North of the Cape and South of the Fly: The Archaeology of Settlement and Subsistence on the Murray Islands, Eastern Torres Strait

Thesis submitted by

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Front cover: view of Waier (left) and Dauar (right) looking southwest from Mer

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This thesis is dedicated to the memory of my Grandad, Arthur Richard Carter
(1914 – 2004)

Thankyou for a childhood filled with flowers and veggie gardens and
a lifetime of so many wonderful memories

Abstract

This dissertation describes analyses and contextualises the results of archaeological investigations carried out between 1998 and 2000 on Mer and Dauar in Torres Strait. Along with Waier these small volcanic islands are commonly known as the Murray Islands, and form the most eastern group of the formation of islands scattered between northeastern Australia and southern Papua New Guinea. Unlike the research into human occupation and subsistence in Australia and New Guinea, the archaeology of the Torres Strait Islands is by contrast a relatively recent academic pursuit. Over the last 30 years various researchers have postulated the timing of first human occupation of Torres Strait, the development of maritime and horticultural subsistence systems and the emergence of ethnohistorically documented trade networks. A lack of archaeological data, however, has prevented informed consideration of these issues.

This dissertation presents the results of the first systematic archaeological excavations undertaken in the Eastern Torres Strait, and includes the first detailed radiocarbon chronological sequence for the Murray Islands and for the Torres Strait more generally. The excavations on Dauar revealed extensive archaeological deposits of marine subsistence remains, and previously unrecorded material culture of Torres Strait; most notably, several sherds of earthenware pottery. These artefacts have provided new opportunities for investigating the traditional trade and exchange networks between the Torres Strait Islands and New Guinea that existed at the time of European contact.

The Murray Islands data illustrates the existence of a maritime subsistence base from the time of first human occupation now securely dated to almost 3000 years BP. Although plant macrofossils where absent during the excavations, evidence for horticultural subsistence on Dauar was identified through the extraction and identification of plant phytoliths and starch grains from excavated sediment samples. In combination with the radiocarbon site chronologies and changes to sediment deposition rates and assemblage densities, it is concluded that these results indicate the onset of widespread clearance and horticultural

activities on the island from at least 2000 years BP, providing the earliest date for the emergence of horticulture so far established in Torres Strait.

Dated to between 2000 and 700 years BP, the excavated pottery from Dauar suggests the possibility of sustained linkages between the peoples of the Eastern Torres Strait and New Guinea. Ethnohistoric records suggest southward trade into the Eastern Torres Strait was dominated by southwestern coastal Papuan communities, and particularly by groups of the Fly Estuary. Surprisingly, mineralogical analysis of selected pottery sherds from the Murray Islands revealed the presence of sand tempers sourced to the metamorphic and volcanic lithology of the Eastern New Guinea Highlands. More accurately, these results are concluded to portray linkages between the Torres Strait and the adjacent southern Papuan lowlands through which more discrete movements and transactions with interior areas occurred along key riverways that connected the hinterland to the coast.

The timing of human occupation of Torres Strait, the development of subsistence systems and the relationships that islanders had with the peoples of northern Australia and the western Pacific have only started to be explored archaeologically. It is concluded from the combined ethnohistorical and field archaeological evidence that settlement and subsistence in Torres Strait is a product of late-Holocene human expansions and cultural intensification previously documented for the adjacent mainlands and the broader western Pacific region. This research confirms that the archaeology of Torres Strait must be interpreted within the broader cultural, chronological and geographical context in which it is centrally located.

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The Murray Islands Archaeological Project would not have eventuated without the support of the Meriam community, members of the Mer Island Community Council, the Mer Gedkem Le, the Council of Elders and the families who consented to excavation on their lands. People that deserve special *esso* include Chairman Ron Day, Lloyd Maza and Sam Wailu. The Passi family provided friendship and a home for me in 1998. For allowing the work at Sokoli I am extremely thankful to Andrew Passi. Esi Tapim and Walter Cowley consented to the work at Kurkur Weid and Pitkik on Mer. On Dauar life was made much easier by staying at Ormi, for which I extend much appreciation to traditional landowners George and Alan Kaddy. Sunny Passi provided assistance in the field in 1998, whom I also thank for his friendship, sense of humor and envious intelligence. Del Passi offered advice and suggestions on all manner of things, for which I am extremely grateful. Aris Kaddy provided assistance in the field and on the water in 2000, without whom my boating skills (or lack there of) would have left us high and dry more than just the once (sorry Aris, had to mention 'the beaching incident'). To all the kids (especially Phil, Joey and Richard), thanks for fun and games on the beach and for providing some memorable light hearted moments.

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Chapter 1: Introduction to the Thesis

The Torres Strait Islands are located between northeastern Australia and the southern coast of Papua New Guinea. Their inhabitants occupy an area that marks the border between Australian hunter-gatherer cultures and Papuan horticulturists (Figure 1.1). Archaeological fieldwork in Torres Strait began in the early 1970s and emerged with a research agenda centered around the 'bridge or barrier' debate and an emphasis on defining the nature and timing of the horticultural economy (Barham and Harris 1983; Harris 1977, 1995; Walker 1972). However, the early hypotheses on the antiquity of human occupation and development of marine and horticultural subsistence in Torres Strait were loosely constructed from minimal archaeological evidence, and relied heavily on ethnohistoric and documentary records (Beckett 1972; Moore 1972; Vanderwal 1973). Only in more recent times has the archaeology of the Torres Strait begun to be considered within the broader regional framework connected in space and time to southern New Guinea and northeastern Australia (Barham 2000; Barham et al. 2004; Carter 2002; in press; David and McNiven 2004).

This thesis concerns an archaeological investigation of prehistoric settlement, subsistence and trade on the Murray Islands in the Eastern Torres Strait, northeastern Australia. By determining the chronology of human occupation of these islands, defining the nature and timing of the developments in the subsistence economy and identifying evidence of regional trade and exchange, this research presents the first investigation, analysis and interpretation of excavated archaeological assemblages from the Eastern Torres Strait. By considering the results within the chronological, economic and cultural frameworks previously established by archaeological research in the neighbouring regions of northern Australia and the western Pacific, this research also places the prehistory of the Murray Islands within a regional context.

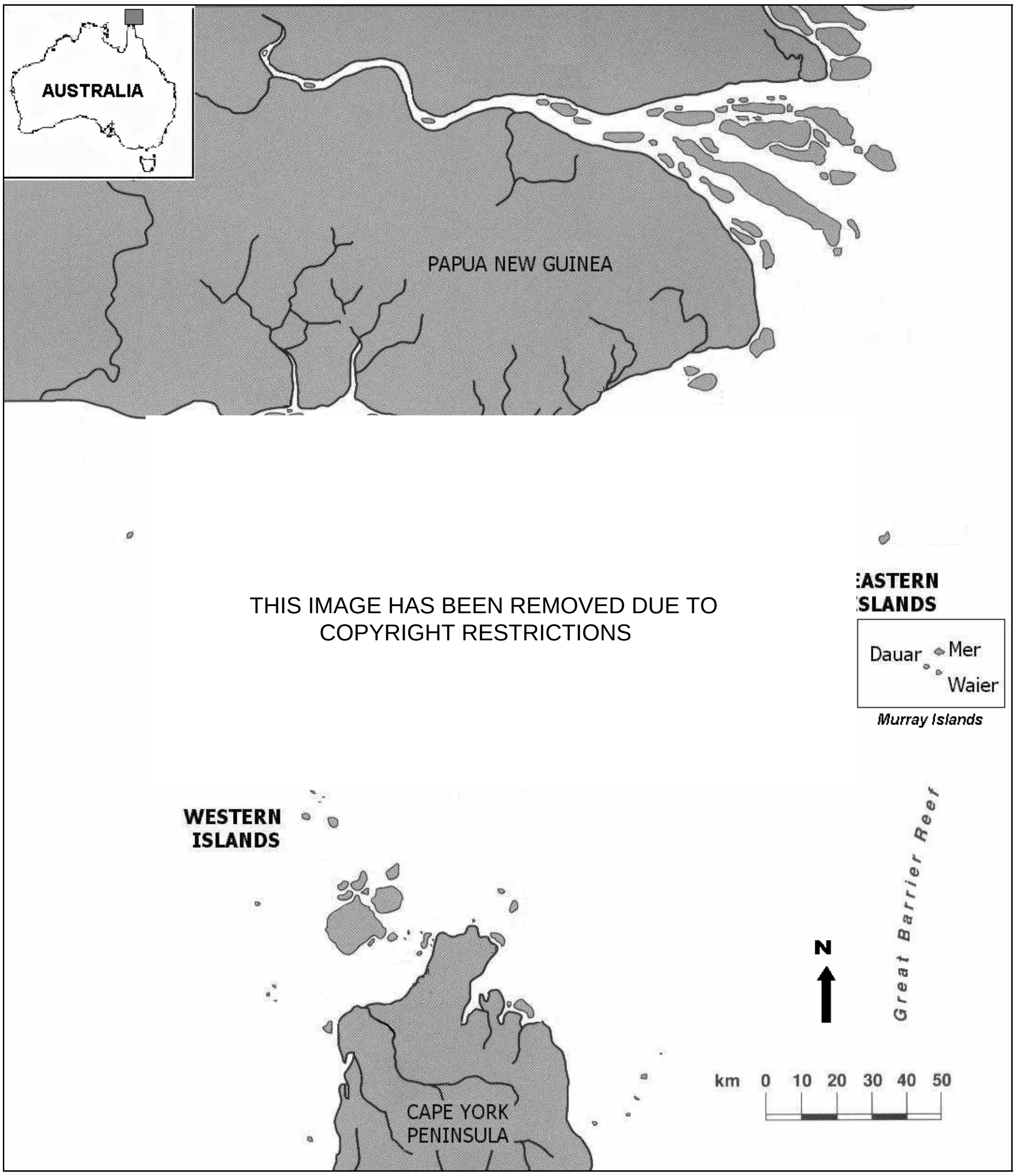

Figure 1.1 Map of Torres Strait showing four main island groups and study area

Objectives and Aims

Because the prehistoric sequences for the Torres Strait were largely unknown at the time my research started in 1998, I developed two major research objectives:

1. To identify and define the prehistory of human settlement, subsistence and trade on the Murray Islands, and

2. To examine the extent to which this prehistory conforms to the general patterns of occupation in the neighboring regions of northern Australia and the western Pacific.

As the thesis was developed, four more specific aims were identified, as follows:

1. To determine the nature and chronology of human occupation, and to identify patterns of prehistoric subsistence on the Murray Islands through space and time,

2. To identify any effects of human settlement and subsistence on the environment in the study area,

3. To examine the extent to which archaeological subsistence and material culture assemblages of the Murray Islands reflect ethnographically recorded cultural assemblages for the Torres Strait, and

4. To identify any evidence within the archaeological record for the development of the area's local and long-distance trade and exchange systems.

Study Area Overview

The Torres Strait Islands are located on a shallow shelf between Cape York in northeastern Australia and New Guinea's southern coast. The Torres Strait itself is approximately 150km wide and comprises a discontinuous chain of largely granitic islands in the west, isolated volcanic islands in the east, scattered coral islands in the centre and a group of northern coastal alluvial islands. The islands were formed between 8500 and 6500 years ago after rising Holocene sea levels submerged the land bridge that joined Australia and New Guinea (Barham and Harris 1983:529).

The Eastern Islands lie within sight of the outer Great Barrier Reef and are located approximately 210km northeast of Cape York and around 100km southwest of New Guinea's Fly Estuary. Unlike the rest of the Torres Strait Islands, whose inhabitants speak Australian Aboriginal languages, the inhabitants of the Eastern Islands speak Meriam Mir, a Papuan (Non-Austronesian) language closely related to the languages of the Trans-Fly region along the southern coast of New Guinea. At the time of European contact the populations of the Eastern Islands were sedentary and relied heavily on fishing and gardening, while the populations of the other islands were more mobile, subsisted on hunting and fishing, and relied to varying degrees on plant collection and cultivation. Eastern Islanders had strong trade and kinship ties with the southern New Guinea coast and indirect ties with Australian Aboriginal populations and Western Islanders through the agency of Central Islanders.

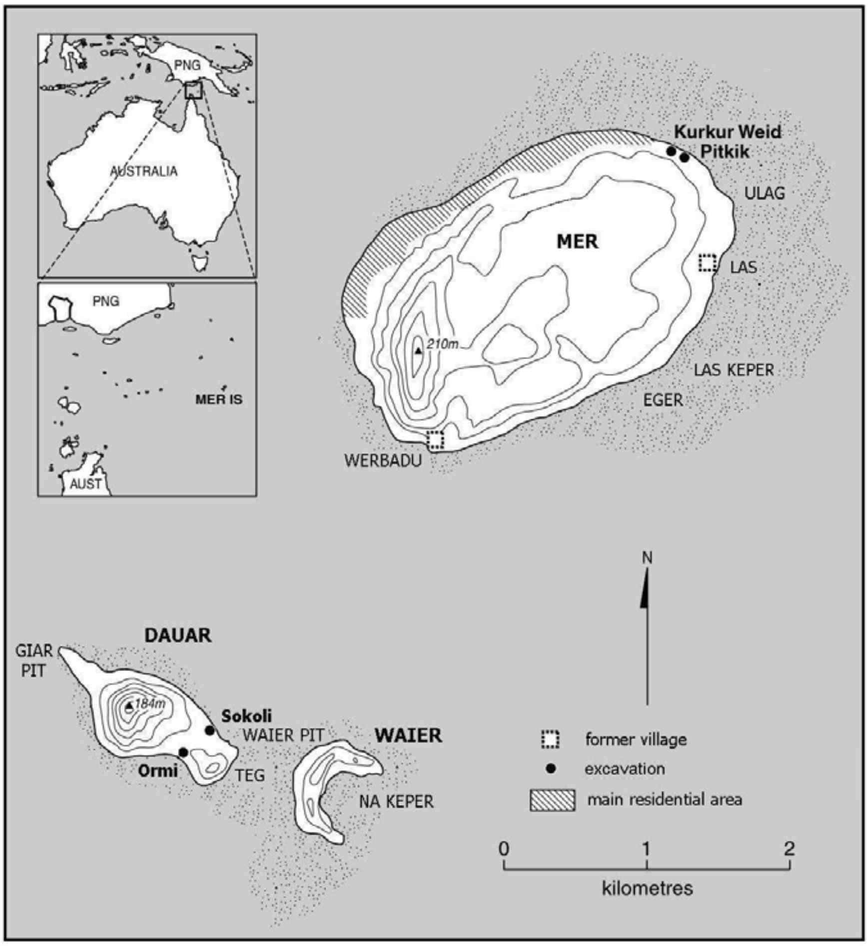

Figure 1.2 Map of Study Area

The investigations in the Eastern Islands which are reported in this thesis focus on the islands of Mer and Dauar, which along with the smallest island of Waier, are commonly known as the Murray Islands (Figure 1.2). Their traditional inhabitants are the Meriam, who at the time of European contact occupied all three islands. The settlements on Dauar and Waier were abandoned during the 1920s and the community today is concentrated on Mer, mostly along the northwestern foreshore and the eastern beach at Las. Dauar and Waier are still used extensively for temporary residence, gardening, fishing and food gathering.

To address the key issues of this thesis - the chronology of human occupation of the Murray Islands, the nature and timing of subsistence change, and the development of regional trade and exchange networks - the Eastern Islands thus offer an excellent geographical vantage point from which to determine and contextualise the human prehistory of Torres Strait. This is particularly the case given the well-documented late Holocene human migrations westward along the southern New Guinea coast, and the archaeologically demonstrated expansion of fisher-horticultural peoples into marginal and offshore island environments throughout the western Pacific during this time (Allen 1977a; Egloff 1979; Kirch 1997; Kirch and Ellison 1994; Spriggs 1997, 1993).

Research Context

This research forms part of a larger collaborative archaeological program called the Murray Islands Archaeological Project (MIAP). The project commenced in 1998 and has been jointly conducted between the Anthropology Department at the University of Arkansas in the United States and the Archaeology Department at James Cook University in Townsville and in conjunction with traditional Meriam landowners. The MIAP was an initiative of the Mer Island Community Council, with the ultimate aim of documenting the chronology of marine resource use on the islands of Mer and Dauar (Bird et al. 2002; Carter 2000, 2003a).

As part of the MIAP, Richardson (2000) has examined shell midden variability on the Murray Islands through comparison of the excavated archaeological shell remains and ethnoarchaeological observations of contemporary prey choice, shellfish processing and discard behavior (see also Bird et al. 2002; Bird et al. 2004). The results of this investigation demonstrated that the relative importance of various shellfish species in contemporary Meriam diets is not reflected in either contemporary shell accumulations or in the proportional representations of shells in the prehistoric assemblages. The fact that the most important shellfish prey types were virtually absent from the archaeological deposits, and conversely, the species that are relatively unimportant quite common in shell assemblages, was attributed to field processing strategies and differential transport of shell material. It was concluded that where locations of procurement and consumption are different, the composition of shell assemblages would reflect behavior that maximised the rate at which resources could be delivered to a central locale (Richardson 2000:43). This theory was offered in explanation for the absence in the shell assemblages of the large tridacnid clam species, and the abundance of the much smaller *Nerita* species.

Richardson's (2000) research offers a useful explanatory framework for examining archaeological shell remains from a purely subsistence or dietary point of view. The investigations conducted in this thesis, however, demonstrate that the nature of archaeological shell assemblages on the Murray Islands requires additional explanations to account for the accumulation, density and proportions of deposited remains. By reviewing the material culture of the Torres Strait and the nature of combined marine and horticultural subsistence on the Murray Islands, it is suggested that certain factors which lay outside of the scope of behavioral ecological models offer supplementary reasons for explaining variability in archaeological marine resource remains.

Fieldwork Details and Limitations

This thesis is based on the analysis and interpretation of data derived from two major seasons of fieldwork carried out between 1998 and 2000 on Mer and Dauar. Waier was not included in the archaeological program as most of the island is regarded as sacred, and so permission to investigate it was not sought. Opportunity for archaeological survey during fieldwork on Mer and Dauar was limited owing to rules associated with access to traditionally-owned land. Territorial boundaries are strongly enforced on the islands and permission from the landowners must be granted before entering onto land, particularly gardens. Free access to land is limited to public areas such as the council building and school on Mer, and the beaches and main roads. To avoid trespassing, archaeological survey was kept within the boundaries of the areas where traditional landowners had previously consented to excavation, beaches and foreshores and public access paths and roads along the foreshore and interior regions of the islands. In spite of these restrictions, it was concluded that the extent and scope of the preliminary investigations provided a representative sample of the coastal archaeology of Mer and Dauar, and was adequate to examine the broad ranging questions posed in this thesis.

It was concluded that stratified archaeological contexts from which reliable archaeological and radiocarbon chronologies might be derived fell into three site categories: i) rock shelter deposits, ii) stratified middens visible in eroding shorelines, and iii) midden material in areas known to have been horticultural gardens within the historic period. Initially one example of each of these site types was selected for excavation, analysis and radiocarbon dating. These were Kurkur Weid, a small rock shelter on the northern coast of Mer, Pitkik, a stratified midden exposed by contemporary shoreline erosion 40m from Kurkur Weid rock shelter, and Sokoli, a former garden located on the northeastern side of Dauar, where surface shell and bone debris suggested the possibility of midden stratigraphy at depth. In 2000 a fourth excavation was undertaken at Ormi on the southwestern side of Dauar, where surface finds and eroding shoreline stratigraphy suggested midden assemblage was present at depth.

Thesis Structure

This thesis is divided into 11 chapters. Chapter 2 introduces the broad cultural and natural backgrounds in which the investigations of this thesis are framed. It provides the environmental background of the Torres Strait and adjacent coasts as the context for a description of the *Torres Strait Cultural Complex* (sensu Barham 2000) as it was documented in early historical accounts and the more recent 19th and early 20th century ethnographies.

Chapter 3 sets the archaeological scene of this research by providing the history and major themes of archaeological research undertaken in the Torres Strait prior to the investigations described in this thesis, and pays particular attention to the results and outcomes of research that are of relevance here. The archaeological background of Cape York and southern New Guinea is also discussed, with a focus on the patterns of human occupation, the nature of excavated cultural assemblages and evidence of regional contact and cultural exchange previously established by investigations of the late-Holocene archaeologies of these regions.

Chapter 4 provides information on the cultural and natural setting of the Murray Islands specifically. In particular, ethnographic information on marine and horticultural subsistence strategies and trade and exchange links with southern New Guinea is provided. The observations of contemporary Meriam marine subsistence strategies mentioned above are also described. Based on these lines of evidence, a number of archaeological implications for the distribution, nature and composition of archaeological site types related to past marine and horticultural subsistence on the Murray Islands are identified.

The results of fieldwork conducted on Mer and Dauar in 1998 and on Dauar in 2000 are described in Chapter 5. Results of the preliminary survey along with site descriptions and excavation methods are included. Site stratigraphies, the diversity and density of the excavated archaeological assemblages and the radiocarbon age-depth sequences for each site are discussed.

Chapter 6 details the methods and results of marine faunal analyses, including the excavated shell and the marine vertebrate remains. The excavated terrestrial vertebrate assemblage is also identified and discussed. The major aim of this chapter is to provide detailed quantification and description of the marine and the terrestrial faunal assemblages. This is undertaken with the main objective to define the nature of the prehistoric marine subsistence economy of the Murray Islands, and secondly, to identify any changes to the marine economy at both a temporal and spatial level.

Chapter 7 provides the results and interpretation of phytolith and starch grain analysis of excavated sediment samples. These analyses were conducted to provide evidence of prehistoric horticulture by identifying microscopic remains of edible plants and patterns or shifts in vegetation owing to human disturbance. Based on the results, and taking into consideration sample size and the preliminary nature of this investigation, the nature of horticultural evidence for each site is summarised. In the context of changes to the marine subsistence economy identified in the previous chapter, conclusions for the timing of the development of the prehistoric horticultural economy on the Murray Islands are included.

The portable artefact assemblages recovered from the excavations are described in Chapter 8. Interpretations of artefact function are provided, based largely on references to the material culture ethnographically collected and documented in Torres Strait. Where no documentary evidence for excavated artefacts exists, as is the case with pottery, the explanation of artefact function and origin is based on analogues from the adjacent Papuan coast. A discussion of the material culture assemblages is based around the identified chronological trends, evidence for subsistence and trade and exchange, and site function.

Chapter 9 outlines the results and interpretation of the mineralogical analysis of four of pottery sherds recovered during the archaeological investigations on Mer and Dauar. The analysis aimed to identify the geological source of the pottery temper and to establish the geographical context of the trade network from which the pottery originated. The results confirm the possibility of previously undocumented trade and exchange networks between the Eastern Torres Strait and New Guinea.

Chapter 10 places the prehistory of the Murray Islands and archaeological research into the wider regional context. The interpretations reached in the previous chapters are discussed in detail with reference to the results of other recent archaeological research in Torres Strait, and models and evidence for human occupation, subsistence development and trade networks for the adjacent mainlands, as well as relevant archaeological evidence from the Pacific. It is concluded from the combined ethnographic and field archaeological evidence, that the timing of human occupation of the Murray Islands and the development of subsistence economies and nature of trade and exchange linkages are a product of late-Holocene human expansion from southern New Guinea, with whom ongoing cultural connections were maintained from the outset. Finally, a brief discussion on recommendations and directions for future research is included.

Chapter 2: The Torres Strait Cultural Complex

Towards the end of the 19th century the Torres Strait islands formed the geographic core of a trans-Strait maritime cultural complex which extended as far as Princess Charlotte Bay on the eastern coast of Cape York, and north along the southwestern Papuan coast into the Fly River estuary. This extensive maritime-based social network was documented in 1898 by distinguished natural scientist and ethnologist Alfred Cort Haddon and other members of the famous Cambridge Anthropological Expedition to Torres Strait. Over a century later the *Torres Strait Cultural Complex*, as it has recently been defined (Barham 2000), continues to represent a unique and dynamic cultural phenomenon to anthropologists and archaeologists alike. This chapter provides a comprehensive description of the Torres Strait Cultural Complex based on the early historical and later ethnographic records for the Torres Strait and its neighboring regions of Cape York and southern coastal New Guinea. As the research objectives of this thesis are concerned with colonisation of the Murray Islands, and the nature of the original subsistence and trade systems, a description of the environmental backdrop against which the Torres Strait Cultural Complex emerged and developed is first provided.

The Environmental Setting

Pleistocene Separation and Holocene Emergence

Southern New Guinea, the Torres Strait islands and Cape York once belonged to the same Pleistocene landmass known as Sahul (Figure 2.1). Over the last 120 000 years, prior to the emergence of the separate Australian and New Guinea mainlands, Sahul underwent several shoreline variations owing to glacio-eustatic changes in sea level. Lying on the eastern margin of the Lake Carpentaria drainage catchment, it is estimated that the shallow shelf topography of the Torres Strait had been dry land for most of the last 55 000 years (Chappell 1983; Chappell and Shackleton 1986).

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Figure 2.1 Map of New Guinea and Northern Australia showing palaeogeography of the Sahul continent (after Barham 1999:72)

The end of the Pleistocene, around 10 000 yrs BP, saw a period of dramatic paleo-environmental and paleo-geographic change in Sahul. Rising temperatures dried up the lakes of inland Australia, rainforests contracted into the higher interior regions of New Guinea and melting ice caps resulted in rising sea levels that drowned vast stretches of low-lying land (Figure 2.1). Between 12 000 and 10 000 yrs BP the Bassian Plain connecting Tasmania to the mainland was inundated, isolating the small landmass after several hundred thousand years of connection. It is estimated that between 8500 and 6500 yrs BP the rising post-glacial seas flooded the shelf between Australia and New Guinea to form Torres Strait (Barham and Harris 1983; Jennings 1972a).

From decades of archaeological research on mainland New Guinea and its offshore islands, including New Ireland, the antiquity of Melanesian occupation has been firmly established at greater than 30 000 – 40 000 yrs BP (Allen et al. 1989; Gorecki et al. 1991; Groube et al. 1986). On the Australian mainland Aboriginal occupation at Sandy Creek I and Nurrabullgin in Cape York (David 1993; Morwood et al. 1995), Carpenter's

Gap rockshelter and Malakunjanja II in the Kimberleys (O'Connor 1995; Roberts et al. 1990), as well as Mimbi Caves in the southern central Kimberleys (Balme 2001) has resulted in a Pleistocene human chronology for northern Australia ranging between 32 000 and 55 000 yrs BP (Figure 2.1). Our understanding of the natural and cultural processes that occurred during the Pleistocene throughout Australia and New Guinea is exceeded by the vast archaeological knowledge of environmental and cultural changes that occurred during the Holocene or the last 10 000 years (for example Allen 1977a; Golson 1977; Kirch 1997; Meehan 1977; Lourandos 1985, 1993; Rowland 1996; Spriggs 1993).

In contrast, our knowledge of the natural history of the Torres Strait and how environmental changes such as Holocene sea level fluctuations affected colonisation and the development of subsistence systems, is considerably less well known. Details about the natural environment and history of the region, including marine physiography and biodiversity, reef development, and floral and faunal diversity have only recently begun to emerge from a set of broad scale regional studies. A number of the following sections on the natural environment of the Torres Strait are largely based on these recent sources.

Environmental Overviews: Southern New Guinea, Torres Strait and Cape York Peninsula

Climate

From the low-lying coastal plains of south-western New Guinea southward across Torres Strait to the southern region of Cape York Peninsula a relatively uniform climate prevails. The region lies in a sub-humid tropical environment and experiences two alternating seasons of wet and dry weather. The dry season extends from April to October while the wet season runs from November through to May, although localised differences in duration of the seasons do occur (Bird 1996:35). Mean annual rainfall increases northward across the Strait and the dry season diminishes in length and severity along the same gradient. In the Torres Strait, on average 95% of the annual precipitation falls between December and April (MaSTS 1993). Across the region the mean monthly temperature is 20°C or more with a mean relative humidity of 65% or more (Denoon and Snowden 1981:42). Average temperatures in the Torres Strait range from 23-29°C during the dry season and 26-31°C in the wet season (Bird 1996:36). Between the months of November and April northern Australia and the eastern Queensland coast are susceptible to the effects of tropical cyclones. These potentially destructive weather events can produce sustained high wind speeds, wave scouring of coasts, damage from wind borne debris, storm surge and torrential rain and flooding. Although tropical cyclones are very infrequent in southern New Guinea and the Torres Strait, wet season weather can bring persistent rain depressions, rough seas and sustained periods of high winds.

Geology, relief and broad vegetation patterns

From the West Papuan border (Irian Jaya) east to the Gulf of Papua and bordered in the north by the mountains of the Southern Highlands is a structural region commonly referred to as the Fly Platform (Loffler 1977:7). It encompasses the modern day Western Province of Papua New Guinea, the largest but most sparsely populated district in the country. Predominantly featureless, the coastal plain of the Oriomo Plateau is elevated to around 3m above sea level and is subject to seasonal and tidal flooding during the wet season and desiccated during the dry. Widely spaced and slow moving rivers including the Bensbach, Morehead, Pahoturi, Binaturi and Oriomo dissect the coast. Coastal waters are shallow and muddy and comprise a maze of swamps, mangroves, muddy tidal flats, and sand bars, connected by innumerable shifting channels, and occasional reefs (Knauff 1993:25). The mouths of the Fly and Bamu Rivers consist of numerous channels separating low islands that are predominantly uninhabited tidal swamps, which combined with muddy waters and floating debris, make river journeys difficult.

Soil along the Oriomo Plateau and the coastal plain is generally clayey and poorly drained, although some fertile soil exists along the narrow beach ridges and inland along rivers and swamps. Mangroves form the dominant vegetation along the muddy shores of the southwestern coast, while inland vegetation habitats include grasslands, open canopy woodlands and patches of rainforest and palm forests (Lawrence 1994:248).

The southwestern coast of New Guinea, the westernmost islands of the Torres Strait and the igneous and metamorphic rocks of Cape York Peninsula are composed of Carboniferous acid volcanic and granitic rocks, which form part of the north-northeast trending pre-Mesozoic ridge known as the Cape York-Oriomo Ridge (Willmott 1972; Willmott et al. 1973).

The Torres Strait is a 150km wide shelf, predominantly between 10-15m deep, and is scattered with more than 100 islands, coral reefs and cays between 141° 15' and 144° 20' E longitude and 9° 20' and 10° 45' S latitude (Figure 2.2). Around the Eastern Torres Strait islands water is deeper ranging from 20 to 40m. Several kilometers further east the Great Barrier Reef marks the edge of the continental shelf where slopes bottom out at a depth of 200m.

The Torres Strait islands are commonly divided into four bio-geographic groups (for both contemporary and alternative names for the Torres Strait Islands see Appendix A, contemporary names appear on Figure 2.2 and are used throughout this thesis). The Northern Islands consist of Boigu, Saibai and Dauan. Dauan is a high granitic rocky island with steep slopes similar to islands of the western group to the south. Vegetation on Dauan includes *Melaleuca* spp. open woodlands, low forests of *Acacia* spp. and wooded slopes of *Corymbia* spp.

Figure 2.2 Map of Torres Strait showing contemporary island names and language divisions

Saibai and Boigu are low islands, with extensive flat clay-band mangrove and brackish water freshwater swamps. These islands were formed by estuarine and mangrove sediments derived from rivers of the southern Papuan coast, and are ecologically and geologically similar to the adjacent Papuan coastline. Dominant vegetation units include closed forests of *Rhizophora* spp. along creek margins and grasslands with emergent *Pandanus* spp. on the more raised inland areas (Nelder 1998). In a recent biodiversity survey undertaken in the Torres Strait Boigu and Saibai recorded the lowest florisitic biodiversity relative to their extent (Neldner 1998:67). Although fish and crabs are plentiful, in comparison to the clearer waters to the south, turtles and dugongs are not as abundant around the northern islands, and reef growth is also inhibited.

The Central Islands, including Warraber, Yam, Puruma and Masig are either smaller, low rocky islands or low sandy cays formed by wave action over reef limestone. Water is scarce on these islands and overall they have a low floristic biodiversity. They are sparsely vegetated with some patches of mangroves, coarse tussock grasslands and low scrub and open shrublands. Beach ridges are characterised by open forests of *Casuarina* spp. and *Terminalia* spp., evergreen notophyll vine forests and groves of coconuts. These islands have extensive fringing reefs with an abundance of marine life.

The islands of Mer, Dauar, Waier, Ugar and Erub comprise the Eastern Islands. Most of these islands are relatively high, small in land area, and composed of volcanic tuffs and basaltic lavas. Soils are deeper and more fertile then in the Western Islands, and locally support dense complex mesophyll vine forest. In less sheltered areas on the high slopes thick grassland has mostly replaced semi-deciduous mesophyll/notophyll vine forests. Vegetation surveys have demonstrated the presence of a high number of alien taxa on the Eastern Islands, which has mostly been attributed to direct human influence through burning and gardening (Neldner 1998:3). Although dugongs are rare around the deeper waters of the Eastern Islands, extensive fringing reefs there support an abundance of marine life including fish, turtles, sharks and rays.

The Pre-Mesozoic Western Islands include the southern-most and largest islands of Muralag, Mua and Badu and to the north and east the much smaller islands of Mabuiag and Nagi. The larger islands are high with steep hill slopes and broad plains with poor clay based or sandy acidic soils. The dominant vegetation units on the Western Islands include stands of *Corymbia/ Eucalyptus* spp; open *Melaleuca* spp. woodlands, and areas of low trees and tall shrubs (Neldner 1998). Upper slopes and ridges are characterised by low open *Acacia* spp. forests with some islands also having sparse herbland within rock crevices where a depth of soil has accumulated. The Western Islands have the highest floristic diversity within the Torres Strait and also recorded the highest number of alien taxa. The high incidence of alien plant species has been interpreted as the result of mining and urbanisation (Neldner 1998:3). The Western Islands are surrounded by a diverse array mud and sand-flats, fringing reefs and mangroves, each contributing to the availability of a variety of marine life including turtle and dugong.

Located approximately 10 – 20km from the southern-most Torres Strait Islands and comprising the same lithology of sedimentary and conglomerate acid volcanic rock, the northern coast of Cape York Peninsula is a montage of high rocky headlands, extensive sandy beaches, mangroves and permanent freshwater springs and soaks. Vegetation is dominated by open schlerophyll forest (especially *Eucalypt* sp. and *Melaleuca* sp.), with occasional grassland, marsh country and patches of rainforest. Beyond the headlands the landscape is slightly elevated and is dominated by lowlands and foothills (Cofinas and Bolton 1995). Numerous tidal rivers and tributaries on the western, northern and central coasts dissect the entire Cape York region.

Most of the coastal and inland terrain of Cape York Peninsula is fairly similar, although along the eastern-central coast the Great Dividing Range and its associated uplands provide a clear physical contrast to the adjacent coastal plains and beaches. This region also generally receives a higher rainfall and has a less severe dry season than the rest of Cape York Peninsula. This has resulted in a greater diversity of vegetation communities, which vary from mountainous rainforests and open-canopy forests and woodlands along valleys to coastal heath, grassland, mangroves and saltpans (Harris 1977:429-430). Swamps of fresh or brackish water that occupy the narrow zone between the beach or rocky foreshore and the inland woodland communities are also common along the sandy beaches of eastern Cape York.

Terrestrial faunal diversity

In the same way that the vegetation communities of Cape York Peninsula and southern coastal New Guinea appear to have broad similarities, both the narrowness of the Torres Strait and the existence of islands within it have ensured that many faunal continuities also occur to the north and south. Barham and Harris (1983:537) explain that the close floral and faunal similarities on either side of the Torres Strait correlate with equivalent habits. Although New Guinea is recognised as considerably more 'species rich' than Australia, based on the ratio of land area to total number of indigenous species, many of the same species occur on both landmasses (Flannery 1995).

Mammals provide a good example of this faunal affinity, as several species belonging to each of the major families (including Macropods, Murids, Phalangerids and Burramyids) are endemic to southern New Guinea and north-eastern Australia (Flannery 1995). Murids (rats, mice and *Melomys*) and Pteteropoids (bats) are the two families with the highest number of species recorded both to the south and north of the Torres Strait. However, just as the distribution of mammals throughout New Guinea demonstrates the relative faunal poverty of the southern coastal and woodland regions, a similar scenario is also the case for the rainforests of Cape York. Based on such evidence it is clear that the recent formation of the Torres Strait Islands has played only a minor role as a marine barrier between two evolving regional faunas. Barham and Harris (1983:537) suggest that the main effect of the Torres Strait has been 'to attenuate faunal diversity northward in woodland habitats, and southward in rain-forest habitats, rather than to create a sharp faunal boundary between Papua and Cape York Peninsula'.

The faunal diversity of Torres Strait has not been subject to the intensity of research that has been undertaken on mainland Australian and New Guinea fauna. However, recent biodiversity studies undertaken in the region combined with information recorded during the historical period, provide a basis for a broad review of the terrestrial fauna of Torres Strait.
A recent synthesis of terrestrial mammals, reptiles and amphibians in Torres Strait has recently been compiled from such data (McNiven and Hitchcock 2004). Their analysis has illustrated that a total of 297 terrestrial mammals, reptiles and amphibians are present throughout the Papuan Trans-Fly region, Torres Strait and Cape York (McNiven and Hitchcock 2004:106-107, Table 1). Of this total, 80 species occur on the Torres Strait islands, while 188 and 189 species are identified from the adjacent regions of New Guinea and Australia respectively. This result reflects earlier research, which demonstrated that very few native species are known to occur on the Torres Strait islands (Freebody 2002:17). Native rodents including *Melomys*, *Rattus* and *Hydromys* species probably dominate the mammal population. Nineteen species of bats have been recorded from nine of the islands, predominantly from the southern group including Muralag, Wayben and Mua islands (Freebody 2002:17). Friday Island, located near Cape York Peninsula, has the only known population of Agile wallabies (*Macropus agilis*) in the Torres Strait (Cameron et al. 1978), although Warham (1962) recorded Agile wallabies on Mai Island near Albany Island in 1958 (see Figure 2.2). The presence of a possible *Phalanger* sp. on Mer was recorded by Jukes (1847 I:49), who observed a small animal in a cage which he later identified as a cuscus, suggesting that ‘the Torres Strait Islanders occasionally procure them from New Guinea’.

The goanna (*Varanus* sp.) is perhaps the most common large reptile throughout the islands, and several other smaller species of ground dwelling lizards and also snakes have been recorded (Cameron et al. 1978). Although an apparent total of 62 land species of reptiles and frogs have been recorded in the Torres Strait, expanses of seawater are considered as major barriers to the dispersal of these groups as their distribution is largely dependent on previous land connections (Freebody 2002:18).

The Torres Strait acts as a major migratory pathway for birds between the Indian and Pacific Oceans: 50% of the 243 coastal and offshore birds recorded in the Torres Strait are classed as migratory (Draffen et al. 1983). However, the majority of bird species identified on the Western Islands are described as sedentary species that have a limited ability to cross water (Draffen et al. 1983). Among these species are the mound-building scrub fowl (*Megapodius freycinet*) and the brush turkey (*Alectura lathami*). The most abundant birds throughout the entire Torres Strait are sea birds, such as Noddies (*Anous* spp.) and Terns (*Sterna* spp.), which also produce large rookeries on sandy cays. As well as the geographical position of an island affecting the assemblage of bird fauna present, it is also inferred that the number of birds on any island is generally proportional to the degree of its botanical diversity rather than the land area of the island (Draffen et al. 1983). Of the terrestrial birds, however, one of the most widespread and commonly consumed species was the Torres Strait pigeon (*Ducula spilorrhoa*) (McNiven and Hitchcock 2004:107).

Several introduced mammal species occur on the Western Islands and include the Rusa Deer (*Cervus timorensis*), horses (*Equus caballus*), pigs (*Sus scrofa*), goats (*Capra hircus*) and cattle (*Bos* spp.). Today domestic and feral pigs, dogs (*Canis familiaris*) and cats (*Felis catus*) are found throughout the Torres Strait on most of the permanently inhabited islands. Historical records indicate some uncertainty as to when these species first appeared in Torres Strait. In the case of pigs, it was also undecided whether the animals observed were New Guinea pigs or the recently introduced European pigs (Brockett 1836:25; Haddon 1912:152). Several historic references to Murray Islanders obtaining dogs from the north coast of 'New Holland' are recorded, suggesting that the importation of dogs from northern Australia and their presence in the Eastern Islands may have been common prior to European contact (Jukes 1847 I:180, King 1983:56 and Rutherford 1833 in Haddon 1935:97).

Summary

From the preceding broad environmental description of southern coastal New Guinea, the Torres Strait islands and Cape York Peninsula two major themes are evident. The first is the wide scale similarity in climate, geology and biodiversity running across Torres Strait and encompassing the northern and southern regions of the adjacent mainlands. Although mammals are largely absent on the Torres Strait islands, the distribution of similar mammal species in regions on the adjacent mainlands also confirms their past palaeogeographic linkages. The second theme is in distinct contrast to these unifying similarities for southern coastal New Guinea and Cape York, and recognises the variability between the Torres Strait Islands demonstrated by geology, topography and vegetation. Unlike southern New Guinea and Cape York Peninsula where the landscape forms the dominant environmental backdrop, however, the Torres Strait islands (comprising a total land area of less than 1000km^2) exist within a vast and complex seascape of coral reefs, cays, tidal currents and marine habitats. The following section provides an environmental background to the development of the Torres Strait seascape and includes both broad regionally based data and data that are relevant to specific islands and islands groups.

The Torres Strait Seascape

The timing of the flooding of the Torresian Plain by around 6500 yrs BP and our wider understanding of Holocene sea level change along the Australian coast has been established for some time (for example Jennings 1972b; Carter and Johnson 1986; Chappell et al. 1983; Lambeck and Nakada 1990; Thom and Chappell 1975). In contrast, the formation and development of the coral reefs within the Torres Strait and our knowledge of the areas marine palaeoecology has only recently been investigated (Barham 1999, 2000; Harris 1995; Woodroffe et al. 2000). The results of this research now allows a comprehensive description of the marine environment of the Torres Strait including information on the timing and nature of reef development, intertidal zone formation, marine resource availability and development of prograded beach environments. Based on several years of data collection and investigation, Barham's (2000) recent synthesis in particular provides a first critical insight into the implications of reef development and beach formation for the timing of human occupation and availability of marine biotypes in the Torres Strait. This will be discussed later, after a more general overview of reef and marine development in the region.

Reef development, resource availability and beach formation

Reef growth is prolific within the Torres Strait, occurring as both fringing coral reefs and as elongate reef platforms, although it is restricted around the northern islands by sediment influx from the Fly Estuary (Woodroffe et al. 2000:332). As the Torres Strait forms a tidal buffer zone between the Coral Sea to the east and the Arafura sea to the west, reef morphology and distribution patterns of sediments are determined by the predominantly east-west axis of tidal and wind driven currents (Harris 1995:151) (Figure 2.3).

Recent investigations of reef growth on the Central Islands of Yam and Warraber and Hammond Island to the south have established that reef colonisation occurred very soon after inundation during the Holocene transgression (Woodroffe et al. 2000). Mid-Holocene emergent reefs were identified on each of the islands and it was concluded that 'extensive reefs with a general morphology similar to the modern reefs existed around 5000 years ago when sea level was about 1m higher than present' (Woodroffe et al. 2000:343). Coring of reef deposits on Yam and Warraber demonstrated that reefs are located over Pleistocene reef limestone remnants, while reef at Hammond Island had built up over non-carbonate bedrock outcrops. Mapping of emergent Holocene microatolls of *Porites* sp. coral heads also indicated that reef growth has prograded seawards with the progressive lowering of sea levels during the last 5000 – 6000 years.

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Figure 2.3 Map of Torres Strait reef morphology
(after Barham and Harris 1983:532)

Barham (2000: 283) has shown that the contemporary patterning of fringing reef ecology and development observed in the Western and Eastern islands is of late Holocene age. The presence of residual fossil structures of *Porites* sp. coral colonies on Mua, Badu and Mer confirm that coral reef growth has prograded seawards and was located much closer inshore during the early Holocene (Plate 2.1). Although radiocarbon dating of these microatolls indicated significant in-shore coral growth occurred at a period of maximum sea level around 6500 to 4000 yrs BP, Barham (2000:284) concluded that fringing reefs around the high islands of the Torres Strait in this period would have been quite unlike present reefs. He suggests that early near-shore coral growth took place primarily as isolated colonial ‘bommies’ within deep subtidal pools and lagoons, resulting in minimal intertidal reef flat while the reef edge was developing (Barham 2000:284). At this time near shore resources would have been limited to rocky foreshore and live subtidal lagoonal types, and higher wave energy conditions during storms and high tides would have prevailed (Barham 2000:284). On Mer and Dauar geomorphological evidence for these conditions is displayed as erosional notches in the soft volcanic lithology (visible in the headland in the mid-background of Plate 2.1).

Plate 2.1 Location of fossil *Porities* coral on Dauar Island

Barham (2000) has concluded that this early type of reef morphology would have meant limited sediment availability for reef flat infilling and near shore sediment accumulation. He suggests that the result of such delayed sedimentation ‘was that development of fringing reefs in Torres Strait, and reef biotypes, lagged significantly behind the approximation of modern shorelines by marine transgression’ (Barham 2000:285). Barham estimates at least a 2000 – 3000 year time lag following shoreline transgression at 6000 yrs BP, before the completion of significant platform reef development (2000:285). Although based on limited data, he also projects a delay in the development of inter-reef sea-grass areas comparable with the present day habitats, and which could not have sustained large turtle and dugong populations prior to 4000 – 3000 yrs BP (Barham 2000:287).

Coring of mangrove facies on Mua and Saibai have demonstrated the presence of inland mangrove communities by 6000 yrs BP (Barham 1999; Budworth and Barham 1987). The Saibai evidence indicates that after 3000 yrs BP mangrove communities were restricted to the coastal fringes, as sedge communities colonised the interior of the island (Barham 1999). However, Barham (2000:288) suggests that from at least 4000 yrs BP onwards mangrove resources, including shellfish and crab communities, were available 'in those areas where mangroves are known to have been a significant component of either archaeologically or ethnohistorically reconstructed past diet', and that the mangrove biotype was probably ubiquitous along the shorelines of many of the larger islands from 7000 yrs BP.

Barham (2000:289) has also demonstrated that fringing reef development and stabilisation of intertidal reef flat surfaces had a direct influence on the onset of beach formation and the development of prograded beach environments in the Torres Strait. On the higher Torres Strait Islands, these beach environments appear to have been favored sites for seasonal camps. Uncorrected radiocarbon dates from Dauar and Nagi suggest that beach formation and the long-term storage of beach sediment in prograded beach units commenced around 3500 – 3000 yrs BP. After this time most fringing reefs had developed and infilled enough to act as a zone of sediment transfer rather than the sediment 'sinks' formed by the fringing lagoonal topography prior to 4000 to 3000 years ago. As Barham (2000:289) explains, the development of fringing reefs 'resulted in commencement of net onshore sediment flux to form beaches, and a probable increase in intertidal sediment accretion overlying reef, (such as carbonate muds and sands supporting sea grass) from c. 3500 BP onwards'.

Summary and implications for human occupation of Torres Strait

Barham's (1999:291-293, Table 1) broad model of Holocene shoreline changes on the Torres Strait islands has a number of implications for human occupation and coastal biotype resource availability. Underlying this model is the rationale that from the time of marine transgression and the establishment of modern shoreline configurations around 7500 yrs BP, human occupation of the Torres Strait islands would have been subject to a variety of ecological constraints (Barham 2000:290).

The apparent 2000 – 3000 year delay in reef flat and platform reef development following marine transgression is regarded as the most significant of these ecological constraints (Barham 2000:290). Barham estimates that 'reefal areas comparable to those of the present day were only achieved some time after 4000 BP' (2000:290). Resource availability was not entirely restricted before this time, however, as partially developed inshore reefs and rocky shoreline biotypes would have provided suitable habitats for exploitable fish and mollusc species. Similarly, protein sources such as turtle and dugong may have been widely available around the shores of the larger islands from as early as 4000 yrs BP. However, Barham (2000) notes that during the early lagoonal phase of reef development the construction of the large stone fish traps seen around the shores of each of the Eastern Islands today, would have been both difficult and less practicable. Only after coral-algae cementation of the reef, which occurred by around 3500 yrs BP due to increased sediment availability, would the construction of fish traps have been possible. In turn the construction of the fish traps themselves served to break onshore wave energy and to promote sedimentation and sea grass colonisation (Barham 2000:294).

From his assessment of Holocene palaeogeographic changes and of coastal and littoral biotype development in the Torres Strait Barham (2000:295) concludes that:

> successful maritime exploitation of coastal resources (using the techniques and strategies documented ethnohistorically for Torres Strait) would have been feasible from c. 4500 BP onwards, *if* the methods used in prehistory were comparable with those established for the ethnohistoric period.

The purpose of the above section has been to provide an environmental framework for the emergence of the Torres Strait Cultural Complex. This information combined with the recent data on the development of the Torres Strait seascape has provided a chronological backdrop for the emergence of reef flats and associated resource zones and development of coastal occupation sites. The following section provides a discussion of the cultural context of the Torres Strait Cultural Complex largely based on historical documentary narratives and late 19th century ethnographies.

The Cultural Setting

> The immediate sphere of operation and influence of the Torres Strait Cultural Complex in the mid-nineteenth century….is defined by the area of which indigenous Torres Strait Islanders are known to have traded or voyaged in search of resources, by demonstrated intermittent contact or reciprocal exchange as defined through warfare, kinship and marriage, and by commonality of myths and beliefs…(Barham 2000:227-228)

The picture of traditional life in the Torres Strait and of the extended cultural complex in which the islands and their occupants were involved has been constructed from a variety of documentary sources. These include the initial observations of European maritime voyagers during the 18th century and the more detailed accounts made by the learned occupants of sailing vessels during 19th century. Knowledge of traditional practices in the region during this period is further enhanced by the published records of European missionaries appointed throughout the islands and the southern coast of New Guinea. However, it is from the ethnographies recorded at the turn of the 20th century that most information about traditional culture and customs of Torres Strait Islanders, and also the coastal Papuans is obtained.

Almost three decades prior to the Cambridge Anthropological Expedition in 1898, however, the Torres Strait had become the base of lucrative international markets in pearl shell and beche-de-mer and was increasingly populated by Japanese, South Sea Islander and European divers and traders (Beckett 1987; Singe 1979). By the beginning of the 20th century the Queensland Government had also taken administrative control of the Torres Strait, and the London Missionary Society had established permanent presence throughout the region. Thus the historical circumstances in which the Cambridge Expedition was undertaken begs the question of how accurately the records of Haddon and his colleagues portray pre-19th century customs and way of life in Torres Strait in general, especially given the apparent biases in the documentary records towards certain islands. This issue is addressed in the latter half of this chapter. Although some background details from the Eastern Islands ethnographies are provided in this chapter, more detailed information about the Murray Islands, including subsistence and trade and exchange is provided in Chapter 4.

Cape York and Western Torres Strait

For Cape York Peninsula and the adjacent Torres Strait islands numerous narrative and ethnographic records exist. A source of particular interest is the journal of O.W. Brierly, an artist on board the HMS *Rattlesnake* during its surveying expedition around northern Australia and New Guinea (Brierly 1848-1850 in Moore 1979). In addition to the detailed observations of mainland Aboriginal groups, Brierly produced a remarkable ethnographic reconstruction of traditional life on Muralag (Prince of Wales Island) based on his interviews with shipwreck survivor Barbara Thompson. As a young Scottish girl she had been the sole survivor of the *Charles Eaton* after it wrecked off the northern coast of Cape York in 1844. She lived with the inhabitants of Muralag until her rescue during the *Rattlesnake* voyage in October 1849. Another major source of information for the western Torres Strait and Cape York is the journal of John MacGillivray (1852 II) who was the zoologist on board the *Rattlesnake*.

Territory and language

The traditional territory of the Cape York Aboriginals, who comprise a number of language groups, extends along the eastern coast to Princess Charlotte Bay and as far as Mapoon along the western coast (see Figure 2.2). Four main Cape York tribes were identified by early observers, amongst whom the Gudang, whose territory extended from Cape York to Fly Point, generally had the most contact with Western Torres Strait Islanders (Jardine 1866; MacGillivray 1852 II; Moore 1979). The languages and dialects spoken by northern Cape York groups are believed to have originated from an Australian mother language called Proto-Northern Paman (Hale 1964 cited in Sharp 1992:13). However, Wurm (1972:355) identified that out of twelve Cape York language groups, four had phonological structures indicative of external Papuan linguistic influence. Known as *Kalaw Lagaw Ya*, the language spoken by the occupants of the Western Torres Strait Islands is phonologically distinct from, but closely related to the Pama Nyungan languages of Cape York (Wurm 1972:349).

According to Brierly (cited in Moore 1979:171) the inhabitants of the western Torres Strait Islands, including Muralag, Mua, Badu and Mabuiag were aware that their islands were located between two larger land areas. Although there is some variation on the spelling of these names throughout the historical literature, Brierly (cited in Moore 1979:210) refers to them as *Mugee Daudthee* for New Guinea, and *Kyiee Daudthee* for Australia. The documentary records indicate that the Kaurareg, the traditional inhabitants of Prince of Wales Island group (for which most information is recorded) and other groups in Western Torres Strait regularly sailed between their islands and adjoining reefs, and regularly visited Cape York where they set up transitory camps. Barbara Thompson recalled such activity:

> After the Badus went away, the Kulkalagas came over. They had at least a dozen canoes. The beach was quite full of them. I should think that at least 300 people came over. They brought all of them, old people and women and children with them and left no one but

> Quiqui, who they thought was drowned upon their island. I think they stopped for about two months (Moore 1979:203).

Although most interactions between Western Islanders and groups from Cape York were friendly and involved trade, resource procurement and even intermarriage, some hostile relations were recorded. Barbara Thompson recalled raids on the Muralag people by certain Cape York groups and also periods of ill feeling of the Muralag against Mua and Badu, brought about by theft and an attempt of her own kidnapping respectively (Moore 1979:307).

Social organisation and mythology

For Cape York tribes and the islanders of Western Torres Strait the basic social unit appeared to be the extended family, further characterised by ‘an exogamous totemic system with territorial attachment, minimal political control by consultation between prominent men and cooperative secret ceremonies for initiation’ (Moore 1979:329).

In terms of mythology, ceremony, magic and initiation, many parallels between the Cape York tribes and Kaurareg of Western Torres Strait were also recorded. Of particular interest was the widespread tradition of cult heroes, such as *Kwioam*, the fierce and mythical Aboriginal warrior (Haddon 1904:67-83). It was suggested that the widespread celebration of the Aboriginal warrior myth may have been the result of an attempt in the past of a northward invasion from the mainland (Haddon 1904:79-80). The *Kwioam* myth was recorded throughout coastal Cape York, Mua, Badu and Mabuiag as well as at Mawatta on the southwestern Papuan coast (Landtman 1917). Sharp (1992:14) suggests the myth of the Aboriginal warrior hero ‘links mainlanders with the Islanders and beyond the Torres Strait to Kiwai and Tugeri country of the land mass to the north they know as Mugie Dudai (the island of New Guinea)’. The warrior hero Siverri, equipped with bows and arrows, a drum and a dugout canoe, provides another example of a western Cape York and Torres Strait culture hero similar to those of the southern Papuan coast (Trezise 1969:11).

Subsistence

The natural resource suites and overall subsistence patterns of the Kauarag were similar to the mainland Cape York groups. During the dry southeast season both groups depended on wild yams, *koti*, and turtle, *waruu*, and to a lesser extent fish, shellfish and other plant foods including fruits and nuts that were in season. Wild yams grew prolifically in high rocky places on the Western Islands, on Mt Adolphus Island (Muri) and in littoral thickets on the mainland. Both groups also used Mt Adolphus during the northwest monsoon season when the food situation was much less favorable. During this time the main staple was a grey paste made from mangrove pods, *buyi*, as well as mangrove and rock oysters and fish and turtle caught offshore.

Spearing was the most common method of obtaining fish, which in the Western Torres Strait was done usually with a multi-pronged wooden spear (Haddon 1935:157). Spearfishing was usually carried out by men, whereas line fishing was often undertaken by women (Moore 1979:272). Hooks made from turtle shell and lines made of coconut fiber were used for this purpose. Barbara Thompson also describes a method used by the Kaurareg to trap fish in the mouths of creeks using mats and branches (Moore 1979:272). Although she claimed that the Kaurareg had no fishing nets, she mentioned that some of the islanders did use them.

Documentary records indicate that a form of plant management of key species, such as yams, was a common practice on the northern Australian mainland and the adjacent Torres Strait islands. Interestingly, Beckett (1972:342) notes that Barbara Thompson's description of the preparation and planting of wild yams species on Muralag may have been due to the circumstances of the two previous years, during which no turtles had been captured. This was in comparison to the season three years previously when she claimed that 300 turtles were captured. There is also the suggestion that yams were generally planted as a back up, in case wild yams failed or were low in numbers. Barbara Thompson's testimony also indicates that sugarcane was often planted on Muralag, having been brought from nearby Nagi (Moore 1979:203).

Brierly (cited in Moore 1979) recorded three different techniques for capturing turtle among the Kaurareg. The most common method was the use of a sucker fish, *gapoo*, which was used to secure a line to turtle which was then easily pursued by a man after jumping from a canoe into the water (Moore 1979:168). This was the method most commonly used for the capture of the flatback turtle (*Chelonia depressa*) whereas green turtles (*Chelonia mydas*), most plentiful during the months of September and October before the wet season, were caught in the water by a man simply jumping in after them. Due to the sharp edge of their shell, hawksbill turtles (*Eretmochelys imbricata*) were often caught on the beaches at night, while they laid their eggs, by simply being turned over on to their backs. Hunting of dugong was accomplished by the use of a large spear with an attached harpoon head, *wap*, was thrust into the animal as a man jumped from a canoe into the water. The harpoon detached itself from the pole letting out a line curled up in the bottom of the canoe (Moore 1979:162). Once dead the dugong was hauled into the nearest beach and sliced into portions and cooked in earth ovens.

The method of cooking commonly observed by Brierly (cited in Moore 1979:108, 200) among Cape York Aborigines and the adjacent Torres Strait Islands was the earth oven or *ami*. This technique was used to cook turtles and also vegetable foods, including yams and mangrove pods:

> Stones are spread over the bottom of it, shallow with sloping sides, and upon this a fire is made and a number of stones put into it. When the stones are thoroughly heated, the fire is taken out from amongst them, the heated stones being left in the pit. The sloping sides of the pit are now lined with bark of tea-tree which is laid all round against the sand. Over the bottom of the pit they lay some of the strong coarse grass, not very dry grass, but moderately so. The *amis* will vary in size (Brierly cited in Moore 1979:169).

Turtle meat and yams was also prepared by boiling in large conch shells (*Syrinx aruanus*) or baler shells (*Melo* sp.), although this method was mostly used when the time of day or rain prevented the construction of an earth oven (Moore 1979:172, 277). Barbara Thompson also recalled that on several of the islands in Western Torres Strait turtle meat was dried and was often carried in canoes as food during voyages (Moore 1979:172).

As terrestrial animals and birds, including wallabies, kangaroos, cuscuses, goannas, cassowaries, brush turkey and scrub fowl were more common on the Australian mainland than on the islands of the Prince of Wales group, these terrestrial resources probably contributed considerably less protein to the Kaurareg diet than they did for the mainland Gudang people (Harris 1977:438). Thus, as Moore (1979:276) suggests, although the latter group may have been better off during the wet season, the Kaurareg 'with the more efficient marine technology, had an ample and extensive diet during the south-east season'

<u>Canoes and trade</u>

From early documentary accounts it is clear that the distribution of outrigger dugout canoes was seen as a crucial technological element in linking the Western islands of Torres Strait, Cape York and southern New Guinea (Sweatman in Allen and Corris 1977:33-36; Brockett 1836; King 1837; MacGillivray 1852 II:4). Early observations in northern Queensland indicate that both single and double outrigger dugout canoes were used along the western and eastern coasts of Cape York (Roth 1908, 1910).

Rowland (1987) has illustrated that observations made during early European voyages confirm the use of single outrigger canoes as far south the Whitsunday Islands. Evidence suggests that single outrigger canoes were manufactured by groups at Cape York and as far south as Princess Charlotte Bay (Haddon and Hornell 1975:191; Thompson 1934:232) (Figure 2.4).

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Figure 2.4 Map of the distribution of double-outrigger canoes (after Barham 2000:229)

The southern distribution of the larger double outrigger canoes was more limited, with vessels observed as far south as the Endeavour River on the eastern coast of Cape York and to Archer River on the western coast (Roth 1908, 1910; Brockett 1836; Jukes 1847 I; MacGillivray 1852 II). The large hulls of the double outrigger canoes were manufactured within the vicinity of the mouth of the Fly Estuary (Beardmore 1890:459; Chalmers 1903:123; Haddon 1904:296-297) (Figure 2.4). Early observations of double outrigger canoes highlights the regional differences of these vessels:

> The same kind of canoe which is found throughout Torres Strait has been seen to extend from Cape York along the eastern coast as far as Fitzroy Island, a distance of 500 miles. It essentially consists of a hollowed-out log, a central platform, and an outrigger on each side. The largest canoes which I have seen are those of the Murray and Darnley Islanders, occasionally as much as sixty feet long, those of the Australians are small, varying at Cape York between fifteen and thirty feet in length (MacGillivray 1852 II:15).

In the Western Torres Strait canoes were obtained from New Guinea through a trade network that ran via Mua or perhaps directly to Badu. The network then continued via Mabuiag, to Saibai, Mawatta and along the coast to the Fly (Moore 1979:303).

Along with canoes, items traded southwards included shells particularly Cone shell (*Conus* sp.), cassowary and bird-of-paradise feathers, stone clubs and bamboo tobacco pipes. Goods traded northwards included ochre spears and spear throwers from the mainland, and pearlshell (*Pinctada margiferita*). Many items were also traded within the Western Islands themselves including bamboo water carriers, pipes and knives, shell ornaments and coconut fiber fishing line.

As Moore (1979:303-306) suggests, it is clear from Barbara Thompson's recollections of constant visits to Muralag by canoes full of people from Nagir, Mua and Badu and less frequently from Mabuiag, Saibai and Yorke, that the continual movements of these groups assisted in the trade and exchange of goods throughout the Western Torres Strait and Cape York (1979:303-306). However, intermarriage no doubt also facilitated cultural and social interactions amongst islanders and mainland Aboriginal groups (Moore 1972:337-339).

The Insular Island Core of Torres Strait

Language

First detailed by Haddon (1935:289), one of the most distinguishing features between the Western and Eastern Islands of Torres Strait, was language. Sweatman (cited in Allen and Corris 1977:23) noted that the language spoken on York Island was distinct from the Eastern Islands language, and appeared 'to bear a greater affinity to Cape York'. As previously mentioned, Kala Lagaw Ya was spoken throughout Western Islands and is the dominant language in Torres Strait, although dialectical variants of it occur in the Central and Northern Islands (Shnukul 1998) (Figure 2.2). Previously referred to as Mabuiag, today these dialects are collectively known as the Western-Central Language (WCL) and, although they are related to the Pama Nyungan languages of Cape York, they also have a strong Papuan influence (Shnukul 1998; Wurm 1972:349).

The language spoken in the Eastern Islands is structurally a Papuan (non-Austronesian) language and belongs to the Eastern Trans-Fly Family (Wurm 1972:349; Lawrence 1994:250) (Figure 2.2). Known as Meriam Mir, this language closely resembles the Bine, Gidra and Gizra languages of the southern New Guinea coast and is further unique in its adoption of some southern New Guinea Kiwai language features (Lawrence 1994). Wurm's (1972) broad linguistic analysis of Torres Strait languages demonstrated that although there was some Australian influence on Meriam Mir, this was negligible in contrast to the strong Papuan influence on Mabuiag.

Architecture

The more sedentary mode of life observed in the Eastern Torres Strait, particularly when compared to the mobile nature of groups in the Western Islands closest to Cape York, is shown by the descriptions of traditional housing throughout the Torres Strait. On Mer, Jukes (1847 I:197) observed that the whole shore ‘was lined with a continuous row of houses, each in a small court-yard of from ten to twenty yards’. In comparison, housing in the Western Islands took on the form of temporary tent-like shelters that were constructed from an array of available materials including pandanus mats, saplings, branches, standing trees, and also paddles and oars from canoes (MacGillivray 1852 II:19; Moore 1979:283). Some of these shelters were quite large, however, such as the ‘long hut’ described by Barbara Thompson (Brierly 1849:155-156 in Moore 1979). In general, ehthnographic records indicate that housing used in the Western Islands was much less substantial than that observed throughout other parts of the Torres Strait (Murray 1874:37; Jukes 1847 I:132). Melville (cited in Haddon 1912:93) the artist on board the HMS *Bramble* and HMS *Fly*, also noted ‘a gradual improvement’ in housing along a northward gradient across the Torres Strait.

On Nagi MacGillivray (1845 II:35) described a village consisting ‘of a single line of huts, which probably would furnish accommodation for, probably, 150 people’. These huts were long and narrow with a framework of bamboo and thatched grass roofs, and were also fenced with a roofed enclosure where cooking usually took place (Figure 2.5). Jukes (1847 I:167) observed well-constructed huts on Yam Island that had gabled roofs of palm leaves and grass thatch and walls made from closely fastened bamboo sticks. Away from the main village on Yam he also observed a single beehive shaped hut which he recognised as the type of house built in the Eastern Islands, and which he interpreted ‘had either been erected in imitation of them, or by some people of those places when on a visit to Masseed’ (Jukes 1847 I:168). On Dauan and Saibai, houses were observed built on stakes eight to ten feet off the ground (Moresby 1876:133; Murray 1876:456 cited in Haddon 1912:99). These were constructed of bamboo, thatched grass roofs and walls of pandanus leafs.

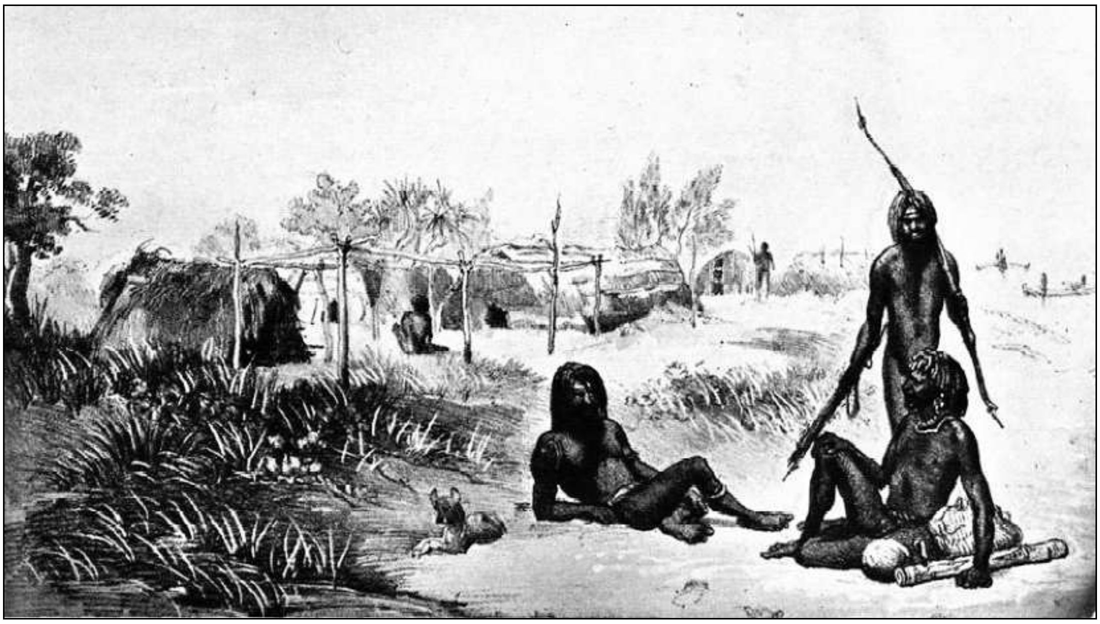

Figure 2.5 Village on Nagi (Melville 1849: plate XVI)

Material culture

Barham (2000:233) points out 'in terms of material culture, the core area of the Torres Strait Cultural Complex exhibited strong affinities with Papua, rather than Cape York'. In the context of personal body ornaments, Haddon (1935:296) suggests that nearly all items:

> …such as plaited or twisted necklaces and arm- and leg-bands, were made locally and appear to be common to all the islands, yet most of them can be matched with those made by the Western Papuans and often with those from other parts of New Guinea.

Body ornaments include headdresses and headbands, nose and ear ornaments, necklaces, shell and bone pendants, belts, armlets and leglets (Figure 2.6). Rope or string was commonly made from either twisted coconut fibre, plaited strips of rattan or bamboo rind. The decorative components of headgear often included feathers and shaped pieces of shell. Pendants were made from various shell species, including the highly prized Cone shell, *dibidibi*, as well as Pearl shell and Baler shell. Rounded boar tusk pendants, *sauad*, were imported from New Guinea and were of great value. In Torres Strait imitation boar tusk pendants were made from *Trochus niloticus* shell, *nasir sauad* (Haddon 1912:51). This species was also used to make arm rings, although throughout Torres

Strait Cone shell arm rings, *wauri*, were the most precious (Haddon 1912:55-56) (Figure 2.6).

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Figure 2.6 From left: Shell pendants, cone shell arm ring (*wauri*), cone shell pendant (*dibidibi*) (Haddon 1912: 47, 236, 44)

Domestic items and tools included shells, such as the large Trumpet and Baler species, which were used for carrying water and for boiling food. Large *Tridacna* spp. clams were also commonly placed at the base of trees as a water collection device. Coconut shell and lengths of bamboo were also widely used as water storage and drinking vessels. Stones and wooden mortar and pestles were used as pounders to soften food. The shells of several bivalve species including *Cyrena*, *Tellina* and *Asaphis*, were used for cutting and scraping. Turtle shell was often shaped into scrapers, while imported cassowary bones from New Guinea were commonly used as coconut huskers. Bamboo knives were mostly used to cut the meat of turtle and dugong. Haddon (1912:125-126; 1935:302) stated that adzes were unknown in Torres Strait, and he only recorded *Tridacna* shell axes on Mer and Badu. Although he failed to record any stone axes, Haddon (1935:302) thought it probable that they were also made. Given McFarlane's (1888) remark that 'the old stone and clam-shell axes have given way to 'white man' goods, as have the bamboo knives and big bailer shell which duty as saucepans', limited observations of shell and stone axes throughout Torres Strait are understandable. In relation to horticultural subsistence, the pointed digging stick appeared to constitute the entire cultivation tool kit (Haddon 1912:144).

Weaponry employed in the Torres Strait consisted of the bow and arrow and a stone-headed club called *gabagaba*. Referred to by Williams (1936:266) as 'the weapon par excellence of the raider', *gabagaba* were using during inter-island feuding and fights between islanders and neighbouring Papuans. They consisted of a shaped stone head attached to a wooden handle that was often decorated with plaited rattan or beads. Handles varied in length from around 38 cm to as long as 1m (Haddon 1912:191) (Figure 2.7). The shape of the stone heads have a variety of forms, including unflanged knobbed clubs, triangular, rectangular, flattened ball, ovoid, flanged star, flanged disc, and knobbed (Haddon 1912:190). Haddon (1912:191) also drew attention to similar forms of stone clubs observed in New Guinea, and suggested that 'owing to the absence of suitable rock the mainlanders, like many of the islanders, must have obtained their weapons by trade or loot'. *Gabagaba* also played an important ceremonial role in some contexts throughout Torres Strait. On Mer in particular, four rayed *gabagaba* known as *seuriseuri* were used in dances and for cermonial purposes (Haddon 1912:192; McNiven 1998; Wilson 1993:154).

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Figure 2.7 Top: stone headed club (*gabagaba),*
Bottom: ceremonial stone club (*seuri seuri*) (Wilson 1988:82)

Subsistence

The subsistence economy of the Torres Strait is characterised by a high degree of dependence on marine resources, but also by a varying reliance across the Strait on cultivated species and other available plant foods. Jukes (1847 I:25) provides a description of the varying levels of horticultural production and reliance on plants foods throughout Torres Strait:

> A great variety of yam-like tubers are cultivated in Torres Strait. Although on Murray and Darnley and other thickly peopled and fertile islands a considerable extent of land in small patches has been brought under cultivation, at the Prince of Wales Islands the cleared spots are far and few in number and of small extent – nor does the latter group naturally produce cocoa-nut or bamboo, or is the culture of banana attempted. On the mainland again I never saw the slightest attempt at gardening.

On Mabuiag and Nagi small areas of cultivated land were observed, although such areas were minimal in scale compared to the extent and organisation of the gardens on Mer (Wilkin cited in Haddon 1912:149). On Nagi MacGillivray (1852 II:36) recorded the cultivation of a broad-leafed species of yam (*Dioscorea* sp.), as well as a species of 'Calladium' with an esculent root that was planted in regular rows of mounded earth (almost certainly Taro, *Colocasia esculenta*). While visiting Dauan in 1873 Moresby (1876:132) observed '…some fine patches of grassy land, well supplied with fresh water, and a richly cultivated valley, producing taro and melons'. At the time of European contact the knowledge of the processing of imported plant foods from New Guinea, such as sago (*Metroxylon* spp.), had extended to Mer, as well as Nagi and further south to Muralag (MacGillivray 1852 II:62).

The vast majority of information on horticulture in the Torres Strait, including types of plant cultivars, methods and seasonality of planting, associated technologies and ceremonial practices, was recorded from the Eastern Islands, and Mer in particular (Haddon 1912:144-151). Such information mostly refers to the common tuberous species of yams and sweet potatoes (*Ipomoea* spp.), and bananas (*Musa* spp.) and coconut (*Cocos nucifera*). However, Haddon (1912:136) did suggest that on Mer the consumption of rhizomes and aroids was more common in the past compared to the late 19th and early 20th centuries. He further suggested that tales and legends associated with such items 'may date back to a time before the cultivation of yams and sweet-potatoes, when the islanders were merely collectors of food' (Haddon 1912:136). Further discussion on the horticultural economy of the Murray Islands is provided in Chapter 4.

Records of the terrestrial faunal subsistence economy within the Torres Strait are limited, particularly for the Central, Eastern and Northern Islands. As Haddon (1912:152) suggests, this is perhaps a reflection of the absence of mammals in the Torres Strait. Information on terrestrial resources is therefore mostly limited to the capture of birds. The species captured varied on an island to island basis, and was seasonal depending on migration paths and periods. Birds were caught predominantly to be eaten, but sometimes also for their plumage (Haddon 1912:153). Various methods were used in their capture including snares, line and bait and airborne missiles.

Descriptions of marine based-subsistence activities throughout the Torres Strait at the time of European contact focus on turtle and dugong capture. Haddon (1912:159) described two turtle hunting seasons; one during the mating season when turtles floating on top of the water were easy prey, and a second extending throughout the remainder of the year when turtles inhabited the deeper waters around offshore reefs. Three major species were recorded throughout the Torres Strait, their distribution varying throughout the region. The Hawksbill turtle (*Eretmochelys imbricata*) was most common around the Western Islands and on the coast of Cape York, and was also the species from which turtle shell for trade was obtained. The Loggerhead turtle (*Caretta caretta*) was a prized food in the Western Islands, while the green turtle (*Chelonia mydas*) was the most common species observed in the Murray Islands. As described in the previous discussion on turtle hunting in the Western Torres Strait, a number of methods for capturing turtles were recorded during the late 19th century (Haddon 1912:159-166, MacGillivray 1852 II:20-22).

Dugong meat is commonly regarded as the most significant marine food source in the pre-European subsistence economy of the entire Torres Strait (Johannes and McFarlane 1991; Mulrennan and Hanssen 1994). Haddon (1912:166), however, claimed that these animals were most abundant at Orman's Reef immediately north of Mabuiag, and in the waters between Mabuiag and New Guinea. Methods of dugong capture included spearing the animals from a canoe on offshore reefs, or at night from a bamboo platform constructed on the shallow reef flat (Figure 2.8). The spear used was the large *wap*, which was fashioned with a barbed head loosely inserted into the butt of the implement.

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Figure 2.8 Dugong platform on Mer (Yonge 1930:194)

MacGillivray (1852 II:25) claimed that the earth oven or *kopa mauri* (as it was widely known) was the 'favorite mode of cooking turtle and dugong throughout the Torres Strait'. Noting that he had only ever seen it made in sandy soil, Haddon (1935:132) suggested that throughout the islands yams and sweet potatoes were also commonly cooked in earth ovens.

Observations and records of other marine subsistence activities in the Torres Strait, such as fishing and in particular the gathering of shellfish, appear much less frequently and with much less detail. Ironically, Haddon (1935:154) notes that both resources were available all year round, and that ‘fish and shellfish are eaten nearly everyday, with occasional meals of turtle and dugong; the two latter are especially rich and oily’ (1912:130). The daily gathering of reef and rocky shore shellfish was undertaken by women and children, while the activity of fishing was practiced by both sexes (Haddon 1912:154-155). Men, however, would dive for crayfish, pearl shells and large cone shells.

Fish were speared or taken with a coconut fibre line and turtle shell hook (Haddon 1912:155). Line fishing was practised from canoes, off rocks or while standing on the reef flat. The use of poisons such as *Derris* sp., was also a common method of procuring fish from shallow lagoons on the reef at low tide. Stone walled fish traps built from local boulders were observed around the fringing reefs of the Erub, Ugar, Mer and Mabuiag. Jukes (1847 I:181) provides a detailed description of the stone fish traps located around the southern coast of Mer:

> These are walls of loose stone, about three feet high, formed in curves and semicircles along the sand flats, each having a radius of one or two hundred yards. They are completely covered at high water, but when the tide falls (its range being about ten feet) many fish are left within these enclosed spaces, or together with crabs and other sea creatures, caught in the interstices of the stones.

