	0.27
BS-D9	9	juvenile P. t	collarbone			1	0.22
BS-D9	9	juvenile P. t	femur			1	0.35
BS-D9	9	juvenile P. t	wing bones			1	0.46
BS-D9	9	juvenile P. t	radius			1	0.24
BS-D9	9	juvenile P. t	humerus			1	0.11
BS-D9	9	juvenile P. t	ulna			1	0.67
BS-D9	9	juvenile P. t	leg bones other			11	1.43
BS-D9	9	juvenile P. g	radius			1	0.11
BS-D9	9	P. huttoni	leg bones other			2	0.07
BS-D9	5	P.griseus	wing bones			2	1.14
BS-D9	5	P.griseus	scapula			4	0.90

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	5	P.griseus	radius			3	0.85
BS-D9	5	P.griseus	tibia	1	1	2	0.80
BS-D9	5	P.griseus	lower bill			2	0.08
BS-D9	5	P.griseus	sternum			2	0.35
BS-D9	6	P.griseus	tibia	1		2	1.05
BS-D9	6	P.griseus	leg bones other			3	0.29
BS-D9	6	P.griseus	pelvis	2	1	3	0.51
BS-D9	6	P.griseus	sternum			1	0.46
BS-D9	6	P.griseus	scapula			1	0.13
BS-D9	6	P.griseus	ulna			1	0.38
BS-D9	7	P.griseus	humerus		1	3	4.63
BS-D9	7	P.griseus	scapula			2	0.47
BS-D9	8	P.griseus	humerus	1		1	3.22
BS-D9	8	P.griseus	scapula			2	0.64
BS-D9	8	P.griseus	pelvis			2	0.30
BS-D9	9	P.griseus	humerus		1	1	1.54
BS-D9	9	P.griseus	radius			4	1.39
BS-D9	9	P.griseus	leg bones other			2	0.21
BS-D9	9	P.griseus	vertebrae & ribs			2	0.33
BS-D9	9	P.griseus	wishbone			1	0.40
BS-D9	9	P.griseus	scapula			2	0.59
BS-D9	9	P.griseus	collarbone			1	0.40

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	4	chick Puffinus	radius			2	0.79
BS-D9	4	chick Puffinus	humerus			4	2.06
BS-D9	4	chick Puffinus	leg bones other			10	1.04
BS-D9	5	chick Puffinus	radius			3	0.75
BS-D9	5	chick Puffinus	humerus		1	6	1.67
BS-D9	5	chick Puffinus	ulna		2	7	0.90
BS-D9	5	chick Puffinus	femur			4	0.25
BS-D9	5	chick Puffinus	leg bones other			14	0.63
BS-D9	5	chick Puffinus	wing bones			3	0.12
BS-D9	6	chick Puffinus	leg bones other			16	0.66
BS-D9	6	chick Puffinus	humerus			4	0.78
BS-D9	6	chick Puffinus	tibia			3	0.31
BS-D9	6	chick Puffinus	ulna	1		3	0.83
BS-D9	7	chick Puffinus	wing bones			1	0.06
BS-D9	7	chick Puffinus	leg bones other			12	0.32
BS-D9	7	chick Puffinus	femur			3	0.28
BS-D9	7	chick Puffinus	tibia			4	0.44
BS-D9	7	chick Puffinus	humerus	1		9	1.82
BS-D9	9	chick Puffinus	leg bones other			4	0.40
BS-D9	9	chick Puffinus	femur			1	0.20
BS-D9	9	chick Puffinus	humerus			8	2.67
BS-D9	10	P.griseus	sternum			2	0.40

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	10	P.griseus	tibia			1	0.37
BS-D9	10	P.griseus	vertebrae & ribs			1	0.08
BS-D9	10	P.griseus	radius			4	1.77
BS-D9	10	P.griseus	wing bones			1	0.53
BS-D9	11	P.griseus	pelvis			1	0.81
BS-D9	11	P.griseus	leg bones other			3	0.41
BS-D9	11	P.griseus	vertebrae & ribs			2	0.28
BS-D9	12	P.griseus	femur			1	0.70
BS-D9	12	P.griseus	wing bones			1	0.10
BS-D9	10	chick Puffinus	vertebrae & ribs			7	0.36
BS-D9	10	chick Puffinus	leg bones other			20	1.38
BS-D9	10	chick Puffinus	femur	1	1	2	0.18
BS-D9	10	chick Puffinus	wing bones			1	0.05
BS-D9	10	chick Puffinus	humerus			10	1.74
BS-D9	11	chick Puffinus	vertebrae & ribs			6	0.12
BS-D9	11	chick Puffinus	humerus			1	0.59
BS-D9	11	chick Puffinus	femur			1	0.13
BS-D9	11	chick Puffinus	leg bones other			22	1.12
BS-D9	12	chick Puffinus	vertebrae & ribs			10	0.59
BS-D9	12	chick Puffinus	leg bones other			5	0.15
BS-D9	12	chick Puffinus	tibia			2	0.17
BS-D9	12	chick Puffinus	femur			4	0.37

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	13	chick Puffinus	leg bones other			4	0.30
BS-D9	10	P. carneipes	pelvis			3	0.57
BS-D9	10	P. carneipes	wishbone			1	0.20
BS-D9	11	P. carneipes				2	0.16
BS-D9	11	P. carneipes	femur			1	0.12
BS-D9	12	P. carneipes	wishbone			2	0.23
BS-D9	11	P. pacificus	radius			1	0.37
BS-D9	11	P. pacificus	wing bones			1	0.02
BS-D9	11	P. pacificus	leg bones other			1	0.11
BS-D9	10	P. tenuirostris	vertebrae & ribs			13	2.53
BS-D9	10	P. tenuirostris	femur	1	1	2	0.80
BS-D9	10	P. tenuirostris	wing bones			5	0.99
BS-D9	10	P. tenuirostris	collarbone	2	1	3	1.13
BS-D9	10	P. tenuirostris	scapula	1		1	0.16
BS-D9	10	P. tenuirostris	radius			4	0.71
BS-D9	10	P. tenuirostris	leg bones other			39	3.35
BS-D9	10	P. tenuirostris	pelvis			1	0.16
BS-D9	10	P. tenuirostris	sternum			4	4.37
BS-D9	10	P. tenuirostris	cranium			7	3.45
BS-D9	10	P. tenuirostris	upper bill			3	0.34
BS-D9	10	P. tenuirostris	lower bill			5	0.28
BS-D9	10	P. tenuirostris	tibia	2	1	6	2.70

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	10	<i>P. tenuirostris</i>	ulna	2	2	7	7.15
BS-D9	10	<i>P. tenuirostris</i>	humerus	2	3	8	11.86
BS-D9	10	<i>P. tenuirostris</i>	sternum			8	0.97
BS-D9	10	<i>P. tenuirostris</i>	unidentifiable			67	4.08
BS-D9	11	<i>P. tenuirostris</i>	leg bones other			32	3.16
BS-D9	11	<i>P. tenuirostris</i>	vertebrae & ribs			36	3.54
BS-D9	11	<i>P. tenuirostris</i>	sternum			7	1.46
BS-D9	11	<i>P. tenuirostris</i>	femur	1	1	3	0.58
BS-D9	11	<i>P. tenuirostris</i>	humerus	1	1	4	4.67
BS-D9	11	<i>P. tenuirostris</i>	pelvis			2	0.37
BS-D9	11	<i>P. tenuirostris</i>	wishbone			3	1.15
BS-D9	11	<i>P. tenuirostris</i>	wing bones			6	1.23
BS-D9	11	<i>P. tenuirostris</i>	ulna	2	1	4	3.70
BS-D9	11	<i>P. tenuirostris</i>	radius			2	1.21
BS-D9	11	<i>P. tenuirostris</i>	tibia	1		1	1.00
BS-D9	11	<i>P. tenuirostris</i>	cranium			2	1.15
BS-D9	11	<i>P. tenuirostris</i>	lower bill			6	0.68
BS-D9	11	<i>P. tenuirostris</i>	upper bill			2	1.00
BS-D9	12	<i>P. tenuirostris</i>	vertebrae & ribs			21	2.10
BS-D9	12	<i>P. tenuirostris</i>	sternum			2	0.40
BS-D9	12	<i>P. tenuirostris</i>	lower bill			3	0.44
BS-D9	12	<i>P. tenuirostris</i>	ulna	1	1	2	2.84

Square	Split	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	12	P. tenuirostris	wing bones			5	1.84
BS-D9	12	P. tenuirostris	leg bones other			15	2.40
BS-D9	12	P. tenuirostris	unidentifiable			33	2.31
BS-D9	13	P. tenuirostris	unidentifiable			28	0.51
BS-D9	13	P. tenuirostris	ulna			1	0.60
BS-D9	14	P. tenuirostris	femur			1	0.99
BS-D9	14	P. tenuirostris	unidentifiable			29	2.16
BS-D9	10	juvenile P. t	humerus	1	1	2	1.85
BS-D9	10	juvenile P. t	wing bones			1	0.32
BS-D9	10	juvenile P. t	vertebrae & ribs			7	0.55
BS-D9	10	juvenile P.p	wing bones			1	0.34
BS-D9	10	juvenile P.p	humerus			1	0.21
BS-D9	10	juvenile P.p	collarbone			1	0.13
BS-D9	10	juvenile P.p	wishbone				0.10
BS-D9	11	juvenile P. t	sternum			6	1.74
BS-D9	11	juvenile P. t	vertebrae & ribs			9	0.78
BS-D9	11	juvenile P. t	wing bones			2	0.16
BS-D9	11	juvenile P. t	leg bones other			6	0.66
BS-D9	11	juvenile P. t	collarbone			1	0.26
BS-D9	11	juvenile P. t	femur	1	1	2	0.64
BS-D9	11	juvenile P. t	tibia	4	2	7	1.29
BS-D9	11	juvenile P. t	humerus			2	0.88

Square	Spit	Species	Element	No. left	No. right	Total No.	Wt gm
BS-D9	11	juvenile P.p	femur	1		1	0.34
BS-D9	11	juvenile P.p	lower bill			4	0.18
BS-D9	12	juvenile P. g	femur			1	0.52
BS-D9	12	juvenile P. t	lower bill			4	0.18
BS-D9	12	juvenile P. t	vertebrae & ribs			7	0.58
BS-D9	12	juvenile P. t	wing bones			1	0.06
BS-D9	12	juvenile P. t	femur			1	0.32
BS-D9	12	juvenile P. t	sternum			1	0.24
BS-D9	12	juvenile P. t	humerus			2	1.67
BS-D9	12	juvenile P.p	wishbone			1	0.09
BS-D9	13	juvenile P. t	humerus			1	0.87
BS-D9	13	juvenile P. t	leg bones other			2	0.15
BS-D9	13	juvenile P. t	wing bones			4	0.32
BS-D9	13	juvenile P. t	cranium			1	0.32
BS-U7		P. tenuirostris				24	7.6
BS-I6		P. tenuirostris				63	16.3

APPENDIX IX

Beeton Rockshelter: Other sea bird bone

Square	Spit	Weight g	Family/sp.	No.	Element
BS-D6	6	0.41	other sea bird	5	?
BS-D6	7	0.46	other sea bird	1	sternum
BS-D6	7	0.27	other sea bird	4	wing bones
BS-D6	7	0.60	other sea bird	12	?
BS-D6	8	0.10	other sea bird	2	sternum
BS-D6	11	0.18	other sea bird	2	wing bones
BS-D6	12	0.42	other sea bird	2	pelvis
BS-D6	12	0.16	other sea bird	2	lower bill
BS-D6	12	0.06	other sea bird	2	?
BS-D6	14	0.53	other sea bird	6	collarbone
BS-D6	15	0.68	other sea bird	4	wing bones
BS-D6	15	0.51	other sea bird	2	wing bones
BS-D6	15	0.36	other sea bird	9	?
BS-D6	15	0.44	other sea bird	6	?
BS-D6	17	0.09	other sea bird	2	?
BS-D6	19	0.44	other sea bird	3	?
BS-D6	19	0.50	other sea bird	1	wishbone

Square	Split	Weight g	Family/sp.	No.	Element
BS-D6	21	0.15	other sea bird	1	upper bill
BS-D6	21	0.06	other sea bird	1	femur
BS-D6	26	0.31	other sea bird	1	?
BS-D6	27	0.21	other sea bird	1	radius
BS-D6	30	0.35	other sea bird	2	?
BS-D6	33	0.22	other sea bird	1	lower bill
BS-D9	4	0.02	other sea bird	1	?
BS-D9	4	0.06	other sea bird	1	wing bones
BS-D9	5	0.21	other sea bird	1	lower bill
BS-D9	5	0.06	other sea bird	2	?
BS-D9	5	0.05	other sea bird	1	wing bones
BS-D9	6	0.25	other sea bird	2	sternum
BS-D9	6	1.32	other sea bird	4	ulna
BS-D9	6	0.21	other sea bird	6	?
BS-D9	6	0.39	other sea bird	3	wishbone
BS-D9	6	0.05	other sea bird	1	lower bill
BS-D9	6	0.21	other sea bird	2	scapula

Square	Split	Weight g	Family/sp.	No.	Element
BS-D9	7	0.14	other sea bird	1	pelvis
BS-D9	7	0.10	other sea bird	1	sternum
BS-D9	7	0.05	other sea bird	2	scapula
BS-D9	8	0.25	other sea bird	4	?
BS-D9	8	0.30	other sea bird	4	lower bill
BS-D9	8	0.34	other sea bird	1	upper bill
BS-D9	9	0.57	other sea bird	1	wing bones
BS-D9	9	0.13	other sea bird	2	wishbone
BS-D9	9	0.19	other sea bird	3	upper bill
BS-D9	9	0.11	other sea bird	2	?
BS-D9	9	1.75	other sea bird	7	wing bones
BS-D9	10	0.19	other sea bird	1	?
BS-D9	10	0.21	other sea bird	2	wishbone
BS-D9	10	0.12	other sea bird	2	wing bones
BS-D6	11	0.40	Penguin	1	cranium
BS-D6	13	0.11	Penguin	1	?
BS-D6	13	0.53	Penguin	8	?

Square	Spit	Weight g	Family/sp.	No.	Element
BS-D6	12	0.39	Penguin	5	cranium
BS-D6	18	0.05	Penguin	1	collarbone
BS-C6	20	0.04	other petrels	1	unidentifiable
BS-C6	19	0.06	other petrels	1	unidentifiable
BS-C6	19	0.08	other petrels	1	?
BS-C6	17	0.76	other petrels	1	ulna
BS-C6	17	0.68	other petrels	1	upper bill
BS-C6	17	0.51	other petrels	6	radius
BS-C6	17	0.11	other petrels	1	scapula
BS-C6	17	0.19	other petrels	4	?
BS-C6	17	0.16	other petrels	2	?
BS-C6	12	0.03	other petrels	1	wing bones
BS-C6	15	0.38	other petrels	4	?
BS-C6	15	0.03	other petrels	3	?
BS-C6	15	0.08	other petrels	1	radius
BS-C6	14	0.44	other petrels	2	wishbone
BS-C6	14	0.35	other petrels	2	?

Square	Spit	Weight g	Family/sp.	No.	Element
BS-C6	14	0.35	other petrels	1	collarbone
BS-C6	14	0.47	other petrels	1	ulna
BS-C6	10	0.60	other petrels	1	tibia
BS-C6	9	0.24	other petrels	1	collarbone
BS-C6	9	0.26	other petrels	4	?
BS-C6	9	0.32	other petrels	7	unidentifiable
BS-C6	9	0.07	other petrels	1	radius
BS-C6	9	0.40	other petrels	1	wing bones
BS-C6	7	0.64	other petrels	6	?
BS-C6	8	1.99	other petrels	2	ulna
BS-C6	8	.3	other petrels	1	radius
BS-C6	8	.37	other petrels	4	wing bones
BS-C6	8	0.04	other petrels	1	?
BS-C6	8	0.54	other petrels	1	?
BS-C6	8	0.17	other petrels	1	pelvis
BS-C6	8	0.06	other petrels	2	radius
BS-C6	11	0.35	other petrels	5	?