<u>Social organisation, ceremony and religion</u>

The majority of information recorded about social organisation in the Torres Strait refers to the island of Mer (Rivers in Haddon 1908:169-184) (as detailed information about Meriam social organisation is provided in Chapter 4, only a summary is provided here). The sedentary population occupied small hamlets on the beach around the peripheries of Mer and

Dauar as well as portions of Waier. Each house site belonged to an individual or a few close agnates, usually brothers, who had inherited it from a biological or adoptive father. These hierarchically-nested, patrilineally related households were defined by Rivers (in Haddon 1908:169) as forming villages and districts (of which there were eight), which formed the basic units in the ritual division of labor as well as the conduct of particular social and religious duties. Haddon (1908:254) regarded totemism as virtually absent among the Meriam and saw this as a product of their isolation and a higher likeliness 'to develop socially independently of their neighbours'. Later 20th century ethnographies, however, recognised that eight totems (one relating to each of the eight districts) were introduced to Mer by the cult figure Malu, as part of the cult of Bomai and Malu (Laade 1973).

Most other information on social organisation in Torres Strait refers to the Western Islands and particularly Mabuiag. The basic components of the social systems for these more mobile populations were the exogamous totemic patriclans (Beckett 1972:323). These patriclans were not necessarily localised but could be found in more than one community. Clans often had more than one totem, *augud*, which included most of the common land and sea animals as well as constellations and mythical persons. Haddon (1935:68) was informed that in the Western Islands any *augud* could be eaten and that a man and woman belonging to the same totem could marry. Moore (1979:262) thus concludes that for the Western Islands:

> …as with the mainland Aborigines, the totemic system applied purely to ritual matters and played little part in everyday social life. Also the inclusion of mythical persons and constellations as totems sounds much closer to an Australian Aboriginal system than to a Melanesian one.

Clans on Mabuiag and Badu were each associated with a stretch of foreshore and tracts of interior land on one or both islands (Beckett 1972:323). These clans were further divided into districts, with each district having two headmen. Land tenure was multi-faceted with some tracts of land owned collectively by clans, while others were owned by individuals or by groups of agnates. The only other island for which some detail about social organisation is available is Saibai. Here the sedentary population was located in two settlements and divided into two clans based on non-exogamous moieties (Haddon 1904). The system of land tenure was similar to that in the Western Islands.

Ceremonial life throughout Torres Strait was characterised by everyday ritual processes as well as the more sacred followings of hero cults and legends. Rituals and ceremonies practiced by the Meriam included those for rain making, fishing, turtle and dugong hunting, gardening and crops as well as love magic and health ailments (Haddon 1908:192-240). These processes involved the production of charms of wood and stone, and sometimes included vocal and dance components. Although the Meriam had many cult heroes, according to Haddon and Myers (Haddon 1908:281-313) the cult of Bomai and Malu was central to social and religious life.

For the Western Islands complex magic and religion associated with fishing and turtle and dugong hunting was recorded (Haddon 1904:330-345). These traditions involved the ritual preparation of canoes and elaborate dances with associated paraphernalia including charms, masks and costumes. Some agricultural magic was also recorded for Mabuiag and Yam Island in the Central Torres Strait, involving dance and the use of garden charms. On many Western and Central Islands ceremonial life centered around an open space, *kwod*, permanently set apart from the rest of the island. Haddon (1904:365) did note, however, that a *kwod* could also be set up temporarily wherever there was a camp. On Nagi MacGillivray (1852 II: 36-37) described the *kwod* as fitted out with two large screens, *wows*, made from bamboo and plaited coconut palm and decorated with large spider shells, conchs and dugong bones. Various death and initiation rites were associated with the *wows*, and in general only men and initiated boys could visit the *kwod* (Haddon 1904:365-366) (Figure 2.9). The *kwod* was also the totemic site of *Kwiom*, which as discussed previously was the principal cult hero of the Western Islanders (Haddon 1904:367-373).

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Figure 2.9 Ceremonial *kwod* site with bamboo screens and shell decoration (Haddon 1904: plate XIX).

Mobility and trade

As previously noted, it was recognised early in the history of European voyaging throughout the region that the technological trait linking the peoples of southern New Guinea, the Torres Strait islands and Cape York Peninsula was the double outrigger canoe. Within the Torres Strait there were repeated observations of movements of groups of people, and in some instances the entire populations of islands. When visiting Erub in the Eastern Torres Strait, Sweatman (cited in Allen and Corris 1977:24) noted regular visitation by parties from several of the Central Islands.

Oral history suggests that Yorke Islanders acted as intermediaries between coastal Papuans and Eastern Islanders as well as Yam and Tutu Islanders. Yorke Islanders were situated close to the Warrior Reef where they obtained turtle and dugong, which they then took to the Papuan coast to exchange for bows and arrows, yams, sago, taro, drums and drumskins

(Lawrence 1994:295). Exchange for garden foods with the Eastern Islanders was particularly important to the people living on the low, sandy infertile Central Islands (Lawrence 1994:295). More detailed information on trade and exchange on the Murray Islands is provided in Chapter 4 (Figure 2.10).

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Figure 2.10 Patterns of customary exchange (Lawrence 1994:274, based on Haddon 1904)

Further to the north, Saibai Island and the coastal Papuan village of Mawatta were viewed as the principal centres or 'middle men' for converging Torres Strait and coastal Papuan exchange routes (Haddon 1904:295; McCarthy 1939-40:184). Obtaining information from Leo Austen, Resident Magistrate at Daru between 1919 and 1924, McCarthy (1939-40:185) wrote that the Kiwai-speaking villages near Daru and from Parama Island and Mawatta, had direct trade linkages with the peoples of Saibai, Dauan and Bogui islands. Further to this they also had kinship relationships which expanded to the peoples of Yam Island and Murray Island. Austen (cited in McCarthy 1939-40:186) claimed that the villages of Saibai, Dauan and Boigu obtained vegetable foods from the mainland as well as Nipa-palm leaf for house building. The main agent in the movement of canoes from the Fly Estuary to the Torres Strait appeared to be the coastal people around Daru. They in turn received pearl shells and cowrie shells (*Cypraea* sp.) from the Torres Strait Islanders, which were dispersed eastwards along the southern New Guinea coast as far as Goaribari Island near the Bamu Estuary (McCarthy 1939-40:186).

In summarising trade routes throughout the Torres Strait McCarthy (1939-40:190) concludes that Saibai and Mawatta were the links between the western and eastern coasts of Cape York and New Guinea 'by trade routes which ran through the western and central islands of Torres Strait'. He also identified another trade route in which the Murray Islands were the interlinking element between the east coast of Cape York and the Parama, Kiwai and Fly Estuary districts of New Guinea (McCarthy 1939-40).

The New Guinea Coast

> The trading operations, when taken in conjunction with the cultural and linguistic evidence, limit Papuan influence on Torres Straits to the area of Papua from the estuary of the Fly westwards…It appears… unnecessary to consider the peoples east of the Fly estuary and those up the Fly River (Haddon 1935:209).

When Haddon arrived in Torres Strait during the late 19th century the adjacent New Guinea coast was occupied by Kiwai-speaking Melanesian populations (Eley 1988 cited in Barham 2000:235). The majority of ethnographic information recorded about the Papuans of the southern New Guinea coast predominantly refers to the Kiwai, and particularly those populations who inhabited the Fly Estuary (Haddon 1935:210-236; Landtman 1927). Members of the Cambridge Expedition team spent one month on Kiwai Island in 1898, which between 1910 and 1912, also became the major focus of Finnish anthropologist Gunnar Landtman (1917, 1927, 1933). More general information about the peoples of the southern New Guinea coast is available from publications written by missionaries stationed in coastal communities during the late 19th century (Chalmers 1887, 1903; McFarlane 1888).

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Figure 2.11 Southern New Guinea (Trans-Fly) showing language groups and places referred to in text (after Singe 1979:72 and Barham 2000:232)

Based largely on oral histories, however, the current understanding is that the coastal Kiwai only came to occupy the areas west of the Fly Estuary, including Kadawa, Katatai, Parama, Mawatta, Tureture and Mabudawan, in the late 19th century due to the establishment of government stations and police posts (Laba 1996; Lawrence 1991; 1994; Wagner 1996) (Figure 2.11). Other areas on the coast west of the Fly, such as Buji (directly adjacent to Boigu Island) and Sigabaduru (located adjacent to Saibai Island), were similarly occupied in the late 19th century by Agob speaking people. Although oral histories from Buji and Sigabaduru link these groups with the inhabitants of both Boigu and Saibai, there is no indication that the populations of the Northern Torres Strait Islands originated from these adjacent mainland Papuan groups (Lawrence 1994:298-299).

Architecture and social organisation

On Kiwai Island, Chalmers (1903:117) observed several villages and estimated the population of around but probably less than 4000 people. Housing was substantial and had a variety of forms, including long houses which were either communal dwellings or men's houses, and smaller huts which were erected at gardens or fishing places to provide temporary shelter during subsistence excursions (Chalmers 1903; Landtman 1927). The basic social unit among the Kiwai was the exogamous patrilineal totemic clan (Haddon 1935:212; Landtman 1927:193). Each person had one totem that could be a land or sea animal, a mythical animal, a plant, a seasonal wind or a manufactured object. Landtman (1927:168) interpreted the totemic system of the Kiwai to serve more of a social function as opposed to a religious function, and identified that men, through such activities as hunting and harpooning, obtained some level of social distinction. Land, including individually owned gardens, was inherited through the male line. The entire island of Kiwai was owned and divided among different villages. Within the boundary of different villages land was divided among individual owners 'except large swamps, which generally belong to the whole community, and certain plots of land which may be owned by a group of people together' (Landtman 1927:196). However, ditches often separated garden plots belonging to different people (Landtman 1927:196).

Ceremony and religion

The most characteristic feature of Kiwai ceremonial life noted by Landtman (1927:298-320) was the belief in mythical figures and cult heroes. The distribution and similarities of stories of cult heroes in Cape York, the

Torres Strait and southern New Guinea has previously been mentioned in reference to the culture hero *Kwiom*. However, there were other similar culture heroes such as *Soida* (New Guinea) or *Sida* (Torres Strait); who,

> Everywhere is regarded as a benefactor: he instructed people in language, he stocked reefs with the valuable cone shell and notably he introduced plants useful to man (all versions), but for personal reasons he gave more food plants to some islands than to other. There is very close association between the sexual act and agricultural fertility (Haddon 1935:377).

At Parama Island at the southern mouth of the Fly Estuary Gill (1876:221) observed similar screens to the *wows* observed at *kwod* sites on several islands throughout Western Torres Strait. Landtman (1927) also recorded several important cults and ceremonies practiced by the Kiwai, including plantation fertility rites, garden increase rites, skill in hunting dugong and in fighting, turtle hunting, sexual instruction for young boys and girls and success in yam growing.

Material culture

The recorded material culture of the Kiwai includes body ornaments, weapons, domestic items, sound producing items, ceremonial items and the tools used in both agricultural and marine subsistence strategies. Body ornaments described include headdresses, ear and nose weights of wood and bone, necklaces and chest ornaments and armlets made from shell. The crescent-shaped pearl shell chest ornament is noted as obtained from the Torres Strait, while the cone shell armlet is considered the most valuable, and the armlet made from two boar tusks was the most commonly used (Landtman 1927:25-26). Items of weaponry showed some regional variation in production and distribution. Two of the more noted weapons include bone headed arrows that only the bush people located further inland of the estuary produced, and stone headed clubs (*gabagaba)*. Landtman (1927:31-32) described *gabagaba* as highly esteemed weapons of the Kiwai, and observed only two of them within the district. In the context of other stone implements used by the Kiwai, such as axes and adzes, it was suggested:

> Their occurrence in the country where there are no stone at all provided by Nature (except in an isolated place at Mabudavane on the coast), is a result of the extensive traffic in various articles which in former times was carried out between the Kiwai country and the islands in Torres Strait (Landtman 1927:33-34).

Landtman (1927:32-35) mentions, however, by his time they were considered of very little value and that he never saw a stone axe or adze in use, but that they were often kept on graves or at water holes or stuck into the ground in an upright position.

The most common implements used for cutting, scraping and carving were valves of *Cyrena* sp. shell, which, along with pieces of coconut shell, were also used as spoons. Chips of shell, bamboo knives and stone, as well as fragments of boar tusks were employed for delicate cutting. Coconut huskers were made from either wood or cassowary bone. Totemic designs such as the face of a man or the figure of a man with arms and legs, were often carved into coconut huskers, while the other end of the larger implements would be shaped into a small spatula to be used for scraping out the coconut kernel (Landtman 1927:38) (Figure 2.12).

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Figure 2.12 Kiwai coconut huskers (Landtman 1933:109)

Landtman (1927:37-39) did not record pottery as a traditional item of Kiwai material culture, but noted a number of vessels for preparing food, storage and carrying water including large shells, coconut bowls, boxes made from bark, lengths of bamboo and gourds which were used specifically for holding lime. Chalmers (1903:008) makes an interesting remark concerning the use of pottery in cooking among the Kiwai;

> Thinking I should be doing a great good, I brought over twenty Motuan cooking pots; some I gave to the teachers, and they cooked vegetables in them, and the others I wished to exchange for curios, but they would not have them. Rather than keep them to be broken, I gave orders they should simply be given away, but even then the natives would not take them. When a Kiwai crew is at Dauan, they prefer their food roasted; and get tired of boiled rice in a few days.

The most common method of cooking among the Kiwai was roasting over an open fire or in an earth oven (Landtman 1927:37). Cooking meat and vegetables by boiling on the other hand was never practised.

Chalmers (1903:117) describes the canoes used by the Kiwai as single outriggers that are obtained from Dibiri on the mainland at the northern mouth of the estuary. He recalls the southward trade of canoes to the Torres Strait:

> The large canoes obtained from Dibiri, are traded to Parama, Tureture, Kadawa and Mawata; and they trade them to Saibai, Dauan, Boigu, Mabuiag, Badu, Moa, Prince of Wales, Waraber, Damut, Masig, Stephens Island, Darnely and Murray. In all these places, the single gives place to the double outrigger, with a platform in the centre, and a large amount of ornamentation fore and aft; these canoes are used for dugong fishing, and for going on long journeys.

Subsistence

Subsistence activities of the Kiwai described in detail by Landtman (1927) include inland hunting, horticulture and the procurement of turtle and dugong from offshore reefs. The principal animals hunted by the Kiwai were the wild boar, wallaby, cassowary, large snakes, goannas and young crocodiles (Landtman 1927:111). The use of bows and arrows and spears were common hunting methods, as were dogs used for hunting pigs, cassowaries and wallabies. Chalmers (1903:119) claimed that agriculture was widely practiced by the Kiwai; ‘everywhere they cultivate the soil and plant taro, yams, sweet potatoes, bananas, and have growing coconuts, bread-fruit, mango and many other fruit bearing trees'. He also remarks that as the island is very low and swampy, drainage was an important part of cultivation, with drains being well cut and ranging from 30cm to almost 1m deep (Chalmers 1903:119). Landtman (1927:75-106) recorded in considerable detail the methods and procedures used in the cultivation of taro, sweet potato, banana, coconut, sago and sugar cane. Gardening tools were few including only wooden digging sticks (often shaped or carved) and baler shell hoes. The chewing of betel nut (*Areca catechu*) and lime was uncommon among the coastal Kiwai, but was more regular in the bush tribes located further inland of the Fly River (Chalmers 1903: 121; Landtman 1927:110).

Harris's (1977) recent investigation of economic strategies in the Papuan coastal zone west of Daru indicated that the gathering of wild plant foods may have played a more important role in the subsistence economy of coastal Papuans than portrayed by Landtman (1927). Harris (1977:449) suggested that many plants had a dual status as wild and tended or cultivated, including numerous fruit trees, kernel-yielding trees (*Terminalia catappa*, *Aleurites molucana* and *Canarium* sp.) and wild herbs such as ginger. He also reported that according to his informants, wild plant foods such as cycads (*Cycas circinnalis*) and the edible mangrove (*Bruguiera gymnorhiza*) until recently been used as staple foods in the coastal villages of Mabaduan, Sigabadura and Buji (Harris 1977:449):

> In general, traditional subsistence in the littoral woodlands and swamps of the Papuan coastal zone appears to have been based on limited horticulture including the tending of semi-wild species, on the gathering of wild plant products and shellfish, on fishing and to a lesser extent turtling and dugong hunting, and on the hunting of wild pigs, wallabies, other small marsupials, lizards, snakes, land birds and waterfowl (Harris 1977:451).

Landtman states that for the Kiwai 'the spearing of fish alongshore is an every day occupation' (1927:143). Using multi-pronged spears, fish were also speared on the outer coral reefs 'before the more serious task of capturing dugong and turtle begins' (Landtman 1927:143). Spearing fish in creeks was also common and was assisted by the setting of numerous traps and dams made of saplings, vines and palm trunks placed at the creek entrances to take advantage of shifting tides and currents. Small fish were also procured through the use of conical shaped baskets (Landtman 1933: Plate 607). Traditionally, fishing nets were not used by the Kiwai, although line fishing using coconut fiber and hooks fashioned from either a small stick, fish spines or turtle shell was common practice (Landtman 1927:142). Women collected shellfish and crabs at low tide on the beach and in the marshes.

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Figure 2.13 Kiwai fish scoop (*Gónea)* (Landtmann 1927:142)

During the day, turtles and dugongs were harpooned from canoes while sailing out on the reefs, and at night the animals were harpooned from platforms constructed on the reef flats. Both methods required the use of a large spear with a detachable harpoon head, called a *wapo.* Thus, capture techniques were very similar to those used in the Torres Strait. Indeed Landtman (1927:127) suggests that the practice of harpooning turtle and dugong along the coast of New Guinea was learnt from the Torres Strait Islanders, a theory corroborated further 'by the fact that harpooning is not practiced at all by the groups of the Kiwai people who live further to the east in the delta of the Fly'.

Discussion

From this discussion on the ethnographic information recorded throughout Torres Strait and the coastal regions of the adjacent mainlands, this chapter has demonstrated that some areas experienced considerable attention from explorers and late 19th century ethnographers alike, while others were subject to more fleeting and even second-hand observations. The Eastern Islands, for example, became a major focus of the Cambridge scholars during the teams' five-month stay on Mer in 1889 (Herle and Rouse 1998). Having also stationed themselves on Mabuiag for a period of one month, reference to culture and way of life in the Western Islands also features prominently in the Haddon volumes. In contrast, less information was recorded for the Central and particularly the Northern Islands, which also appeared to be situated outside of the major navigational paths of vessels during much of the 19th and early 20th centuries. The implications of this documentary emphasis on the Eastern Islands in the context of the archaeology of horticulture in Torres Strait are discussed in Chapter 3.

In the context of marine subsistence, however, by the late 19th century and the beginning of sustained European presence in the region, ethnographic records illustrate that the coastal zone was a major focus of resource exploitation throughout Torres Strait and on the adjacent mainland coasts. In each of these regions a variety of marine resources were exploited including intertidal shellfish and fish, and the larger often offshore resources of turtle and dugong.

The subsistence activities that received most attention in the early ethnographies were dugong harpooning and turtle hunting. Both of these activities are characterised by excitement and danger, and accorded prestige and status to the men who were successful in capture. The procurement of both dugong and turtle, however, was characterised by a degree of seasonality. In the case of dugongs, their availability also varied depending on conditions such as water depth and visibility, and the distribution of seagrass beds for feeding. In contrast, the more mundane, female orientated, activities of fishing and particularly shellfish gathering, received very little attention, despite recognition of the facts that both resources were available all year round and that their procurement was a daily activity. Although a diverse range of mollusc and fish species may have been procured as staple dietary resources, information on the biodiversity of marine habitats, abundance, availability and range of exploited species is unavailable in the ethnographic record.

Common technologies were used in marine subsistence activities throughout Cape York, Torres Strait and southern coastal New Guinea, including the spear and the hook and line. However, the documentary evidence reveals a degree of regional variation and intensification of maritime subsistence technologies, such as fish traps. In the Western Torres Strait the Kaurareg constructed temporary traps in creeks and streams from materials such as branches and mats. The extensive stone fish traps observed on several islands in Torres Strait represent a more permanent and intensified marine procurement strategy. The construction of these traps implies the presence of a large and permanent labor force, and also a degree of social organisation and cohesion among the islands' population. On Mer, for example, both the observed sedentary mode of life and the high degree of social structure demonstrated by clan divisions, property rights and cult following, provide a supportive base for such a time-consuming and labor intensive undertaking.

Within the ethnohistorically recorded information on trade and exchange throughout Torres Strait and the coastal regions of the neighbouring mainlands, the distribution of the dugout canoe was undoubtedly viewed as the key element. These vessels allowed the distribution of goods and materials, enabled the exploitation of distant supplementary and staple resources and fostered social connections through intermarriage and kinship relationships, as well as raiding and warfare.

However, from the above discussion it is clear that historically trade in Torres Strait was viewed in terms of a series of commercial networks and transactions that primarily facilitated the dispersal of goods and material items. Lawrence (1994:289) has recently pointed out that this simplistic or generalised view of an inflexible and unchanging system of customary exchange throughout Torres Strait is ultimately incorrect. It was not until the ethnographies recorded towards the end of the 19th century that an understanding of the social networks and kinship systems underlying the relationships between Torres Strait islanders, Cape York Aborigines and Papuans were adequately recognised and detailed (Haddon 1904, 1908; Landtman 1927; Thomson 1933, 1934).

What is more easily extracted from the early accounts is that the nature of the trading relationships varied geographically, depending on the inter-island and island-mainland distances involved (Harris 1979:85). Another discernible feature of the trade systems documented during the early period of European occupation is the relationship between resource availability or abundance and increased role in exchange. Lawrence (1994:271) notes that due to their greater access to natural resources 'certain villages and islands possessed greater facilities than others and were in a position to exchange their surplus production for scarce resources, thereby dominating intra-insular trade'. This was apparent on an inter-island scale between the Central and Eastern islands, where the inhabitants of the former, relatively infertile islands provided turtle and valuable shells for vegetable foods from the inhabitants of the latter, more fertile islands.

The above discussion demonstrates that at the time of sustained European contact in Torres Strait in the late 19th century, regional trade was dominated by alliance and exchanges with coastal Kiwai speaking groups located in the Fly Estuary and along the southwestern coast of New Guinea. The Kiwai learnt to harpoon turtle and dugong from Torres Strait Islanders, this practice being unknown to the groups that lived further east along the Fly Estuary (Landtman 1927:127). The Kiwai groups located west of the Fly Estuary only occupied the coast in the late 19th century and so, as initially highlighted by Barham (2000:235), the ethnohistorically described trading systems between the Torres Strait and these coastal Kiwai must have only originated during this time. Lawrence (1998:13) argues that from the 1850s onwards the coastal Kiwai dominated older established exchange networks, becoming the mediators between coastal Papuans and Islanders as well as controlling the fish-for-garden produce exchange between themselves and their coastal hinterland neighbours.

The absence of trading groups at points along the southwestern Papuan coast prior to the late 19th century is extraneous to the earlier emergence of maritime based trade in the region, particularly as the Fly Estuary seems to be the origin of both the Kiwai and double outrigger canoes hulls. In other words, evidence for movement and interaction of peoples and the operation of trading networks within the Torres Strait and between New Guinea and Cape York Peninsula was possible well before the migratory expansions of Kiwai groups along the southwestern Papuan coast during the 19th century. Indeed trading relationships between Torres Strait Islanders and more inland Papuan groups has been suggested by several sources (Lawrence 1994; McCarthy 1939-40; Swadling and Aniamato 1989:230). This is particularly well documented by oral history evidence from riverine groups living along the Pahaturi, Binaturi and Oriomo Rivers which suggests the Bine- and Gizra-speaking groups were in contact with Torres Strait Islanders before the Kiwai people settled along the coast;

> The oral accounts stress that access to the Binaturi River enabled the Masingara people to gain and then maintain contacts with the Torres Strait Islanders…After the establishment of initial contacts, the Islanders would come to the coast in their canoes to exchange with the villages inland. It was after this that the people of Masingara and Kunini villages began to acquire and use ocean going canoes (Lawrence 1994:309).

Lawrence (1994:307, 309, 311, 319) concludes from oral history evidence that contact between the Central and Eastern Islanders and coastal Papuans, prior to the westward movement of the Kiwai along the coast, were initially the results of both accidental and deliberate voyages of Papuans on bamboo rafts. He suggests that as the riverine Papuans became more knowledgeable and skilled in sea faring technology, contact became easier and more regular, and even more so after the coming of colonial administration (Lawrence 1994:319). Thus, although the documentary record is limited, the nature of oral history evidence indicates the possibility of links between Torres Strait Islanders and more interior peoples of southwestern New Guinea before the more coastal dominated systems detailed by ethnographies and other historical accounts came into force.

Conclusions

The first section of this chapter demonstrated that the Torres Strait Cultural Complex, encompassing Cape York Peninsula, the Torres Strait Islands and southern New Guinea, operated within a region characterised by broad palaeogeographic and climatic similarities. The Torres Strait Islands emerged by the middle of the Holocene after rising sea levels flooded the Torresian Plain, and today are commonly divided into four main bio-geographic groups based on similarities in geology, topography and floral and faunal diversity. On either side of the Strait the shared palaeogeographical history of southwestern Papuan coast and Cape York is demonstrated to a degree by floral and faunal affinities, each vegetated by open canopy woodland species and populated by common mammal and avian species. Equally, the diversity of these regions is displayed by landscape, geomorphology and relief, with Cape York dominated by rocky headlands, sandy beach flats and saltpans, and southwestern Papua by swamps, poorly drained alluvial plains and low islands.

For Australia and Papua New Guinea, archaeologists have established reliable chronologies of human occupation and have developed a broad understanding of environmental changes and how these relate to the timing of human occupation, and the nature of settlement patterns and subsistence economies. In contrast, the environmental record and in particular the development of the marine environment of Torres Strait, has only recently become the focus of research. Results have demonstrated that extensive reefs similar to the modern Torres Strait reefs had developed by 5000 years ago and progressed seawards with the lowering of sea levels. A similar mid-Holocene time frame is also estimated for the emergence of mangrove communities around many of the larger islands. However, investigations on high islands including Mer, have indicated that the development of fringing reefs, reef flat biotypes, and the formation of prograded beach environments may not have occurred until around 3500 yrs BP due to limited availability of sediment. Various implications of these findings for the timing of human occupation of the Torres Strait islands have been identified. These include the delayed development of occupiable land surfaces, and the restricted availability of coastal resources including inshore molluscan species, nearshore fish as well as offshore turtle and dugong populations, until at least 3500 yrs BP.

In spite of certain biases and shortcomings, the broader picture presented by the early Torres Strait ethnographies described in this chapter illustrate that towards the end of the 19th century the islands formed the central geographic cores of a trans-Strait socio-economic maritime network. This encompassed the Aboriginal communities of coastal Cape York and the peoples of the southern New Guinea coast, and was made possible by the double outrigger canoe as the common medium of maritime voyaging. Linkages through formal trade, warfare, inter-marriages and regular, less informal inter-island and island-mainland movements fostered a degree of cultural continuity across the Strait and between the islands and adjacent coasts. These are demonstrated by material culture, subsistence strategies and technologies as well as by less tangible forms of evidence including language, social organisation, ceremony, mythology and associated beliefs such as hero cults.

However, just as obvious as the cultural continuity, is a significant degree of cultural discontinuity within the Torres Strait Cultural Complex. This is manifested in distinct regional and localised forms of material culture, subsistence practices, language and in the socio-religious realm. Due to maritime voyaging technologies distances proved no barrier to the interaction of the region's occupants. However, it was perhaps also the distance between islands and island groups and island groups and the adjacent mainland groups, which fostered the development of unique cultural identities both within Torres Strait and across the broader region. This emerging theme of cultural continuity and discontinuity across Torres Strait is demonstrated further in Chapter Three, which provides a description on the archaeology of the Torres Strait Islands and the adjacent northern and southern coasts. This chapter pays particular attention to the archaeological evidence for occupation, subsistence and trade in Torres Strait, and as indicated in the discussion above, identifies discrepancies between the early ethnographic records and the region's emerging archaeological record.

Chapter 3: The Archaeology of Settlement and Subsistence in Torres Strait

In spite of its rich historical record and the comprehensive information recorded during the Cambridge Anthropological Expedition in 1898-99, the Torres Strait Islands remained archaeologically unexplored well into the late twentieth century (Carter in press). It was not until the 1970s that the first preliminary surveys and excavations were undertaken, with almost another decade passing before systematic investigations in the Torres Strait commenced. In contrast, archaeological research in New Guinea and Australia was already vigorously underway by the 1970s, with the results of intensive fieldwork, radiocarbon dating and other analyses providing evidence for the development of major regional models on human occupation, migration, subsistence and exchange (for example Birdsell 1977; Bowdler 1977; Golson 1977; Jones 1973, 1979; Kirk and Thorne 1976).

This chapter outlines the history and major themes of archaeological research undertaken in the Torres Strait, paying particular attention to the themes of this thesis. The first half of this chapter undertakes this task in the context of the timing of human occupation, evidence of marine and horticultural subsistence and evidence for trade and linkages. The remaining half of the chapter outlines the results of archaeological research carried out in northern Queensland and southern coastal New Guinea, and identifies results of relevance or consequence to the timing of occupation of Torres Strait and the development of its subsistence economies and trade networks.

The Archaeology of Torres Strait: A Prelude to Research

In 1971 a Torres Strait Symposium was held by the Research School of Pacific Studies at the Australian National University, representing the first Australian gathering of professionals and academics with specialist knowledge on the natural or cultural history of the Torres Strait. Around 80% of the Symposium's participants were from scientific backgrounds, including the biological sciences, forestry and botany, geography, entomology, geomorphology, human biology and meteorology. As further evidence for the lack of archaeological interest the Torres Strait had received prior to the 1970s, the Symposium proceedings was devoid of any archaeological discussion based on research undertaken within the Torres Strait (Walker 1972). Authors referred only to possible scenarios for the region's prehistory through knowledge of the occupation and economic and cultural development on the Australian and Papuan mainlands (Golson 1972). It is also clear, however, that at the time there was a general lack of knowledge about the natural history of Torres Strait. This is pointed out by volume's editor who noted, that 'most authors refer to the dearth of basic information which limits their confidence in their conclusions' (Walker 1972:vii).

As a prelude to the commencement of archaeological research in the region, the 1971 Symposium highlighted the need to address several basic questions. These included the antiquity of human occupation of the Torres Strait, the nature of traditional subsistence systems and the development of linkages between Torres Strait Islanders and the occupants of the mainlands to the north and south. The degree to which the archaeological evidence might support or refute the ethnohistoric record for the region was also viewed as an important component in developing a greater understanding of the prehistory of Torres Strait (Moore 1972; Beckett 1972; Golson 1972). However, perhaps the most significant outcome of the Symposium was the inception of the bridge and barrier debate, which questioned the role that the Torres Strait played in the emergence of the divergent subsistence economies to its north and south. This is encapsulated by Walker (1972:405):

> Indeed, its waters have provided food resources and its Islanders, though developing some cultural individualities of their own, have been strongly influenced by the peoples on one side of the Strait or the other. Yet the contrast between horticultural man to the north and hunter-gatherer to the south remains, starker and more

> perplexingly than anywhere else in the world. For man's languages, and even his genes, the Strait has provided a bridge but for his subsistence technique, a remarkably strong and persistent barrier.

A comprehensive overview of archaeological investigations and research in Torres Strait has recently been compiled by Barham et al. (2004), with a useful synthesis on the region's archaeological heritage also provided by McNiven et al. (2004). The following section is largely derived from the same primary sources used by these authors, although presents a more specific review of the archaeology of Torres Strait in light of the major objectives of this thesis. The exhaustive discussion on the archaeology of Torres Strait by Barham et al. (2004) refers widely to the published results of the MIAP (Carter 2001; 2002; 2003b; Carter et al. 2004a). Consequently, some of the major conclusions offered in the Barham et al. (2004) review on the antiquity of human occupation, the timing of horticultural development and the evidence for trade and exchange, are largely based on the research conducted as part of this thesis.

As the primary aim of this chapter is to establish the nature of the archaeology of Torres Strait at the commencement of the Murray Islands investigations in 1998, the major hypotheses established by Barham et al. (2004) will not be included or discussed here. This is also the case for hypotheses recently generated from the results of excavations on Badu (David et al. 2004), although some of their results are mentioned below. Some of the more recent conclusions on the archaeology of settlement and subsistence in Torres Strait generated by other researchers are considered in Chapter 10, where a discussion and main conclusions based on the results of the Murray Islands investigations are considered within a broader regional context.

The Timing of Human Occupation

Between the commencement of archaeological research in the Torres Strait in the early 1970s (Moore 1979; Vanderwal 1973a) and the MIAP investigations of 1998, a total of 16 radiocarbon dates had been obtained for archaeological contexts throughout the region (Barham et al. 2004: Table 1A and Table 1B). Four of these dates were from shell middens on Muralag and Evans Bay on Cape York, as well as a rockshelter at Red Island Point on the mainland. From the results Moore (1979:14) concluded that the excavated cultural assemblages from Muralag and Cape York were broadly consistent with the ethnographic record. From a quantitative analysis of the assemblage he identified two periods of intensive occupation – the last 100 years or so before European occupation and between 600 and 700 years ago. He also suggested that the lateness of the radiocarbon dates did not necessarily imply that occupation was a recent occurrence, but that the results were more a product of geomorphology. Moore (1979:15) concluded that earlier sites may be located either further inland or on the larger off-shore adjacent islands where coastlines have been less modified by progradation.

Two of the radiocarbon dates were derived from excavations on Mua and Nagi, with the primary objective of determining whether there was any evidence for occupation of Torres Strait prior to 700 years ago (Rowland 1984, 1985). Charcoal from the excavation on Long Beach, Mua Island produced a modern date (less than 250 years BP) (ANU-3025). The Nagi excavation revealed two occupation layers, the lower one featuring a fire pit. Charcoal from a depth of 65-67cm produced a result of 730 ± 80 years BP (ANU-3026). These results led Rowland (1985:129-130) to conclude that excavated sites in the Torres Strait have shown no clear evidence of occupation prior to 700 – 800 years ago. He emphasised, however, that at the time of European contact Torres Strait Islanders displayed a sophisticated and unique cultural system and the question of such a development occurring within 800 years is equivocal (Rowland 1985:130). This researcher postulated that given the complex cultural and physical history of the islands, a human history from at least 6000 years ago and perhaps well into the Pleistocene was possible (Rowland 1985:123).

The majority of radiocarbon dates obtained for Torres Strait before the MIAP were predominantly from the Western and Northern Islands (Mua, Mabuiag and Saibai). These dates were part of the first long-term investigations into the archaeological and paleoenvironmental history of prehistoric settlement and subsistence in Torres Strait. Known as the Torres Strait Research Project and led by David Harris, who was based at University College London (UCL) at the time, the aims of this research, as most recently defined:

> ….were to establish a regional chronology of Holocene sea level and coastal dynamics and then to reconstruct palaeoenvironmental settings at local scales…appropriate to modelling both horticultural and coastal resource aspects of the archaeological record (Barham et al. 2004: 14).

As part of the UCL team, Ghaleb (1990) obtained three charcoal-derived dates from excavated midden contexts at Gumu on Mabuiag. The radiocarbon dates ranged from 1050 ± 100 (Beta-21386) to modern (Beta-21384). As another member of the UCL team, Barham obtained three radiocarbon dates from midden contexts on Mua and four from middens on Saibai (Barham 1981; Barham et al. 2004:13). Three of the Saibai dates were from midden deposits underlying relict mound-and-ditch field systems at Woam, and one was from a dense midden with shell, bone and flaked stone near the Saibai village. The charcoal sample from the latter site produced a date of 410 ± 80 years BP (Beta 13481) (Barham 1999).

For the Woam excavation the three dated samples consisted of paired charcoal and shell from a depth of 55-60cm, and a second shell sample from the same depth. The radiocarbon results varied in age from 780 ± 70 BP (Beta 3614) and 2890 ± 60 BP (Beta 6885) for the paired charcoal and shell dates respectively, and 1420 ± 60 BP (Beta 6934) for the separate shell sample. Barham and Harris (1985:277) suggested a number of reasons for the discrepancy in the radiocarbon dates, including a low rate of deposition, spatial variability in the deposition of food refuse, discontinuous use of discrete areas of the midden surface over time and mixing or reworking of the midden surface. They also acknowledged that the lack of environmental isotopic data for the region proved problematic in the application of calibration curves established from work elsewhere (Barham and Harris 1985:264). Considering such factors it was concluded for the Woam site that ‘a significant component of the basal midden stratigraphy dates from c. 700 radiocarbon years BP, and represents a maximum age for the mound-and-ditch system (Barham and Harris 1985:277).

Barham’s (1999) more recent report on the results of investigations on the Saibai mound-and-ditch systems provides a review of the earlier data. From coring of swamp facies and the reconstruction of sedimentary and pollen records, the recent results have led to revisions of the chronological data for the antiquity of human occupation on the island and the timing of the emergence of the horticultural systems. From the evidence it is interpreted that by 3000 yrs BP ecological adjustments to Holocene sea level changes had caused large-scale mangrove dieback and a transition to *Eleocharis*-dominated swamp throughout the interior swamp systems of Saibai. The last stages of swamp infilling occurred around 2500 yrs BP, while a further unique sedimentary event commenced around 1200 yrs BP. This involved direct sedimentation from the clayland into swamps leading to a rejuvenation of sediment accumulation rates further favouring the development of sedge-swamp plant communities. The following conclusions were made;

> The combined on-site archaeological radiocarbon dates, and off-site palaeonvironmental reconstruction, provide sufficient evidence to now model first occupation of the northern Torres Strait islands at some time after 2500 yr BP. By this time clayland areas were free from tidal incursion – a process which had commenced in the preceding 1500 – 1000 yrs. Also, higher local habitat and resource diversity existed on Saibai, than at any time since 6500 yr BP. The development of agricultural mound-and-ditch systems, probably also involving water management and well construction, dates to some time after 1200 yr BP, and therefore significantly post-dates the onset of sedge swamp development by at least 1000 yr (Barham 1999:101).

Barham’s (1999) investigations on Saibai also served to demonstrate an apparent association between the timing of human occupation and the nature and development of island physiography. As discussed in the previous chapter, Barham (2000) concluded that maritime exploitation of coastal resources (based on ethnohistorically documented techniques and strategies) may have also been limited owing to a time-lag in reef flat formation and resource habitat stabilisaiton. Therefore the demonstrated 2500 year time-depth for human occupation of the Torres Strait is broadly consistent with the estimated 2000 - 3000 year delay in reef and resource habitat development after shoreline transgression of the Strait around 6000 yrs BP (Chapter 2).

Summary

The majority of the radiocarbon dates produced from the initial investigations into the antiquity of human occupation of Torres Strait resulted in conclusions that occupation was broadly consistent with the 19th century ethnographic record of the region (Moore 1979; Vanderwal 1973a). However, the suspected existence of older occupation sites perhaps located inland and away from the destructive affects of wind and water was also voiced by several researchers (Vanderwal 1973a; Moore 1979; Rowland 1984). Surprisingly, the shallow nature of the occupation deposits was not offered in explanation for the recent time-depth of human occupation. In their recent synthesis paper, however, Barham et al. (2004:35) have explained that there is a poor relationship between depth and age of archaeological contexts across Torres Strait, with more recently obtained samples from depths of 40 - 60cm producing radiocarbon dates that span the full range of known Holocene occupation of the islands.

Barham's (1999) recent assertion concerning the reliability of the Woam midden radiocarbon results provided a new benchmark for the antiquity of human occupation of the Torres Strait. The estimation of at least 2500 years of human occupation in the Torres Strait for the first time allowed consideration of the scenario that the complex cultural, economic and social systems recorded in the region at the time of European contact had originated and developed during the early Holocene. As initiated by

Barham (1999, 2000) the expansion of the human chronology of the Torres Strait also provided the opportunity to consider the archaeology in the context of regional subsistence strategies, human chronologies and trade networks previously established for the adjacent Australian and Papuan regions.

The Marine and Horticultural Subsistence Economies

As a result of widespread concern expressed by Torres Strait Islanders 'that significant domains of traditional knowledge and cultural heritage sites and place were being lost or jeopardised by uncontrolled development and other pressures associated with social change', from 1996-1998 the Culture Site Documentation Project (CSDP) was conducted for Torres Strait (Fitzpatrick et al. 1998; McNiven et al. 2004:75). The penultimate aim of this project was 'to establish an enduring culture site management program with a detailed database and methodology Islanders could use for conservation and development planning throughout the region' (McNiven et al. 2004:75).

The culture site database was constructed through a comprehensive literature review, including ethnographic and archaeological literature recorded for Torres Strait (see McNiven et al. 2004:76 for primary source details), and the archaeological sites inventory for Torres Strait held with the Queensland Environmental Protection Agency (EPA). Historical texts such as ships logs, missionary accounts and local history and stories were also utilised. No field surveys were undertaken as part of the CSDP.

Based on information tabulated from the literature categories, a total of 621 archaeological sites (known and potential) were recorded for 42 islands (McNiven et al. 2004:76). The greatest number of sites were recorded for Boigu and Saibai in Northern Torres Strait with the Eastern Islands recording the second highest number. These are followed by the Western Islands of Mabuiag and Mua, with the Central Islands and the Muralag group located in the southwest closest to Cape York recording the lowest number of sites. Twenty-one different site types were identified (see McNiven et al. 2004: Table 1). The two most common archaeological site types are horticulture/grove/tree sites (n=174) and stone walled fish traps (n=115). These are followed by arrangements of shell, bone and/or stone (n=103), old village sites (n=71), burial/skull locations (n=62) and shell middens (n=51). Arrangements of shell, bone and/or stone are noted as the most widespread site type, found on 25 islands (McNiven et al. 2004:77). Table 3.1 provides a list of the frequency of selected site types associated with subsistence and site occupation.

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Table 3.1 Selected frequencies of site types for Torres Strait identified as part of CSDP (1996-1998) (after McNiven et al. 2004:77).

Interestingly, the researchers noted vast differences between this data and the government records. They explained that only half the 42 islands with archaeological sites have registrations with the EPA (McNiven et al. 2004:78). The majority of these are from Saibai and Mua, which is concluded to reflect the focus of past archaeological research (see above discussion). As the most obvious discrepancies in the data:

> Three-quarters (76%) of the EPA sites are shell middens. In contrast, no stone tool quarries/sources, ochre quarries, clam shell water holders, and 'other' stone structures have been registered. Similarly, only 10 of the 115 fishtraps and 12 of the known 174 horticulture/ grove/tree sites have been registered (McNiven et al. 2004:78).

A number of reasons are offered for these discrepancies in registration, including the different archaeological perceptions and abilities of recorders, as well as the specific interests of researchers and their abiding by community wishes in avoiding sites of special significance (McNiven et al. 2004:78). However, based on the results of the CSDP a number of implications for the nature of archaeological evidence for marine and horticultural subsistence in Torres Strait arise.

The Evidence for Horticulture

Firstly, at initial glance and contrary to the registered archaeological site record for Torres Strait (prior to 1998), the CSDP data suggests that sites indicative of past horticultural practices may be as abundant as the evidence of past marine based subsistence strategies, i.e. shell middens. This seems to be the case particularly for the Northern Islands, which recorded the highest incidence of horticultural related site types. As demonstrated by Table 3.1, however, this appears to be considerably less so for the Eastern Islands, which recorded the third lowest number of horticulture/grove/tree sites. This result is surprising in the light of Haddon's (1912) view that horticulture was most intensive in the Eastern Islands. However, it does support a component of Harris's (1977) model of subsistence strategies across Torres Strait, which was based on documentary evidence and early fieldwork (Harris 1975). Harris (1977:444-45) postulated a north-south subsistence gradient across Torres Strait, where the greatest dependence on horticultural production occurred in the north, was of lesser importance on Badu and Moa, and even more so on the islands closest to the Australian mainland, where 'plant foods were obtained mainly by gathering'.

The extensive relict mound-and-ditch systems on Saibai recorded by Barham (1981) were located inland of canals previously recorded by Harris (1975). The first of these systems was located 2.5km south of the present village and had a 30m wide well located in the centre. Covering a total area of 1.9ha, the garden features varied in size and shape from 40m long rectangular formations to circular mounds with a diameter of 5m. A ground survey revealed large numbers of quartz flakes, two irregular shaped stones of leucocratic biotite granite and an isolated shell scatter of

Anadara sp. and *Syrinx aruanus*. Based on these results of the 1980 field season Barham (1981:19) concluded ‘both the gardens and the well construction suggest considerable organised labour inputs, and given optimal sedimentary facies, the Saibai sites represent the most significant evidence for land use history within Torres Strait…’. In a follow up field season it was also identified that the relict mounds and ditches on Saibai were restricted to the interior of the western side of the island and were located on clayland areas lying 0.5 - 3.0m above the high tide mark and beyond the limits of seasonal inundation.

In contrast to Vanderwal’s (1973a) meager findings on Yam in the Central Islands, Neal (1989) recorded several sites within the three areas surveyed. These included a number of linear, curvilinear, circular and semicircular stone structures and stone cairns averaging about 25cm in height and 1-1.5m in diameter. Collectively the stone arrangements were interpreted ‘as structural features forming part of a very extensive relic horticultural system’ and included garden boundaries, pedestrian pathways, drainage channels, retaining walls as well as less spatially patterned piles of stone gathered up during cultivation procedures (Neal 1989:9). Similarly, on Mabuiag Neal (1989) recorded five sites comprising a number of stone arrangements including stone cairns, and circular, semicircular, curvilinear and linear stone arrangements. At site MABUIAG 3 where a rock wall 15-30cm in height ran parallel for 30-40m to a creek gully, Neal (1989:6) interpreted the structure as evidence of water management techniques associated with nearby horticultural systems. However, Barham et al. (2004:21) note that the location of the site on a ridgeline suggests that the stone wall may equally represent marine hunting lookouts or boundary markers, as recorded by Moore (1979:153, 272-273).

Based on this evidence from the Northern and Central Islands as well as a more substantial review of the archaeological evidence from Torres Strait, Barham et al. (2004:45, Table 3) have identified three main site categories of archaeological features indicative of horticulture in the region: 1) constructed mound-and-ditch systems, 2) linear and curved linear mounds, and 3) complexes of stone arrangements and stone cairns. Of relevance to the investigation of prehistoric horticulture on the Murray Islands detailed in this thesis, Barham et al. (2004: 46) point out that 'once extensive areas of mound-and-ditch systems are considered, the evidence for prehistoric agriculture/horticulture, and the geographic pattern, shifts considerably'. There is no ethnographic evidence for the use of these mound-and-ditch horticultural systems in the Eastern Islands, which appear to be restricted to Saibai, Boigu and Dauan, adjacent areas of lowland Papua New Guinea (see discussion below), Mabuiag, and on Badu and Mua in areas associated with post-missionary settlement (Barham et al. 2004:46). As explained:

> At a simple level this pattern is consistent with the geographic distribution of areas of lowland extensive enough to reward cultivation, but where wet season flooding by either fresh or brackish waters represents a problem that might be mediated by 'raised beds' separated by ditches (Barham et al. 2004:46).

As detailed in the following chapter, these physiographic conditions are absent from Mer, Dauar, Waier and the other high, small islands in Eastern Torres Strait. Thus contrary to Haddon's (1912:144) portrayal of the Eastern Islanders as the 'horticulturalists' of Torres Strait, the emerging archaeological picture suggests that evidence for horticulture is most visible in the Northern Islands, were gardening was generally regarded as considerably less important to the late 19th century subsistence economy. However, apart from the mounded topography of the sites themselves and the associated ditches and wells, excavation in the Northern Islands has failed to recover macro floral remains of cultivated species or artefactual evidence associated with horticulture.

As illustrated by the ambiguous results of three stratigraphically consistent samples extracted from the basal deposit of the Woam midden (Barham and Harris 1985), the dating of horticultural sites in Torres Strait has so far been problematic. Although recent lithostratigraphic analyses of the Saibai swamp has rectified this chronological discrepancy (Barham 1999), this provides a useful indicator of the potential problems associated with the dating of archaeological remains extracted from mounded horticultural features, and particularly where mound construction occurred after midden deposition.

Thus the results of archaeological fieldwork in the Torres Strait during the 1980s refuted Harris's (1977, 1979) suggestion that horticulture was most intensively practiced on the small, high rocky islands of Mabuiag, Dauan and Nagi. The work conducted throughout the Northern Islands demonstrated that evidence for horticulture had to be extended to include the very large areas of Saibai, and to a lesser extent Boigu. In the context of these advancements in our understanding of the distribution of horticultural practices across Torres Strait, Harris's (1977:456-457) belief that the relationship between island size, population pressure and diversity and availability resource habitats as a precursor to the degree or intensity of horticultural production, appears to pale.

The Evidence for Marine Subsistence

Second, the results of the CSDP also highlighted the fact that evidence for past marine-based subsistence in Torres Strait was widespread and was visible in a variety of archaeological contexts. This included surface scatters, stratified and mounded remains of shell and the bones of fish, turtle and dugong (Barham 1981; Barham and Harris 1983, 1985; Coleman 1985, 1990; Ghaleb 1990; Harris and Ghaleb 1987; Moore 1974, 1978, 1979; Neal 1989; Rowland 1984, 1985; Vanderwal 1973a), technologies used in the procurement of marine resources, such as stone fish traps and dugong bone mounds (Barham 1981; Barham and Harris 1983, 1985; Ghaleb 1990), non-secular physical formations (dugong increase and *zogo* sites) (Ghaleb 1990; Harris and Ghaleb 1987; see also McNiven and Feldman 2003), as well as the representation of marine resources such as fish, turtle, dugong, sharks and sting-rays in rock art (Barham 1981, 2000; Beckett 1963; Cole and David 1992).

In spite of the proliferation of shell middens in the region, however, detailed examination of an excavated marine faunal assemblage from Torres Strait is confined to Ghaleb's (1990) research at Gumu on Mabuiag. The results demonstrated that the vast majority of excavated faunal remains consisted of marine shellfish and bone from turtle, dugong and fish. While around half of the excavated shell was highly fragmented and unidentifiable to species level, identifiable species were from a variety of habitats including sandy, rocky, coral reef, mangrove and deep water (Ghaleb 1990:270). Although species from all five habitats were identified throughout the excavations, patterns of relative abundance provided some evidence for an increase in species diversity over time in which mangrove species (*Polymesoda* sp. and *Terebralia* sp.) and reef-flat species (including *Melo* sp, and *Tridacna* sp.) were favored over sandy shore species such as *Paphies striata*.

Ghaleb's (1990) investigations also demonstrated large quantities of fragmented dugong bone in association with coastal middens. According to Ghaleb's (1990:251-252) weight calculations, turtle comprised the next most abundant fauna after dugong, and consisted mostly of fragmented remains of the carapace and plastron. Fish bone comprised the least abundant marine faunal category, and owing to its highly fragmented nature was almost entirely unidentifiable. The remains that were identified demonstrated a relatively low species diversity consisting of fish from eleven families, particularly Labridae, Scaridae and Lethrinidae, but all of which inhabit the near-shore zone (Ghaleb 1990:292). The test-pitting and excavation of coastal middens on Dauan (Vanderwal 1973a), Mua (Rowland 1984, 1985), Muralag (Harris et al. 1985) and Mabuiag (Ghaleb 1990), also demonstrated the predominance of archaeological marine faunal remains.

Summary

From the above discussion it is clear that the emerging picture of the archaeology of subsistence in Torres Strait is complex, involving a certain level of contradictory evidence between the ethnohistorical records, published archaeological data and the inventory of government registered sites. Due to a lack of archaeological fieldwork in the region, the early models for the nature and distribution of horticultural subsistence in Torres Strait were based on ethnohistorical evidence (Harris 1977, 1979). With the subsequent commencement of field-based research, initially limited to the Northern and Western Islands, the inaccuracies and biases in the ethnohistorical records were revealed. As the busiest decade of research, the archaeological investigations conducted throughout the 1980s (Barham 1981; Barham and Harris 1983, 1985; Harris and Ghaleb 1987) and the recent re-examination of the data (Barham 1999, 2000) have revealed that the prehistoric horticultural economy of Torres Strait may have developed through complex interplay of a variety of factors, including island stabilisation, physiography and topography.

The archaeological evidence for the marine subsistence economy was demonstrated by early research as being widespread throughout Torres Strait and indicated by a range of evidence such as middens, discrete accumulations of marine mammal bones and stone fish traps. In spite of the abundance of middens, however, investigations of these assemblages was generally limited to species identification of the marine shell and faunal components, with minimal consideration of spatial and temporal change. Thus, the analysis of the marine faunal assemblages from the Murray Islands outlined in Chapter 6 provides an important contribution towards an understanding of the nature of archaeological subsistence in Torres Strait.

Archaeological Evidence for Trade and Linkages

A relatively small assemblage of portable cultural artefacts has been archaeologically recovered from Torres Strait. From research conducted prior to the MIAP, flaked stone (ground and unmodified) was the most prolific artefact type recorded from both surface and excavated sites. Vanderwal (1973a) reported flaked stone for Dauan, Mer, Dauar, Gabba, Mabuiag and Pulu Islet, while unmodified lithic micro-debitage was recorded for the excavations on Cape York (Moore 1979), Mua (Barham and Harris 1987) and at Gumu on Mabuiag (Harris and Ghaleb 1987; Ghaleb 1990). In most cases only small numbers of artefacts were recorded, and in some instances such as for Mer and Dauar, a single flaked artefact was recorded. These artefacts were believed to be imported from the Western Islands (Vanderwal 1973a:184). The artefacts recorded on the Western Islands were made from local quartz and porphyritic microgranite raw materials (Ghaleb 1990; Vanderwal 1973a:182, 178-179). Quartz flakes have been observed on Saibai, where the absence of bedrock suggests that the lithic material must have been imported from Dauan or the New Guinea mainland where there are bedrock outcrops (Barham and Harris 1987; Barham et al. 2004:30). To date the only known stone quarry in Torres Strait is recorded for Dauan (Vanderwal 1973:182), which is also the same site that Haddon (1912:191-192) identified historically as a raw material source for club heads (*gabagaba*).

Discussions of stone as a raw material in Torres Strait by Haddon (1912:190-193) refer largely to stone-headed clubs (*gabagaba*), the general perception being that these implements were imported to Torres Strait from New Guinea (Allen and Corris 1977:33; Haddon 1900:244; MacGillivray 1852 II:4, 19). Recent geological sourcing analyses of a number of ethnographic and archaeological *gabagaba* undertaken by McNiven (1998), however, have demonstrated that the main source of raw material was within Torres Strait, and particularly from the Western and Eastern Islands. G*abagaba* manufacture (Hitchcock 2004; McNiven and Von Gnielinski 2004) and the origin of Kiwai stone axes (McNiven et al. 2004) have also more recently been examined. The results of their geological analyses have confirmed that the majority of the *gabagaba* and stone axes historically provenenced to New Guinea were produced from raw material in Torres Strait. Although *in situ* archaeological evidence that could testify to the prehistoric manufacture of these items is lacking from

Torres Strait, these investigations suggest their production and importation to New Guinea may have considerable antiquity.

Before the Murray Islands archaeological investigations the only earthern pottery sherds recorded for Torres Strait were from Booby Island, located in the far southwest south of Muralag. Queensland Museum staff first investigated the island in 1981 as part of a preliminary archaeological survey (Coleman 1985). Booby Island is a rocky outcrop and has a number of rockshelters that were the focus of the team's investigations. Due to its location at the western entrance of the Torres Strait passage and the fact that it was uninhabited by indigenous occupants, Booby Island was a regular stop-over point for sailing vessels from the early 19th Century (Nicholson 1996). The island also became a maritime 'post office' as visiting ships often left letters and other mail to be picked up and carried on by the next vessel. Booby Island was also regularly used as a refuge for shipwreck survivors, with funds provided by the New South Wales government to permanently stock one of the island's caves with food and water, as well as other provisions such as books, newspapers, cigars and rum (Nicholson 1996:3). Due to this frequent use and disturbance and vandalism caused by modern day 'treasure hunters', many of the rockshelter deposits on Booby Island are highly disturbed (Coleman 1985).

In a return trip to the island in 1990, several pottery sherds were recovered, although no precise location of the artefacts is given. They are described as 'extremely crude, low-fired earthenware pottery shards representing the majority of the remains of at least two small pottery vessels' (Coleman 1991:3). Although the antiquity of the artefacts was regarded as questionable, Coleman (1991) believed that as there are no clay or natural fuel sources on the island, tests which may determine the origin of the clay and antiquity of the sherds were warranted. An examination of one of the sherds was undertaken by Cox and Watchman (2000).

The sherd was a rim fragment of what was interpreted to be a small personal serving bowl with an orifice of 160mm. It was suggested that the crude appearance of the sherd was the result of extensive spalling i.e. exploding, of the interior and exterior surfaces of the vessel during firing. In spite of this damage on the exterior surface below the rim a panel of widely spaced oblique slashes was visible. The sherd was made from a very coarse paste with inclusions of up to 3mm, which included white feldspar, grey quartz, quartzite and red-brown fine-grained weathered volcanic clasts. Both shell or sand tempers were absent, and it was interpreted that the vessel may have been fashioned out of coarse sedimentary clay that was used in its natural state. The results of chemical analysis of the clay indicated that it was iron-rich and relatively high in chloride. The investigators concluded:

> Without detailed knowledge of the nature of the provenance it is difficult to say whether the high chlorine content represents original use of seawater during preparation of the bowl or is a function of post-depositional leaching in a marine environment (Cox and Watchman 2000:3).

As indicated in the previous chapter, pottery has generally not been viewed as a traditional indigenous component of the material culture assemblage of Torres Strait. However, several historical references to pottery in the Torres Strait have been identified. Vanderwal (1973a:187, citing McFarlane 1874:3) noted an observation of New Guinea pottery on Puruma in the late 19th century. MacMillan (1957:115) reported that Mission teachers gave earthenware vessels of New Guinea origin to Sir William Macleay when he visited Darnley Island in 1873. Thirdly, Myres (1901:98) reference to pottery in Torres Strait appears to be a case of mistaken citation of Haddon’s (1901:118) observations of pottery manufacture in Port Moresby. In the first two instances, however, it is clear that the missionary occupation of Torres Strait by the late 19th century was the most likely reason for the presence of pottery in the region at this time.

Although more indicative of social connectivity across the Torres Strait rather than as evidence of trade, Barham et al. (2004:54-55) discuss regional affinities in rock art styles, designs and motifs. The characteristics of Torres Strait rock-art (predominantly on Mua, Naghi, Dauan) referred to as demonstrating Papuan stylistic elements include the high-incidence of anthropomorphic and zoomorphic images in painted rock-art, the use of natural, unusual landforms such as boulders, and figurative depiction of marine animals and maritime images, including both single-hull and double outrigger canoes. As noted by Barham et al. (2004:55) the dating of rock art and determining chronological patterns to link stylistic affinities to occupation events will represent a major step forward in understanding the cultural origins of Torres Strait. Some interesting developments in dating early 19th century Torres Strait rock art through radiocarbon dating and analysis of associated occupation deposits have recently been reported for Mua Island (David et al. 2001; 2004, see also McNiven et al. 2000 for other recent technological advancements in deciphering painted rock art in Torres Strait).

Summary

The recent surge of archaeological research in Torres Strait, particularly in the Western Islands, has considerably advanced knowledge on the origin and trade pathways of stone artefact raw material, largely through the analyses of curated artefacts collected during the Cambridge Expedition and throughout the 20th century. It is clear, however, that what remains for Torres Strait is a lack of excavated *in situ* artefacts from which to directly determine the chronology and time-depth of trade and exchange.

Archaeology of Northern Queensland: Evidence for Linkages to the Late-Holocene Occupation of Torres Strait?

Our understanding of the nature of late Holocene Aboriginal hunter-gatherer settlement patterns, and of the associated social, economic and technological changes that occurred in various part of the country during this period have been greatly enhanced by archaeological research undertaken throughout northern and also central coastal regions of Queensland (for example Bailey 1977, 1983, 1999, Barker 1996, 1999; Beaton 1985; Border 1999; Lilley et al. 1999; Rowland 1982, 1983, 1989, 1999, McNiven 1999).

This body of research has provided evidence to support a late-Holocene intensification in the region from around 3000 yrs BP. This is evidenced by an increase in site occupation and land use in Cape York and along coastal regions of Queensland more generally, the initial occupation of offshore islands, and an increase in dependence on marine resources including shellfish, fish and turtle. Each of these attributes provide evidence that the occupation and development of cultural complexity in Torres Strait may have been a component of a wider regional process of late Holocene intensification. This is supported by 'Melanesian' influences in Cape York and along the Queensland coast, the most prominent of which is the southward distribution of both the double and single outrigger canoes (Rowland 1987).

However, in spite of the evidence for Melanesian influence on the northern Australian mainland, the archaeology of Torres Strait and the regions strong cultural continuities with southern New Guinea confirm that the cultural origins of Torres Strait lie firmly to the north. Although the recent results of excavations on Badu are reported to provide evidence of use of the island by Australian Aboriginal populations after Holocene transgression and before 3500 yrs BP, it is concluded that permanent occupation of Badu during the late Holocene was by Papuans from the north (David et al. 2004). The following section therefore provides an archaeological overview of southern coastal New Guinea largely as a chronological framework for reviewing the evidence for, and timing of, human occupation and cultural development in Torres Strait.

The Archaeology of Southern New Guinea

Archaeological research undertaken on the southern Papuan coast has investigated the antiquity of human occupation, but has predominantly focused on defining the nature of local trade, exchange and cultural interaction through the excavation and analysis of pottery (for example Allen 1972; Bickler 1997; Frankel and Rhoads 1994; Rhoads 1980, 1982, 1983; Sandy and Davis 1983; Swadling 1980; Vanderwal 1973b, 1978; Worthing 1980). Although this represents a substantial body of archaeological investigation, it is clear that by the mid 1980s research in southern Papua had taken a back-seat to the large-scale excavation programs conducted throughout New Guinea's northern offshore islands in search of Lapita.

The results of archaeological research on the southern New Guinea coast, including analysis of excavated cultural assemblages and radiocarbon dating, have demonstrated that the presence of pottery around 2000 yrs BP represents the first permanent human occupation of this region. However, several early pre-ceramic occupation sites are recorded, including Kukuba Cave on Yule Island at almost 4000 yrs BP (Vanderwal 1973b), and the Ouloubomoto and Rupo sites in the Gulf dating between 2500 yrs BP and 2000 yrs BP (Rhoads 1980) (Figure 3.1). Bickler (1997:151) remarks on the intriguing nature of this outcome, given that occupation elsewhere in New Guinea commenced tens of thousands of years earlier. He further notes that pottery production throughout Near Oceania had also already existed for about 1500 years before the tradition appeared in southern Papua (Bickler 1997). The results of radiocarbon dating from the site of Nebira 4, located approximately 16km north of Port Moresby, also confirm the relatively late antiquity of the southern Papua sequences, indicating that human occupation of the inland plain occurred around 2000 BP (Allen 1972). This period, dating from 2000 to 1200 years BP, is commonly designated as the 'Early Period' (Allen 1977a:391).

The remains of distinct red-slipped pottery constitute the dominant cultural material in the majority of the Early Period occupation sites in southern Papua. It is from the examination of these assemblages that a conclusion on the origin of the ceramic-bearing colonising populations of southern coastal Papua is derived. This is largely based on the comparison of the pottery from Nebira 4 and Oposisi (Yule Island), where both assemblages displayed almost identical features in form, decoration and antiquity (Allen 1972; Vanderwal 1973b). The ceramic assemblages were regarded as generically related to Lapita, and it was assumed '…the red-slipped pottery users spoke an Austronesian language, and that their origins are to be sought in the widespread migration(s) of pottery using peoples into the Pacific in the first or second millennia B.C.' (Allen 1972:122).

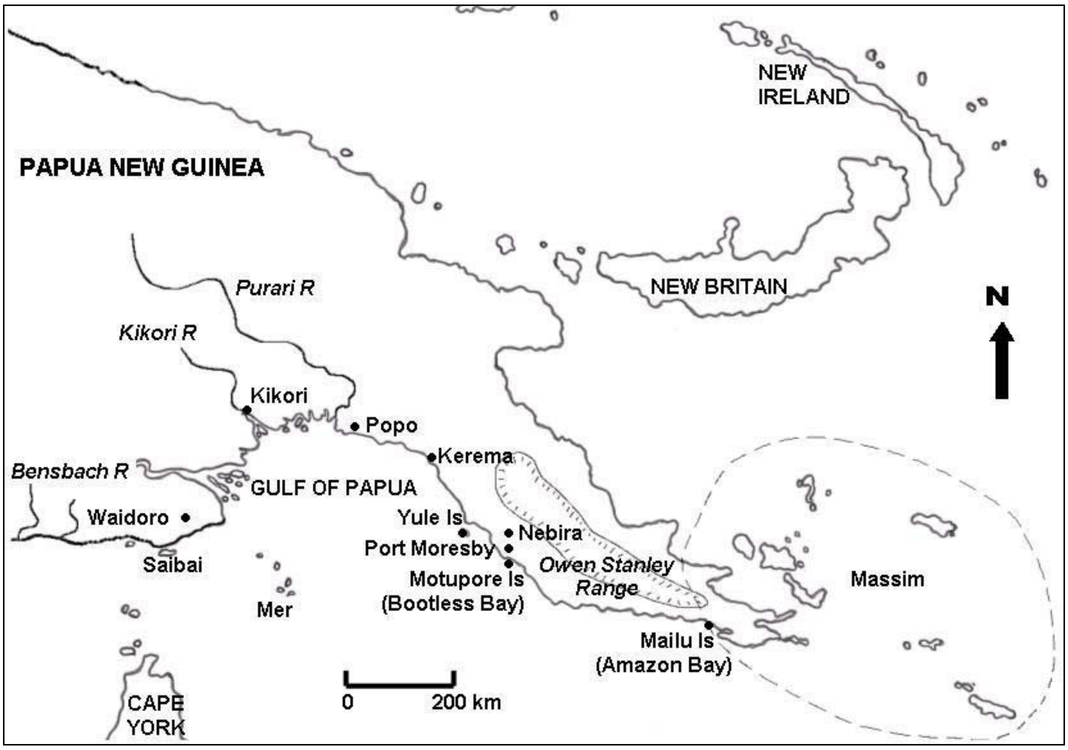

Figure 3.1 Southern New Guinea showing sites referred to in text

Pottery dating to this period was recovered during archaeological investigations at Samoa, located at Kikori inland of the Gulf of Papua (Rhoads 1983). The excavated pottery assemblage totaled 1.6kg and comprised mostly small sherds weighing about 2g. Based on morphological features, three different vessel forms were identified with a small number of sherds also having red slip and incised decorations. Rhoads (1983:99-100) concluded that the pottery assemblage was deposited during two phases; an early phase dating from 1900 yrs BP and a more recent phase dating to around 1400 – 1600 yrs BP. Due to the small size of the pottery assemblage no comparisons were made with pottery recovered from other sites along the Papuan coast.

Numerous chemical and petrographic analyses of excavated pottery assemblages have demonstrated early patterns and changes in production and trade along the southern Papuan coast (Allen and Rye 1982; Bickler 1997; Frankel and Rhoads 1994; Rye and Allen 1980; Rye and Duerden 1982; Swadling 1980). Bickler (1997) conducted one of the more recent analyses and included sherds from Port Moresby, Yule Island and the Gulf of Papua. Petrographic analyses revealed features that distinguished the pottery sherds, including the presence of chert in Port Moresby pottery, and the presence of larger fragments of quartzite, quartz and feldspar in the Yule Island wares. Bickler's (1997:159) results confirmed 'a rapid adaptation to local conditions indicated by the use of local clay sources during the earliest times', and the long distance exchange of pottery around Yule Island and Port Moresby between 1900 and 850 cal BP. Although exchange from Yule Island sites to the Gulf occurs simultaneously with the first evidence of pottery on Yule Island, from 1400 cal BP there is evidence that Port Moresby potters joined in exchanges with Gulf populations (Bickler 1997:160).

From 1200 yrs BP there is widespread change in settlement and pottery production and exchange along the south coast (Irwin 1985; 1991; Rhoads 1982). Dating from 1200 to 400 years ago this period is known as the 'Intermediate' or 'Middle Period' (Allen 1977a:393). During this time, Yule Island sites were abandoned and exchange between the Gulf and regions to the east stopped. This is known as the 'Ceramic hiccup' (Rhoads 1982:146) and is associated with the breakdown of exchange systems in the Papuan Gulf and the southern central coast. Several reasons for this shift have been offered, including the westward migration of peoples from the Massim (Bulmer 1975) and the movement of inland peoples from behind Port Moresby to the coast (Allen 1977b:448).

The most recent or 'Late Period' of occupation along the southern Papuan coast dates from 400 yrs BP and represents historically-recorded patterns of pottery production and exchange in the region. The most archaeologically distinctive trade network during this period is known as the *hiri* (1977a, 1977b; Frankel and Rhoads 1994). This was the annual voyage undertaken by Motu-speaking pottery traders from Motupore Island westward to the Gulf to trade for canoe hulls and sago (Figure 3.1). It is concluded that the Motu arrived at Motupore near Port Moresby around 800 yrs BP, which is signaled by a change in style of pottery decoration, as well as the deposition of substantial quantities of flaked stone artefacts, bone remains, marine shell and shell jewelry (Allen 1977a:443).

The commencement of Late Period pottery production and exchange from 400 yrs BP is attributed to number of factors including an economic necessity of the Motu to manipulate food resources beyond their immediate zone of marine exploitation (Allen 1977b:447), a desire to maintain links with regular trading partners and as a mechanism to acquire prestige associated with successful high profile activities (Frankel and Rhoads 1994:1). Late Period pottery assemblages have been recovered from several sites located between Kikori and Port Moresby, including Popo and Kerema (Frankel and Rhoads 1994). Petrological examination of these sherds has demonstrated that the pottery was imported from the east around Bootless Bay (Figure 3.1).

Archaeological research on the southern Papuan coast has been dominated by a focus on pottery assemblage, but the excavated sites have also produced significant quantities of subsistence remains including both marine and terrestrial resources, as well as an assortment of material culture items made from stone, shell and bone. In relation to the nature of subsistence assemblages in particular, a number of interpretations have been made of a change in focus between a marine-based economy and a more inland economy throughout the 2000-years of occupation.

Allen (1972:116) identified that pig, macropod (predominantly *Macropus agilis*) and fish dominated the excavated faunal assemblage at Nebira 4. (Figure 3.1). Dog teeth were also recovered, with two specimens exhibiting drill holes found in conjunction with shell beads (Allen 1972:119). Significantly, however, it was demonstrated that the percentage weight of marine faunal remains at the site showed 'a sharp decrease from the earliest levels to the most recent…', which 'suggests a strong marine element in the economy which diminishes in importance through time' (Allen 1972:116).

Based on this evidence Allen (1972:122) concluded that the most plausible reason why the Nebira people settled so far inland from the coast 'when presumably they could have established themselves right on the coast', was the availability of valuable gardening land and also the presumed good hunting conditions. A total of 51 shell artefacts were also recovered from the site, including small disc beads, drilled shells and ten pieces of *Conus* sp. armbands. This provides support for Allen's (1972:123) final conclusion that although Nebira 4 represents an attempt to move into a new ecological niche, networks and links were maintained with coastal settlers across long distances.

The excavation at Oposisi on Yule Island revealed numerous artefacts dating from 2000 yrs BP, including bone awls, spatulae, adze-like scrapers, tubular beads, pendants and gravers (Vanderwal 1973b:421-423). Many of these items were polished and have been interpreted as having had a range of functional and ornamental or decorative purposes. Shell artefacts included armbands made from *Trochus* sp. and *Conus* sp. shells, and a single pearl-shell artefact that was both ground and polished (Vanderwal 1973b:423-424). Vanderwal (1973b:424) identified many parallels between the Oposisi cultural assemblage and items recovered from elsewhere throughout New Guinea and the Pacific, with this evidence no doubt contributing to his conclusion that ‘those responsible for the Oposisi culture were descendants of the Lapita ‘traders’’. Several bone and shell artefacts were also recovered from excavations and surface surveys near Kikori in the Gulf Province (Rhoads 1983) (Figure 3.1). These included *Cypraea* sp. shell oranaments and shaped pieces of *Tridacna* shell with drilled holes. One of the bone artefacts is described as a broken fragment of polished bone spatula with a carving of a human face (Rhoads 1983:103).

The nature and density of the stone artefact assemblages recovered in southern Papuan sites is relatively varied. Over 7000 flaked artefacts, 12 hammerstones and two axe-head fragments were recovered at Nebira 4, along with small quantities of Massim obsidian in the earliest levels (Allen 1972:109) (Figure 3.1). With the major characteristic of the Nebira 4 stone assemblage being the small size of the artefacts, Allen (1972:109) defines it as ‘a small flake and core tool tradition’, comprising local fine-grained chert that occurs widely in the Port Moresby region. Other characteristics include a high proportion of scrapers (many of which show evidence of retouching), and an increase in the quantity of flaked stone in the upper most levels. Allen (1972:116) concludes that the lithic assemblage from Nebira 4 ‘is a relatively complex suite of flaked stone tools previously undocumented in New Guinea’, but also confirms that this unique assemblage bears very little or no resemblance to the mid-Holocene Australian stone assemblages.

Less complex stone artefact assemblages were recovered from Kikori (Rhoads 1983), and the sites of Oposisi and Apere Venuna (Vanderwal 1978). For Kikori a total of two small cores, four flakes and four fragmented axe-heads comprised the entire stone assemblage. One artefact was made from quartzite, while the remaining flakes were identified as a non-local chert. The axe-head raw materials were identified as a local volcanic tuff and a metamorphic volcanic rock most probably sourced from the western Owen Stanley Mountains approximately 300km southeast of the Samoa site (Rhoads 1983:101) (Figure 3.1). From his examination of 17 adzes recovered from Oposisi and Apere Venuna, Vanderwal (1978:417) comments on similarities between these and axe head fragments from Nebira 4 and Amazon Bay further east, concluding that 'the Oposisi / Apere Venuna adze forms could easily be lost in an early Oceanic adze kit' (Vanderwal 1978:417).

In returning to the topic of horticulture in coastal Papua, it is clear that the archaeology of southern lowland horticulture is considerably less well known than the intensively studied horticultural economy of the New Guinea Highlands (Denham et al. 2003; Golson 1976, 1977, 1989, 1991; Wilson 1998). Barham and Harris's (1985) investigation at Waidoro, located approximately 45km west of Daru and some 20km northeast of Saibai Island, is the only archaeological research undertaken on mounded field systems in the region. More recently, however, Hitchcock (1996) has also described relict horticultural ditch-and mound systems along the lower Bensbach River in the Western Province (Figure 3.1).

The Waidoro area is a mixture of lowland forest, grassland and alluvial plains, and is flooded annually during the wet season (Laba 1975:32). By preference traditional gardens were cultivated in the forested areas, where plots were cleared of trees and the ground prepared for planting (Laba 1975:34). Barham and Harris (1985:267-268) noted that although mounds are still cultivated on an extensive scale by traditional methods at Waidoro, mound construction took place before living memory of the present villagers. The recorded mounds were rectilinear in plan and ranged from 16-20m in length and 9-11m in width, with their surfaces approximately 40cm above the level of the ditch base (Barham and Harris 1985:267). The growing season was dependent on the length and intensity of the wet season (January to August), during which time the ditches filled with water. The principal crop Taro (*Colocasia esculenta*), was planted on the highest part of the mounds, where other crops such as beans, yam, sugar cane, banana, sweet potato and manioc were also occasionally grown (Barham and Harris 1985:268, Laba 1975:34). Traditional gardening tools included digging sticks and stone axes, and since the late 19th century, metal axes (Laba 1975:34-35).

Preliminary test pitting undertaken by Barham and Harris (1985) to locate underlying substrates and suitable organic material for radiocarbon dating was unsuccessful. They concluded that much like the horticultural ditch-and mound systems on Saibai, the former functioning of the Waidoro field systems 'appears to be intimately connected with micro-topographically controlled adaptations to seasonal changes in water levels' (Barham and Harris 1985:271). Hitchcock's (1996:38) preliminary investigations of raised field systems in the lower Bensbach River area support this view, and based on field survey, archival research and testimonies from the Waratha people, he concludes:

> The evidence to date clearly demonstrates that in the lower Bensbach River area, relict mound-and-ditch fields were constructed up until the 1930s, when as a result of dynamic vegetational and hydrological changes the Waratha ceased making them.

Hitchcock (1996:37) states that in response to these changing conditions the Waratha 'shifted to a wet season agricultural regime based on swidden cultivation in forested areas above the flood waters'.

Archaeological Implications for Torres Strait

The archaeological evidence from southern New Guinea has suggested a surprisingly recent human occupation of this region. However, initial human occupation of the region is dated to around 4000 years BP, which confirms the presence of non-ceramic populations along the southern Papuan coast before the proposed settlement of Torres Strait around 2500 yrs BP. The recovery of pottery from 1900 BP at Kikori inland of the Gulf Province, however, suggests the possibility of contact between the late Holocene occupants of Torres Strait and the Early Period ceramic traditions in New Guinea.

Although limited, anthropological and archaeological investigations on the nature of horticultural systems in southern Papua have revealed similarities to the relict mound-and-ditch fields on Saibai adjacent to the coast, as well as the presence of a suite of cultigens also documented ehthnographically for the Eastern Torres Strait. These traits confirm that connectivity between lowland southern Papuans as well as interior riverine groups with the Northern and Eastern Torres Strait Islands may have considerable time-depth and date to well before the late 19th century.

Conclusions

This chapter has demonstrated that in spite of 30 years of archaeological research in the Torres Strait, answers to the fundamental questions of the antiquity of human occupation, the development of marine and horticultural subsistence and the nature of pre-European trade and exchange, have only recently begun to emerge. Even so, these answers have largely emerged for Northern Torres Strait, where the majority of long-term research before the commencement of MIAP was concentrated. During the last 30 years the Eastern Islands experienced a single fledgling archaeological inspection, which although brief and non-systematic in nature, did document the archaeological potential of the Murray Islands (Vanderwal 1973a). As the following chapters on the natural and cultural background of the Murray Islands and the results of the archaeological excavations and analyses demonstrate, such an interpretation is certainly justified.