Square	Spit	Weight g	Family/sp.	No.	Element
BS-C6	11	0.83	other petrels	3	humerus
BS-C6	11	0.45	other petrels	1	ulna
BS-C6	11	1.34	other petrels	5	?
BS-C6	11	0.46	other petrels	1	radius
BS-C6	11	0.34	other petrels	2	scapula
BS-C6	11	0.14	other petrels	1	femur
BS-C6	12	1.09	other petrels	3	wing bones
BS-C6	12	0.18	other petrels	2	?
BS-C6	12	0.24	other petrels	3	?
BS-C6	12	0.55	other petrels	1	ulna
BS-C6	12	0.11	other petrels	1	tibia
BS-C6	12	0.08	other petrels	1	scapula
BS-C6	16	0.70	other petrels	4	?
BS-C6	16	0.04	other petrels	1	cranium
BS-C6	16	0.06	other petrels	1	wing bones
BS-C6	18	0.69	other petrels	1	tibia
BS-C6	18	0.04	other petrels	1	?

Square	Split	Weight g	Family/sp.	No.	Element
BS-C6	18	0.14	other petrels	3	?
BS-D6	5	0.28	other petrels	6	?
BS-D6	5	1.00	other petrels	3	collarbone
BS-D6	5	0.13	other petrels	1	?
BS-I6	6	.89	other petrels	1	

APPENDIX X

Beeton Rockshelter: Stone data

Square	Spit	No.	wt g	Implement description	Dimensions (l b w) mm	Retouch length mm	Use-wear	Stone type	Cortex
BS D9	4	1	1.94	small round 'thumbnail' scraper	14 16 6	21	detectable	quartz - glassy translucent	
BS D9	9	1	3.9	small round steep-edged scraper	21 20 9	29	detectable	quartz - glassy white	pebble w- worn 20%
BS D9	10	1	13.11	steep edged scraper	36 24 13	39	detectable	quartzite - cream/grey	other 5%
BS D9	10	1	1.13	small rounded steep edged scraper	18 12 5	12		crystal quartz clear	crystal facet 20%
BS D6	5	1	4.17	retouched flake	31 18 10	14		quartzite - rust brown	
BS D6	6	1	4.89	end scraper	37 15 12		detectable	quartz - white	
BS D6	8	1	2.58	round scraper	33 31 6		detectable	quartz - white	
BS D6	12	1	1.87	small round 'thumbnail' scraper	18 16 5	22	detectable	quartz - glassy white	
BS D6	12	1	4.31	small end scraper	29 16 8	12		quartz - white	smooth vein 50%
BS D6	14	1	1.33	utilised broken flake	24 12 4		detectable	crystal quartz clear	
BS D6	14	1	3.87	steep edged scraper	29 24 9	22		quartz - white	smooth vein 30%
BS D6	16	1	4.33	small rounded 'thumbnail' scraper	21 18 9	24	detectable	quartz - grey	

Square	Spit	No.	wt g	Implement description	Dimensions (l b w) mm	Retouch length mm	Use-wear	Stone type	Cortex
BS D6	16	1	1.95	retouched flake	24 19 5	17	detectable	quartzite	
BS D6	17	1	28.93	large steep edged scraper	46 31 14	59	detectable	quartzite	
BS D6	33	1	1.92	small scraper	20 16 5	21	detectable	quartz - white	
BS C6	5	1	1.05	small steep edged scraper	12 10 6	19	detectable	crystal quartz clear	
BS C6	7	1	4.45	utilised flake	32 18 7		detectable	crystal quartz clear	crystal facets 5%
BS C6	7	1	0.69	small retouched flake	16 10 3	16	detectable	quartz - glassy translucent	waterworn facet
BS C6	8	1	.76	small retouched flake	12 18 4	11	detectable	crystal qtz - clear smoky	
BS C6	10	1	1.51	retouched flake	21 16 4	8	detectable	crystal quartz clear	
BS C6	11	1	8.35	retouched flake	26 29 8	28		quartzite	
BS C6	11	1	1.8	retouched flake	21 16 5	27	2 sides	crystal quartz clear - topaz?	water worn facets
BS C6	12	1	1.94	retouched flake	20 14 7	17	detectable	quartz - white	
BS C6	12	1	17.25	utilised flaked piece	44 31 9		detectable	crystal quartz - clear	

Square	Split	No.	wt g	Implement description	Dimensions (l b w) mm	Retouch length mm	Use-wear	Stone type	Cortex
BS C6	14	1	3.43	retouched flake	15 21 3	11	detectable	quartz - glassy translucent	
BS C6	15	1	1.17	utilised flaked piece	29 11 4		detectable	crystal quartz - clear	
BS U7	9	1	1.75	steep edged end scraper	20 11 7	13	detectable	crystal qtz - clear smoky	

Square	Spit	Dimensions (l b w) mm	wt g	Stone type	Manuport description	No.
BS D9	5	all >40 min.	624.36	local contact rock	waterworn cobble pieces - all appear fire split	7
BS D9	6	93 78 30	208.41	local contact rock	25% water worn but not cobble cortex	1
BS D9	6	71 87 18	121.4	consolidated limestone	large flat piece possibly purposefully shaped	1
BS D9	7	47 44 25	58.67	granite	water worn cobble, weathering quartzose surface 80% cortex	1
BS D9	9	70 41 49	76.29	local contact rock	split rock with 30% rough cortex	1
BS D9	9	52 40 36	79.53	quartzite	cobble with waterworn cortex	1
BS D9	13	22 17 8	3.73	quartz - grey	chunk of reef or vein with about 80% rough vein cortex	1
BS D9	5	20 15 16	6.56	quartzite	100% smooth water worn pebble cortex	1
BS D6	10	57 34 51	120.48	local contact rock	cobble with fracture and pitting 80% water worn cortex	1

Square	Split	Dimensions (l b w) mm	wt g	Stone type	Manuport description	No.
BS D6	11	72 59 39	222.45	local contact rock	unmodified water worn cobble	1
BS D6	12	>27 min.	252.38	local contact rock	5 fire split pieces all appear to be from one larger parent piece	5
BS D6	21	51 24 20	213.63	local contact rock	possibly pitted (very weathered) hammerstone water worn cobble	1
BS D6	22	59 54 44	157.42	quartz	water worn cobble with possible pitting	1
BS D6	27	45 31 20	37.87	local contact rock	smooth unmodified pebble	1
BS C6	7	85 36 54	223.17	local contact rock	unmodified cobble	1
BS C6	8	89 38 22	87.22	local contact rock	pitted piece of grindstone	1
BS C6	8	84 54 18	62.32	local contact rock	piec of fire split local rock	1
BS C6	11	129 45 32	263.37	local contact rock	elongated cobble with possible pit marks	1

Square	Spit	Dimensions (l b w) mm	wt g	Stone type	Manuport description	No.
BS C6	13	29 16 14	9.31	quartz	unmodified water worn pebble	1
BS U7	6	46 39 24	60.63	quartzite	unmodified water worn pebble	1
BS U7	9	61 48 38	134.32	local contact rock	unmodified water worn pebble	1
BS U7	9	49 32 20	48.05	quartzite	unmodified water worn pebble	1
BS U7	9	31 28 16	16.86	quartz	unmodified water worn pebble	1
BS U7	9	112 57 32	333	local contact rock	piece of large local rock fire split?	1
BS U7	10	31 28 31	25.02	quartzite	unmodified water worn pebble	1
BS U7	13	23 19 15	9.21	quartzite	unmodified water worn pebble	1
BS U7	14	68 59 39	173.36	local contact rock	piece of large local rock fire split?	1

Square	Spit	Dimensions (l b w) mm	wt g	Stone type	Manuport description	No.
BS 16	8	44 27 15	28.72	quartzite	unmodified water worn pebble	1
BS 16	10	56 35 21	60.90	quartzite	unmodified water worn pebble	1

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D9	1	3	1	.66	quartz		
BS D9	2	5	1	1.69	quartz		
BS D9	2	3	1	.41	silcrete	1	
BS D9	2	3	1	.31	crystal qtz	1	1 crystal facet
BS D9	2	2	8	.65	crystal qtz	2	
BS D9	2	1	1	.01	crystal qtz		
BS D9	2	2	31	3.31	quartz	11	
BS D9	2	1	4	.1	quartz		
BS D9	2	3	7	1.82	quartz	2	
BS D9	2	4	1	.46	quartz		
BS D9	3	4	3	2.28	quartz	1	
BS D9	3	3	7	2.27	quartz	2	
BS D9	3	2	25	1.98	quartz	5	
BS D9	3	1	3	.07	quartz	0	
BS D9	3	2	1	.06	quartzite	1	
BS D9	3	3	1	.31	crystal qtz	0	
BS D9	3	2	4	.32	crystal qtz	3	
BS D9	3	1	1	.01	crystal qtz	1	
BS D9	4	1	7	.21	quartz	0	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D9	4	2	59	7.34	quartz	12	
BS D9	4	3	49	15.08	quartz	21	
BS D9	4	4	17	13.85	quartz	11	
BS D9	4	5	4	5.06	quartz	4	
BS D9	4	5	1	2.21	quartzite	1	
BS D9	4	4	1	2.89	contact rock*	1	
BS D9	4	3	2	.49	quartzite	2	
BS D9	4	3	1	.67	chert	1	reef or vein
BS D9	4	9	1	30.39	contact rock*	1	1 pebble
BS D9	4	7	1	9.27	ind. limestone		1 pebble
BS D9	4	1	3	.09	crystal qtz	2	
BS D9	4	2	12	.83	crystal qtz	8	
BS D9	4	3	5	.77	crystal qtz	4	
BS D9	4	4	1	1.26	crystal qtz	1	1 crystal facet
BS D9	5	1	4	.16	quartz		
BS D9	5	2	87	8.38	quartz	21	
BS D9	5	3	49	11.35	quartz	27	
BS D9	5	4	23	16.49	quartz	12	
BS D9	5	5	5	12.72	quartz	2	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D9	5	6	7	21.92	quartz	3	2 pebble
BS D9	5	7	2	14.73	quartz		
BS D9	5	9	1	6.18	quartz	1	
BS D9	5	1	3	.08	crystal qtz	1	5 crystal facets
BS D9	5	2	21	1.72	crystal qtz	17	
BS D9	5	3	2	.31	crystal qtz	2	
BS D9	5	4	2	.40	crystal qtz	2	
BS D9	5	5	1	1.68	ind. limestone	1	
BS D9	5	3	1	.18	contact rock*	1	
BS D9	5	2	1	.09	quartzite	1	
BS D9	5	2	2	1.87	quartzite	2	
BS D9	6	1	4	.11	quartz		
BS D9	6	2	69	6.87	quartz	26	
BS D9	6	3	55	14.93	quartz	33	
BS D9	6	4	19	21.72	quartz	11	
BS D9	6	5	7	19.36	quartz	4	
BS D9	6	6	1	3.67	quartz		
BS D9	6	7	1	3.34	quartz		
BS D9	6	12	1	45.27	quartz	1	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D9	6	1	3	.05	crystal qtz	1	
BS D9	6	2	16	1.11	crystal qtz	8	
BS D9	6	3	10	1.98	crystal qtz	9	
BS D9	6	4	3	2.55	crystal qtz	3	
BS D9	6	5	1	1.14	contact rock*	1	
BS D9	6	3	1	.18	quartzite		1 pebble
BS D9	7	1	4	.13	quartz	2	
BS D9	7	2	45	3.65	quartz	23	
BS D9	7	3	45	14.81	quartz		17 pebble
BS D9	7	4	12	9.16	quartz	6	3 pebble, 1 vein
BS D9	7	5	9	17.25	quartz	5	2 pebble, 1 vein
BS D9	7	6	2	3.2	quartz	1	
BS D9	7	7	1	8.51	quartz		1 reef or vein
BS D9	7	9	1	12.05	quartz	1	
BS D9	7	8	1	14.95	quartz		
BS D9	7	4	1	.57	crystal qtz	1	
BS D9	7	3	5	1.54	crystal qtz	4	2 crystal facet
BS D9	7	2	18	1.39	crystal qtz	14	3 crystal facet
BS D9	7	3	1	.14	quartzite	1	

Square	Splt	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D9	7	4	2	.84	quartzite	2	
BS D9	7	5	1	.54	quartzite	1	
BS D9	8	2	61	5.12	quartz	16	
BS D9	8	3	48	14.95	quartz	26	
BS D9	8	4	12	14.42	quartz	8	2 crystal facet
BS D9	8	5	6	11.98	quartz	2	
BS D9	8	6	3	6.96	quartz	3	
BS D9	8	1	2	.08	crystal qtz	1	
BS D9	8	2	9	.94	crystal qtz	7	
BS D9	8	3	3	.97	crystal qtz	3	1 crystal facet
BS D9	8	4	1	.28	crystal qtz	1	
BS D9	8	2	1	.07	quartzite	1	
BS D9	9	1	4	.13	quartz		
BS D9	9	2	32	3.26	quartz	14	2 crystal facet
BS D9	9	3	28	8.2	quartz	16	3 crystal facet
BS D9	9	4	13	13.05	quartz	7	
BS D9	9	5	6	10.02	quartz	2	pebble
BS D9	9	6	1	5.17	quartz		
BS D9	9	8	1	16.05	quartz	1	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D9	9	1	1	.02	crystal qtz		
BS D9	9	2	11	.75	crystal qtz	6	2 crystal facet
BS D9	9	3	5	1.39	crystal qtz	3	2 crystal facet
BS D9	9	4	2	2.03	crystal qtz	1 bipolar	
BS D9	9	5	1	.94	crystal qtz	1 bipolar	
BS D9	9	3	1	.12	quartzite	1	
BS D9	9	6	2	2.25	contact rock*	1	
BS D9	9	3	1	.32	cherty hornfels	1	
BS D9	10	1	2	.05	quartz		
BS D9	10	2	42	4.36	quartz	8	2 crystal facet
BS D9	10	3	32	9.88	quartz	19	2 pebble 1 facet
BS D9	10	4	11	7.62	quartz	4	3 pebble
BS D9	10	5	6	13.91	quartz	2	
BS D9	10	6	1	4.87	quartz	1	
BS D9	10	11	1	16.63	quartz		
BS D9	10	3	2	.57	crystal qtz	2	
BS D9	10	2	17	1.36	crystal qtz	11	3 crystal facets
BS D9	10	4	1	.91	quartzite	1	
BS D9	10	3	1	.17	quartzite	1	

Beeton Rockshelter

Unmodified flakes and flaked pieces

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D9	10	2	1	.04	chert (jasper)	1	
BS D9	11	1	3	.09	quartz		
BS D9	11	2	22	2.12	quartz	8	
BS D9	11	3	19	5.12	quartz	9	
BS D9	11	4	3	3.09	quartz	2	1 pebble
BS D9	11	5	5	15.71	quartz	1	1 crystal facet
BS D9	11	7	1	2.2	quartz		
BS D9	11	1	1	.03	crystal qtz	1	
BS D9	11	2	6	.4	crystal qtz	4	2 crystal facet
BS D9	11	3	2	.37	crystal qtz	2	
BS D9	11	2	2	.14	quartzite	2	
BS D9	11	3	2	.2	quartzite	2	
BS D9	12	5	1	.4	quartz	1	
BS D9	12	4	4	3.11	quartz	2	2 pebble
BS D9	12	3	12	3.58	quartz	9	
BS D9	12	2	48	3.52	quartz	21	4 facet 2 pebble
BS D9	12	1	3	.09	quartz		
BS D9	12	4	1	.2	crystal qtz	1	
BS D9	12	3	3	.48	crystal qtz	2	1 crystal facet

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D9	12	2	6	.54	crystal qtz	4	2 crystal facet
BS D9	12	3	2	.33	quartzite	2	
BS D9	12	2	1	.12	quartzite	1	
BS D9	13	2	15	.83	quartz	5	
BS D9	13	1	1	.02	quartz		
BS D9	13	3	8	2.16	quartz	4	
BS D9	13	4	2	2.24	quartz	2	1 facet 1 pebble
BS D9	13	5	1	3.28	quartz		reef or vein
BS D9	13	5	1	.21	crystal qtz	1 bipolar	
BS D9	13	2	5	.36	crystal qtz	2	2 crystal facet
BS D9	13	3	2	.55	crystal qtz	1	1 crystal facet
BS D9	14	2	4	.23	quartz		1 pebble
BS D9	14	3	4	1.13	quartz	1	1 crystal facet
BS D9	14	4	3	2.78	quartz	1	
BS D9	14	2	1	.09	crystal qtz	1	
BS D9	14	3	2	.27	crystal qtz	2	
BS D9	14	5	1	1.78	quartzite	1	
BS D9	14	6	1	1.27	quartzite	1	
BS D9	14	4	2	1.69	quartzite	2	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D9	14	3	1	.17	quartzite	1	
BS D9	15	4	1	.97	quartz		1 pebble
BS D9	15	3	1	.24	quartz	1	
BS D9	15	4	1	.94	quartzite	1	
BS D9	16	2	4	.15	quartz	2	
BS D9	16	3	1	.15	quartz		1 pebble
BS D9	17	2	2	.31	crystal qtz	1	2 crystal facet
BS D9	17	2	9	.59	quartz	2	1 crystal facet
BS D9	17	3	3	.30	quartz	2	
BS D9	17	5	1	2.31	quartz	1	
BS D9	17	6	1	2.93	quartz	1 bipolar	
BS D9	19	3	1	.24	quartz	1	
BS I6	2	5	1	2.3	quartz		
BS I6	2	2	1	.04	quartz		
BS I6	2	3	1	.3	quartz		
BS I6	3	2	1	.06	crystal qtz		
BS I6	3	4	1	.37	quartz		
BS I6	3	2	1	.01	quartz		
BS I6	3	1	1	.01	crystal qtz		

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS l6	3	2	1	.05	quartz		
BS l6	4	2	1	.1	quartz		
BS l6	4	2	1	.15	quartz		
BS l6	4	3	1	.19	quartz		
BS l6	4	2	1	.26	crystal qtz		
BS l6	4	3	1	.91	quartz		
BS l6	4	3	1	.47	quartz		
BS l6	4	2	1	.13	crystal qtz		
BS l6	4	2	1	.07	quartz		
BS l6	4	1	1	.04	quartz		
BS l6	4	1	1	.03	quartz		
BS l6	4	2	1	.13	quartz		
BS l6	4	2	1	.10	quartz		
BS l6	4	2	1	.14	quartz		
BS l6	5	4	1	1.43	quartz		
BS l6	5	3	1	.71	quartz		
BS l6	5	3	1	.21	quartz		
BS l6	5	2	1	.05	quartz		
BS l6	5	2	1	.06	quartz		

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS I6	5	2	1	.07	quartz		
BS I6	5	2	1	.09	quartz		
BS I6	6	4	1	.72	quartz		
BS I6	6	2	1	.14	quartz		
BS I6	6	2	1	.04	quartz		
BS I6	6	2	1	.05	quartz		
BS I6	6	2	1	.04	quartz		
BS I6	6	2	1	.02	quartz		
BS I6	6	1	1	.03	crystal qtz	1	
BS I6	6	1	1	.02	quartz		
BS I6	6	1	1	.02	crystal qtz		
BS I6	6	1	1	.02	quartz		
BS I6	7	1	1	.02	quartz		
BS I6	7	2	1	.04	quartz		
BS I6	7	1	1	.01	quartz		
BS I6	7	3	1	.12	quartzite	1	
BS I6	8	2	1	.03	quartz		
BS I6	8	2	1	.08	quartz		
BS I6	8	2	1	.17	quartz		

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS l6	8	1	1	.04	quartz		
BS l6	8	1	1	.03	quartz		
BS l6	8	1	1	.04	quartz		
BS l6	8	4	1	.73	quartz		
BS l6	8	3	1	.23	quartz	1	
BS l6	8	5	1	1.02	quartz	1	
BS l6	8	3	1	.85	quartz		
BS l6	9	2	1	.02	crystal qtz		
BS l6	9	1	1	.02	quartz		
BS l6	9	2	1	.03	quartz		
BS l6	9	1	1	.02	quartz		
BS l6	9	3	1	.13	quartz	1	
BS l6	9	3	1	.14	quartzite	1	
BS l6	11	6	1	3.63	quartz	1	
BS l6	11	4	1	3.01	quartz		
BS l6	14	1	1	.01	crystal qtz		
BS l6	14	2	1	.02	crystal qtz	1	
BS l6	14	3	1	.32	quartz	1	
BS l6	14	2	1	.04	quartz	1	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS I6	14	3	1	.03	crystal qtz		
BS I6	16	2	1	.09	quartz		
BS I6	16	3	1	.47	quartz		
BS I6	18	2	1	.04	quartzite	1	
BS D6	2	2	4	.31	quartz	1	
BS D6	2	3	2	.59	quartz	1	
BS D6	3	1	1	.01	quartz	1	
BS D6	3	2	9	.91	quartz	5	
BS D6	3	3	5	1.28	quartz	3	
BS D6	3	4	1	1.01	quartz	1	
BS D6	4	5	4	11.18	quartz	3, 2 bipolar	
BS D6	4	4	7	6.79	quartz	2	1 pebble
BS D6	4	3	8	3.15	quartz	3	1 pebble 2 facet
BS D6	4	2	31	3.04	quartz	5, 2 bipolar	3 facet
BS D6	4	2	1	.08	quartzite	1	
BS D6	4	4	1	.39	crystal qtz	1	
BS D6	4	3	1	.18	crystal qtz	1	1 facet
BS D6	4	2	1	.02	crystal qtz	1	
BS D6	5	2	13	.49	quartz	4	3 pebble

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	5	3	9	5.19	quartz	6	2 pebble 1 facet
BS D6	5	4	7	9.99	quartz	3, 2 bipolar	3 pebble 1 facet
BS D6	5	5	2	7.39	quartz	2, 2 bipolar	1 pebble
BS D6	5	2	1	.07	crystal qtz	1	
BS D6	5	3	1	.22	crystal qtz	1	
BS D6	5	4	1	.48	hornfels	1	
BS D6	6	3	3	1.02	crystal qtz	3	2 facet
BS D6	6	6	1	4.83	quartzite	1	
BS D6	6	2	16	1.40	quartz	9	2 pebble 1 facet
BS D6	6	3	9	3.68	quartz	4	1 vein 2 pebble
BS D6	6	4	9	9.48	quartz	6	2 crystal facet
BS D6	6	5	4	4.3	quartz	2	1 pebble
BS D6	6	6	1	6.82	quartz		reef or vein
BS D6	6	7	1	7.41	quartz	1	
BS D6	7	1	3	.07	quartz		
BS D6	7	2	12	1.56	quartz	4	1 crystal facet
BS D6	7	3	13	5.54	quartz	8	2 pebble
BS D6	7	4	9	5.5	quartz	9	2 facet 2 pebble
BS D6	7	5	2	3.46	quartz	2	1 crystal facet

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	7	6	2	8.23	quartz	1	vein
BS D6	7	7	2	16.97	quartz	2, 1 bipolar	2 pebble
BS D6	7	8	1	6.25	quartz	1 bipolar	vein
BS D6	7	2	7	.08	quartzite	1	
BS D6	7	2	1	.59	crystal qtz	5	
BS D6	7	3	1	.3	crystal qtz	1	
BS D6	8	11	1	15.67	quartz	1 bipolar	
BS D6	8	10	1	8.77	quartz		
BS D6	8	7	1	19.22	quartz		
BS D6	8	5	5	8.18	quartz	4 bipolar	1 vein 1 facet
BS D6	8	4	7	7.03	quartz	3, 1 bipolar	2 vein 3 pebble
BS D6	8	3	15	7.01	quartz	9	3 facet 1 pebble 1 vein
BS D6	8	2	29	3.39	quartz	17	1 facet 1 pebble
BS D6	8	2	1	.18	ind. limestone	1	
BS D6	8	5	1	.49	crystal qtz	1	1 crystal facet
BS D6	8	3	4	.84	crystal qtz	4	2 crystal facet
BS D6	8	2	7	.47	crystal qtz	5	1 crystal facet
BS D6	9	1	2	.07	quartz		
BS D6	9	2	28	2.58	quartz	19	3 crystal facet

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	9	3	17	4.76	quartz	7	3 pebble
BS D6	9	4	6	5.67	quartz	5	3 pebble
BS D6	9	5	4	8.73	quartz	3	2 pebble 2 facet
BS D6	9	6	1	3.59	quartz		1 pebble
BS D6	9	4	3	1.26	crystal qtz	3	
BS D6	9	3	1	.54	crystal qtz	1	
BS D6	9	2	4	.27	crystal qtz	3	
BS D6	10	7	1	7.53	quartz		vein
BS D6	10	6	1	7.6	quartz		
BS D6	10	5	5	7.91	quartz	4, 1 bipolar	2 pebble 1 vein
BS D6	10	4	7	7.92	quartz	5, 2 bipolar	3 crystal facet
BS D6	10	3	18	5.08	quartz	8	2 pebble
BS D6	10	2	40	3.04	quartz	13	1 crystal facet
BS D6	10	3	4	.9	crystal qtz	4	2 crystal facet
BS D6	10	2	7	.41	crystal qtz	5	
BS D6	11	1	1	.03	quartz		
BS D6	11	2	52	6.06	quartz	14	2 crystal facet
BS D6	11	3	20	6.4	quartz	13, 2 bipolar	2 pebble
BS D6	11	4	6	4.81	quartz	4, 1 bipolar	1 pebble 1 facet

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	11	5	4	5.91	quartz	3 bipolar	3 pebble 1 facet
BS D6	11	6	3	8.93	quartz	3, 2 bipolar	
BS D6	11	5	1	1.33	crystal qtz	1	1 crystal facet
BS D6	11	3	3	.66	crystal qtz	2	
BS D6	11	2	4	.25	crystal qtz	3	1 crystal facet
BS D6	12	1	4	.1	quartz		
BS D6	12	2	59	5.08	quartz	29	2 crystal facet
BS D6	12	3	22	7.42	quartz	16, 2 bipolar	2 pebble 1 facet
BS D6	12	4	6	5.94	quartz	5, 1 bipolar	3 pebble
BS D6	12	5	6	9.01	quartz	3, 1 bipolar	1 crystal facet
BS D6	12	7	2	15.47	quartz	2, 1 bipolar	
BS D6	12	3	2	.59	crystal qtz	2	
BS D6	12	2	1	.07	crystal qtz	1	1 crystal facet
BS D6	12	2	1	.06	quartzite	1	
BS D6	12	4	1	.44	chert	1	
BS D6	12	5	1	1.29	quartzite	1	
BS D6	12	6	1	4.59	quartzite	1	1 pebble
BS D6	12	3	1	.52	quartzite	1	
BS D6	13	1	2	.02	quartz		

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	13	2	40	3	quartz	17	
BS D6	13	3	11	14.95	quartz	8, 2 bipolar	
BS D6	13	4	3	4.34	quartz	3	
BS D6	13	5	2	5	quartz	1, 1 bipolar	1 crystal facet
BS D6	13	2	11	.51	crystal qtz		2 crystal facet
BS D6	13	3	2	.26	crystal qtz		
BS D6	13	4	1	.53	quartzite	1	
BS D6	13	3	2	.25	quartzite	1	
BS D6	14	2	66	6.37	quartz	27	4 pebble
BS D6	14	3	12	4	quartz	4	2 pebble 1 facet
BS D6	14	4	9	8.36	quartz	3, 1 bipolar	2 pebble 2 vein
BS D6	14	5	3	5.45	quartz	2, 2 bipolar	
BS D6	14	6	4	15.89	quartz	2, 1 bipolar	
BS D6	14	8	1	4.21	quartz	1	1 pebble
BS D6	14	3	3	.47	crystal qtz	2	
BS D6	14	2	7	.34	crystal qtz	6	
BS D6	15	2	54	5.4	quartz	22	
BS D6	15	3	21	7.51	quartz	10	1 crystal facet
BS D6	15	4	5	3.27	quartz	2	1 pebble

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	15	5	2	2.66	quartz	1, 1 bipolar	
BS D6	15	6	5	12.11	quartz	4, 1 bipolar	1 crystal facet
BS D6	15	5	1	1.84	chert	1	
BS D6	15	6	1	2.66	contact rock*	1	
BS D6	15	4	1	1.01	crystal qtz	1	1 crystal facet
BS D6	15	3	1	.11	crystal qtz	1	
BS D6	15	2	6	.18	crystal qtz	3	
BS D6	16	2	38	3.39	quartz	17	2 pebble
BS D6	16	3	13	3.95	quartz	4	
BS D6	16	4	5	5.1	quartz	2, 1 bipolar	1 pebble 1 facet
BS D6	16	5	4	8.14	quartz	3, 2 bipolar	2 pebble
BS D6	16	6	1	7.17	quartz	1	1 vein
BS D6	16	9	1	11.05	quartz	1	
BS D6	16	2	8	.31	crystal qtz	7	
BS D6	16	4	1	.69	crystal qtz	1	
BS D6	16	5	1	2.32	crystal qtz		1 crystal facet
BS D6	16	6	1	1.77	crystal qtz	1	1 water worn
BS D6	17	3	2	.49	quartz	2	1 pebble
BS D6	17	2	14	.88	quartz	9	

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	17	11	1	27.37	quartz		1 vein
BS D6	17	10	2	77.18	quartz	1, 1 bipolar	1 vein
BS D6	17	8	1	17.16	quartz	1	1 vein
BS D6	17	7	1	4.55	quartz	1, 1 bipolar	1 vein
BS D6	17	6	1	2.78	quartz	1	1 vein
BS D6	17	5	3	5.77	quartz	2, 1 bipolar	1 pebble, 1 vein
BS D6	17	4	6	5.27	quartz	3, 1 bipolar	2 vein
BS D6	17	3	5	2.06	quartz	2	
BS D6	17	2	44	4.23	quartz	16	1 pebble
BS D6	18	8	1	14.65	quartz	1, 1 bipolar	1 crystal facet
BS D6	18	7	1	3.21	quartz	1	
BS D6	18	6	1	3.98	quartz		1 vein
BS D6	18	5	2	7.11	quartz	1	1 vein
BS D6	18	4	5	9.61	quartz	2	2 vein
BS D6	18	3	8	2.13	quartz	4	1 pebble
BS D6	18	2	54	4.79	quartz	23	
BS D6	18	2	1	.12	contact rock*	1	
BS D6	18	3	2	.94	crystal qtz	2	1 crystal facet
BS D6	18	2	6	.29	crystal qtz	5	