Lastly, however, a further contrast to the rudimentary state of Torres Strait archaeology during the late 20th century is the intensively investigated and well-documented mid- to late Holocene archaeological sequences of both northern Queensland and southern New Guinea. Radiocarbon chronologies have established that the localised expansions and migration of coastal populations, intensification of subsistence systems, development in technologies and the enhancement of social and cultural networks in both of these regions occurred within the last 3000 - 2000 years. The fact that a similar late-Holocene human antiquity is emerging for Torres Strait confirms that these islands were not peripheral to the dynamic and complex changes experienced by populations to the north and the south.

Chapter 4: The Natural and Cultural Background to the Murray Islands

> *The island, towering black, big Gelam with its little hills sloping away down to the indistinct lands. A stone's throw across the water was shadowed the precipitous peak of tiny Dauar with the castellated cliffs of Waier, isle of evil, beside it; and over all a dome of velvet blue pierced by a million stars. It seemed that the curtains of heaven were withdrawn, so that the angels might gaze upon Mer* (Idriess 1947:1).

This extract illustrates the remarkable degree to which the physical presence of the Murray Islands captured the imagination of mid 20th century romantic novelists. As demonstrated in the previous chapter, however, these intriguing narratives and a large body of ethnographic literature evidently failed to promote future archaeological interest in the Murray Islands. Taking a significantly less fanciful and romantic approach, this chapter first provides an environmental description of the Murray Islands, followed by information on the islands' cultural setting. Throughout the chapter an emphasis on information relevant to the objectives of this thesis is maintained.

The Natural Setting

The islands of Mer, Dauar and Waier are the remains of three well preserved volcanic cones of Pleistocene age, during which they were last active (Willmott et al. 1973:14). Commonly referred to as the *Maer Volcanics*, the erosionally degraded Pleistocene basalt and tuff that comprise the small volcanic islands of the Eastern Torres Strait (including the Murray Islands, Erub and Ugar), a small exposure at Bramble Cay in the northeast of Torres Strait, and the calcareous tuff and tuffaceous sediments forming Daru Island on the southern coast of New Guinea (Willmott et al. 1973:50).

Mer

Mer Island is the largest of the Murray group (Plate 4.1). It is separated from Dauar and Waier to the southwest by a channel approximately 2km wide and 40m deep. The island is approximately 2.8km in length, 1.65km at its widest point and with an area of 386ha. A simple twofold division of the island's geology and derived soils into predominantly ash deposits in the higher western half of the island, and lava flows in the lower eastern part of the island, conditions present topography, regolith and vegetation.

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Plate 4.1 Mer Island with Waier (left) and Dauar (right) in background (photo: Gateway Resort Museum, Horn Island)

The western half of Mer consists of the remnants of an elliptical crater, Gelam, composed of volcanic ash and scoria locally imbedded with lava (Figure 4.1). The crater rim is now highest on the northwest side of the island, where a summit peak reaches a height of 210m. A long grass covered ridge runs for 1.3km above the northwest coast and present village at Umar, terminating at a low hill, Zomar. Deeply incised valleys dissect the southwestern part of the island, which accommodate waterfalls and gullies fed by ephemeral wet-season streams.

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Figure 4.1 Mer Island showing place names referred to in text (after Bird 1996:109)

Two deep valleys reach the southern shore at Nemer Pit and Werbadu (Haddon et al. 1894, Plate XXII). A third valley, running east-southeast reaches the coast at Er, and marks the geological boundary between tuffs to the west and basalt lava flows to the east. The western half of the island now supports low scrub and fired grasslands, with local pockets of vine woodland along creeks. The eastern interior is a relatively flat tableland formed on low viscosity olivine-basalt lava flows lying c. 60-80m above sea level. The interior is extremely fertile, with deep reddish-brown soils developed on the underlying lavas. Densely vegetated today, Haddon (1935 I:30-31) described the eastern interior of Mer as thick with vegetation and cultivated crops.

Mer is completely surrounded by a large fringing reef of variable width, being widest off the northeast, east and southeast shorelines. In the northwest the fringing reef is partially covered by sea-grass beds developed on calcareous muds deposited within the protected area formed by large fish traps. A lithothamnion ridge forms the outer margin of the eastern and southeast reef flat. Live corals are predominantly restricted to the outer fringing reef and reef edge, except on the east of the island (Mayer 1918) (see Figure 4.1 for illustration of reef zones).

The southern coastline is either formed of low cliffs, or undercut marine notches eroded into bedrock, with boulder beaches marginal to the reef flat. Isolated sand beaches occur on the east and southeast coasts (at Las and the former village sites of Er and Werbadu) but most sandy beaches are restricted to the north and northwest coastline (leeward to the southwest trade winds). Most parts of the coastline exhibit modern erosion around storm tidal datums, revealing archaeological stratigraphy in many eroding sections at the junction of lower slopes with the present beach. Most beaches exhibit either cemented lava boulder beaches, or coarse sandy beachrock at elevations between low tide and high tide datums. Mayer (1918:7) noted the rapid rate of cementation of the Holocene intertidal beachrocks, and also described archaeological artefacts (granite manuports, which he interpreted as slingshot ammunition) cementing into the upper surface of the beachrock. These lithified deposits reflect substantially higher wave energy environments than those operating at present, suggesting that coastal intertidal and subtidal environments may have altered substantially since the mid-Holocene, as reef flat developed off shore.

Dauar

Dauar is the second largest of the Murray Islands and is 1.6km in length and approximately 800m at its widest point (Plate 4.2). The island's topography is dominated by the remains of two volcanic ash cones formed of steeply dipping tuffs. The larger, Au Dauar, rises steeply to 185m above the sea, with the smaller, Kebi Dauar, rising to 76m (Haddon 1935 I:31-32, Jukes 1847 I:205) (Figure 4.2). The coastline is variably rocky with low undercut cliffs, erosional notches and intertidal rock platforms and beach rock forming the shoreline within embayments. Most of the latter, such as at Sokoli and Ormi, show evidence for active marine erosion, exposing beach sands, rock talus and colluvium in low (1 - 4m high) eroding cliff sections.

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Plate 4.2 Waier Island (foreground) and Dauar Island (background)
(Photo: Gateway Resort Museum, Horn Island)

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Figure 4.2 Schematic map of Waier Island and Dauar Island showing place names referred to in text (Lawrie 1979)

Well-developed sand spits occur at the eastern end of Dauar (facing Waier) at Teg (Haddon 1935 I:31, Haddon et al. 1894, Plate XXIII) and at the western end of the island at Giar Pit. The island interior has variable soil cover, with grassland and bushes on the upper slopes, and denser woodland with deciduous thicket on lower areas (Haddon et al. 1894:437).

Waier

Waier is the smallest island in the Murray group and is formed by a crescent shaped rim of a small volcanic crater, breached towards the southeast to form a lagoon (Plate 4.2). The island is only 610m in diameter and is composed entirely of stratified volcanic tuffs (Haddon 1935:332; Haddon et al. 1894:438-439) with near-vertical walls that rise out of the sea about 80m above the fringing reef. Slopes are very steep all over the islet and are severely furrowed and fissured. Most of the coastline is cliffed and rocky except for a sand beach on the eastern side of the lagoon, a small beach on the north side of the islet, and a sand spit, Waier Pit, facing Dauar to the west (Figure 4.2). There is minimal soil and vegetation cover on Waier, except in gullies and a small patch of luxuriant vegetation located on the small beach in the interior lagoon. Waier and Dauar are also enclosed by a single fringing reef. During high tides the islands are separated by only 100m of lagoon underlain by subtidal and intertidal sandbars.

Flora and Fauna

Recent research into the terrestrial biodiversity of the Torres Strait islands has largely been based on broad regional studies and surveys, resulting in limited data being available for the taxonomic and distributional data of individual islands or island groups (Cameron et al. 1978; Draffen et al. 1983; Freebody 2002; Neldner 1998). Data on the terrestrial flora and fauna of the Murray Islands has been extracted from surveys undertaken by Freebody (2002) and Neldner (1998). Where it is available, historical data on the islands floral and faunal species are also cited. Observations of flora and patterns of vegetation were also noted by the author during archaeological fieldwork on Mer and Dauar and are used in addition to these published sources.

Local flora and vegetation patterns

In a recent biodiversity survey of Torres Strait, the Eastern Islands recorded the highest percentage of alien taxa, forming 26.4% of the total (Neldner 1998:67). This is reflected in the identified proportions of plant families on the islands, with the largest number of species recorded being of Poaceae (grasses) with 31 species, Fabaceae (herbs, vines, shrubs and trees) with 23 species and Euphorbiaceae (deciduous trees and oil and starch producing crops) with 17 species (Neldner 1998). The proliferation of alien taxa on the Eastern Islands is attributed to the disturbance created by direct human influences such as urbanisation and cropping, and indirect influences through altered fire regimes. In the latter instance, Neldner (1998:30) commented that the extensive grasslands on the slopes of Mer were an example of the high level of disturbance caused by deliberate burning. There is also some historical reference to vegetation disturbance on Mer.

Haddon (1912:146) recalls Robert Bruce mentioning to him in 1889 that an enormous quantity of timber had been felled on Mer for the construction of the missionaries' houses, but particularly for boat building. However, observation of the grass covered slopes on Mer during the late 19th century suggest that this vegetation type may have existed well before permanent European presence on the island (Jukes 1847 I:175). Haddon et al. (1894:427) also remarked on the less fertile nature of the western half of Mer, owing to the high permeability of soils derived from the underlying ash. Chalmers and Gill (1885:28) also commented on the drought-prone nature of parts of Mer in 1877.

In contrast to the sparsely vegetated western slopes of the island, historical observations of the eastern half of Mer recorded the luxuriant and abundant nature of its vegetation. Haddon (1935:30-31) describes profuse coconut groves, fruit trees such as mangoes and gardens of bananas (*Musaceae* sp.), yams (*Dioscorea* sp.) and sweet potatoes (*Ipomoea* sp.) in this part of the island. Many of these species are recognised as staple plant-foods throughout Melanesia (French 1986; Yen 1995). Today on Mer the eastern half of the interior tableland still supports dense vine thicket, groves of bamboo, feral mango trees and secondary re-growth interspersed with garden plots. Plate 4.3 provides an aerial view of Mer showing the contemporary division between grasslands in the west and dense vegetation in the east.

Plate 4.3 Aerial view of north coast of Mer Island showing west-east vegetation differences

The eastern side of Mer and a small portion on the southwest coast at Werbadu, where a deep valley dissects the foreshore bringing freshwater from the slopes, consist of a vegetation unit defined as closed mesophyll vine forest vegetation (Neldner 1998:28). In addition to the cultivated species mentioned previously, a number of canopy tree species as well as low trees, shrubs and robust climbers may be present in this region. Scattered Taro (*Alocasia macrorrhiza*) and ferns occur in places on the ground layer, which is otherwise sparse. This vegetation unit is described as restricted to sheltered, more inland areas.

On the dryer, more exposed slopes the closed mesophyll vine forests are reduced to a vegetation unit defined as semi-deciduous mesophyll/notophyll vine forest (Neldner 1998:28). In addition to the vegetation types mentioned above, deciduous canopy trees such as *Bombax ceiba* var. *leiocarpum* occur in these areas. In the western half of Mer the *Themeda* spp. grasslands have almost entirely replaced the semi-deciduous slope vegetation (Nelder 1998:28).

A small vegetation unit defined as open woodlands and herblands on the littoral zone is located along the northwest foreshore of Mer (Freebody 2002). Species noted on the frontal dunes include pandanus *(Pandanus tectorius*), sea almond (*Terminalia catappa*), orchid tree (*Bauhinia purpurea*), coconut (*Cocos nucifera*) and cheese fruit (*Morinda citrofolia*). Ground cover on beach ridges is dominated by *Ipomea pes-caprae* and low grasses. Several of these species are typical Melanesian tree domesticates (Yen 1995).

Semi-deciduous mesophyll/notophyll vine forest most consistently defines the dominant vegetation type observed on the western half of Dauar Island. The rocky slopes of the larger western hill are scattered with *Bombax ceiba* var. *leiocarpum* interspersed amongst low grasslands, while the lower slopes of the smaller eastern hill are vegetated with woodland with deciduous thicket more common in the closed mesophyll vine forest vegetation unit. The lower interior saddle of Dauar has variable soil cover and is vegetated with pockets of bamboo (*Bambusa* sp.), but is mostly dominated by low to medium canopy trees and shrubs (particularly Fabaceae) and large numbers of Malvaceae (particularly *Hibiscus* sp.). Various cultivated species also grow in the interior portion of Dauar, including pawpaw (*Carica papaya*), banana (*Musa* sp.) and cassava (*Manihot esculenta*). In areas where the littoral zone meets an exposed beach, such as at Sokoli and Ormi, common species include coconut

(*Cocos nucifera*), frangipani (*Plumeria* sp.) and pandanus (*Pandanus tectorius)*.

The results of recent biodiversity surveys and information obtained in historical records indicate that a number of indigenous activities and post-contact processes may have played a significant role in the contemporary nature and distribution of vegetation on the Murray Islands. These include burning, clearing and planting by islanders, post contact clearing and felling, and localised fertility caused by the underlying geology of the islands. The diversity of the floral species present also indicates that a number of varieties have been introduced. These include decorative angiosperms such as frangipani and hibiscus, and a number of economic species such as the pawpaw and mango. The faunal diversity of the Murray Islands is similar in that it is also a product of several external factors (Cameron et al. 1978 and Draffen et al. 1983).

Terrestrial and marine fauna

Information on the terrestrial faunal of the Murray Islands is relatively limited. Although Haddon (1912:152) observed wild pigs on Mer around the turn of the 20th century, based on a review of historical accounts McNiven and Hitchcock (2004:113) suggest that 'pigs were absent or extremely rare in Torres Strait prior to European settlement'. Today pigs are kept on Mer in small numbers for specific large-scale feasts, and are usually obtained from feral stock on neighboring Erub Island (Bliege Bird et al. 1995:6). Several historic references to Murray Islanders obtaining dogs from the north coast of 'New Holland' (Jukes 1847 I:180, King 1983:56 and Rutherford 1833 in Haddon 1935:97) are recorded. Today both dogs and cats are kept on Mer as pets. Rodents including *Melomys*, *Rattus* and *Hydromys* species probably comprise the dominant mammal population on the Murray Islands.

Goannas (*Varanus* sp.) are common on the Murray Islands and today are captured primarily for their oil and skin for drum making (Bliege Bird et al.

1995:5). Although over twenty species of snakes have been identified in the Torres Strait (Cameron et al. 1978), snakes are today rarely encountered on the Murray Islands. Green tree frogs *(Litoria caerulea*) on the other hand, are commonly observed on Mer. Coastal and offshore birds including herons (*Egretta* spp.), frigate birds (*Fregata* spp.), terns (*Sterna* spp.), noddies (*Anous* spp.) and the Torres Strait pigeon (*Ducula spilorrhoa*) are observed on the Murray Islands. Larger birds of prey such as kites (*Haliastur* spp.) and sea eagles (*Haliaeetus leucogaster*) can be seen nesting in trees along the coast.

In contrast to the limited terrestrial faunal diversity of the Murray Islands, a much greater diversity and abundance of species occupies the marine environment. The coasts of Mer, Dauar and Waier provide a variety of intertidal habitats including tidal pools and inshore lagoons, expansive reef flats and fringing reefs, sandy beach embayments and rocky foreshore areas. A great diversity of molluscs, crustacea and fish inhabit these ecosystems, providing an abundance of edible resources.

Although almost 1500 fish species have been recorded for the northern Great Barrier Reef, ten families, including reef and pelagic species, have been identified as particularly important to contemporary Meriam subsistence (Bird 1996:30). Mollusc species commonly collected and eaten in the Eastern Islands today include numerous common tropical reef and rocky shore gastropods and bivalve species (Johannes and MacFarlane 1991:98) (details on species given below). Crustacea, including prawns and crabs are rare, although, the tropical rock lobster (*Panulirus ornatus*) is more common and is today used by the Meriam for commercial and subsistence purposes (Bird 1996:31). Octopus and squid are abundant in the waters of Eastern Torres Strait and are eaten and used as bait. Sharks are common around the Eastern Islands, but along with rays and eels are not generally eaten today. Green turtles (*Chelonia mydas*) are the most common turtle around the Murray Islands and are especially abundant during the mating season (September to December) and nesting season (October to March). Hawksbill turtles (*Eretmochelys* *imbricata*) occur less commonly and are significantly less important to the contemporary Meriam diet (Bird 1996:30). Dugongs (*Dugong dugon*) are rarely seen in the deeper waters around the Eastern Islands today, but may have been more common in the past (Johannes and MacFarlane 1991:98).

The Cultural Setting

People and Demography

Traditionally the Meriam inhabited Dauar, Waier and small villages around the entire coast of Mer. At the time of Haddon's visit in 1888 and 1889, however, a schoolhouse and church had already been constructed in the area that forms the centre of the modern village of Umar on Mer (Laade 1973:152). By the 1960s villages on Dauar and Waier were abandoned and the Meriam population became concentrated in a narrow village along the northwest foreshore of Mer and at Las, a small village on the eastern side of the island. Early population estimates suggest that the Murray Islands were densely populated at the time of European contact. In 1802 Matthew Flinders estimated a population of 700 (Haddon 1935:95), while the London Missionary Society records of 1873 suggest a population of 800 (Murray 1872:34). The current indigenous population of the Murray Islands is around 400 (Australian Bureau of Statistics 2001).

The first recorded observations of village life on Mer depict scenes of large dome-shaped huts (commonly called beehive huts) in clusters along the beach (Brockett 1836:24-25; Jukes 1847 I:132) (Figure 4.3). Made from lengths of bamboo scaffold and covered with grass thatch, the houses were relatively large measuring approximately 15 feet high and 18 feet in diameter (Jukes 1847 I:251). They were also fenced with large bamboo poles and had gardens and coconut groves (Jukes 1847 I:172). This organised and permanent style of village life in the Eastern Islands was referred to by Jukes (1847 I:132) as a feature confirming that Torres Strait

Islanders were different to the indigenous people of mainland Australia, and more similar to the Papuans of New Guinea.

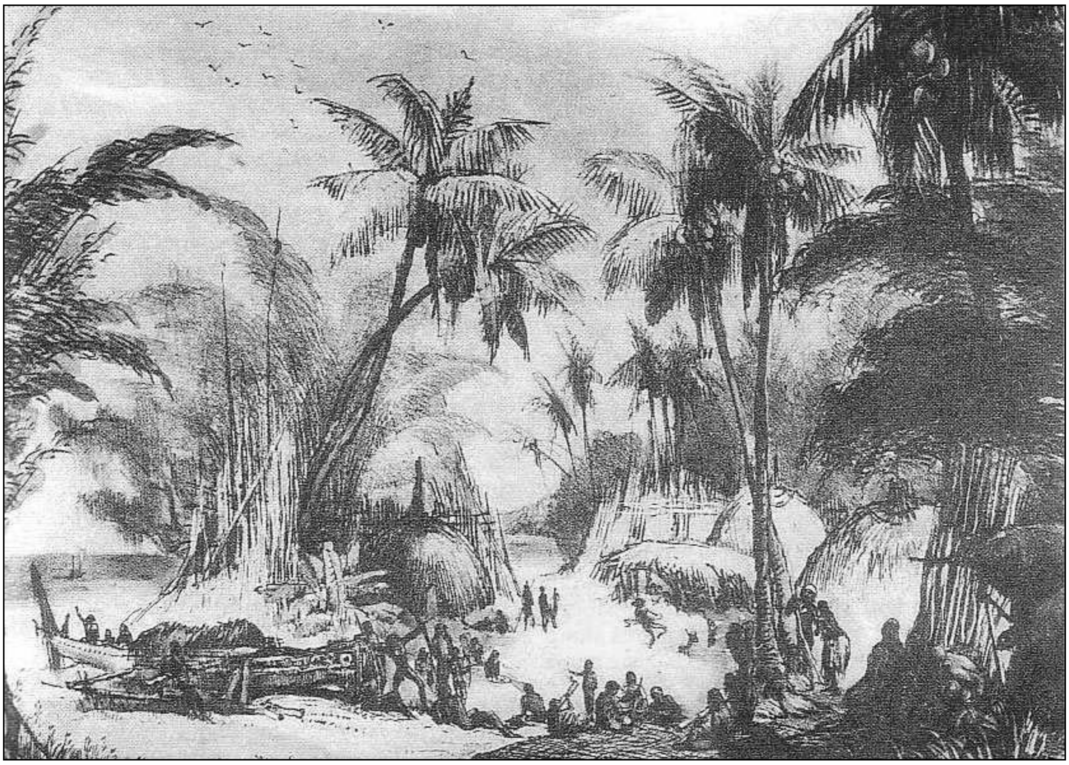

Figure 4.3 Village scene on Erub (Darnley Is) (Melville 1848: plate XVII)

Language and Oral Tradition

The language spoken by Eastern Torres Strait islanders, Meriam Mir is distinct not only from Australian languages, but within the Torres Strait itself. Haddon (1935:289) stated that 'the most prominent difference between western and eastern islanders is that they speak entirely different languages which have no genealogical connection'. Meriam Mir belongs to the Papuan (Non-Austronesian) language family and is closely related to the Bine, Gidra and Gizra languages spoken by the inhabitants of the Oriomo River region on the New Guinea mainland (see Figure 2.2). As a member of the Eastern Trans-Fly linguistic family, Miriam Mir is distinguished also by its adoption of some southern New Guinean Kiwai language features (Lawrence 1991) (see Figure 2.2). Miriam Mir is linguistically distinct from Kala Lagaw Ya and the dialectical variants of this language spoken throughout the rest of the Torres Strait. Kala Lagaw Ya is structurally an Aboriginal language and is closely related to Pama Nyungan languages from Cape York Peninsula, although does have some Papuan elements (Wurm 1972).

Although displaying some Australian elements, as a member of the Eastern Trans-Fly languages, Meriam Mir is seen as a product of the southward movement of languages from central and southern New Guinea, including Kiwai, around 2000 years ago (Wurm 1972). This influence came almost 2000 years after the splitting of the Eastern Trans-Fly stock into daughter languages, estimated to have occurred 3000 to 4000 years ago (Wurm 1972:361). Citing the contemporary and historic trade relationships between Meriam and Kiwai, Bird (1996:46) offers the possibility:

> …that the distinction between Meriam Mir and other Trans-Fly languages developed in situ after a sub-set of the stock Eastern Trans-Fly speaking population emigrated to the Eastern Islands and later had extensive contact with Kiwai speakers.

A number of Meriam oral legends also provide evidence in support of a southern New Guinea origin, such as the story of Pop and Kod who came from the Fly River district to found the Meriam population (Lawrie 1970). Although the Meriam recognise New Guinea as the home of their ancestors, Las on the eastern side of Mer is where they consider their social origin to lie (Bird 1996:48).

Trade and Material Culture

Chapter 2 demonstrated that ethnographic records and oral histories provide strong evidence for exchange partnerships and kinship ties between the Meriam and coastal Papuan groups of the Fly Estuary, including Parama Island, Sui and Kiwai Island, and the southwestern coastal villages of Mabudawan, Mawatta and Katatai (Lawrence 1994:297) (see Figure 2.11). Haddon (1935:183) describes the trade route from Mer as via Erub and Ugar to the Central Islands including Damut and Tutu, then directly north to Daru where goods moved eastwards along the coast to Parama and Kiwai, and west to the coastal sites of Mawatta and Turituri (see Figure 2.10). Although several trade routes and patterns of exchange are recorded (Lawrence 1994: Figs. 25-29), the principal trade route into the Eastern Torres Strait appears to have an origin in the Fly Estuary and then traveled a westward route along the southwest coast:

> Formerly Murray Island had a brisk trade with the New Guinea coast from the Fly River westward. This was carried out directly, but was conducted by a privileged tribe at Murray Island, through Darnley Island, and then by Darnley through Warrior Island. In this tedious and round about way the Murray Islanders obtained their canoes from New Guinea, and the Papuans obtained their shell ornaments (Macgregor 1911:4).

Goods sent to Papua via this route included shell ornaments such as pendants, armlets, necklaces nose ornaments and pearl shell breast ornaments, turtle shell and gifts of food. The islanders received in return cassowary and bird of paradise feathers, dogs-teeth necklaces, pigs tusks, sago-palm petticoats, pandanus mats, bows and arrows, stone-headed clubs, drums and canoes, with Haddon (1935:182) suggesting that 'in fact nearly all their moveable requirements for work, fight or play came from the Fly River'.

On Mer the Komet clan appears to have played a central role in inter-island and regional trade (Haddon 1908:186; Laade 1969). This clan specialised in voyaging to other islands and members were renowned throughout the region for their seafaring skills and as intermediaries in trade and exchange (Lawrence 1994:259, 273; 1988:23). According to Haddon (1908:185) members of the Komet clan were the 'traders in canoes' for the Murray Islanders, the canoes being traded directly from the Fly Estuary via Parama, then to Ugar, Erub and Mer (Figure 4.4).

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Figure 4.4 'A native canoe meeting strangers off the Murray Islands' (Edwin Porcher 1845). Note left to right, Mer, Waier and Dauar (Photo National Library pic-an4101817)

In contrast to their trading associations with Papuan groups, Haddon (1908:185) remarked that 'owing to their remote situation the Meriam were practically debarred from intercourse with Australia and the inter-insular trade probably did not amount to very much…'. Baldwin (1976:16) has suggested that head hunting practices of the Central and Western Island groups may have prevented Eastern Islanders from making contact with Cape York Aboriginal groups. As Lawrence (1994:287) states, for the relatively resource rich Eastern Islanders contact with Papuans of the southwest coast was not only considerably easier, but also more economically advantageous than contact with southern Aboriginal groups.

However, several references to Murray Islanders voyaging southward to the eastern coast of Cape York suggest some level of direct contact between the Eastern Torres Strait Islanders and the peoples of northern Australia (Jukes 1847 II:541; King 1837:26). Through a combination of oral evidence and documented kinship ties, Lawrence (1994:297) confirms that while contact between Eastern Islanders and southern mainland groups was limited, at the time of European contact the main exchange contacts for the Murray Islands was with 'coastal Papuans concentrated on the coastal Kiwai-speaking peoples of the lower Fly estuary, Parama Is. and the Mawatta-Katatai coast'.

Social Organisation and Subsistence

Meriam social organisation and territoriality centres around eight Meriam clans (nosik): Meriam (Piadram and Samsep), Geuram, Magaram, Dauareb, Peibri, Komet, Meuram and Zagareb (Rivers in Haddon 1935:22) (Figure 4.5). Bird (1996:38) explains that Meriam clans 'are composed of groups of patrilineally related, mostly exogamous, totemically organised descent groups grounded in their spatial relationship to the Meriam land and seascape'. Each clan is associated with their own totem (lubabat), seasonal wind (kerker), and island district (ged). Clan-owned property on Mer is divided into wedge-like portions that extend from the interior of the island outward to include stone-walled fish traps (*sai*) and the edge of the fringing reef. Fishing and land use rights within clan boundaries are further divided among patrilineages (Johannes and MacFarlane 1984). Residential plots (including the foreshore to the edge of the fringing reef) and interior garden plots are owned and managed by individual patrilines (Bird 1996:40). Although property inheritance usually passed from a father to his eldest son, Wilkin (cited in Haddon 1908:165) described the interesting occurrence among the Meriam where a man could also leave, give away or loan land and gardens to whomever he wished. This practice still occurs on the Murray Islands today.

As mentioned briefly in Chapter 2, Haddon (1908:192-240) recognised that the cult of Bomai-Malo and its associated initiation rites, public ceremonies, sacred power (zogo), law (Malo ra gelar) and customary land tenure (gelar tonar), were of supreme significance to Meriam life. Bomai is said to have arrived on Mer in the form of an octopus whose eight tentacles represent the eight clans of Mer. Malo ra gelar set out the rules for all Meriam concerning gardening activities, land and food utilisation, social conduct, and property rights and obligations (Laade 1969, 1973).

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Figure 4.5 Mer Island showing clan divisions and fishtraps (after Haddon 1935:160)

From the Bomai-Malo cult arose a secret society of initiated men from various clans, each having their own set of ceremonial and public responsibilities. The most important of these men were the zogo le, who were entitled to take leading parts in the ceremonies and received limited public offerings in the form of food and gifts. These men were also the regulators of Malo re gelar and gelar tonar and could enforce these traditions with punishment by death. Today Malo re gelar and gelar tonar remain of great significance to the Meriam (see Sharp 1993).

Although there is some variation in the way the organisation and nomenclature of Meriam clans are described in the ethnohistorical and anthropological literature, the subject of clan specialisation has remained a common topic of interest (Bird et al. 2000; Carter in press; Laade 1969, 1973; Lawrence 1994; Sharpe 1993). The central role played by the Komet clan as intermediaries in trade has been mentioned previously. Based on his fieldwork on Mer during the 1950s Laade (1969) identified a fundamental east-west distinction between the Meriam clans. He suggested that the Meriam Le, comprising the Piadram, Zagareb, Geaurem and Magaram clans were regarded as 'the people belong garden', while the Komet Le, consisting of the remaining clans were 'the people belong water' (Laade 1969:36). According to Laade's (1969) interpretation the Meriam Le were the gardeners of Mer and owned most of the fertile land on the eastern side of the island. The Komet Le on the other hand, inhabited Dauar, Waier and the western side of Mer, and did the majority of fishing and the hunting and gathering of resources (Laade 1969). Importantly, Laade (1969) identified that clan specialisation did not translate into restrictions on the consumption of either marine or vegetable foods, but encompassed a form of prohibition on the subsistence activities themselves. A comment from one of Laade's (1969:36) informants emphasises this point:

> When I been young I went for sardines with weres [fish scoop]. I fall, got sore leg. My grandfather he take my weres, break it say: 'You never go fishing again'. Bush (gardenland) your fishing ground. You (are a) Samep.

However, recent anthropological fieldwork conducted on the Murray Islands has highlighted inaccuracies in Laade's (1969, 1973) descriptions of clan specialisation. Based on observations of Meriam subsistence activities and the roles played by men, women and children, Bird and Bliege Bird (pers.comm.) claim that most of the specialisation in a clan was the result of male-male competition. They suggest, for example, that while Meriam men competed especially in gardening and displaying produce, Komet men competed in broader affairs of trade while Dauareb men were great spearfishermen. While some of these competitions revolved around subsistence activities, it was indeed not the case that Meriam Le had to rely on trading garden produce for fish as a matter of daily subsistence. The research shows that while men compete socially in specialties that may be associated with clans, women of all clans fish, garden and collect shellfish as a matter of daily household subsistence.

Anthropological research undertaken on Mer has also demonstrated that until the 1970s gardening remained the focus of most of men's effort, with considerably less time spent on fishing or hunting (Duncan 1973). Men concentrated on the labor intensive planting of yams and bananas, which were designated for competitive display at feasts, rather than family consumption (Bird 1996:101). While women were not permitted to enter these 'display' gardens, both men and women tended 'kitchen' gardens, which grew a broader variety of produce for household consumption. Thus unlike men, it appears that women have predominantly concentrated on fishing and gathering activities (Bird et al.1997:101). This confirms Haddon's (1912:154-455) observation that the gathering of shellfish was a subsistence activity predominantly undertaken by women and children.

Archaeological implications

Traditional clan organisation and the role clans played in the overall subsistence economies of the Murray islands must be considered in the context of these recent anthropological observations. This work has demonstrated that any prediction of the distribution and nature of archaeological site types based on historically documented descriptions of clan organisation and subsistence would be problematic. According to Laade's (1973) interpretations, marine subsistence remains, such as shell middens, would be disproportionately located on the western side of Mer and on Dauar and Waier, while the archaeology of the eastern side of Mer would comprise predominantly evidence of horticultural subsistence. The research conducted by Bird et al. (1997) has indicated that such a clear-cut division of subsistence-related archaeological site types across the islands is not likely. Indeed Laade (1973:155) himself noted that the stone fish traps around the northern and eastern margins of Mer, are located precisely around the district of the Meriam Le, the supposed 'gardeners of Mer'.

A similar physical blurring of divisional constructs based on subsistence specialisation and location to resources as those described for the Murray Islands, are also characteristic of Island Melanesian societies, as recently illustrated by Roe (2000). In the Port Sandwich area of southeast Malakula in Vanuatu, Roe (2000:205) observed that the spatial configuration of coastal and inland subsistence production included the location of fishing shrines in the forest and yam shrines on inshore coral reef heads. This was interpreted as evidence of the risky, but successful curation of the ritual centres of subsistence production by opposing groups (Roe 2000:205). In his discussion on the bush-saltwater subsistence divide in the Solomon Islands and Vanuatu, Roe (2000:217) concludes that 'the geographical position of archaeological sites in the landscape…cannot be taken per se as unequivocal evidence of the economic focus of the cultural group(s) who once were its inhabitants'.

The historically recorded evidence on the geology of Mer, and both the past and contemporary distribution of garden plots and vegetation communities on the island confirms the presence of horticultural gardens in the island's eastern fertile half. Evidence also suggests, however, that small household gardens were associated with houses and villages located along most of Mer's coastline. Much like the distribution of archaeological marine subsistence remains on the islands, archaeological evidence associated with past gardening practices may therefore be recoverable from areas of past occupation or settlement located in coastal areas. Thus the implication of this is that archaeological evidence of horticultural practices on the Murray Islands may not be as geographically restricted or bounded as Laade's (1969, 1973) interpretation of subsistence specialistation infer.

Terrestrial Subsistence: Faunal and Floral Resources

Many early sources noted a lack of dependence on terrestrial fauna as subsistence resources throughout Torres Strait (Allen and Corris 1977:25; Haddon 1912:152; MacGillivray 1852 II:25). For the Murray Islands, however, some information on the procurement of terrestrial resources was recorded. Haddon (1912:152-153) mentions a number of techniques used by the Meriam for the capture of bird species including herons, frigates and terns. Techniques included the use of a small bow and arrow, knocking down low-flying birds with lengths of bamboo, line and sardine bait and underwater snares. Birds could also be caught by hand when unable to quickly fly away from the branches of certain species of sticky fruit bearing trees. During the breeding season terns eggs were also obtained from regular trips to offshore sandbanks (Haddon 1912:154).

Although Haddon (1912:138) claims that goanna was eaten on Muralag, Moa, Saibai, Dauan, Boigu and in New Guinea, he does not mention it as an edible resource on the Murray Islands. However, goanna oil is obtained on Mer for medicinal purposes and the skin is widely used across the Torres Strait for the making of drums, *wasikor*. Haddon (1912:139) suggests that snakes were roasted and eaten by men of a certain *zogo*, while frogs were collected by the basketful on Mer and were roasted before eating. The restricted faunal diversity of the Murray Islands combined with the limited nature to which fauna were used in subsistence, implies that very little evidence of terrestrially based fauna may be archaeologically recovered.

In contrast to the limited role that terrestrial fauna evidently played in subsistence, plant foods were highly significant resources (Allen and Corris 1977:25; Brockett 1836:25; MacGillivray 1852:25). A remarkable amount of information was recorded on the types and diversity of edible species on the Murray Islands as well as on gardening and horticultural methods. This information is largely derived from Haddon and the records of the Cambridge Expedition, and provides important data for the subsequent interpretation of the archaeological record, and particularly in identifying and characterising the nature of the pre-European horticultural economy.

Haddon (1912:130, 132) concluded that the yam, banana and coconut were the most important vegetable foods in the Torres Strait, with the Eastern Islands being the 'best off' in terms of their availability. Nineteen varieties of bananas were recorded on Mer, each characterised according to taste, ripeness and most suitable method for cooking (Haddon 1912:133). Haddon (1912:133) claimed that in addition to a number of indigenous or bush bananas, two introduced varieties grew on Mer including a 'Lifu' (New Guinean) variety and a Chinese 'Cavendish' variety. Banana leaves were frequently used as plates and for wrapping other foods such as yams and sweet potatoes for roasting. Bananas were roasted but more commonly boiled with coconut milk in shells.

The large Eumusa section of the *Musa* genus was initially thought to have originated on the southeast Asian mainland (Simmonds 1962). However, more recent genetic analyses have demonstrated that the wild species *Musa accuminata* ssp. *banksii*, was domesticated in New Guinea and subsequently dispersed to southeast Asia where hybridization with local varieties occurred (Lebot 1999). The presence of seed and leaf phytoliths from the *Musa accuminata* spp. *banksii* at Kuk in the highlands of New Guinea dating from almost 7000 cal BP, confirms the hypothesis of the domestication of the Eumusa section in New Guinea (Denham et al. 2003). The origin and distribution of the smaller Australimusa family of cultivated bananas, which spread into Island Melanesia and eastern Polynesia, is similarly assigned to New Guinea (Argent 1976; Simmonds 1962). Largely based on the recent review of stratigraphic, archaeological and archaeobotanical evidence from the Kuk site, a recent theory proposes that before any known Southeast Asian influences, New Guinea was a primary centre of agricultural development and plant domestication (Denham et al. 2003). In light of such a theory, it is possible that the use of banana in subsistence on the Murray Islands may date to well before the late 19th century ethnographic observations.

Haddon (1912:136) remarked on the presence of a number of yam varieties in the Torres Strait, although he was unsure whether some varieties were true yams or merely 'wild yams or yam-like tubers'. Both Haddon (1912:136) and MacGillivray (1852 II:26) refer to the common cultivated yam as *ketai*, although, whether this is a wild variety or an introduced species is not made clear. On Mer Haddon (1912:136) recorded the names for a number of pink and white yam varieties. Yams were cooked by roasting or by boiling in water or coconut milk.

Yams belong to the large *Dioscorea* genus with around 600 species that favour tropical and sub-tropical environments. Telford (1986) lists five *Dioscorea* sp. for northern and eastern Australia, two of which he describes as endemic (*D. transversa* and *D. hastifolia*), two of which he claims are of indigenous pre-European introduction (*D. bulbifera* and *D. pentaphylla*), and one which is regarded as a recent introduction (*D. alata*). In New Guinea both wild and cultivated forms of *D. bulbifera* and *D. pentaphylla* have been observed, with these species also having a broad distribution throughout tropical Asia (Yen 1995:836). Yam varieties have also been recorded as part of the diet of Aboriginal groups in northern Australia, such as *D. transversa* and *D. bulbifera* for the Gidjingali people of Arnhem Land (Jones and Meehan 1989). This evidence suggests that the variety of yams observed on the Murray Islands in the late 19th century may have comprised both naturally occurring tuberous varieties, as well as domesticates that may have been introduced from New Guinea.

Haddon (1912:136) also observed three ‘indigenous’ forms of sweet potato and suggested that ‘several other varieties have been introduced’. As a New World crop, the sweet potato (*Ipomeae batatas*) originated in tropical America and was also grown in the West Indies and Mexico (Conklin 1963:129). Although there has been some debate (for example Merrill 1954; Suggs 1960 versus de Candolle 1959; Hornell 1946; Yen 1971), the widely accepted theory is that the global spread of the sweet potato was facilitated by 16th century Portuguese ships which carried it to Africa and parts of Indonesia, and that its introduction into the remote Pacific was by 17th century Spanish vessels sailing from the Pacific coast of Mexico (Conklin 1957:133).

Of the 400 or more species of *Ipomoea* that are distributed throughout the world’s tropical regions, *Ipomoea batatas* is the only species of economic importance (Cobley 1957:171). As these plants rarely reproduce from seeds, cultivated sweet potatoes are propagated by cuttings of the stems or root tubers. As this is so, Haddon’s (1912:136) distinction between naturally occurring and introduced sweet potato species on Mer requires some re-interpretation. His observations of multiple sweet potato varieties perhaps more accurately reflect a natural diversification of *Ipomoea batatas*, which may have occurred within a period of several hundred years after its arrival into the region. This is supported by archaeological research in the New Guinea Highlands, which has demonstrated intensive sweet potato cultivation at Kuk dating from around 250 yrs BP (Golson 1997; Denham et al. 2003).

Meriam names for taro and arrowroot were also recorded, as were several other varieties of edible aroids, vines, roots and leaves (Haddon 1912:136). The latin name cited by Haddon for Taro is *Colocasia macrorhiza*. It is likely that this illustrates his confusion between the species *Colocasia esculenta* and *Alocasia macrorhiza.* The former species is widely regarded as a very important crop in Melanesian and Pacific subsistence, while the latter has been identified as having a greater economic significance in the Bismarck Archipelago and in western

Melanesia and Polynesia in comparison to mainland New Guinea (Yen 1995:835). Furthermore, whereas *A. macrorhiza* is generally accepted as an introduced species to New Guinea and northern Australia, there is increasing evidence to suggest that domestication of *C. esculenta* may have occurred within Melanesia during the Pleistocene (Lebot 1999:624). This hypothesis is supported by the recent data from Kuk, which has also confirmed the presence of *C. esculenta* in the New Guinea Highlands from the late Holocene (Denham et al. 2003). Regardless of Haddon's ambiguous species identification, the presence of either *C. esculenta* or *A. macrorhiza* provides further evidence in support of prehistoric plant cultivation on the Murray Islands.

Haddon (1912:136) cited Meriam names for nine varieties of sugar cane, and suggested that this species was 'indigenous' to Mer. Contrary to this interpretation, however, genetic analyses have unequivocally demonstrated that the species *Saccharum officinarum* originated in New Guinea where it was also first domesticated (Lebot 1999; Warner 1962). This suggests that at some time prior to the late 19th century, transportation of the species occurred from New Guinea to the Murray Islands, and as discussed in Chapter 2, throughout numerous other islands in Torres Strait.

On Mer coconut milk was used for cooking and drinking, while the oil, which was largely used by the Meriam for ceremonial purposes, was extracted by scraping the ripe kernal (Haddon 1912:132). Haddon (1912:132) also claimed that coconut palms were much more plentiful in the Eastern Islands and on Saibai compared to the few observed on the Western Islands. Haddon (1912:133) recorded almost twenty Meriam words associated with the growth of coconuts, and the colour, size and stages of ripeness of the nut.

Although earlier views regarded *Cocus nucifera* as the cultivated variety of previously wild species and therefore provided evidence of human planting (Corner 1966), more recent hypotheses lend support 'to the possibility that spontaneous coconut populations may be truly wild and capable of wide natural dispersal' (Sauer 1971:309). One of the main bodies of evidence in support of this model is the adaptation of the nuts for dispersal by ocean current over vast distances. This is owed to the ability of the nut 'to remain buoyant and viable after several months in sea water' (Sauer 1971:311). A germinating coconut can then be shifted up the beach by waves after it has begun to sprout. Limited by wave reach, and also by shade and competing inland flora, the natural habitat of the coconut is an extremely narrow zone on the foreshore, where the crowns of the palms overhang low shrubs and beach creepers.

Archaeological remains of *Cocus nucifera* have been recovered from several islands across the Pacific and range in date from between approximately 2700 and 5400 years BP (Hossfeld 1965; Kirch and Yen 1982; Spriggs 1984; Yen 1973). This evidence is largely interpreted as supporting the natural dispersal hypothesis for the establishment of this species, as the presence of the coconut remains significantly predate the human settlement of these islands.

Haddon's (1935:30-31) observation of the presence of coconut groves in the high eastern interior region of Mer, however, places the species out of its natural habitat in the narrow zone along foreshore where competition for height is limited. This suggests that cultivation of coconuts was probably occurring on the Murray Islands prior to the first European sightings during the early to mid 19th century.

Two varieties of edible pandanus were identified on Mer, each with seeds that were roasted before eating and leaves which were used for mat-making (Haddon 1912:134). Other edible species of nut or fruit bearing trees more recently identified on the Murray Islands include *mikir*, native almond (*Terminalia catappa*); *iger*, native cashew (*Semecarpus australiensis*); and *enoa*, wild plum (*Manikara kauki*) (Bliege Bird et al. 1995). Haddon (1912:134) refers to *waiwai* as wild mango, while pawpaw, watermelon, maize, rockmelon, pumpkin, potatoes, and peaches were all regarded as recently introduced.

According to Yen (1995:840) the genus *Pandanus* has the widest ecological range of adaptation and also perhaps the most domesticated forms of any native Pacific plants. In New Guinea the species is located at subalpine mountainous and mid-altitudinal ranges, and on riverine and coastal habitats. As the ubiquitous 'screw pine' (*Pandanus spiralis*) is often found with domesticated forms of the species, multiple origin hypothesis for cultivation of *Pandanus* are regarded as more favorable than a diffusionist theory (Yen 1995:840). The foraging-to-planting process of domestication of this species may have commenced in the New Guinea Highlands as early as 20 000 years ago (White and O'Connell 1982). Given this time-frame, by end of the 19th century it is possible that both wild and domesticate species of *Pandanus* were present on the Murray Islands.

Most notable of the other domesticate tree species mentioned above *is T. catappa*, which is widely distributed throughout Malaysia, New Guinea, most of the Pacific as well as the tropical coasts of Australia (Yen 1995:839-840). Although not cultivated in the majority of these regions, everywhere it is acknowledged as a supplementary food source, including Arnem Land in northern Australia. As Haddon (1912:136) indicated, it is possible that *T. catappa* along with other native nut and fruit varieties may have been much more important to subsistence on the Murray Islands prior to the intensive cultivation of yams and sweet potato documented at the time of European contact.

Horticultural Methods

A review of the horticultural methods used on the Murray Islands provide an insight into the possible nature of archaeological evidence of the pre-European horticultural economy. According to Haddon (1912:146), the Meriam had two broad land classifications in relation to gardening. Seau ged, was land thickly vegetated with coconut groves or large closed canopy trees that had plenty of shade and rich soil suitable for the planting of yam varieties and bananas. Wargor ged, was sparsely timbered land that had no large trees or had a few bushes and grass only. Sugar cane, bananas, sweet potato, pawpaws and some yam varieties were planted on this land, although Seau ged was preferred for the planting of yams.

Beginning around the end of August and continuing through the wet season until the end of the year, Gedub ismi, was the time for clearing undergrowth and cutting down trees in preparation for planting new gardens. Prior to the introduction of iron axes and knives, clearing was done with shell axes (Haddon 1912:145). Sweet potato vine cuttings were planted in mounds or hillocks, although as MacGillivray (1852 II:256) describes, a great deal of preparation was involved in the planting of yams:

> …the patch of ground in strewed with branches and wood, which when thoroughly dry are set on fire to clear the surface, - the ground is loosely turned up with a sharpened stick, and the cut pieces of yam are planted at irregular intervals, each with a small pole to climb up. These operations are completed just before the commencement of the wet season, or in the month of October.

Each year ground that had been fallow for four to five years was cleared and a new garden, kerkar gedub, planted while another portion lay fallow. Good yams were believed to come from fresh soil, while banana crops exhausted the soil rapidly, so were grown until the fruit gradually diminished. Old plants were never removed but were allowed to become overgrown and die off. Haddon (1912:147) noted that there was no regular rotation of crops, as generally the same kind of plant was cultivated on the old land after a fallow period. Clearing of land was therefore a yearly occurrence.

Archaeological implications

As described by Haddon, the classification of land based on the density and openness of vegetation and soil fertility suggests that gardening and horticulture on the Murray Islands may have been spatially patterned, with certain species and combination of species only occurring in certain areas. The above information suggests that all cultivated species, although to a degree excluding yams, were planted in more open areas with sparse and low vegetation. Based on the nature of vegetation on Mer and Dauar and as suggested earlier in this chapter, such areas may have been more common on the coastal fringes where vegetation was predominantly sparse and low. This type of floral habitat is particularly characteristic of the low saddle located between the two hills of Dauar and extending to either side of the island at Sokoli and Ormi (see Figure 4.1).

Furthermore, although garden plots lay fallow for a period and were subsequently cleared and prepared for planting, the fact that the same crops were repeatedly grown in the same area suggests that build up of evidence may have occurred. This evidence may exist in the form of the remains (either macro- or microscopic) of edible species with recognisable temporal depth patterns. As the ethnographically observed methods of horticulture on the Murray Islands did not involve wet land cultivation or the construction of drainage channels, this also suggests that the archaeological evidence for horticulture may exist in the form of the remains of the plants and cultigens themselves. Another form of evidence for horticulture on the Murray Islands may be visible patterns or changes in vegetation and the redeposition of sediments brought about by initial clearance episodes. The recovery of such information is supported by the recent results of biodiversity surveys undertaken in Torres Strait, which as discussed previously in this chapter, have demonstrated a high proportion of anthropogenic vegetation.

Maritime Subsistence: Resources and Methods

On Mer Haddon (1912) observed that women collected shellfish and speared fish of all kinds on the fringing reef during low tides. He noted that in calm weather during the November northwest monsoon, women would also go to the outer reefs in a piece of broken canoe and wade out to spear rock cod and other small fish. Called a *pau*, the section of canoe hull was fashioned with ‘a piece of would nailed to each end to keep the water out’ (Haddon 1912:158). Men and women would fish by torch light at night, which was common throughout the year when the tide was suitable. Small fish, octopus, crayfish and crabs would be captured in the lagoons and small pools. Opportunistic hauls of large quantities of fish were also recorded by Haddon (1912:158), such as the night time spearing of large gar fish shoals in the deep water around Mer from February to March. Although Haddon (1912:159) remarked that fishing nets were unknown in the Torres Strait, conical fish scoops made from bamboo, *weres*, were often used by Murray Islanders to collect large numbers of sardines, *tup*, which shoal along the shore all year round (Figure 4.6, 4.7). Poisoning pools and lagoons with toxic plants such as *Derris* sp., was also used as a method to obtain fish on Mer.

Figure 4.6 Bamboo fish scoop (*weres*) (Haddon 1912:156)

Fig 4.7 Fishing scene on Mer Island (Dauar in background) catching sardines with *weres* fish scoop (Photo: Frank Hurley c.1920s, National Library pic-an23382042)

Turtle was considered as the most important meat source for the Meriam, particularly as this species occurred in much greater numbers around the Eastern Islands than the dugong. The most common species of turtle recorded around the Murray Islands was the green turtle, which were most commonly caught with the *wap*, or by a man simply jumping into the water and tying a rope around the turtle's flipper. Haddon (1912:168) claimed that dugong were rarely caught at the Murray Islands and that the Meriam only occasionally erected the bamboo platforms. Yonge (1930:193) also claimed that dugong were rarely caught around the Murray Islands, but during his visit to the islands in the early 20th century, photographed a bamboo platform constructed on the reef flat on the southeastern side of Mer (Yonge 1930, see Figure 2.8).

Thus while the ethnohistorical record has provided some valuable insight into marine subsistence on the Murray Islands, unfortunately little detail exists on shellfishing strategies in the region; this is problematic for two key reasons. Firstly, as indicated in Chapter 3, the importance of shellfish and of intertidal gathering in coastal economies during the late Holocene throughout northern Australia and southern New Guinea is well documented. Secondly and as detailed in the following chapter, the shells of marine invertebrates represent the most abundant category of faunal remains excavated from the archaeological sites on Mer and Dauar. This occurrence, however, may simply be a product of various taphonomic factors resulting in the differential preservation of archaeological shell remains. Fortunately, research that greatly assists in understanding the formation and composition of the archaeological shell assemblages excavated from Mer and Dauar is to hand.

Contemporary Meriam Intertidal Marine Resource Gathering

Mentioned briefly in Chapter 1, between 1993 and 1998 American anthropologists Bird and Bliege Bird conducted extensive fieldwork on the Murray Islands as part of the Meriam Ethnographic Research Project in Ecological Anthropology. This research focused on maritime subsistence activities within the framework of evolutionary ecology. Bird's 1996 PhD dissertation on intertidal foraging strategies among the Meriam is an impressive investigation of shellfish gathering and processing strategies within the theoretical settings of central-place foraging and behavioural ecology. Although this research focused primarily on contemporary shellfishing strategies, it was identified that transport and processing decisions would have implications on shell-midden variability and for the analysis and interpretation of prehistoric subsistence assemblages (Bird (1996:241; see also Bird and Bliege Bird 1997:54).

Subsistence activities, prey types, prey choice and discard behavior

Bird's (1996:106) use of the term intertidal gathering refers to subsistence activities that occur between the foreshore and the subtidal margin. Based on mapping of the distribution of reef flat resources during which he participated in and observed shellfish gathering, Bird (1996:106) determined that intertidal gathering on the Murray Islands consists of two types of activities: reef-flat collecting and rocky-shore harvesting. These subsistence activities are characterised by 'differences in resource distribution, the types of resources encountered, differences in nutritional return rate and gain functions, and for the most part they are mutually exclusive activities' (Bird 1996:106-107).

Bird (1996) divided the reef flat into three broad zones based on the substrate zonation of Mer. The *supralittoral fringe* is located closest to the foreshore and has a substrate scattered with large volcanic boulders and cobbles with patches of coral sand and sea grass. The *midlittoral fringe* is dominated by coral sands, sea grasses and intertidal pools, with a varying distribution of micro-atolls, live soft corals and branch coral flats interspersed with coral sands. The s*ublittoral fringe* is located furthest from the foreshore and is dominated by large live micro-atolls and sand patches with a varying distribution of algal pavement that extends to the subtidal reef edge. The extreme margin of sublittoral fringe is dominated by large coral heads (see Figure 4.1).

A number of key species or 'prey types' were distributed sparsely within the substrate zones, although variations in density of populations showed that some species preferred one zone over another. The gastropod prey types most commonly encountered on the reef included spider conch (*Lambis lambis*), tiger cowrie (*Cypraea tigris*), top shell (*Trochus niloticus*) and red-lipped conch (*Strombus luhuanus*). Several species including turbo shell (*Turbo petholatus*), vase shell (*Vasum turbinellus*), baler shell (*Melo amphora*), trumpet shell (*Syrinx auranus*) and abalone (*Haliotis varia*), are described as rarely encountered and less commonly taken. The bivalve species identified as commonly collected include bear paw clam (*Hippopus hippopus*), various tridacnids including *Tridacna squammosa* and *Tridacna maxima* with rarer collections of pearl shell (*Pinctada margaretifera*), and oysters (*Crassostrea* sp). Figure 4.8 provides schematic representation of the distribution of the majority of these species.

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Figure 4.8 Schematic representation of reef intertidal zone showing distribution of key shell species (after Bird and Bleige Bird 1995:12)

Unlike the widespread dispersal of reef flat resources, Bird (1996) found that rocky shore resources were concentrated in patches exclusively in the supralittoral fringe, and were found only within zones of volcanic rocks and cobbles. Two species form the total of resources taken from the rocky shore; the small ribbed nerite (*Nerita undata*) and the small sunset clam *Asaphis violascens.* Chitons (Polyplacophora) were the species most widely distributed, while nerites (*Nerita undata* and *Nerita albicilla*) and limpets (*Patelloida saccharina*) occurred in similar densities. *Asaphis violascense* are located 5 - 10cm below the surface within silty sand and must be dug for, while the nerites are plucked from boulders and rock walls.

Bird's (1996) fieldwork demonstrated that reef flat collecting was by far the most important shellfish-gathering strategy for contemporary Meriam. From the 91 reef gathering episodes, Bird (1996:123) calculated that *Hippopus hippopus*, *Tridacna* spp. (including *T. squammosa*, *maxima* and *gigas*) and *Lambis lambis* comprised 90% of all the edible weight, energy and protein harvested. Part of Bird's (1996) analysis was to investigate the effect that the constraints faced by foragers, such as volume and weight of a load of unprocessed shellfish, would have on shell deposition at residential sites or 'kitchen middens'. The results illustrated that for *H. hipppous* and *Tridacna* spp. their calculated dietary contribution was under-represented in shell accumulations, representing less than 10% of the reconstructed edible flesh weight. Conversely the remains of the rocky-shore resources *Asaphis* sp. and *Nerita* spp. were over-represented in the accumulations, comprising over 30% of the flesh weight in the sampled household remains (Bird 1996:213).

Bird's (1996) observations confirmed that these discrepancies were the result of prey choice and differential field processing and transport of shellfish prey types. Bird et al. (2002:461) explain the factors affecting prey choice among Meriam shellfish gatherers as follows:

> Meriam adults and children make decisions about intertidal prey selection in a manner consistent with the hypothesis that only those prey that increase the rate at which energy can be gained while foraging will be handled on encounter. Those prey types which will on average reduce foraging return rates are almost always passed over by foragers… In other words, overall proportional representation of each prey type across all specimens collected on

> all focal follows is predictable in terms of energy tradeoffs of remaining in a patch or of handling an item on encounter in a patch.

Thus although prey choice is predictable, there is a simple explanation for the inconsistency observed in contemporary household accumulations: much of what is collected during shellfish gathering is processed at the point of procurement, with the shell remains left on the reef. This is particularly the case for the large bivalve species including *Hippopus hippopus* and *Tridacna* spp. and also for *Lambis lambis,* which is most commonly encounter-processed. Conversely, other species are always transported whole to residential or 'dinner time' camps, such as the rocky-shore species *Asaphis* sp and *Nerita* spp., which during his fieldwork Bird (1996:146) never once observed being processed in the field prior to transport. These species were usually cooked by boiling, although both were occasionally roasted.

<u>Archaeological implications</u>

The archeological implications of prey choice and shellfish processing and discard behavior described by Bird (1996) have recently been examined by Richardson (2000) (see also Bird et al. 2002 and Bird et al. 2004). On the basis of behavioral ecological theory and predictive models generated through central place foraging theory, she analysed the excavated shell assemblages from Sokoli on Dauar and Pitkik and Kurkur Weid on Mer. Her results demonstrated that contemporary household shell deposits and the three excavated archaeological shell assemblages were similar, and contained a high proportion of *Nerita* spp. and very low numbers of *Tridacna* spp. and *Hippopus hippopus.* Richardson (2000:45) attributes these similarities to the transport and processing decisions described above.

Based on field processing data another model was developed that could predict the probability at which unprocessed shellfish would be transported from a known distance to a central place. The results from statistical comparison of the total edible flesh represented in the archaeological samples, the contemporary shell accumulations and the foraging follow data show that the archaeological assemblages from Sokoli, Kurkur and Pitkik 'predict the observed prey choice during ethnographic observations' (Richardson 2000:47). Based on these results, it was concluded that:

> the predictive model developed…supports the hypothesis that Meriam foragers in the past selected a similar range of shellfish species and processed them under similar conditions as modern Meriam foragers in a manner that efficiently returned the edible flesh to a central base (Richardson 2000:59).

Given the lack of ethnohistorical information on the strategies and methods of traditional shellfishing, the work undertaken by Bird (1996) and subsequently by Richardson (2000) is important for attempting to understand the excavated archeological record of the Murray Islands. Although it is recognised that simply correlating archaeological assemblages with ethnographic behavior is problematic, Richardson (2000:4) explains the benefits in adopting a behavioral ecological approach:

> Generating predictive hypotheses about human transport behavior, testing them ethnographically, and then investigating such predictions in a real archaeological situation, like midden assemblages, can lead to new understanding of midden variability and subsistence strategies of the past.

However, the ethnographic evidence for Torres Strait demonstrates that the benefits of shell went beyond a dietary or subsistence contribution. As a raw material, a variety of shell species were widely used as cutting implements, as vessels for water collection and storage, body ornamentation, and most significantly, as items of trade that attracted considerable economic and social value throughout the region. Although Richardson's (2000) investigation of the Murray Islands archaeological assemblages has produced important information relating to past marine shellfishing strategies, it fails to recognise or account for the deposition of shell remains that may have resulted from other non-subsistence related activities.

A further problematic issue with Richardson's (2000) analysis of the archaeological shell assemblages is the lack of consideration of the impact that the prehistoric horticultural subsistence economy may have had on the abundance and deposition of shell remains. As indicated in the above discussion, horticulture on the Murray Islands may have considerable antiquity and included the gathering of naturally occurring species as well as the more intensive cultivation of domesticated crops. In light of the ethnographic evidence therefore, a suggestion that the emergence of horticulture may have had some impact on the nature of marine subsistence strategies, which also resulted in changes to the spatial and temporal patterns of the density and composition of archaeological assemblages, is not entirely unfounded.

The interpretation of the archaeological assemblages from Mer and Dauar conducted in this thesis considers the diversity of ethnographically documented uses of shell in Torres Strait, the emergence and nature of horticulture on the Murray Islands, as well as data provided from the analysis of the excavated vertebrate remains. This represents a more holistic approach to documenting the nature of subsistence on the Murray Islands, and provides a level of information that is more applicable on a regional scale at understanding the timing and nature of settlement and subsistence development in Torres Strait.

Conclusions

This chapter has provided a comprehensive background to the natural environment of the Murray Islands and a description of Meriam culture based largely on late 19th century ethnographic accounts and recent anthropological observations. This data demonstrates that in trade and exchange networks, kinship, language, oral histories and origin legends, there is a strong historical link between the Murray Islands and the Fly Estuary region of the southern New Guinea coast.

The ethnographic accounts of Meriam social organisation illustrate a complex system based on totemic-based clan divisions with rules on territoriality and access to resources that encompassed both land and reef. In contrast to earlier ethnographies which emphasised definite cultural and physical boundaries between marine and horticultural based subsistence regimes (Laade 1969, 1973), recent anthropological data suggests that subsistence was far less structured and is more accurately viewed in terms of daily household activities inclusive of both widespread marine and horticultural based practices (Bird et al. 1997). The archaeological implications of this data combined with other ethnographic and archaeological evidence mentioned earlier, suggest that evidence of both past marine and horticultural subsistence on the Murray Islands may be widely distributed.

As a product of their fertile soils and extensive fringing reefs, the ethnohistorically documented subsistence economy of the Murray Islands featured a diversity of marine and horticultural resources. Commonly procured marine foods included shell fish, fish and turtle, while horticultural production relied heavily on common Pacific cultigens including banana, coconut, yams and the recent sweet potato plant, as well as variety of fruit and nut bearing trees. In the above review of ethnograhpically documented plants foods on the Murray Islands, evidence for the origin and domestication of common western Pacific horticultural crops, as well as the cultural histories of other naturally occurring supplementary plant species in these regions, has been cited. This discussion has demonstrated the likelihood that the ethnohistorically described horticultural economy of the Murray Islands originated well before the late 19th century.

In contrast to the well-documented horticultural economy, the early ethnographies recorded for the maritime subsistence economy of the Murray Islands were comparatively lacking in detail. Surprisingly, this is particularly the case for the observed daily activity of shellfish gathering. Recent anthropological investigations undertaken on the islands thus provide a valuable insight into this subsistence activity. Implications of this data for interpreting the nature of archeological shell middens on the islands have been identified, and are re-considered in the analysis of the excavated faunal assemblages which forms the content of Chapter 6. Firstly, Chapter 5 provides the details of the results of the Murray Islands archaeological investigations, including the results of survey and excavation, and descriptions of archaeological stratigraphy, chronology and the excavated assemblages.

Chapter 5: Results of Fieldwork on Mer and Dauar

Prior to the investigations conducted as part of this thesis, the archaeology of the Murray Islands was largely undocumented. By the end of the last millennium the picture of Torres Strait prehistory that was beginning to emerge was predominantly based on archaeological research conducted on the Western and Northern Islands. This chapter provides the results of the first systematic and long-term archaeological investigations ever undertaken on the Murray Islands. As such it represents a timely development in documenting the nature of archaeological site types on the Murray Islands and in constructing a baseline for the interpretation of the excavated archaeological assemblages.

This chapter contributes the background to the Murray Islands Archaeological Project (MIAP), from which this thesis is derived. The survey results are discussed and include a description of site types recorded and the location and context of stratified archaeological deposits deemed suitable for excavation. A section on excavation methods is followed by a description of each selected excavation site and of site stratigraphy, a summary of midden distributions and a brief discussion on depositional sequence and chronology. Finally, a more detailed discussion and synthesis of the results of radiocarbon dating is provided, including interpretations of age-depth sequences and the evidence for early site formation and occupation and subsistence development. Although some quantitative information on excavated artefacts is provided, the nature and chronology of material culture assemblages is discussed in Chapter 8.

The Murray Islands Archaeological Project

The Murray Islands Archaeological Project commenced in 1998 as an initiative of the Mer Island Community Council to document the chronology of marine resource use on the islands of Mer and Dauar (Bird et al. 2002:459). Bird and Bliege Bird were living on Mer at the time and on behalf of the Council liaised with Dr Peter Veth from the School of Anthropology, Archaeology, and Sociology at James Cook University about conducting excavations to address some basic questions about the human occupation of the Murray Islands. An initial reconnaissance trip to Mer and Dauar was made by Veth, where he was shown a range of prospective archaeological sites that included sites of contemporary significance to particular families with whom Bird and Bliege Bird had worked closely. With consent from the traditional landowners, two shell samples were extracted from basal levels of eroded midden deposits at Sokoli and Ormi on Dauar for radiocarbon dating. The samples returned ages of 1663 - 1413 cal BP (Wk-6098) for Sokoli and 1588 - 1354 cal BP (Wk-6096) for Ormi, confirming the archaeological potential of these sites. The subsequent archaeological investigations conducted on Mer and Dauar form this basis of this PhD and have also been detailed elsewhere (Carter 2002; Carter et al. 2004a, 2004b; Parr and Carter 2003).

Two field seasons were conducted as part of the MIAP, including seven weeks from August to September in 1998 and seven weeks from August to October in 2000. In January 2001 an opportunity was also taken to conduct a week-long survey of sewerage trenches dug as part of a Queensland Government major infrastructure program. All the archaeological work carried out as part of the MIAP was conducted in conjunction with the Mer Island Community Council and Meriam traditional landowners, who jointly set out guidelines for the excavations and the removal of any cultural remains from the islands. The archaeological fieldwork was carried out with local field assistants and with collaboration and assistance from a number of researchers and postgraduate student volunteers.

Archaeological Survey

A variety of archaeological site types and contexts were recorded on Mer and Dauar during the 1998 field season. Waier was not included in the archaeological program as most of the island is regarded as sacred, and therefore permission to investigate it was not sought. In the areas investigated, site-types recorded on the two larger islands included shell middens, stone arrangements, land boundary markers, sacred (zogo) sites, stone fish traps, rock engravings and grinding grooves, as well as a shell decorated rock overhang.

Large numbers of carved bedrock panels were recorded along the south-western foreshore of Mer. From Gigo to Nem, several panels of 10 to 40 grinding grooves were recorded, including two basalt boulders which also displayed grooves (see Figure 4.1, Plates 5.1 and 5.2). From Nem to Terker approximately 20 carved bedrock designs were photographed, including fish, sharks, turtles, headless anthropomorphic figures, canoes, vulvae and various geometric designs including four-rayed axe heads (*seuriseuri*) (Plate 5.3a-d). As described in Chapter 2, unlike *gabagaba*s which were used as weapons, *seuriseuri* were symbolic implements worn for ceremonial purposes (Wilson 1988:82).

Further along the southeastern coast of Mer the large complexes of stone fish traps (*sai*) are clearly visible during low tide (Plate 5.4). These are impressive, predominantly rectangular shaped structures of low walls (around 50cm in height) constructed from basalt boulders. Fish traps extend around the entire northeastern – southeastern coast of Mer where the fringing reef is most extensive (see Figure 4.1). Today fish traps are also clearly visible at low tide on Dauar at Ormi, on the southeastern side of the island. Although there are a number of stone fish trap complexes around Dauar and Waier which are also visible from aerial views, apart from those at Ormi, the majority of these are no longer used or repaired.

Plate 5.1 Bedrock grinding grooves

Plate 5.2 Basalt boulder grinding grooves

Plate 5.3a Shark engraving

Plate 5.3b *Seuriseuri* engraving

Plate 5.3c Turtle engraving

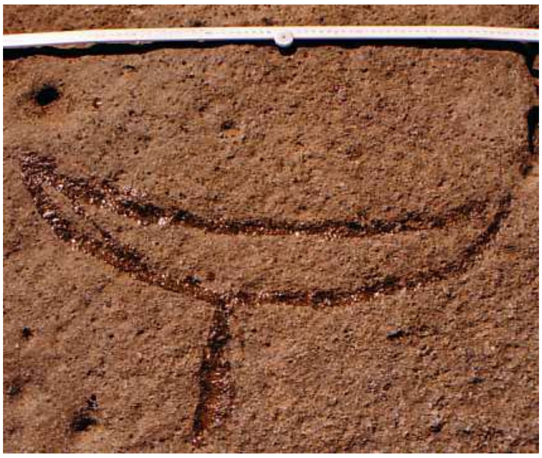

Plate 5.3d Canoe(?) engraving

Plate 5.4 Stone fish traps along southeast coast of Mer

Along the sloping terrace around the east and southeastern side of Mer, two *Mukeis zogo* sites were recorded. These sites consisted of a carved basalt figure surrounded by a 1 - 2m wide circular arrangement of basalt boulders and several large *Tridacna* valves, *Lambis lambis* and *Strombus luhuanus* shells. On the southwestern side of Mer, on a ridge overlooking Terker to the east and Werbadu to the southwest, a small discrete concentration of *Polymesoda coaxans* shells scattered among rounded basalt cobbles was recorded. This species (commonly known as *akul*), lives in muddy, estuarine substrates and is not found today around the reefs and sand of the Murray Islands. Haddon (1901:143) interpreted *Mukeis zogo* as symbols that promoted garden productivity and also served to deter trespassers or thieves from gardens.

On the northern side of Mer, adjacent to the rockshelter at Kurkur Weid, two small rock overhangs were located (see Figure 4.1). The overhang closest to Kurkur Weid appeared to be decorated with small *Strombus luhuanus* shells, which had been inserted into circular holes made in the rock wall. The surface deposit included several large *Anadara antiquata* valves, a species that is also uncommon to the islands today. The symbolism or significance of this shell decoration is unknown.

The survey indicated that archaeological sites with marine subsistence remains, including stratified deposits of shell and marine vertebrate remains, were restricted to coastal parts of Mer and Dauar immediately adjacent to the foreshore zone. In most cases the sites were known areas of past occupation or village sites, such as the beach embayments at Sokoli and Ormi on Dauar and Wer Badu on the southwestern side of Mer (see Figures 4.1, 4.2). At each of these sites the archaeological deposit was visible in the stratigraphy of eroding shoreline profiles, with dense surface deposits observed in the area immediately behind these profiles. A common feature of these sites is their elevation several meters above the height of the modern high tide datum and thus their protection from tidal influences. The density of surface deposits at these sites also decreased markedly with distance from the shoreline, with virtually no archaeological material observed 30 meters inland from the foreshore.

Several scatters of shells associated with small rock and boulder arrangements were recorded in 2000, during a survey of the lower slope of Kebi Dauar inland and west of the excavation site at Ormi. The shells consisted predominantly of collections of single species, such as *Tridacna* sp. and large *Lambis lambis.* These arrangements were constructed as boundary markers and apparently have no particular association with subsistence activities (Aris Kaddy pers. comm.). Surveys along the roads in the high interior parts of Mer revealed similarly sparse deposits of marine subsistence remains, and in all cases consisted of a thin surface veneer of very fragmented shell.

In January 2001 the installment of sewerage infrastructure on Mer provided an opportunity to survey 3m deep pipe-trenches that had been excavated along the length of the village adjacent to the main road. No archaeological remains were observed in the trenches, which also lacked visible natural stratification. At the same time, two major housing subdivisions were under way in the interior of Mer, where extensive areas of land had been cleared for housing and road construction (see Figure 4.1, Plate 5.5). Although surface remains may have been destroyed or re-deposited below the surface by earthmoving equipment, a survey of the larger subdivision site at Zomar failed to find any archaeological deposit.

Plate 5.5 Bulldozer clearing land at Zomar, northwestern high interior of Mer

Although limited in scale owing to restrictions in access to land, the level of survey conducted on the islands of Mer and Dauar suggested that stratified archaeological contexts from which reliable archaeological and radiocarbon chronologies might be derived fell into three site categories: i) rockshelter deposits, ii) midden stratigraphies visible in eroding shoreline stratigraphy, and iii) midden material in areas known to have been horticultural gardens within the historic period. Initially three sites representing examples of each of these site types were selected for excavation.

The selected sites were Kurkur Weid, a small rockshelter on the northern coast of Mer, Pitkik, a stratified midden exposed by contemporary shoreline erosion 40 m from the Kurkur Weid rockshelter, and Sokoli, a former garden area located on the northeastern side of Dauar, where surface shell debris and a preliminary radiocarbon date suggested the possibility of buried midden stratigraphy (Figure 5.1). During the 2000 field season on Dauar a further excavation was conducted. It was located at Ormi on the southeastern side of the island, where radiocarbon testing, surface deposit and eroding shoreline stratigraphy suggested that midden material might occur at depth.

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Figure 5.1 Map of Murray Islands showing location of excavation sites

Excavation and Analytical Methods

Excavation was undertaken by natural stratigraphic layers whenever easily recognised and otherwise by arbitrary 10cm units. All deposits were excavated by trowel except for an approximately 20cm section of the middle deposit at Sokoli, which was loosened by a metal pick because the sediment was so compacted. Care was taken to avoid damage to shell remains, although some material was accidentally fragmented. The provenience of all excavated cultural material was recorded by excavation unit, with in situ artefacts and shells suitable for radiocarbon dating recorded three-dimensionally.

Excavations of the Mer Island sites continued until natural site features obstructed the process, or in the case of Kurkur Weid, safe access to the lower portion of the excavation square. For Sokoli and Ormi on Dauar, excavation continued until the basal cultural deposits were reached. Although excavation below these depths to sterile matrix was not achieved due to time constraints, augering at Sokoli to a depth of 60cm below the floor of the final Excavation Unit confirmed the presence of culturally-sterile matrix below the base of the excavation. The excavated deposits were dry sieved through nested 6mm and 3mm wire mesh. Further details on the handling of the excavated assemblages are provided in the following chapter.

Stratigraphic profiles for each site were recorded and drawn, and for each Stratigraphic Unit (SU) a general sedimentological description was made, composition of archaeological assemblage noted, Munsell colour determined and a sediment sample extracted. For each excavation profile drawing Stratigraphic Units are numbered consecutively from the ground surface downwards. Through the use of a hand lens and reference charts analysis of sediment samples in the laboratory included identification of particle size, texture and structure. The deposits are further delineated into major Horizons based on clear boundaries between stratigraphic units, such as dramatic colour or texture change and the increase or decrease in quantity of archaeological remains. Horizons are consecutively labeled in roman numerals from the top to the bottom of the profile drawings. Appendix B provides the data for the rates of sediment deposition at each site, also illustrated in Figures 5.4, 5.6, 5.10, 5.14.

A suite 22 radiocarbon dates was obtained as part of the archaeological investigations on Mer and Dauar. The dates for Sokoli, Kurkur Weid, Pitkik the Ormi beach section have been previously published by Carter (2001) as uncalibrated (C14) ages. More recently these dates along with the radiocarbon dates obtained from the excavation at Ormi have been reported as calibrated age ranges (cal BP) based on a number of calibration programs such as CALIB (v4.3) and OXCAL (Carter 2002; Carter et al. 2004a, 2004b).

All samples were sent for processing to the Radiocarbon Dating Laboratory at the University of Waikato. Marine shell was submitted for dating in all instances except for one charcoal sample. Shell samples predominantly included the reef species *Lambis lambis* and *Strombus luhuanus*, which were the two most abundant food taxa throughout the excavated marine invertebrate assemblages. One *Conus* sp. shell from Ormi was also submitted for dating. All shell samples were washed, dried and weighed before dispatch. The charcoal sample was removed with tweezers from aluminum foil it was packed into in the field, weighed and placed back into the foil. At the dating laboratory all samples were physically and chemically pretreated using standard procedures.

Barham et al. (2004:35-36) have suggested that the application of the oceanic reservoir effect (ORE) by subtracting 450 ± 35 years, provides a suitable remedy to account for the apparent temporal variation in marine reservoir ages in marine shell material. However, in an attempt to provide regionally applicable chronological data for Torres Strait and the northeastern Queensland region, all dates presented here have been recalibrated by applying a ΔR correction value for northeast Australia of 12

± 7, based on recent recommendations made by Ulm (2002a, 2002b). All samples were calibrated by the computer program CALIB (v4.4) (Stuiver and Reimer 1993) using the marine calibration model dataset of Stuiver et al. (1998) for marine shells. The charcoal determination was calibrated using the atmospheric decadal dataset of Stuiver et al. (1998) with no laboratory error multiplier. Twenty-four years was subtracted from terrestrially-derived (atmospheric) samples before calibration to correct for 14C variations between northern and southern hemispheres (after Ulm and Reid 2000:11). All Murray Islands radiocarbon dates discussed throughout this thesis refer to the calibrated age (cal BP) based on 2σ calibrated age range.

Kurkur Weid Rockshelter

This rockshelter is situated approximately 2m above the level of the mean high tide datum and is protected from extreme storm wave action by a basaltic rock outcrop (Plate 5.6).

Plate 5.6 Kurkur Weid rockshelter, Mer.

The shelter is 7m long at the mouth and extends to 3.5m deep from the drip line, with a maximum ceiling height to around 2.5m. Although the ceiling height increases from the back of the shelter, hitting one's head during the course of the excavation was a common occurrence. The shelter has formed through weathering and erosion of a weakly lithified unit of aa lava, interstratified with massive lava units. Figure 5.2 provides the site plan for Kurkur Weid, and the floor plan and profile of the rockshelter.

Immediately seawards of the shelter, a small sand beach is enclosed within the cove created by two lava flows forming minor promontories. The beach overlies a partially-cemented basalt-boulder beach deposit, which forms a narrow intertidal fringe to the junction with the reef flat, approximately 20m seawards. At the reef-flat edge, silty sand-flats extend 15-20m over, and obscure, the coral-algal cemented reef-flat, grading seawards for 100m into seagrass beds developed on the silt-flat facies. The reef-flat is protected in this area by the numerous stone fish traps that surround the entire north, east and southeast margins of the island. The live-coral edge of the modern fringing reef is approximately 150m beyond the seaward margin of the fish traps, over 250m north of the rockshelter.

The floor of the shelter consists of very fine, dry, silty sand and is sparsely scattered with cobble sized roof fall. Other surface deposit includes numerous shells of modern reef species, including *Lambis lambis*, *Cypraea tigris*, *Strombus luhuanus* and several small valves of *Tridacna gigas*. Modern items observed included a metal knife and pieces of coloured textile. A semi-circular arrangement of *Lambis lambis* and *Tridacna* spp. shells on a bed of coarse white beach sand is located in the southwestern corner of the shelter. The shells were blackened, most likely owing to a combination of microbial and lichen activity.