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	19	2	54	4.19	quartz	24	
BS D6	19	3	9	3.92	quartz	3	2 vein
BS D6	19	4	1	.64	quartz	1	
BS D6	19	5	3	5.98	quartz	3, 1 bipolar	
BS D6	19	6	2	10.63	quartz	2, 2 bipolar	1 vein
BS D6	19	3	1	.16	contact rock*	1	
BS D6	19	3	1	.45	quartzite	1	
BS D6	19	3	1	.31	crystal qtz	1	
BS D6	19	2	11	.41	crystal qtz	8	
BS D6	20	2	50	3.72	quartz	19	2 vein, 2 pebble
BS D6	20	3	13	3.67	quartz	5	1 vein, 3 pebble
BS D6	20	4	1	1.64	quartz		
BS D6	20	6	1	3.66	quartz	1	
BS D6	20	7	1	11.72	contact rock*	1	
BS D6	20	2	5	.28	crystal qtz	5	
BS D6	21	8	1	8.69	quartz	1	vein
BS D6	21	6	2	8.45	quartz	2, 1 bipolar	1 vein, 1 facet
BS D6	21	5	2	1.5	quartz	2	1 vein
BS D6	21	4	3	2.06	quartz	1	2 pebble

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	21	3	12	3.05	quartz	7	
BS D6	21	2	45	4.24	quartz	19	
BS D6	21	5	1	1.81	quartzite	1	1 pebble
BS D6	21	3	1	.12	crystal qtz	1	
BS D6	21	2	3	.11	crystal qtz	1	
BS D6	22	2	55	3.64	quartz	18	
BS D6	22	3	7	2.52	quartz	3	2 vein
BS D6	22	4	3	1.92	quartz	3	1 crystal facet
BS D6	22	3	1	.62	ind. limestone	1	
BS D6	22	4	1	.26	crystal qtz	1	
BS D6	22	2	4	.10	crystal qtz	3	
BS D6	23	2	30	2.76	quartz	12	
BS D6	23	3	7	3.49	quartz	5	2 pebble, 1 facet
BS D6	23	4	3	5.73	quartz	1	1 pebble, 1 facet
BS D6	23	5	3	7.47	quartz	3, 1 bipolar	1 pebble, 1 vein
BS D6	23	6	2	8.8	quartz	2, 2 bipolar	
BS D6	23	7	1	3.16	quartz	1	
BS D6	23	2	7	2.7	crystal qtz	3	
BS D6	24	10	1	31.7	quartz	1	

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	24	3	9	3.08	quartz	6	1 pebble, 1 facet
BS D6	24	2	27	1.83	quartz	12	1crystal facet
BS D6	24	4	1	.3	crystal qtz	1	
BS D6	24	3	2	.27	crystal qtz	2	1crystal facet
BS D6	24	2	4	.21	crystal qtz	2	1crystal facet
BS D6	25	9	1	13.89	quartz		1 vein
BS D6	25	7	1	3.06	quartz	1	
BS D6	25	5	3	8.87	quartz	1	1 vein, 1 pebble
BS D6	25	4	2	1.2	quartz	1	1crystal facet
BS D6	25	3	6	1.95	quartz	2	1 pebble
BS D6	25	2	19	2.1	quartz	8	1 crystal facet
BS D6	25	3	4	.24	crystal qtz	2	1 pebble
BS D6	25	2	3	.15	crystal qtz	1	
BS D6	26	8	1	6.04	quartzite	1	
BS D6	26	5	1	1.43	contact rock*	1	
BS D6	26	7	2	6.12	quartz	1	1 vein
BS D6	26	4	2	1.42	quartz	1	1 vein
BS D6	26	3	3	1.59	quartz	1	
BS D6	26	2	10	.57	quartz	2	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	26	2	8	3.11	crystal qtz	5	
BS D6	27	5	1	2.45	quartz	1, 1 bipolar	
BS D6	27	3	1	.25	quartz	1	1 vein
BS D6	27	2	11	.57	quartz	3	
BS D6	27	3	2	.5	crystal qtz	2	1 crystal facet
BS D6	27	2	2	.17	crystal qtz	1	
BS D6	28	4	1	.96	quartz	1	
BS D6	28	3	1	1.2	quartz	1	
BS D6	28	2	3	.25	quartz		
BS D6	28	1	2	.05	quartz		
BS D6	28	2	2	.24	crystal qtz	2	
BS D6	28	6	1	5.24	quartz	1	1 crystal facet
BS D6	29	6	1	6.38	contact rock*	1	
BS D6	29	5	2	6.02	quartz	1	1 pebble
BS D6	29	4	1	.52	quartz	1	
BS D6	29	3	4	1.73	quartz	3	
BS D6	29	2	16	1.05	quartz	6	
BS D6	29	3	1	.18	crystal qtz	1	1 crystal facet
BS D6	29	2	4	.15	crystal qtz	3	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	30	2	11	.94	quartz	3	
BS D6	30	3	1	.17	quartz	4	1 pebble
BS D6	30	4	1	.49	quartz	1	
BS D6	30	5	1	4.37	quartz		1 vein
BS D6	30	4	1	.45	quartzite	1	
BS D6	30	4	1	.2	cherty hornfels	1	
BS D6	30	3	1	.24	crystal qtz	1	waterworn facet
BS D6	30	2	6	.35	crystal qtz	4	1 crystal facet
BS D6	31	4	2	1.62	quartz	1	
BS D6	31	3	1	.1	quartz	1	
BS D6	31	2	3	.12	quartz	1	
BS D6	31	2	1	.03	crystal qtz		
BS D6	32	8	1	7.49	quartzite	1	
BS D6	32	7	1	4.82	quartz	1, 1 bipolar	1 vein
BS D6	32	4	2	.91	quartz	2	1 pebble
BS D6	32	2	9	.52	quartz	5	
BS D6	32	3	1	.32	crystal qtz		1 crystal facet
BS D6	33	8	1	6.02	quartzite	1	
BS D6	33	3	1	.3	quartzite	1	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	33	3	1	.72	crystal qtz	1	
BS D6	33	6	1	1.92	quartz	1	1 crystal facet
BS D6	33	4	1	.7	quartz	1	1 vein
BS D6	33	2	5	.51	quartz	2	
BS D6	33	3	5	1.15	quartz	3	1 crystal facet
BS D6	34	3	1	.26	quartz		1 crystal facet
BS D6	34	2	1	.32	quartz	1	
BS D6	34	3	2	.21	crystal qtz	2	
BS D6	35	5	1	.95	quartz	1	
BS D6	35	3	2	.47	quartz	1	
BS D6	36	3	1	.31	crystal qtz	1	waterworn facet
BS D6	37	3	1	.34	quartzite	1	
BS D6	37	2	1	.06	quartzite	1	
BS D6	37	4	2	.85	quartz	1	1 crystal facet
BS D6	37	2	4	.3	quartz	3	
BS D6	38	3	1	.3	quartz	1	
BS D6	38	2	6	.38	quartz	4	
BS D6	38	3	1	.12	crystal qtz	1	
BS D6	38	2	3	.38	crystal qtz	3	2 crystal facet

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS D6	39	3	1	.03	crystal qtz	1	
BS D6	39	6	1	4.03	quartzite	1	w'worn cobble
BS D6	39	2	2	.23	quartz	1	
BS D6	39	6	1	5.9	quartz		1 vein
BS C6	3	4	1	1.83	quartz	1	1 vein
BS C6	3	3	1	.33	quartz	1	1 pebble
BS C6	4	3	3	.67	quartz	1	
BS C6	4	2	4	.36	quartz	2	
BS C6	4	1	1	.02	quartz		
BS C6	5	3	1	.31	chert	1	
BS C6	6	3	2	.97	crystal qtz	2	
BS C6	6	4	1	.63	crystal qtz	1	1 vein
BS C6	6	6	2	3.9	quartz	2, 1 bipolar	1 vein
BS C6	6	5	2	4.85	quartz	2, 1 bipolar	1 vein
BS C6	6	4	7	6.98	quartz	3, 1 bipolar	1 pebble 1 vein
BS C6	6	3	11	3.84	quartz	1	
BS C6	6	2	8	1.12	quartz	6	1 crystal facet
BS C6	7	1	3	.09	quartz		
BS C6	7	2	23	2.56	quartz	13	1 crystal facet

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS C6	7	3	13	4.17	quartz	10	2 vein 1 pebble
BS C6	7	4	8	5.7	quartz	5, 1 bipolar	2 pebble 2 vein
BS C6	7	5	2	3.89	quartz	2, 1 bipolar	1 pebble 1 facet
BS C6	7	6	1	5.99	quartz	1	
BS C6	7	7	1	8.32	quartz		waterworn vein
BS C6	7	6	1	8.31	contact rock*	1	
BS C6	8	8	1	13.19	quartz	1, 1 bipolar	
BS C6	8	7	1	10.46	quartz	1	1 vein
BS C6	8	5	2	2.9	quartz	1	2 vein
BS C6	8	4	11	10.29	quartz	8, 2 bipolar	2 pebble 2 facet
BS C6	8	3	13	5.66	quartz	8	1 vein 1 pebble
BS C6	8	2	26	3.07	quartz	12	1 crystal facet
BS C6	8	1	3	.08	quartz	1	
BS C6	8	5	1	1.5	chert	1	
BS C6	8	3	1	.73	crystal qtz		
BS C6	8	2	4	.42	crystal qtz	3	
BS C6	9	2	29	2.23	quartz	12	4 vein
BS C6	9	3	17	5.59	quartz	10	
BS C6	9	4	6	6.01	quartz	3	3 vein

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS C6	9	5	1	1.65	quartz	1	1 pebble
BS C6	9	6	2	7.18	quartz	2, 1 bipolar	1 pebble 1 facet
BS C6	9	7	1	8.34	quartz	1	1 vein
BS C6	9	4	1	.53	crystal qtz	1, 1 bipolar	
BS C6	9	3	1	.05	crystal qtz	1, 1 bipolar	
BS C6	9	2	4	.32	crystal qtz	3	
BS C6	10	6	1	.62	quartz	1	1 vein
BS C6	10	5	3	6.17	quartz	2	1 crystal facet
BS C6	10	4	5	4.42	quartz	4	1 pebble, 1 facet
BS C6	10	3	11	2.82	quartz	8	1 pebble
BS C6	10	2	31	2.55	quartz	17	
BS C6	10	3	2	.2	crystal qtz	2	
BS C6	10	2	9	.49	crystal qtz	6	
BS C6	11	2	29	3.18	quartz	13	
BS C6	11	3	26	8.72	quartz	13	3 vein 1 facet
BS C6	11	4	8	10.23	quartz	6, 1 bipolar	6 vein
BS C6	11	5	5	10.93	quartz	4, 2 bipolar	3 vein 1 pebble
BS C6	11	6	3	9.15	quartz	3, 1 bipolar	1 vein 1 pebble
BS C6	11	5	1	2.39	crystal qtz	1	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS C6	11	4	1	.38	crystal qtz	1	
BS C6	11	3	3	.59	crystal qtz	2	
BS C6	11	2	7	.36	crystal qtz	5	
BS C6	12	2	16	1.68	quartz	12	2 pebble
BS C6	12	3	22	9.12	quartz	20	2 pebble 1 facet
BS C6	12	4	4	6.54	quartz	3, 1 bipolar	
BS C6	12	5	9	14.88	quartz	6, 2 bipolar	2 vein 1 facet 2 pebble
BS C6	12	6	3	6.79	quartz	2, 1 bipolar	1 facet 1 vein
BS C6	12	8	2	12.50	quartz	2, 1 bipolar	
BS C6	12	6	1	5.98	silcrete	1	present 10%
BS C6	12	5	2	2.77	quartzite	2	
BS C6	12	6	1	3.10	crystal qtz	1	1 crystal facet
BS C6	12	5	1	3.17	crystal qtz	1	1 pebble
BS C6	12	3	5	2.13	crystal qtz	5	
BS C6	12	2	11	1.42	crystal qtz	9	
BS C6	13	2	26	2.87	quartz	18	
BS C6	13	3	17	9.13	quartz	10	3 pebble 1 vein
BS C6	13	4	9	6.39	quartz	7, 2 bipolar	1 pebble 2 vein
BS C6	13	5	6	11.98	quartz	3, 2 bipolar	1 pebble 2 vein

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS C6	13	6	2	10.23	quartz	3, 2 bipolar	1 pebble 1 facet
BS C6	13	7	5	36.68	quartz	5, 2 bipolar	3 pebble 1 vein
BS C6	13	5	1	1.47	chert	1	present 25%
BS C6	13	5	1	.53	cherty hornfels	1	
BS C6	13	3	1	.85	quartzite		
BS C6	13	5	2	3.47	crystal qtz	2	
BS C6	13	4	1	.52	crystal qtz	1	
BS C6	13	3	5	1.06	crystal qtz	4	
BS C6	13	2	10	1.32	crystal qtz	9	
BS C6	14	2	28	2.52	quartz	12	
BS C6	14	3	21	8.06	quartz	12	2 facet 1 pebble
BS C6	14	4	7	8.83	quartz	3	1 vein 1 pebble
BS C6	14	5	7	6.40	quartz	5, 1 bipolar	1 pebble 1 facet
BS C6	14	6	2	9.81	quartz	1, 1 bipolar	1 vein
BS C6	14	4	1	1.74	ind. limestone	1	
BS C6	14	4	2	.56	crystal qtz	2	
BS C6	14	3	1	.05	crystal qtz	1	
BS C6	14	2	10	.37	crystal qtz	8	
BS C6	15	2	19	14.03	quartz	8	

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS C6	15	3	8	4.78	quartz	3	2 pebble
BS C6	15	4	5	3.24	quartz	4	2 vein
BS C6	15	5	6	1.55	quartz	6	1 facet 3 vein
BS C6	15	7	1	5.65	quartzite	1	
BS C6	15	6	1	2.77	chert	1	
BS C6	15	6	1	2.76	crystal qtz	1	facet waterworn
BS C6	15	4	1	.9	crystal qtz	1	facet waterworn
BS C6	15	3	1	.1	crystal qtz	1	
BS C6	15	2	5	.21	crystal qtz	5	
BS C6	16	2	16	2.31	quartz	11	
BS C6	16	3	12	3.43	quartz	8	
BS C6	16	4	7	7.38	quartz	3	2 pebble 1 vein
BS C6	16	5	7	13.24	quartz	7, 1 bipolar	1 facet 1 pebble 1 vein
BS C6	16	6	1	11.36	quartz	1, 1 bipolar	
BS C6	16	7	1	8.58	quartz		
BS C6	16	4	1	.66	chert	1	
BS C6	16	4	2	2.77	crystal qtz	2	
BS C6	16	2	3	.13	crystal qtz	3	
BS C6	17	5	1	.57	crystal qtz	1, 1 bipolar	

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS C6	17	3	1	.44	crystal qtz	1	
BS C6	17	2	9	1.07	quartz	6	
BS C6	17	3	4	1.57	quartz	2	1 pebble
BS C6	17	4	3	2.19	quartz	1	1 pebble 1 vein
BS C6	17	5	2	2.47	quartz	2	1 vein
BS C6	18	8	1	6.57	quartz	1, 1 bipolar	1 vein
BS C6	18	4	1	.67	quartz	1	
BS C6	18	3	4	.87	quartz	3	
BS C6	18	2	4	.37	quartz	3	
BS C6	18	3	1	.1	crystal qtz	1	
BS C6	18	5	1	.71	cherty hornfels	1	
BS C6	18	9	1	19.54	quartzite	1	1 cobble
BS C6	19	2	8	1.01	quartz	4	
BS C6	19	3	5	1.63	quartz	4	
BS C6	19	4	2	2.5	quartz	2	1 pebble 1 vein
BS C6	19	5	1	5	quartz	1	
BS C6	19	6	1	16.11	quartz		1 vein
BS C6	20	7	1	4.69	quartz	1	1 vein
BS C6	20	4	1	.61	quartz	1	

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS C6	20	3	2	.98	quartz	2	
BS C6	20	2	1	.6	quartz		
BS C6	20	3	1	.3	cherty hornfels	1	
BS C6	21	3	1	.18	quartz		
BS C6	22	5	1	1.01	quartz		
BS C6	22	2	2	.05	quartz		
BS C6	23	3	1	.14	quartz	1	
BS C6	24	4	1	.34	quartz	1	
BS C6	24	2	3	.21	quartz	1	
BS C6	25	3	1	.35	quartz		
BS C6	31	2	1	.22	quartz		
BS U7	4	4	1	2.11	quartz		1 vein
BS U7	4	2	1	.11	quartz	1	
BS U7	5	6	1	3.59	quartz		1 pebble
BS U7	5	5	1	1.22	quartz	1	1 pebble
BS U7	5	4	2	1.27	quartz	1	1 vein
BS U7	5	3	1	.25	quartz	1	
BS U7	5	2	3	.24	quartz	1	
BS U7	5	3	1	.12	crystal qtz	1	

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS U7	5	2	1	.15	crystal qtz	1	
BS U7	6	6	1	1.03	quartzite	1	
BS U7	6	5	1	1.33	quartz	1	1 vein
BS U7	6	3	5	3.68	quartz	4	1 vein
BS U7	6	2	20	7.77	quartz	13	
BS U7	6	2	2	.05	crystal qtz	2	
BS U7	7	3	1	.25	crystal qtz	1	
BS U7	7	2	1	.17	quartz	1	
BS U7	8	5	1	1.28	quartz		1 vein
BS U7	8	4	2	1.42	quartz	2	
BS U7	8	2	5	.85	quartz	3	
BS U7	9	9	1	7.43	contact rock*	1	
BS U7	9	5	1	.45	quartz	1, 1 bipolar	
BS U7	9	4	5	5.64	quartz	4	
BS U7	9	3	3	1.09	quartz	2	
BS U7	9	2	2	.19	quartz		1 vein
BS U7	10	6	1	3.74	quartz	1	
BS U7	10	5	1	1.78	quartz	1	
BS U7	10	4	4	4.21	quartz	3	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
BS U7	10	3	2	.63	quartz	2	2 pebble 1 vein
BS U7	11	4	1	.88	quartz	1	
BS U7	11	3	1	.71	quartz	1	
BS U7	13	3	1	.81	quartz	1	
BS U7	14	3	1	.38	quartz	1	
BS U7	15	2	1	.07	quartz		

APPENDIX XI

Beeton Rockshelter: Ochre analysis results



RED STAINED QUARTZ ARTEFACT

Robin,

the quartz crystal fragment;

'1 FEBR 92 BS

C6 12 Y

with the red material adhering to the two smoother faces has been bombarded with 15KV electrons in a JEOL model JSM 6400 scanning electron microscope.

The X-rays emitted as a result have energies characteristic of interactions with silicon nuclei in the main, as one would expect. (Scans 10, 11, 12)

Minor peaks in the spectrum belong to

calcium
chlorine
magnesium
sodium
potassium,

and

which might also be expected, since these elements are common in minerals, including quartz, and soils.

On the red covered faces, (Scan 10) these minor elements are more significant than on the cleaner face.

On the red faces, two additional peaks;

iron
and aluminium

are

prominent.

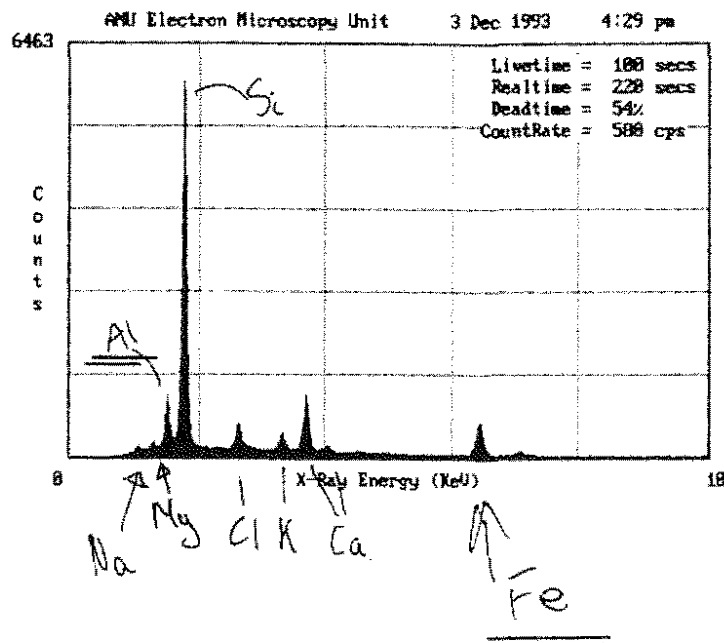
The owners of the analysis programme discourage us from numerically quantifying the peaks in analyses like this, since the geometry of the irradiated surfaces with respect to the X-ray detector is so variable, (see sketch) but the answer is what you expected; that the red stuff is iron rich clay, ie. ochre.

David W Buckle

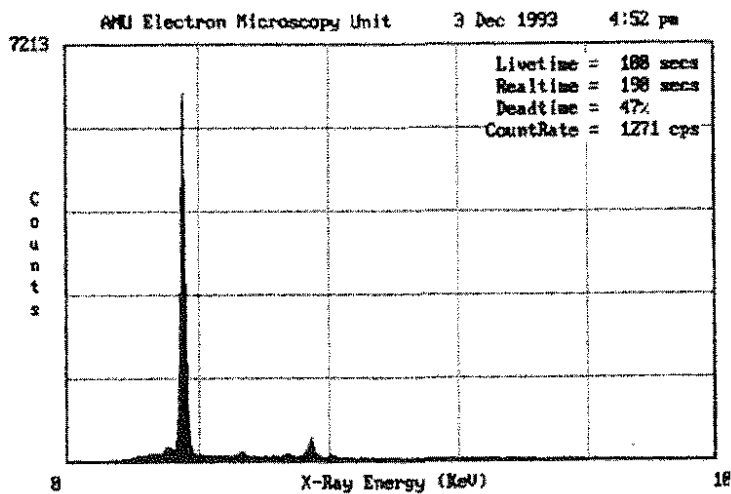
JEOL JSM 6400 Scanning Electron Microscope.

3/12/93

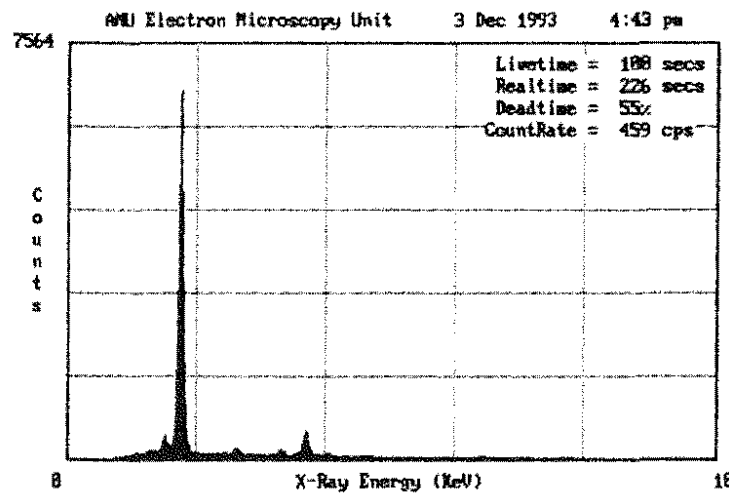
⑩ Quartz Yr! @ red material



⑫ Quartz Yr!
clean side.



⑪ Quartz Yr!, clean side



APPENDIX XII

Beeton Rockshelter: Fossil and scallop shell

APPENDIX XII Fossil and Scallop shell

BEETON ROCKSHELTER UNWORKED FOSSIL SHELL *Eucrassatella* sp.

square	spit	umbo	wt g	No. of pieces
BS-D9	4		1.21	4
BS-D9	4	1	3.77	1
BS-D9	4		4.03	1
BS-D9	5	1	15.47	1
BS-D9	5		1.92	8
BS-D9	5		1.75	1
BS-D9	6		4.32	9
BS-D9	6		1.33	1
BS-D9	6		2.53	1
BS-D9	6		3.43	1
BS-D9	7		2.56	5
BS-D9	7	1	16.74	1
BS-D9	8		1.57	1
BS-D9	8		1.13	1
BS-D9	8		1.29	1
BS-D9	8		3	1
BS-D9	9		1.02	2
BS-D9	10		2.71	1
BS-D9	10		1.49	1
BS-D9	10		.55	1
BS-D9	11		1.04	5
BS-D9	12		1.56	4
BS-D9	13		1.03	3
BS-D9	16		.85	1

square	spit	umbo	wt g	No.
BS-D6	6		.26	1
BS-D6	11	1	17.95	1
BS-D6	11	1	19.2	1
BS-D6	11		1.01	1
BS-D6	12		16.24	1
BS-D6	13		.62	5
BS-D6	14	1	13.18	1
BS-D6	16		.52	1
BS-D6	22		3.97	1
BS-D6	22	1	14.67	1
BS-D6	26		1.92	1
BS-D6	26		2.43	1
BS-D6	28		6.51	1
BS-C6	4		2.05	1
BS-C6	5		2.52	1
BS-C6	7		2.46	1
BS-C6	8		1.76	1
BS-C6	9	1	18.03	1
BS-C6	10		.38	1
BS-C6	10		.63	1
BS-C6	11		1.29	1
BS-C6	12	1	10.13	1
BS-C6	12		.34	1
BS-C6	13		.17	1
BS-C6	14		5.98	1
BS-C6	16		3.53	1
BS-C6	16		.95	1
BS-C6	16		1.16	2
BS-C6	17		1.10	2
BS-C6	19		5.77	1
BS-U7	9		7.16	1
BS-I6	10	1*	33.96	1
Total			274.2	94

*almost complete valve - unworked

BEETON ROCKSHELTER
SCALLOP SHELL *Pecten* sp.

Square	Spit	l x b mm	wt g
BS-D6	12	56 x 27	6.23
BS-D6	29	29 x 12	1.81
BS-D9	4	24 x 21	3.3
BS-D9	6	11 x 12	.68
BS-D9	9	11 x 14	.52
BS-D9	9	20 x 14	.66
BS-C6	10	21 x 10	.64
BS-C6	11	31 x 22	1.58
BS-C6	14	32 x 13	.55
BS-C6	14	20 x 9	.49
BS-C6	4	22 x 10	.76
BS-C6	13	71 x 31	6.72
BS-C6	7	45 x 22	.6
BS-C6	7	21 x 15	2.8
BS-C6	8	15 x 18	.51
BS-C6	8	43 x 36	5.14
BS-C6	6	12 x 13	.52
BS-U7	5	32 x 25	1.67
Total wt			35.18

APPENDIX XIII

Mannalargenna Cave: Bone data base

Faunal Database Element Key

1	maxilla
2	mandible
3	cranium
4	teeth
5	vertebrae
6	ribs
7	clavicle
8	scapula
9	humerus
10	radius
11	ulna
12	femur
13	tibia
14	fibula
15	pelvis
16	carpals/metacarpals/tarsals/ metatarsals/phalanges/claws
17	unidentifiable (fragmented bone)

Mannalargenna Cave

Burnt Bone

Spit	Size	Family	Species other	element	Total no.	Wt gm
5	med. & large	unidentifiable		17	3	1.90
5	med. & large	unidentifiable	fragments <20mm	17	8	1.13
8	med. & large	unidentifiable		17	1	0.50
10	med. & large	unidentifiable	fragments <20mm	17	6	0.55
11	med. & large	unidentifiable	fragments <20mm	17	1	0.05
12	med. & large	unidentifiable		17	4	0.67
13	med. & large	unidentifiable	fragments <20mm	17	13	0.43
13	large	Vombatidae		4	1	0.42
14	med. & large	unidentifiable	fragments <20mm	17	7	0.78
14	med. & large	unidentifiable	fragments >20 mm	17	2	2.23
15	med. & large	unidentifiable		17	1	0.02
16	med. & large	unidentifiable	fragments <20mm	17	17	2.63
17	med. & large	unidentifiable		17	12	1.77
17	med. & large	unidentifiable	fragments <20mm	17	3	0.88
18	med. & large	unidentifiable		17	18	2.31
19	med. & large	unidentifiable		17	47	3.96
20	med. & large	unidentifiable		17	52	3.20
21	med. & large	unidentifiable	fragments <20mm	17	34	2.40
22	med. & large	unidentifiable	fragments <20mm	17	35	2.57
23	small	unidentifiable	all			0.58
23	med. & large	unidentifiable	fragments <20mm	17	43	4.65
23	small	unidentifiable	all			0.70
23	large	Macropodidae		4	1	0.34
23	medium	?		4	1	0.10
23	med. & large	unidentifiable	fragments <20mm	17	80	5.22
24	small	unidentifiable	all	?	30	0.97
24	med. & large	unidentifiable	fragments <20mm	?	95	8.84

Spit	Size	Family	Species other	element	Total no.	Wt gm
24	small	unidentifiable	fragments <20mm	17	28	0.40
24	med. & large	unidentifiable	fragments <20mm	17	16	1.60
25	small	unidentifiable	all			0.34
25	med. & large	unidentifiable	all		85	9.43
26	med. & large	unidentifiable	fragments <20mm	17	49	2.70
27	med. & large	unidentifiable		17	27	1.93
28	med. & large	unidentifiable	fragments <20mm	17	43	3.33
29	med. & large	unidentifiable	fragments <20mm	17	9	0.48
30	med. & large	unidentifiable		17	4	0.21
30	med. & large	unidentifiable		17	7	0.48
31	med. & large	unidentifiable		17	2	0.15
31	med. & large	unidentifiable		17	3	0.30
32	med. & large	unidentifiable		17	4	0.30
32	med. & large	unidentifiable		17	3	0.14
33	med. & large	unidentifiable		17	6	0.64
33	med. & large	unidentifiable		17	18	2.44
34	med. & large	unidentifiable		17	3	0.18

Mannalargenna Cave

Unburnt Bone

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
1	small	Muridae		1	1	2	0.20	2
1	small	Muridae		0	1	1	0.01	2
1	small	Muridae				3	0.30	3
1	small	Dasyuridae		2	0	2	0.05	2
1	small	Muridae			1	2	0.20	12
1	small	Muridae		2	0	2	0.08	9
1	small	Dasyuridae				1	0.02	9
1	small	unidentifiable					1.00	
1	medium	unidentifiable					0.25	
1	small	unidentifiable				14	0.26	17
1	medium	unidentifiable				17	1.06	17
1	medium	unidentifiable	Thylogale billardieri				?	
2	medium	Potoroidae				1	0.51	4
2	small	Muridae		1	1	3	0.15	9
2	small	Muridae		0	1	3	0.20	12
2	small	Dasyuridae		0	1	1	0.13	9
2	small	Muridae	Mastacomys fuscus	0	1	1	0.16	1
2	small	Muridae		1	0	1	0.02	2
2	small	Muridae		2	1	3	0.27	2
2	medium	Peramelidae				1	0.02	1
2	medium	unidentifiable	all others				0.55	
2	small	unidentifiable	all others				2.64	
2	small	unidentifiable				23	0.52	17
2	med. & large	unidentifiable				27	4.70	17
2	large	Macropodidae	?	0	1	1	0.52	4
2	small	Muridae		2	0	3	0.12	9
2	small	Muridae		0	1	3	0.13	12