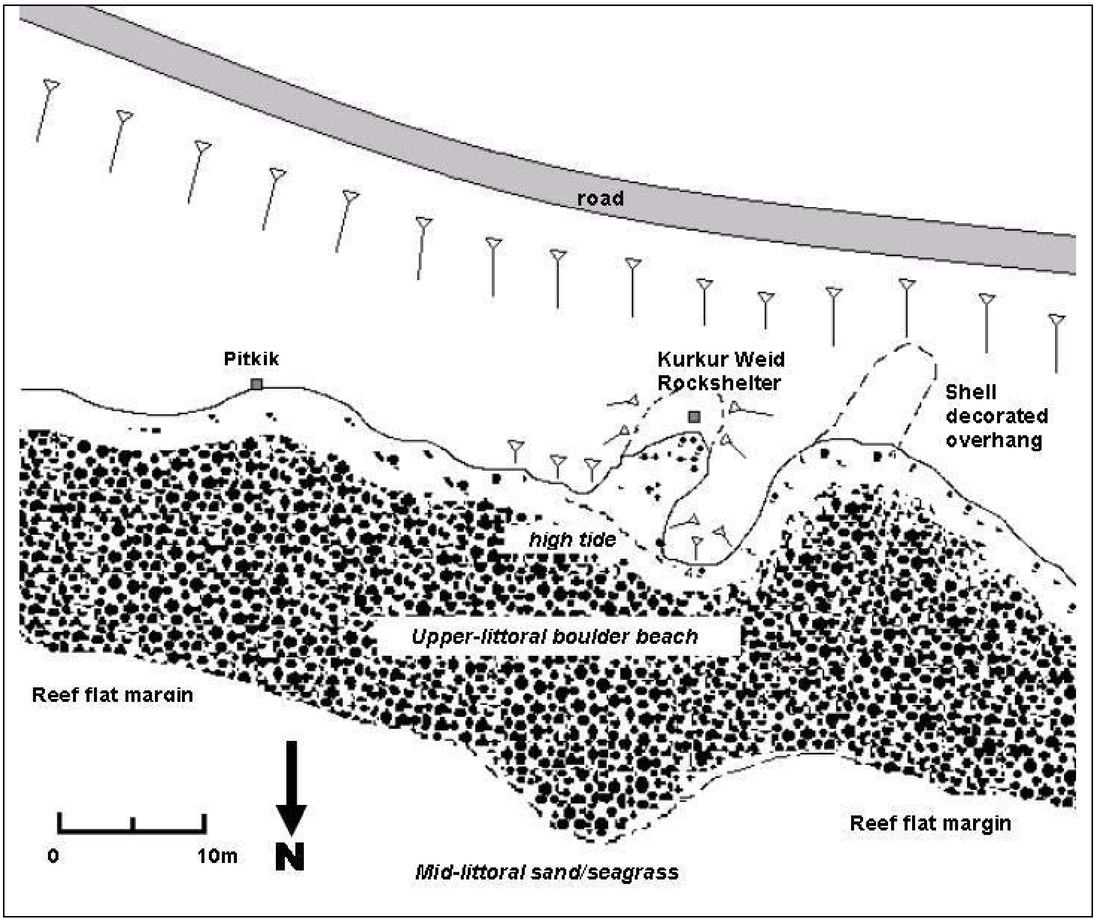
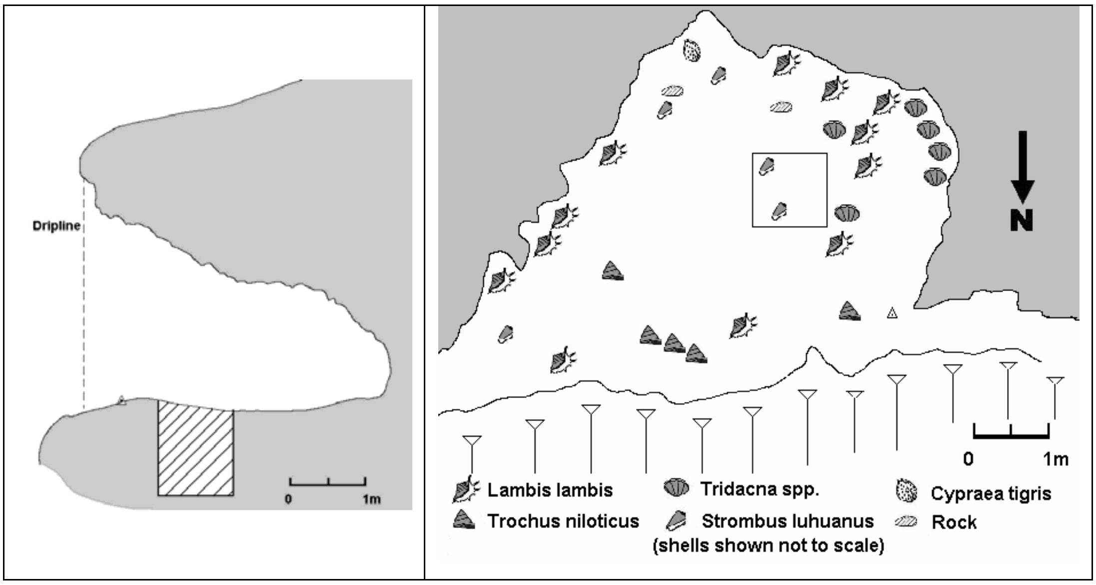


Figure 5.2 Kurkur Weid site plan, rockshelter profile and floor plan (note location of Pitkik profile to the left)



Excavation and stratigraphy

A single 1m x 1m excavation was placed approximately half a meter east of the shell arrangement near the centre of the shelter. Excavation Units (XU) were initially set arbitrarily at 2cm, but discrete Stratigraphic Units in the upper section of the deposit resulted in excavation by visible strata. For the rest of the deposit, however, excavation was completed in 10cm units as it was hindered by a large boulder that took up almost three-quarters of the surface area of the square. Excavation ceased at approximately 130cm below the surface owing to increasing difficulty in standing in the square and the lack of adequate surface area for excavation. A representative stratigraphic profile of the excavation square at Kurkur Weid is illustrated in Figure 5.3.

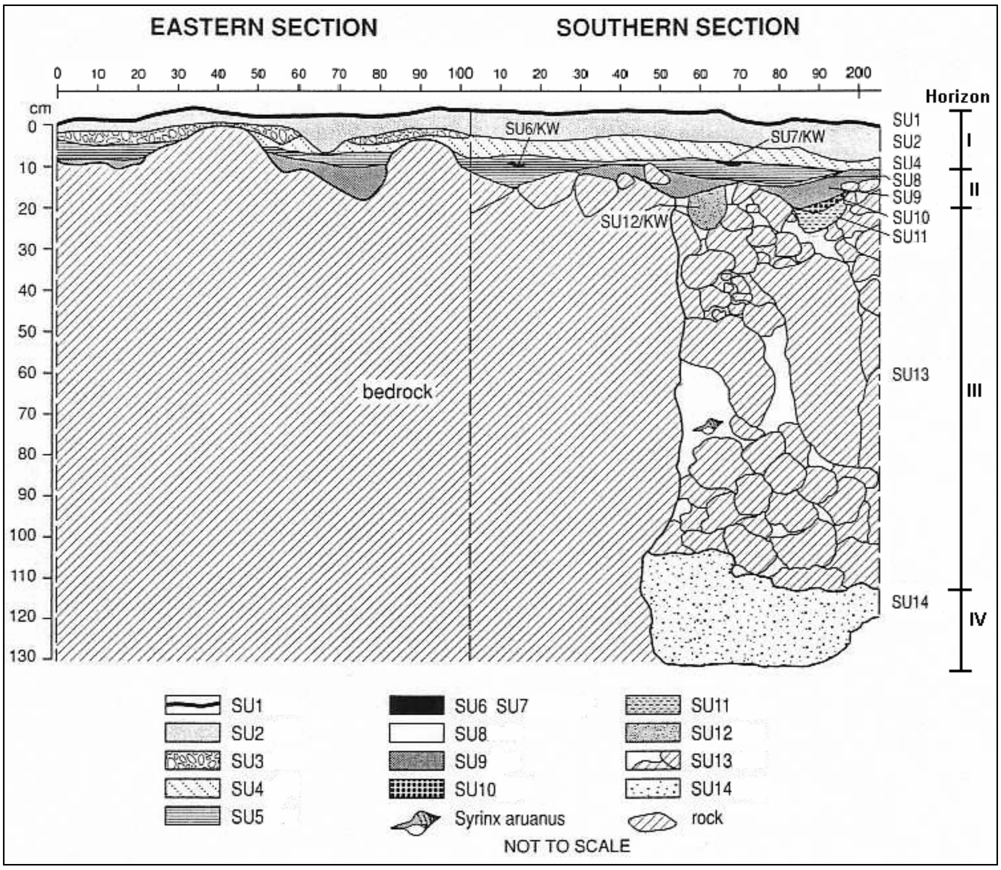


Figure 5.3 Kurkur Weid stratigraphic profile

Comprising a total of 14 Stratigraphic Units (Table 5.1), the deposit consists of a silty sediment derived primarily from weathering of the lava from the ceiling and walls of the shelter interspersed with angular clasts of roof fall, the density of which decreased with depth. Four main horizons are identified (Figure 5.3). One of the more notable features of the excavation at Kurkur Weid refers to Horizon III. This Horizon consists of a brownish silty sand matrix with some clay inclusions and is densely interspersed with pebble to boulder sized angular fragments of roof fall. During excavation all fieldworkers commented on the spongy feeling of the sediment underfoot, which was presumably caused by the pockets of air interspersed amongst the loosely consolidated boulders and shells.

SU	Description
1	Surface layer of brown (7.5YR4/3) sediment with a high percentage of clacareous sand grains and some charcoal flecking. Structureless rounded to sub-rounded fine sand to coarse silt. Boundary is sharp. Some cobble-size roof fall on surface. Recent cultural deposit including several shell species and small textile pieces.
2	Brown (7.5YR 5/3) coarse to medium sand with high percentage of calcareous sand grains. Weak structure with decrease in amount of charcoal flecking from SU1. Upper boundary is abrupt with increasing numbers of weathered vesicular basalt cobbles and boulders occurring with depth. Moderate amount of shell midden.
3	Light brownish grey (10YR 6/2) coarse sand to fine gravel as discontinuous layer in eastern section of square. Moderate structure with very high percentage of calcareous sand grains and small rounded coral inclusions. Lower boundary is sharp.
4	Brown (10YR 5/3) weakly structured medium sand as discontinuous layer in western section of square where lower boundary is clear. Lower percentage of calcareous sand grains but still visible throughout matrix. Midden content is more fragmented.
5	Yellowish brown (10YR (5/4), moderately structured coarse sand with abrupt lower boundary but less so in eastern section of square where layer is disturbed by underlaying rock. Increase in midden component relative to previous layer.
6	Discrete pocket of greyish brown (10YR 5/2) fine sand within SU5. Weak structured matrix with charcoal flecking. Lower boundary is sharp.
7	Small lense of light brownish grey (10YR 6/2) coarse sand with rounded basaltic grains within SU5. Moderately structured with loose consistency and abrupt lower boundary.
8	Fine lense of white carbonate sand speckled with basaltic inclusions.
9	Brown (7.5YR 4/3) moderately structured medium sand interspersed along base of volcanic bedrock in eastern section of square. Abrupt lower boundary in southern section. Low % of calcareous sand grains with moderate shell midden content.
10	Small cavity infill of light yellow brown (10YR 6/4) coarse sand with rounded basalt inclusions.
11	Small cavity infill of greyish brown (10 YR 5/2) medium sand with angular volcanic pebbles.
12	Pocket of dark yellowish brown (10YR 4/4) medium sand with visible humic matter beneath SU9 and within upper matrix of SU13.
13	Brown (10YR 5/3) medium sand with clear upper boundary marked by the appearance of angular basalt cobbles and boulders which continue in large numbers throughout layer. Weak to moderate structure with some clay and low % of calcareous sand grains. High density midden deposit including large, whole shells.
14	Brown (10YR 4/3) medium grained sand with weak structure and moist at the time of excavation. Very low amount of shell, some clay and coarse angular calcareous sand grains and coral pieces observed throughout matrix.

Table 5.1 Kurkur Weid Stratigraphic Unit descriptions

Midden distribution

Table 5.2 presents the quantity (g) and density (g/m^3) of the excavated assemblage categories, including shell, bone (terrestrial and marine), charcoal, coral and natural stone. The data are presented for each XU within the appropriate SU and Horizon. The density of marine shell (the principal midden component), bone, charcoal and coral decreases between Horizon I and Horizon II while that of stone increases. Horizon III contains the highest density of shell for the whole assemblage, and displays an increase in the middle of the unit, followed by a decrease in the lowermost section. Charcoal, coral and stone densities in Horizon III increase until the lower section of the unit, where coral and stone decrease and charcoal is absent. Bone density in Horizon III is consistent with Horizon I and Horizon II until a sharp increase in the lower section. Charcoal and stone are absent in Horizon IV, while coral density decreases further and the density of both bone and shell decreases slightly in comparison to the lower deposit of Horizon III.

Chronology and deposition

A total of three shell samples were selected for radiocarbon dating; these represent the upper, middle and lower portions of the deposit. Table 5.4 provides the results of radiocarbon dating for Kurkur Weid. The most obvious feature of the radiocarbon sequence for Kurkur Weid is the inversion of the two dates obtained from Wk-13369 and Wk-6749. This data provides a date as old as 1295 cal BP (at two standard deviations) for the earliest deposition of marine subsistence remains at Kurkur Weid, but also indicates that reworking of the archaeological deposit may have occurred. The presence of coarse beach-sand with small fragments of water worn coral and shell in the basal layer lends support to this interpretation.

Horizon/SU	XU	Volume (m^3)	Shell (g)	g/m^3	Bone (g)	g/m^3	Charcoal (g)	g/m^3	Coral (g)	g/m^3	Stone (g)	g/m^3
I/1-4	1	0.050	3707.36	74147.2	1.03	20.6	13.88	277.6	46.05	921.0	551.12	11022.4
	2	0.017	440.15	25891.2	0.60	35.3	6.37	374.7	48.89	2875.9	3671.96	215997.7
	3	0.011	2139.40	194490.9	0.49	44.5	4.82	438.2	4.20	381.8	4711.30	428300.0
II/5-12	4	0.016	505.22	31576.3	0	0	0.79	49.4	0.72	45.0	8500.00	531250.0
	5	0.019	142.17	7482.6	0	0	1.78	93.7	8.55	450.0	3962.40	208547.4
III/13	6	0.040	2674.43	66860.8	1.29	32.3	4.47	111.8	151.51	3787.8	22671.33	566783.3
	7	0.024	1169.76	48740.0	0.09	3.8	4.64	193.3	1.70	70.8	5664.19	236007.9
	8	0.025	1428.84	57153.6	0.74	29.6	2.72	108.8	70.95	2838.0	10500.00	420000.0
	9	0.020	2114.47	105723.5	0.82	41.0	0.23	11.5	414.94	20747.0	9581.56	479078.0
	10	0.023	312.80	13600.0	0.65	28.3	0.32	13.9	170.86	7428.7	6740.00	293043.5
	11	0.015	395.00	26333.3	0.10	6.7	0.06	4.00	163.11	10874.0	5894.30	392953.3
	12	0.018	512.68	28482.2	2.88	160.0	0.37	20.6	625.60	34755.6	17359.50	964416.7
	13	0.030	2344.89	78163.0	35.40	1180.0	0.24	8.0	55.86	1862.0	16500.00	550000.0
	14	0.017	138.43	8142.9	17.50	1029.4	0	0	0	0	666.91	39230.0
	15	0.031	4786.86	154414.8	5.72	184.5	0	0	44.67	1441.0	0	0
IV/14	16	0.016	633.33	38383.6	10.93	662.4	0	0	0	0	0	0
	17	0.021	174.50	8309.5	1.54	73.3	0	0	0	0	0	0

Table 5.2 Kurkur Weid midden weight (g) and density (g/m^3) by Horizon, Excavation Unit and Stratigraphic Unit

Horizon/SU	XU	Volume (m^3)	Shell (g)	g/m^3	Bone (g)	g/m^3	Charcoal (g)	g/m^3	Coral (g)	g/m^3	Stone (g)	g/m^3
I/1	1	0.124	2570.89	20733.0	1.67	13.5	1.55	12.5	158.86	1281.1	6000.00	48387.1
II/2	2	0.025	44.54	1781.6	0	0	0	0	20.80	832.0	1230.60	49224.0
III/3-4	3	0.045	402.57	8847.7	0.73	16.0	4.23	93.0	0	0	712.50	15659.3
	4	0.024	229.43	9559.6	0.64	26.7	1.54	64.2	0	0	811.60	33816.7
IV/5-6	5	0.063	751.62	11930.5	7.40	117.5	0.61	9.7	0	0	328.60	5215.9
	6	0.060	531.86	8791.1	0	0	1.56	25.8	1.52	25.1	250.00	4132.2
V/7	7	0.068	373.00	5485.3	118.58	1743.8	0	0	0	0	21.00	308.8
	8	0.042	657.10	15461.2	1.20	28.2	0	0	0.99	23.3	52.00	122.4

Table 5.3 Pitkik midden weight (g) and density (g/m^3) by Horizon, Excavation Unit and Stratigraphic Unit

Site	Lab. Code	Horizon/ SU	Depth (cm)	Sample	$\delta^{13}C$	% Marine	^{14}C Age	ΔR	Calibrated age (68.3% prob.) cal BP	Calibrated age (95.4% prob.) cal BP
Excavated samples										
Kurkur Weid Sq 1	Wk-13368	III/13	c. 25	*Lambis lambis*	1.9±0.2	88.9±0.4	949 ± 38 BP	12±7	607-539	518-633
Kurkur Weid Sq 1	WK-13369	III/13	c. 72	*Lambis lambis*	2.8±0.2	81.7±0.4	1623 ± 38 BP	12±7	1277-1214	1168-1295
Kurkur Weid Sq 1	Wk-6749	IV/14	c. 130	*Strombus luhuanus*	2.8±0.2	85.2±0.5	1290 ± 50 BP	12±7	929- 824	759-965
Pitkik Sq 1	Wk-13366	I/1	c. 30	*Lambis lambis*	3.3±0.2	91.4±0.4	726 ± 38 BP	12±7	435-339	307-464
Pitkik Sq 1	Wk-13367	IV/5	c. 69	*Lambis lambis*	2.3±0.2	84.9±0.4	1314 ± 38 BP	12±7	950-876	817-969
Pitkik Sq 1	Wk-6750	V/7	c. 110	*Lambis lambis*	3.1±0.2	85.4±0.5	1270 ± 50 BP	12±7	812-798	743-944
Sokoli Sq 1	Wk-7444	I/3A	c.33	*Strombus luhuanus*	2.8 ±0.2	86.3±0.5	1180 ±45 BP	12±7	797-694	874-673
Sokoli Sq 1	Wk-7480	II/5	c.70	*Srombus luhuanus*	2.6 ±0.2	75.3±0.5	2280 ±50 BP	12±7	2027-1902	2104-1864
Sokoli Sq 1	Wk-10164	III/10	c.125	*Strombus luhuanus*	2.5 ±0.2	78.4±0.4	1951 ±43 BP	12±7	1622-1521	1692-1483
Sokoli Sq 1	Wk-10165	IV/12A	c.170	*Strombus luhuanus*	2.4 ±0.2	77.5±0.5	2044 ±51 BP	12±7	1750-1611	1815-1561
Sokoli Sq 1	Wk-7481	V/14	c.195	*Strombus luhuanus*	2.8 ±0.2	75.8±0.5	2230 ±50 BP	12±7	1971-1859	2039-1802
Sokoli Sq 1	Wk-7445	V/14	c.235	*Stombus luhuanus*	2.3 ±0.2	70.2±0.4	2840 ±50 BP	12±7	2771-2685	2792-2535
Ormi Sq 1	Wk-10161	I/1	c.15.2	*Lambis lambis*	1.4 ±0.2	77.2±0.5	2074 ±48 BP	12±7	1809-1683	1846-1602
Ormi Sq 1	Wk-8885	I/4	c.40	*Lambis lambis*	1.4 ±0.2	74.4±0.5	2370 ±50 BP	12±7	2138-2009	2208-1949
Ormi Sq 1	Wk-10162	II/6	c.99	*Lambis lambis*	1.4 ±0.2	76.5±0.5	2148 ±48 BP	12±7	1873-1756	1922-1704
Ormi Sq 1	Wk-8917	III/8	c.110	Charcoal	-25.7 ±0.2	77.5±0.8	2050 ±80 BP	-	2065-1887	2158-1816
Ormi Sq 1	Wk-10163	IV/12	c.178	*Lambis lambis*	1.5 ±0.2	73.8±0.4	2435 ±48 BP	12±7	2209-2119	2307-2053
Ormi Sq 1	Wk-8918	V/13	c.210	*Conus sp.*	2.3 ± 0.2	70.3±0.5	2840 ±60 BP	12±7	2779-2657	2819-2493
Collected samples										
Sokoli beach section	Wk-6098	-	-	*Strombus luhunaus*	2.0 ± 0.2	78.8±0.4	1920 ± 50 BP	12±7	1606-1480	1663-1413
Ormi beach section	Wk-6096	-	-	*Lambis lambis*	1.4 ± 0.2	79.3±0.4	1870 ± 50 BP	12±7	1526-1414	1588-1354
Sokoli, upper beachrock	Wk-6751	-	-	*Lambis lambis*	1.9 ± 0.2	68.3±0.5	3060 ± 60 BP	12±7	3004-2849	3082-2779
Sokoli, lower beachrock	Wk-6752	-	-	*Strombus luhuanus*	2.9 ± 0.2	67.6±0.5	3150 ± 70 BP	12±7	3161-2958	3258-2869

Table 5.4 Radiocarbon dates for archaeological contexts from Mer and Dauar

However, the loosely consolidated nature of the middle section of the assemblage would have facilitated the down-movement of material through airpockets. Alternatively therefore, the results of radiocarbon dating may illustrate post-depositional movement of the archaeological assemblage at Kurkur Weid, with gravity being the major taphonomic force.Due to the limited number of radiocarbon dates obtained from Kurkur Weid, an age-depth curve for the site is not provided.

The rate of sediment accumulation illustrated in Figure 5.4 shows that the site may have been most intensively used between 520 and 780 cal BP, which is the date range for Horizon III. The lower densities of shell and bone remains recovered in Horizon II and Horizon I confirm that site use after 520 cal BP was not as intensive (see Table 4.2). The presence of metal and textiles in the upper-most stratigraphic units, however, may provide evidence of occupation and use of the rockshelter during the historic period and the recent past. For Kurkur Weid and each of the excavations, the correlating age ranges for each stratigraphic Horizon constructed from the results of radiocarbon dating are listed in appropriate figure captions.

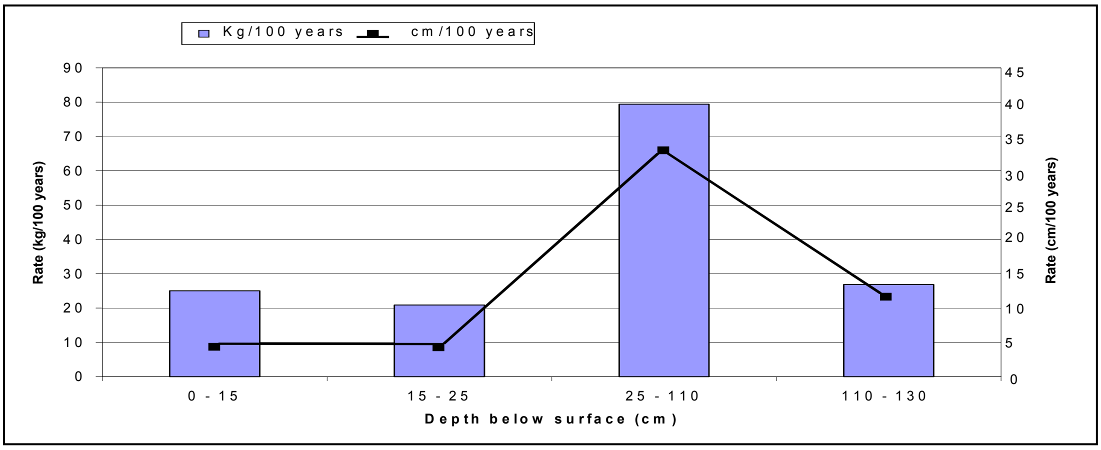


Figure 5.4 Kurkur Weid rate of sediment accumulation (I: 0-15cm, 0-315 cal BP, II: 15-25cm, 315-520 cal BP, III: 25-110cm, 520-780 cal BP; IV: 110-130 cal BP)

Pitkik

The excavation at Pitkik was of a small section of the lowest part of the northeast-facing slope located approximately 50m along the beach from Kurkur Weid rockshelter (Figure 5.2). At the junction of the slope base with the modern upper tidal beach zone, a 1.5m high section was exposed by storm wave erosion. Dense shell was visible within this section, forming an undulating but continuous stratigraphic unit which could be traced 5 - 10m along the shore east and west of the area excavated. Contemporary erosion at the site is most probably caused by high tide storm action during the northwest (wet season) monsoon.

The slope above the section is steep and vegetated and comprises rock debris and colluvial sediments derived from the weathering of vertical exposed sections of both vesicular basalt and weakly-welded volcanic scoria bedrock. On much of the slope, loose rocks lie close to the angle of repose, and are easily dislodged. The soil surface on the lower slope is variable, composed of large gravel clasts, isolated boulders and large shells (e.g. *Tridacna* spp.) derived from eroding archaeological contexts upslope.

Excavation and stratigraphy

A 1 m-wide section of the beach berm at Pitkik was cleared of vegetation to expose a vertical section profile 120 - 130cm in height (Plate 5.7, 5.8). Vertical and horizontal string lines were set up in order to control the excavation, and from which excavation levels and *in situ* measurements were also taken. The 1 m-wide profile was excavated into the section to a depth of 50cm, following the natural stratification. Eight Stratigraphic Units comprised mainly of slope derived colluvium were recorded. The site stratigraphy is illustrated in Figure 5.5 and described in Table 5.5. Five major Horizons within the Pitkik deposit were identified.

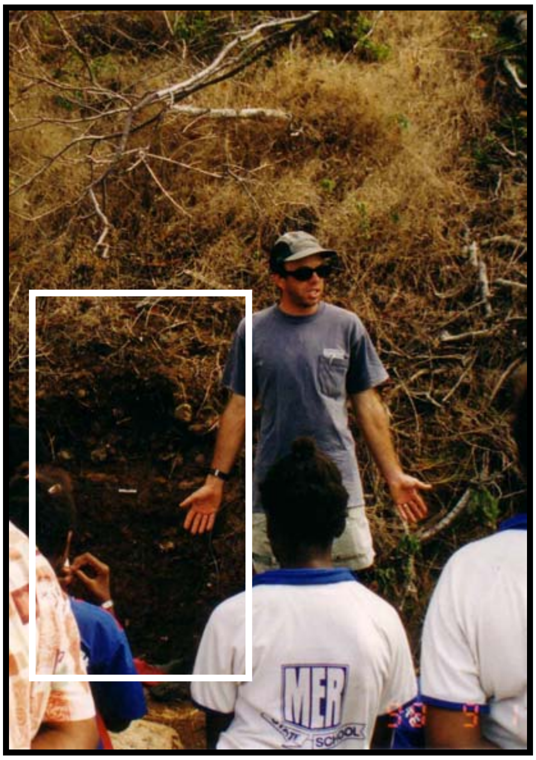


Plate 5.7 Pitkik prior to excavation

Plate 5.8 Pitkik partially excavated

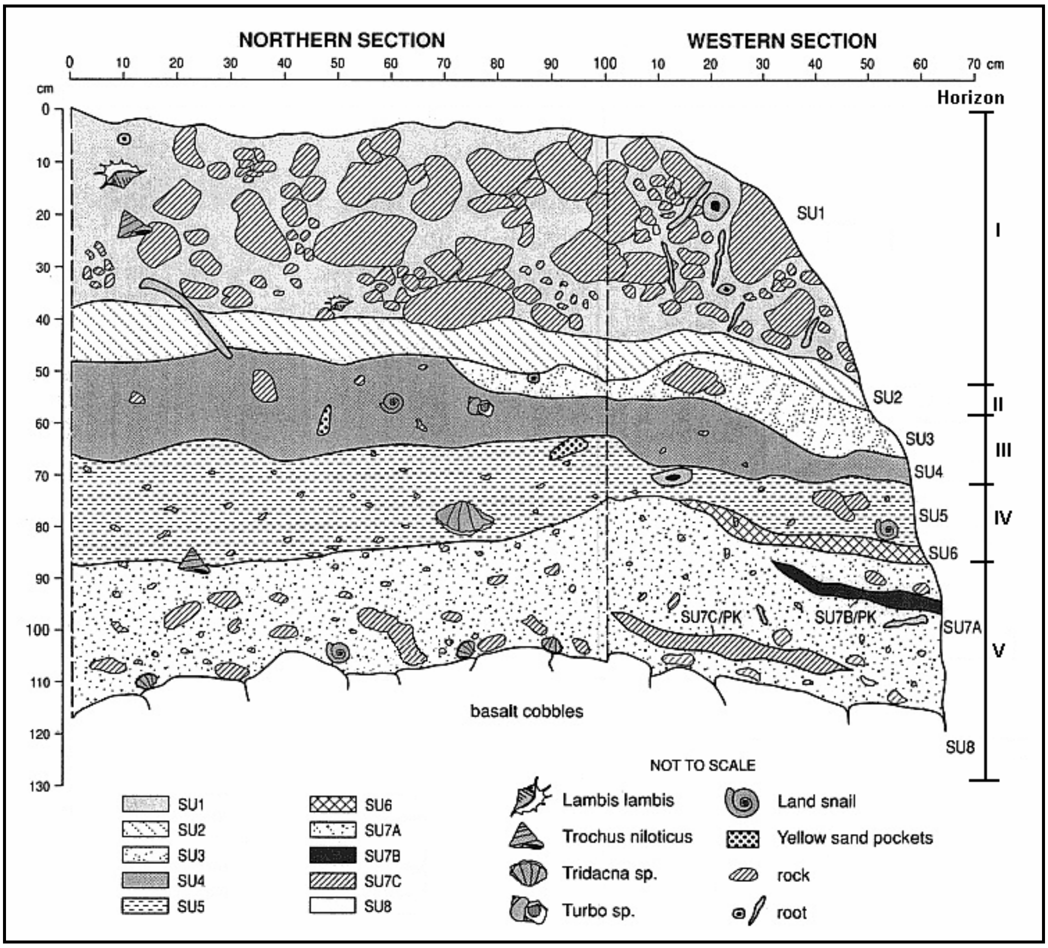


Figure 5.5 Pitkik excavation profile

SU	Description
1	Very dark greyish brown (10YR 3/2) coarse to medium sand matrix with moderate structure interspersed with rubbly colluvium composed of large gravel clasts, and isolated boulders. Loosely consolidated matrix with high percentage of calcareous sand grains observed throughout matrix. Abundant amount of midden including large, whole shells. Extensive root penetration.
2	Yellowish brown (10YR 5/6) coarse sand to fine gravel with a high percentage of calcareous sand grains. Upper boundary is clear. Decrease in amount of charcoal and midden component, consisting mostly of shell fragments. Matrix is less rubbly with no boulders and fewer cobbles than SU1. Continued root s.
3	Dark yellowish brown (10YR 3/4) coarse sand with some clay content. Moderate structure with a clear upper boundary. Discrete unit of yellow sands diffused throughout a brown sandy-clayey matrix. Some root penetration. Some whole shells including *Nerita* sp. and *Strombus* sp. Few rocky clasts.
4	Dark brown (10YR 3/3) medium to fine sands interspersed with subangular cobbles and small boulder clasts of weathered vesicular basalt. Midden component consists mostly of shell fragments, with burnt coral and pumice.
5	Dark brown (7.5YR 3/3) fine sand with moderately structured gravel sized clasts. High frequency of sub-rounded pellets and pebbles (possibly water sorted) with less calcareous sand grains than previous SU. Moderate amount of midden containing some whole and burnt shells.
6	Dark brown (10YR 3/3) medium sands with gravel sized volcanic clasts. Moderate to strong structure with clear northwards dipping lower boundary. Burnt shell frags.
7A	Dark yellowish brown (10YR 3/4) medium sands with a very strong structure forming a highly compact layer also containing coarse calcareous sand grains and angular coral fragments. Numerous sub-angular to rounded cobbles of basalt. High frequency of burnt and/or fractured stone and charcoal with red flecking within a very firm over-consolidated clay-silt matrix. Lower boundary is clear. Moderate amount of midden, with evidence of *in sutu* firing of a *Strombus luhuanus* specimen displaying thermal fracturing of body whorl.
7B	Brown (7.5YR 4/4) coarse sands with gravel sized clasts as discrete layer on northwards dip within SU7.
7C	Discrete layer of coarse carbonate (shell and coral) sands 2-6 cm in thickness, which dipped and thinned northwards along the section.
8	Basal SU comprising large rounded and smoothed cobbles of basalt, sub-horizonally bedded with some shell and underlain by well-sorted shelly medium sands (archaeological sterile).

Table 5.5 Pitkik Stratigraphic Unit descriptions

Midden distribution

Table 5.3 presents the quantity (g) and density (g/m^3) of the excavated assemblage categories, including shell, bone (terrestrial and marine), charcoal, coral and natural stone. The highest densities of excavated shell and coral are present in Horizon I. The density of all categories decreases substantially between Horizon I and Horizon II. Shell, bone and charcoal increase between Horizon II and Horizon III, while coral is absent and the density of stone decreases. Shell increases slightly in Horizon IV but overall remains consistent with the density in Horizon III. Bone and coral show an overall increase from the previous Horizon, while there is also a general decrease in charcoal density and a further consistent decrease in stone. Horizon V exhibits a decrease in coral and stone and an absence of charcoal. This Horizon also contains the second-highest shell density in the site and the lowest density of stone.

Deposition and chronology

Due to the limited number of radiocarbon dates obtained from Pitkik, a age-depth curve for the site is not provided. The results of radiocarbon dating, however, demonstrate a deposition sequence similar to Kurkur Weid (Table 5.4). The results of Wk-13367 and Wk-6750 indicate that the earliest deposition of archaeological shell remains occurred around 800 cal BP and may have been quite rapid in the lower section of the site. Wk-13366 from the upper deposit returned a date of around 375 cal BP, suggesting that the rate of deposition in the upper section may have slowed. This is confirmed by the rate of sedimentation accumulation at Pitkik (Figure 5.6), which illustrates that the sediment was deposited at the site most rapidly in Horizon IV, and then slowed considerably after around 775 cal BP.

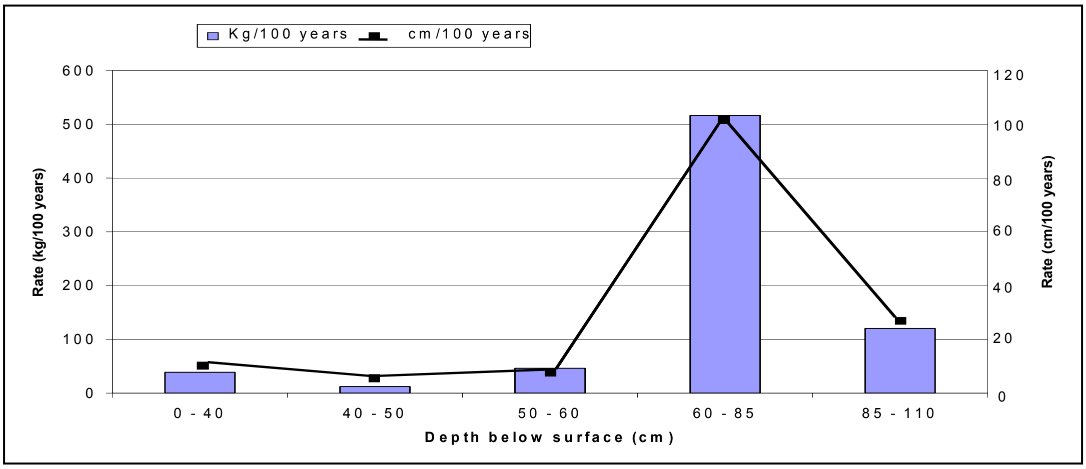


Figure 5.6 Pitkik rate of sediment accumulation
(I: 0-40cm, 0-380 cal BP; II: 40-50cm, 380-610 cal BP; III: 50-60cm, 610-775 cal BP; IV: 60-8cm, 775-800 cal BP; V: 85-110cm, 800-900 cal BP).

Sokoli

The Sokoli site is located on the north-northeastern side of Dauar, the second largest of the three islands in the Murray group. The site lies in an elevated position behind a small embayment, Eg, at the northern end of a low col that separates the hills of Au Dauar and Kebi Dauar (Figure 5.1, Plate 5.9). The low cliffed northern coastline of Dauar is breached at this point by a paleovalley, incised through lithified well-bedded volcanic tuffs. The paleovalley is probably of pre-Holocene age, and has been partially blocked at its mouth by beach formation during the mid- to late-Holocene. Unconsolidated shell-rich colluvium, underlain by weathered beach sands, forms a 2 - 3m high eroding section at the low cliff at the eastern end of the beach. A small wet season stream channel has an outflow at the western end of the beach where lithified beachrock is absent on the foreshore.

Fronting the eroding bank is the modern upper tidal beach and beds of coarse sand, shelly and fine gravel conglomerate beachrock that overlie an inclined erosional unconformity cut into volcanic tuffs. The cemented beachrock also contains numerous and very water worn specimens of *Lambis lambis*, *Strombus luhuanus*, *Tridacna* spp., and *Trochus niloticus* (Plate 5.10). The beachrock dips seaward, and may locally underlie the landward coral reef-flat margin. The reef-flat is narrow (<80 m) and comprises carbonate sands and silts, coral-algal lithified debris, and sparse seagrass. Live coral growth is restricted to a narrow 10 m seaward margin, mostly of *Acropora* spp. branching corals, where the reef drops very steeply into deep water.

Sokoli is a patch of heavily vegetated and fertile land located directly above the beachrock foreshore, but separated from it, and protected from modern wave action by the eroded beach section. Sokoli is a patrilineally owned garden plot supporting patches of sweet potatoes, pumpkins and yams amongst thickets of native shrubs, wild passionfruit and cherry tomatoes.

Plate 5.9: Location of excavation at Sokoli

Plate 5.10: Sokoli beachrock formation

Plate 5.11: Sokoli linear mound feature

The site is characterised also by two linear mounded ridges that run in a northeast – southwest direction upslope across the site (Plate 5.11). During the initial 1998 field season these mounds were initially identified as deposits similar to those described by Vanderwal (1973:183), mentioned previously in Chapter Three. Closer inspection of the site in 2000 revealed that the ridges were the likely result of clearing and bulldozing which took place early in 1998. Several other areas cleared on Dauar are also distinct in this way; being flat with a distinctive low creeper and vine vegetation cover, and often with visibly mounded or ridged edges owing to bulldozing of earth and perhaps archaeological deposits to the perimeter.

<u>Excavation and stratigraphy</u>

A 2m x 1m excavation square was set up at the site several meters to the west of the disturbed area and several meters from a small historic period cemetery (Figure 5.7). Once the area was cleared of vegetation, visible surface deposits were seen to include several specimens of common reef species including *Trochus niloticus*, *Lambis lambis* and *Nerita* spp. Excavation was conducted in 10cm units throughout most of the deposit except for several of the lower units where excavation was conducted in approximately 15cm – 20cm units owing to time constraints. Excavation of the feature comprising SU4C was not excavated separately as the boundary between this feature and the surrounding matrices was very unclear during excavation. It was only once excavation of the site was completed that the definite formation of SU4C could be made out. However, the upper horizontal deposit of SU4A/SU4B was removed as a single Excavation Unit.

Stratigraphy at the site was complex comprising 25 Stratigraphic Units within five broad Horizons. A section drawing of the excavation at Sokoli showing Stratigraphic Units and Horizons is found in Figure 5.8 and a description of the stratigraphy in Table 3.5. Horizon II and Horizon III contain the most distinguishing stratigraphic feature of the site. Horizon II consists of a continuous surface unit of fine powdery grey ashy sediment with charcoal fragments (SU4A/SU4B) and lower units of very compact brownish to yellowish sands heavily mottled with grey ashy sediment and clay inclusions. Horizon III includes the considerably less ashy linear extension of SU4C which in the western section continues to a depth of 160cm below the surface to the base of the Horizon IV. The surrounding matrix in Horizon III consists of slightly less consolidated units of yellowish to red sandy sediment with clay inclusions. Stratigraphic Unit 4A therefore represents a unique stratigraphic feature that is differentiated from the surrounding sediment matrices at the site by shape, sediment colour and as well as the nature of the archaeological assemblage (Plate 5.12). Based on this evidence it is possible that SU4 represents a manufactured soil through garden preparation, and that SU4C is the remnant of plant growth, representing root penetration or perhaps a yam hole.

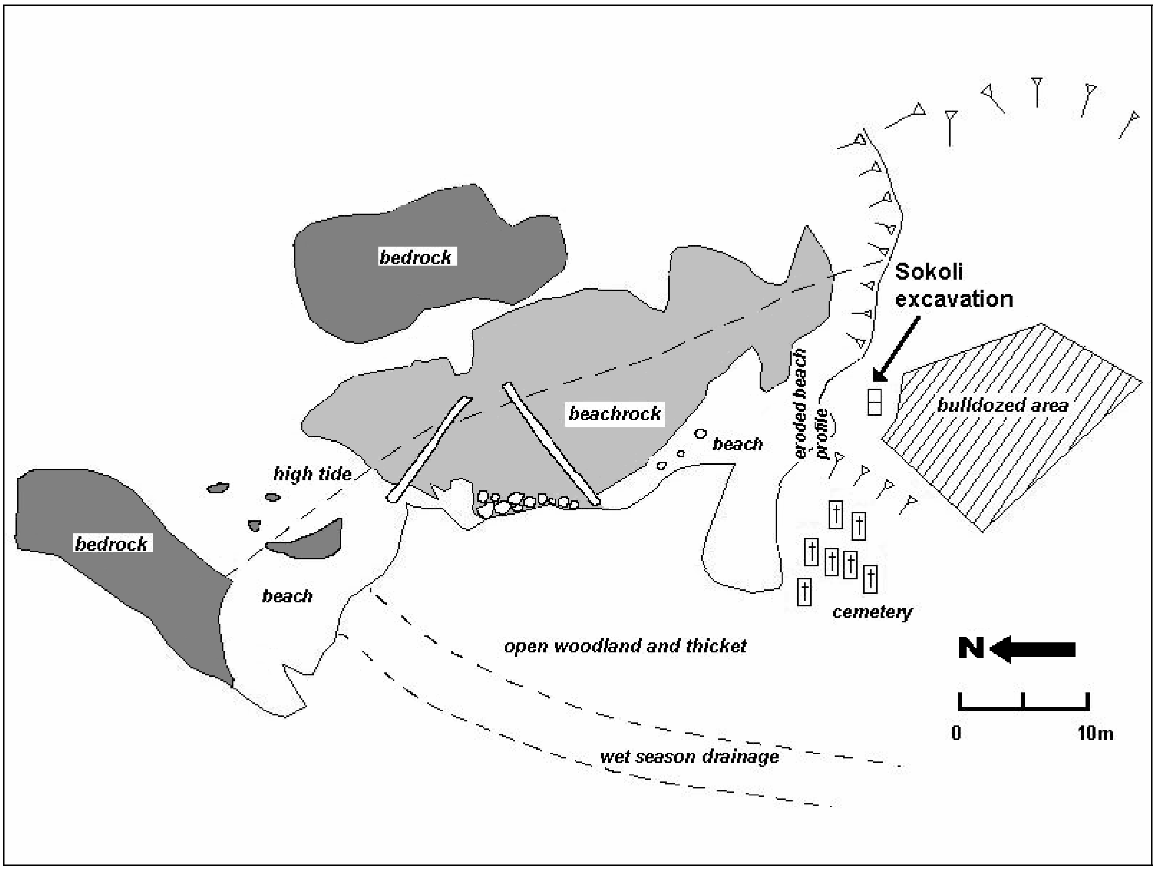


Figure 5.7 Site plan of Sokoli, Dauar Island

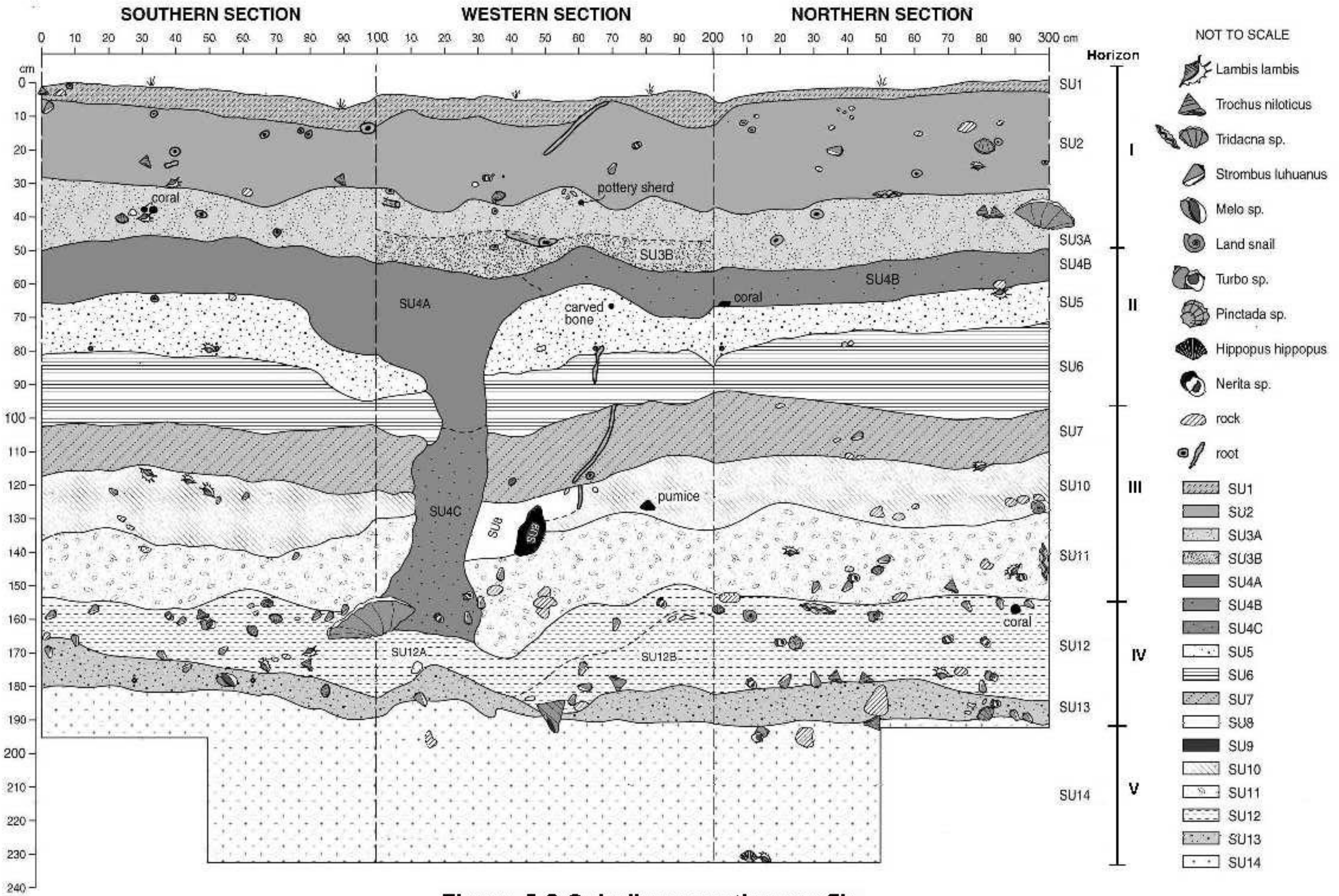


Figure 5.8 Sokoli excavation profile

SU	Description
1	Very dark brown (7.5YR 2.5/3) fine sand to coarse silt with a moderate percentage of calcareous sand grains. Weakly structured matrix with visible organic plant matter throughout upper section. Low amount of midden. Lower boundary is clear and relatively smooth.
2	Very dark brown (7.5YR 2/3) fine sand to coarse silt with a higher percentage of calcareous sand grains than SU1. Lower voundary is clear and relatively smooth. Structure is stronger and more compact than SU1. Moderate amount of shell.
3A	Dark brown (7.5YR 3/4) fine sand to coarse silt with a less calcareous sand inclusions than SU2. Moderate structure with a clear lower boundary except for the western section which represent s transition into SU3B. Increase in midden.
3B	Transitional layer comprising greyish brown (10YR 5/2) fine sand in western section of square. Weakly structured with abrupt lower boundary.
4A	Dark greyish brown (10YR 4/2) medium to fine silt with some fine sand and a low percentage of calcareous sand grains. Structureless with loose consistency and a clear uneven lower boundary extending at depth in western section of square. Increase in amount of midden with abundance of fragmented and burnt shell. Increase in amount of bone and charcoal from previous SU.
4B	Greyish brown (10YR 5/2) fine sand to coarse silt representing northern extension of SU4A. Structureless sediment slightly more consolidated than SU4A with continuing calcareous sand grain content. Clear and smooth lower boundary. High midden content consisting mostly of shell fragments.
4C	Brown (7.5 YR 4/2) medium to fine sand forming linear extension of SU4B. Boundary is clear but diffused by sediment of adjacent SUs. Low % sand grains.
5	Dark brown (7.5YR 3/4) fine sand to coarse silt with moderate structure noticeable more compact than sediment of SU4A and SU4B. Less midden component relative to previous SUs. Clear lower boundary following dip of above strata in western section.
6	Dark reddish brown (5YR 3/3) fine sand to coarse silt with some clay content forming very hard and strongly consolidated sediment. Upper boundary clear except where sediment of SU4C diffuses through layer. Very low midden content.
7	Dark brown (7.5YR 3/3) fine sand to coarse silt with fewer calcareous sand grains than previous SU. Lower boundary clear and smooth. Low midden content.
8	Yellowish red (5YR 4/6) medium sand containing whole shell and bone. Sediment has moderate structure.
9	Dark reddish grey (5YR 4/2) medium sand with ashy bands and charcoal flecking.
10	Dark reddish brown (5YR 3/3) fine sand to coarse silt with clear and wavy boundary. Sediment more loosely consolidated SU6 and SU7. Low midden content but slight increase from SU7.
11	Very dark greyish brown (10YR 3/2) medium sand with moderate structure. Lower boundary is clear and dips in western section adjacent to base of Layer 4C. Noticeable increase in midden content relative to previous four layers.
12A	Dark yellowish brown (10YR 4/4) medium sand with moderate structure and loose consistency and higher percentage of calcareous sand grains than previous SU. Very high midden content including large, whole shells and bone.
12B	Dark yellowish brown (10YR 4/4) medium sand mottled with less yellow sand than SU12A. Abundant midden component.
13	Yellowish brown (10YR 5/4) medium sand with moderate structure and moderate percentage of calcareous sand grains. Midden content continuing with large whole shells.
14	Reddish brown (5YR 4/6) coarse sand with moderate structure and high percentage of calcareous sand grains. Strong structure with very loose consistency. Lower amount of midden content relative to previous three SUs.

Table 5.6 Sokoli Stratigraphic Unit descriptions

Plate 5.12 Sokoli excavation featuring SU4

Plate 5.13 Sokoli excavation showing lower sediment change

Another potentially significant stratigraphic feature at Sokoli is the transition from Horizon V to Horizon IV. This marks a change in sediment from a coarse loosely consolidated reddish sand with a high proportion of calcareous inclusions in Horizon V, to a more consolidated yellowish-brown sand with less calcareous inclusions in Horizon IV (Plate 5.13). This provides evidence to suggest that from Horizon IV the sediment source site may have gradually changed from a beach environment to a more interior source such as colluvium.

Midden distribution

Table 5.7 shows the quantity (g) and density (g/m^3) of the excavated assemblage categories including shell, bone (terrestrial and marine), charcoal, coral and natural stone. The density of shell, which represents the most abundant midden component at the site, increases with depth, with Horizon II recording the lowest shell density figures. The amount of bone recovered varies throughout the site, with three peaks recorded at the base of Horizon I, the surface of Horizon III and halfway through Horizon V. In Horizons II – V bone density appears to be highest at the surface of the units and then decreases with depth. Horizon I has the lowest bone density figures. No clear patterning is evident in the distribution of coral although the lowest densities were recorded in the middle section of the deposit across Horizon II and Horizon III and in the uppermost layers of Horizon I. Charcoal density peaks at the transition zone between Horizon I and Horizon II after which it decreases towards the base of the deposit. The density of stone is highest in Horizon IV and Horizon V with Horizons I - III recording much lower densities.

Horizon/SU	XU	Volume (m^3)	Shell (g)	g/m^3	Bone (g)	g/m^3	Charcoal (g)	g/m^3	Coral (g)	g/m^3	Stone (g)	g/m^3
I/1-3	1	0.028	178.44	6261.1	48.13	1688.8	0	0	12.21	42.8	197.64	6934.7
	2	0.030	306.98	10064.9	1.83	60.0	0	0	0	0	0	0
	3	0.029	112.22	3869.7	3.68	126.9	0	0	0	0	10.70	360.0
	4	0.061	406.15	6604.1	26.38	428.9	0	0	7.70	125.5	0	0
	5	0.054	333.92	6127.0	7.57	138.9	0	0	0	0	104.84	1923.7
	6	0.055	1084.83	19724.2	15.55	282.7	0.38	6.9	36.68	666.9	53.37	970.4
	7	0.050	957.25	19145.0	12.12	242.4	0.5	10.0	0	0	9.35	187.0
	8	0.077	1858.74	23983.7	76.54	987.6	1.02	13.2	129.00	1664.5	41.01	529.2
	9	0.064	1982.66	30979.1	217.77	3402.7	7.24	113.1	81.40	1271.9	92.68	1448.1
II/4-6	10	0.124	433.43	3481.4	66.49	534.1	7.23	58.1	30.72	246.8	0	0
	11	0.066	1543.66	23388.8	56.98	863.3	3.58	54.2	195.59	2963.5	69.21	1048.6
	12	0.088	413.88	4703.2	36.42	413.9	0	0	9.44	107.3	52.25	593.8
	13	0.061	186.45	3031.7	26.12	424.7	0.83	13.5	18.93	307.8	11.94	194.1
	14	0.074	98.91	1327.7	8.42	113.0	0	0	52.22	700.9	2.24	30.1
III/7-11	15	0.090	529.61	5852.0	138.62	1531.7	1.84	20.3	0	0	19.27	212.9
	16	0.123	2178.02	17635.8	82.49	667.9	0	0	37.43	303.1	144.55	1170.4
	17	0.100	3018.14	30181.4	40.63	406.3	0	0	73.77	737.7	197.19	1971.9
	18	0.049	2367.25	48311.2	24.54	500.8	0.46	9.4	19.91	406.3	276.17	5636.1
	19	0.081	3502.83	42979.5	84.66	1038.8	0.12	1.5	47.40	581.6	750.70	9211.0
IV/12-13	20	0.120	11370.18	94751.5	71.95	599.6	0.96	8.0	269.35	2244.6	1081.50	9012.5
	21	0.094	4898.29	52109.5	62.52	665.1	0.45	4.8	149.61	1591.6	703.10	7479.8
	22	0.079	8214.71	103983.7	43.69	553.0	0.29	3.7	79.61	1007.7	438.71	5553.3
V/14	23	0.042	5275.97	125618.3	119.02	2833.8	0	0	63.07	1501.7	411.38	9794.8
	24	0.058	2466.85	42168.4	57.05	975.2	0.01	0.2	9.31	159.1	237.40	4058.2
	25	0.133	1207.77	9081.0	7.14	53.7	0	0	79.28	596.1	11.54	86.8

Table 5.7 Sokoli midden weight (g) and density (g/m^3) by Horizon, Excavation Unit and Stratigraphic Unit

Deposition and chronology

A total of six radiocarbon dates were obtained from archaeological shell samples from Sokoli to construct an adequate age-depth sequence (Table 5.4). The results suggest that initial occupation of the site occurred around 2600 cal BP (Wk-7445). The age-depth curve (Figure 5.10) illustrates that from approximately 1800 cal BP (Wk-7481) deposition at the site increased substantially. The result of the marine shell extracted from immediately below SU4A represents an anomaly in the age-depth sequence for the site (Wk-7480). Excluding this result, however, the date of the formation of SU4 is estimated to be around 900 cal BP. The fact that the date for Wk-7480 is double this, suggests that some disturbance to the middle section of the deposit has occurred, and that it may be associated with the formation of SU4. The uppermost sample from Sokoli dated to around 700 cal BP (Wk-7444).

The rate of sediment accumulation at Sokoli illustrated in Figure 5.9 confirms that from Horizon IV the rate of deposition at the site increased and was greatest between 1800 and 1400 cal BP. This onset of this rapid accumulation of deposit coincides with a change in the nature of the sediment between Horizon V and Horizon IV described above. After 1400 cal BP, however, the rate of sediment accumulation steadily decreases.

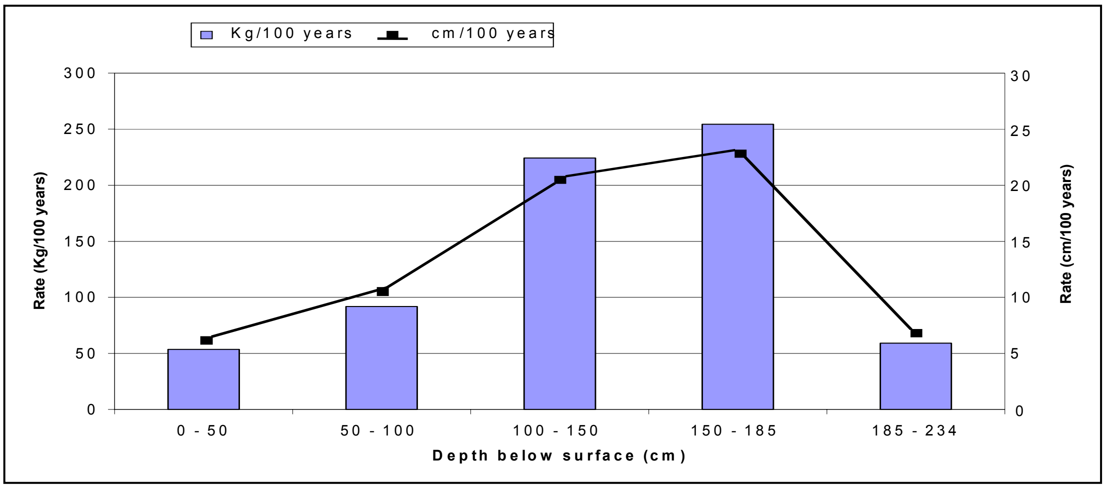


Figure 5.9 Sokoli rate of sediment accumulation
(I: 0-50cm, 0-900 cal BP; II:50-100cm, 900-1400 cal BP; III: 100-150cm, 1400-1650 cal BP; IV: 150-185cm, 1650-1800 cal BP; 185-234cm, 1800-2600 cal BP)

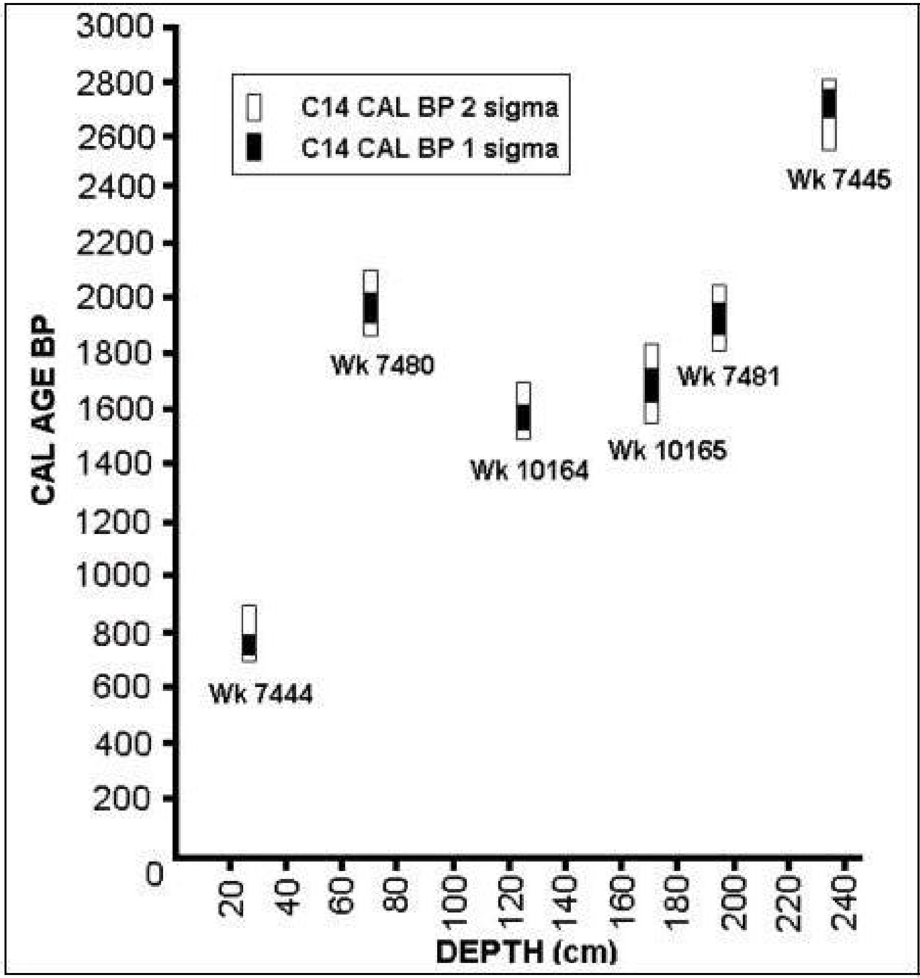


Figure 5.9 Radiocarbon age-depth curve for Sokoli excavation

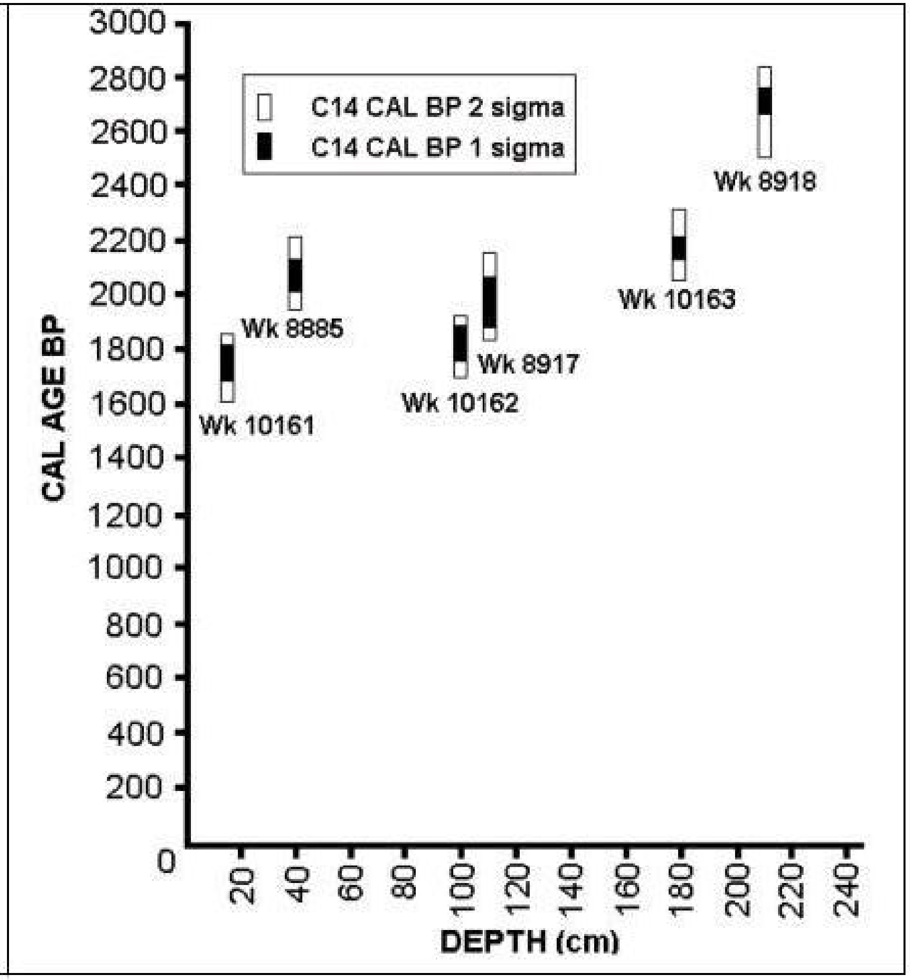


Figure 5.13 Radiocarbon age-depth curve for Ormi excavation

Ormi

Ormi is located on the southern coastline of Dauar, at the southern end of the low col which separates the hills of Au Dauar and Kebi Dauar (see Figure 5.1). Like Sokoli, the site of Ormi lies in a small embayment which also represents a breach in the island's coastline by a paleovalley of probable pre-Holocene age (Plate 5.14). The paleovalley at Ormi, however, has been blocked by a combination of mid- to late-Holocene beach formation and the seaward downslope movement and deposition of colluvium, including rocks and boulders from the steep southwestern slope of Au Dauar. A large wet season stream channel has formed from high up on this slope with an outflow onto the beach to the west of the site. The littoral zone immediately seaward of the outflow is littered with rocks and large boulders that obviously originated from some point inland along the stream channel.

In another similarity to Sokoli, coarsely-grained beachrock conglomerate is also present on the beach at Ormi, but is absent in the path of the stream outflow adjacent to the site. The beachrock deposit is located along the foreshore immediately seawards of an eroding low 1 - 3m bank section between the excavation area and the modern beach (Figure 5.11). The stratigraphy of the eroding section comprises unconsolidated shell-rich colluvium, underlain by weathered beach sands, and runs at varying heights along the length of the beach. Erosion of the beach profile at Ormi is exacerbated by the annual burrowing of nesting green turtles which causes extensive deflation and dispersal of archaeological deposit (mostly midden shell) across the foreshore.

The reef flat at Ormi is extensive, stretching for approximately 370m to the outer reef edge. There are several stone-fish traps located at approximately 30m from the foreshore and extending seaward to around 115m (see Plate 5.14). The reef flat comprises carbonate sands and silts, coral-algal lithified debris (particularly around the stone fish traps), and sparse seagrass. Live coral growth is abundant towards and on the reef edge and consists mostly of coral bombie varieties within small lagoons.

Plate 5.14 Site of Ormi excavation showing stone fish traps and reef edge in background

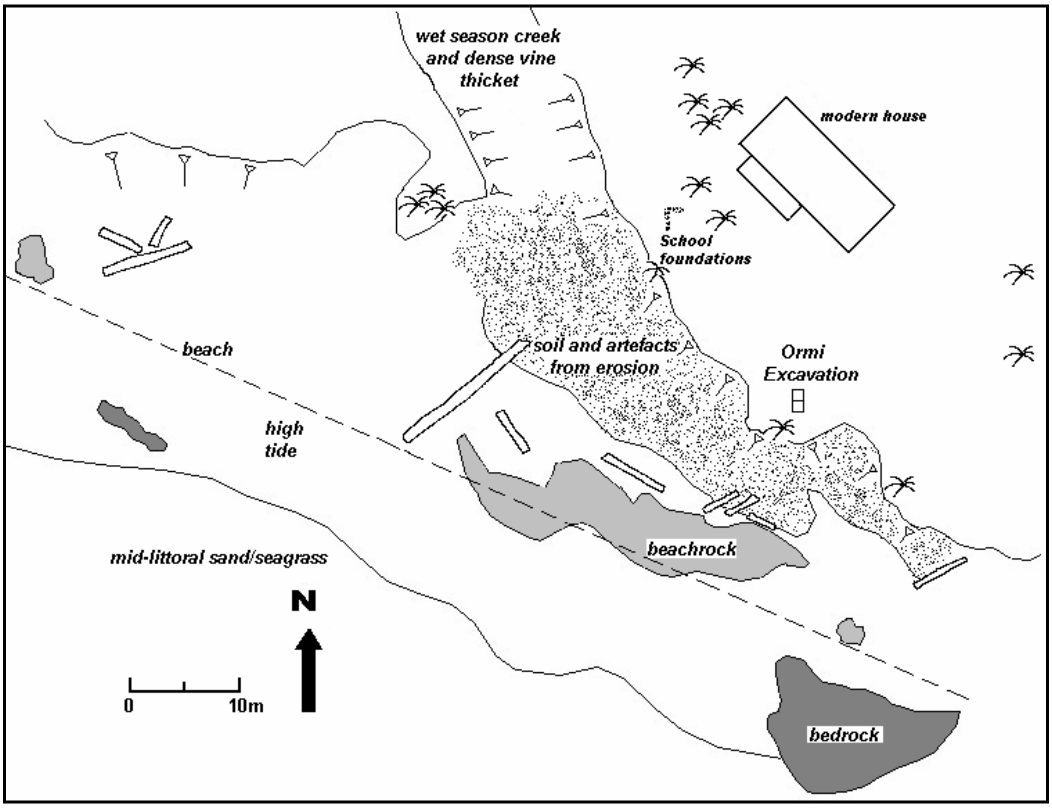


Figure 5.11 Ormi site plan

A school was located at the site of Ormi during the early 20th century when a portion of the Meriam community still resided on Dauar. The only evidence of an historic structure at the site consists of a small section of foundation rubble and several broken slabs of concrete, which apparently represent the toilet block. A house, built at the site approximately eight years ago, lies several meters behind the approximate location of the school. To assist in the movement of construction equipment from Sokoli to Ormi, a road was cleared from one side of the island to the other. This road runs parallel to the eastern side of the house at Ormi and continues to the foreshore. It is possible that the archaeological deposit eroding out onto the foreshore at Ormi is material that was cleared from the site in order to create a level base for construction.

Excavation and stratigraphy

The 2m x 1m excavation square at Ormi was located 2.5m landward of the eroded profile, approximately 2m west of the cleared road area and around 10m from the house (Figure 5.11). The location of the excavation is elevated to approximately 3m above the mean high tide datum, and situated immediately behind the highest section of the eroded beach profile. Once ground cover and vegetation was cleared from the site, visible surface deposits consisted of numerous shells including *Tridacna* spp., *Lambis lambis*, *Trochus niloticus*, and several large clumps of coral. Excavation was conducted in 10cm units throughout the entire deposit.
SU11 and SU12 were not excavated separately as these features were only detected after excavation during drawing of the stratigraphic profiles.

Figure 5.12 shows a drawing of the 13 stratigraphic units and five Horizons recorded for the excavation at Ormi. A description of Stratigraphic Units is provided in Table 5.8. Like Sokoli, although much more abrupt, is a transition in the sediment halfway through the excavation between Horizon IV and Horizon III (Plate 5.15).

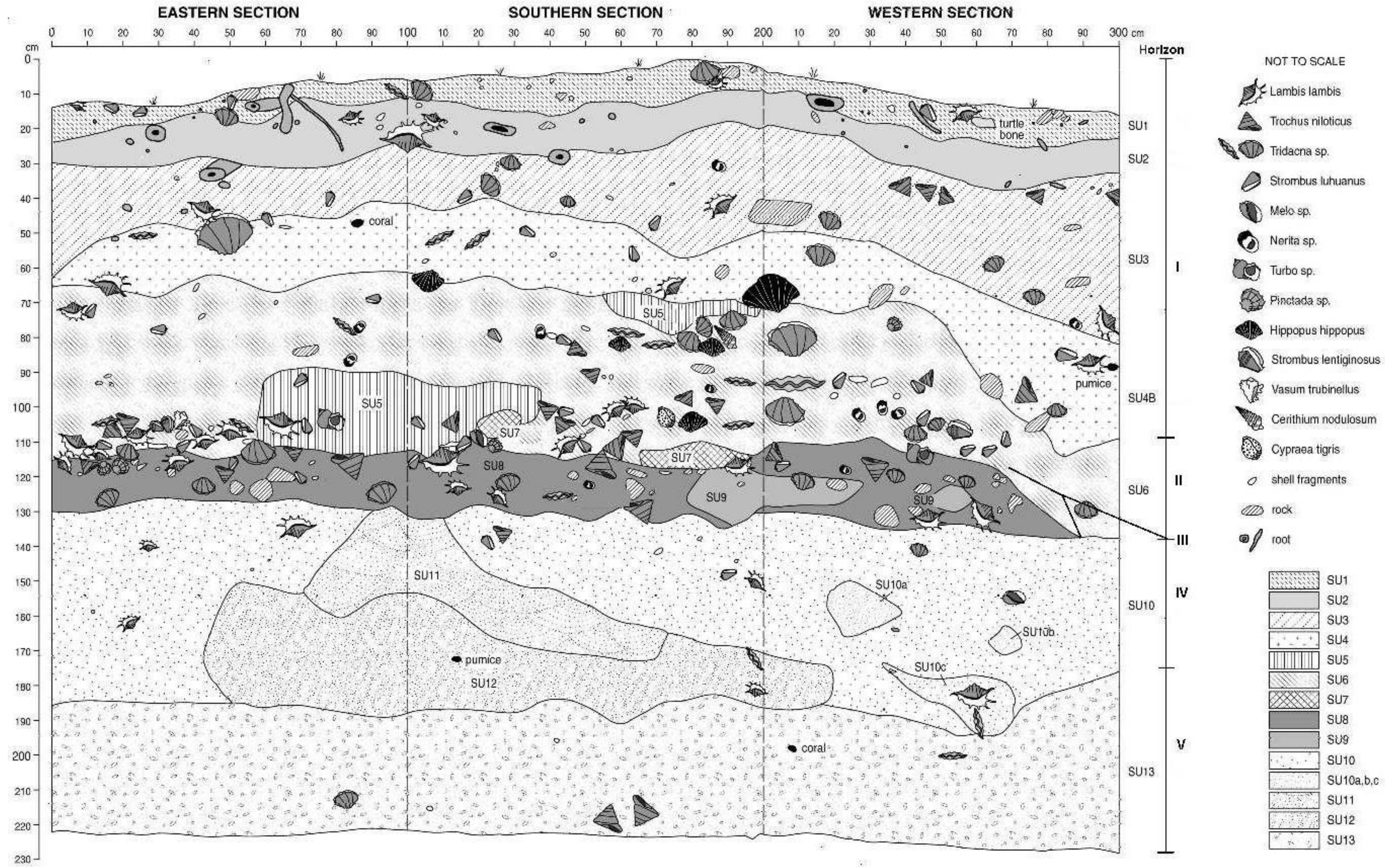


Figure 5.12 Ormi excavation profile

SU	Description
1	Very dark brown (7.5YR 2.5/2) well sorted medium grained sand with high percentage of calcareous sand grains. Small to larger size root penetration through center section of square and increasing with depth. Lower boundary is clear with a distinct northwards facing dip. High midden content including a number of shells on surface.
2	Very dark greyish brown (10YR 3/2) medium grained sand more compact than surface layer. High percentage of calcareous sand grains with root penetration continuing throughout this SU. Less midden content.
3	Dark yellowish brown (10YR3/4) medium grained sand. Noticeably lower percentage of calcareous sand grains. Upper boundary clear with layer thickening and dipping in western section of square. Increase in midden component.
4	Dark greyish brown (10YR 4/2) medium grained sand. Transitional layer containing almost no calcareous sand grains. Layering steeply dipping in western section of square. Midden content consistent with previous SU.
5	Greyish brown (10YR 5/2) medium grained sand within two distinct features occurring within broader matrix of SU6. Contains visibly less archaeological remains that SU6.
6	Dark greyish brown (10 YR 4/2) medium grained sand. Moderate structure with clear lower boundary that follows dip in strata in western section of square. Abundant midden component including large, whole shells and bone.
7	Dark greyish brown (10YR 4/2) medium grained sand forming isolated feature within the surrounding matrix of SU6. Contained less shell than SU6.
8	Very dark grey (10YR 3/1) medium grained sand with soft pebble to cobble sized rocks occurring throughout matrix . Upper boundary is sharp and smooth but terminates in western section. Abundant midden content with a high frequency of blackened shell and charcoal.
9	Black (10YR 2/1) fine sand to coarse silt within broader matrix of SU8. Weakly structured sediment within oddly shaped features containing noticeably less midden content than SU8.
10	Brown (7.5 YR 4/4) coarse sand with moderate percentage of calcareous sand grains marking distinct transition from SU8. Loosely consolidated with considerably less midden component.
10a	Brown (7.5YR 4/3) coarse sand with moderate structure as triangular shaped feature within SU10.
10b	Brown (10YR 4/3) coarse sand with moderate structure as circular shaped feature within SU10.
10c	Brown (7.5YR 4/3) coarse sand with moderate structure as gourd shaped feature within SU10. Distinguished from the matrix of SU10 by a more consolidated and stronger structure.
11	Brown (7.5YR 3/3) coarse sand with some clay inclusions causing sediment to clump, but otherwise crumble easily when pressure is applied. High percentage of coarse calcareous sand grains and coral fragments.
12	Brown (7.5 YR 4/4) coarse sand as horizontally linear feature located immediately below SU11. Sediment is clumpy but breaks easily and is other wise loosely consolidated. Lower frequency of calcareous sand grains relative to SU11.
13	Dark yellowish brown (10YR 3/4) coarse sand to fine gravel with a high percentage of coarse calcareous sand grains. Sediment is loosely consolidated with moderate structure. Low midden content but cultural material still present.

Table 5.8 Ormi Stratigraphic Unit descriptions

Plate 5.15 Ormi excavation showing lower sediment change

This transition represents a change from homogeneous brown, loosely consolidated coarse sand with calcareous inclusions in Horizon IV, to very dark grey, medium-grained sand with small angular rocks dispersed throughout. The nature of these sediments suggests that much like Sokoli, a change in the source of sediment from beach sands to possible colluvium has occurred. In comparison to the two lowest Horizons, another distinguishing characteristic of Horizon III is the apparent increase in the quantity of archaeological remains, which is clearly illustrated in Figure 5.12.