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
2	small	Muridae	Mastacomys fuscus	1	0	1	0.17	1
2	small	Muridae	?	1	0	1	0.01	2
2	small	Muridae	?	2	1	3	0.23	2
2	small	Muridae	?			1	0.02	4
2	small	Dasyuridae		1	0	1	0.10	9
2	medium	Macropodidae	Thylogale billardieri				?	
2	small	unidentifiable	fragments <20mm			21	0.46	17
2	med. & large	unidentifiable	fragments <20mm			27	4.72	17
2	medium	unidentifiable	all others				0.42	
2	small	unidentifiable	all others				2.05	
3	medium	Macropodidae	Thylogale billardieri				?	
3	small	Dasyuridae		0	1	1	0.02	12
3	small	Muridae		1	3	6	0.50	12
3	small	Dasyuridae		1	0	1	0.04	2
3	small	Muridae		4	5	11	0.46	9
3	small	Muridae	Mastacomys fuscus	0	1	1	0.20	1
3	small	Muridae	?	0	2	2	0.07	1
3	small	Muridae				1	0.09	4
3	small	Muridae	Rattus lutreolus	3	1	4	0.55	2
3	small	Muridae	Rattus lutreolus	0	1	1	0.11	1
3	small	unidentifiable	fragments <20mm			18	1.05	17
3	med. & large	unidentifiable	fragments <20mm			32	5.40	17
3	med. & large	unidentifiable	all others				0.25	
3	small	unidentifiable	all others				2.27	
3	small	unidentifiable	all others				0.04	
4	large	Macropodidae					4.27	16
4	large	Macropodidae				1	0.06	9

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
4	small	Muridae		3	3	7	0.38	12
4	medium	Potoroidae				1	0.05	4
4	small	Dasyuridae		2	0	2	0.07	9
4	small	Muridae		0	5	7	0.20	9
4	small	Dasyuridae		0	1	1	0.04	1
4	small	Dasyuridae		0	2	2	0.05	2
4	small	Muridae	?	2	3	5	0.84	2
4	small	Muridae	?	2	3	5	0.31	1
4	small	unidentifiable	fragments <20mm			27	1.08	17
4	med. & large	unidentifiable	fragments <20mm			50	5.28	
4	large	Vombatidae	mixed				9.22	
4	med. & large	unidentifiable	all other				0.52	
4	small	unidentifiable	all other				1.82	
4	small	unidentifiable	all other				1.82	
5	small	Muridae	?	1	0	1	0.11	2
5	small	Muridae	?	0	1	1	0.09	1
5	medium	Peramelidae				1	0.02	4
5	small	Dasyuridae		0	1	1	0.08	9
5	small	Muridae		6	1	12	0.44	9
5	small	Muridae		3	2	5	0.25	12
5	small	Dasyuridae		1	0	1	0.08	2
5	small	Muridae				2	0.18	3
5	small	Muridae				3	0.12	4
5	small	Muridae	Mastacomys fuscus	1	0	1	0.20	1
5	small	Muridae	Pseudomys sp.	1	0	1	0.06	1
5	small	unidentifiable	all other				2.52	
5	medium	unidentifiable	all other				1.10	

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
5	large	unidentifiable	all other				5.74	
5	small	unidentifiable	fragments <20mm			17	0.70	17
5	med. & large	unidentifiable	fragments <20mm			58	9.93	17
5	med. & large	Macropodidae				1	1.56	6
6	small	Muridae	Mastacomys fuscus	0	1	1	0.20	2
6	small	Muridae	?	1	0	1	0.06	1
6	small	Muridae	Mastacomys fuscus			1	0.10	1
6	small	Muridae	Rattus lutreolus	0	2	2	0.02	1
6	small	Muridae	?	1	2	3	0.25	1
6	small	Muridae	?	1	0	1	0.12	2
6	small	Muridae	?	0	1	1	0.12	2
6	small	Muridae	?	1	1	2	0.50	1
6	small	Muridae				12	0.50	4
6	medium	Peramelidae				1	0.10	1
6	medium	Peramelidae				4	0.17	4
6	small	Dasyuridae		1	0	1	0.01	2
6	small	Dasyuridae		0	1	1	0.02	1
6	small	Muridae		4	1	10	0.67	12
6	large	Vombatidae				1	0.28	4
6	small	Muridae		6	7	13	0.73	9
6	small	Dasyuridae		1	0	1	0.02	12
6	medium	unidentifiable	all other				1.66	
6	small	unidentifiable	all other				5.19	
6	large	unidentifiable	all other				1.58	
6	small	unidentifiable	fragments <20mm			180	3.45	17
6	large	unidentifiable	fragments <20mm			310	33.08	17
6	large	unidentifiable	fragments >20 mm				4.74	17

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
7	large	Vombatidae				1	0.57	4
7	small	Muridae	?	0	1	1	0.05	2
7	small	Muridae	Pseudomys sp.	1	0	1	0.08	2
7	small	Muridae	?	2	1	4	0.23	1
7	small	Muridae	?	0	1	1	0.06	2
7	medium	Peramelidae				1	0.03	4
7	small	Dasyuridae		0	1	1	0.01	1
7	small	Muridae		0	4	7	0.33	9
7	med. & large	unidentifiable	all other				1.87	
7	small	unidentifiable	all other				1.41	
7	small	unidentifiable	fragments <20mm			35	0.70	17
7	med. & large	unidentifiable	fragments <20mm			116	9.48	17
7	med. & large	unidentifiable	fragments >20 mm			4	1.50	17
8	medium	Peramelidae				1	0.05	4
8	large	Macropodidae				1	0.20	4
8	small	Muridae				4	0.18	9
8	large	Macropodidae	Macropus rufogriseus			1	0.31	4
8	large	Vombatidae				1	0.80	4
8	small	Dasyuridae		0	1	1	0.03	9
8	small	Muridae	Mastacomys fuscus	1	0	1	0.17	2
8	small	Muridae	?	2	2	5	0.36	1
8	small	Muridae	Pseudomys sp.			1	0.02	1
8	small	Muridae	?	1	1	2	0.05	2
8	small	unidentifiable	all other				2.90	
8	med. & large	unidentifiable	all other				1.62	
8	small	unidentifiable	fragments <20mm			179	4.12	17
8	med. & large	unidentifiable	fragments <20mm			119	13.90	17

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
8	med. & large	unidentifiable	fragments >20 mm			5	1.81	17
9	small	Muridae				2	0.20	4
9	small	Muridae	?	1	1	2	0.12	1
9	small	Muridae	?	0	2	2	0.08	2
9	small	Muridae		1	1	3	0.12	9
9	small	Muridae		0	1	2	0.20	12
9	small	Muridae	all other				1.28	
9	med. & large	unidentifiable	all other				0.10	16
9	med. & large	unidentifiable	fragments <20mm			56	5.90	17
10	small	Muridae		0	1	1	0.3	12
10	medium	Macropodidae	Thylogale billardieri	1	1	1	0.61	Premax.
10	large	Macropodidae	?			1	0.25	4
10	medium	Potoroidae	?			1	0.07	4
10	medium	Peramelidae		1	0	1	0.16	2
10	large	Vombatidae				1	0.76	4
10	large	Macropodidae				5	6.33	16
10	small	Muridae		5	2	8	0.30	9
10	small	Dasyuridae		0	2	2	0.05	2
10	small	Muridae	?			1	0.56	3
10	small	Muridae	Mastacomys fuscus	0	1	1	0.17	1
10	small	Muridae	?	0	1	1	0.01	2
10	small	Muridae	?	1	2	2		1
10	small	Muridae	?	0	1	1	0.11	2
10	small	Muridae	?	1	1	2		1
10	small	unidentifiable	all other				3.64	
10	medium	unidentifiable	all other				1.60	
10	med. & large	unidentifiable	fragments <20mm			460	36.30	17

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
10	med. & large	unidentifiable	fragments >20 mm			1	0.48	17
10	large	unidentifiable	fragments <20mm			9	6.20	17
10	large	unidentifiable	fragments >20 mm			2	1.58	17
10	small	unidentifiable	fragments <20mm			108	2.49	17
11	small	Muridae	?	1	0	1	0.16	2
11	small	Muridae	?	1	0	1		1
11	small	Muridae	Mastacomys fuscus	0	2	2	0.62	2
11	small	Muridae	?	1	1	2	0.40	2
11	small	Muridae	?			1		1
11	small	Muridae	?	2	2	4	0.14	2
11	small	Muridae				1		3
11	medium	Potoroidae				1	0.05	4
11	medium	Peramelidae				1	0.01	4
11	small	Muridae		3	2	5	0.20	9
11	small	Muridae		2	2	4	0.02	12
11	small	unidentifiable	all other				2.05	
11	medium	unidentifiable	all other				0.80	
11	med. & large	unidentifiable	fragments <20mm			172	21.50	17
11	med. & large	unidentifiable	fragments >20 mm			3	3.63	17
12	small	Muridae	Mastacomys fuscus	1	1	2	0.65	2
12	small	Muridae	Mastacomys fuscus	1	0	2		1
12	small	Muridae	?	2	0	2	0.10	2
12	medium	Vombatidae				1	3.20	4
12	medium	Peramelidae		0	1	1	0.63	2
12	small	Dasyuridae		1	1	2	0.01	2
12	small	Muridae		2	2	4	0.24	9
12	small	Muridae		2	3	5	0.83	12

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
12	small	Dasyuridae				1	0.01	9
12	medium	Macropodidae	Thylogale billardieri			1	0.04	4
12	small	unidentifiable	all other				2.56	
12	medium	unidentifiable	all other				1.88	
12	large	Macropodidae				3	2.22	16
12	large	unidentifiable	fragments <20mm			12	4.27	17
12	large	unidentifiable	fragments >20 mm			4	6.61	17
12	med. & large	unidentifiable	fragments <20mm			342	25.74	17
12	med. & large	unidentifiable	fragments >20 mm			3	1.02	17
12	small	Muridae	?	0	1	1	0.19	2
13	medium	Potoroidae				1	0.01	4
13	small	Dasyuridae		1	0	1	0.02	2
13	small	Muridae	Pseudomys sp.	1	0	2	0.16	2
13	small	Muridae	Mastacomys fuscus	1	1	2	0.30	1
13	small	Muridae	?	2	0	2	0.05	1
13	small	Muridae	?	0	1	1	0.07	2
13	small	Muridae				1	0.01	12
13	small	Dasyuridae		1	0	1	0.07	9
13	medium	Peramelidae		0	1	1	0.27	2
13	large	Macropodidae	?			1	0.39	4
13	small	Muridae	all other				1.40	
13	medium	unidentifiable	all other				1.61	
13	large	unidentifiable	all other				12.69	
13	small	unidentifiable	fragments <20mm			45	0.78	17
13	med. & large	unidentifiable	fragments <20mm			443	34.17	17
13	med. & large	unidentifiable	fragments >20 mm			7	4.39	17
14	large	Macropodidae				1	0.69	15

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
14	medium	Peramelidae				3	0.01	4
14	small	Dasyuridae		1	0	1	0.01	2
14	small	Muridae	Mastacomys fuscus	1	1	2	0.57	2
14	small	Muridae	?	1	1	2	0.01	1
14	small	Muridae	?	2	0	3	0.12	1
14	small	Muridae	Pseudomys sp.	1	0	1	0.10	2
14	small	Muridae		2	2	9	0.22	9
14	small	Muridae		1	0	3	0.21	12
14	medium	Peramelidae		1	0	1	0.14	2
14	medium	Potoroidae				1	0.11	4
14	medium	Macropodidae	Thylogale billiardieri			1	0.01	4
14	large	Macropodidae	?			2	0.17	4
14	small	unidentifiable	all other				1.85	
14	medium	unidentifiable	all other				0.48	
14	large	unidentifiable	all other				2.14	
14	small	unidentifiable	fragments <20mm			167	3.53	17
14	large	unidentifiable	fragments >20 mm			2	7.00	17
14	large	unidentifiable	fragments <20mm			2	1.74	17
14	med. & large	unidentifiable	fragments <20mm			515	37.25	17
14	med. & large	unidentifiable	fragments >20 mm			5	1.68	17
15	small	Muridae	Mastacomys fuscus	0	1	1	0.26	2
15	small	Muridae	?	4	3	7	0.41	1
15	small	Muridae	?	0	2	2		2
15	small	Muridae	Pseudomys sp.	0	1	1	0.31	2
15	small	Muridae	Pseudomys sp.	1	0	1		1
15	small	Muridae		3	3	6	0.42	9
15	small	Muridae		1	5	7	0.33	12

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
15	small	Dasyuridae		1	0	1	0.01	2
15	medium	Macropodidae	Thylogale billardieri			2	0.15	4
15	large	Macropodidae	?			1	0.14	4
15	small	unidentifiable	all other				1.61	
15	medium	unidentifiable	all other				0.95	
15	large	unidentifiable	all other				3.08	
15	small	unidentifiable	fragments <20mm			100	1.62	17
15	med. & large	unidentifiable	fragments <20mm			365	25.52	17
15	med. & large	unidentifiable	fragments >20 mm			5	3.34	17
16	large	Vombatidae				1	0.30	4
16	small	Muridae		4	6	17	0.87	9
16	small	Muridae		1	0	5	0.18	12
16	small	Muridae	Mastacomys fuscus	0	1	1	0.23	1
16	small	Muridae	?	1	2	3	0.28	1
16	small	Muridae	Pseudomys sp.	1	1	4		2
16	small	Muridae	Pseudomys sp.	1	1	2	0.17	2
16	small	Dasyuridae		1	0	1	0.02	2
16	medium	Peramelidae				7	0.23	4
16	medium	Macropodidae	Thylogale billardieri	1	0	1	1.08	2
16	large	Macropodidae	?			1	0.38	4
16	small	unidentifiable	all other				2.93	
16	large	unidentifiable	fragments <20mm			4	9.32	17
16	medium	unidentifiable	all other				1.55	
16	small	unidentifiable	fragments <20mm			272	5.80	17
16	med. & large	unidentifiable	fragments <20mm			582	46.40	17
17	small	unidentifiable	all other				2.77	
17	medium	unidentifiable	all other				0.35	

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
17	medium	Macropodidae	Thylogale billardieri	1	0	1	1.09	2
17	small	Muridae		4	3	9	0.42	12
17	small	Muridae		3	5	9	0.37	9
17	medium	Peramelidae				1	0.03	2
17	small	Dasyuridae		1	0	2		2
17	small	Dasyuridae		0	1	1	0.17	1
17	medium	Macropodidae	Thylogale billardieri			4	0.45	4
17	large	Vombatidae				2	0.90	4
17	small	Dasyuridae		0	2	2		9
17	small	Dasyuridae		0	1	1	0.12	12
17	small	Muridae	Mastacomys fuscus	2	2	4		1
17	small	Muridae	Mastacomys fuscus	1	0	1	0.70	2
17	small	Muridae	Pseudomys sp.	1	3	5		1
17	small	Muridae	Pseudomys sp.	1	2	3	0.40	2
17	small	unidentifiable	fragments <20mm			180	4.19	17
17	med. & large	unidentifiable	fragments <20mm			350	27.81	17
17	small	unidentifiable	all other				1.05	
17	medium	unidentifiable	all other				0.82	
17	small	Muridae				2	0.08	12
17	small	Muridae		0	1	3	0.15	9
17	medium	Peramelidae				2	0.03	4
17	medium	Macropodidae				1	0.02	4
17	small	Dasyuridae		1	0	1	0.04	2
17	small	Muridae	Mastacomys fuscus	1		2	0.31	1
17	small	Muridae	Pseudomys sp.	0	1	1		2
17	small	Muridae	Pseudomys sp.	1	0	3	0.30	1
17	small	unidentifiable	fragments <20mm			85	2.07	17