As mentioned above SU11 and SU12 were noted during the drawing of the stratigraphic profiles. Examination of the sediment samples taken from these units revealed a higher clay content than in the surrounding sediment matrix of SU10 and SU13. It is largely owing to the presence of these features that the lower half of the deposit is divided into two horizons. Both features lie horizontal and also appear to extend from SU8 in Horizon III. Due to this association the features within Horizon IV are interpreted as the possible stratigraphic remnants of tree roots or possibly evidence of the growth of a cultivated species.

Midden distribution

Table 5.9 presents the quantity (g) and density (g/m^3) of the excavated assemblage categories, including shell, bone (terrestrial and marine), charcoal, coral and natural stone. Shell density figures are the highest of all the sites excavated on Mer and Dauar with peaks in the upper deposits of Horizon I and Horizon III. The lowest shell densities are recorded for Horizon V and Horizon IV, with the highest densities recorded in the upper half of the deposit. Bone densities at the site are variable, with peaks recorded near the base of Horizon I, and at the transition between Horizon IV and Horizon III. Coral density figures also vary throughout the assemblage, with peaks recorded at the surface of Horizon V, the transition between Horizon III and Horizon II and at the surface of Horizon I. As with shell, the lowest bone densities for Ormi are recorded in Horizon IV and Horizon V. Between Horizon II and Horizon III the densities of charcoal, coral and stone dramatically increase, while both charcoal and stone decrease with greater depth in Horizon IV and Horizon V. As with shell, peaks in the density of charcoal, coral and stone are also recorded in the surface layer of Horizon I.

Deposition and chronology

A total of six radiocarbon dates from five excavated marine shell samples and one charcoal sample were obtained from Ormi. Sample details and the results of dating are listed in Table 5.4, and the results are plotted in Figure 5.13. The result of the basal shell sample suggests that, like Sokoli, the initial deposit of archaeological remains at Ormi occurred around 2600 cal BP (Wk-8918). The uppermost sample returned an age of around 1650 cal BP (Wk-10161). This result suggests that deposition at the site was rapid and that the most recent archaeological deposit (post-dating approximately 1650 cal BP) is not *in situ*.

Horizon/SU	XU	Volume (m^3)	Shell (g)	g/m^3	Bone (g)	g/m^3	Charcoal (g)	g/m^3	Coral (g)	g/m^3	Stone (g)	g/m^3
I/1-4	1	0.010	3055.49	305539.0	10.72	107.2	0.91	91.0	205.10	20510.0	1196.70	119670.0
	2	0.068	8115.67	118132.0	53.15	773.7	0.76	11.1	232.70	3387.2	2705.61	39383.0
	3	0.092	7973.10	86664.1	96.78	1052.0	0.31	3.4	198.20	2154.3	1988.60	21615.2
	4	0.070	4509.27	63961.3	43.02	610.2	0.33	4.7	131.11	1859.7	1931.10	27391.5
	5	0.086	6355.15	73897.1	62.99	732.4	0.09	1.0	193.60	2251.2	1613.60	18762.8
	6	0.086	5365.20	62025.4	55.44	640.9	0.10	1.2	544.70	6297.1	1175.80	13593.1
	7	0.079	5248.82	65774.7	101.09	1266.8	0	0	315.47	3953.3	1298.70	16274.4
	8	0.059	4595.59	77236.8	29.36	493.4	0.39	6.6	63.54	1067.9	1992.40	33485.7
II/5-7	9	0.089	6664.76	74717.0	52.30	586.3	0	0	229.93	2577.7	3036.10	34037.0
	10	0.106	7549.26	70885.1	61.44	576.9	0.10	0.9	231.23	2171.2	4819.60	45254.5
	11	0.092	7847.39	84836.6	59.95	648.1	1.47	15.9	104.70	1131.9	4398.40	47550.3
	12	0.063	4490.07	70709.8	33.68	530.4	1.11	17.5	77.79	1225.0	1307.22	20586.4
	13	0.054	4647.08	85267.5	24.99	458.5	1.39	25.5	265.77	4876.5	953.90	17502.8
III/8-9	14	0.071	12336.41	172537.2	49.71	695.2	0.93	13.0	674.50	9433.6	1860.07	26015.0
	15	0.081	14429.46	178141.5	55.41	684.1	16.02	197.8	596.16	7360.0	3271.45	40388.4
	16	0.070	4883.42	69763.1	92.88	1326.9	7.71	110.1	134.46	1920.9	12828.30	183261.4
IV/10-12	17	0.062	3948.25	62770.3	32.49	516.5	1.20	19.1	115.80	1841.0	1817.50	28895.1
	18	0.099	1890.48	18999.8	30.18	303.3	0.60	6.0	129.04	1296.9	507.44	5099.9
	19	0.103	1995.82	19376.9	26.25	254.9	0.20	1.9	126.19	1225.1	442.60	4297.1
	20	0.122	1280.54	10496.2	14.86	121.8	0.50	4.1	126.14	1034.0	340.39	2790.1
	21	0.113	2844.38	25171.5	31.00	274.3	0	0	219.21	1940.0	646.70	5723.0
V/13	22	0.087	3034.06	45284.5	44.14	507.4	0.27	3.1	571.93	6574.0	578.30	6647.1
	23	0.066	951.91	14422.9	20.31	307.7	0.29	4.4	359.40	5445.5	370.48	5613.3
	24	0.131	1628.87	12434.1	165.71	1265.0	0.58	4.4	415.30	3170.2	911.70	6959.5
	25	0.090	1545.20	17168.9	43.46	482.9	0.01	0.1	312.77	3475.2	214.52	2383.6

Table 5.9 Ormi midden weight (g) and density (g/m^3) by Horizon, Excavation Unit and Stratigraphic Unit

The rate of sediment accumulation at Ormi illustrated in Figure 5.14 confirms that sedimentation at the site increased steadily from the time of first occupation, and was greatest in Horizon II dated to between approximately 1900 and 1800 cal BP. Based on the radiocarbon age-depth curve (Figure 5.13) the sediment change and increase in the quantity of archaeological remains between Horizon IV and Horizon III is dated to around 2000 cal BP.

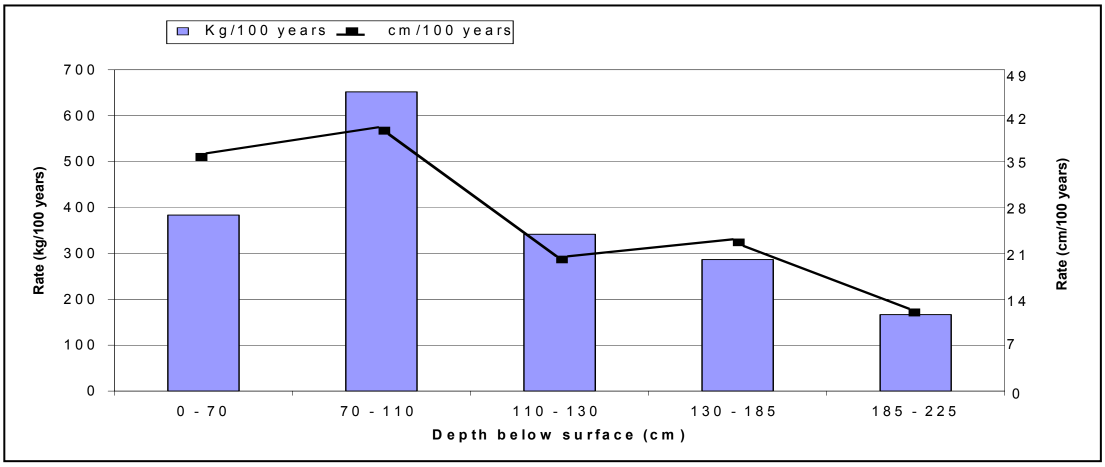


Figure 5.14 Ormi rate of sediment accumulation
(I: 0-70cm, 1600-1900 cal BP; II: 70-110cm, 1800-1900 cal BP; III: 110-130cm, 1900-2000 cal BP; IV: 130-185cm, 2000-2250 cal BP; V: 185-225cm, 2250-2600 cal BP).

According to the age-depth curve the date of the deposition of the pottery sherds recovered in Horizon I occurred around 1650 cal BP, while the remaining sherds were deposited at the site between 2600 and 2000 cal BP. However, as all but one of the pottery sherds recovered in Horizons IV and V are very small (the larger sherd was recovered at 135cm bsl at the surface of Horizon IV), it is possible that these artefacts have moved down through the loosely consolidated sandy matrix of the lower two Horizons. The presence of SU11 and SU12 in Horizon IV may also account for some downward movement of material that was originally deposited higher in the assemblage.

Discussion

Chronology of Site Formation and Occupation

During the first field season in 1998, with the aim of determining the date of the onset of beach formation on Dauar, two mollusc samples (*Lambis lambis* and *Strombus luhuanus*) were taken from the eroding surface and the basal unit of the cemented beachrock facies in the intertidal zone at Sokoli. At the time of collection it was noted that the *Lambis lambis* specimen, sampled from the upper surface of the beachrock, exhibited fracturing that is characteristic of shells processed by the Meriam today (Bird and Bliege Bird 1997:42).

The beachrock facies at Sokoli are steeply dipping seaward and are very coarse textured, indicating intertidal high wave energies and sorting. It is therefore unlikely that the upper shell sample, dating to around 2800 cal BP (Wk-6751) is *in situ*. It may, however, derive from a processing site within the extreme upper tidal area on the beach, which was then incorporated into the beach stratigraphy by wave action. As the beach surface prograded, the material lithified through post-depositional cementation at depth. Beachrock sample Wk-6752 is from a boulder conglomerate *c.*1-1.5 m lower in the beachrock sequence and immediately above the erosional unconformity that forms the basal contact of the Holocene beach conglomerate over the volcanic bedrock. Dating to around 2900 cal BP, this sample marks the onset of beach formation at this point in the sequence. Thus, the interpretation of the upper sample as archaeological is partly supported by independent stratigraphic evidence of rapid accumulation (and progradation) commencing around 3000 yrs BP, which might favour incorporation of archaeological material discarded on the beach shoreface, or in the immediate vicinity.

The initial radiocarbon samples extracted from the beach profiles at Sokoli, (Wk-6098) and Ormi (Wk-6096) were taken as an estimate of the antiquity of coastal archaeological deposits on Dauar. The results indicated that the deposits were in the order of approximately 1600 - 1400 cal BP, confirming the exploitation of marine resources some 1400 years after beach formation on Dauar (see Table 5.4). However, the results of radiocarbon dating of excavated *in situ* basal shell samples at the Sokoli and Ormi demonstrate the initial deposit of cultural material at around 2600 cal BP (Wk-7445 and Wk-8918), shortly after beach formation. During this initial stage of occupation the depositional environment of both sites appears to be similar, formed from coarse sediments derived from open coastal environments. Both the chronology and sedimentology of the excavated sites therefore confirm Barham's (2000) hypothesis that sediment accumulation and beach formation in Torres Strait followed a 2000 – 3000 year time-lag after the Holocene transgression highstand at 6000 BP.

In contrast to the Dauar sites, however, the results of radiocarbon dating the excavations on Mer revealed one significant feature in relation to site formation and early occupation: the deposition of the earliest archaeological marine resource remains at Kurkur Weid and Pitkik occurred at around 1200 cal BP (Wk-13369) and 800 cal BP respectively (Wk-13367), significantly later than at Sokoli and Ormi. For Kurkur Weid it is suggested that the later occupation date may be a reflection of the recent formation of the rockshelter itself. It is possible that weathering of the back wall of the shelter may have been delayed by regolith and vegetation coverage, as observed on the slope above the shelter and at Pitkik today (Plate 5.7). As the erosive effects of wind and possible storm surge destroyed coverage on the lower slopes, exposure of the back wall of the shelter to similar conditions initiated the evolution of the site as it exists today. The large boulder in the eastern half of the excavation square provides possible evidence for ceiling collapse, while at the same time sediment at the base of the deposit indicates multiple sources including *in situ* weathering and beach contexts fronting the site.

Although only a small portion of the lower deposit at Kurkur Weid was recoverable, the absence of stone in these lower units may represent a period of site stabilisation, attracting occupants to the shelter for the first time as early as 1295 cal BP (Wk-13369). Although no well-defined or isolated hearths were identified in the excavation, an increase in the quantity of stone in the deposit after this time may be the result of an increase in site use resulting in roof fall caused by the lighting of fires. This interpretation is supported by the increase in the rate of sediment accumulation at the site between 780 and 520 cal BP, during which time the density of shell remains also increases. In contrast to the quantity of shell recovered from the Dauar sites, however, both the low volume of shell excavated from Kurkur Weid and the relatively slow rate of deposition determined by radiocarbon dating (Wk-13368), are possible evidence for intermittent occupation of the rockshelter.

The steep slope and nature of the sediment at Pitkik suggests that most of the excavated archaeological material originated from the hill above the site. The chronological sequence for Pitkik illustrates that slope-derived colluvium has steadily filled the site from as early as around 950 cal BP (maximum age range of Wk-13367 and Wk-6750 at two standard deviations). Although this date is a couple of hundred years after the first deposition of archaeological remains and possible first occupation at Kurkur Weid, it provides further evidence that initial use of the area reflects localised and fairly recent geological stabilisation.

Chronology of Subsistence and Change

On Dauar the nature of the excavated assemblages and site chronologies provide evidence in support of the exploitation of marine resources from 2600 cal BP. One of the obvious stratigraphic features of the Dauar sites is the dramatic change in strata in the lower section of the deposits. At Sokoli this is dated to around 1800 cal BP and earlier for Ormi at around 2000 cal BP. At this point there is a change from typically coastal sediment to a more colluvially derived matrix of finer-grained dark greyish-brown sediment. At both sites this transition broadly coincides with an increase in the rate of sediment accumulation and quantity of archaeological deposit.

It is concluded that the change in sediment identified at Sokoli and Ormi may have been the result of widespread clearance activities leading to destabilisation of up-slope soils and the accumulation and infilling of lower coastal embayments. The trends illustrated in Figure 5.10 and Figure 5.14 indicate that after the initial dramatic increase in sediment accumulation that occurred at Sokoli and Ormi around 1800 cal BP, the rates of sediment accumulation appear to decrease (Horizon I and II at Sokoli and Horizon I at Ormi). This suggests that after the initial clearance episodes, stabilisation of the horticultural landscape on Dauar may have occurred. This is also consistent with the methods of planting described in the ethnographic record, which report fallow periods of several years as well as garden vegetation being left to naturally decompose after soil fertility had been exhausted.

These results provide preliminary evidence in support of the possible emergence of the horticultural practices on Dauar between 2000 and 1800 cal BP. Although deposit dating from 1600 cal BP is absent from Ormi (probably owing to recent construction activities at the site), the decrease in the quantity of archaeological remains at Sokoli by 1650 cal BP also provides evidence of an increasing dependence on horticultural subsistence on Dauar by this time. The fact that Sokoli is a historically designated patrilineally owned garden plot further supports this hypothesis. It also confirms the possibility that SU4 is the result of some form of horticultural related activity, such as garden preparation or the growth of a cultivated species, such as yam. In the same instance there is also the possibility that SU11 and SU12 at Ormi similarly resulted from horticulture-related disturbance.

The later date determined for the occupation and exploitation of marine resources at Kurkur Weid and Pitkik between 1200 and 800 cal BP is interpreted as reflecting localised site formation and stabilisation processes and in the case of Kurkur Weid, more temporary site use. Combined with the nature of the sites themselves, the absence of stratigraphic and artefactual evidence that could testify to the presence of horticultural subsistence at Kurkur Weid and Pitkik is not surprising.

Conclusions

The archaeological investigations described in this chapter represent the first archaeological excavations undertaken in the eastern Torres Strait. Subject to some restrictions, however, the investigations conducted on Mer and Dauar represent a small archaeological sample of the Murray Islands. Although broad trends in the timing of occupation and subsistence development are apparent, it is recognised that further work may assist in clarifying and defining the occupation sequences.

The extent of archaeological survey on Mer and Dauar revealed a variety of site types. These included *zogo* sites, rock engravings and grinding grooves, rockshelters with occupational debris and extensive stratified shell midden deposits. On Dauar preliminary radiocarbon dating of two of the latter site types revealed potential to determine the antiquity of island occupation and possibly the timing of the emergence of the ethnographically documented maritime and horticultural subsistence economies. Radiocarbon dating and stratigraphic evidence from the excavations at Sokoli and Ormi suggest that initial human occupation of Dauar and exploitation of marine resources had occurred by 2600 cal BP. Significantly, this result is chronologically consistent with the timing of occupation determined for Saibai in the Northern Islands at around 2500 yrs BP (Barham 1999). The results of radiocarbon dating shell samples from beachrock on the island's foreshore confirm that beach formation had only occurred several hundred years before human occupation around 2900 cal BP. This evidence supports Barham's (2000) hypothesis of a 2000 – 3000 time-lag after inundation of the Torres Strait shelf during the mid Holocene, and that the islands may not have been viable for human occupation until 3500 years ago.

The preliminary examination of the excavated cultural assemblages detailed in this chapter has provided possible evidence for the emergence of horticultural activities on Dauar from 2000 cal BP, and for the establishment of the horticultural economy by 1650 cal BP. This evidence consists of changes in the nature of the marine subsistence assemblage over time, changes in sediment and deposition rates and the presence of possible cultigens indicated by several distinct and unusual stratigraphic features. The excavations at Kurkur Weid and Pitkik on the other hand, revealed that occupation and the exploitation of marine resources in this area occurred significantly later at around by 1000 cal BP. This result is not interpreted as evidence of the later occupation of nearby Mer, but is a possible indication of recent geological processes and their impact on the nature of island occupation and site use. The nature of marine subsistence as demonstrated by each of the Murray Islands excavations is investigated in more detail in the following chapter. Further evidence for horticultural subsistence on the Murray Islands forms the content of Chapter 7, which describes the results of phytolith and starch grain analysis of excavated sediment samples.

Chapter 6: Marine Subsistence

The most abundant cultural component of each of the Murray Islands excavations is the remains of intertidal marine resources. These deposits consist largely of shell, with smaller quantities of the bones of fish and marine mammal. As a record of past marine resource use on Mer and Dauar, the analysis and quantification of these assemblages provide a means to define the nature of subsistence on the Murray Islands. The aim of this chapter is to illustrate the broad temporal and spatial trends in the marine subsistence economy that are revealed by the analysis of the excavated marine faunal assemblages from each site. Useful characteristics employed to demonstrate these trends are shell and bone concentration (density), shell species distribution and diversity and shell size. Although the remains of terrestrial vertebrates comprised a very small proportion of the excavated bone assemblages, this material is also included in the analysis of the vertebrate assemblages.

Field Sorting Procedures

Preliminary sorting of the excavated 6mm sieve residue was undertaken in the field to discard the unwanted material (such as non-artefactual stone), to reduce the weight of the material that was to be transported back to Townsville, and to reduce the time spent on sorting in the laboratory. Before being discarded, all non-artefactual material was weighed. Artefactual material was first sorted into the general and easily discernable categories of shell, artefactual stone, bone, charcoal, coral etc. All materials were bagged and labeled appropriately. After sorting and removal of the larger cultural material, the remaining 6mm residue was bagged and labeled as ‘coarse unsorted remains’. At Ormi the remaining 6mm residue was wet sieved in salt water, primarily to reduce the amount of unwanted sediment that collected in the sieve. Wet sieving took place in the shallows when wave activity was minimal, using the 3mm sieve to limit the loss of small material. The wet sieved material was spread onto makeshift trays and allowed to air-dry in shade before being bagged and labeled as ‘coarse unsorted remains (wet-sieved)’.

The fine 3mm residue for each site consisted almost entirely of sediment with a very small proportion of shell fragments and other materials. As the quantity of 3mm residue recovered from each site was considerable, for logistical reasons only a sample (one large bag) from each Excavation Unit (XU) at each site was kept. This material was bagged directly from the sieve and labeled as ‘unsorted fine remains’.

Laboratory Methods and Sampling

In the laboratory, priority was first given to the shell remains, which were gently washed to remove all sediment from the internal cavities so as not to bias weight calculations. The material was then air-dried in a drying cabinet for 24 hours. All coarse unsorted remains were similarly washed and wet sieved through 3mm mesh in order to limit any loss of material. Upon discovering that some sediment still remained after wet sieving of the Ormi material in the field, several bags of coarse unsorted remains were wet sieved for a second time in the laboratory through 3mm mesh. All wet sieved material was then air-dried overnight in a drying cabinet. The other non-shell remains that were bagged and separated in the field (artefactual stone, bone, pumice etc.) were cleaned by dusting with a brush.

For each site 100% of the excavated 6mm residue was analysed. No residue collected from the fine 3mm sieve was included in the analysis. As the majority of the shellfish species present in the excavations consisted of large reef gastropods, it was concluded that the quantity of shell remains collected in the 3mm would be negligible, and that the time spent on the sorting and analysis of these remains would be better utilised elsewhere.

Shell Analysis

> Faunal remains from midden sites are usually analysed to address questions regarding changes in diet, economy and habitat exploitation through time. The analytical techniques used are therefore designed to maximise the amount of data that can be extracted from an often fragmentary archaeological record (Przywolnik 2002:54).

The method of calculating proportions of different mollusc species by weighing whole and fragmentary remains is useful in contributing information about the relative abundance of species within sites (for example Bailey 1975; Baker 1981; Beaton 1985). Where shellfish species vary considerably in size, however, the abundance of small-sized taxa may be underestimated by measurement of weight (Mowat 1995:81). As different species also differ in the degree of fragmentation as well as morphological features such as shell thickness, Mason et al. (1998) suggest that use of this technique alone may cause sample bias.

The calculation of minimum number of individuals (MNI) for each mollusc species 'provide a count that estimates minimum species frequency without having to identify every shell fragment' (Przywolnik 2002:56). In the instance that shells are highly fragmented with the possibility of one individual being spread throughout an entire deposit, MNI remedies this situation 'as only the diagnostic parts of each individual are counted, and there is usually only one diagnostic part used for each species' (Mowat 1995:83). For bivalves the diagnostic shell attribute most commonly used to calculate MNI is the umbo or hinge, while for gastropods the columella is often considered as representative of an individual (Waselkov 1987:158). It has been suggested, however, that minimum number counts disguise the significant difference in size of species and of individuals (Bowdler 1983:140). For example, one Tridacnid clam provides considerably more meat than a nerite, but direct comparisons of MNI counts for these species provide no indication of the difference in calorific content. It is recommended therefore, that relative size measurement of mollusc species are considered when interpreting quantitative data based on MNI (Bowdler 1983; Mason et al. 1998).

By taking into account the above analytical considerations, as well as the disproportionate representation of species previously identified for the Murray Islands archaeological shell assemblages described in Chapter 4, this investigation uses a combination of MNI counts, species proportions by weight and size analysis in an attempt to present a balanced and accurate analysis of the species represented in the excavated deposits from Mer and Dauar.

Firstly, the shell assemblage for each XU was sorted into species. One exception to this rule was the large Tridacnid clams (*Tridacna gigas*, *Tridacna squamosa*, *Tridacna crocea* and *Tridacna maxima*), that proved very difficult to identify to species level. Therefore, to avoid any incorrect species identifications all remains of the Tridacnids were collectively identified as such and treated as *Tridacna* spp. This was not the case for the clam species *Hippopus hippopus*, which belongs to the Tridacnidae family but is more easily distinguished by its sculpture of convex radial ribs. All species identifications were made with reference to a number of sources including Abbott and Dance (1998), Coleman (1975), Hinton (1975), Lamprell and Whitehead (1992), Lamprell and Healy (1998) and Short and Potter (1987).

The remains for each species were then separated into four categories; whole shell, half shell, diagnostic fragment or fragment. Whole shells usually had an undamaged diagnostic component (for example the umbo or columella) and permitted the measurement of two maximum dimensions (see below for definitions). Half shells displayed more than 50% of the diagnostic component and were intact enough to allow one maximum dimension measurement. Diagnostic fragments were defined as any shell fragment that possessed 50% or greater of its diagnostic attribute, but from which no maximum dimension measurements were obtainable.

Fragments had less than 50% of their diagnostic part and could not be measured for maximum dimensions.

For all bivalves, the umbo or hinge represented the diagnostic component used to identify an individual specimen, while the most frequently occurring valve (left or right) was used to calculate MNI. The diversity of gastropods meant that a number of diagnostic components were used to identify individuals. For *Strombus* sp. and *Conus* sp. the spire was used to identify individual specimens, while for *Trochus* sp. and *Nerita* sp., the columella represented an individual specimen. On this basis the MNI counts for each species represented the total sum of whole shells, half shells and diagnostic fragments. Total weight calculations for each species were based on the sum of the weights determined for all whole shells, half shells, diagnostic fragments and fragments. The diagnostic attributes selected to determine MNI counts for all shell species represent the thickest and most durable part of the shell, and remained the same throughout the entire analysis program.

For most gastropods, length was measured from the apex or posterior extremity to the anterior canal or extremity, and the width was the distance between the widest part of the shell, usually at the shoulder of the body whorl. For more conical gastropods such as *Trochus* sp., length was measured between the base of the shell and the apex while the width was defined as the diameter of the shell's base. For *Nerita* sp., length was defined as the distance between the anterior and posterior extremities and width measurements were taken across the distance of the opercula opening. For bivalves, shell height was measured between the umbo and the opposite edge of the valve, while the valve length was taken as the distance between the anterior and posterior. All measurements were taken with callipers and were recorded to the nearest millimetre.

Concentration of Shell

A total of around 60kg of shell was recovered from Sokoli, while almost 130kg was recovered from Ormi. On Mer, 19kg and 5.5kg of shell was recovered from Kurkur Weid and Pitkik respectively. Table 6.1 provides the density (g/m^3), total weight and total MNI of shell remains for each stratigraphic Horizon for each site. Figures 6.1 – 6.4 illustrate the rate of shell accumulation at each site (the captions for all Chapter 6 figures include the depth below surface and correlating calibrated age range for each Horizon).

	Date range (cal BP)	Total shell weight (g)	Shell density (g/m^3)	Total MNI
SOKOLI				
Horizon I	0 – 900	7221.19	16029.30	208
Horizon II	900 – 1 400	2577.42	6218.14	78
Horizon III	1 400 – 1 550	11595.85	26087.40	412
Horizon IV	1 550 – 1 700	24483.18	83560.34	1 374
Horizon V	1 700 – 2 600	8950.59	38332.29	234
ORMI				
Horizon I	1 600 – 1 800	45218.19	81768.88	968
Horizon II	1 800 – 1 900	31198.56	76805.91	1 110
Horizon III	1 900 – 2 000	31649.29	142244.00	970
Horizon IV	2 000 – 2 250	11959.47	23899.82	433
Horizon V	2 250 – 2 600	7160.04	19144.50	160
KURKUR WEID				
Horizon I	0 – 150	6286.91	80601.41	57
Horizon II	150 – 250	647.39	18496.86	22
Horizon III	250 – 780	15878.16	65342.22	208
Horizon IV	780 – 1 000	807.83	21542.13	32
PITKIK				
Horizon I	0 – 380	2570.89	20732.98	74
Horizon II	380 – 420	44.54	1781.60	9
Horizon III	420 – 500	632.00	9093.52	77
Horizon IV	500 – 650	1283.48	10392.55	66
Horizon V	650 – 780	1030.10	9322.17	53

Table 6.1 Shell weight, density and MNI data for excavated deposits

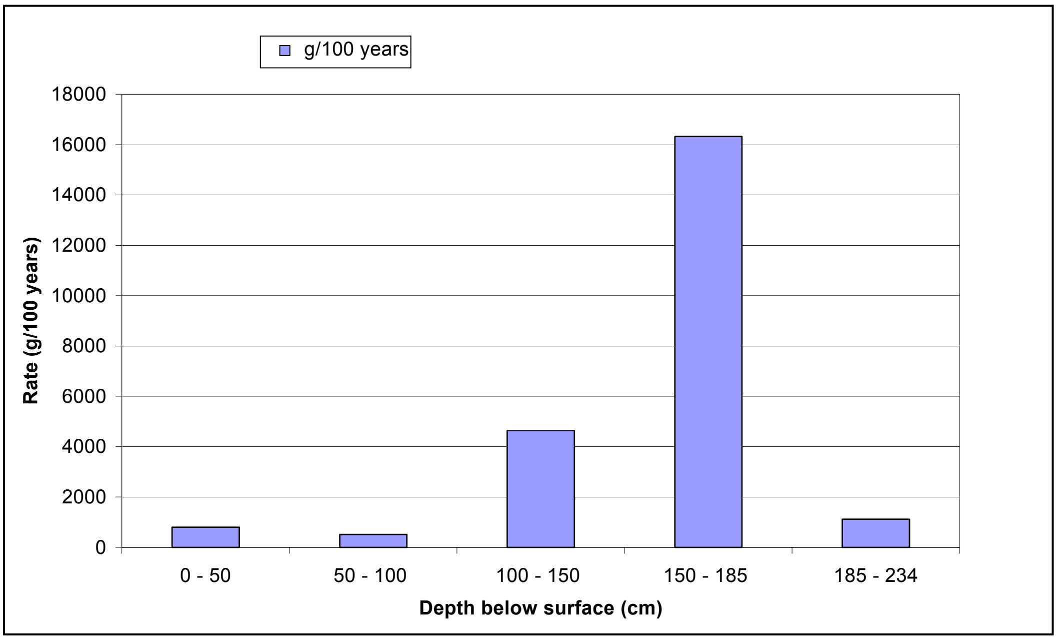


Figure 6.1 Sokoli rate of shell accumulation
(I: 0-50cm, 0-900 cal BP; II: 50-100cm, 900-1400 cal BP; III: 100-150cm, 1400-1650 cal BP; IV: 150-185cm, 1650-1800 cal BP; V: 185-234cm, 1800-2600 cal BP)

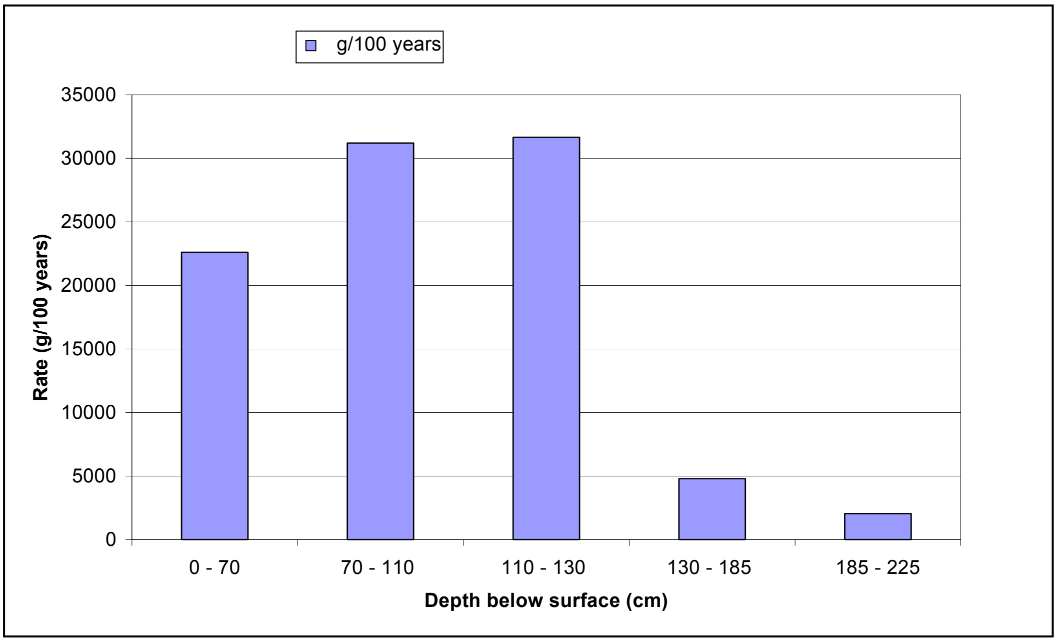


Figure 6.2 Ormi rate of shell accumulation
(I: 0-70cm, 1600-1800 cal BP; II: 70-110cm, 1800-1900cal BP; III: 110-130cm, 1900-2000 call BP; IV: 130-185cm, 2000-2250 cal BP; V: 185-225cm, 2250-2600 cal BP)

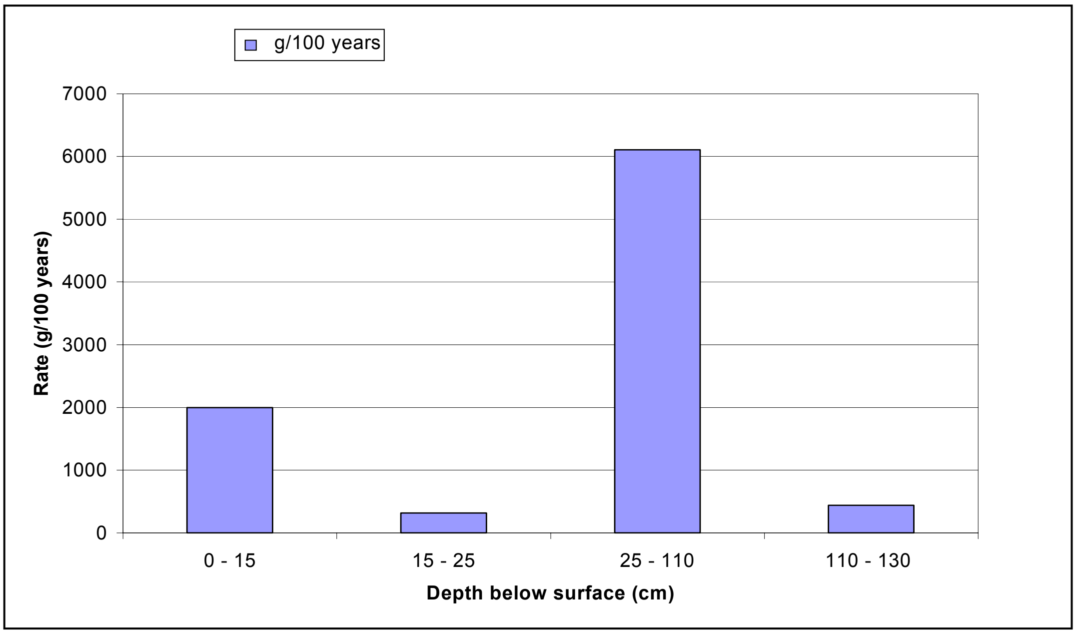


Figure 6.3 Kurkur Weid rate of shell accumulation
(I: 0-15cm, 0-315 cal BP; II: 15-25cm, 315-520 cal BP; III: 25-110cm, 520-780 cal BP; IV: 110-130cm, 780-965 cal BP)

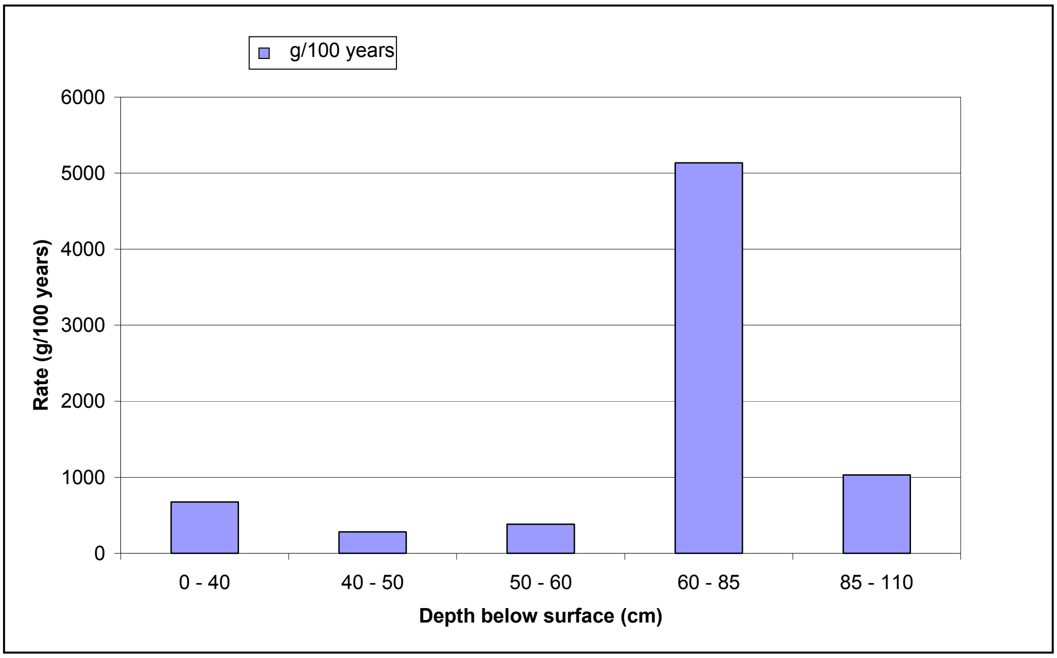


Figure 6.4 Rate of shell accumulation at Pitkik
(I: 0-40cm, 0-380 cal BP; II: 40-50cm, 380-610 cal BP; III: 50-60cm, 610-775 cal BP; IV: 60-85cm, 775-800 cal BP; V: 85-110cm, 800-900 cal BP).

Sokoli

The density of shell at Sokoli is greatest in the lower half of the excavation, with Horizon IV dated between 1650 and 1800 cal BP recording the highest density for the entire assemblage (Table 6.1). After 1650 cal BP density decreases markedly and is lowest between 900 and 1400 cal BP. Density then increases in the uppermost stratigraphic Horizon from 900 cal BP. Table 6.1 also demonstrates that the distribution of MNI at Sokoli was highest in Horizon IV and lowest in Horizon II, confirming the trends illustrated by density. Both MNI distribution and shell density trends are paralleled by the rate of shell accumulation illustrated in Figure 6.1, which demonstrates the majority of the shell remains were deposited at Sokoli between 1400 and 1800 cal BP.

Ormi

Table 6.1 illustrates that for Ormi the lowest shell density is recorded in Horizons V and IV dating from 2000 - 2600 cal BP. Density then significantly increases within the period 2000 - 1900 cal BP where it records the highest density reading for the entire assemblage. After this period density decreases at Ormi, but remains higher than the density of the assemblage in the lower half of the site. The overall distribution of MNI recorded for Ormi also indicates that a greater quantity of shell was deposited at the site from 2000 cal BP. This trend is confirmed by the rate of shell accumulation at Ormi, which demonstrates that the majority of the shell assemblage at the site was deposited after 2000 cal BP (Figure 6.2).

Kurkur Weid

Table 6.1 illustrates the variable pattern of shell density at Kurkur Weid. The highest densities are recorded in the middle stratigraphic Horizon dating from 780 – 520 cal BP and the uppermost Horizon dating from 380 cal BP. The MNI distribution at Kurkur Weid confirms this trend, with 83% of the total MNI identified for the site occurring in Horizon III and Horizon I.

The rate of shell accumulation at Kurkur Weid illustrated in Figure 6.3 also shows that the largest quantity of remains were deposited during these periods.

Pitkik

Table 6.1 shows that the greatest density of shell remains was deposited at Pitkik in the uppermost Horizon dating from 380 cal BP. For Horizons V – III the density was approximately half that recorded for Horizon I, while Horizon II dating from 380 - 610 cal BP recorded the lowest shell density. The MNI distribution for Pitkik indicates that around 70% of MNI occur in the lower half of the deposit dating from 610 - 900 cal BP. The rate of shell accumulation at Pitkik illustrated in Figure 6.4 shows that deposition of shell was greatest in the lower half of the site, particularly in the short period from 775 – 800 cal BP. The rate of shell accumulation increased in the uppermost deposit from 380 cal BP.

Summary

The most noticeable difference between the Sokoli and Ormi deposits on Dauar is the total density of the excavated shell assemblages. During the 1000 years of occupation that the entire Ormi deposit represents, the shell density equals almost 350 kg/m^3. For the equivalent time period at Sokoli (2600 – 1650 cal BP), density represents approximately a third of the entire Ormi assemblage. The MNI identified at the sites also varied accordingly, with Sokoli recording approximately two-thirds of the total MNI identified at Ormi. Not surprisingly the rate of shell accumulation at Ormi was significantly greater than at Sokoli, even though the fastest rate of accumulation at the latter site occurred before 1650 cal BP (see Figure 6.1).

At both Dauar sites dramatic increases in the density of shell remains, MNI and the rate of shell accumulation coincide with a major stratigraphic change from coarse orange sand to finer-grained brown colluvium described in the previous chapter. At Ormi this occurs between Horizon IV and Horizon III at 2000 cal BP, and slightly later at Sokoli between Horizon V and Horizon IV at 1800 cal BP. While this stratigraphic transition represents a change in the source of sediment entering the sites, the nature of the shell assemblages deposited during this episode also suggests an intensification of marine shell exploitation. At Sokoli, however, from 1650 cal BP there is a significant decrease in the density of shell remains and in the rate of shell accumulation, and by 1400 cal BP the shell assemblage reaches its lowest density.

From the time of occupation of both sites around 2600 cal BP, the deposition of considerable quantities of marine resources provide quantifiable evidence in support of the presence of the marine subsistence economy on Dauar. The marine economy intensified between 2000 and 1650 cal BP resulting in a dramatic increase in the number and rate of deposition of marine shell across the island. This economic intensification evidently coincided with widespread topographic changes on Dauar, possibly as a result of disturbance to hill slope sediment and its accumulation in low lying coastal occupation areas. At Sokoli there is subsequent evidence of de-intensification of the marine economy from around 1650 cal BP, demonstrated by a decrease in the density of shell remains and rate of shell accumulation.

The Kurkur Weid and Pitkik excavations on Mer represent roughly the same period of occupation: the last 1000 years. The rate of shell accumulation at both sites is significantly slower than that demonstrated by the Sokoli and Ormi assemblages on Dauar. Given that the Kurkur Weid and Pitkik assemblages comprise rockshelter deposit and hillslope deposit respectively, their rates of shell accumulation are more in line with temporary site use and sporadic deposition. Although the concentration of shell remains at Kurkur Weid indicates that the site had been continually used over the last 1000 years, site use was evidently most frequent between 780 – 520 cal BP, and more recently during the last 380 years. At Pitkik shell density is highest in the most recent period dating from 380 cal BP, while the rate of accumulation is fastest around 800 cal BP. This may reflect possible clearance of slopes above Pitkik around this time, including recent post-mission clearance activities.

Shell Species Distributions

The excavated shell midden deposits from Mer and Dauar contain a variety of marine species from both littoral sandy substrates and rocky substrates, although predominantly from the former. Each of the excavated sites, however, contain the remains of seven commonly-occurring species; waved nerite (*Nerita undata*), red-lipped conch (*Strombus luhuanus*), spider conch (*Lambis lambis*), clam (including *Tridacna gigas*, *Tridacna squamosa*, *Tridacna crocea*, *Tridacna maxima* and *Hippopus hippopus*), tiger cowrie (*Cypraea tigris*) and top shell (*Trochus niloticus*). Nerites are small gastropods that inhabit rocky shores often in considerable numbers. The large Tridacnid bivalves, including *Hippopus hippopus*, inhabit the shallow waters of the middle to lower intertidal zone and can grow to up to 60cm in length, although the larger specimens tend to occur in deeper waters. The red-lipped conch is a relatively small gastropod that can reach a maximum size of 5cm, and is found on sand in shallow waters in the lower intertidal. The spider conch is a considerably larger species (up to 17cm) and inhabits the shallow water of the middle intertidal. Tiger cowries occur under rocks in the middle intertidal and can grow up to 9cm. Top shells inhabit the shallow waters of the upper intertidal and can reach a maximum size of 13cm. See Table 6.2 for a summary of these details.

The identification of these species as commonly occurring in the archaeological assemblages is broadly consistent with the key mollusc species identified in contemporary Meriam shellfish gathering activities (Bird 1996; Bird and Bliege Bird 1997).

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Table 6.2 Commonly occurring mollusc species habitat list (after Abbott and Dance 1998)

Apart from these seven species, however, approximately 50 – 60 other marine shell species have been identified in the excavated marine shell assemblages, although they are much less frequently occurring. These species comprise a variety of both reef gastropods and bivalves. The gastropods include turban shell (*Turbo* sp.), polished and ox-palate nerites (*Nerita polita* and *Nerita albicilla*), furrowed periwinkle (*Planaxis sulcatus*), vase shell (*Vasum turbinellus*), trumpet shell (*Syrinx auranus*) and baler shell (*Melo* sp.). Bivalve species include sunset clam (*Asaphis violascens*), pearl shell (*Pinctada margaretifera*), lucina clams (*Codakia* sp.), telin clams (*Tellina* sp.) and rock oyster (*Saccostrea cucullata*). The shell remains of limpets (*Patelloida* sp.) and chitons (*Acanthopleura* sp.) are also present. These much less frequently occurring species represent a diverse size range; from the small periwinkle (2cm) to the large trumpet shell (80cm). They also represent a variety of marine habitats and environmental conditions. Pearl shell, for example, occurs in offshore waters from 5 to 30m in depth, while the beach clams occur in sandy beach substrates. Other species such as nerites, periwinkles, oyster, chitons and limpets occur wherever there is a rocky intertidal shore. Small quantities of terrestrial snail were also recovered from each site, although identification of these remains to species was not attempted. Details of the identification of the excavated molluscan remains for each site are listed in Appendix C.

Bird and Bliege-Bird (1997:41) describe several of these less frequently occurring archaeological shell species as both less commonly, and rarely collected during contemporary reef flat gathering on the Murray Islands. The presence of these species in the Mer and Dauar assemblages, as well as a large number of other species that have not been observed as part of the suite of contemporary shellfish gathered for subsistence, suggests that the nature of archaeological deposits on the Murray Islands may be a product of other factors, in addition to human behaviour related to shell processing and transportation. This issue is considered further below.

Table 6.3 shows the number of marine shell species identified in each Horizon in each of the excavated sites. This shows that compared to the Sokoli and Ormi deposits on Dauar, only half the number of marine shell species was identified for the Kurkur Weid and Pitkik deposits on Mer. As demonstrated in the previous section, however, this result is in line with the significantly greater quantity of shell remains that were deposited at the Dauar sites.

	SOKOLI	**ORMI**	**KURKUR WEID**	**PITKIK**
Horizon I	68	61	15	21
Horizon II	45	64	21	17
Horizon III	48	43	42	35
Horizon IV	57	41	22	29
Horizon V	43	41	-	26
Av. No. species per Horizon	52	50	25	25

Table 6.3 Number and average number of mollusc species

At Ormi there is an overall trend of increasing species diversity from the base to the surface of the deposit, with Horizon II and Horizon I (1900 – 1600 cal BP) both containing above the average number of species per stratigraphic horizon. This trend is less linear at Sokoli, but the data suggest an initial increase in species diversity in Horizon IV between 1800 – 1650 cal BP, followed by a second increase in the upper most horizon at 900 cal BP, with both these Horizons containing above the average number of species (see Table 6.3). At Kurkur Weid Horizon III (780 – 520 cal BP) is the only stratigraphic horizon that contains above the calculated average number of species. At Pitkik the lower three Horizons contain above the average number of species with evidence of a possible increase in species diversity between 780 – 420 cal BP. The upper-most horizons on the other hand indicate a possible decrease in species diversity from 420 cal BP onwards.

For Sokoli and Ormi the trends of an increase in species diversity argue against the de-intensification of the marine subsistence strategies on Dauar indicated by the decrease in shell density in the upper sections of the sites (Table 6.1). However, an increase in species diversity suggests the possibility of a reduction in the available population of more favoured species, such as *Lambis lambis* and *Tridacna* spp. At Sokoli, the increase in the number of species in Horizon IV is contemporaneous with the increase in the rate of sedimentation at the site between 1400 and 1800 cal BP (see Figure 5.10). For Ormi this pattern is also evident, with the increase in species diversity in Horizon II occurring at the same time as the increase in the rate of sediment accumulation between 1800 and 1900 cal BP (see Figure 5.14). This indicates that horticultural clearance activities on Dauar may have coincided with an intensification of the exploitation of marine resources. This is supported by the increase in the density of shell remains at Sokoli and Ormi evident during these periods. Evidence for the over-exploitation of shell species on Dauar is examined further in a size analysis of several of the commonly occurring species from Sokoli and Ormi, but is first addressed in the context of the distribution of the commonly occurring species. The distribution of commonly occurring species at Kurkur Weid and Pitkik is also considered.

Tables 6.4 – 6.7 show the total weight and MNI calculations for six of the most commonly occurring marine shell species for each site. These include *Tridacna* spp., *Hippopus hippopus*, *Lambis lambis*, *Trochus niloticus*, *Nerita undata* and *Strombus luhuanus.* Based on both weight and MNI calculations *Cyprae tigris* is the least-commonly occurring species in each of the excavated deposits and is not included in the following analysis of species distribution.

SOKOLI	Species	Total weight	MNI
Horizon I	*Hippopus hippopus*	172.03	2
	Lambis lambis	1480.31	9
	Nerita undata	201.83	69
	Strombus luhuanus	690.08	38
	Tridacna spp.	3154.02	3
	Trochus niloticus	363.17	1
% of shell assemblage	8.8	84.00	58.70
Horizon II	*Hippopus hippopus*	92.81	0
	Lambis lambis	391.49	1
	Nerita undata	257.27	15
	Strombus luhuanus	262.11	20
	Tridacna spp.	572.61	1
	Trochus niloticus	64.34	0
% of shell assemblage	13.3	63.60	47.40
Horizon III	*Hippopus hippopus*	315.58	1
	Lambis lambis	1211.58	5
	Nerita undata	387.56	155
	Strombus luhuanus	2462.42	126
	Tridacna spp.	3306.58	4
	Trochus niloticus	1261.44	11
% of shell assemblage	12.5	77.10	73.30
Horizon IV	*Hippopus hippopus*	730.01	4
	Lambis lambis	2220.55	16
	Nerita undata	1551.57	695
	Strombus luhuanus	7793.30	367
	Tridacna spp.	5945.77	21
	Trochus niloticus	3100.62	24
% of shell assemblage	10.5	87.20	82.00
Horizon V	*Hippopus hippopus*	102.49	0
	Lambis lambis	1429.96	8
	Nerita undata	239.60	112
	Strombus luhuanus	686.66	30
	Tridacna spp.	3166.26	5
	Trochus niloticus	1736.15	14
% of shell assemblage	14	82.20	72.20

Table 6.4 Sokoli most commonly-occurring mollusc species

ORMI	Species	Total weight	MNI
Horizon I	*Hippopus hippopus*	1631.90	5
	Lambis lambis	8421.55	36
	Nerita undata	911.28	446
	Strombus luhuanus	3333.50	195
	Tridacna spp.	10981.13	16
	Trochus niloticus	2984.42	17
% of shell assemblage	9.8	62.50	73.80
Horizon II	*Hippopus hippopus*	1073.20	3
	Lambis lambis	3924.99	27
	Nerita undata	1171.18	499
	Strombus luhuanus	3532.66	176
	Tridacna spp.	7685.49	14
	Trochus niloticus	3963.57	42
% of shell assemblage	9.4	68.40	68.60
Horizon III	*Hippopus hippopus*	1547.58	9
	Lambis lambis	5472.24	52
	Nerita undata	1034.42	351
	Strombus luhuanus	6516.80	302
	Tridacna spp.	4938.56	29
	Trochus niloticus	4070.23	72
% of shell assemblage	14	74.50	84.00
Horizon IV	*Hippopus hippopus*	224.63	3
	Lambis lambis	1808.80	8
	Nerita undata	478.14	269
	Strombus luhuanus	573.21	28
	Tridacna spp.	2570.99	10
	Trochus niloticus	1287.93	15
% of shell assemblage	14.6	58.10	77.00
Horizon V	*Hippopus hippopus*	28.10	0
	Lambis lambis	2323.84	14
	Nerita undata	62.39	53
	Strombus luhuanus	234.91	11
	Tridacna spp.	1642.05	7
	Trochus niloticus	1183.45	13
% of shell assemblage	14.6	76.40	61.30

Table 6.5 Ormi commonly-occurring mollusc species

KURKUR WEID	Species	Total weight	MNI
Horizon I	*Hippopus hippopus*	69.05	0
	Lambis lambis	508.98	3
	Nerita undata	283.49	27
	Strombus luhuanus	157.51	6
	Tridacna spp.	4982.00	2
	Trochus niloticus	42.05	1
% of shell assemblage	40	96.12	68.40
Horizon II	*Hippopus hippopus*	201.68	1
	Lambis lambis	303.50	2
	Nerita undata	7.93	9
	Strombus luhuanus	44.70	2
	Tridacna sp.	15.28	1
	Trochus niloticus	15.91	0
% of shell assemblage	28.6	91.00	68.20
Horizon III	*Hippopus hippopus*	2294.80	1
	Lambis lambis	5319.99	33
	Nerita undata	27.96	31
	Strombus luhuanus	616.79	29
	Tridacna sp.	2383.46	8
	Trochus niloticus	4141.22	31
% of shell assemblage	14.3	93.10	64.40
Horizon IV	*Hippopus hippopus*	2.45	0
	Lambis lambis	413.03	5
	Nerita undata	10.97	11
	Strombus luhuanus	107.84	6
	Tridacna sp.	42.85	0
	Trochus niloticus	2.60	0
% of shell assemblage	27.3	71.80	68.80

Table 6.6 Kurkur Weid commonly-occurring mollusc species

PITKIK	Species	Total weight	MNI
Horizon I	*Hippopus hippopus*	303.80	0
	Lambis lambis	813.71	5
	Nerita undata	52.75	33
	Strombus luhuanus	73.16	3
	Tridacna spp.	44.03	0
	Trochus niloticus	719.74	9
% of shell assemblage	28.6	78.10	67.60
Horizon II	*Hippopus hippopus*	0	0
	Lambis lambis	4.66	0
	Nerita undata	3.04	2
	Strombus luhuanus	0	0
	Tridacna spp.	0	0
	Trochus niloticus	0.90	0
% of shell assemblage	35.3	19.30	22.2
Horizon III	*Hippopus hippopus*	0	0
	Lambis lambis	25.74	0
	Nerita undata	79.41	45
	Strombus luhuanus	180.23	9
	Tridacna spp.	11.60	0
	Trochus niloticus	27.96	0
% of shell assemblage	17.1	51.50	70.10
Horizon IV	*Hippopus hippopus*	26.76	1
	Lambis lambis	339.42	1
	Nerita undata	43.39	22
	Strombus luhuanus	249.39	19
	Tridacna spp.	230.84	0
	Trochus niloticus	251.84	0
% of shell assemblage	20.7	89.00	65.20
Horizon V	*Hippopus hippopus*	0	0
	Lambis lambis	277.05	0
	Nerita undata	35.22	24
	Strombus luhuanus	197.20	12
	Tridacna spp.	124.33	1
	Trochus niloticus	66.49	0
% of shell assemblage	23.1	68.10	69.80

Table 6.7 Pitkik most commonly-occurring mollusc species

Sokoli

Table 6.4 illustrates that at Sokoli these six species comprise less than 15% of the total number of species identified in each stratigraphic Horizon, but form between 63% and 87% of the total shell weight from each Horizon. The total %MNI these species comprise varies throughout the deposit, ranging from between approximately 45% and 85% for each stratigraphic Horizon. Both the highest %weight and %MNI of these species is recorded in Horizon IV, dating between 1800 - 1650 cal BP. The data for this stratigraphic Horizon also show an increase in the diversity of mollusc species along with a possible increase in the size range of the six most common mollusc species, demonstrated by an increase in the overall proportion of shell weight. This result therefore contradicts the earlier suggestions of a reduction in the populations of the larger, more favoured species at this time, as the quantity (weight and MNI) of all commonly occurring species show a dramatic increase between Horizon V and Horizon IV, and also between the two uppermost Horizons.

The data also exhibit that throughout the Sokoli deposit there is a broad trend of disproportionate ratios of weight to MNI. For example, within each Horizon the species *Nerita undata* and *Strombus luhuanus* record the highest MNI count, but generally comprise a considerably smaller proportion of shell weight compared to *Tridacna* spp. and *Lambis lambis,* which repeatedly record significantly lower MNI counts. This is understood in the context that as *Strombus luhuanus* and particularly *Nerita undata* are small shells, it would take a considerable number of them to equal the weight of one medium sized *Tridacna* spp. valve, or two larger specimens of *Lambis lambis*. However, an exception to the disproportionate weight to MNI occurs in Horizon IV, where *Strombus luhuanus* records the highest weight and the second- highest MNI count. In Horizon III this species records both the second highest weight and MNI calculations. These diversions from the wider trend occur between 1700 and 1400 cal BP, and provide supporting evidence of the possible exploitation of larger individuals of the commonly occurring species during this time.

Ormi

Table 6.5 shows that for Ormi these six species comprise between 10% and 15% of the total number of species identified in each stratigraphic Horizon. The total weight these species contribute to the shell assemblage varies from approximately 58% – 75%, while they comprise a range of between 60% – 85% of the total MNI. In Horizon III (2000 – 1900 cal BP) these species contribute the highest % weight calculation and the highest % MNI calculation. The data also show that from 2000 cal BP there is an increase is species diversity with the possibility of an increase in the size range of the commonly occurring mollusc species, demonstrated by an increase in their combined total weight proportions after this time. Like Sokoli, this trend also contradicts the suggestion of a reduction in the availability of favoured, larger species at Ormi, as the trend for an increase in the quantities (weight and MNI) of all commonly occurring species is also apparent in Horizon I.

The same broad trend of disproportionate ratios of weight to MNI of the six mollusc species is similarly demonstrated at Ormi. *Nerita undata* and *Strombus luhuanus* most commonly reach the highest MNI counts throughout the deposit, and in most cases record a total weight of significantly less than *Tridacna spp*. and *Lambis lambis*, which occur in much smaller numbers. In Horizon III, however, *Strombus luhuanus* forms the highest weight and MNI counts, and in Horizon II occurs in similar quantities (based on weight) to *Lambis lambis*, and *Trochus niloticus*, which record significantly lower MNI counts. This occurs between 2000 and 1800 cal BP, and provides further evidence for the exploitation of larger specimens of the commonly-occurring species within this period.

Kurkur Weid

At Kurkur Weid the six species comprise between 14% and 40% of the total species identified in the deposit (Table 6.6). These species make up between 40% and 95% of the total proportion of shell weight, while their % MNI proportions are more restricted ranging between approximately 65% and 70%. These data indicate an increase in species diversity in the lower half of the site between 965 and 520 cal BP, and a possible increase in the size range of the six commonly occurring species demonstrated by an increase in their combined total weight proportions during this period. From 520 cal BP species diversity appears to decrease and by the uppermost deposit dating from 380 cal BP, the six species form 40% of the total number of identified species and almost 95% of the total shell weight. Although the MNI distribution throughout Kurkur Weid remains fairly constant at between 60% and 70%, the data support the general trends described above.

The disproportionate trend of shell weight to MNI at Kurkur Weid is also evident, with the smaller gastropods *Nerita undata* and *Strombus luhuanus* generally occurring in greater numbers than their larger counter parts, which repeatedly reach higher weight readings. This trend is least apparent in Horizon III, however, where *Lambis lambis* and *Trochus niloticus* record both the highest weight and MNI calculations.

Pitkik

At Pitkik the six species make up approximately 15% - 35% of the total species identified throughout the assemblage (Table 6.7). Excluding Horizon II, these species form between approximately between 50% and 80% of the total weight and between 65% and 70% of the total MNI per stratigraphic horizon. In Horizon II they comprise significantly lower proportions of the shell assemblage: around 20% of both the total weight and total MNI calculations. This trend no doubt reflects the very low density of shell remains in this stratigraphic horizon (see Table 6.1). The disproportionate trend of shell weight to MNI is also demonstrated by the Pitkik assemblage, where a total of 90% of MNI recorded for the entire assemblage comprise only *Nerita undata* and *Strombus luhuanus*.

Summary

The above analysis of marine molluscan species diversity has demonstrated that from the time of initial occupation and use of the excavated Dauar and Mer sites, the exploitation of marine shell has focused on several key species. In general the remains of these species comprise the majority of the weight and MNI calculated for each of the excavated shell assemblages. For each stratigraphic Horizon at Sokoli and Ormi, however, they form no more than 15% of the total number of species identified. This suggests that 75% of the species at these sites consist of very small quantities of fragmented shell remains (possibly of large species), or the intact specimens of very small species. A sample of the other, less frequently occurring species described previously supports both of these possibilities, indicating the presence of both small and large species in the Dauar assemblages. The six commonly occurring species at Kurkur Weid and Pitkik overall form a much higher proportion of the species range owing to the lower species diversity that characterises these sites.

The most prominent trend illustrated by the commonly occurring species data for Sokoli (Table 6.4) and Ormi (Table 6.5), is the coincidental increase in species diversity, shell quantity and the suspected increase in shell size, with the major stratigraphic transitions at both the Dauar sites. This provides further data in support of the intensification of marine resource exploitation on the island between 2000 and 1650 cal BP, and of its contemporaneity with the widespread transition of the sedimentary environment from beach sand to colluvium. During this period the almost proportional ratio of shell weight to MNI for *Strombus luhuanus* at both sites also indicates a possible increase in the size range of targeted individuals. The overall trend for Sokoli and Ormi during the following 300

– 400 years is of a decrease in species diversity and size range of key species. From 1400 cal BP the initial intensification trend at Sokoli reappears with the data indicating a secondary increase in species diversity and possible increase in the size range of the key species. However, as the disproportionate trend of shell weight to MNI is maintained in upper Stratigraphic Units, it is concluded that marine resource exploitation within this period was not as intensive as it was during the initial phase dating from 1800 – 1650 cal BP. Both the density of shell and the rates of accumulation at Sokoli support this interpretation.

The broad trends illustrated by species proportions and the disproportionate ratio of shell weight to shell MNI have been previously suggested by Richardson's (2000) analysis of the Murray Islands archaeological shell assemblages. Richardson (2000) interpreted the results of analysis through models of behavioral ecology, and concluded that transport and processing behavior accounted for the apparent discontinuities between the archaeological shell deposits and the ethnographically-documented observations. These discontinuities included the archaeological under-representation of the larger more economically important species, such as *Tridacna* spp., *Hippopus hippopus* and *Lambis lambis*, and the presence of large numbers of the smaller, less economically important species such as *Nerita undata* and *Strombus luhuanus* (Richardson 2000).

In the context of these interpretations, the equal proportions (based on MNI) of *Lambis lambis*, *Nerita undata*, *Strombus luhuanus* and *Trochus niloticus* observed in Horizon III at Kurkur Weid, suggest that transport and processing behavior may not have been a key influence on the nature of shell remains at this site. Given the temporary nature of the use of the Kurkur Weid rockshelter, combined with its location on the immediate foreshore, the broader patterns of shellfish transport and processing behavior documented in the Murray Islands may not have applied to the majority of the excavated shell assemblage.

Further evidence to support the hypothesis that cultural factors, as well as ecological factors, may have played a significant role in the deposition of archaeological shell, is the increase in the quantity of the remains from larger shell species on Dauar, such as the Tridacnid clams and *Lambis lambis*. Although the incidence of the selection of larger shells brought back to shore goes against the model of on-reef processing, on the other hand it provides evidence in support of wide-scale economic and cultural intensification. This intensification may have involved increased use of shell as a raw material, including its use for domestic and ornamental purposes on the Murray Islands, as well as in the manufacture of goods for exportation in regional trade and exchange. As the documented cultural value of shell and its importance as a raw material in Torres Strait is ignored in optimal foraging models, the omission of this information from hypotheses concerning the nature of archaeological shell deposits on the Murray Islands is demonstrated as somewhat problematic.

Shell Species Sizes

Shell size analysis was undertaken to confirm the suspected increase in the size range of shell species on Dauar between 2000 and 1650 cal BP and to identify any broad changes to the size ranges of the commonly occurring species in the Sokoli and Ormi assemblages. Although there were suspected increases in the size range of species at Kurkur Weid and Pitkik, size analysis of shells for these sites is not included. The reasons for this include the more restricted time range of the excavated Mer deposits, and their lesser capacity to reveal broad changes in the marine subsistence economy from the time of initial island occupation. A third reason for not conducting shell-size analysis of the commonly occurring species at Kurkur Weid and Pitkik is the very small numbers of shells from which measurements were obtainable. In the majority of stratigraphic Horizons *Tridacna* spp., *Trochus niloticus* and *Hippopus hippopus* only comprised one or two measured individuals (see Appendix D, Tables 1, 2 for size data on the commonly occurring species from Kurkur Weid and Pitkik on Mer).

The size data presented for Sokoli and Ormi are for the species *Nerita undata, Strombus luhuanus*, *Lambis lambis*, *Tridacna* spp. and *Trochus niloticus. Hippopus hippopus* is not included due to the small numbers measured for size (see Appendix D, Tables 3, 4 for the size data of all six species from Sokoli and Ormi). Size ranges are illustrated by plotting the calculated minimum, maximum and mean measurements of each species for each stratigraphic Horizon at each site. To provide the most accurate representation of the size of each species these measurements are taken from the maximum sizes, which for all species except *Trochus niloticus*, was shell length. The size dimensions for *Trochus niloticus* included width as the distance across the base of the shell, and length as the distance between the apex of the shell and the base. The width and length of shells of this species were usually similar, with the maximum dimension often alternating between the two measurements. Therefore the maximum measurement used for size-range analysis was the larger of width and length. In the cases where one or the other could be recorded for a single individual, that value was included in the size range analysis. Excluding *Trochus niloticus*, the size data for the most-commonly occurring species include only individuals from which length measurements were taken, and excludes any individuals from which only a width, or, in the case of bivalves, height measurement was taken.

Sokoli

The size range data for species at Sokoli are presented in Appendix E, Figures 1 – 5.. For *Nerita undata* (Figure 1) there is a degree of variation in size, with the most obvious trend being a decrease after 1400 cal BP, although the mean size remains relatively uniform. The size data for *Strombus luhuanus* (Figure 2) also show considerable diversity, with the major trend being an increase in mean size over time, but particularly between 2600 and 1650 cal BP. For *Lambis lambis*, *Tridacna* spp. and *Trochus niloticus* (Figures 3, 4, 5), the presence of only one specimen from which a maximum measurement was obtainable in several stratigraphic horizons, has resulted in slightly skewed trends. For *Lambis*

lambis the data illustrate a relatively uniform size range, with the mean varying little throughout the assemblage. Changes in the size of *Tridacna* spp. are less discernible, although a possible increase in mean size from 1400 cal BP is indicated. For *Trochus niloticus*, excluding the single very large specimen present in Horizon II, the overall trend for this species suggests a relatively uniform size with little variation in the mean throughout the deposit.

Ormi

The size range data for Ormi is provided in Appendix E, Figures 6 – 10. For *Nerita undata* (Figure 6) the data show very little variation throughout the assemblage. The most noteable trends are a broad size range between 2600 and 1900 cal BP, and an increase in size after 1800 cal BP. The data for *Strombus luhuanus* (Figure 7) similarly show little variation in size throughout the assemblage. The most prominent feature for this species is an increase in size range between 2250 and 2000 cal BP. Similar to Sokoli, the size data for both *Lambis lambis* and *Tridacna* spp. (Figures 8, 9) are affected by a small number of measured specimens in Horizon IV. Taking this into account, the broad trend for both species appears to be a decrease in either mean size or both mean size and size-range between 2600 and 1600 cal BP. The main trend for the size range of *Trochus niloticus* (Figure 10) is a slight decrease in size between 2600 and 1600 cal BP, and particularly by 1800 cal BP, where the data illustrate a decrease in both size-range and mean size.

Summary

At both Dauar sites the species that demonstrated changes in size-range and mean size were *Nerita undata* and *Strombus luhuanus*. For both Sokoli and Ormi, any size-changes to *Lambis lambis*, *Tridacna* spp. and *Trochus niloticus* were considerably less visible. This is largely due to the smaller archaeological sample of these species and a paucity of sized individuals. At Sokoli the size of *Nerita undata* remains consistent from the time of initial site occupation at 2600 cal BP until 1400 cal BP, where it decreases substantially, although mean size is maintained. The most dramatic change for *Strombus luhuanus* is an increase in the size range and mean size of shells between 2600 and 1800 cal BP. For Ormi the most prominent changes are an increase in size of both species between initial site occupation at 2600 cal BP and termination of the deposit at 1600 cal BP. The fact that changes in the size of these species are more prominent at Sokoli than Ormi, is testimony to the greater time depth represented by the Sokoli deposit and the longer period in which evidence of change over time can accumulate.

Overall this data supports the previous interpretation of an intensification of the marine resource economy on Dauar between 2000 and 1800 cal BP, and tentatively illustrates the possible over-exploitation of marine shell species by at least 1400 cal BP. Alternatively, the targeting of smaller sized individuals may also indicate a decline in the importance of larger shells for subsistence by this time. The decrease in shell density and the rate of shell accumulation previously demonstrated for Sokoli also provide evidence to support this.

Shell Fracturing

The presence of fracture patterns on shell excavated from the Murray Islands has been described previously (Carter et al. 2004:250). It was noted that descriptions of shell damage observed during subsistence processing in contemporary ethnographic situations were consistent with fracturing recorded for a number of archaeological shell specimens. Plate 6.1 illustrates examples of the diagnostic processing holes observed on a variety of shell species recovered from the Murray Islands excavations. These are *Lambis lambis*, *Strombus luhuanus*, *Cypraea tigris* and *Trochus niloticus*. Table 6.8 shows that for each of these species, a number of shells displaying diagnostic processing holes were recovered from all four excavations. Ormi recorded the greatest number of shells with diagnostic fracturing (n=61), followed by Kurkur Weid (n=40) and Sokoli (n=39), with Pitkik containing only five shells with the characteristic fracturing.

Plate 6.1 Diagnostic shell processing holes (from top left clockwise) – *Cypraea tigris*, *Lambis lambis*, *Trochus niloticus* and *Strombus luhuanus*

The larger number of diagnostically fractured shells present at Ormi is consistent with the overall higher density of shell recovered from this site. The presence of a smaller number of fractured shells at Sokoli is in accordance with the lower density of shell recovered at this site, as well as the previously demonstrated decrease in rate of shell accumulation after 1650 cal BP (see Figure 6.1). The high number of shells with process fracturing recovered from Kurkur Weid is considered to reflect both site location and site function; its short distance from the reef and protective, comfortable setting providing a suitable locale for immediate processing and consumption of marine resources. This confirms the previous interpretation that the more proportional quantities of commonly occurring species at Kurkur Weid reflect different patterns of shellfish transport and processing behavior than those responsible for the more disproportionate species ratios at Sokoli and Ormi on Dauar.

KURKUR WEID	**SPECIES**	**MNI**
Horizon I	*Cypraea tigris*	1
	Lambis lambis	2
	Strombus luhuanus	2
	Turbo argyrostomus	1
		Total 6
Horizon II	*Lambis lambis*	Total 1
Horizon III	*Cypraea tigris*	1
	Lambis lambis	21
	Strombus lentigonosus	1
	Strombus luhuanus	5
	Trochus niloticus	4
		Total 31
Horizon IV	*Lambis lambis*	1
	Strombus luhuanus	1
		Total 2

SOKOLI	**SPECIES**	**MNI**
Horizon I	*Lambis Lambis*	4
	Strombus luhuanus	8
	Vasum turbinellum	1
		Total 13
Horizon II	*Cypraea tigris*	1
	Lambis lambis	2
	Strombus luhuanus	2
		Total 5
Horizon III	*Cypraea tigris*	1
	Lambis lambis	2
	Strombus luhuanus	8
		Total 11
Horizon IV	*Lambis lambis*	1
	Strombus luhanus	3
		Total 4
Horizon V	*Cypraea tigris*	1
	Lambis lambis	3
	Melo amphora	1
	Strombus luhuanus	1
		Total 6

PITKIK	**SPECIES**	**MNI**
Horizon I	*Lambis lambis*	1
	Trochus miloticus	1
		Total 2
Horizon II	-	-
Horizon III	*Cypraea tigris*	Total 1
Horizon IV	*Lambis lambis*	1
	Strombus gibberuls	1
		Total 2

ORMI	**SPECIES**	**MNI**
Horizon I	*Cyprae tigris*	1
	Lambis lambis	9
	Strombus luhuanus	2
		Total 12
Horizon II	*Cypraea tigrsi*	3
	Lambis lambis	5
	Strombus luhuanus	2
	Trochus niloticus	1
		Total 11
Horizon III	*Cyprae tigris*	4
	Lambis lambis	28
		Total 32
Horizon IV	*Cyrprae tigris*	Total 1
Horizon V	*Lambis lambis*	Total 5

Table 6.8 Distribution of shells with diagnostic processing fracturing

Sorting and Identification of Vertebrate Faunal Remains

The total bone assemblage recovered from the Murray Islands excavations amounts to 6511 fragments, weighing 2.88kg. Most of the bone was highly fragmentary with varying degrees of burning, making accurate identification difficult and calculation of MNI impossible. In the laboratory all bone fragments were initially separated into the easily identifiable categories of fish, turtle, dog, rodent and unidentified. Fragments from the 'unidentified' category required further identification from vertebrate reference collections held by the School of Anthropology, Archaeology and Sociology at James Cook University and specimens of the Vertebrate Zoology collection at the Museum of Queensland in Brisbane.

Fish bone consisted predominantly of cranial fragments, including dentaries, premaxillas and six otoliths, followed by vertebrae as the next most common type of bone. For the purposes of identification all otoliths and samples of all diagnostic dentaries, premaxillas and pharyngeal teeth plates, were sent to the Ichthyology section at the Queensland Museum for identification. Fifty-one samples were selected for identification including 26 from Sokoli, 23 from Ormi and one each from Kurkur Weid and Pitkik. The remains of turtle *(Chelonia mydas)* consisted entirely of fragments of carapace. No dugong bone was recovered from the excavations on Dauar and Mer. This is interpreted to support the ethnographic record for the Murray Islands, which described dugong as rarely encountered in the deeper waters and where turtle represented the most common and abundant marine mammal procured for subsistence.

Terrestrial vertebrate remains consisted of reptile, mammal and dog. Some avifaunal remains were also identified. Reptile was separated into general categories of goanna, lizard and snake, while bones of *Rattus rattus* and a single macropod tooth constituted the only mammal remains. *Rattus rattus* bone comprised the only faunal remains with identifiable diagnostic components, allowing the calculation of MNI by counting the most commonly occurring identifiable skeletal element. The remaining bone assemblage constituted the unidentifiable category and consisted of extremely small fragmented pieces.

Sokoli

A total of 3250 bone fragments weighing around 1.3kg was recovered from Sokoli. The distribution of faunal remains by stratigraphic horizons for Sokoli is summarised in Table 6.8. Over 95% of the bone assemblage in each Horizon consists entirely of the remains of marine fish and turtle (Figure 6.5). By weight, Horizon III and Horizon I contain the most bone fragments overall (58%), while the remaining Horizons contain almost the same quantity, comprising between 13% and 14% of the assemblage (Figure 6.6). Turtle is the largest category by weight, and accounts for 69% of the total assemblage. Fish bone is the next most abundant category (24.1%), followed by unidentified remains (3.7%). The remaining terrestrial vertebrate categories comprise a total of 3.2% of the entire Sokoli bone assemblage. Based on average weight, the largest faunal remains recovered were dog, averaging 2.5g and consisting of several teeth and fragments of mandible and vertebrae. Turtle was recovered as the second largest type of bone fragment, although with an average weight of 0.8g, this testifies to the highly fragmented nature of the bone, as well as the small size of fragments from the remaining faunal categories.

The rate of bone accumulation at Sokoli is illustrated in Figure 6.7, which shows that bone was deposited fastest between 1800 and 1400 cal BP. Although the number of bone fragments decreased slightly in this period, the overall size of the remains increased. This general trend is illustrated by the rate of accumulation of fish and turtle bone (Figures 6.8 and 6.9), which shows both the higher quantity and larger size of the remains deposited between 1800 and 1400 cal BP. After this time the rate of accumulation of turtle and fish bone at Sokoli substantially decreased.