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
17	med. & large	unidentifiable	fragments <20mm			215	15.10	17
17	med. & large	unidentifiable	fragments >20 mm			1	0.50	17
18	small	unidentifiable	all other				3.80	
18	medium	unidentifiable	all other				1.18	
18	small	Muridae		1	2	14	0.60	9
18	medium	Potoroidae				3	0.31	4
18	large	Vombatidae				1	0.32	4
18	medium	Macropodidae	Thylogale billardieri			4	0.53	4
18	small	Dasyuridae		0	2	3		2
18	small	Dasyuridae				1	0.07	1
18	small	Muridae	Mastacomys fuscus	2	0	2		2
18	small	Muridae	Mastacomys fuscus	1	2	4	0.81	1
18	small	Muridae	Pseudomys sp.	3	3	7		1
18	small	Muridae	Pseudomys sp.	1	2	3	0.50	2
18	small	Muridae		3	1	11	0.76	12
18	small	unidentifiable	fragments <20mm			555	12.50	17
18	med. & large	unidentifiable	fragments <20mm			180	20.52	17
18	med. & large	unidentifiable	fragments >20 mm				1.97	3
19	small	unidentifiable	all other				5.34	
19	medium	unidentifiable	all other				1.15	
19	large	Vombatidae				2	1.38	4
19	large	Macropodidae				1	2.57	16
19	medium	Peramelidae		1	0	1		1
19	medium	Peramelidae		0	1	1	0.11	2
19	medium	Peramelidae				4	0.12	4
19	medium	Macropodidae	Thylogale billardieri			2	0.28	4
19	small	Dasyuridae		1	3	4	0.10	2

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
19	small	Muridae	Pseudomys sp.	2	3	6		1
19	small	Muridae	Pseudomys sp.	3	2	5	0.35	2
19	small	Muridae	Mastacomys fuscus	3	3	6		1
19	small	Muridae	Mastacomys fuscus	0	1	1	1.06	2
19	small	Muridae	Rattus lutreolus	1	1	2	0.20	1
19	small	Muridae		1	1	6	0.31	12
19	small	Muridae		1	3	11	0.43	9
19	small	unidentifiable	fragments <20mm			675	14.17	17
19	med. & large	unidentifiable	fragments <20mm			140	15.34	17
19	med. & large	unidentifiable	fragments >20 mm			3	2.36	17
20	small	unidentifiable	all other				5.10	
20	medium	unidentifiable	all other				2.69	
20	large	unidentifiable				2	0.79	16
20	medium	Peramelidae				1	0.10	9
20	medium	Peramelidae				5		4
20	medium	Peramelidae		0	1	1	0.16	2
20	small	Muridae		5	3	17	0.65	9
20	small	Muridae		5	4	10	1.23	12
20	medium	Peramelidae				1	0.12	9
20	small	Dasyuridae		2	2	4	0.15	2
20	small	Muridae	Pseudomys sp.	1	6	7		1
20	small	Muridae	Pseudomys sp.	3	2	5	0.93	2
20	small	Muridae	Mastacomys fuscus	6	4	13		1
20	small	Muridae	Mastacomys fuscus	1	5	9		2
20	medium	Macropodidae	Thylogale billardieri			1	0.18	4
20	large	unidentifiable				2	0.25	4
20	large	Macropodidae				1	0.52	4

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
20	small	unidentifiable	fragments <20mm			720	17.62	17
20	med. & large	unidentifiable	fragments <20mm			167	22.02	17
20	med. & large	unidentifiable	fragments >20 mm			7	24.45	17
21	small	unidentifiable	all other				5.17	
21	medium	unidentifiable	all other				2.03	
21	small	Muridae		3	3	8	0.82	12
21	small	Muridae		3	4	10	0.54	9
21	small	Muridae	Mastacomys fuscus	3	1	4		1
21	small	Muridae	Mastacomys fuscus	1	0	2	1.06	2
21	small	Muridae	Pseudomys sp.	3	2	5		1
21	small	Muridae	Pseudomys sp.	1	5	6	1.30	2
21	small	Dasyuridae		1	1	2	0.03	1
21	medium	Peramelidae				1		2
21	medium	Peramelidae				4	0.22	4
21	small	unidentifiable	fragments <20mm			735	18.48	17
21	med. & large	unidentifiable	fragments <20mm			140	21.91	17
21	med. & large	unidentifiable	fragments >20 mm			3	7.22	17
22	small	unidentifiable	all other				3.06	
22	medium	unidentifiable	all other				2.60	
22	small	Muridae		1	3	5	0.25	12
22	small	Muridae		3	3	16	0.63	9
22	small	Dasyuridae				1	0.01	9
22	small	Dasyuridae		1	1	2	0.02	2
22	medium	Peramelidae				5	0.12	4
22	large	Vombatidae				1	0.11	4
22	small	Muridae	Mastacomys fuscus	0	1	2	0.27	1
22	small	Muridae	Pseudomys sp.	2	2	4		1

Split	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
22	small	Muridae	Pseudomys sp.	2	2	4	0.46	1
22	small	unidentifiable	fragments <20mm			530	11.57	17
22	med. & large	unidentifiable	fragments <20mm			245	26.80	17
22	med. & large	unidentifiable	fragments >20 mm			2	1.90	17
23	small	unidentifiable	all other				17.20	
23	medium	unidentifiable	all other				7.15	
23	small	Dasyuridae		3	8	11		2
23	small	Dasyuridae		2	2	4	0.43	1
23	small	Dasyuridae		3	4	7		9
23	small	Dasyuridae		1	4	5	0.28	12
23	small	Muridae		13	11	61	2.30	9
23	small	Muridae		13	13	34	2.47	12
23	small	Muridae	Mastacomys fuscus	5	5	10		2
23	small	Muridae	Mastacomys fuscus	4	3	7	3.98	1
23	small	Muridae	Pseudomys sp.	12	14	27		1
23	small	Muridae	Pseudomys sp.	8	8	16	3.02	2
23	small	Muridae	Rattus lutreolus			1		1
23	small	Muridae	Rattus lutreolus			1	0.06	2
23	medium	Peramelidae				1	0.16	9
23	medium	Peramelidae				2		4
23	medium	Macropodidae	Thylogale billardieri			2	0.14	4
23	large	Macropodidae	Macropus rufogriseus			1	0.16	4
23	medium	Macropodidae	?			6	0.25	4
23	med. & large	unidentifiable				1	0.26	15
23	small	unidentifiable				1150	21.40	17
23	small	unidentifiable	all other				1.14	
23	small	Muridae		4	6	10		1

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
23	small	Muridae		1	0	2	1.05	2
23	med. & large	unidentifiable	fragments <20mm			37	5.20	17
23	med. & large	unidentifiable	fragments >20 mm			2	7.28	17
23	small	unidentifiable	fragments <20mm			315	6.00	17
24	small	unidentifiable	all other				10.54	
24	medium	unidentifiable	all other				3.18	
24	small	Muridae	Pseudomys sp.	10	11	23		1
24	small	Muridae	Pseudomys sp.	3	7	11	1.90	2
24	small	Muridae	Mastacomys fuscus	1	1	2		1
24	small	Muridae	Mastacomys fuscus	0	2	2	1.03	2
24	small	Muridae	Rattus lutreolus	1	0	1		1
24	small	Muridae	Rattus lutreolus	0	1	1	0.06	2
24	small	Muridae		7	8	17	1.93	12
24	small	Muridae		6	8	33	1.23	9
24	small	Dasyuridae		2	2	4		1
24	small	Dasyuridae		3	3	6	0.32	2
24	small	Dasyuridae		2	2	4		9
24	small	Dasyuridae		2	2	4	0.23	12
24	medium	Peramelidae		0	1	1	0.03	2
24	med. & large	Macropodidae ?				3	0.36	4
24	med. & large	unidentifiable	fragments <20mm			425	45.78	17
24	med. & large	unidentifiable	fragments >20 mm			4	4.08	17
24	small	unidentifiable	fragments <20mm			655	13.76	17
24	small	unidentifiable	all other				0.08	
24	medium	unidentifiable	all other				0.20	
24	small	Muridae		0	1	1		1
24	small	Muridae		0	1	1	0.10	2

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
24	medium	Peramelidae				2	0.04	4
24	small	Muridae		1	2	3	0.04	9
24	small	Dasyuridae		1	1	2		12
24	small	Dasyuridae		0	1	1	0.05	9
25	small	unidentifiable	all other				8.74	
25	medium	unidentifiable	al other				1.54	
25	large	Vombatidae				1	2.34	4
25	medium	Peramelidae				13	0.30	4
25	medium	Dasyuridae	Quoll			1	0.05	4
25	small	Dasyuridae		2	3	5		2
25	small	Dasyuridae		1	1	2		12
25	small	Dasyuridae				1	0.18	9
25	large	Macropodidae				1	0.50	4
25	med. & large	Macropodidae				6	0.41	4
25	medium	Potoroidae				1	0.12	4
25	medium	Macropodidae	Thylogale billardieri			2	0.13	4
25	small	Muridae		6	6	20	1.01	9
25	small	Muridae		4	3	8	0.72	12
25	small	Muridae	Pseudomys sp.	2	2	4		1
25	small	Muridae		2	1	3	0.66	2
25	small	Muridae	Mastacomys fuscus	1	0	1		2
25	small	Muridae	Mastacomys fuscus	2	1	7	1.16	1
25	small	unidentifiable	fragments <20mm			1110	24.20	17
25	med. & large	unidentifiable	fragments <20mm			198	24.62	17
25	med. & large	unidentifiable	fragments >20 mm			2	2.16	17
26	small	Dasyuridae		2	1	3		9
26	medium	Peramelidae				12	0.69	4

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
26	medium	Macropodidae	Thylogale billardieri			6	0.77	4
26	medium	Peramelidae		1	1	2	0.23	2
26	medium	Potoroidae	Bettongia gaimardi			1	0.07	4
26	medium	Peramelidae				1	0.08	1
26	med. & large	Macropodidae				2	0.22	4
26	small	Dasyuridae		4	6	11	0.43	2
26	small	Dasyuridae		0	1	1		1
26	small	Muridae	Pseudomys sp.			2	0.10	4
26	small	Muridae	?	1	2	3	0.05	2
26	small	Muridae	?	0	1	1		1
26	small	Muridae	Mastacomys fuscus	2	5	7	1.90	2
26	small	Muridae	Mastacomys fuscus	1	1	2		1
26	small	Muridae	?	5	5	10	1.61	2
26	small	Muridae	?	10	5	15		1
26	small	Muridae		11	13	25	3.16	12
26	small	Muridae		21	18	44	2.26	9
26	small	Dasyuridae				3	0.13	12
26	small	Dasyuridae		1	1	2	0.03	2
26	med. & large	Macropodidae					4.50	16
26	large	unidentifiable	all other				6.69	
26	small	unidentifiable	all other				16.69	
26	small	unidentifiable	fragments <20mm			928	18.55	17
26	med. & large	unidentifiable	fragments <20mm			547	59.86	17
26	med. & large	unidentifiable	fragments >20 mm			4	3.31	17
27	small	unidentifiable	all other				12.14	
27	medium	unidentifiable	all other				5.26	
27	small	Muridae		7	16	34	1.18	9

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
27	small	Muridae		11	12	25	2.52	12
27	small	Dasyuridae		7	1	9		2
27	small	Dasyuridae		4	2	6	0.33	1
27	small	Dasyuridae		1	2	4		12
27	small	Dasyuridae		3	1	5	0.15	9
27	medium	Peramelidae		1	0	3		2
27	medium	Peramelidae				8	0.35	4
27	small	Bat				1	0.01	9
27	medium	Potoroidae				2	0.18	4
27	medium	Macropodidae	Thylogale billardieri			3	0.66	4
27	medium	Macropodidae				2		4
27	small	Muridae	Pseudomys sp.	6	8	16		1
27	small	Muridae	Pseudomys sp.	4	4	10	1.81	2
27	small	Muridae	Mastacomys fuscus	3	4	7		1
27	small	Muridae	Mastacomys fuscus	3	0	3	2.24	2
27	small	Muridae	Rattus lutreolus	1	0	1	0.24	2
27	large	Macropodidae				1	1.68	?
27	small	unidentifiable				710	17.10	17
27	med. & large	unidentifiable	fragments <20mm			405	60.35	17
27	med. & large	unidentifiable	fragments >20 mm			3	1.32	17
28	small	Muridae	Pseudomys sp.	0	1	1	0.07	1
28	small	Muridae	?	7	7	14	1.61	1
28	small	Muridae	?	6	2	8		2
28	small	Muridae	Rattus lutreolus	0	1	1	0.41	2
28	small	Muridae	Rattus lutreolus	1	0	2		1
28	small	Muridae	Mastacomys fuscus	1	1	2	0.92	2
28	small	Muridae	Mastacomys fuscus	0	1	3		1

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
28	small	Muridae		5	6	14	1.40	12
28	small	Muridae		9	9	25	0.65	9
28	med. & large	Macropodidae				4	0.30	4
28	small	Dasyuridae		3	2	5	0.13	2
28	small	Dasyuridae		1	1	2		1
28	small	Dasyuridae		1	1	3	0.02	9
28	small	Dasyuridae				1		12
28	medium	Peramelidae				7	0.11	4
28	medium	Peramelidae				1	0.23	9
28	medium	unidentifiable	other				3.29	
28	small	unidentifiable	other				11.38	
28	small	unidentifiable	fragments <20mm			620	10.75	17
28	med. & large	unidentifiable	fragments <20mm			266	36.87	17
28	large	Macropodidae	fragments >20 mm			1	4.70	13
28	med. & large	unidentifiable	fragments >20 mm			6	5.40	17
28	medium	Peramelidae		0	1	1	0.29	2
29	small	Dasyuridae		2	3	5	0.14	2
29	small	Dasyuridae		2	2	4		1
29	small	Dasyuridae				1	0.01	12
29	medium	Peramelidae				3	0.03	4
29	medium	Dasyuridae	quoll			2	0.06	4
29	medium	Peramelidae				1	0.39	12
29	medium	Phalangeridae	Trichosurus vulpecula	1	0	1	0.38	1
29	medium	Potoroidae	?	1	0	1	1.00	1
29	small	Muridae	Mastacomys fuscus	3	0	3	2.10	2
29	small	Muridae	Mastacomys fuscus	2	3	11		1
29	small	Muridae	?	2	0	2	0.03	2

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
29	small	Muridae	?	0	1	1		1
29	small	Muridae	?	5	3	8	0.86	2
29	small	Muridae	?	2	4	6		1
29	small	Muridae		8	7	26	1.86	12
29	small	Muridae		9	8	29	1.02	9
29	small	Dasyuridae		3	2	3	0.10	12
29	medium	unidentifiable	all other				4.92	
29	small	unidentifiable	all other				8.00	
29	small	unidentifiable	fragments <20mm			410	10.46	17
29	med. & large	unidentifiable	fragments <20mm			263	41.68	17
29	med. & large	unidentifiable	fragments >20 mm			2	2.00	17
30	small	unidentifiable	all other				8.00	
30	medium	unidentifiable	all other				3.49	
30	large	unidentifiable					1.74	
30	medium	Peramelidae				6	0.30	4
30	medium	Peramelidae				1	0.22	12
30	small	Muridae		8	12	32	1.17	9
30	small	Muridae		4	5	12	1.01	12
30	small	Muridae	Mastacomys fuscus	2	2	4		1
30	small	Muridae	Mastacomys fuscus	2	1	3	1.0	2
30	small	Muridae	Rattus lutreolus			1	0.11	1
30	small	Muridae	Pseudomys sp.	1	2	3		1
30	small	Muridae	Pseudomys sp.	3	3	6	1.86	2
30	small	Dasyuridae		5	1	7		1
30	small	Dasyuridae		7	11	18	0.60	2
30	small	Dasyuridae		2	3	5		9
30	small	Dasyuridae		3	0	3	0.14	12