	Fish		Turtle		Rodent		Reptile		Dog		Bird		Unidentified		TOTAL	
	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g
Horizon I	87	12.74	224	356.66	nil	nil	nil	nil	14	31.17	3	1.23	26	7.87	353	409.67
Horizon II	69	23.01	208	161.83	4	0.42	8	0.91	1	0.73	Nil	nil	15	6.69	302	193.61
Horizon III	249	48.9	406	303.01	3	0.23	Nil	Nil	Nil	nil	5	1.23	59	16.66	722	369.87
Horizon IV	461	69.06	302	94.52	1	0.09	1	0.04	1	0.33	2	1.5	82	12.6	853	178.14
Horizon V	986	168.11	12	4.64	1	0.08	3	0.1	Nil	nil	5	4.33	14	5.97	1020	183.23
TOTAL	1852	321.82	1152	920.66	9	0.82	12	1.05	16	32.23	15	8.29	196	49.79	3250	1334.66
% weight	24.1		69.0		0.1		0.1		2.4		0.6		3.7			
Mean weight	0.17		0.8		0.09		0.08		2.01		0.55		0.25		0.41	

Table 6.9 Sokoli vertebrate assemblage

	Fish		Turtle		Rodent		Reptile		Dog		Bird		Macropod		Unidentified		TOTAL	
	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g
Horizon I	796	218.29	421	257.52	1	0.07	19	1.81	1	0.11	8	3.35	nil	nil	19	23.64	1265	504.79
Horizon II	451	93.28	149	126.66	nil	nil	2	0.15	1	0.22	5	2.09	nil	nil	15	8.9	623	231.3
Horizon III	327	111.23	100	42.92	nil	nil	5	0.79	nil	nil	1	0.13	nil	nil	27	14.09	460	169.16
Horizon IV	330	114.6	26	39.55	1	0.11	nil	nil	nil	nil	11	2.51	nil	nil	18	4.38	387	161.15
Horizon V	217	173.4	5	97.44	nil	nil	nil	nil	nil	nil	2	0.2	1	1.36	3	2.22	227	274.43
TOTAL	2121	710.8	701	564.09	2	0.18	26	2.75	2	0.33	27	8.28	1	1.36	82	53.3	2962	1340.83
% weight	53.01		42.07		0.01		0.2		0.02		0.61		0.1		4.0			
Mean weight	0.33		0.8		0.09		0.1		0.16		0.3		1.36		0.65		0.45	

Table 6.10 Ormi vertebrate assemblage

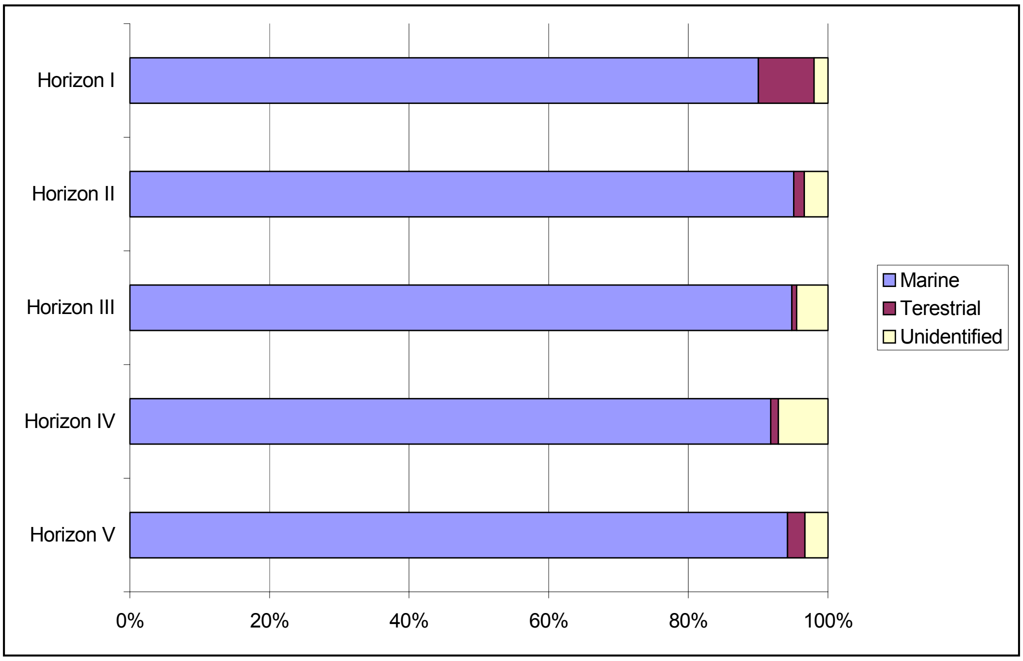

Figure 6.5 Sokoli vertebrate proportions
(I: 0-50cm, 0-900 cal BP; II: 50-100cm, 900-1400 cal BP; III: 100-150cm, 1400-1650 cal BP; IV: 150-185cm, 1650-1800 cal BP; V: 185-234cm, 1800-2600 cal BP)

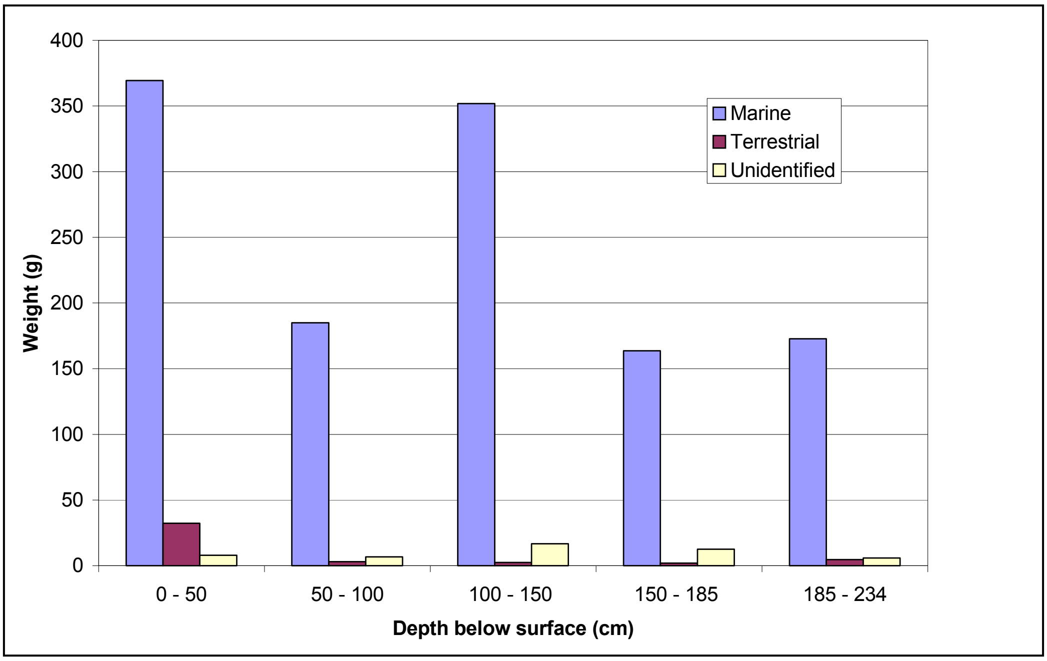

Figure 6.6 Sokoli vertebrate assemblage distribution
(I: 0-50cm, 0-900 cal BP; II: 50-100cm, 900-1400 cal BP; III: 100-150cm, 1400-1650 cal BP; IV: 150-185cm, 1650-1800 cal BP; V: 185-234cm, 1800-2600 cal BP)

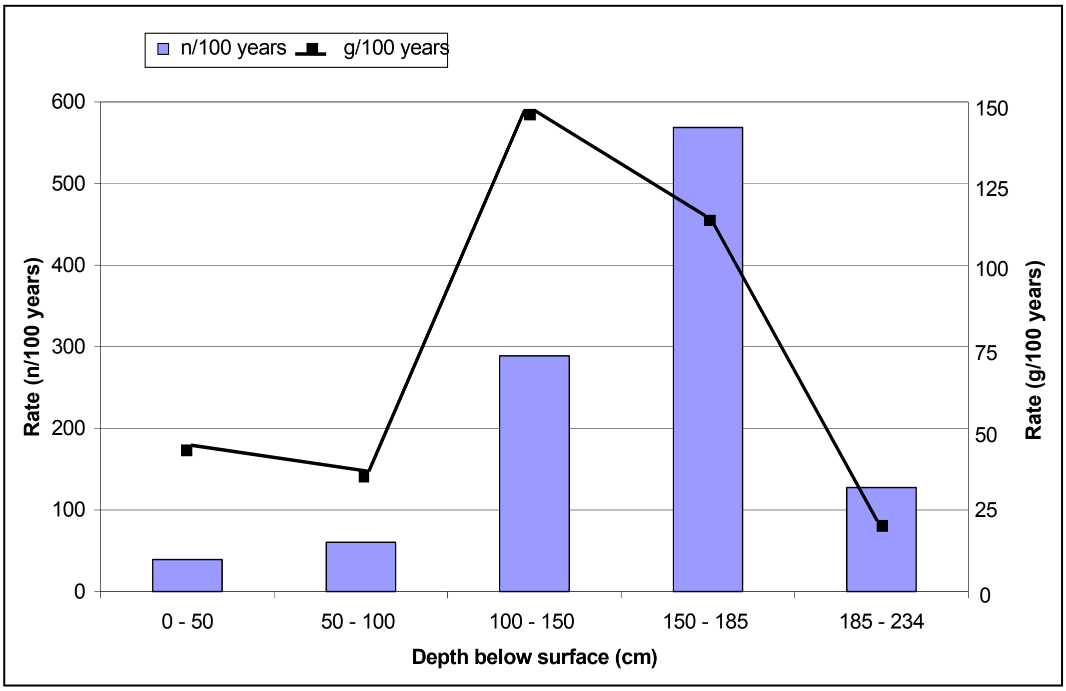

Figure 6.7 Sokoli rate of bone accumulation
(I: 0-50cm, 0-900 cal BP; II: 50-100cm, 900-1400 cal BP; III: 100-150cm, 1400-1650 cal BP; IV: 150-185cm, 1650-1800 cal BP; V: 185-234cm, 1800-2600 cal BP)

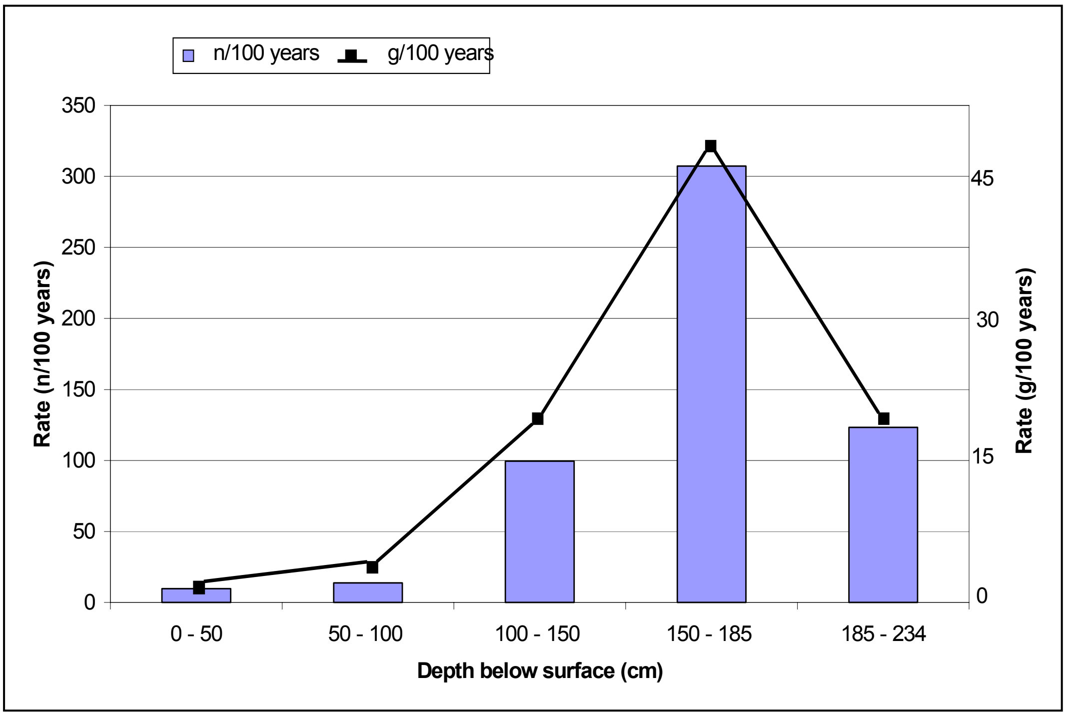

Figure 6.8 Sokoli rate of fish bone accumulation
(I: 0-50cm, 0-900 cal BP; II: 50-100cm, 900-1400 cal BP; III: 100-150cm, 1400-1650 cal BP; IV: 150-185cm, 1650-1800 cal BP; V: 185-234cm, 1800-2600 cal BP)

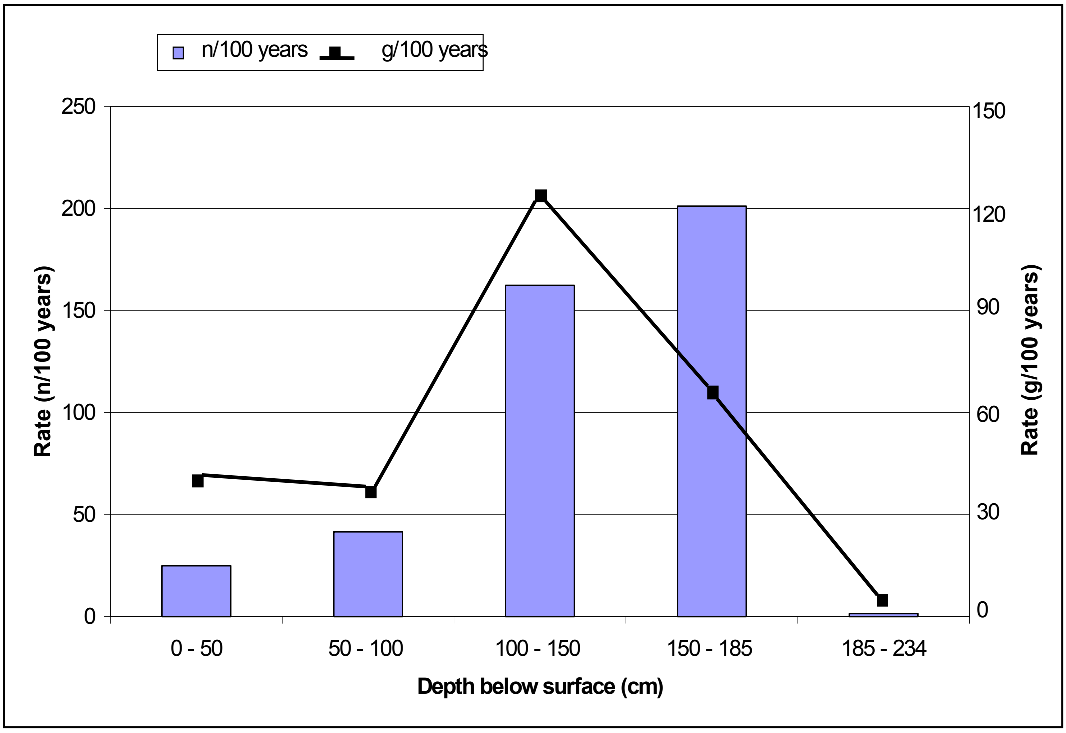

Figure 6.9 Sokoli rate of turtle bone accumulation (I: 0-50cm, 0-900 cal BP; II: 50-100cm, 900-1400 cal BP; III: 100-150cm, 1400-1650 cal BP; IV: 150-185cm, 1650-1800 cal BP; V: 185-234cm, 1800-2600 cal BP)

Parrotfish *(Scarus* sp.) and wrasses *(Labridae sp.)* comprised 68% of the fish bone recovered at Sokoli. Other species include emperors *(Lethrinus sp.),* trevally *(Caranx* sp.), tusk fish *(Choerodon sp.)* and mackeral *(Scomber* sp.). A tooth from a small shark *(Carcharhinus* sp.) was also identified (see Appendix F, Table 1). Excluding the shark, these fish are medium to large reef-dwellers common in coastal waters and reefs of tropical Australia (Allen 1997). They predominantly inhabit shallow waters, although trevally and mackeral are large school fish that are also located in deeper waters of offshore reefs. Common reefs sharks also inhabit offshore reefs but can also frequent shallow inshore waters. Although patterns in the distribution of fish species at Sokoli are not discernible from this preliminary analysis, the results do suggest the fish bone assemblage represents a variety of species from a range of habitats including both inshore and offshore reef environments.

Details of the identified bone fragments from the remaining faunal categories from Sokoli are described in Appendix F, Table 2. The remains of goanna, small lizard and small snake consist entirely of vertebrae, while bird consists of both unidentified fragments and fragments of wing bone. Although species identification of the bird bone was not attempted owing to the small and fragmentary nature of the assemblage, it was concluded that the skeletal components represented the remains of a large species. This was based on a size comparison of the Sokoli bird bone fragments with reference skeletons of a Torres Strait pigeon and a sea eagle. The former species (*Ducula spilorrhoa*) is a member of the family Columbidae, which includes pigeons and doves of an average size of 300 - 400mm. Sea eagles are members of the large bird family Accipitridae, and can grow up to a size of almost 900mm. Comparison of these specimens with the Sokoli bird bone clearly demonstrated the excavated bone was more in the size range of the eagle.

Rattus rattus bone occurred in deposit dating from 2600 to 900 cal BP. The remains consisted of a variety of skeletal elements, the majority being intact mandibles (see Appendix F, Table 3). Based on the incidence of right lower mandible bones, an MNI of four was identified for Sokoli. Apart from the two premolars occurring between 1800 - 1650 cal BP and 1400 - 900 cal BP, the majority of the dog bone from Sokoli was recovered in the upper deposit dating from 900 cal BP. These remains consist of six fragments of vertebrae, three fragments of a broken left lower mandible, and single teeth including one premolar, two molars and one incisor.

Ormi

Almost 3000 bone fragments weighing around 1.3kg were recovered from Ormi. The distribution of faunal remains by stratigraphic horizons for Ormi is summarised in Table 6.9. In a further similarity to Sokoli, over 95% of the bone assemblage from Ormi comprised of fish and turtle remains (Figure 6.10). Figure 6.11 illustrates that by weight, the remains were relatively evenly distributed throughout the deposit, with the largest proportion of the assemblage (36%) occurring in the upper most section, from 1800 - 1600 cal BP. The second largest proportion (20%) was found in the lower most section dating from 2600 - 2250 cal BP. The middle section of the Ormi deposit, dating between 2250 and 1800 cal BP, contains the remaining 44% of the bone assemblage. Fish bone is the largest category by weight and forms around 53% of the bone assemblage. The second largest category is turtle at 42%, with the identified terrestrial faunal categories comprising the remaining 5% of the bone assemblage. Excluding the single macropod molar recovered from the lower most deposit, turtle bone constitute the largest bone fragments at Ormi. These remains are similar to the fragmented nature of turtle bone at Sokoli, with the turtle bone at Ormi also recording a mean weight of only 0.8g.

As illustrated by Figure 6.12, the rate of bone accumulation at Ormi was fastest after 2000 cal BP and continued to increase until the surface of the deposit, dated at 1600 cal BP. The accumulation rates of both fish and turtle bone at Ormi (Figures 6.13 and 6.14) broadly support this trend, although between 1900 - 1800 cal BP, the size of the fish remains appears to decrease while the size of turtle fragments increases.

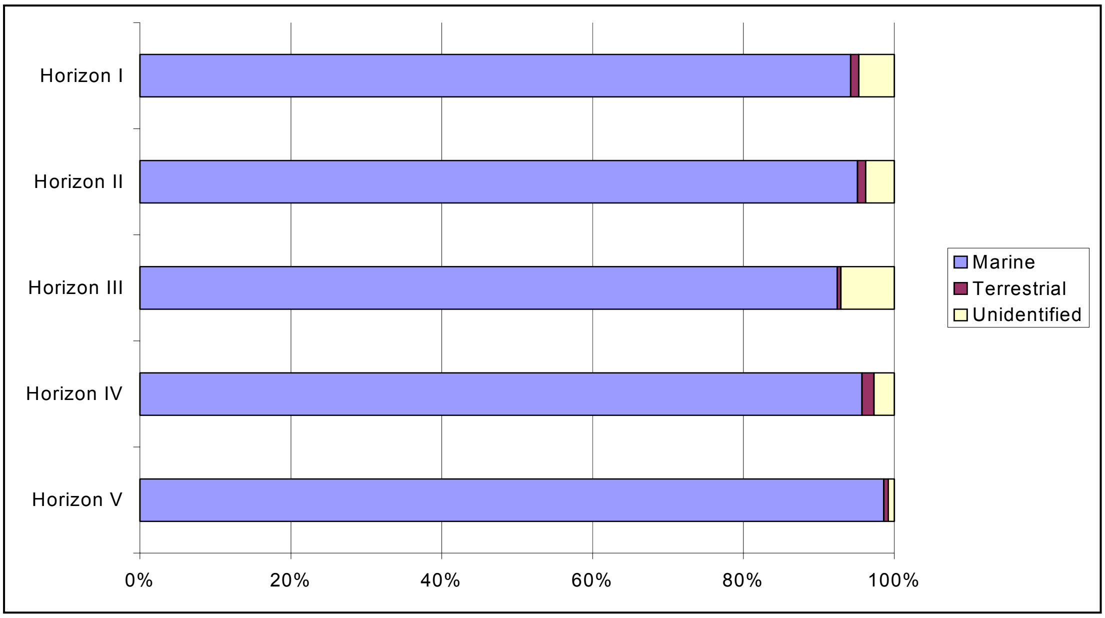

Figure 6.10 Ormi vertebrate proportions
(I: 0-70cm, 1600-1800 cal BP; II: 70-110cm, 1800-1900cal BP; III: 110-130cm, 1900-2000 call BP; IV: 130-185cm, 2000-2250 cal BP; V: 185-225cm, 2250-2600 cal BP)

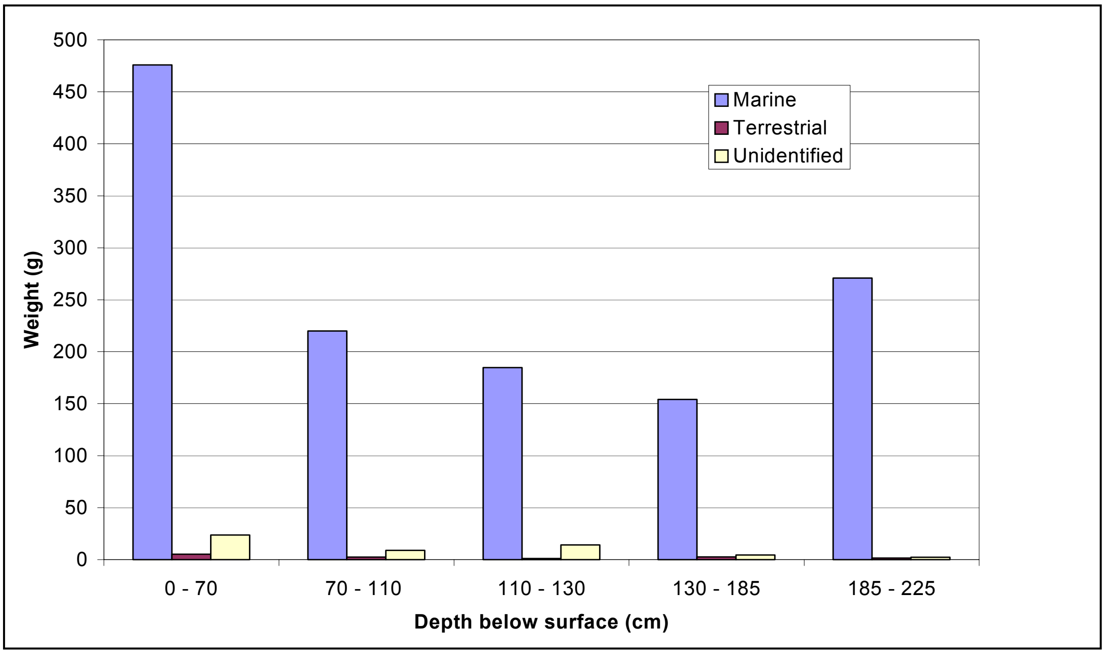

Figure 6.11 Ormi vertebrate assemblage distribution
(I: 0-70cm, 1600-1800 cal BP; II: 70-110cm, 1800-1900cal BP; III: 110-130cm, 1900-2000 call BP; IV: 130-185cm, 2000-2250 cal BP; V: 185-225cm, 2250-2600 cal BP)

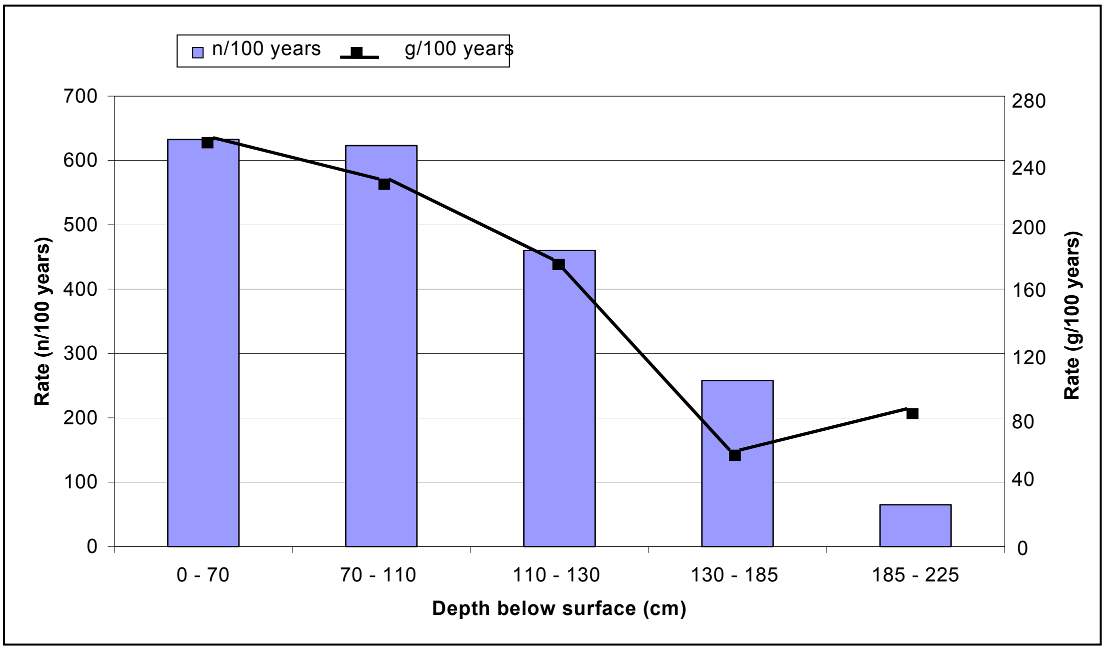

Figure 6.12 Rate of vertebrate accumulation at Ormi
(I: 0-70cm, 1600-1800 cal BP; II: 70-110cm, 1800-1900cal BP; III: 110-130cm, 1900-2000 call BP; IV: 130-185cm, 2000-2250 cal BP; V: 185-225cm, 2250-2600 cal BP)

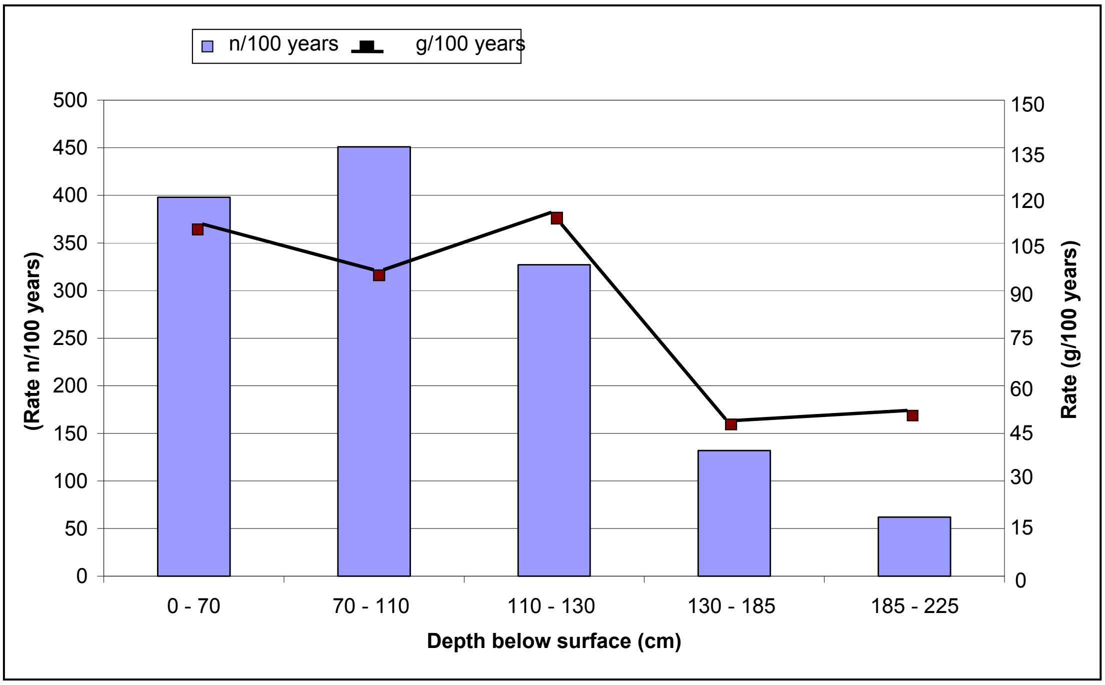

Figure 6.13 Rate of fish bone accumulation at Ormi
(I: 0-70cm, 1600-1800 cal BP; II: 70-110cm, 1800-1900cal BP; III: 110-130cm, 1900-2000 call BP; IV: 130-185cm, 2000-2250 cal BP; V: 185-225cm, 2250-2600 cal BP)

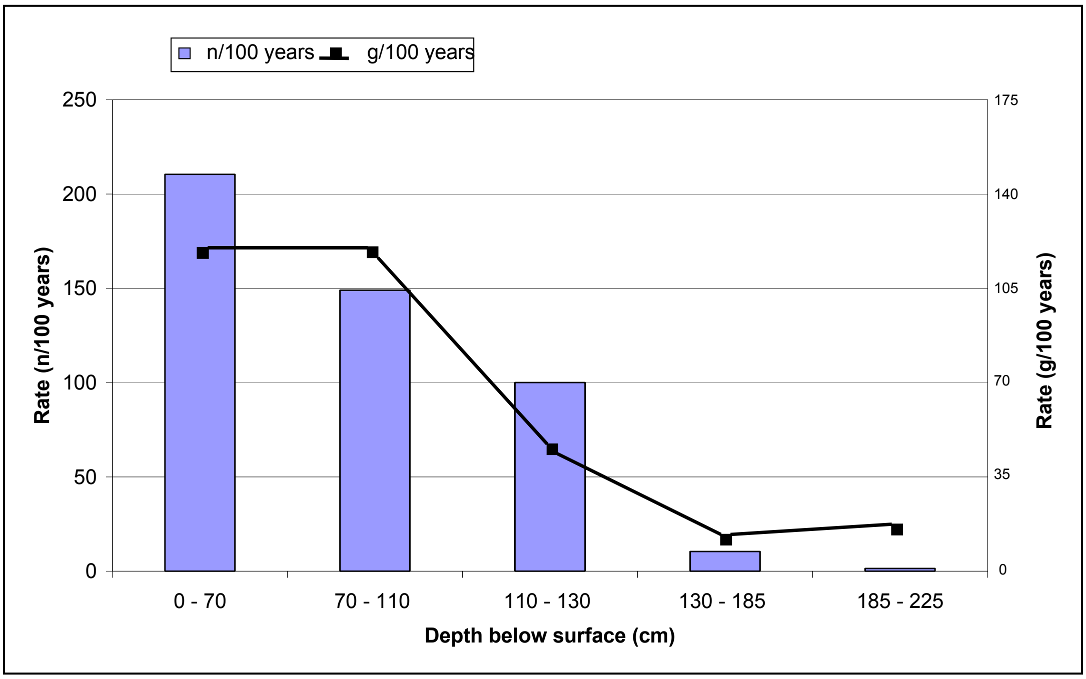

Figure 6.14 Rate of turtle bone accumulation at Ormi
(I: 0-70cm, 1600-1800 cal BP; II: 70-110cm, 1800-1900cal BP; III: 110-130cm, 1900-2000 call BP; IV: 130-185cm, 2000-2250 cal BP; V: 185-225cm, 2250-2600 cal BP)

Analysis of the maxilla samples and otoliths indicated that 77% of the fish bone from Ormi consisted of parrotfish (*Scarus* sp.) and wrasses (*Labridae* sp.). The remaining 23% of samples consisted of two other species; emperor or bream (*Lethrinus sp.*) and tusk fish (*Choerodon sp.*) (see Appendix G, Table 1). Although more sophisticated and detailed analyses of the fish remains are required, this result suggests that the fish remains deposited at Ormi may represent a more restricted species range than the Sokoli fish assemblage. However, this result may reflect the fact that the Ormi assemblage covers only half the time period than is represented by the Sokoli assemblage. Nonetheless, these results may provide evidence for a possible increase in the range of fish species exploited on Dauar from approximately 1 600 cal BP.

Details of the identified bone fragments from the remaining faunal categories from Ormi are described in Appendix G, Table 2. Bird remains were recovered from the entire sequence, with the majority from the upper deposit dating from 1800 - 1600 cal BP. The bird assemblage consisted of wing and leg components as well as unidentified fragments. The same comparative analysis undertaken with the Sokoli samples was conducted with the Ormi bird bone, and also indicated that the archaeological bone represented a larger bird. Vertebrae comprised the only skeletal components of goanna, lizard and snake, and were limited to deposit dating between 2000 and 1600 cal BP. Dog remains consisted of two incisors located in the upper deposit dating from 1900 - 1600 cal BP. *Rattus rattus* bone consisted of two skeletal elements, representing 2 MNI for the entire deposit (see Appendix G, Table 3). These remains were recovered in Horizon IV dating from 2250 - 2000 cal BP and in Horizon I dating from 1800 - 1600 cal BP. A single macropod premolar was recovered at the base of the Ormi excavation dating from 2600 cal BP. Although heavy concretion has prevented species identification, the size of the tooth is consistent with Agile wallaby (*Macropus agilis*) currently found both to the north and south of Torres Strait.

Kurkur Weid

From Kurkur Weid a sum of 221 bone fragments weighing less than 100g were recovered. The distribution of faunal remains by stratigraphic horizons at Kurkur Weid is summarised in Table 6.10. Based on the number of remains the largest faunal category is turtle (60%) followed by fish (13%) (Table 6.10). Figure 6.15 illustrates terrestrial vertebrate remains form 63% by weight of all bone fragments in the upper most section of the site. By weight, the majority of the marine vertebrate bone (82%) was recovered from the middle section of the deposit dating from 780 - 520 cal BP (Figure 6.16). The rate of bone accumulation at Kurkur Weid shown in Figure 6.17 demonstrates that bone was also deposited most rapidly between 780 - 520 cal BP. No bone remains were recovered from deposit dating between 520 - 315 cal BP. Excluding the single bird bone recovered from the deposit, turtle bone comprised the overall largest bone fragments, although with a recorded mean weight of only 0.55g.

The majority of the 30 fish bones recovered from the deposit consisted of cranial fragments, and included only a single diagnostic pharyngeal tooth plate (see Appendix H, Table 1). This bone was identified as wrasse (*Labridae sp.*) and was recovered from the middle deposit dating between 780 - 520 cal BP. Details of the terrestrial bone assemblage from Kurkur Weid are provided in Appendix H, Table 2. The largest number of terrestrial vertebrate bones was also recovered from Horizon III and consisted of fragments of *Rattus rattus.* An MNI of two was calculated from the total of 49 bone fragments identified for this period, based on the incidence of lower left mandibles (see Appendix H, Table 3). *Rattus rattus* fragments were also recovered in Horizon IV and Horizon I recording a total MNI of one. The unidentified bird bone was also recovered from the uppermost deposit, while three small snake vertebrae were the only other terrestrial vertebrate remains from the period 780 - 520 cal BP.

	Fish		Turtle		Rodent		Reptile		Bird		TOTAL	
	n	**g**	**n**	**g**	**n**	**g**	**n**	**g**	**n**	**g**	**n**	**g**
Horizon I	13	0.77	nil	nil	3	0.44	nil	nil	1	0.91	17	2.12
Horizon II	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
Horizon III	17	1.19	129	61.58	49	4.01	3	0.16	nil	nil	198	66.94
Horizon IV	nil	nil	3	12.14	3	0.33	nil	nil	nil	nil	6	12.47
TOTAL	30	1.96	132	73.72	55	4.78	3	0.16	1	0.91	221	81.53
% weight	2.4		90.4		5.9		0.2		1.1			
Mean weight	0.06		0.55		0.08		0.05		0.91		0.36	

Table 6.11 Kurkur Weid vertebrate assemblage

	Fish		Turtle		Reptile		Unidentified		TOTAL	
	n	**g**	**n**	**g**	**n**	**g**	**n**	**g**	**n**	**g**
Horizon I	24	0.81	1	0.23	1	0.06	5	0.11	31	1.21
Horizon II	nil	Nil	Nil	Nil	nil	Nil	Nil	Nil	Nil	Nil
Horizon III	8	0.51	5	0.86	nil	Nil	Nil	Nil	13	1.37
Horizon IV	2	0.02	5	7.13	nil	Nil	4	0.25	11	7.4
Horizon V	nil	nil	22	119.55	nil	Nil	1	0.23	23	119.78
TOTAL	34	1.34	33	127.77	1	0.06	10	0.59	78	129.76
% weight	1.0		98.5		0.04		0.45			
Mean weight	0.03		3.9		0.06		0.05		1.7	

Table 6.12 Pitkik vertebrate assemblage

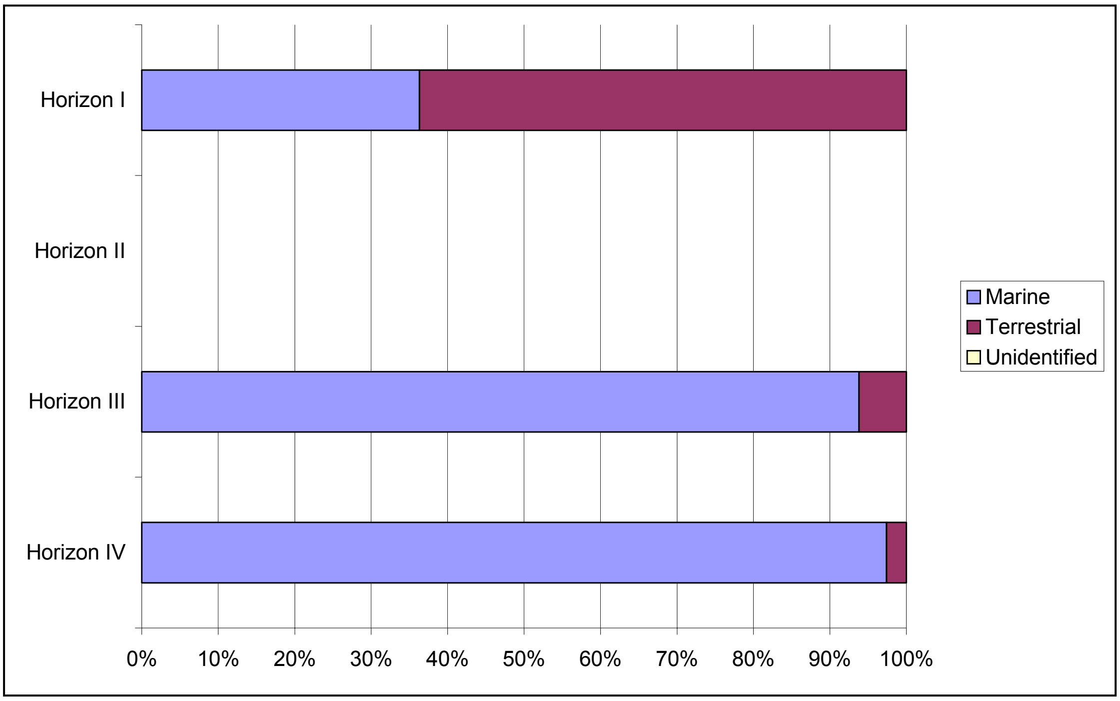

Figure 6.15 Kurkur Weid proportions of vertebrate remains (I: 0-15cm, 0-315 cal BP; II: 15-25cm, 315-520 cal BP; III: 25-110cm, 520-780 cal BP; IV: 110-130cm, 780-965 cal BP)

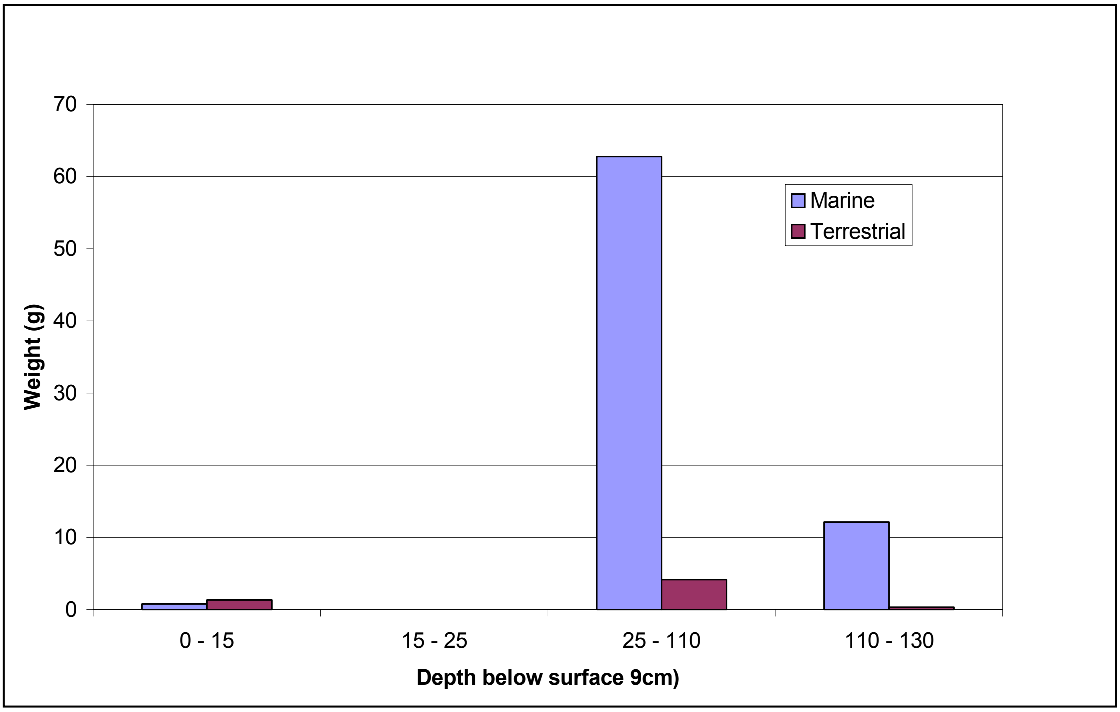

Figure 6.16 Kurkur Weid vertebrate assemblage distribution (I: 0-15cm, 0-315 cal BP; II: 15-25cm, 315-520 cal BP; III: 25-110cm, 520-780 cal BP; IV: 110-130cm, 780-965 cal BP)

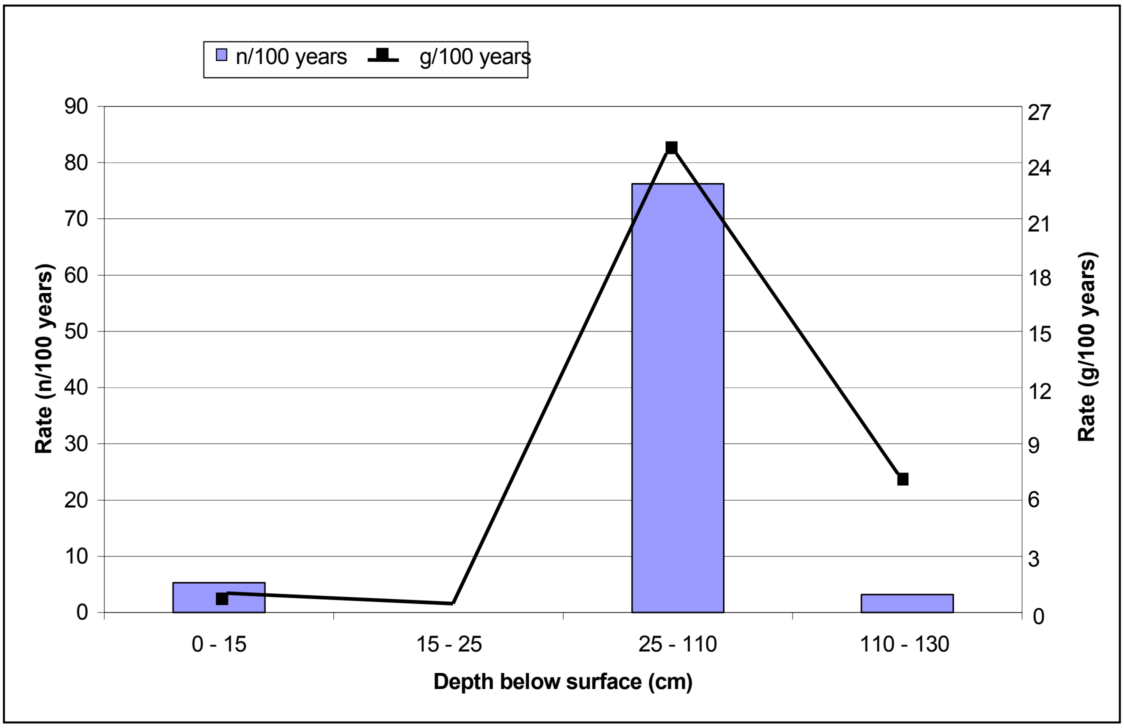

Figure 6.17 Kurkur Weid rate of vertebrate accumulation
(I: 0-15cm, 0-315 cal BP; II: 15-25cm, 315-520 cal BP; III: 25-110cm, 520-780 cal BP; IV: 110-130cm, 780-965 cal BP)

Pitkik

A sum of 78 fragments weighing almost 130g were recovered from Pitkik. The distribution of faunal remains by stratigraphic horizons is summarised in Table 6.11. A total of 98.5% of the bone fragments is from turtle, with fish comprising only 1% of the vertebrate assemblage. The proportions of the vertebrate assemblage for Pitkik are illustrated in Figure 6.18. Figure 6.19 shows that almost 98% of the bone by weight occurred in the lower deposit within the short period 900 - 775 cal BP. This is confirmed by the rate of bone accumulation at Pitkik (Figure 6.20). This demonstrates the small size of remains in the middle and upper section of the deposit dating to after 775 cal BP, the majority of which is fish (72%). Fish bone consisted predominately of vertebrae, with only one diagnostic pharyngeal tooth plate, identified as wrasse (*Labridae* sp.), recovered in the most recent horizon (see Appendix I, Table 1). A single small lizard vertebra and ten unidentified fragments form the remaining bone assemblage at Pitkik. The vertebrae and half the unidentified fragments occur in the most recent deposit dating from 380 cal BP, while the other half of the unidentified bone assemblage occurs between 900 and 775 cal BP (see Appendix I, Table 2 for details).

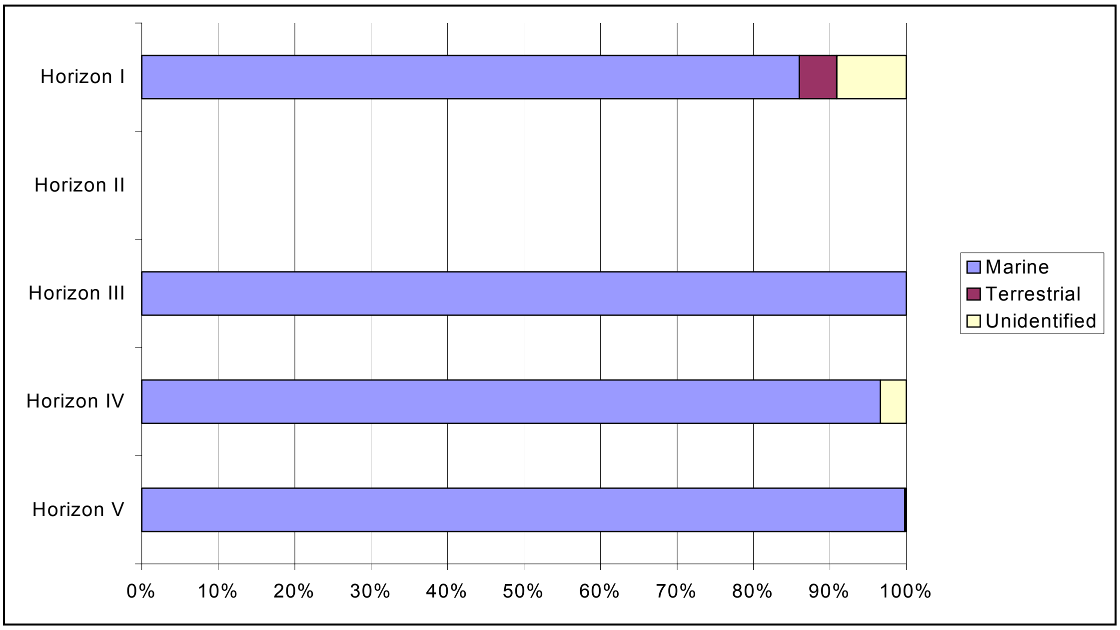

Figure 6.18 Pitkik vertebrate proportions (I: 0-40cm, 0-380 cal BP; II: 40-50cm, 380-610 cal BP; III: 50-60cm, 610-775 cal BP; IV: 60-85cm, 775-800 cal BP; V: 85-110cm, 800-900 cal BP).

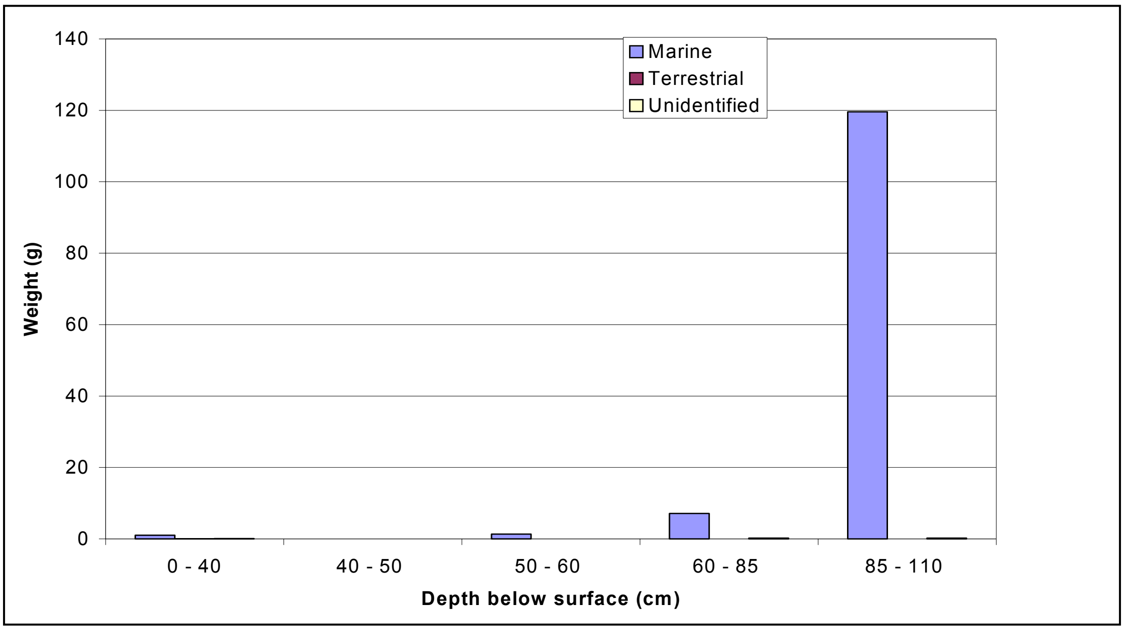

Figure 6.19 Pitkik vertebrate assemblage distribution (I: 0-40cm, 0-380 cal B II: 40-50cm, 380-610 cal BP; III: 50-60cm, 610-775 cal BP; IV: 60-85cm, 775-800 cal BP; V: 85-110cm, 800-900 cal BP).

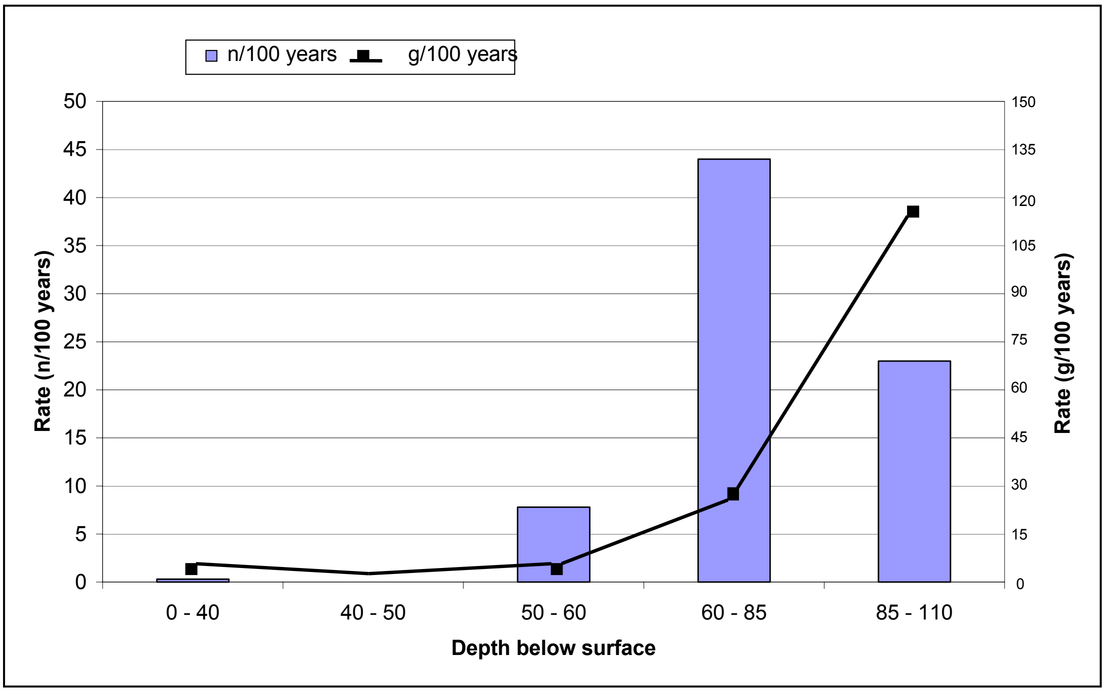

Figure 6.20 Pitkik rate of vertebrate accumulation (I: 0-40cm, 0-380 cal BP; II: 40-50cm, 380-610 cal BP; III: 50-60cm, 610-775 cal BP; IV: 60-85cm, 775-800 cal BP; V: 85-110cm, 800-900 cal BP).

Summary

Vertebrate assemblages recovered from the excavations on Mer and Dauar are dominated by the remains of marine fauna. Significantly smaller quantities of faunal remains were recovered from the excavations on Mer. This is probably because of the nature of the sites themselves and the shorter time-depth represented by the assemblages. On Dauar, a greater quantity of turtle bone was recovered from Sokoli, but the trend of an increase in the deposition of turtle bone over time was also apparent in the Ormi turtle bone assemblage. This result suggests the possibility of a widespread increase in the exploitation and consumption of turtle on Dauar from the time of initial island occupation at 2600 cal BP. However, the trends illustrated by the quantity and rate of accumulation of fish bone at the Dauar sites differ considerably.

The proportions of fish bone show an overall increase from the time of occupation at Ormi at 2600 cal BP to 1600 cal BP when the sequence terminates. At Sokoli, on the other hand, the proportions of fish bone consistently decrease from the time of occupation at 2600 cal BP. This result is intriguing in the context of the suspected greater diversity of fish species at Sokoli. As mentioned earlier, the apparently lower species diversity at Ormi may reflect the shallower time depth of this deposit, 1000 years, compared to the 2600 years of occupation represented by the Sokoli assemblage. This result also assumes, however, a wider diversity of species was being exploited at Sokoli in spite of the considerably lower quantity of fish bone deposited. This may have been the case from 1600 cal BP or perhaps from as early as 1800 cal BP if the increase in quantity of fish bone in the upper most stratigraphic horizon of Ormi is any indication.

The remaining vertebrate categories at Sokoli and Ormi represent the fragmented bones of a limited diversity of terrestrial animal species; *Rattus rattus*, small goannas, lizards and snakes, dog, large birds and wallaby. Owing to the very low quantities of these remains, the question of whether the terrestrial vertebrate assemblages represent evidence of subsistence is debatable. As discussed in Chapter 4, however, each of the faunal species present archaeologically, excluding wallaby, feature throughout the ethnohistorical record of the Murray Islands in a variety of socio-economic, utilitarian and indeed subsistence contexts. What is more conclusive is that the limited diversity of archaeological terrestrial vertebrate remains confirms both ethnohistorical and contemporary observations of the presence of very few terrestrial species on the Murray Islands, and of the low diversity of faunal species throughout the Torres Strait more generally. However, one exception to the question of whether the excavated faunal remains provide evidence of terrestrial focused subsistence is the wallaby, which is represented by a single tooth in the basal deposit at Ormi. A discussion on the recovery of the macropod tooth is provided in Chapter 10, and addresses the issue of the introduction and the regional translocation of this species in Torres Strait. The recovery of *Rattus rattus* and dog bone is also considered within the context of these issues.

Owing to the recovery of small quantities of bone from each of the identified terrestrial faunal categories, the trend of an overall increase in the deposition of terrestrial faunal remains at these sites from as early as 2000 cal BP is best illustrated by the unidentified faunal category. More specifically, at both Dauar sites the increase in the deposition of unidentified fauna coincided with the stratigraphic transition from coarse grained beach sands to finer grained colluvium. As evidence of increased exploitation of terrestrial fauna from 2000 cal BP, this trend confirms the intensification of subsistence and an increase in activity and disturbance to the islands' landscape dating from this time.

Conclusions

Analysis of the excavated marine invertebrate and vertebrate assemblages has provided a detailed record of past marine subsistence on Mer and Dauar, producing evidence of broad spatial and temporal trends in the pre-European marine subsistence economy of the Murray Islands. On Mer the excavated deposits from the Kurkur Weid rockshelter and the hill side profile at Pitkik provide a sample of the material remains of approximately the last 1000 years of marine subsistence on Mer. Analysis of the assemblages from these sites has revealed a number of similarities to the excavated marine assemblages from Sokoli and Ormi on Dauar. The most notable of these is the high proportions of the same common mollusc species and the general lack of terrestrial vertebrate remains. In this context the Kurkur Weid and Pitkik assemblages have confirmed the presence of the marine resource economy on the islands during the last 1000 years. Significantly, however, the Kurkur Weid and Pitkik deposits have demonstrated the high level of continuity in the overall nature of the marine subsistence economy from initial occupation of the Murray Islands around 2600 cal BP. It is concluded that the differences between the Mer and Dauar assemblages, such as the lower density and diversity of shell, and the smaller quantities of marine vertebrate remains, are the result of the different nature of the sites themselves: the former representing the sporadic accumulation of rockshelter deposits and hill-side colluvium, the latter representing the ongoing long-term occupation of open coastal situations.

The archaeological record of marine subsistence strategies on Dauar commences from the time of initial human occupation of the island at 2600 cal BP. In contrast to the Sokoli marine shell assemblage, however, the Ormi assemblage represents a considerably greater quantity of marine shell that was deposited within a much shorter period of time. The implication of this is the existence of differences in the nature and intensity of site use on Dauar dating from initial occupation. Although representing a much shorter period of occupation, the Kurkur Weid and Pitkik assemblages both provide evidence for variation in the deposition of marine subsistence remains, confirming that site use and function are reflected in the nature of archaeological deposit.

Variability in the species composition of shell deposits on the Murray Islands has been demonstrated by the work of Richardson (2000) and Bird et al. (2002, 2004). As well as not recognising other cultural, non-subsistence related activities in the formation of marine subsistence deposits on the Murray Islands, these investigations have also failed to consider spatial differences in the density of the shell assemblages, as well as the temporal changes identified in the preceding analysis. A number of matters require consideration in this context, particularly in relation to the Dauar sites, and are taken up below.

As described in Chapter 4, the intertidal area adjacent to Ormi features extensive and highly productive reef flats which also contain numerous networks of well-structured and maintained stone fish traps. On the other hand, on the northeastern side of the island adjacent to Sokoli, the reef flat is much more restricted and poorly developed. Although fish traps are present, they were only identified from the air and appeared smaller and badly maintained. This suggests that distance to marine resources, including those in the reef-flat and rocky shore zones, and access to fish trap technology, may have played a significant role in spatial differences in the formation and rate of accumulation of archaeological deposits on Dauar.

There is also evidence for temporal variation in the archaeological marine subsistence assemblages on Dauar. In the previous chapter a major stratigraphic change at both Ormi and Sokoli was identified. A feature of this stratigraphic transition was a rapid increase in the rate of sediment accumulation. This chapter has confirmed that at both sites this episode is coeval with a significant increase in the quantity, diversity, size range and rate of accumulation of shell remains. This evidence has been interpreted as intensification of the marine subsistence economy, combined with a possible intensification of land use and disturbance to the island's topography. Based on the radiocarbon age depth curves, however, these changes occurred at approximately 2000 cal BP at Ormi, and several hundred years later at Sokoli, around 1800 cal BP. This chronological sequence indicates that although subsistence intensification and land disturbance on Dauar commenced at approximately 2 000 cal BP, the process was widespread and continued for several hundred years, resulting in temporal variation in the deposition of excavated subsistence remains.

The greater time depth of the Sokoli site revealed evidence for a reduction on marine resource dependence from as early as 1650 cal BP. This was illustrated by a decrease in the density of shell remains, a decrease in the quantity, proportions and size range of the most common mollusc species, as well as a decrease in the rate of accumulation of marine faunal remains. These data indicate the role of marine resources in the subsistence economy may have diminished from 1650 cal BP. This hypothesis, combined with the evidence of possible disturbance to sedimentary environments from 2000 cal BP, hints at the emergence and gravity of horticultural subsistence practices on Dauar some time between 2000 and 1650 cal BP. This hypothesis is tested by the identification and analysis of excavated plant microfossils from Sokoli and Ormi, which forms the content of Chapter 7.

Chapter 7: Horticultural Subsistence

The analysis and radiocarbon dating of excavated marine shell assemblage from Dauar have confirmed the exploitation of marine resources from the time of initial occupation around 2600 cal BP. However, unequivocal archaeological evidence for the presence of the prehistoric horticultural economy was not observed during the excavations or preliminary analysis of the archaeological remains. Although depositional changes hint at landscape modification, alone this is insufficient grounds for establishing the emergence of horticultural practices, especially where the adoption of such practices did not involve major landscape modification, as appears to be the case for the Murray Islands. An analysis of the fossil phytolith and starch grain content of excavated sediment samples was undertaken to address this situation by identifying microscopic evidence for vegetation changes and the presence of edible species at the excavated sites (Parr and Carter 2003). The microfossil plant analysis undertaken for the Dauar contexts represents the first archaeological application of this technique in the Torres Strait, and provides the first attempt at identifying palaeobotanical remains associated with prehistoric horticulture in the region.

Horticulture in Torres Strait: Antiquity and Nature of Evidence

The horticultural economy of Torres Strait has received considerable interest in the ethnographic record, although this is mainly restricted to descriptive lists of plant and vegetable foods procured throughout the region (Beckett 1972:315-316; Durrad 1939-1940:398-399; Haddon 1912:130-151; Harris 1976). Not until the second half of the 20th century, however, did discussions and debate about the varying degrees of reliance on cultivated vegetable resources across the Torres Strait reach the forefront of archaeology (Golson 1972; Harris 1977). In spite of such prolonged interest, the question of the antiquity of the development of horticultural subsistence in the Torres Strait remained virtually uninvestigated until recently (Barham and Harris 1985, 1987; Barham 1999; Carter 2002; Parr and Carter 2003; Harris 1995).

Barham's (1999) palaeoenvironmental reconstruction of Holocene swamp environments and the development of agriculture on Saibai Island stands as the first scientific attempt at determining the antiquity of terrestrial based subsistence in the Torres Strait. This research represents a culmination of earlier investigations into the nature and antiquity of these systems based on field survey, excavation and radiocarbon chronologies (Barham 1981; Barham and Harris 1983, 1985, 1987). The more recent reconstruction of the mid- to late-Holocene palaeoenvironmental history of Saibai has provided new insights into the nature and chronology of the island's horticultural systems (Barham 1999). As these have been discussed previously, only a number of summary points relevant to the investigations of horticulture on the Murray Islands are highlighted:

- the development of agricultural systems on Saibai at 1200 years BP post-dates the estimated time of first human occupation of the island by almost 1500 years,

- the construction of the agricultural field systems on Saibai was dependent on ecological stabilisation after changing environmental conditions brought about the Holocene mean sea level fluctuations from 3000 years BP and,

- prehistoric cultivation on Saibai required the modification and construction of the landscape to suit environmental conditions, resulting in clearly identifiable archaeological evidence (i.e. drainage canals, wells, ditches and mounds).

Unlike Saibai where remnant field constructions testified to the presence of past horticultural practices on the island, both the ethnohistorical record and the archaeological survey confirm that similar modification of the landscape was not practiced on the Murray Islands. Based on the geomorphology of these islands alone - compare the low swampy relief of Saibai and the high volcanic slopes of the Eastern Islands - the absence of relict wet-land ditch-and-mound field systems on Mer and Dauar is not surprising. A different analytical technique is thus applied for the current investigation of horticulture on the Murray Islands. Owing to the lack of unequivocal physical or stratigraphic evidence for horticulture in the excavations, it was concluded that the identification of microbotanical remains of plants and vegetable foods might provide the only recoverable evidence of prehistoric horticultural economy. Plant phytoliths and starch grains are two such types of archaeologically recoverable microbotanical remains.

Phytoliths and Starch Grains as Evidence for Horticulture

Phytoliths (commonly referred to as opal phytoliths) are microscopic particles that form when plant cells become filled with opaline silica from groundwater (Wilson 1985:90). Once solidified, the silica forms a cast of the plant's cell which can measure 5 to 100 microns in size. Phytolith characteristics, such as size and shape, are determined during this process of primary deposition. Secondary deposition occurs when a plant dies, and the phytoliths are released as discrete particles into a sedimentary matrix. It is at this point that phytoliths enter the realm of archaeological interest, with their analysis ranging 'from the recording of phytolith presence/absence, through identification of specific plant species, to detection of past micro- and macro-climatic changes' (Bowdery 1989:161).

Two of the major applications of phytolith analysis include investigations into prehistoric plants and agriculture and environmental reconstruction (Bowdery 1989). Studies of the origin and domestication of a number of cultigens, including maize (Pearsall 1989), squash, pumpkin and bottle gourd (Bozarth 1986, 1987) and banana (Denham et al. 2003; Wilson 1985), have greatly benefited from phytolith studies. In a number of instances, phytolith analysis has supplemented and enhanced pollen data, demonstrating it to be an extremely useful tool for interpreting vegetation changes and clearance patterns (Bowdery 1995; Carbone 1977; Kealhofer and Piperno 1998; Parr et al. 2001a; Piperno and Clary 1984).

Unfortunately, the analysis of tropical archaeological soils in search of evidence for typical Pacific root crops, such as yams (*Dioscorea* sp.), taro (*Colocasia esculenta*) and sweet potato (*Ipomea* sp.) is problematic. Neither of these tuberous species take up and deposit silica intracellularly, so therefore they do not have phytoliths (Wilson 1985:90). As discussed in Chapter Two, these cultigens were documented ethnohistorically as vegetable foods on the Murray Islands, and may have formed a significant component of the pre-European diet. A solution to this problem is the identification and analysis of starch grains, which form a common method used for the identification of roots and tubers in archaeological contexts, such as sediment matrices and stone tool residues (Hather 1994; Loy 1994; Loy et al. 1992; Urgent et al. 1981, 1986).

The Archaeological Samples: Methodology, Analysis and Results

Processing and analysis of the phytoliths and starch grains in the excavated sediment samples from the Murray Islands sites was undertaken by Jeff Parr, from the Centre for Geoarchaeology and Paleoenvironmental Research at Southern Cross University in Lismore, New South Wales. The results of the analysis of samples from Ormi and Sokoli were recently reported by Parr and Carter (2003) (Appendix J). This chapter provides a summary of the results detailed in Appendix J, although the interpretive discussion below has been generated with the specific aims of this thesis in mind.

Sediment samples were selected for phytolith and starch grain analysis with several considerations in mind. Firstly, the selection of a limited number of samples from each excavation was necessitated due to restricted funding. Although a complete column sample from each site would have been ideal, in this instance only preliminary testing of several key stratigraphic samples was possible. Thus sediment samples from stratigraphic features or layers suspected to be the result of possible horticultural activity, or that are unusual or distinct in comparison to the general site stratigraphy, were selected for analysis. Stratigraphic Unit 4 at Sokoli and SU11 at Ormi provided ideal candidates for plant microfossil analysis. A further consideration in the selection of sediment samples was the aim to interpret change in vegetation over time and the timing of the absence/ presence of edible species. Hence the final consideration in selecting samples was to select the Stratigraphic Units which also had reliable radiocarbon age determinations.

As the excavations at Kurkur Weid and Pitkik on Mer failed to produce any evidence for horticulture, phytolith and starch grain analysis of sediment samples was limited to the excavations at Sokoli and Ormi on Dauar. This chapter describes the results of analysis from four Stratigraphic Units at Sokoli and five Stratigraphic Units at Ormi. As the results for Sokoli represent the combination of data from two different but consecutive Excavation Units within each Stratigraphic Unit, the total sample quantity (300 phytoliths) is double that presented for the Ormi samples (150 phytoliths).

Sediment samples were processed using the microwave phytolith and starch extraction procedure described in Parr (2002). A Perkin - Elmer Multiwave Microwave Sample Preparation System was used for simultaneous phytolith and starch-grain extraction. Extracted samples were weighed, mounted onto microscope slides and scanned at 400x magnification on an Olympus BH2 microscope. A sample of 150 potentially diagnostic phytoliths (i.e. known to occur in particular vegetation types) was then counted for each slide. Phytolith nomenclature was adopted from that used in a number of recent papers and plant families were identified using available data sources (see Appendix J for specific details on references). Additionally, modern plant samples collected by Lentfer and co-researchers in West New Britain, Papua New Guinea and specimens from the Southern Cross University Herbarium were processed (using the microwave digestion technique described in Parr et al. (2001b) for phytolith reference material. However, in the absence of a plant reference collection specific to the study area, many of the above types overlapped with other plant families rendering them as undiagnostic. These types were therefore combined under the heading 'Miscellaneous'.

Counts were also made for starch grains and carbonised particles during the scanning of microscope slides for fossil phytoliths. Using the Australian Museum Starch Reference Collection as a guide, the fossil starch grains recovered from the sediment samples were compared to those of known species using characteristics described in Lentfer et. al. (2002) Therin et. al. (1999) and Therin (1994). The carbonised material that was counted included microscopic charcoal particles and charred phytoliths.

Phytolith numbers were generally low in all samples, particularly in those samples with a pH of eight and above, indicating poor preservation. Nevertheless, all samples from each site contain diagnostic phytoliths. Absolute counts of phytolith types for all samples are shown in Tables 7.1 and 7.2 and are a synthesis of the data provided in Tables 2 and 3 in Appendix J. The results of analysis are also illustrated in Figures 7.1 and 7.3, where the identified microfossil remains are grouped into their respective plant families or vegetation type. Images of selected phytoliths and starch grains from the archaeological samples and comparative plant reference material are provided in Plates 7.1a, 7.1b and 7.1c at the back of this chapter.

Sokoli

The Sokoli results show that the majority of phytoliths identified in all samples fall into the miscellaneous vegetation type. Phytoliths of trees and shrubs were the second most common class, followed by Poaceae (grasses), and finally by Arecaceae (palms) as the vegetation type with the lowest number of identified specimens. Cystoliths and carbonised particles were also identified in all samples.

Identification and distribution of phytolith species

Figure 7.1 illustrates that the sample with the highest proportion of miscellaneous phytolith types was SU14, which also contained a large proportion of trees and shrubs. Most of the unidentified types are heavily pitted indicating deterioration of silica owing to the alkalinity of the soil or substantial weathering of sediments. Poaceae (grasses) and Arecaceae (palms) formed a small proportion of phytoliths from the basal Stratigraphic Unit. Phytoliths of the palm *Cocos nucifera* (coconut) are present in SU14, while the grass phytoliths resemble those of *Themeda australis*. Between SU14 and SU7 the proportion of miscellaneous phytoliths decreases and there is an increase in tree and shrub phytoliths.

Two Musaceae (banana) phytoliths were identified in SU4 and represent the only Musa phytoliths found for the Sokoli site (Table 7.1, Plate 7.1a). By SU4 there is a further substantial decrease in miscellaneous vegetation and an increase in tree and shrub phytoliths, as well as Poaceae and Arecaceae phytoliths. The carbonised phytoliths in SU4 are predominantly grass bullyforms that resemble those of *Imperata cylindrica.* The sediment sample from SU4 is unique in that it contained the largest component of *Cocos nucifera* palm types recorded from all the Sokoli samples. Between SU4 and SU2 Poaceae and miscellaneous categories decrease, while SU2 exhibits a slight decrease in miscellaneous and Arecaceae phytolith types and an increase in the proportion of tree and shrub and Poaceae phytoliths. Carbonised material was identified in each of the sediment samples, although the largest quantity of carbonised material was identified in SU7.

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Table 7.1 Absolute counts of phytolith types, starch grains and carbonised particles for Sokoli (after Parr and Carter 2003:136)

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Figure 7.1 Proportion of phytolith types grouped into family or broad vegetation types for Sokoli (after Parr and Carter 2003:Table 3)

Presence and identification of starch grains

Several starch grains were identified in SU7 and SU14. Starch grains of a structure similar, yet not identical, to the types found in *Ipomoea batatas* (sweet potato) were identified in SU14. A single starch grain identified in SU7 closely resembles *Manihot esculenta* (cassava). Three unidentified starch grains were also recorded from SU7. Although the tentatively identified starch grains display similar morphological features to these edible plant varieties, on the grounds that the samples consists of only a single starch grain for each and the possibility of laboratory error, the Sokoli starch grains are considered as anomalies and are not considered in the interpretive discussion below.

Vegetation change over time

The palaeobotanical evidence from Sokoli provides the basis for adequate interpretation of the nature of vegetation change at the site over time. The phytolith content of SU14 indicates that around 2600 cal BP vegetation at Sokoli comprises mostly unidentified miscellaneous species with little indication of coverage by tree and shrub species, grasses and especially palms. This suggests that at around the time of first human occupation, vegetation at the site may have been relatively open with few medium- to high-canopy species. The grass phytoliths identified in SU14 resembled those of *Themeda australis*, which is reported to occur in the Torres Strait Islands in predominately stable open habitats (Barham 1999). As described in Chapter 5, the nature of sediment at the base of the site suggested that at the time of first occupation, Sokoli existed as a relatively exposed open coastal area. Thus the results of the microfossil plant content of SU14 support the earlier interpretations of site formation at Sokoli.

The results for SU7 suggest that miscellaneous species remained dominant until 1400 cal BP, but that their coverage had somewhat decreased as the numbers of herbaceous trees and shrubs increased.

After 1800 cal BP the nature of the sediment excavated from Sokoli changed from coarse, red, beach sands in Horizon V, to finer grained, brown sand in Horizon IV. Although the difference between the microfossil plant content of SU14 and SU7 is not great, an increase in tree and shrub phytoliths may well indicate an increase in sediment to the site from more vegetated areas, such as the vegetated slopes of Dauar.

The analysis of SU4 demonstrates that vegetation at the site had changed substantially by 900 cal BP. Grass cover was more prolific, as were palms, particularly coconut. The presence of carbonised bullyforms of the grass *Imperata cylindrica* and the absence of *Themeda australis* indicates that by this time the former, more robust exotic species may have replaced the latter native species. *Imperata cylindrica* is found on deep sandy and/or clay soils often after disturbance and particularly following fire (Beadle et al. 1991). The presence of at least two economically-important food producing species in SU4, coconut and banana, provides further evidence for possible anthropogenic modification of the landsape by 900 cal BP. These results also support the previous interpretation that SU4 represents evidence of clearance and the stratigraphic remnant of the growth of cultivated species.

The results for SU2 indicate that a slight decrease in trees and shrubs occurred after 900 cal BP, although miscellaneous varieties increased along with grasses. This vegetation pattern may indicate a period of a lack of growth characteristic of fallow regimes. This contrasts with the vegetation habitat illustrated by SU14, which dates to the time of first occupation almost 2000 years earlier, and had significantly less coverage by grasses and palms. The results for SU4 therefore suggest an intermittent period of possible horticultural activity between initial occupation and 900 cal BP, illustrated by the presence of edible species as well as more robust, fire resistant secondary regrowth. The presence of carbonised particles throughout the deposit also supports the interpretation of past firing practices at Sokoli.

Ormi

Figure 7.2 illustrates that at Ormi phytoliths of trees and shrubs dominate throughout the site, while Poaceae (grasses) phytoliths occur as the second most dominant vegetation type. Although miscellaneous phytoliths are present in all four samples, they occur in significantly lower numbers in comparison to Sokoli. Overall Arecaceae (palms) represent the least common vegetation type throughout the site. Carbonised material was prolific only in the two uppermost samples (Table 7.2).

<u>Identification and distribution of phytolith species</u>

The largest quantities of miscellaneous and Poaceae phytoliths were identified in SU11, where Musuaceae (banana) phytoliths were also recorded (Table 7.2). Between SU10 and SU8 the most obvious trends are an increase in the number of Poaceae phytoliths and a decrease in the number of Arecaceaeeeae phytoliths (Figure 7.2). Grass bullyform phytoliths of the types found in *Imperata cylindrica* were identified in SU10. Based on the irregular ovate morphology of sphere phytoliths, their spinules and their size, the palm types that occur in SU8 are tentatively identified as *Cocos nucifera*. Musacaea phytoliths were also identified in the samples from SU10 and SU8 (Plate 7.1b). Straitgraphic Unit 6 shows a further decrease in Arecaceae phytoliths and an increase in miscellaneous vegetation (Figure 7.2). The highest proportion of tree and shrub vegetation out of all four samples occurred in SU4, with very small numbers of Poaceae and miscellaneous phytoliths. A small percentage of the phytoliths in SU4 and SU6 were of carbonised bullyform types.

<u>Presence and identification of starch grains</u>

Several identified and non-identified starch grains were recorded in the sediment samples from SU6 and SU11. Most notably, however, from SU11 several starch grains resembling the starch types of *Dioscorea pentaphylla* were identified (Plate 7.1c).

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Table 7.2 Absolute counts of phytolith types, starch grains and carbonised particles for Ormi (after Parr and Carter 2003:136)

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Figure 7.2 Proportion of phytolith types grouped into family or broad vegetation types for Ormi (after Parr and Carter 2003:Table 2)

Vegetation change over time

Although there is some indication of an overall decrease in palms and increase in grasses over time, between 2600 and 1600 cal BP vegetation at Ormi remained dominated by trees and shrubs. The presence of *Dioscorea* sp. starch grains in SU11 and *Musaceae* sp. phytoliths in both SU10 and SU11 indicate the presence of two economic plant varieties shortly after initial occupation at 2600 cal BP. Each of these are present immediately below the transition zone from coarse, red beach sands in Horizon IV to the finer-grained, black silty sand of Horizon III. This provides some confirmation of the previous interpretation that SU11 and SU12 at Ormi may represent the remnant features of disturbance due to the growth of cultivated species.

Discussion

As discussed in Chapter 3, the economic species observed during the ethnohistoric period on the Murray Islands, including banana, coconut and yam, each has different origins as cultivated crops. In the context of the chronology of phytoliths and starch grains identified in the excavations on Dauar, a further discussion on species origins and the history of the domestication of several common Pacific cultigens is warranted.