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
30	small	unidentifiable	fragments <20mm			740	12.64	17
30	med. & large	unidentifiable	fragments <20mm			500	72.3?	17
30	small	unidentifiable	all other				12.74	
30	medium	unidentifiable	all other				2.40	
30	small	Muridae		9	9	25	1.78	12
30	small	Muridae		11	11	30	1.05	9
30	medium	Dasyuridae	quoll sp?	0	1	1	0.52	2
30	medium	Potoroidae				1	0.14	4
30	medium	Macropodidae	Thylogale billardieri			2	0.23	4
30	medium	Peramelidae				4	0.18	4
30	large	Vombatidae	wombat			1	0.62	4
30	medium	Peramelidae		1	0	1	0.12	9
30	small	Dasyuridae		2	2	4		1
30	small	Dasyuridae		4	2	6	0.17	2
30	small	Dasyuridae				3		9
30	small	Dasyuridae				1	0.07	12
30	small	Muridae	Pseudomys sp.	3	3	8		1
30	small	Muridae	Pseudomys sp.	9	5	14	0.68	2
30	small	Muridae	Mastacomys fuscus	3	0	3		2
30	small	Muridae	Mastacomys fuscus	1	0	5	1.18	1
30	small	Muridae	Rattus lutreolus	1	1	2	0.32	2
30	small	unidentifiable				780	15.06	17
30	med. & large	unidentifiable	fragments <20mm			365	44.66	17
30	med. & large	unidentifiable	fragments >20 mm			3	1.72	17
30	small	unidentifiable	all other				0.98	
30	medium	unidentifiable	all other				0.36	
30	small	Muridae		1	1	3	0.06	9

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
30	small	Muridae	Mastacomys fuscus	1	0	1		2
30	small	Muridae	Mastacomys fuscus	1	0	1	0.50	1
30	small	Muridae	Pseudomys sp.	1	0	1	0.08	2
30	small	Dasyuridae				1	0.10	1
30	medium	Macropodidae				1	0.10	4
30	small	unidentifiable	fragments <20mm			135	1.68	17
30	med. & large	unidentifiable	fragments <20mm			67	6.36	17
31	small	unidentifiable	all other				31.88	
31	medium	unidentifiable	all other				8.29	
31	large	Macropodidae					5.13	16
31	small	Muridae		30	25	84	6.65	12
31	small	Muridae		35	30	115	3.73	9
31	medium	Peramelidae		2	1	3	0.65	12
31	medium	Peramelidae				3	0.35	9
31	medium	Peramelidae		0	3	4	0.32	2
31	medium	Peramelidae				28	0.60	4
31	small	Dasyuridae		13	19	36	0.85	2
31	small	Dasyuridae		4	9	14	0.30	1
31	small	Dasyuridae		6	5	11	0.28	12
31	small	Dasyuridae		7	10	26	0.57	9
31	medium	Dasyuridae	?			1	0.10	4
31	medium	Macropodidae	Thylogale billardieri			4	0.47	4
31	medium	Potoroidae	Bettongia gaimardi			5	0.64	4
31	large	Macropodidae	Macropus giganteus			1	0.04	4
31	large	Macropodidae	?			3	0.40	4
31	med. & large	Macropodidae				6	0.52	4
31	large	Vombatidae				2	0.46	4

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
31	small	unidentifiable	fragments <20mm			1945	35.54	17
31	small	Muridae		0	2	2	0.07	1
31	med. & large	Macropodidae	fragments >20 mm			9	4.04	17
31	med. & large	Macropodidae	fragments <20mm			896	116.10	17
31	small	Muridae				120	3.83	4
31	small	Muridae	?	2	4	6	0.20	2
31	small	Muridae	?	1	0	1	0.03	1
31	small	Muridae					0.66	3
31	small	Muridae	Mastacomys fuscus	11	5	16	3.82	2
31	small	Muridae	Mastacomys fuscus	4	6	12	1.89	1
31	small	Muridae	?	10	15	25	2.39	2
31	small	Muridae	?	18	16	34	1.78	1
31	small	Muridae	Rattus lutreolus	4	2	6	1.10	2
31	small	Muridae	Pseudomys sp.	1	0	2	0.18	1
31	small	Muridae	Pseudomys sp.	3	1	4	0.18	1
31	small	Muridae	all other				19.08	
31	medium	unidentifiable	all other				2.18	
31	large	Macropodidae					0.41	16
31	small	Dasyuridae		4	6	12	0.21	12
31	small	Dasyuridae		2	5	7	0.14	1
31	small	Dasyuridae		8	10	18	0.55	2
31	medium	Peramelidae				25	0.50	4
31	medium	Dasyuridae				1	0.05	4
31	medium	Macropodidae	Thylogale billardieri			3	0.54	4
31	medium	Macropodidae	Thylogale billardieri			1	0.45	2
31	large	Macropodidae	Macropus rufogriseus			5	1.59	4
31	small	Muridae	Rattus lutreolus	1	1	2	1.31	1,2

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
31	small	Muridae					2.7	4
31	small	Muridae	Mastacomys fuscus	9	3	12	2.23	2
31	small	Muridae	Mastacomys fuscus	3	6	12	1.47	1
31	small	Muridae	?	0	3	3	0.17	1
31	small	Muridae	?	1	3	4		2
31	small	Muridae	?	10	10	20	2.54	2
31	small	Muridae	?	9	9	20		1
31	small	Muridae		17	12	79	2.16	9
31	small	Dasyuridae		2	2	5	0.17	9
31	medium	Peramelidae				1	0.51	9
31	small	Muridae		13	15	39	2.13	12
31	small	unidentifiable	fragments <20mm			1365	19.27	17
31	medium	Peramelidae				1	0.61	12
31	med. & large	unidentifiable	fragments <20mm			644	58.19	17
31	med. & large	unidentifiable	fragments >20 mm			5	2.83	17
32	small	unidentifiable	other				9.67	
32	medium	unidentifiable	other				2.27	
32	large	Macropodidae				1	2.07	16
32	medium	Peramelidae		0	1	1	0.57	12
32	small	Muridae		5	3	11	2.24	12
32	small	Dasyuridae		3	1	10	0.62	9
32	small	Dasyuridae		3	0	3	0.11	9
32	medium	Peramelidae		0	1	2	0.74	2
32	medium	Peramelidae				18	0.36	4
32	small	Dasyuridae		1	1	3	0.12	2
32	small	Muridae	Pseudomys sp.	4	1	6		1
32	small	Muridae	Pseudomys sp.	4		5	0.58	2

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
32	small	Muridae	Rattus lutreolus	1	0	3	0.11	1
32	small	Muridae	Mastacomys fuscus	2	2	4		1
32	small	Muridae	Mastacomys fuscus	2	1	4	1.31	2
32	medium	Potoroidae	?			2	0.56	4
32	small	unidentifiable	fragments <20mm			357	6.91	17
32	med. & large	unidentifiable	fragments <20mm			212	34.72	17
32	med. & large	unidentifiable	fragments >20 mm			3	2.53	17
32	small	unidentifiable	other				23.69	
32	medium	unidentifiable	other				12.09	
32	small	Dasyuridae		3	4	7	0.20	12
32	small	Dasyuridae		1	2	5	0.10	9
32	small	Muridae		16	25	47	6.43	12
32	small	Muridae		22	25	49	2.32	9
32	medium	Peramelidae		2	1	4	1.40	9
32	medium	Peramelidae		4	0	8		2
32	medium	Peramelidae				1	1.48	1
32	medium	Peramelidae				42	0.82	4
32	small	Dasyuridae		6	8	14		2
32	small	Dasyuridae		3	0	4	0.54	1
32	medium	Dasyuridae		1	0	1	0.16	12
32	medium	Dasyuridae	?			1	0.24	2
32	small	Muridae	?	18	14	34		2
32	small	Muridae	?	7	3	10	3.13	1
32	small	Muridae	Pseudomys sp.	4	7	11		1
32	small	Muridae	Pseudomys sp.			5	0.54	2
32	small	Muridae	Rattus lutreolus	8	4	12		2
32	small	Muridae	Rattus lutreolus	4	4	9	3.28	1

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
32	small	Muridae	?	1	2	3		1
32	small	Muridae	?	2	1	3	0.17	2
32	medium	Potoroidae	?			4	0.54	4
32	medium	Potoroidae		1	0	1	0.97	1
32	large	Macropodidae				11	1.89	4
32	medium	Dasyuridae	?			2	0.32	4
32	med. & large	unidentifiable					4.12	16
32	med. & large	unidentifiable					4.05	5
32	small	unidentifiable	fragments <20mm			1385	27.30	17
32	med. & large	unidentifiable	fragments <20mm			1147	131.37	17
32	med. & large	unidentifiable	fragments >20 mm			11	8.09	17
33	small	unidentifiable	other				4.45	
33	medium	unidentifiable	other				1.97	
33	medium	Peramelidae				1	0.45	12
33	small	Muridae		5	4	9	0.73	9
33	small	Muridae		8	10	22	2.50	12
33	small	Dasyuridae		2	0	2	0.05	12
33	small	Muridae	Pseudomys sp.	1	2	3		2
33	small	Muridae	Pseudomys sp.	1	0	1	0.60	1
33	small	Muridae	Rattus lutreolus	1	0	1	0.30	2
33	small	Muridae	?	2	2	4		2
33	small	Muridae	?	2	1	3	1.75	1
33	medium	Potoroidae	?	0	1	1	2.31	1
33	medium	Macropodidae	Thylogale billardieri			5	0.57	4
33	medium	Dasyuridae				1	0.09	4
33	medium	Peramelidae				6	0.19	4
33	small	Dasyuridae		0	1	1		1

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
33	small	Dasyuridae		0	0	1	0.06	2
33	small	unidentifiable	fragments <20mm			210	3.20	17
33	med. & large	unidentifiable	fragments <20mm			230	21.41	17
33	med. & large	unidentifiable	fragments >20 mm			3	3.34	17
33	med. & large	unidentifiable				3	2.15	16
33	small	unidentifiable	other				3.10	
33	medium	unidentifiable	other				2.39	
33	medium	Potoroidae				1	0.40	2
33	small	Muridae		3	0	5	0.51	12
33	medium	Peramelidae				1	0.32	9
33	medium	Peramelidae				5	0.15	4
33	small	Muridae		1	4	5	1.87	9
33	small	Dasyuridae				2		12
33	small	Dasyuridae		2	0	2		2
33	small	Dasyuridae		1	1	2	0.21	1
3	small	Muridae	Pseudomys sp.	8	4	15		2
33	small	Muridae	Pseudomys sp.	4	1	6	1.92	1
33	small	Muridae	Mastacomys fuscus	0	2	2		1
33	small	Muridae	Mastacomys fuscus	0	1		1.22	2
33	small	Muridae	Rattus lutreolus	0	1	1	0.20	2
33	medium	Macropodidae				1	0.10	4
33	large	unidentifiable				2	0.26	4
33	small	unidentifiable	fragments <20mm			135	2.73	17
33	med. & large	unidentifiable	fragments <20mm			205	23.56	17
33	med. & large	unidentifiable	fragments >20 mm			2	0.88	17
34	medium	unidentifiable	other				2.39	
34	small	unidentifiable	other				1.60	

Spit	Size	Family	Species other	no. left	no. right	Total no.	Wt gm	element
34	small	Muridae		1	1	7	0.30	9
34	medium	Peramelidae				2	0.08	4
34	small	Dasyuridae		1	1	2	0.06	1
34	small	Muridae	Pseudomys sp.	1	0	1		1
34	small	Muridae	Pseudomys sp.	1	0	1	0.19	2
34	small	Muridae	Mastacomys fuscus	1	0	1		2
34	small	Muridae	Mastacomys fuscus	0	2	2	0.86	1
34	small	unidentifiable	fragments <20mm			135	3.12	17
34	med. & large	unidentifiable	fragments <20mm			70	7.42	17

APPENDIX XIV

Mannalargenna Cave: Unmodified stone artefacts

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
MCF1	2	2	1	.15	quartz		1 crystal facet
MCF1	6	4	2	2.52	quartz	2	
MCF1	8	4	1	.34	quartz	1	
MCF1	12	4	1	.64	crystal qtz	1	w'worn facet
MCF1	13	3	1	.28	quartzite	1	
MCF1	13	3	1	.19	crystal qtz	1	
MCF1	13	4	1	.3	crystal qtz	1	
MCF1	15	9	1	14.43	quartz	1	1 vein
MCF1	16	2	1	.03	quartz	1	
MCF1	16	5	1	3.13	quartz		vein and facet
MCF1	16	7	1	14.06	quartz	1, 1 bipolar	1 pebble
MCF1	17	2	3	0.08	quartz	2	
MCF1	17b	2	1	.13	quartzite	1	
MCF1	18	4	1	.2	crystal qtz	1	
MCF1	18	6	1	3	quartz	1, 1 bipolar	
MCF1	18	2	1	.08	quartz	1	
MCF1	19	3	1	.39	crystal qtz	1	1 crystal facet
MCF1	19	3	1	.38	quartz		

Square	Split	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
MCF1	20	3	1	.41	quartz		
MCF1	21	3	1	.34	quartz	1	
MCF1	21	2	6	.37	quartz	3	
MCF1	21	2	3	.06	crystal qtz		
MCF1	22	3	1	.12	quartz	1	
MCF1	22	2	5	.28	quartz	2	
MCF1	22	5	1	2.35	quartz	1, 1 bipolar	1 pebble
MCF1	23	2	21	1.5	quartz	8	
MCF1	23	3	2	.95	quartz	2	
MCF1	23	4	3	2.23	quartz	3	1 vein 1 pebble
MCF1	23	5	2	3.53	quartz	2, 1 bipolar	2 pebble
MCF1	23	2	2	.13	crystal qtz	2	
MCF1	24	8	1	10.47	ind. limestone	1	
MCF1	24	6	1	4.29	quartz	1, 1 bipolar	1 pebble
MCF1	24	4	2	3.04	quartz	2, 1 bipolar	
MCF1	24	3	3	.67	quartz	3	
MCF1	24	2	6	.58	quartz	3	
MCF1	24	2	1	.04	quartz	1	

Square	Spit	Size category	No.	wt g	Stone type	No. with bulb /impact pt	Cortex
MCF1	26	3	1	.35	quartz	1	
MCF1	26	2	1	.06	quartz		
MCF1	27	4	2	1.88	quartz	2, 1 bipolar	
MCF1	27	3	1	1.56	quartz	2	
MCF1	27	2	1	.03	quartz		
MCF1	27	4	1	1.12	quartz	1	
MCF1	28	2	1	.16	quartz	1	
MCF1	30 u	2	1	.02	quartz	1	
MCF1	32	4	1	1.75	quartz		1 vein
MCF1	33 l	3	1	.8	quartz	1	

APPENDIX XV

Charcoal weights Mannalargenna Cave FI

APPENDIX XV

Charcoal weights Mannalargenna Cave FI inner chamber square excavation

FI Spit No.	Charcoal wt g
1	0.04
2	1.36
3	0.63
4	1.80
5	2.24
6	3.70
7	3.96
8	2.72
9	0.78
10	6.48
11	4.48
12	5.03
13	4.43
14	3.14
15	0.67
16	2.51
17	7.51
18	2.11
19	6.95
20	2.58
21	5.51
22	3.90
23	23.99
24	10.71
25	4.02
26	2.59
27	3.67
28	0.74
29	1.78
30	12.63
31	0.72
32	0.56
33	2.22
34	0.04