The starch grains identified in SU11 at Ormi resemble the species *Dioscorea pentaphylla*. This species occurs throughout Southeast Asia, locally on Thursday Island, in northern Queensland, New Guinea and on most of the Pacific Islands (Telford 1986:199). The results of genetic analysis of several *Dioscorea* sp., including *D. alata* (native to Southeast Asia and found in the Northern Territory and northern and eastern Queensland) and *D. bulbifera* (occurs in western Africa and southern Asia and located throughout the Pacific and in northern Australia and coastal Queensland) have indicated that variation of these species has occurred in New Guinea and that domestication may have occurred locally (Martin and Rhodes 1977; Ramser et al. 1996). As mentioned previously, records of both wild and cultivated forms of *D. pentaphylla* and *D. bulbifera* in New Guinea can be seen to support this argument (Yen 1995:836).

Although species identification has not been made, the *Musa* phytoliths identified in SU11, SU10 and SU8 at Ormi have similar morphological characteristics to the edible varieties of *Musa banksii*, *Musa maclayii* or *Musa schizocarpa* (Argent 1976). *Musa maclayii* belongs to the Australimusa section of bananas, while the other two varieties are from the larger Eumusa section. Each of these species, however, may have originated from human selective processes of wild varieties, such as *Musa accuminata or Musa balbisiana* (Moore 1957). As described in Chapter 4, recent genetic analysis of *Musa accuminata* spp. *banksii*, has demonstrated that domestication of the large Eumusa section of bananas probably occurred in New Guinea (Lebot 1999; Denham et al. 2003), and not in Southeast Asia as previously thought (Simmonds 1962). This is now in accordance with the origin and distribution of the smaller Australimusa section, which is also assigned to New Guinea (Argent 1976; Simmonds 1962). Thus, like the *D. pentaphylla* starch grains from Ormi, it is possible that the *Musa* sp. phytoliths, dating from 2600 – 1900 cal BP, represent the importation of already domesticated varieties from New Guinea.

Cocus nucifera phytoliths were identified in SU14 and SU4 at Sokoli and in SU8 at Ormi. The presence of coconut on Dauar therefore ranges from the time of initial occupation at 2600 cal BP, to 900 cal BP. As discussed in Chapter Four, a widely accepted hypothesis is that the establishment of coconut populations occurred through the natural dispersal of wild nuts over vast oceanic distances (Sauer 1971). Archaeologically recovered coconut husk remains throughout the Pacific dating from 5400 years BP, around 2000 years before human occupation, can be seen to support the natural dispersal hypothesis (Hossfeld 1965; Kirch and Yen 1982; Spriggs 1984; Yen 1973). However, Sauer (1971:318) also acknowledges the possibility that deliberate planting of coconuts by indigenous populations may have also taken place.

In light of this evidence, the presence of coconut phytoliths from coastal contexts on Dauar from as early as 2600 cal BP does not allow for distinguishing between natural and human dispersal mechanisms. However, as the coconut groves in the high interior regions on Mer are located outside of the species favored and natural habitat zone along the foreshore, and are also estimated to be of considerable antiquity, it is thus plausible that deliberate planting of coconuts on the Murray Islands may have occurred from the time of initial occupation.

Conclusions

Based on the nature of the horticultural practices documented for Torres Strait at the turn of the 20th century, it appears that planting of the majority of cultivated species, including bananas, and tuberous varieties such as yams, was done in open areas and perhaps in the close vicinity of the coasts. It was also suggested that there might also be a degree of temporal continuity in the nature of species cultivated, as the same crops were repeatedly grown in the same areas. The results of phytolith and starch grain analysis have confirmed that coastal situations, such as Sokoli and Ormi on Dauar, were the likely sites of past horticultural subsistence practices. Although the results have successfully revealed the presence of a number of economic species on Dauar, including coconut and varieties of Musaceae and *Dioscorea*, the limited number of samples analysed have unfortunately not revealed any definite chronological patterns in the growth and cultivation of these species. As outlined above, the trends that have been identified include broad patterns of vegetation change on Dauar, as well as the absence or presence of edible species.

It is concluded that the presence of coconut palm, but particularly *Dioscorea* and Musaceae species on Dauar shortly after initial human occupation, provides evidence of the importation of cultigens from New Guinea. The change in stratigraphy on the island from beach sands to colluvial sediment dating to between 2000 and 1800 cal BP suggests the commencement of horticultural systems associated with the production of the vegetable imports. Other evidence for horticulture includes possible burning, which, may have been responsible for the deposition of carbonised material at Sokoli from as early as 2600 cal BP, but which is apparent at Ormi only after 1800 cal BP. At Sokoli, however, the results also demonstrated that replacement of the native grass species *Themeda australis* by the more fire resistant *Imperata cylindrica* had occurred by 900 cal BP. Another broad change to vegetation on Dauar after approximately 2000 cal BP included a shift from open and sparse coverage typical of relatively undisturbed sites, to an increase in palms, grasses and tree and shrub varieties indicative of a level of disturbance.

This evidence therefore suggests that the horticultural economy of the Murray Islands developed considerably earlier than is currently indicated on Saibai, which is estimated to have developed around 1000 cal BP (Barham 1999). However, unlike Saibai where mid-Holocene sediment accumulation continued up until this time, similar levels of late-Holocene ecological change and adjustment may not have occurred on the high Eastern Islands of Torres Strait. As discussed in Chapter 5, radiocarbon dating of lithified beach rock facies on Dauar indicated that beach formation and stabilisation had occurred by approximately 3000 cal BP. This may have resulted in the immediate availability of coastal areas suitable not only for occupation and the procurement of littoral marine resources, but also for the preparation of horticultural systems. Although useable land surfaces and a high level of local habitat and resource diversity existed in the Northern Islands from around 2500 years BP, Barham (1999:101) has suggested that ongoing ecological changes, such as the infilling of coastal swamps, prevented the construction of horticultural mound-and-ditch systems for at least 1000 years after occupation. However, the results of the Dauar horticultural investigations indicate that Barham's (1999) focus on mound-and-ditch systems on Saibai may have obscured the potential for identification of evidence for earlier, less intensive horticultural systems, such as those found on the Murray Islands.

A point that remains concerns the documented nature of vegetation and vegetation communities on the Murray Islands. The information obtained from historical records, ethnographic accounts, on-site observations during the archaeological investigations and recent vegetation surveys demonstrated that a number of pre- and post-contact activities contributed to the contemporary nature and distribution of vegetation on the Murray Islands. Activities such as burning, clearing and prehistoric planting regimes, post-contact felling, as well as localised variations in soil fertility, have each played a role in the development of the islands' flora. The results of the phytolith and starch-grain analyses confirms this interpretation.

The phytolith and starch grain analyses of excavated sediment samples from Sokoli and Ormi described in this chapter represent the first application of these techniques in an attempt to recover and identify evidence for prehistoric horticulture in Torres Strait. Although preliminary, the results have provided intriguing data on the nature and the timing of horticulture on the Murray Islands, including the identification of species that were documented during the late 19th century as common cultivated crops. The strength of these results, however, lies in their association with the stratigraphic features previously described for the excavated sites on Dauar. These include the change in the nature of sediment from beach sand to colluvium, the rapid increase in sedimentation rates as well as the stratigraphic anomalies represented by SU4 at Sokoli and SU11 and SU12 at Ormi. In the broader context of investigating the timing of prehistoric horticulture throughout Torres Strait, these results also illustrate the utility of plant microfossil analysis in the absence of unequivocal gross morphological evidence, such as mound-and-ditch systems.

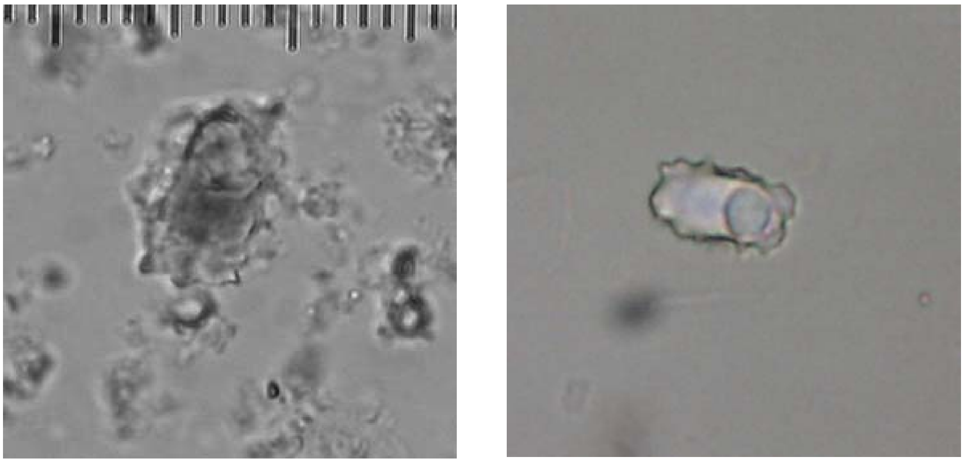

Plate 7.1a. Arial view of a Musaceae phytolith from Sokoli SU4 (left) and *Musa maclayii* from plant reference material (right) at 400x magnification (width of field 40μm).

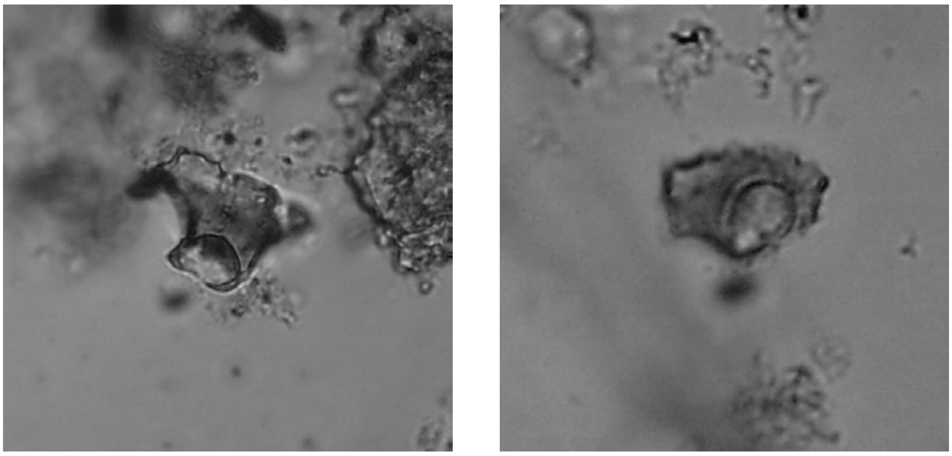

Plate 7.1b. Arial view of a Musaceae phytoliths from Ormi SU10 (left) and SU8 (right) at 400x magnification (width of field 40 μm).

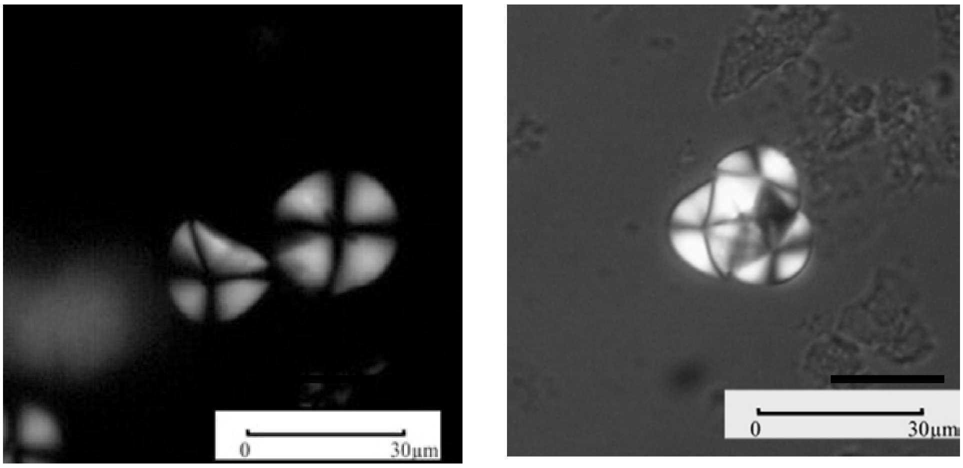

Plate 7.1c. Starch grains of *Dioscorea pentaphylla* from the Australian Museum Starch Reference Collection (left) and *D Dioscorea* sp. starch grain from sample SU11 at Ormi.

Chapter 8: The Material Culture Assemblage

From the extensive catalogue of artefacts collected during the Cambridge Anthropological Expedition we have developed an excellent knowledge of Torres Strait material culture as it existed at the close of the 19th century (Haddon 1912; Lawrence 1994; Landtman 1933; Moore 1984). However, we are considerably less well informed about the material culture of the Torres Strait from an archaeological perspective. Consequently, the antiquity or time-depth of the artefacts collected historically and the degree of influence European occupation had on the nature of Torres Strait material culture have failed to be recognised or adequately examined.

This chapter provides a detailed description of the excavated material culture assemblage from the Murray Islands. Although many of the items have been described ethnographically, several of the excavated artefacts, most notably the pottery sherds, have not been previously recorded in the Torres Strait. Collectively the assemblages provide new evidence of both local production and of regional trade and exchange throughout Torres Strait, and extends the antiquity of these networks to well before the ethnographically recorded past.

The first section of this chapter provides a description of the excavated material culture assemblage for each site followed by interpretation with reference to relevant ethnohistorical data and the radiocarbon age ranges. Each of the key artefacts has been allocated a reference number and illustrations of them are also included at the end of this chapter. Lastly, a discussion of the material culture assemblages is provided under four sections: chronological trends, evidence for subsistence, evidence of trade and exchange and evidence of site use.

Kurkur Weid

As listed in Table 8.1, a small number of artefacts were recovered from the excavation at Kurkur Weid.

Horizon / cal BP age range	Stone abrader	Modified coral	Metal	Textile
Horizon I 0 - 315	-	-	4	3
Horizon II 315 - 520	-	-	-	2
Horizon III 520 - 780	1	3	-	-
Horizon IV 780 - 965	-	-	-	-
Subtotal	1	3	4	5

Table 8.1 Artefact assemblage excavated from Kurkur Weid

Stone Abrader (SA1)

From the upper portion of Horizon III at Kurkur Weid a basalt manuport displaying an abraded surface was recovered (Plate 8.1). SA1 is an L shaped stone with usewear across a 4.7cm wide area at one end. Haddon (1912:123-124) recorded that stones and fine-grained wooden mortar and pestle implements were used for pounding and softening dugong skin, and foods, such as roasted bananas. Although the texture of the volcanic ash stone is rough and vesicular, the use wear indicates that the artefact was used as an abrader rather than as a pounder. SA1 was deposited at the site between 520 – 780 cal BP.

Modified Coral (MC1, MC2 and MC3)

Three modified coral artefacts were recovered; two (MC1 and MC2) (Plate 8.2 and Plate 8.3) from the upper section, and one (MC3) (Plate 8.4) from the lower section of Horizon III. MC1 and MC3 are pieces of coral, one elongate (15.3cm long) and one round (7.5cm in diameter), which both display a continuos worn groove around their circumference. MC2 is a smaller (4.5cm) tear-shaped piece of coral with a perforated hole through its distal end.

MC1 and MC3 are very similar in form to the stone fishing sinkers described by Haddon (see Plate 8.4). He notes that the name *mekek par*, suggests that they were used with fishing line, which was commonly made from twisted strands of coconut fiber (Haddon 1912:89). However, perforated coral or stone fishing sinkers have not previously been described. Perforated shell and bone pendants were commonly worn on Mer and were also used to decorate shoulder belts worn by men during fighting and dancing (Haddon 1912:42-55), but there is no record of such ornaments being made from coral. Each of the modified coral artefacts was deposited at Kurkur Weid between 315 and 780 cal BP.

Metal

Four pieces of rusted metal weighing 5g in total were recovered from the upper 5 cm of deposit in Horizon I. The fragments are cylindrical in shape and are probably nails. Islanders may have traded food for iron with Europeans as early as the 1840s (Jukes 1847 I; Moore 1979). However, it was probably not until the establishment of the London Missionary Society (LMS) in the 1860s that items such as nails were widely used in the region and their presence confirms that the upper 5cm of deposit at Kurkur Weid post-dates this period.

Textiles

Several small pieces of textile were recovered, including three blue coloured pieces (0.05g) from the surface layer of Horizon I and two pieces of calico (1.2g) from the upper layer of Horizon III. Calico was widely distributed to the islanders by LMS missionaries during the late 19th century. The presence of textiles in the upper 25cm of the deposit confirms use of the rockshelter during the historic period, but also suggests that disturbance of the most recent deposit has caused smaller items to move downwards.

Summary

The small numbers of artefacts recovered from Kurkur Weid consist of items used for domestic purposes (abrader SA1) and in subsistence activities (fishing sinkers MC1 and MC3). Although MC2 may be a pendant, there is no documentary evidence to suggest that body ornaments were made from coral. Similarly there is also a lack of evidence to confirm that MC2 was a type of fishing sinker. Each of these artefacts was recovered in deposit dating from 780 cal BP, suggesting that from this time the Kurkur Weid rockshelter may have been used for the manufacture, repair and/or storage of fishing gear.

As demonstrated in Chapter 6, the highest densities of both marine shell and marine and terrestrial vertebrate remains were recovered in Horizon III dating from 780 - 520 cal BP. This confirms that the busiest phase of occupation of the rockshelter occurred approximately 200 years after its initial occupation. The presence of metal remains and modern textiles demonstrate that the rockshelter was used throughout the historic past (from at least the 1860s), which is also signaled by an increase in the density of subsistence remains in Horizon I.

Pitkik

Ground shell (GS1)

A single ground shell artefact (GS1) was recovered from the excavation at Pitkik within Horizon IV (Plate 8.8). Manufactured from the thick body whorl of *Conus* shell, it has a ground utilised edge, indicating that it may have been used as a scraper.

Haddon (1912:124-125) recorded that shells used on Mer for cutting and scraping were whole valves of *Polymesoda erosa (akul)*, *Asaphis sp*. and *Tellina sp*. Shell scrapers fashioned from gastropods and bivalves were not described ethnographically. The most common use of *Conus* sp. shells were as chest pendants (*dibidibi*), which were manufactured from the flat circular shell apex, and as armlets (*wauri*), made from the body of the shell (see Figure 2.6). While the Pitkik artefact is very similar in form to shell pendants illustrated by Haddon (see Figure 2.6), the absence of a perforation on GS1 argues against an ornamental function. The artefact was recovered from Horizon IV and was deposited at the site within the short period between 800 and 775 cal BP.

The presence of only one portable artefact at Ptikik confirms the earlier interpretation (see Chapter 6) that deposit at the site may not reflect *in situ* occupation, but a derivation from deposits originally located on the hill slope. The estimated antiquity of the artefact may also account for the absence of comparable items in the ethnohistoric record. Following the introduction by Europeans of knives and other metal implements, the production of gastropod shell scrapers, which would have involved much more skill and energy than using a whole valve scraper, may have ceased.

Sokoli

Sokoli produced the biggest range of artefact types: stone debitage, modified coral, a coral abrader, ground shell, *Trochus* rings, incised bone, and pottery. Details of the excavated material culture assemblage are provided in Table 8.2.

Stone Debitage

Stone debitage forms the most abundant artefact type excavated from Sokoli. The stone assemblage comprises predominantly small (<1cm long) undiagnostic flaked pieces. Table 8.3 presents the distribution and raw material data for the stone assemblage from Sokoli.

Horizon / cal BP age range	Stone debitage	Modified coral	Coral abrader	Ground shell	*Trochus* ring	Incised bone	Pottery
Horizon I 0 - 900	8	-	-	-	-	-	1
Horizon II 900 – 1400	28	1	-	1	-	1	-
Horizon III 1400 - 1650	5	-	-	-	-	1	-
Horizon IV 1650 - 1800	3	-	1	-	1	-	-
Horizon V 1800 - 2600	2	1	-	-	1	-	-
Subtotal	46	2	1	1	-	2	1

Table 8.2 Artefacts excavated from Sokoli

	n	Rhyolite debitage (gm)	n	Quartz debitage (gm)
Horizon I **0 – 900 cal BP**				
XU 4	1	0.27	0	0
XU 5	2	0.45	0	0
XU 6	3	0.88	0	0
XU 8	2	0.27	0	0
Subtotals	8	1.87	0	0
Horizon II **900 – 1400 cal BP**				
XU 10	20	10.79	0	0
XU 11	6	3.31	0	0
XU 12	1	0.26	0	0
XU 13	1	0.17	0	0
Subtotals	28	14.53	0	0
Horizon III **1400 - 1650 cal BP**				
XU 15	1	0.14	0	0
XU 16	1	0.94	0	0
XU 17	3	0.5	0	0
XU 19	0	0	2	0.76
Subtotals	5	1.58	2	0.76
Horizon IV **1650 – 1800 cal BP**				
XU 20	1	0.34	0	0
Subtotal	1	0.34	0	0
Horizon V **1800 – 2600 cal BP**				
XU 23	2	1.96	0	0
Subtotal	2	1.96	0	0
Total	44	20.28	2	0.76

Table 8.3 Distribution of stone debitage at Sokoli

Distribution and raw material

Almost 96% (n=44) of the stone assemblage consisted of porphyritic rhyolite, with the remaining debitage (n=2) comprising clear quartz. The porphyritic rhyolite ranges in colour from black to green-grey but consistently contains distinct orange coloured phenocyrsts of potassium feldspar. There is no identifiable change in the colour or texture of the porphyritic rhyolite from Horizon I to Horizon V. The majority of the rhyolite debitage (60%) was recovered from Horizon II, indicating an increase in the quantity of stone debitage deposited at Sokoli between 900 and 1400 cal BP. The clear quartz stone artefacts were restricted to Horizon III and date to between 1400 and 1650 cal BP.

The practice of stone tool reduction, such as flaking, was not ethnographically recorded in Torres Strait. However, the nature of the stone assemblage recovered from Sokoli, consisting of undiagnostic lithic debris, provides evidence for some type of stone artefact manufacture, although the finished tool is not archaeologically present. Stone club heads (*gabagaba* and *seuriseuri*) were the most common stone item recorded throughout Torres Strait during the late 19th Century, and provide a possible candidate for the origin of the stone debitage at Sokoli. According to Haddon (1912:13) small chips of quartz were used for face and body scarification, particularly in the Western Islands. However, the absence of a sharp flaked edge on quartz flaked piece recovered from Sokoli indicates that it is unlikely to have served this function.

Modified Coral (MC4 and MC5)

Two modified coral pieces were recovered from Sokoli. Horizon II contained a rounded piece of coral with perforations and with worn grooves around part of its circumference (MC4) (Plate 8.5). Horizon V contained a roughly oval shaped piece displaying a worn groove (MC5) (Plate 8.6) in the same style as the modified coral recovered from Kurkur Weid. CM5 was deposited at the site between 1800 and 2600 cal BP, while CM4 was deposited later between 900 and 1400 cal BP. It is likely that both artefacts were used, like those from Kurkur Weid (CM1 and CM3), as fishing sinkers.

Coral Abrader (CA1)

One coral abrader (CA1), from Horizon IV, was recovered. The artefact is 11.1 cm in length and has three distinct areas of ground use wear along the distal edge (Plate 8.7). In a similarity to the stone abrader identified in Kurkur Weid (SA1), the patterning of use wear on the coral indicates that the artefact was also used in an abrasive motion, and was not used for pounding. CA1 dates to between 1650 and 1800 cal BP, suggesting that it was deposited at the site between CM4 and CM5 described above.

Ground Shell (GS2)

The only shell artefact recovered from Sokoli (GS2) loosely resembles a flake (Plate 8.9). The artefact has one ground edge with use wear, and was probably shaped from *Tridacna* shell. GS2 was recovered from Horizon II and dates to between 900 and 1400 cal BP.

Tridacna gigas shell was used for the manufacture of shell adze blades in the Torres Strait, although details about the processes of manufacture are lacking (Haddon 1912:125-126, Fig. 159-160). As mentioned previously in the context of the shell artefact recovered from Pitkik (GS1), there is no ethnohistorical data that describes the manufacture of scrapers from whole shell specimens.

Trochus Rings (TR1 and TR2)

Two fragments of modified *Trochus niloticus* shell were recovered from Sokoli, including one from Horizon V (TR1) and one from Horizon IV (TR2) (Plate 8.10). TR1 has a relatively square cross section and based on the large proportion of nacre exposed, may be a fragment of a nearly completed *Trochus* ring. In comparison, TR2 has very little exposed nacre and is in a much earlier stage of manufacture, with visible working along its edges. TR1 and TR2 were deposited at the site between initial occupation at 2600 cal BP and 1650 cal BP.

Haddon (1912:50-51) recalls that, on Mer, imitation boar tusk ring pendants *sauad* were made from the *Trochus niloticus* shell *nasir* (see Plate 8.10). Men belonging to the sacred Bomai-Malu fraternity wore these body ornaments at the completion of initiation ceremonies (Haddon 1912:50). Although highly valued the boar tusk *sauad* had to be imported from New Guinea, and *Trochus* shell rings (*nasir sauad*) were thought to be an easier (and perhaps cheaper) alternative (Haddon 1912:51). Arm-rings made from *Trochus niloticus* shell were also sometimes fashioned in the Torres Strait (Haddon 1912:155). However, the *Conus* shell armlets mentioned previously were of significantly greater value throughout the region, and were highly prized units of exchange (Haddon 1912:56; Landtman 1943:43).

Incised Bone (IB1 and IB2)

Two bone artefacts were recovered from Sokoli: a hollow spatula shaped artefact with an incised design of a man's face (IB1) from Horizon II, and a small broken fragment of incised bone (IB2) from Horizon III (Plate 8.11).

IB1 is 7.8 cm in length and is made from a highly polished, dense bone. The spatulate end is broken and is approximately 4mm wider than the width of the hollow at the top of the artefact. The incised face has large eyes, a long and narrow nose with flared nostrils and an open mouth. The carving below the mouth may represent a goatie style beard. Above the eyes is a band of decoration with a diamond shaped centrepiece.

The broken half of IB2 reveals a very porous bone structure. It is unlikely that the bone was naturally hollow and is probably turtle. Measuring 2.2cm in length the fragment appears to be the highly polished top of an artefact that had a rounded surface. Although some incising is visible on the artefact no design is discernible. The deposition of IB1 occurred between 900 and 1400 cal BP, while IB2 was deposited slightly earlier between 1400 and 1650 cal BP.

The descriptions of a number of bone artefacts collected from Mer as part of the Cambridge Anthropological Expedition to Torres Strait resemble IB1 from Sokoli. One object in particular is described as 'cassowary leg bone with ground spatulate end and incised decoration (mostly incised chevron patterns)' (Cambridge 1999). This artefact is classified as a coconut husker imported from New Guinea. Plate 8.11 also illustrates two undecorated cassowary bone coconut huskers collected from Mer by Haddon (1912:127). Ethnographic records and museum collections testify to the practice of carving throughout the Torres Strait, with wood and bone being the favored materials. Bone in particular was fashioned and used as arrowheads and points, husking implements, pendants and musical instruments. On Mer, turtle bone, and less commonly fish bone, were predominantly used for the manufacture of such items.

Pottery (SOK1)

One pottery sherd was recovered from Horizon I at Sokoli (SOK1) (Plate 8.12). This represents the first pottery recovered from an *in situ* archaeological context in Torres Strait. The sherd is tan coloured, has a square rim and displays a small area of red slip on a smaller portion of its exterior surface. The surface of the sherd is very smooth and the fabric consists of a fine-grained clay. Using a standard rim chart the diameter of the vessel's orifice has been estimated at around 20cm. The slight curvature of the sherd suggests that it may have been a restricted vessel and not of bowl form. Recovered from the lower section of Horizon I, the artefact was deposited at the site approximately 700 cal BP.

Haddon (1912:122) claimed that in the Torres Strait 'pottery was entirely unknown, as was also the art of carving wooden vessels' and that ‘recourse had therefore to be had to natural receptacles, such as shells, coco-nuts, gourds and lengths of bamboo’. As discussed in Chapter 3, several historical references to pottery in Torres Strait have been identified (Macleay 1957:115; McFarlane 1874 in Vanderwal 1972a; Myres 1901). However, the context in which the vessels were observed suggests that their presence was the result of a heightening of trade and bartering activity in the region during the late 19th century, which may have been directed at missionaries and other foreign occupants. Similarly, the pottery sherds found on Booby Island (Coleman 1991; Cox and Watchman 2000) are also of unknown and dubious antiquity and provide no direct evidence of pre-European trade throughout Torres Strait.

Summary

The material culture assemblage excavated from Sokoli largely consists of artefacts that have a utilitarian function. These include a coral abrader and ground shell flake. The recovery of a pottery rim sherd suggests that the intact vessel to which it belonged may have been suitable for storage. However, in the absence of other pottery sherds belonging to the same vessel and ethnohistoric references on the use or importation of pottery in the Torres Strait, the function of the artefact remains unknown.

As outlined in Chapter 3 only a very small number of flaked stone artefacts have previously been recorded from archaeological contexts in Torres Strait. The majority of these are from the Western Islands of Mabuiag, Gabba and Dauan (Vanderwal 1973a), and from Badu (David et al. 2004). On the western side of Dauan a stone quarry was identified, with ‘a relatively coarse grained slate grey to green igneous rock’ (Vanderwal 1973a:182). During his six-month survey Vanderwal (1973a) identified several other stone artefact raw materials including a porphyritic microgranite, a finer-grained igneous rock and quartz. From the Badu 15 rockshelter, flaked stone artefacts of ‘mostly quartz and volcanic rocks’ were recovered (David et al. 2004). The artefacts are very small with the majority weighing less than one gram (although one artefact weighing

37.8g was recorded). From each of Mer and Dauar, where Vanderwal (1973a:184) also declared that ‘stone suitable for flaking does not occur’, a single stone artefact ‘made of the same microgranite as seen in the western high islands’ was identified.

Rhyolite and quartz are igneous rocks and are the dominant raw materials of the excavated flaked stone assemblage from Sokoli. Both raw materials are consistent with the general geological classifications of stone artefacts previously recorded in the Torres Strait. The porphyritic nature of basalt on Mer was described by Haddon et al. (1894:434). They also noted that many basalt blocks, bombs or flows tended to take on a lighter green-grey shade due to the various inclusions, such as feldspar, pumiceous dust and the orange-decomposition of many of the glassy fragments (Haddon et al. 1894:434-435). A similar porphyritic nature of granitic rocks on Dauan in the Western Islands was also identified by Haddon et al. (1894:462-463). Hornblende, plagioclase and magnetite were recorded as abundant inclusions and as the cause of the granular structure of the Dauan granite.

Based on the geological evidence therefore, it is interpreted that the undiagnostic flaked stone assemblage from Sokoli is manufacturing debris from stone sourced locally from the Murray Islands. Further to this point, Vanderwal’s (1973a) failure to identify differences in the igneous composition of stone artefacts from the Western and Eastern Islands may have been due to the similar porphyritic nature. In the context of the possible manufacture of stone items on the Murray Islands, the chronology and distribution of stone debris at Sokoli indicates that such activities took place on Dauar from around 2000 cal BP and had increased in regularity by 1400 cal BP.

The presence of *Trochus* ring fragments at Sokoli, although not directly informative as to site function, suggests that these ethnographically recorded artefacts have a considerable antiquity on the Murray Islands. Both the documentary and archaeological evidence indicates that the artefacts were items of local manufacture, and may have served an important function as a raw material substitute for imported boar tusk from New Guinea. The incised bone (IB1), although perhaps originating from New Guinea may also represent the skilled craftsmenship of a Torres Strait Islander. Based on the ethnohistorical records the probable function of IB1 was a coconut scraper. However, its distinct form also allows for the possibility that it may have been intended for use as a spatula to mix betel nut and lime. This was commonly chewed throughout New Guinea as a mild narcotic, although Haddon (1912:143) noted its absence in Torres Strait.

Ormi

From Ormi the second largest number of artefact types were recovered (Table 8.4). These consisted of stone debitage, modified stone, ground shell, metal and pottery.

	Stone debitage	Modified stone	Ground shell	Metal	Pottery
Horizon I 1600 - 1800	57	1	2	68	2
Horizon II 1800 - 1900	13	-	-	-	-
Horizon III 1900 - 2000	-	-	-	-	1
Horizon IV 2000 - 2250	17	-	-	-	19
Horizon V 2250 - 2600	6	1	-	-	1
Subtotal	93	2	2	68	23

Table 8.4 Artefacts assemblage excavated from Ormi

Stone Debitage

Distribution and raw materials

The stone debitage excavated form Ormi consisted of unretouched amorphous flaked pieces similar to the stone debitage recovered from Sokoli. As listed in Table 8.5, the Ormi stone assemblage comprised a total of 93 flaked pieces, almost 97% (n=90) of which are porphyritic rhyolite. The remaining flaked pieces comprise one quartz artefact and two creamy coloured silicious artefacts. Around 62% of rhyolite debitage are from Horizon I, indicating an increase in the quantity of stone deposited at Ormi around 1800 cal BP. The quartz artefact and one silicious flaked piece are from Horizon IV (2000 –2250 cal BP), while the remaining silicious artefact is also from Horizon I.

	n	Rhyolite debitage (gm)	n	Quartz debitage (gm)	n	Silicious debitage (gm)
Horizon 1600 – 1800 cal BP						
XU1	2	6.25	0	0	0	0
XU2	8	8.2	0	0	0	0
XU3	9	11.6	0	0	0	0
XU4	10	27.59	0	0	0	0
XU5	11	8.87	0	0	0	0
XU6	9	13.04	0	0	0	0
XU7	5	2.72	0	0	1	0.27
XU8	2	6.65	0	0	0	0
Subtotal	56	84.92	0	0	1	0.27
Horizon II 1800 – 1900 cal BP						
XU9	11	5.46	0	0	0	0
XU10	1	0.4	0	0	0	0
XU11	1	1.76	0	0	0	0
Subtotal	13	7.62	0	0	0	0
Horizon IV 2000 - 2250 cal BP						
XU17	3	4.02	0	0	0	0
XU18	1	0.33	0	0	0	0
XU19	7	3.29	0	0	0	0
XU20	3	1.18	1	2.42	0	0
XU21	1	0.32	0	0	1	1.9
Subtotal	15	9.14	1	2.42	1	1.9
Horizon V 2250 – 2600 cal BP						
XU22	2	1.17	0	0	0	0
XU23	2	1.67	0	0	0	0
XU24	2	0.61	0	0	0	0
Subtotal	6	3.45	0	0	0	0
Total	90	105.13	1	2.42	2	2.17

Table 8.5 Distribution of stone debitage at Ormi

Like the Sokoli stone assemblage, the porphyritic rhyolite artefacts recovered from Ormi vary in colour throughout the deposit from black to green-grey. They also consistently contain distinct orange coloured phenocyrsts of potassium feldspar. In contrast to Sokoli, however, around twice the number of stone debris was recovered at Ormi. The flaked pieces from Ormi are also slightly larger (predominantly <2cm long), with the average weight of flaked pieces from Ormi around two and half times the average weight of flaked pieces from Sokoli.

Approximately 22% of the stone debitage from Ormi was recovered in the lower section of the site dating between 2000 and 2600 cal BP (see Table 8.5). It is concluded, however, that due to the small size of these artefacts, the loosely consolidated nature of the sediment in this section of the site and the likelihood of post-deposition disturbance caused by SU11 and SU12, the stone debitage recovered in Horizon IV and Horizon V may not have been *in situ*. It is suggested that the stone debitage may not have been deposited at the site until after 2000 cal BP.

Modified Stone (MS1 and MS2)

From the excavation at Ormi two small stones, each with worn grooves around the circumference were recovered. The smaller irregular shaped artefact (MS1) comprises a light volcanic tuff (Plate 8.13), while the larger oval shaped artefact (MS2) consists a hard volcanic tuff (Plate 8.14). Both artefacts are likely to have been used as fishing sinkers, with string line tied along the groove to secure the item (Haddon 1912:155). The artefacts were deposited at the site approximately 1000 years apart, the larger artefact around 2600 cal BP and the smaller one around 1600 cal BP.

Ground Shell (GS3 and GS4)

Two ground shell artefacts were recovered from Ormi (GS3 and GS4) (Plate 8.15). Both have been fashioned into a scraper from the thick anterior portion of the columella lip of *Lambis lambis* shells and show edge grinding. They were recovered from the same XU in Horizon I and date to between 1600 and 1800 cal BP. The presence of these artefacts also supports the notion that the production of domestic items from shell, such as scrapers, may predate permanent European presence in the Torres Strait and the use of knives and other metal implements.

Metal

A total of 55.25 g of metal fragments was recovered at Ormi, with the majority of the remains (99%) excavated from the surface of the deposit in Horizon 1. The fragments are badly rusted and predominantly consist of small thin flat pieces, some with circular perforations. The metal pieces may be less than 100 years old, and could be the remains of building materials (ie. fasteners) used for the construction of the schoolhouse during the early 20th century. The material fragments are unlikely to pre-date the 1860s.

Pottery (ORM1 - ORM23)

A total of 23 pottery sherds were recovered from Ormi: two sherds in Horizon I, one in Horizon III, 19 in Horizon IV and one in Horizon V. None of the sherds is diagnostic and they are all small, ranging in size from 8.9mm (ORM20) to 33.5mm (ORM2). Based on a number of identified differences in sherd colour, thicknesses and fabric texture, several different types of vessels may be represented by the Ormi pottery assemblage (see Table 8.6 for details on the Ormi pottery sherds) (Figure 8.1, 8.2).

A total of 82% of the pottery sherds (ORM4 – ORM22) were recovered from the lower half of the deposit, suggesting that they were deposited before 2000 cal BP. However, due to the strong possibility of the downward movement of these small sherds post-deposition (much like the flaked stone artefacts recovered in the lower Horizons), the more likely time-frame for the deposition of the sherds is concluded to be post-2000 cal BP (further discussion on the chronology of excavated pottery assemblage from Ormi is provided in the following chapter).

Context	Sherd	Max. sherd size (mm)	Max. sherd Thickness (mm)	Exterior colour	Fabric (colour and texture)
Horizon I	ORM1	30.0	6.2	Dark brown, tan	Black, fine grained
	ORM2	29.5	5.5	Light brown/ orange	Light brown, fine grained
Horizon III	ORM3	27.1	8.75	Dark brown-black	Dark brown, coarse grained
Horizon IV	ORM4	15.6	3.6	Light brown-beige	Black, coarse grained with white inclusions
	ORM5	15.6	3.8	Light brown-beige	Black, coarse grained with white inclusions
	ORM6	15.5	2.45	Light brown-beige	Light brown, coarse grained with white inclusions
	ORM7	23.2	4.8	Brown-orange	Dark brown, coarse grained with white inclusions
	ORM8	18.7	4.25	Light brown-orange	Light brown-yellow, fine grained with white inclusions
	ORM9	10.2	3.75	Light brown	Brown, smooth grained with white inclusions
	ORM10	11.2	2.25	Light brown-orange	Dark brown, coarse grained with white inclusions
	ORM11	14.0	2.9	Light brown	Brown, smooth grained with white inclusions
	ORM12	12.0	3.8	Light orange	Light orange, smooth grained
	ORM13	17.5	5.5	Black with brown slip	Light tan-coarse grained, with few white inclusions
	ORM14	14.0	6.01	Black with brown slip	Light tan-coarse grained, with few white inclusions
	ORM15	19.0	4.75	Black with brown slip	Light tan-coarse grained, with few white inclusions
	ORM16	9.7	4.5	Black with brown slip	Light tan-coarse grained, with few white inclusions
	ORM17	20.0	4.0	Orange	Light brown-yellow, coarse grained
	ORM18	18.3	2.45	Dark brown-black	Black, coarse grained
	ORM19	14.2	2.25	Dark brown-black	Black, coarse grained
	ORM20	8.9	2.4	Light tan	Light tan
	ORM21	10.5	2.2	Light brown-black	Light brown, fine grained with few white inclusions
	ORM22	9.5	2.7	Black with brown slip	Light brown-black, fine grained
Horizon V	ORM23	13.2	5.5	Light grey	Light grey-black, coarse grained with few white inclusions

Table 8.6 Ormi pottery sherds morphology

In spite of the likely disturbance to the site, however, the nature of the pottery assemblage suggests that within the period of 2000 – 1600 cal BP, small and fragile vessels may have given way to larger and more robust ones.

Summary

The artefact types recovered from Ormi are predominantly utilitarian or domestic items. These include stone fishing sinkers and shell scrapers. As indicated earlier in the context of the pottery sherd from Sokoli, the function of the pottery deposited at Ormi is also unknown. The majority of the pottery sherds, consisting of very small, thin pieces, were most likely deposited between 2000 and 1800 cal BP. The distribution of stone debitage illustrates that the majority of flaked pieces were also deposited in the upper section of the deposit, although slightly later between 1800 and 1600 cal BP. The distribution and chronology of the Ormi stone assemblage confirms the possible manufacture of stone items on Dauar from as early as 2000 cal BP and an increase in the frequency of this activity between 1800 and 1400 cal BP.

As described in detail in Chapter 6, the density of shell and bone at Ormi significantly increased in the upper half of the excavation after 2000 cal BP. The rate of sediment accumulation at the site had also increased by this time and was greatest in Horizon II dating from 1900 – 1800 cal BP. This evidence combined with the distribution of stone debitage and pottery sherds as the most abundant artefact types recovered from Ormi, suggest that intensity of site use increased, particularly from 2000 cal BP.

Due to their small size, post-deposition disturbance has been established as the likely reason for the recovery of the small pottery sherds and stone debitage in the lower two Horizons of Ormi dating between 2000 and 2600 cal BP. The only other material culture item recovered from the lower deposit (XU25) was the stone fishing sinker (MS1). The sinker is small and heavy, and like the pottery sherds and flaked stone artefacts, may have also moved down through the lower Horizons post-deposition. However, the recovery of a coral fishing sinker from Horizon V at Sokoli dating from 2600 - 1800 cal BP, suggests that MS1 from Ormi may have been recovered *in situ*. The antiquity of the artefact may therefore be in the order of 2600 cal BP, dating from the time of initial site occupation. This suggests that marine subsistence technologies were used on Dauar from the time of settlement; an hypothesis also supported by the quantity of fish bone recovered from the basal units at both the Ormi and Sokoli sites (Chapter 6).

Zomar – A Surface Pottery Find (MER1/MER2)

In 2000 during the second field season on the Murray Islands a further two pottery sherds were brought to my attention. During the construction of two telecommunication towers at Zomar on Mer in 1998, the two sherds were noticed and collected by a local resident. The site of Zomar is located in the high interior of Mer at the northeastern end of Gelam (see Figure 4.1). There is no information on the exact location and provenience of the artefacts.

The two sherds (MER1/MER2) are much larger than the excavated sherds from Dauar and appear to be of an entirely different vessel form, being considerably thicker and made from a very coarse-grained fabric. The smaller sherd (MER1) also has decoration, but which has been quite badly eroded (Figure 8.3). Of the entire Murray Islands pottery assemblage, this is the only sherd to display incised decoration.

Discussion

Perhaps the most outstanding feature of the Murray Islands material culture assemblage is the small number of artefacts recovered. This raises a number of issues, including the nature of the sites themselves and the intensity of site use and occupation. These are addressed below in a discussion of chronological trends, and the evidence for subsistence, trade and exchange, and variability in site use.

Chronological Trends

Stone artefacts cover three categories including stone debitage, modified stone and a stone abrader. Debitage is the most abundant stone artefact type and was recovered from Sokoli and Ormi on Dauar. Comprising only small, unretouched flaked pieces, the highest frequency of stone debitage at both sites occurs after 2000 cal BP. The dominant raw material is a locally sourced porphyritic rhyolite, although several artefacts of quartz and amphorous silica occur between approximately 2000 and 1500 cal BP. Stone sinkers and a stone abrader comprised the remaining stone artefact types; these range in date from 2600 to 520 cal BP. This chronology suggests the long-term use of stone for a variety of domestic and subsistence related purposes on the Murray Islands.

The most common type of shell tool is the scraper, which appears to have been used from approximately 1800 - 775 cal BP. The artefacts have been made from several species including the gastropods *Lambis lambis* and *Conus* spp. and from the giant clam *Tridacna gigas*. The absence of ethnohistoric references to these types of shell scrapers suggest that by the historic period they may have been replaced by the whole valve scrapers and/or by the metal equivalents commonly recorded during the early 20th century (Haddon 1912:124). The two *Trochus* ring fragments from Sokoli comprise the other shell artefact type, dating to between 2600 and 1650 cal BP. Coral artefacts consisted of coral fishing sinkers and a coral abrader, dating from between 2600 and 315 cal BP. The time-frame of these artefacts suggests the presence of a diversity of artefacts on the Murray Islands dating from the time of initial occupation to the past.

Evidence for Subsistence

Of the artefact types recovered from the Murray Islands excavations, fishing sinkers are the only item interpreted as unequivocally being related to subsistence activities. A total of six fishing sinkers were identified, with two each from Ormi, Sokoli and Kurkur Weid. These were made from both stone and coral and all exhibit a grooved line around their circumference. The artefacts have a broad antiquity ranging from the time of occupation of Dauar at 2600 cal BP to the more recent date of 520 cal BP at Kurkur Weid. This evidence in turn indicates that fishing by the method of line and sinker was a widespread maritime subsistence activity throughout the prehistoric occupation on Mer and Dauar. In contrast, artefactual evidence in support of the horticultural subsistence practices was virtually absent from the material culture assemblages.

Evidence for Trade and Exchange

The next chapter details the results of mineralogical analysis of several of the pottery sherds, which demonstrate that the artefacts were manufactured in New Guinea. The ethnographic record provides no evidence for pottery manufacture within Torres Strait, or of its importation from New Guinea as a traditional item of exchange. The recovery of pottery sherds on the Murray Islands, therefore, demonstrates two things. Firstly, that pottery was a commodity of trade and exchange between Torres Strait and New Guinea, even though the archaeological evidence indicates that it was probably not regularly or intensively exchanged. Secondly, both the distribution and quantity of the archaeological pottery assemblage indicates that trade in earthenware may have ceased by the late 19th century, which also is supported by the absence of pottery in the ethnographic networks of trade recorded between Torres Strait and New Guinea. Although spanning 1300 years, the distribution of the excavated sherds indicates that the majority of the artefacts were deposited around 2000 cal BP, with deposition rates declining significantly shortly afterwards.

The interpretation that the stone debris excavated from the Dauar sites provide evidence of stone artefact manufacture, such as *gabagaba*, also holds implications for trade and exchange on the Murray Islands. Firstly, this scenario supports the results of McNiven's (1998) investigations, where it was demonstrated that the Torres Strait Islands were the main source of raw material for *gabagaba* manufacture, and not southern Papua as recorded in the ethnographic literature. Secondly, the presence of stone debitage on Dauar from 2000 cal BP suggests the possibility that the production, and possibly the exchange, of such items in Torres Strait has considerable prehistoric time-depth.

Furthermore, the distribution of the excavated stone debris on Dauar also indicates that stone artefact manufacture may have increased between 1400 and 1800 cal BP. The suspected increase in stone artefact manufacture may represent an intensification of trade and exchange systems in which the Murray Islands may have contributed one of the region's most sought after items. The results of mineralogical analyses of large stone axes found in the southern Papuan lowlands and particularly on Kiwai Island conducted by McNiven et al. (2004:282), has confirmed that similar to *gabagaba*, 'most of Kiwai axes (including the Kiwai 'type' axes) were made from stone quarried in Torres Strait'. The majority of the analysed axes were made from raw material in the Western Islands and particularly Badu and Moa. Although none of the stone axes were sourced to the Eastern Islands, the extensive bedrock panels of grinding grooves on Mer strongly suggests the possibility of past stone artefact manufacture on the Murray Islands.

Other possible evidence of trade and exchange on the Murray Islands are the items of incised bone recovered from Sokoli. Although species identification of the bones might assist in confirming their place of origin, given the dense nature of the larger artefact (IB1), and the ethnographic references to cassowary bone scrapers imported from New Guinea, this artefact may represent an item of exchange. At this stage of analysis, however, there is no evidence to refute the possibility that the incising of the artefacts themselves may have occurred in the Torres Strait and indeed possibly by a Murray Islander. The deposition of the artefacts sometime between 1650 and 900 cal BP suggests that both the artefacts may have been part of the same trade and exchange system that brought the ceramics.

Evidence for Site Function

Overall there is a considerable degree of variability in the compositional qualities of the material culture assemblage from the four Murray Island sites. Sokoli contained the highest number of artefact types including utilitarian items (stone debitage, shell scraper, coral abrader), subsistence items (fishing sinkers), ornamental items (incised bones, *Trochus* rings) and pottery. Although Ormi contained considerably fewer artefact types, including undiagnositic stone, fishing sinkers, shell scrapers, metal and pottery, the densities of stone debitage and pottery sherds in this deposit were in comparison considerably higher.

Previous chapters have illustrated a decrease in density of marine subsistence remains at Sokoli particularly from 1650 cal BP, and a dramatic decrease in the rate of sediment accumulation from 2000 cal BP. This is attributed to a possible shift to horticultural subsistence activities at Sokoli from 2000 cal BP. However, the excavated material culture assemblages from Sokoli and Ormi provide no evidence in support of the emergence of the horticultural economy on Dauar. As mentioned above the only significant difference in the nature of the excavated material culture assemblages from Dauar is a greater quantity of stone debris recovered from Ormi. Interestingly, the recovery of less stone debris at Sokoli is consistent with its known status as a former garden area. In this context the higher density of marine subsistence remains at Ormi (Chapter 6) suggests that at this site the horticultural subsistence economy may have been peripheral to its use. Therefore the presence of a larger quantity of stone debris at Ormi may be more consistent with generalised site use, which unlike Sokoli, was orientated more towards marine subsistence and domestic or technological tool production.

The number and nature of artefacts recovered from Kurkur Weid and particularly Pitkik on Mer are distinct from the Dauar material culture assemblages. At Pitkik the recovery of a single artefact (shell scraper) confirmed the earlier interpretation that the deposit had not formed *in situ*, but was comprised of colluvium and archaeological remains that originated from the slope above the site. The artefacts recovered from Kurkur Weid reflect the nature of the site as a rockshelter used not only for the processing of marine subsistence remains, but also for the possible preparation or storage of items used for the procurement of marine resources. The relatively low density of material culture items recovered from Kurkur Weid further confirms the temporary nature of occupation and use of the site, as demonstrated by the densities of both marine invertebrate and vertebrate remains.

Conclusions

This chapter has described the first archaeological material culture assemblages from the Murray Islands and the Torres Strait more generally. These assemblages have provided the unique opportunity to examine the archaeological time-depth of ethnographically recorded artefacts, such as fishing sinkers and *Trochus* rings, but also of several items historically and archaeologically unknown for the region, including pottery and intricately incised bone. For Kurkur Weid the nature, distribution and chronology of the excavated artefacts adequately informed on site function. For Sokoli and Ormi on Dauar, although a similar limited range of artefacts were recovered, the nature of stone debris indicate a possible difference in site use associated with subsistence.

Evidence for trade and exchange on the Murray Islands was significantly more recognisable from the material culture assemblages. The excavated lithic debris are tentatively interpreted as evidence for stone artefact manufacture, which is indirectly supported by the presence of grinding grooves on the Murray Islands, as well as new evidence which has demonstrated the Eastern Islands as a raw material source for stone club-heads. The estimated time-depth for the production of such items on Dauar is at least 2000 years, extending the antiquity of these well-documented items until well before the late 19th century ethnohistoric period. The incised bone artefact represents an item that probably originated in New Guinea, as did the excavated pottery sherds, which represent the first pottery recovered from *in situ* archaeological contexts in Torres Strait. With an estimated antiquity of around 2000 years, these artefacts allow new insight into the antiquity of trade and exchange networks between Torres Strait and New Guinea. The origin of the Murray Islands pottery sherds and the trading networks from which they originated is explored in greater detail in Chapter 9.

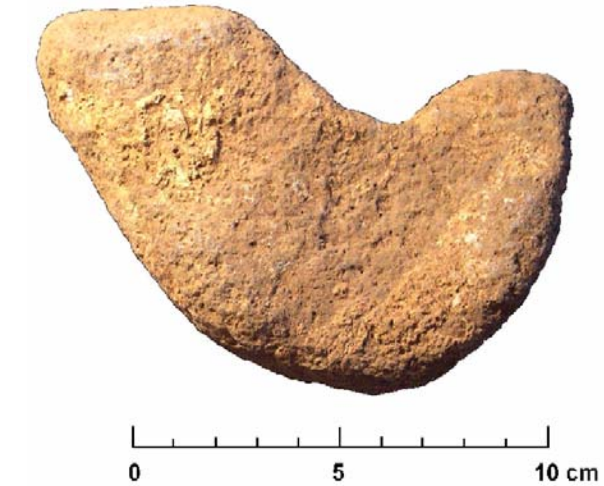

Plate 8.1 Stone abrader (SA1) from Kurkur Weid

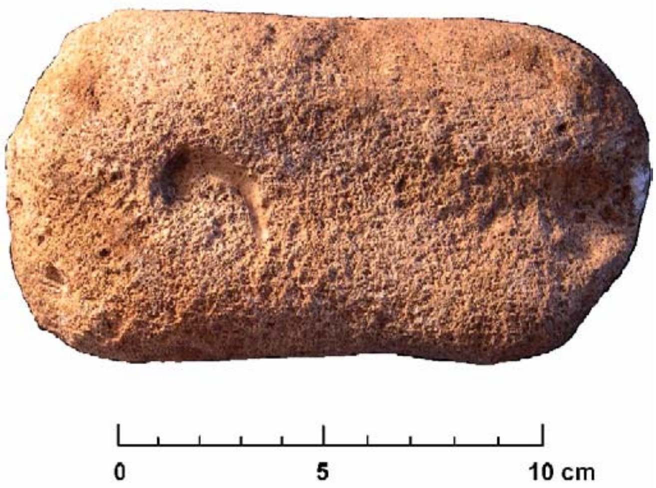

Plate 8.2 Coral fishing sinker (MC1) from Kurkur Weid

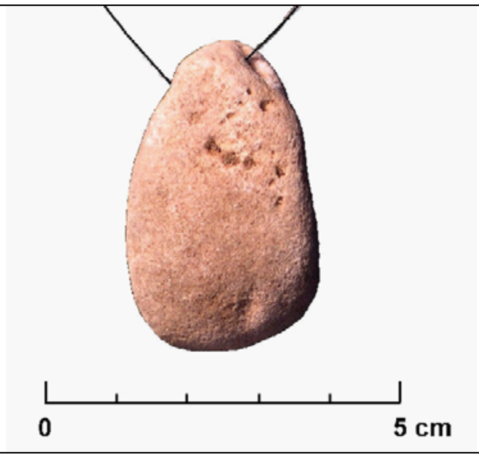

Plate 8.3 Coral fishing sinker (MC2) from Kurkur Weid

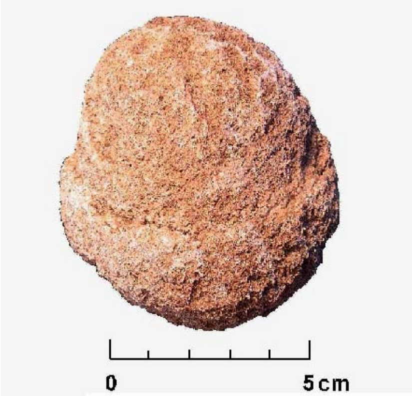

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Plate 8.4 Coral fishing (MC3) sinker from Kurkur Weid (left), compared with ethnographic sample (right) (Haddon 1912:155)

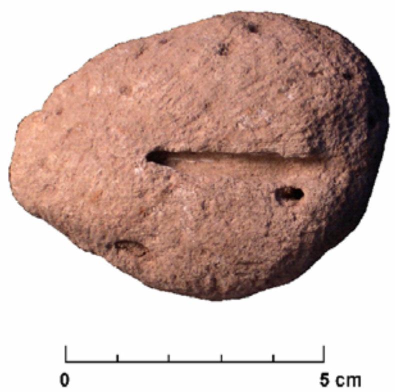

Plate 8.5 Coral fishing sinker (MC4) from Sokoli

Plate 8.6 Coral fishing sinker (MC5) from Sokoli

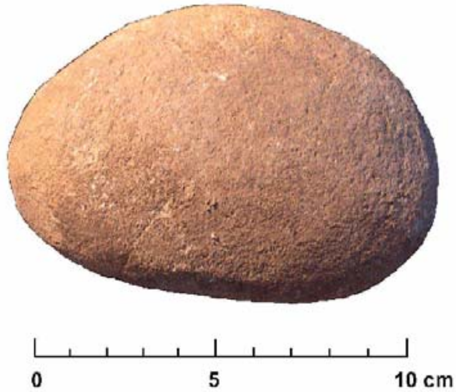

Plate 8.7 Coral abrader (CA1) from Sokoli

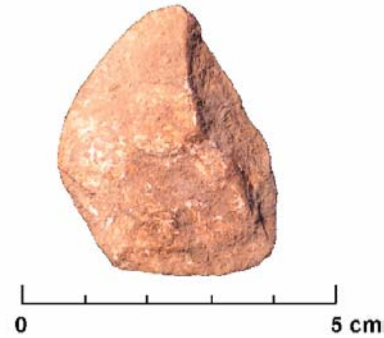

Plate 8.8 *Conus* sp. ground shell scraper (GS1) from Pitkik

Plate 8.9 *Tridacna* sp. (?) ground shell (GS2) from Sokoli

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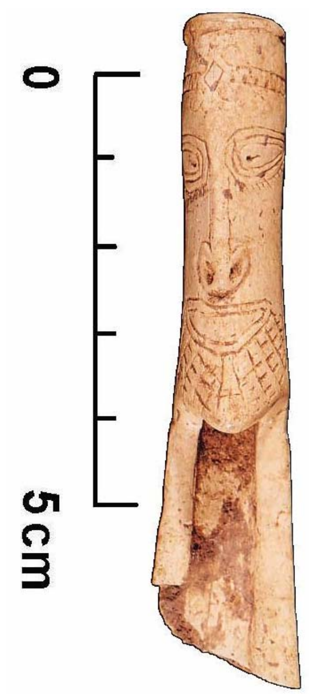
Plate 8.10 *Trochus* ring fragments (left TR1, right, TR2) from Sokoli (left), with ethnographic example of *nasir sauad* Trochus ring (Haddon 1912: Plate 7 Fig 5)



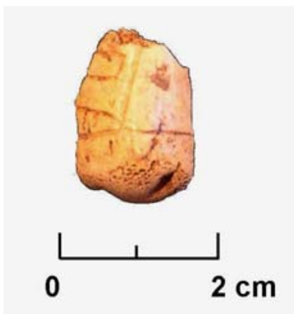


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Plate 8.11 Incised bone husker (?) (left, IB1) and fragment of incised bone (centre, IB2) from Sokoli, with (right) ethnographic illustration of cassowary bone coconut huskers imported from New Guinea (Haddon 1912:127)

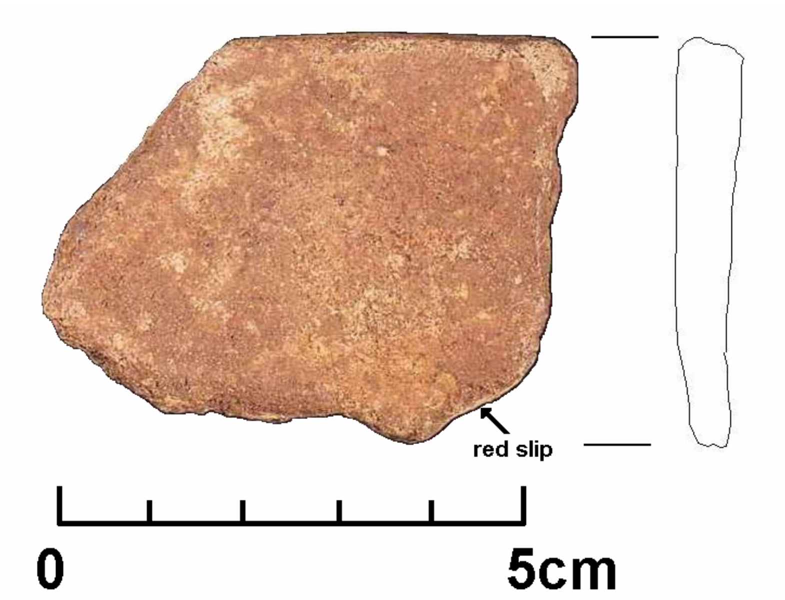

Plate 8.12 Pottery sherd (SOK1) from Sokoli

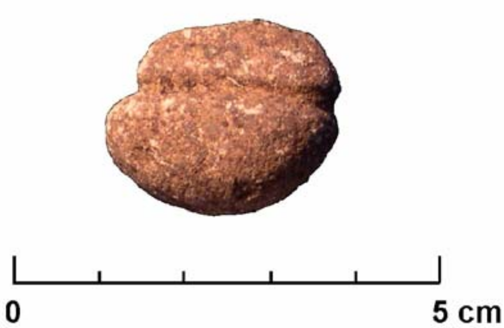

Plate 8.13 Stone fishing sinker (MS1) from Ormi

Plate 8.14 Stone fishing sinker (MS2) from Ormi

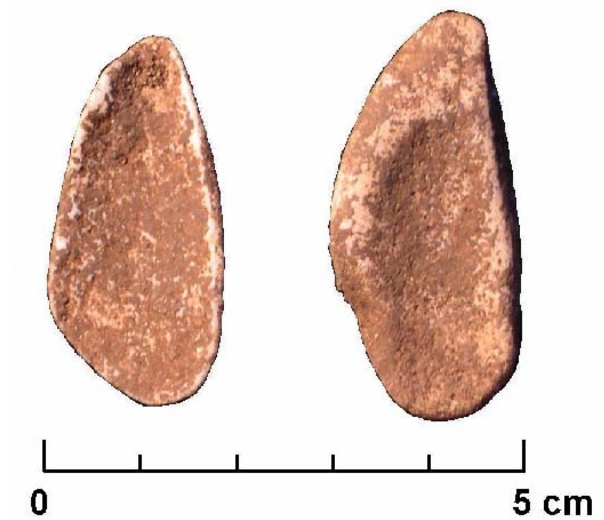

Plate 8.15 *Lambis lambis* ground edge scrapers (GS3 and GS4) from Ormi

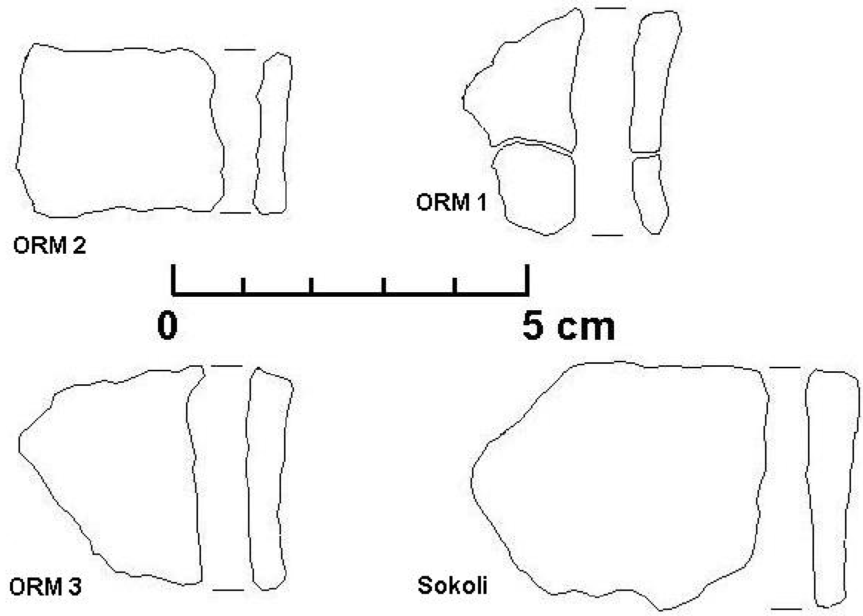

Figure 8.1 Large pottery sherds from Ormi and Sokoli

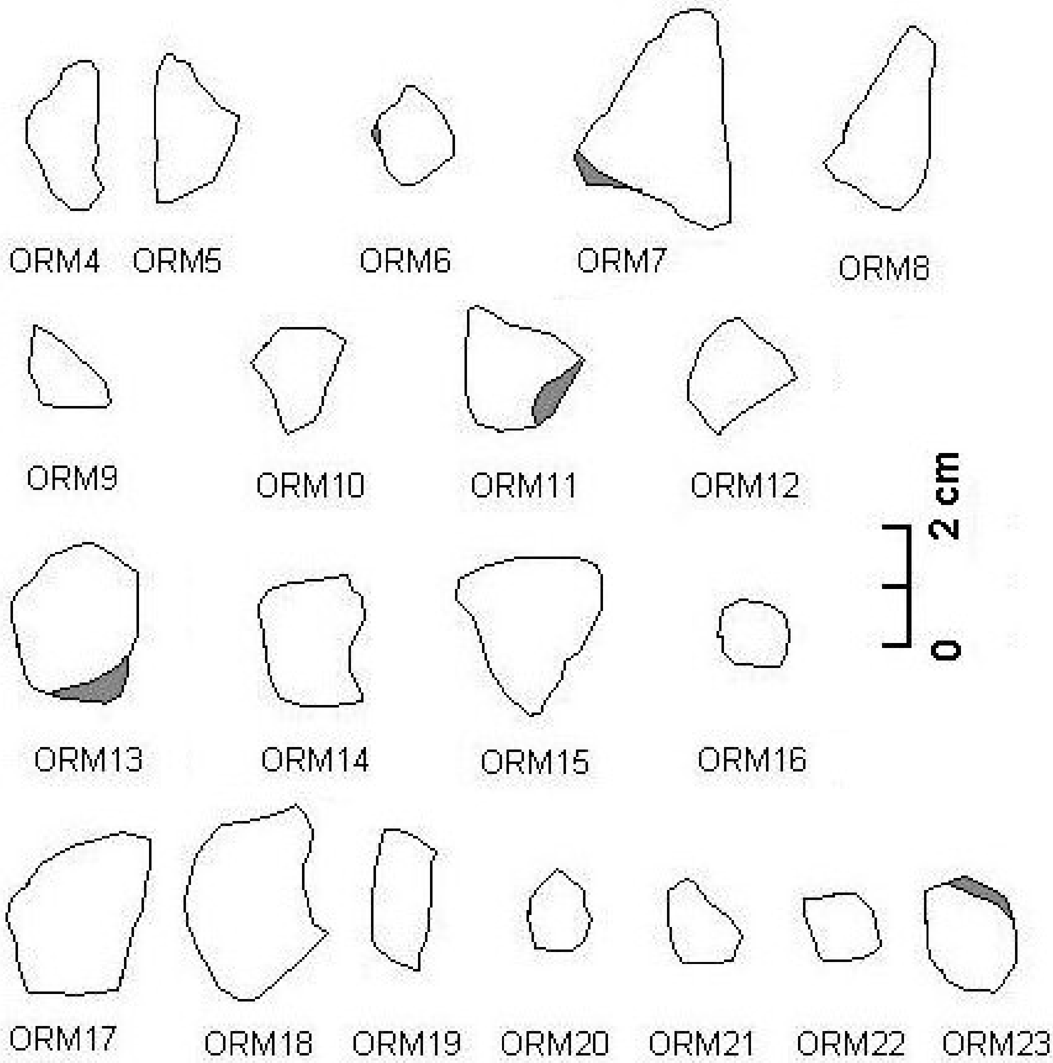

Figure 8.2 Small pottery sherds from Ormi

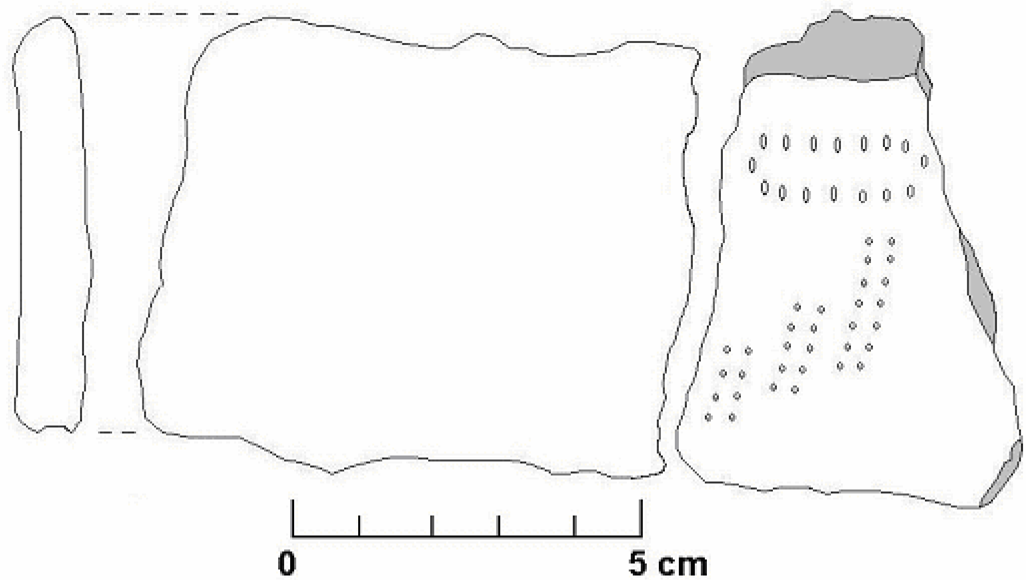

Figure 8.3 Pottery sherds (left MER2, right MER1) from disturbed area at Zomar

Chapter 9: Results of Analyses of the Murray Islands Pottery

To date, the picture of trade and exchange in Torres Strait has been largely developed from the ethnohistorical record and to a lesser degree from oral histories (Lawrence 1989, 1991, 1994; Moore 1984). While our knowledge of the subject is considerable, what has been lacking is an understanding of the pre-European trade systems as well as the chronological framework for their emergence and development. This is because of the absence of any archaeological evidence from Torres Strait that could provide data on such systems. The recovery of pottery sherds from the Murray Islands provides new opportunities to investigate the nature of trade and exchange in Torres Strait. Through mineralogical analyses of these artefacts the recovery of information about their origin and manufacture is possible. Combined with the results of radiocarbon dating, this information provides a unique opportunity to extend the time-depth of trade and exchange on the Murray Islands and to characterise the geographical setting in which it operated.

Pottery in Archaeology

Earthenware pottery is often a characteristic artefact type recovered from late Holocene archaeological sites in the western Pacific. Consequently the archaeological analysis of pottery has played a significant role in defining and explaining systems and networks of local and regional pottery production, distribution and exchange (for example, Ambrose 1992; Bedford and Clark 2001; Dickinson and Shutler 1968, 1971; Hunt 1988; Neff et al. 1988; Summerhayes and Walker 1982; Summerhayes 2000). Until the recent recovery of several *in situ* pottery sherds on the Murray Islands, such an opportunity had never presented itself in Torres Strait.

Analyses of archaeological ceramics often include a detailed examination or classification of the assemblage based on diagnostic morphological charcteristics (Frankel and Rhoads 1994; Green 1990; Summerhayes 2000; Wickler 2001). These features include vessel form, fabric type, colour, thickness, styles and patterns of decoration, and features discernible from rim fragments such as vessel form. Morphological analyses of ceramic assemblages often produce statistical profiles enabling the identification of temporal and spatial patterns in ceramic distribution and exchange.

The majority of studies of Oceanic pottery, however, have utilised chemical sourcing analysis as a means to determine patterns of trade, exchange and distribution (Clough 1992:177). Rye (1976:106) suggests that an important advantage of this technique is that it provides an opportunity to assess the relationship between the potter and his or her environment, as 'each pottery vessel reflects decisions made about materials and techniques as well as cultural choices, and thus represents a combination of many variables which may be useful in archaeological interpretation'. The chemical or mineralogical classification of pottery may also offer a much more informative analytical procedure in the event of the recovery of a pottery assemblage insufficient in size to support a morphological analysis.

The major aim of mineralogical analyses is to characterise the geo-chemical attributes of the mineral inclusions that are often added to potting clay as temper. Tempering is defined in the archaeological literature as the mixing of additives, such as sand, with clay to improve its workability and strength, thus:

> By noting the type, size and shape of mineral inclusions in the pottery sherds, it is possible to deduce the geological origins of the inclusions, … and often to then pinpoint the specific location of the source of the pottery materials (Rye 1976:107).

However, Hunt (1993:52) has identified two limitations of the petrographic analysis of temper; the first being the presumption of the inclusion of non-clay materials in the first place, and secondly, in relation to determining ceramic provenance, the need for pre-existing data on the geology and geologic variability of a region. Where such knowledge exists, however, as in the case of the Pacific Islands, Dickinson and Shutler (1971:192) affirm that:

> With adequate data, the temper sands in sherds collected from an archaeological site can be classed as indigenous or exotic to the island, to the island group, or the tectonic province where the site is located.

The identification of 'exotic' pottery temper, however, does not necessarily imply the importation of pottery, as the clay itself may have been procured locally. Ambrose (1992:170) notes that in Melanesia clay is often acquired from particular localities as a reflection of the high value potters can place on raw materials. He suggests that sand fillers on the other hand, are gathered locally from beaches or streams 'without the same degree of selection given to clays' (Ambrose 1992:170). Nonetheless, if the origin of exotic pottery tempers can be established, 'some knowledge of actual paths of trade or migration can be gained' (Dickinson and Shutler 1971:192). This has been demonstrated for a number of pottery assemblages from the Pacific (Dickinson 1969, 1971; Dickinson and Shutler 1971, 2000).

A number of techniques are used to chemically characterise pottery clay, including X-ray spectrometry, energy dispersive X-ray (EDS) microanalysis and microprobe (SEM) and proton-induced X-ray emission (PIXE). Hunt (1993:52) suggests that an advantage of these techniques is the production of data useful in multivariate characterisation of different sources of clay, and suggests that 'differences in compositional groups imply a probable number of clay sources/production locales, even if the specific source of the clay remains unknown'. Before providing the details about the techniques used in the analysis of the Murray Islands pottery sherds, a description and illustration of each of the artefacts is provided.

The Murray Islands Pottery Sherds: Descriptions, Analysis and Results

The pottery sherd excavated from Sokoli in 1998 was returned to the traditional landowner of the site upon returning to Mer for the 2000 field season. It was under this condition that permission to take the artefact from the island in 1998 was granted. As a result this sherd was not included in the mineralogical analyses program of the Murray Islands pottery, as this was initiated only after the recovery of the pottery sherds during the 2000 field season on Dauar. The pottery sherds that were included in the analysis program consisted of ORM1, ORM2, ORM3 and MER2.

Sherds ORM1, ORM2 and ORM3

Although a total of 23 pottery sherds were recovered from the excavation at Ormi (as detailed in the previous chapter), due to funding constraints and the preliminary nature of this investigation, only the three larger sherds were selected for mineralogical analysis.

Sherds ORM1 and ORM2 are small and are slightly different in colour with smooth surfaces (Plate 9.1). ORM1 has a maximum thickness of 6.2mm while ORM2 has a maximum thickness of 5.5mm. Sherd ORM3 is more robust with a maximum thickness of 8.75mm and is blackened on its outer surface, which may be the result of either use of the vessel or *in situ* burning of the archaeological deposit. Based on physical attributes of colour, thickness and texture of their clay fabric, each of the Ormi sherds appear to be distinct, which suggests that they may represent different pottery vessels.

Sherds MER1/MER2

Sherds MER1/MER2 are very different from the sherds recovered from the excavations on Dauar (Plate 9.1). The fragments conjoin to form a single large sherd measuring 11cm x 5.63cm, almost three times the size of the excavated sherds. Sherds MER1/MER2 are dark red in colour and are also very robust, with both having a maximum thickness of 10.5 mm. Their surface is rough, with very coarse-grained mineral inclusions visible to the naked eye. The large size and slight curvature of the sherds suggests that they formed part of a vessel of considerable size. The most significant feature of the sherds, however, is the distinctive but weathered dentate decoration on the upper section of sherd MER1. Due to the lack of archaeological excavation at the Zomar site, no dates for sherds MER1/MER2 are available. As it did not display decoration, the larger sherd (MER2) was thin sectioned and subject to mineralogical analyses.

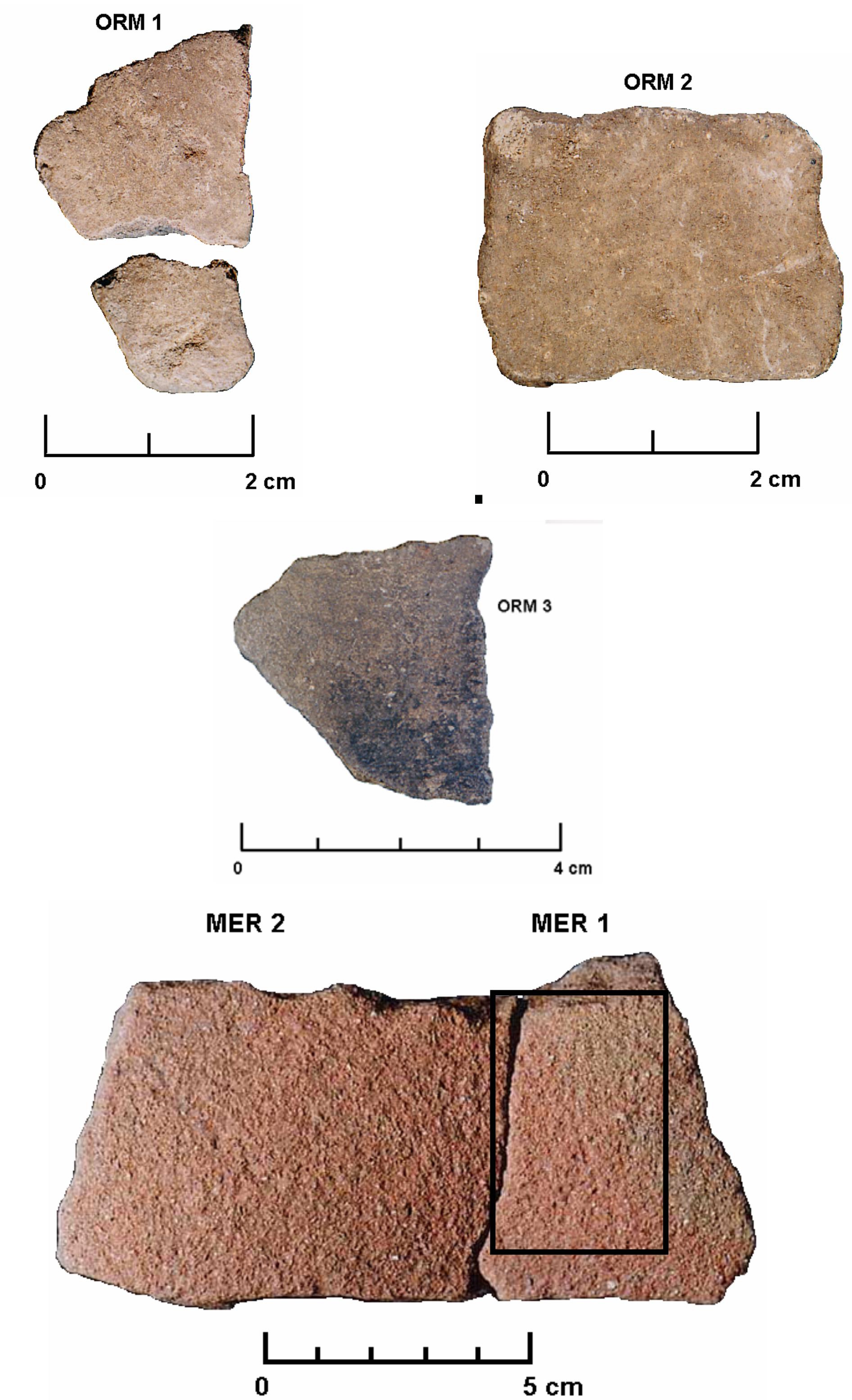

Plate 9.1 Analysed Murray Islands pottery sherds

Methods and Methodology of Analyses

Owing to the small size of the Murray Islands pottery assemblage and its lack of diagnostic morphological features, it was concluded that a chemical analysis of the sherds offered the most useful and informative analytical technique in determining possible sourcing characteristics. First thin sections of each of the sherds were prepared. Dr Mike Rubenac from the Department of Earth Sciences, James Cook University initially undertook chemical analysis of the temper sands using EDS and SEM. Rock fragments and individual minerals were identified by examination under a polarising microscope, while the elemental composition of selected minerals was determined using an electron microprobe. Colour photographs of the minerals were taken using a Leica DMXRP photomicroscope.

Emeritus Professor William Dickinson of the Department of Geology at the University of Arizona undertook a secondary analysis of the pottery thin-sections. Dickinson is perhaps the world's foremost expert on the analysis of Oceanic temper mineralogy. He conducted a petrographic analysis of the temper inclusions in the pottery sherds through microscopic examination of the thin sections. Features of the sedimentology and general character of the temper sands were recorded, and quantitative counts of grain types in sherds ORM2 and MER2 was undertaken.

The principal aim of the analysis of the Murray Islands pottery sherds was to determine their probable place of manufacture, in order to investigate whether they were commodities in pre-European trade and exchange in Torres Strait. Although an examination of the pottery clay was not possible, the charactersation of the temper sands was sufficient to demonstrate pre-European links between Torres Strait and New Guinea.

Results and Hypotheses

A summary of the results of the mineralogical analyses undertaken by Rubenac is provided in Table 9.1. His analysis revealed that the mineralogy of temper sands in each of the sherds derived from both igneous and metamorphic sources, and identifies the presence of a number of minerals including hornblende, pyroxene, feldspar, muscovite, quartzite and olivine (see Appendix K for photographs of mineral inclusions). Elemental analysis of feldspars in each of the thin sections revealed the presence of a suite of rock types including plagioclase, calcalkaline and shoshonitic feldspars (Figure 9.1). Each of these types are commonly associated with the geology of the late Cenozoic volcanoes distributed throughout the western Pacific, including the large stratovolcanoes of the New Guinea Highlands (Johnson et al. 1973; Mackenzie and Chappell 1972) (Figure 9.2). The elemental composition of pyroxenes in the pottery sherds also demonstrated similarities to pyroxenes from volcanic rocks in the Highlands (Figure 9.3).

Sherd	Mineral	Origin	Features of Mineralogical Composition
ORM1, ORM2, ORM3, MER2	Hornblende	Igneous	- singular crystals of brown hornblende derived from phenocrysts - variability in TiO2, FeO, MgO and Al203
ORM1, ORM2, ORM3, MER2	Pyroxene	Igneous	- dominance of clinopyroxene, identification of only one orthopyroxene (MER2) - range of composition charcteristic of a calcalkaline volcanic suite
ORM1, ORM2, ORM3, MER2	Feldspar	Igneous	- presence of high K plagioclase feldspars, probably derived from crystallisation from high K magmas - single outlier feldspar (ORM1) derived from granite in metamorphic basement
MER2	Muscovite	Metamorphic	- muscovite-quartz-epidote schist typical of greenschist facies

Table 9.1. Summary of microprobe analyses on selected minerals in pottery sherds undertaken by Rubenac

The volcanoes of the New Guinea Highlands rest on a folded sequence of sedimentary rocks that overlie a late Paleozoic granitic and metamorphic basement. Petrographically, these volcanoes comprise a calcalkaline volcanic suite, containing rocks relatively rich in calcium, with a predominance of acid rocks. According to Mackenzie and Chappell (1972:60-61) the mixed shoshonitic and calc-alkaline chemistry of the Highlands volcanics is the result of a combination of factors, including minor low-pressure crystal fractionation involving olivine, clinopyroxene, and to a lesser extent, calcic plagioclase, producing some enrichment in iron, silica, sodium and potassium in the shoshonites. The variation in the content of potassium and other 'incompatible elements' may also either be inherited from the source rocks in the base of the crust, or as the basaltic melt passes upward through the mantle containing interstitial melt rich in these elements. This process may also account for the presence of the metamorphic detritus identified in the sherds, including slate, schist and muscovite, which may have originated from the underlying Paleozoic basement.

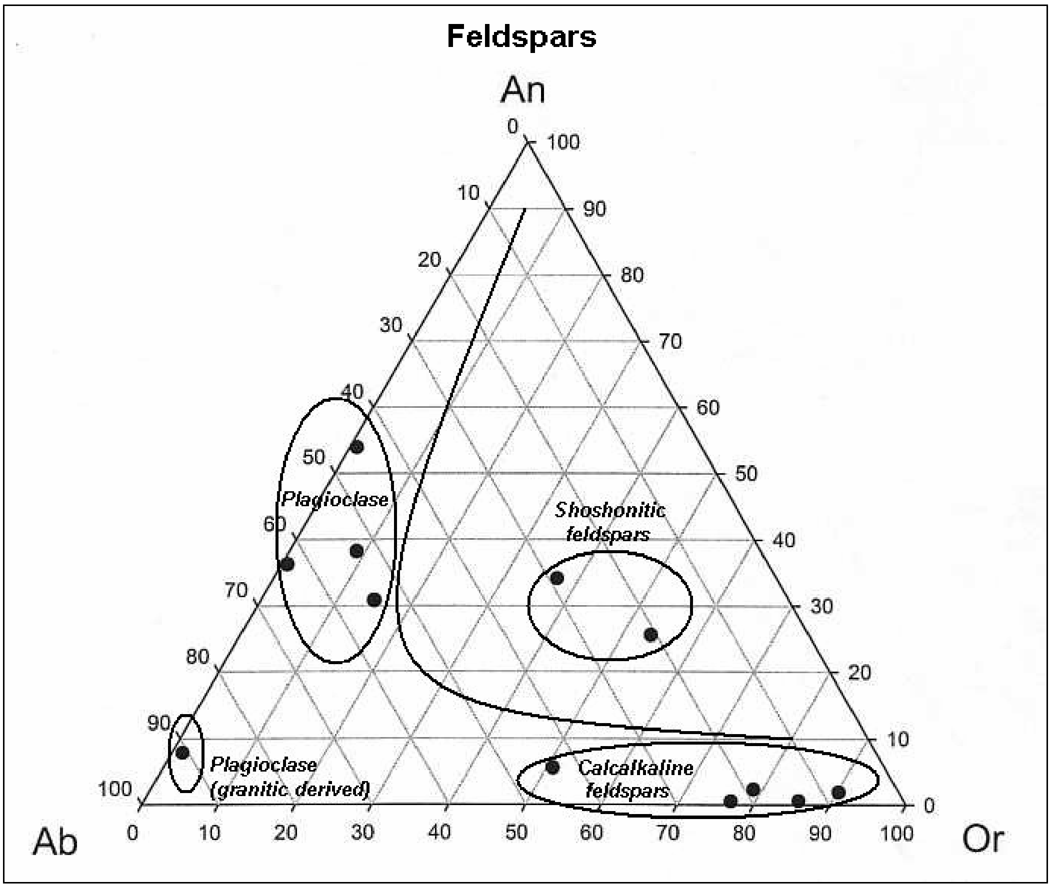

Figure 9.1: Compositional variation of feldspars in Murray Islands pottery

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Figure 9.2 Map showing distribution of late Cenozoic volcanoes throughout the western Pacific (after Johnson et al. 1973:125)

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Figure 9.3 Pyroxenes from pottery showing elemental consistencies with New Guinea Highlands volcanic signatures (after Mackenzie and Johnson 1984)

The mineralogical data described above leads to preliminary speculation that the source of the Murray Islands pottery temper may have originated in the vicinity of the New Guinea Highlands. As the ethnohisotorical record for Torres Strait discussed in Chapter 2 failed to document any direct contact between the eastern Torres Strait islands and the interior communities of New Guinea, two hypotheses were formulated to explain the mineralogy of the pottery sherds:

1. Although ultimately originating from the New Guinea Highlands, stream sands comprising variable volcanic and metamorphic detritus present in the Murray Islands pottery flowed to more southern lowland coastal reaches where the manufacture of the pottery and its distribution to the eastern Torres Strait occurred.

2. Alternatively, pottery was manufactured in the area of the New Guinea Highlands at the temper source, and was subsequently transported from this region to the Eastern Torres Strait.

Dickinson's secondary analysis of the pottery thin sections confirmed the general volcanic and metamorphic mineralogy of the pottery, but revealed that the sherds comprised two basic groups (ORM2 and MER2, and ORM1 and ORM3) based on the variability of mineralogy and the sedimentology of the temper sands (Table 9.2). Dickinson's report on the results of the petrographic analyses of the Murray Islands sherds is provided in Appendix L, and forms the basis of the following discussion.

Firstly, the results of Dickinson's analysis provide the basic level of petrological data required for a comparison between the mineralogy of the pottery sherds and the geology of the Torres Strait Islands. The conclusion drawn is that the eruptive suite of the Murray Islands and the overall volcanic suite of the Torres Strait Islands are not a credible source for the mafic volcanic or the metasedimentary detritus present in the pottery sherds.

Sherd/ Group	Size and Sorting	Angularity	Type of origin	General Mineralogy	Specific Features of Mineralogy	Level of Variability
ORM2 and MER2	coarse and moderately sorted (median size in medium sand range)	subangular to subrounded aggregates	fluvial	Generically similar mixtures of volcanic and metamorphic detritus Absence of calcareous grains from reef detritus	Presence of rare composite quartz-feldspar grains derived from intrusive granitic rocks. Presence of muscovite in MER2 Frequency % of grain types show ratio of volcanic to metamorphic detritus greater in ORM2 than in MER2	High – derivation of separate locales likely
ORM1 and ORM3	finer grained (median size in fine sand range), evenly sorted	subangular to subrounded	fluvial	Low occurrence of volcanic detritus with sparse metamorphic detritus Absence of calcareous grains from reef detritus	Dominance of quartz and feldspar perhaps recycled from sedimentary strata. Quantitative grain counts not attempted due to fine nature of sand and high degree of similarity	Low – derivation form same locale likely

Table 9.2. Summary of the results of mineralogical analysis of pottery sherds undertaken by Dickinson

Attention is also drawn to the prevalence of emergent Quaternary reefs throughout the Torres Strait, and that the lack of calcareous grains in the pottery sherds provides further evidence of the unsuitability of local Torres Strait temper sources.

Secondly, another basic conclusion drawn by Dickinson (Appendix L:4) is that 'appropriate sources for the mafic volcanic detritus in the Murray Islands tempers occur widely in the Quaternary highland volcanic province of central mainland Papua New Guinea'. The vast geographic expanse of the Highlands region is noted, stretching 300km from east to west and 200km from the north to the south. This conclusion, however, supports the initial microprobe data produced by Rubenac, which indicated possible derivation of the mineral detritus in the pottery sherds from the New Guinea Highlands.

Thirdly, two different sources for the coarser grained sherds (ORM2 and MER2) and the finer grained sherds (ORM1 and ORM3) are also identified. The volcanic edifice in the PNG Highlands known as the Kubor Anticline (Bain et al. 1975) is identified as a likely source for the coarser grained temper sands, which are characterised by the presence of subordinate but significant admixtures of non-volcanic detritus from metamorphic rocks.

Forming the backbone of the rugged Kubor Range in the central Highlands of New Guinea, the Kubor Anticline covers a more restricted belt between the Hagen-Giluwe-Ialibu volcano cluster to the west and the Suaru-Karimui cluster to the south (Figure 9.4). The Kubor Range is characterised by the intrusion of granitic rocks into the metamorphic basement, with drainage systems tapping both of these deposits and leading off the Range into the Waghi River in the northeast, and into the Tua River in the southeast.

Although the mixed volcanic, metamorphic and granitic detritus of the pottery sherds is consistent with the geology of the Kubor region, the level of analysis does not allow the identification of which river segments may have served as a source for the detritus. However, 'from a strictly geological standpoint', Dickinson (Appendix L:5) suggests that the most attractive candidate for a source stream for the coarse sand tempers of ORM2 and MER2 is the Mogono River. The Mogono River is a secondary tributary of the Tua River and heads through combined granitic and metamorphic bedrock off the central Kubor range between Mount Kubor and Mount Digini, subsequently flowing through the northwest margin of the Suaru volcanic edifice (Figure 9.4). Based on the morphology of the Mogono drainage system, Dickinson (Appendix L:5) claims that the ratio of volcanic to metamorphic detritus in local river sands would be likely to increase monotonically downstream.

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Figure 9.4 Location of major eruptive centres and distribution of volcanic rocks in the New Guinea Highlands (after Mackenzie and Johnson 1984:3)

Table 225-1 in Appendix L provides a summary of the sedimentology and mineralogy of the two groups of temper sands. The frequency percentages of grain types in the two coarser grained sherds show that the ratio of volcanic to metamorphic detritus is greater in ORM2 than in MER2. The higher ratio of ferromagnesian mineral grains to feldspar grains also suggests that a significant proportion of the feldspar component of the temper sands in ORM2 and MER2 derives from granitic bedrock (exposed in the Mogono River headwaters), rather than from phenocrysts (large crystals) in volcanic rock. Dickinson (Appendix L:6) draws parallels between the nature of the ferromagnesian silicate grains reported from the Highland Volcanic Province (Mackenzie 1976:225, 28) and claims that the high ratio of clinopyroxene to olivine and hornblende in the pottery tempers is compatible with derivation from the Suaru volcanic edifice. This area is located adjacent to the course of the Mogono River and exposes shoshonitic rocks similar to those of Mount Hagen (Willmott et al. 1973:70-71) (Figure 9.4). The results of the grain type frequency percentages calculated for ORM2 and MER2 are interpreted as placing added emphasis on the variable nature of the Murray Islands tempers, but also as highlighting the suitability of the variable Mogono River sands as an attractive potential source.

Quantitative counts of grain types in the finer-grained sherds (ORM1 and ORM3) were not attempted owing to the difficulty of identification of such fine sand and also because of the similar nature of the two tempers, which may derive from the same locale. Dickinson (Appendix L:6) concluded that due to 'the lack of metamorphic detritus, coupled with apparent dilution of the volcanic detritus with recycled sedimentary debris', an origin outside of the Waghi-Tua drainage system is likely. The Kikori River along the southwest fringe of the highlands volcanic province is identified as a likely candidate, or elsewhere that is located 'well downstream near the coast where sand from multiple sources is well mixed and of finer grain size than upstream' (Appendix L:6) (Figure 9.4).

Lastly, the results of Dickinson's analysis (Appendix L) also provide an adequate interpretive framework for assessing the validity of the two hypotheses outlined previously. Importantly, however, this must be undertaken with two new considerations in mind. The first is that the variability of the temper sands in the pottery sherds indicates that the stream sands must have derived from multiple sites on the New Guinea mainland. Secondly, it is clear that the mechanisms of fluvial transport and deposition must be considered.

Accordingly, Dickinson (Appendix L:7) suggests that areas of strong relief can yield floods of volcanics-rich sand and basement detritus for long distances along energetic waterways to the headwaters of streams that otherwise yield less voluminous sandy debris, although this 'is not precluded in principle'. Streams may also drop most of their coarser sand upstream at some distance from the coast, while finer grained sands are better candidates for deriving from the lower reaches of a trunk system. This information alludes to the possibility that the coarser-grained sherds were manufactured in an interior region while the finer-grained sherds were manufactured in a more lowland environment. This interpretation suggests that the origin, production and transport of the Murray Islands pottery sherds may have resulted from a combination of the cultural and geological processes outlined in both of the original hypotheses. This suggests that a more accurate interpretation is offered by a single proposition constructed from elements of the original suggestions:

> That the temper sands comprising the variable volcanic and metamophic detritus present in the Murray Islands pottery sherds represent *at least two separate source locales* both derived from the New Guinea Highlands. The sources include an *inland region* that provided a coarser temper sand and a mineralogy close to the volcanic and metasedimentary suite of the source, and a *lowland region* which contributed fluvially-transported temper sands comprising of finer grained materials and a diluted version of the parent volcanic and metasedimentary suite. The production of pottery in both of these

regions suggests that transfer of the wares to the Murray Islands may have occurred through *multiple routes*, or from agents who received their pottery from *multiple sources*.

Discussion

This hypothesis requires the consideration of two key topics. The first of these is the archaeologically documented record of pottery production and distribution in the New Guinea Highlands. Secondly, evidence for trade routes and exchanges that may have extended beyond the southern Papuan coast must be considered, as does the possibility of the existence of trade networks between Torres Strait and New Guinea that were not documented by the late 19th century ethnograhies.

Pottery in the New Guinea Highlands

The archaeological history of the New Guinea Highlands and the significance of the region's prehistory in the development of agriculture, and the emergence of complex societies in the late Holocene has been well-researched by archaeologists (Gorecki 1986; Hughes 1977a; White 1972, Golson 1977, 1991, 1997). One of the most distinguishing archaeological features to arise from this research, is the apparent lack of pottery production in the region, thus confirming Watson's (1955:121) earlier statement that the Highlands 'are generally thought to be without pottery, and indeed its manufacture and distribution are not great'.

However, two areas in the Eastern Highlands where pottery was made in the recent past have been identified, including the region inhabited by the Agarabi people of the Ramu-Markham divide in the Eastern Highlands and the Kundiawa district of the Chimbu province which is inhabited by the Sinasina people (May and Tuckson 2000:154) (Figure 9.5). It has been demonstrated that, compared to trade in shells throughout the region, trade in pottery was fairly limited and mostly confined to adjacent eastern regions (Hughes 1977a:128-129; May and Tuckson 2000:154). Eastern Highlands pottery is

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Figure 9.5: Map of New Guinea Highlands showing locations of archaeological pottery finds mentioned in text (after Mackenzie and Johnson 1984:3)

also quite distinctive in form, being pointed-based and deeply proportioned (May and Tuckson 2000: Figs. 7.2 and 7.3). It is also claimed that throughout the Highland communities the vessels were used solely for cooking (Hughes 1977a:115). Such interpretations on form and function support Hughes' (1977a:129) suggestion that 'the only reasonable explanation of the small scale of the highlands pottery trade and its lack of integration into general bartering activity, was its exotic quality'.

Since Watson's (1955) first insights into pottery in the Eastern New Guinea Highlands, pottery sherds have been recovered from a number of archaeological excavations and surveys conducted throughout the Highlands (Bulmer 1966, 1969; Hughes 1977a; Watson 1977; 1993; Watson and Cole 1978; White 1972). In most cases, analysis of this material has been limited to stylistic and morphological features, providing data on form, type and function. Some sourcing analyses have also been undertaken, including a number of sherds from Aibura in the Eastern Highlands (White 1972), and sherds from Yerem in the Central Highlands (Gorecki 1989) (Figure 9.5).

The results of White's (1972) analysis of six archaeological sherds and contemporary sherds of known origin from Aibura confirmed that four of the excavated sherds contained granite, quartzite rock fragments, fragments of weathered K-Na feldspar, quartz and occasional green hornblende. This mineralogy is consistent with an origin from the Bena Bena formation, which is within the Agarabi language area (Figure 9.5). The two other excavated sherds had a very different mineralogy, as they contained fresh angular pyroxene, feldspar, rounded basalt with one sherd also containing calcite shell fragments from beach sand. Based on this mineralogy and the results of examination of a sherd from Yabob Island, it was concluded that these sherds originated from the coast at Madang, 130km away (White 1972, Appendix 3) (Figure 9.5). These results led White (1972:63) to conclude that 'pottery came into Aibura from a variety of sources', and that the extent of the pottery trade into the region was unexpected, 'especially when such bulky and fragile objects as pots are involved' (White 1972:63). A single rim sherd located on the surface of the site at Kafiavana by White (1972) was identified as petrographically similar to one of the excavated Aibura sherds, and was reported to have also originated from the Bena Bena River area (White 1972:95).

Results of the Yerem and Yuat River pottery analysis illustrated that the sherds contained very angular particles and both volcanic and metamorphic minerals, including metamorphic quartz (Gorecki 1989:183). Ethnohistorical sources indicate that pottery from villages to the east of the Yuat River entered an expansive trade system through exchange with Biwat people to the west, via a 'system that was almost exclusively along waterways and was conducted separately from bush trading' (McDowell 1989:31) (Figure 9.5).

From this review of the archaeology of New Guinea Highlands pottery, a number of summary points are drawn:

- Although limited, sourcing analyses have illustrated the general nature of the volcanic and metamorphic geology of the Highlands region present in pottery sherds,
- Sourcing analyses also revealed the unexpected extent of the dispersal of Highlands pottery throughout the region, and the multiple source locations used by potters,
- The suggested 'exotic' nature of Highlands pottery is viewed as consistent with the region's documented role in complex ceremonial exchange, well illustrated by the movement of other goods including shell and stone axes (Swadling and Aniamato 1989; Rhoades and Mackenzie 1991),

Based on this evidence it is plausible to draw tentative association between New Guinea Highlands pottery and the sherds recovered from the Murray Islands. However, it is critical to note that the maximum antiquity identified for pottery production in the Highlands is around 1000 years (White 1972:148). The date of the pottery sherds excavated from Dauar is estimated as ranging from approximately 2000 to 700 cal BP, as early as 1000 years before the first archaeologically documented production of Highlands pottery.

Thus, based on the available archaeological evidence from the New Guinea Highlands and the current widely accepted theories for the timing of pottery manufacture in this region, it is unlikely that the Murray Islands pottery was manufactured here. Combined with the results described in the first half of this chapter, it is thus most likely that the production of the Murray Islands sherds occurred within the vicinity of southern New Guinea, where permanent human occupation and the appearance of pottery occurred simultaneously around 2000 years ago (Rhoades 1980).

Southern New Guinea Pottery and Coastal Hinterland Trade

A number of sourcing analyses of pottery from Early Period (2000 – 1200 years BP) sites along the southern Papuan coast have been undertaken. These include pottery assemblages from Port Moresby (Allen and Rye 1982; Allen and Duerden 1982; Bickler 1997; Rye and Duerden 1982), Yule Island (Bickler 1997, Frankel and Rhoads 1994), and the Gulf (Bickler 1997; Vanderwal 1978; Worthing 1980). Bickler's (1997) analysis demonstrated that centres of pottery production along the southern Papuan coast were differentiated according to sherd mineralogy. He demonstrated that Port Moresby pottery contained chert, while large inclusions of quartzite, quartz and feldspar distinguished Yule Island pottery (see Figure 3.1). Although from the more recent ceramic period, Worthing's (1980:92) analysis of sherds from Motopore Island revealed the combined metamorphic and igneous nature of pottery raw materials in this region:

> Notable features of the sand mineralogy are composite grains of quartz occasionally containing muscovite, separate muscovite flakes, fragments of micaceous schist…The presence of these minerals and fragments indicates a metamorphic provenance. The pyroxene and feldspar suggest derivation from an igneous source.

Worthing (1980:94) suggested that the source of the metamorphic materials was undoubtedly the Owen Stanley Range, which forms the metamorphic spine of eastern Papua (see Figure 3.1). Collectively, these results illustrate that a common archaeological signature of pottery from southern and eastern coastal New Guinea is a combined metamorphic and igneous mineralogy that reflects the underlying geology of the region. Although a similar makeup has been illustrated by the analysis of the Murray Islands sherds, their mineralogy places the source of the pottery tempers further west and within the reaches of rivers located between the Gulf of Papua and the Highlands. This draws attention to the possibility of the existence of exchange networks between coastal and riverine Papuan hinterland groups and the Murray Islands.

Figure 9.6: Map of trade routes linking Cape York, the Torres Strait Islands and interior regions of New Guinea (after McCarthy 1939-40:181)

McCarthy's (1939-1940) brief sketch of trade routes throughout the New Guinea hinterland region northward of the Fly Estuary demonstrated links with the Torres Strait (Figure 9.6). Observations made in the early 20th century indicate that pearl shell was entering the Highlands from the south, with the evidence confirming that this trade pre-dated pearl shells brought into the Highlands by Europeans (Swadling and Aniamato 1989:230). McCarthy (1939-1940:188) claimed that the 'shell ornaments pass from Torres Strait through Mawatta, Budji, to the Keraki and thence via the Wiram up the Fly'

(McCarthy 1939-40:188). This discussion on trade throughout the Purari Delta region (McCarthy 1939-40:188-189) describes a system which saw shell and other goods from the Torres Strait Islands traded to the Kiwai and then to coastal villages at the Fly River where they subsequently moved into the interior. His summary provides a description of the interlinking nature of trade in the region, and also highlights the importance of the river systems for the transfer of goods:

> Trade routes across the central ranges link the trade of the Sepik and its tributaries in the Mandated Territory of New Guinea with that of the Fly and Strickland rivers, thus linking the north and south coasts of the island by trade routes; trade routes pass from the coast to the central ranges via the Bamu, Turama, Kikori, Purari and other rivers flowing into the Gulf of Papua (McCarthy 1939-40:189).

The movement of goods between lowland coastal regions of New Guinea and the Highlands was more recently examined in the context of stone-axe trade in prehistoric Papua (Rhoads and Mackenzie 1991). These researchers believed that owing to a research focus on coastal exchange systems, the importance of ground-stone axes and valuable sourcing data they could produce, was not recognized. Rhoads and Mackenzie's (1991) analysis serves to highlight the role that Torres Strait pearl shell (*kina*) played in the Highlands ceremonial exchange during the proto-historic period. They cite informants from Kikori and adjacent areas in the northern margins of the Papuan Gulf who indicated a southwest to northeast movement of *kina* in this area. The shell ultimately entered the Highlands fringe via the Kairi, who traded directly with groups in the Samberigi Valley who in turn exchanged goods with people in the remote valleys north of Mt Murray (Rhoads and Mackenzie 1991:43) (see Figure 9.5). Although the intense exploitation of Highlands quarries only occurred in the last 500-1000 years (Burton 1984:245), it is suggested that the long-distance movement of axes southward and the synchronous movement of shells northward was 'an exchange fuelled largely by intense ceremonial exchange in the Central Highlands of New Guinea' (Rhoads and Mackenzie 1991:43).

The analyses provided by McCarthy (1939-40) and Rhoads and Mackenzie (1991) have served to highlight at least two important points in the context of the possible sourcing of the Murray Islands pottery temper to the New Guinea Highlands. Firstly, they demonstrate that at the time of European contact throughout the region, long-distance trading networks between the Torres Strait Islands and the New Guinea Highlands existed. These networks ran via interlinking trade connections with communities along the southwestern Papuan coast, and particularly those located in the Fly Estuary and adjacent riverine areas. Secondly, and perhaps as a result of being strategically placed along the extensive river systems that stretched from the Highlands to the coast, it seems that riverine groups played a key role in the dispersal and transfer of goods to the north and south. The sourcing of the Murray Islands pottery temper to stream sands from larger river systems within varying reaches of Highlands is thus made more significant.

Conclusions

The preliminary mineralogical analyses of several of the pottery sherds recovered during archaeological investigations on the Murray Islands have provided important information on the nature of prehistoric trade and exchange in Torres Strait. Firstly, in line with the ethnohistorical record the results confirm that the pottery was not manufactured on the Murray Islands or anywhere within Torres Strait. Secondly, the results demonstrate that the New Guinea mainland was the source of the pottery tempers, which is also the most likely place of manufacture. Combined with the chronology of the pottery sherds, but specifically the artefacts recovered from the excavation at Ormi, the antiquity of the trade systems between the Murray Islands and the New Guinea mainland is firmly dated to 2000 cal BP.

The nature of the results also support the suggestion for an important role played in trade and exchange by southern New Guinea hinterland groups, and their broader role as intermediaries in the transfer of goods between Torres Strait and the Highlands. The mineralogy of the sherds also suggests that pottery temper was obtained from multiple sources, and combined with different stylistic attributes of the assemblage best illustrated by the decorated sherd MER2, support the third hypothesis formulated above. Most significantly this hypothesis highlights the possibility of considerably broader and more complex networks of production, distribution and exchange between Torres Strait and New Guinea than previously documented.

Chapter 10: Occupation, Subsistence and Trade on the Murray Islands in a Regional Setting

The first three chapters of this thesis provided the cultural, environmental and archaeological setting in which the subsequent investigations of the archaeology of occupation, subsistence and trade on the Murray Islands were grounded. This final chapter discusses the results of this research, examining the timing of human occupation, the nature and development of maritime and horticultural subsistence and the evidence for trade and exchange in a local and regional context, placing the Murray Islands and Torres Strait within the wider cultural framework of late-Holocene settlement throughout northern Australia and the western Pacific.

The Timing of Human Occupation

The archaeological excavations and the results of radiocarbon dating have established permanent occupation on Dauar dating between 3000 and 2500 yrs BP. This suggests that human colonisation of the Eastern Torres Strait occurred around the same time as occupation on Saibai in the Northern Islands, previously dated to around 2500 yrs BP (Barham 1999). This late Holocene time-depth for permanent human settlement in the region supports the model of a 2000 – 3000 year delay in reef-flat development and beach stabilisation and formation in Torres Strait following the Holocene marine transgression around 7500 years ago (Barham 2000).

It is hypothesised that this delay imposed a number of ecological constraints for the emergence of reef-flat biotypes and resource zones in Torres Strait, including coastal mangrove communities and inter-tidal reefs, as well as the preferred feeding habitats of large turtle and dugong populations prior to 4500 yrs BP (Barham 2000:295). It was also suggested that the nature of reef development in Torres Strait prior to 3500 – 3000 yrs BP, limited to offshore coral 'bommies' with deep subtidal pools and lagoons, prevented the formation of prograded beach environments and suitable occupation sites until this time. Only after 3500 yrs BP and due to an increase in sediment availability and reef-flat formation, was the construction of the large stone-walled fish traps present around many of the islands, including Mer, possible (Barham 2000:294).

To the north of Torres Strait, the first (non-ceramic) occupation of the southern Papuan coast dating approximately between 4000 and 2000 yrs BP, falls within the period of initial human occupation on the Murray Islands and on Saibai. The appearance of pottery in southern Papua from around 2000 yrs BP is suggested to signal permanent occupation of the coast by Austronesian speaking groups who first appeared in the Bismarck Archipelago 3300 years ago from southeast Asia (Spriggs 1997). As testimony to great skill in sea-voyaging and navigation, the eastward Austronesian expansion from New Britain off the north coast of New Guinea through the Pacific and to Tonga and Samoa in western Polynesia, occurred within a period of around 600 years (Burney et al. 1999; Dickinson and Green 1998; Summerhayes 2000).

Thus, on the basis of the post-3000 year chronology of occupation determined for the Murray Islands and Saibai, any direct connection between the primary Austronesian expansion and human colonisation of Torres Strait appears dubious. However, the results of recent archaeological investigations undertaken on Badu as part of the Western Torres Strait Cultural History Project (David and McNiven 2004) have been interpreted as providing new evidence in support of indirect links between late-Holocene Austronesian populations and the occupation of Torres Strait. This evidence derives largely from the result of excavations conducted in the Badu 15 rockshelter on Badu Island (David et al. 2004).

The Badu 15 rockshelter, measuring 11m wide, 6m deep and 3m high, is located approximately 3.5km from the coast and is slightly elevated above the surrounding landscape. Two 50cm x 50cm excavations were conducted towards the front of the shelter. A three-phase cultural sequence dating from 8000 yrs BP has been established from the results of the analysis and the radiocarbon dates from the excavations. The major achievement of this work has been to show that:

> The Badu 15 excavations have for the first time revealed sediments from the period when many of the islands were still linked to the Australian mainland (ancestral Cape York Peninsula) (8000-6000 years ago) and possibly also during the preceding land-bridge phase (>8000 years BP) (David et al. 2004:73).

Phase 1, dating from 8000 – 6000 yrs BP, is characterised by occasional stone artefacts, which are 'the only definite cultural materials' recovered from the excavations (David et al. 2004:71). At a calculated rate of 0.8 cm/100 years, 15cm of sediment was deposited within this 2000-year period. This data is suggested to indicate 'definitive and sustained human presence' during the separation of Badu from the Australian mainland (David et al. 2004:72). Phase 2 dates from 6000 – 3500 yrs BP and features an absence of sustained artefact discard, a slight increase in sedimentation rates and is interpreted as indicating sporadic, low-level use of the island during this period. Phase 3, beginning sometime between 3500 and 3000 years ago, is marked by sustained artefact discard and a significant increase in sedimentation rates from 1.5cm/100 years to 7.7cm/100 years, 'likely indicating the commencement of intensive burning of the surrounding landscape causing slope instability' (David et al. 2004:74). This evidence is interpreted to signal the permanent occupation of Badu after 3500 - 3000 yrs BP.

David et al. (2004:73) suggest that Phase 2 (6000 – 3500 yrs BP) is 'of great significance to understanding cultural dynamics across the whole of Australia'. They infer that as the southern Papuan coastline was located 30km inland of its present location during this time, and that as the estuarine mud islands of Boigu and Saibai did not exist (until 3000 yrs BP), this would have necessitated sea-crossings of distances over 100km if the groups visiting Badu had originated from the north:

> On the other hand, during this same period of time access to Badu from Cape York necessitated a sea crossing of about 18km…and at least four other crossings of a few kilometers each – plus many other smaller crossings – a feat likely requiring short to medium distance sea-going canoes (David et al. 2004:74).

They also cite the increasing intensity of site use on the Australian mainland and the occupation of distant off shore islands along the Queensland coast to support the proposition that the broader 'systematic territorial and sea-based expansions' of which the sporadic use of Badu between 6000 – 3500 yrs BP was a part, 'took place from Australia rather than from southern Papua' (David et al. 2004:74). For the final and permanent phase of occupation of Badu dating from 3500 yrs BP, however, it is concluded that the change in occupational intensities from this time represent an influx of people from the north or northeast, and more specifically of Austronesians, or in the least 'by peoples related historically and culturally to these specialised seafarers, or by nearby peoples culturally influenced by them' (David et al. 2004:74).

The evidence introduced by David et al. (2004:74-75) in support of a 'Papuan-Austronesian' settlement of Torres Strait includes regional rock art stylistic affinities, oral traditions and language similarities. In relation to linguistics, they note that 'some words in many (if not all) of the languages of the Torres Strait area have strong resemblances to Austronesian vocabulary, in some cases to that of Papuan Central District and South-East Papuan Austronesian languages' (David et al. 2004:74). As McNiven and David (2004:221) have recently acknowledged, the antiquity of all rock art in Torres Strait is presently unknown. Similarly, the utility of oral traditions in regards to 3000 yr BP population movements within the region may also be considered as suspect. Thus based on current evidence from Torres Strait, there is nothing in the dated archaeological assemblages that argues for an Austronesian ancestry. However, the chronological contemporaneity between the widespread Austronesian expansion into the western Pacific and the permanent occupation of Badu between 3500 and 3000 yrs BP is recognised as favoring a connection between these two events (David et al. 2004). It is suggested here that it is precisely this chronology which also argues against the hypothesis for an Austronesian component in the initial late Holocene colonisation of Torres Strait.

The long-term archaeological research conducted on the southern Papuan coast has failed to recover pottery pre-dating 2000 yrs BP. The Early Period (2000 – 1200 yrs BP) and so-called 'Lapitoid' ceramics from southern Papua are interpreted as evidence of the first permanent occupation of the region by Austronesian speaking groups from the east (Vanderwal 1973b). Therefore, based on the current evidence, the hypothesis that any involvement by Austronesians in the settlement of the western Torres Strait islands between 3500 and 3000 yrs BP implies that these groups bypassed the southern Papuan coast, voyaging directly to the Torres Strait from the Near Oceanic islands off the east coast of mainland New Guinea. This in turn suggests that the Eastern Islands, including the Murray Islands, would have probably been their first stopover in Torres Strait. However, a lack of evidence to support occupation of Dauar before 3000 – 2500 yrs BP can be seen to refute this idea. As noted above, although the Austronesian expansion into Island Melanesia and across the Pacific occurred within a relatively short period of time, to date, a lack of archaeological evidence from southern Papua dating from before 2000 year BP holds the greatest weight in arguing against the direct involvement of Austronesians in the occupation of Torres Strait around 3000 yrs BP.

However, in conjunction with the radiocarbon chronologies now established for the Murray Islands and previously for Saibai, the occupation sequence recently determined for Badu provides a very important insight into the regional prehistory of the Torres Strait. This is noted by David et al. (2004:76), who state that 'the temporal synchronicity of island colonisation and cultural innovations in northern Australia and Island Melanesia imply some form of historical connection through chains of connection via Torres Strait'. When considered within the context of the well-documented late Holocene archeology of Island Melanesia, however, we must accept that the Austronesian expansion most likely had very little role in the initial occupation of Torres Strait. As discussed further below, that the Austronesian speaking groups had an impact on the subsequent development of the Torres Strait Cultural Complex (sensu Barham 2000) is significantly more plausible.

The Marine and Horticultural Economies

Sites, Stratigraphies and Chronologies

Although limited in extent, owing to strict laws in gaining access to traditionally owned land, the archaeological survey undertaken on Mer and Dauar demonstrated that archaeological deposits, from which radiocarbon chronologies and stratified deposits of subsistence remains could be recovered, were located in coastal embayments and foreshore rockshelters. The sites selected for excavation included two midden deposits at Sokoli and Ormi on Dauar, representing the first site type, and the Kurkur Weid rockshelter on Mer as the second site type. A fourth site, Pitkik, was also excavated and represents an accumulation of colluvial slope deposit and archaeological material located on the coast near the Kurkur Weid rockshelter.

Excavation at Sokoli and Ormi on Dauar recovered extensive stratified archaeological deposits comprising, most abundantly, inter-tidal marine shell remains and smaller quantities of the fragmented bone of marine and terrestrial vertebrates. From Kurkur Weid and Pitkik on Mer deposits of shell and small numbers of vertebrate remains were similarly recovered, although in substantially lower densities than the economic assemblages from Dauar. Broad stratigraphic horizons were identified for each deposit, representing distinct changes in sediment matrices as well as the density of archaeological remains, but particularly shell.

Radiocarbon dating of basal shell samples from the lowest horizons for each site confirmed the deposition of marine subsistence remains on

Dauar from 2600 cal BP and at Kurkur Weid and Pitkik on Mer from around 900 cal BP. Excluding Ormi, the surface deposits excavated at each site represent the recent past (approximately the last 350 years). At Ormi, the results of radiocarbon dating indicated that deposit post-dating 1600 cal BP has been removed, most likely due to recent construction activities at the site. The difference in the estimated maximum time-depth of site occupation on Dauar and Mer is interpreted as reflecting localised site formation processes. In particular this includes the recent stabilisation of the Kurkur Weid rockshelter which may have prevented its use until almost 1000 cal BP, and a period of recent slope instability on Mer probably caused by prehistoric clearance, as well as post-missionisation construction.

On Dauar the excavations revealed a widespread change in the nature of the sediment matrices on the island, dated at Ormi to 2000 cal BP and slightly later at Sokoli to 1800 cal BP. Stratigraphically this is illustrated by a transition from coarse, orange coloured beach sands to brown-black finer grained silty sand, as well a visible increase in the quantity of archaeological shell remains. At Sokoli SU4 was distinct from the surrounding stratigraphy as a continuous horizontal layer of grey, fine-grained sility sediment that extended as a 1-metre long isolated vertical feature in the western section of the site. The formation of this feature is dated to between 1400 and 900 cal BP based on the radiocarbon age-depth curve for Sokoli. At Ormi, SU11 and SU12 form discontinuous horizontal features of clayey compact sediment distinct from the surrounding matrices of the loosely consolidated sand (SU10). The formation of these features occurred between 2250 and 2000 cal BP based on the radiocarbon age-depth curve determined for Ormi. For Kurkur Weid and Pitkik on Mer no distinct or unusual stratigraphic features within the matrices of rubbly colluvium were visible.

Marine Fauna: Evidence for Subsistence Change

Laboratory analysis and quantification of the excavated cultural assemblages confirmed that the remains of marine molluscs were the most abundant faunal component at each site. Overall Ormi recorded the highest density of shell remains (343 kg/m^3), which is double the density of shell from Sokoli (170.2 kg/m^3). The total shell density at Kurkur Weid was 186 kg/m^2 and was significantly lower for Pitkik at 51.3 kg/m^3. On Mer the highest density of shell remains were recovered in the surface horizons, at both sites dating from around 350 cal BP. At Kurkur Weid the second highest density of shell remains was recorded for Horizon III dating 780 – 520 cal BP, where the rate of shell accumulation was also greatest. Combined with the high MNI recorded for this horizon, it is concluded that this period and the recent past represent the most intensive use of the Kurkur Weid rockshelter.

At both Sokoli and Ormi on Dauar significant increases in shell densities are associated with the stratigraphic transition from coarse orange sand to brown colluvium. For Sokoli these processes are also consistent with a dramatic increase in the rate of sediment accumulation at approximately 1800 cal BP. For Ormi, however, although an increase in the rate of accumulation is consistent with the sediment change and increase in shell density around 2250 cal BP, a dramatic increase in the rate of sediment accumulation occurs at 1900 cal BP, around the same period as that identified for Sokoli.

Although any material post-dating 1600 cal BP is missing from Ormi, it is concluded from the nature of the archaeological assemblage from Sokoli that a change in subsistence regime on Dauar occurred after 1650 cal BP. This is best illustrated by a decrease in the density of shell remains after this time. Significantly, however, this is preceded by a change in sediment at the site to a brown colluvial matrix as well as a significant increase in the rate of sediment accumulation. The change in sediment and the increase in the rate of sediment accumulation are also apparent at Ormi, with both processes at this site similarly occurring before 1650 cal BP. From the combined stratigraphic and archaeological evidence it is concluded that the change in the nature of subsistence on Dauar may have been due to a greater dependence on non-marine resources and the emergence of horticulture. This is initially illustrated by the deposition of colluvium as the likely result of sediment instability caused by hillslope clearance from 2000 cal BP, and secondly, by a substantial decrease in the density of archaeological shell remains by 1650 cal BP.

In the context of this hypothesis, the results of previous archaeological investigations into the impact of human occupation on the natural environment and ecosystems of islands are relevant to the Murray Islands investigations. Such research has particularly focused on islands throughout Melanesia and the Pacific, and has identified a number of human induced processes that have contributed to environmental transformation (Burney 1997; Fitzhugh and Hunt 1997; Gosden and Webb 1994; Kirch 1983; Kirch et al. 1991; Kirch and Ellison 1994). The most relevant of these to the Murray Islands contexts are processes of modification to the physical landscape or landforms, such as erosion, deposition and re-arrangement of the landscape through construction of terraces, field systems and so on. On the small Polynesian island of Tikopia for example, Kirch and Yen (1982:147-160) identified that the rate of colluvial deposition from the high volcanic slopes 'was significantly increased in the period following human colonisation, and that forest clearance with burning was a primary cause of the increased erosion on the higher slopes'. For Lapita sites, evidence for accelerated rates of erosion is commonly regarded as indicative of gardening on hillslopes (Gosden 1989; Hope and Spriggs 1982; Spriggs 1993:192).

These well-documented late-Holocene changes therefore support the hypothesis that the dramatic change in sediment and the accelerated rate of accumulation on Dauar indicate prehistoric horticultural clearance and intensified use of the landscape. As further evidence cited for the impact of initial human occupation on island biota, Wickler (2001:233) recalls that qualitative observations of decline in shell densities in late-Holocene archaeological sites throughout the Pacific have been interpreted as evidence of species over-exploitation (for example Kirch and Yen 1982; Kirch 1983). However, Wickler's (2001:233) analysis of the marine invertebrate assemblages excavated from several sites on Buka Island in the northern Solomons revealed no such change in shell density over time 'with much lower figures for the preceramic and Lapita phase deposits than those with later ceramic phase occupation'.

Importantly, Wickler (2001:232) also notes that trends in the densities and frequencies of molluscs must be considered within the context of 'data regarding past environments, shellfish habitats and behavior, and human collection strategies'. As interpreted by Allen (1972:116) for Nebira 4 on the southern coastal Papuan hinterland, the sharp decrease in the percentage weight of marine faunal remains indicated a diminishment in the importance on the marine economy over time and a greater reliance on inland gardening. It is in light of such data for the Murray Islands and of the demonstrated lack of change in species distribution and size ranges of key molluscan species over time (detailed further below), that the decrease in shell density at Sokoli by 1400 cal BP provides evidence for horticulture on Dauar by this time.

Marine Vertebrates: Turtle as Evidence for Social Complexity

The hypothesis of a decline in marine resource subsistence and horticultural emergence on Dauar is broadly supported by the rate of deposition of vertebrate remains at Sokoli, which, comprising largely fish and turtle, decrease after 1650 cal BP. Although a greater diversity of fish species was identified at Sokoli in comparison to the Ormi fish assemblage, this result is interpreted as reflecting the greater time-depth represented by Sokoli. The greater species diversity may also indicate the procurement of fish through stone fish trap technology in addition to both nearshore and offshore fishing using hook, sinker and line. Interestingly, however, the amount of turtle bone steadily increases throughout the

Sokoli deposit, with the largest quantity recorded in Horizon I from 900 cal BP. This trend illustrates the possibility of an increase in the exploitation and consumption of turtle on Dauar from initial occupation at 2600 cal BP. This evidence is perhaps best interpreted within the context of contemporary ethnographic observation of marine subsistence activities on the Murray Islands.

Bird et al. (2000:6) suggest that 'turtle hunting cannot be understood unless you know it is often not about food per se, but about feasting, social status and displays of generosity'. This is demonstrated by the different nature of turtle sharing and feasting during the two turtle seasons: collecting season (*nam terpei*) between October and March, and hunting season (*nam deraimer*) from April to September. Unlike during *nam terpei* when turtles are nesting on sandbeaches around the islands, Bird et al. (2000:10) explain that the hunting and sharing of turtle during *nam deraimer* season holds no benefit for the hunters or their households:

> Turtle are acquired for public consumption. The benefit to hunters from hunting lies not in their generosity, but in the benefits gained by signaling their skill as hunters…Hunters receive acknowledgment from potential competitors based on his skill, and in the past, may have been able to impress the parents of the women they wished to marry.

The trend depicted by the archaeological turtle bone assemblages from Dauar suggests that the social importance of turtle hunting and sharing on the Murray Islands may have considerable cultural time-depth. Notably, stone fish traps as a technology associated with feasting and the procurement of large quantities of marine resources, is also in line with archaeological evidence of an increase in the deposition of turtle bone on Dauar. Such evidence implies that the high degree of social complexity on the Murray Islands first documented in the late 19th century had existed well before sustained European presence in Torres Strait. The results of species and size analysis of the excavated shell assemblages provide further illustration of the archaeological visibility of ethnographically observed marine subsistence practices among the Meriam.

Variability in Archaeological Shell: The Validity of Ethnographic Data

The analysis of marine subsistence remains detailed in this thesis focused on six of the most commonly occurring species identified in each of Murray Islands excavations, consisting of the reef-flat species *Lambis lambis*, *Strombus luhuanus*, *Trochus niloticus*, *Tridacna* spp., and *Hippopus hippopus*, and the rocky-shore species *Nerita undata*. Based on MNI calculations, the results consistently demonstrated for all sites that the two smallest species (*Strombus luhuanus* and *Nerita undata*) were the most abundant. Weight calculations, however, revealed that the majority of the excavated shell assemblages comprised the remains of the larger species, particularly *Tridacna* spp. and *Lambis lambis*. These same species proportions were previously illustrated by Richardson's (2000) analysis of the excavated shell remains from Sokoli, Kurkur Weid and Pitkik.

Through the application of ethnographically collected data, she demonstrated that both the archaeological shell assemblages and contemporary househod middens comprise proportionally different species in comparison to the live assemblages collected by foragers that were recorded during anthropological fieldwork (Bird 1996; Bird and Bliege Bird 1997). Through observations of contemporary shellfish gathering among the Meriam, a number of key dietary species were identified, including the large reef-flat *Tridacna* sp. clams, *Hippopus hippopus* and *Lambis lambis*. In contrast, *Strombus luhuanus* and the small rocky-shore species *Nerita undata* are considerably less important as marine subsistence resources. The disproportionately high number of these smaller, economically less important species in both contemporary household middens and the archaeological middens was examined by Richardson (2000) in the context of shellfish choice, transport and processing strategies.

The species proportions in both contemporary household middens and the archaeological middens is attributed to the preference for the larger and heavier species to be processed on the reef where the shell is also discarded, while the smaller and lighter species are brought back to a central place for processing. The predictive models developed by Richardson (2000) were argued to demonstrate a broad level of continuity between past and contemporary shellfish species targeted for subsistence on the Murray Islands, as well as the conditions under which they were processed and discarded. Although these trends were confirmed by each of the excavated Murray Islands shell assemblages undertaken as part of this thesis, several other factors were identified as contributing to the nature of the archaeological deposits.

Through a more detailed analysis of the chronological trends in the shell data, the analysis conducted as part of the current investigation has considered shell density variation, change in species diversity as well as species size over time. Shell at both Sokoli and Ormi demonstrated the trend of an increase in density in association with a dramatic increase in the rate of colluvial sediment deposition. Along with an increase in the quantities of the most commonly occurring mollusc species, this evidence is interpreted as the intensification of subsistence on Dauar dating from around 2000 cal BP. Trends demonstrated at both Sokoli and Ormi after 2000 cal BP of an increase in MNI and a more proportional MNI to weight ratio of *Strombus luhuanus*, were initially suspected to be evidence of over-exploitation. The results of size analysis of this species, as well as for *Nerita undata*, *Lambis lambis*, *Tridacna* spp. and *Trochus niloticus*, failed to illustrate any definite trends in support of either increases or decreases in both the mean size and size range over time. One exception to this was *Nerita undata* at Sokoli, which demonstrated a significant decrease in size range after 1400 cal BP. As a species documented ethnographically with low economic importance in subsistence, a decrease in the size range of *Nerita undata* at 1400 cal BP supports the hypothesis of a decline in the dependence on marine resources on Dauar by this time (Meehan .

As well as the changing nature of subsistence regimes, the identification of a great number of other, less frequently occurring mollusc species, along with the deposition of considerable quantities of larger, anthropologically documented subsistence species, suggests that factors other than human foraging and gathering behaviour contributed to the deposition of archaeological deposits on the Murray Islands. The ethnographic record for Torres Strait illustrates the widespread and diverse role that shell played in the domestic, social and economic realm. Some evidence of this has been identified in the excavated material culture from Mer and Dauar, which includes a number of shell scrapers and the possible discarded components of unfinished *Trochus* shell rings.

Terrestrial Fauna: Implications for the Introduction of Species

Consistent with both the ethnohistoric record and contemporary faunal surveys of Torres Strait, the excavated terrestrial fauna assemblage confirms the limited availability of fauna on the Murray Islands and the minor role these resources played in prehistoric subsistence. Due to the highly fragmented nature of the faunal assemblage, the majority of the terrestrial bone was unidentified. Small quantities of bird were recovered from Ormi and Sokoli, with preliminary analysis confirming they are the remains of large species. Several small goanna, snake and lizard vertebrae were also recovered from the Dauar sites, although as with bird, no change or patterns in their distributions were discernible due the small quantity of the remains.

Dog (teeth and fragmented vertebrae) was identified in the Dauar faunal assemblage dating from 1800 cal BP. A recent discussion on the translocation of terrestrial fauna in Torres Strait refers to dogs in the region as Dingoes (*Canis lupus dingo*) (McNiven and Hitchcock 2004:120). This identification is based on historical descriptions of Torres Strait dogs as being similar in appearance to the native Australian dog, as well as the fact that like dingoes, these dogs were not heard to bark (for example, Jukes 1847 I:199, 268-269). Several historical references of the importation of dogs from the Australian mainland into Torres Strait supports the interpretation of the presence of dingoes on the islands. McNiven and Hitchcock (2004:120) also report that a number of material culture items decorated with ‘dogs’ teeth were collected throughout the Torres Strait, including Badu, Mabuiag, Yam and Mer. Haddon (1912:23, 41; 1935:296), however, claimed the majority of dogs teeth in Torres Strait were imported from New Guinea.

The dog remains excavated from Dauar represent the only archaeologically recovered evidence of this species in Torres Strait, providing a time-depth for its presence from 1800 cal BP. In spite of a general lack of archaeological evidence, however, McNiven and Hitchcock (2004:121) suggest the Torres Strait played a key role in the origin of the Australian dingo. This is surmised around the estimated antiquity for the human occupation of Torres Strait 3000 – 2500 years ago, and that this period falls between the maximum antiquity of Dingo in New Guinea at 5500 yrs BP (Bulmer 2001) and the first appearance of dingo in Australia around 3500 – 3000 yrs BP (Corbett 1995; Gollan 1984; Meehan et al. 1999). Although this hypothesis is logical and concurs with the recent recovery of dog remains dating to the last 3500 years on the Aru Islands west of Irian Jaya (O’Connor et al. 2002), a wider sample of archaeological dog bone from the Torres Strait is clearly warranted before any firm conclusions can be reached.

The recovery of a single macropod tooth from Ormi on Dauar allows further consideration of the terrestrial faunas of Torres Strait, and the role that islanders played in their development and distribution. As noted in Chapter 2, the only record of Agile wallabies in the Torres Strait refer to Mai Island near Albany Island (Warham 1962), and Friday Island near Muralag Island (Cameron et al. 1984) off the coast of northern Cape York. Agile Wallaby remains (teeth, long bone, vertebra and a metatarsal) have been archeologically recovered from two midden deposits on Mua Island (Harris et al.1985:16), and are estimated to date within the last 1000 years (Barham 2000). Macropod remains have also recently been excavated from a rockshelter on Mua, consisting of a molar fragment dating to within the same period (David et al. 2004).

McNiven and Hitchcock (2004:119) concluded that the macropod remains from Mua were highly unlikely to represent 'natural' elements of the islands fauna 'with ancestral connections to the Torresian land bridge of more than 8,000 years ago'. Alternatively, they hypothesise that archaeological macropod remains on Mua 'points to the importation of macropods, most likely from Kaurareg neighbours to the south' (McNiven and Hitchcock 2004:119). They note that whether or not the wallabies were live imports or were a small population descended from live imports could not be determined (McNiven and Hitchcock 2004:119). Nonetheless, with a land area of 170km^2, Mua is included among a small group of the Torres Strait Islands identified as capable of supporting long-term viable populations of macropods (Abbott 1980). The other islands are Murulag (205 km^2), Saibai (106km^2), Badu (105km^2) and Boigu (85km^2).

In the context of this biogeographical data, the presence of a single macropod molar from the basal deposit at Ormi is similarly interpreted as evidence of their import into Torres Strait. Moreover, given the distance of the Eastern Islands to both Cape York and the southern Papuan coast (the regional extent of natural distributions of *M. agilis* populations), the Dauar macropod is most likely to represent a live import. However, as the distance between New Guinea and the eastern islands is somewhat shorter than that from Cape York, it is possible that live macropod importation occurred from the north.

McNiven and Hitchcock (2004:119), however, have concluded that the Kaurareg hunted macropods on Torres Strait before European contact. This is inferred from both the small size of Friday Island and the long distance between it and Cape York required to be swum by colonising wallabies. This is seen as supporting their conclusion that 'wallabies were introduced by Aboriginal Islanders (the Kaurareg) from either Cape York stocks or stocks that once existed on other islands such as Murulag' (McNiven and Hitchcock 2004:118). It is therefore possible that the Dauar macropod may have originated within the Torres Strait itself, but given the distance between Dauar and Muralag for example, live importation remains the most likely scenario. Finally, however, the recovery of only a single tooth from the Murray Islands not only confirms McNiven and Hitchcock's (2004:119) sentiment that macropods were not a relict faunal population on the islands after Holocene transgression around 7500 years ago, but that any trade in them was also likely to have been unusual.

The third and final terrestrial species for consideration within the wider scenario of faunal translocation across Torres Strait is *Rattus rattus*. Remains of *Rattus rattus* were recovered from each of the Murray Islands excavations, with the largest quantity of bone recorded from Horizon III (780 – 520 cal BP) at Kurkur Weid. On Dauar *Rattus rattus* bone was recovered from the basal deposit dating to 2600 cal BP, although the majority of the remains post-date approximately 1800 cal BP. The Pacific Rat (*Rattus exulans*) has been recorded in Torres Strait (Strahn 1995:650; Watts and Aslin 1981:260) and a specimen was collected from Mer in the late 19th century (McNiven and Hitchcock 2004:122). However, the absence of archaeological remains *of Rattus exulans* from the Murray Islands can be seen to support 'the possibility that the rodent first arrived in the second half of the 19th century with Pacific missionaries and/or pearl shellers' (McNiven and Hitchcock 2004:122). Significantly, the absence of archaeological *Rattus exulans* in Torres Strait also disputes the hypothesis for a direct Austronesian involvement in occupation, as this species, along with pig and chicken (also absent from archaeological assemblages from the Murray Islands), are considered as signatures of Austronesian colonization (Green 2000:379). Further archaeological and chronological investigations into the faunal assemblages from Torres Strait are required, however, before any definitive scenarios for the introduction of species are proposed.

On a further but final note about the Murray Islands *Rattus rattus* assemblages, a greater quantity of remains were recovered from Sokoli (MNI=11) in comparison to Ormi (MNI=2) and the majority of remains from Sokoli occurred in deposit post-dating 1800 cal BP. Thus consistent with the suspected emergence of horticulture on Dauar by 1650 cal BP, an increase in the quantity of rat remains may reflect an increase in the island's rat population brought about by the heightened availability of their food sources, i.e. vegetables and plants. The chronological distribution of the archaeological *Rattus rattus* remains on Dauar may therefore be related to the emergence of horticulture on the island by 1650 cal BP.

Horticulture: Evidence of Emergence

From the early 20th century, like the dependence on marine resources, the importance of horticultural subsistence on the Murray Islands has waned in the face of European occupation and the availability of store-brought commodities. However, a considerable prehistoric time-depth for horticulture on the Murray Islands is alluded to by the dense and established nature of contemporary gardens, numerous early historic references to trade and exchange of garden produce, as well as Meriam mythology and oral histories associated with horticultural preparation, gardening protocol and crops. Although not surprising, the archaeological excavations at Kurkur Weid and Pitkik on Mer failed to produce any evidence for horticulture. Indeed, apart from several distinct stratigraphic features revealed by the excavations at Sokoli and Ormi, no other stratigraphic, archaeological or macrofloral evidence for horticulture was recovered from the excavations on Dauar.

With the aims of identifying microscopic remains of edible species and changes in vegetation over time due to horticultural clearing and planting, phytolith and starch grain analysis of selected sediment samples from Sokoli and Ormi was undertaken. A further aim of this analysis was to confirm whether the stratigraphic features SU4 at Sokoli and SU11 and SU12 at Ormi were the result of horticulture. The results confirmed the presence of remains of ethnohistorically documented horticultural crops, including coconut, banana and yam as well as changes in vegetation indicative of burning, clearing and possible fallow periods. The chronological trends established for vegetation changes support the hypothesis of clearance on Dauar from as early as 2000 cal BP, confirmed by a change in grass species at Sokoli from the native *Themeda australis* to the more fire resistant *Imperata cyclindrica*.

From the examination of a combination of ethnographic, archaeological and historical data previously recorded for plant varieties commonly exploited throughout Australia , but more so from the western Pacific, it was deduced that imported crops may have been present from the time of initial occupation of Dauar. This is predominantly founded within the context of increasing evidence for the mid- to late-Holocene emergence of domesticated species within New Guinea and the wider western Pacific region (Denham et al. 2003). Thus the presence of phytoliths of *Musaceae* sp. and coconut and starch grains of *Dioscorea* sp. in basal stratigraphic contexts at both Sokoli and Ormi, confirm that cultigens, along with horticulture, may have been components of the initial colonising strategy for Eastern Torres Strait. In particular, the presence of banana phytoliths and *Dioscorea* sp. starch grains in SU11 at Ormi confirm the likelihood that both SU11 and SU12 are associated with the growth of edible species. Similarly, the presence of banana phytoliths in a more recent deposit at Sokoli (SU4) dating between 1400 and 900 cal BP, confirm that it may also be a product of horticulturally related activities.

Horticulture within Torres Strait

The results of the investigations into the archaeology of horticulture on the Murray Islands provide a useful addition to information on the timing and nature of horticulture on the low, alluvial island of Saibai (Barham 1999). Although earlier investigations revealed problems associated with the stratigraphic integrity of dated samples as the suspected result of mound-and-ditch construction (Barham and Harris 1985), recent investigation of the lithostratigraphic records of Holocene swamps on the island have provided more accurate results (Barham 1999). Estimated at around 1000 cal BP, the construction of horticultural mound-and-ditches on the island as well as associated water management strategies and wells, significantly post-dates human occupation by around 1500 years. This time-lag between occupation and the development of visible horticultural systems is seen to reflect a shift from mangrove to sedge-swamp dominated communities brought about by minor fluctuations in local sea level.

However, the timing for the emergence of horticulture determined for Dauar alludes to the possibility for evidence on Saibai, of less intensive systems that had little in the way of constructed features prior to 1200 yrs BP. Although both the ethnographic record and the contemporary visibility of archaeological remains, such as mound-and-ditch systems, illustrate a diversity in the nature of horticulture across Torres Strait, this thesis has demonstrated the recovery of early, much less visible evidence for horticulture through microfossil plant analysis of excavated sediments. Although differences in localised ecological adjustments to sea level, island topography, elevation and geology may have a part in the apparent differential development of horticulture across Torres Strait, it is clear that the earliest signatures for horticultural practices and the presence of cultigens in Torres Strait must be considered when developing regional models for the development of prehistoric subsistence economies.

Material Culture and Trade and Exchange

As was initially noted by Haddon (1935:296), the material culture of Torres Strait had a strong affinity and resemblance to that recorded in southern New Guinea. As discussed in Chapter Two, this was particularly the case for the Central, Northern and Eastern Islands, and was less so for the western islands close to Cape York Peninsula. For the occupants of the Western Islands trade and exchange with mainland Aboriginal groups was regular and intensive, and was much more indirect with Papuans to the north, who were often involved only through other islands as trading intermediaries. For the Murray Islands, ethnographic evidence and contemporary oral histories testify to direct trading links with Papuans along the southern coast, and particularly from the Fly Estuary. The Kiwai, including the migratory groups that more recently settled on islands and areas west of the Fly during the 19th century, are commonly identified as the group with whom Murray Islanders had the most contact.

The excavated material culture assemblages, although limited in both the number and diversity of artefacts, revealed direct cultural and technological associations with southern Papua. Although the pottery sherds are the most obvious in demonstrating these links with the north, most of the artefacts recovered from Mer and Dauar confirm Melanesian influences and connections. Importantly, however, it is also these non-ceramic items that demonstrate an affinity between the Murray Islands cultural assemblages and the late-Holocene occupation period of Island Melanesia and the Pacific.

Shell Artefacts

Ground shell is a common artefact type throughout archaeological sites dating from the time of initial colonisation of the Pacific Islands (Smith 2001:151). Although there is evidence of shell modification in Island Melanesia from initial human occupation during the Pleistocene (Allen 1993), shell artefacts are considerably more common in late-Holocene archaeological deposits.

From excavations of Lapita and post-Lapita sites in the Arawe Islands in the West New Britain Province of Papua New Guinea, a range of shell artefacts were recovered, including adzes, chisels, points, disks, armbands, scrapers, fishhooks, lures and sinkers (Smith 2001). These had been manufactured from a range of species including *Tridacna* sp., *Conus* sp., *Trochus niloticus* and *Cyraea* sp. Shell artefacts have also been found in early occupation sites along the southern New Guinea coast, such as at Oposisi on Yule Island. Dating from 2000 yrs BP, several *Conus* sp. bracelets, *Trochus* sp. armbands and a polished pearl shell (*Pinctada* sp.) tablet were recovered from this site (Vanderwal 1978:422-423).

Two fragments of suspected *Trochus* shell rings were also recovered from Dauar, dating between 2600 and 1650 cal BP. There is evidence to suggest that these items may have been made in imitation of the boar-tusk rings worn by men of the sacred Bomai-Malu fraternity. Although a number of *Trochus* shell ring artefacts have been recovered from sites dating from as early as 8500 yrs BP throughout western Melanesia (Allen and Gosden 1989:52; Spriggs 1997:52), they have also been identified as a component of the early and late Lapita cultural assemblages (Smith 2001).

Other shell artefacts recovered from Ormi on Dauar and Pitkik on Mer are interpreted as scrapers, and have been deliberately fashioned from whole shells of *Lambis lambis* and *Conus sp*. and date to between 1800 and 775 cal BP. Haddon (1912:124-125) describes that the shells used on Mer for cutting and scraping purposes were whole valves of akul (*Polymesoda erosa*), *Asaphis* sp. and *Tellina* sp.. The absence of ethnographic references to the types of shell artefacts recovered archaeologically, may provide evidence of the influence that European goods, such as metal and knives, had on the traditional material culture of Torres Strait by the turn of the 19th century.

However, there is a remarkable similarity between the two *Lambis lambis* ground shell artefacts (GS3 and GS4) from Ormi and ground shell artefacts archaeologically recorded from a number of sites throughout Vanuatu (Garanger 1982; Garanger 1972: Figs. 40, 283, 292). Although these artefacts are called ‘adzes’, they are also made from the robust columella of *Lambis lambis* shells, but are considerably larger (around 10cm) than GS3 and GS4 from Ormi (around 4cm). The Ormi artefacts date to between 1800 – 1600 cal BP, while the Vanuatu artefacts were recovered in excavations dating from as early as around 2800 yrs BP and from surface contexts (Garanger 1972: Fig. 297). Given the small size and the rounded margins of the Ormi ground shell artefacts, it is unlikely that they were used as adzes. Although there is no ehthnohistorical reference to these type of artefacts, it is concluded that their most likely function was as scrapers.

Stone Artefacts

Two stone fishing sinkers were excavated from Ormi on Dauar, ranging in date from 2600 cal BP to 1600 cal BP. This was interpreted as providing evidence for subsistence fishing from the time of initial occupation of Dauar. A range of fishing gear has been recovered from archaeological sites throughout the western Pacific. Although shell fish hooks tend to be the most visible of these technologies, particularly from the last 3000 years, fishing sinkers and lures are also among them. For example, from sites in the Loyalty Islands in New Calendonia stone sinkers defined as 'heavy oval sinkers with a central groove line' were recovered (Sand 2001:81). These artefacts appeared late in the cultural complex of New Caledonia at around 1350 yrs BP. A further similarity in the material culture assemblage from the Murray Islands and the non-ceramic assemblage of New Caledonia is the presence of pebbles with impacted edges (Sand 2001:81, Fig. 4h). Although it is noted that these artefacts are present throughout the entire 3000-year occupation sequence on New Caledonia, there is a lack of analysis and temporal data for this artefact type (Sand 2001:81). However, numerous hand-held stone abraders were also recovered from Buka Island, where changes in raw material and patterns in their spatial and temporal distribution were interpreted to reflect differences in the production of shell artefact types throughout the Lapita occupation phase (Wickler 2001:189-190, Plate 7.6).

Flaked stone debris comprised the most abundant artefact type in the Murray Islands material culture assemblages. These were recovered from Sokoli and Ormi on Dauar, but were absent from Kurkur Weid and Pitkik on Mer. The raw material of the stone debris was predominantly porphyritic rhyolite (95%). The igneous nature of the raw material suggests they were sourced locally from Dauar or any of the Murray Islands, the volcanic rocks of which are distinctly basaltic with abundant porphyritic olivine and clinopyroxene phenocrysts (Haddon et al. 1894:432-433).

The archaeological recovery of stone debris from Dauar is surprising in the context of the lack of references for the use of flaked stone tools throughout Torres Strait in the ethnographic record, as well as the small number of stone artefacts archaeologically recorded for Torres Strait. The majority of flaked stone previously recorded throughout Torres Strait was located on the Western Islands, particularly on Dauan (Vanderwal 1973a) and as described above, more recently on Badu (David et al. 2004). However, the only stone quarry reported to date in Torres Strait is on Dauan, where Vanderwal (1973a:182) recorded an outcropping of 'a relatively coarse grained slate grey to green igneous rock' on the western side of the island. It was also this site that Haddon (1912:191-192) identified historically as a raw material source for club heads (*gabagaba*). As outlined in Chapter 2, it is these stone-headed cubs that dominate the ethnographic literature on stone as a raw material for artefact manufacture in Torres Strait. Recent detailed historical overviews and analysis of Torres Strait *gabagaba* (McNiven 1998; McNiven et al. 2004), therefore provide important and useful information of relevance to the flaked stone assemblages recorded for the Murray Islands.

The recent geological sourcing of a number of ethnographic and archaeological *gabagaba* demonstrated that the main source of raw material was within Torres Strait, and particularly from the Western and Eastern island groups (McNiven 1998). This result stands in contrast to the early ethnographic records, in which the Papuan lowlands were identified as the primary source of Torres Strait *gabagaba* (Allen and Corris 1977:33; Haddon 1900:244; MacGillivray 1852, II:4, 19), in spite of it being 'an area essentially devoid of stone suitable for club manufacture' (McNiven 1998:107). The recent investigation of stone club heads from Dauan provides the first synthesis of historical and geological data on the production of these artefacts (McNiven et al. 2004).

From these investigations it is concluded that although a wide range of raw materials were selected for the production of the Torres Strait *gabagaba*, clearly:

> Islanders were targeting certain fine-grained igneous rocks that were: 1) homogenous and isotropic (e.g. free of faults and cleavage lines) – able to to predictably shaped by flaking: and 2) tough (i.e. fine-grained, random interlocking crystal structure) – able to withstand the prolonged shock and stress of impact pecking and conducive to the production of a smooth, glossy finish with grinding (McNiven et al. 2004:294).

Most of the artefacts are from igneous (volcanic and plutonic) rocks, such as andesite, basalt, and fine-grained microdiorite/quartz-gabbro. Collectively these rocks belong to the basement rocks of the Badu Suite and Torres Strait Volcanic Group (von Gnielinski et al. 1998), and from the Maer Volcanics Group of Eastern Torres Strait (Willmott 1972), as more recently determined from the identification of a trachybasalt stone club (McNiven et al. 2004:294). Descriptions of the methods of stone-club production in Torres Strait and New Guinea are also provided, which for New Guinea are considerably more detailed and based on historical and contemporary observations (McNiven et al. 2004).

Perhaps the most obvious difference identified in the manufacture process between the two regions is the initial selection of the raw material. In New Guinea the raw material for stone clubs appears to have been from natural 'pebbles' only, and not from quarried blanks. Based on the Dauan club heads analysed, however, it is not sure whether in Torres Strait, 'stone raw material was originally picked-up from the ground surface, excavated from sediments or separated from bedrock' (McNiven et al. 2004:295). Two of the Dauan artefacts (numbers 5 and 6) are large retouched flakes, and are thus interpreted as providing 'first insights into Melanesian stone club head manufacture using large flakes as blanks' (McNiven et al. 2004:297).

In Torres Strait refined shaping and hafting of the hole was achieved by flaking and pecking and to a lesser degree reaming (grinding). The final finishing process required extensive grinding, a process which is illustrated by grinding grooves recorded in the bedrock outcrops on the southeastern foreshore of Mer (see Plate 5.1, 5.2). Smoothing of the hafting hole required the insertion and rotation of a small grinding implement, such as a conical shaped stone. In New Guinea, excavation of the hafting hole was undertaken by pecking and drilling; the former through the use of pointed stones, and the latter by sharpened bamboo. Shaping of the stone was done by banging it against another stone, while final finishing touches were applied in a number of ways, including rubbing against hand-held stones, smoking them in a fires and rubbing them in animal fat (McNiven 2004:299).

Importantly, this information combined with the discovery of a stone club head on Dauan made from rock only occurring in the Eastern Islands, holds a number of new implications for interpretation of the flaked stone assemblage recovered from the excavations on Dauar. Firstly, given the stone debris is small and undiagnositic, it is possible that the assemblage represents the discarded waste from the manufacture of larger, primary artefacts, such as club heads. Secondly, as the flaked stone assemblage consists entirely of locally occurring rock, this further supports the possibility of stone artefact production in the Murray Islands. Finally, the presence on Mer of bedrock panels with extensive grinding grooves also suggests prehistoric production of stone artefacts, possibly *gabagaba*, in the Murray Islands.

In comparison to Ormi, a smaller number of stone debris was identified at Sokoli. Although the results of sediment analysis for Ormi produced evidence for the presence of edible plant species shortly after occupation at 2600 cal BP, the high density of shell remains at the site suggests that activities associated with horticultural subsistence may have been less prevalent than at Sokoli. The presence of a larger quantity of stone debris at Ormi is possible evidence of multi-purpose site use, including the processing and discard of marine resource remains as well as technological production. Alternatively, occupation at the historically documented garden site of Sokoli may have been more focused on horticultural production; an interpretation that is supported be the decrease in the density of marine shell remains at the site from 1650 cal BP.

Bone Artefacts

The intricately carved bone artefact recovered from Sokoli (IB1) represents one of the more significant material culture items recovered from the Murray Islands. Carving was traditionally a very common practice throughout the Torres Strait Islands and remains an important cultural activity today (Wilson 1993). Bone in particular was fashioned for use as arrowheads and points, husking implements, pendants and musical instruments. On Mer, turtle bone and less commonly fish bone were mainly used for the manufacture of such items. However, the descriptions of bone artefacts collected from Mer during the Cambridge Expedition allude to the possibility that the Sokoli artefact is a decorated coconut scraper made from cassowary bone imported from New Guinea (Cambridge 2001).

Further evidence to support the proposition that the Sokoli bone artefact was imported from New Guinea is a similar type of artefact recovered during a surface survey of the Samoa village at Kikori in the Papuan Gulf (Plate 10.1). Although this artefact is not defined as a either a spatula or a scraper, it appears very similar in form to the artefact from Sokoli:

> It measures 4.4 cm long, 1.2 cm wide and 0.8 cm thick. The original bone surface has been finely ground and polished and a delicately featured representation of a human face is carved at one end. The most remarkable aspects of this item are the slanted eye designs and bun coiffure (Rhoads 1983:103).

A bone artefact that was identified as a spatula was recovered from the lower horizon of the excavation at Samoa, and was described as 5 cm in length with a flat and rounded end (Rhoads 1983:103). It was estimated to have been deposited at the site between 1900 and 1600 yrs BP (Rhoads 1983:99). The Sokoli artefact is dated to around 2000 yrs BP, broadly contemporary with the Samoa item (Plate 10.2).

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Plate 10.1 Incised bone artefact (IB1) from Sokoli, Dauar Island

Plate 10.2 Incised bone artefact from Samoa site at Kikori, southern New Guinea (after Rhoads 1983:103)

Coral Artefacts

The coral artefacts recovered from the Murray Islands include two fishing sinkers from Kurkur Weid of similar form to the stone fishing sinkers from Ormi, and one cobble sized abrader from Sokoli similar to the impacted stone from Kurkur Weid. Both branch (*Acropora* sp.) and block coral artefacts with ground edges were recovered from excavations and surface contexts on Buka Island, and are described as ‘common artefact types dating back to the Lapita period in both Melanesia and Polynesia’ (Wickler 2001:191-193, Plate 7.7).

The tear-drop shaped coral artefact (MC2) with a perforation through its distal end recovered from Kurkur has no ethnohistorically recorded equivalent in Torres Strait. However, similar artefacts of stone have been described in Pacific contexts, including New Caledonia, where recovered items are described with ‘a large ground or drilled hole in one extremity or in the centre’ (Sand 2001:81). These are defined as fishing net sinkers. Haddon (1912) claimed that fishing nets were not used in the Torres Strait, although a conical shaped fish scoop was regularly used on the Murray Islands to collect small fish shoaling close into shore. Given this evidence and the recovery of only one of this type of artefact from the excavations, the pre-late 19th century use of fishing nets on the Murray Islands cannot be substantiated at this stage.

Pottery

The pottery assemblage recovered from the Murray Islands comprised 24 sherds from excavations on Dauar and one large conjoining sherd from a surface context on Mer (MER1/MER2). All but one of the excavated sherds (SOK1) were from Ormi, where a diversity of pottery fabrics potentially representing the remains of a number of different pottery vessels were identified. The range of antiquity for the entire excavated pottery assemblage from Dauar is estimated at between 2000 and 700 cal BP. Although approximately 87% of the sherds from Ormi were recovered in Horizon IV and Horizon V, which pre-date 2000 cal BP, disturbance caused by plant root growth in the lower Horizons may well have caused the sherds to move post-deposition. Both the small sizes of the pottery sherds recovered below Horizon III and the loosely consolidated nature of sediment in Horizon IV and Horizon V confirm the likelihood that the original context of the Ormi pottery assemblage was Horizon III.

The Murray Islands sherds represent the first pottery recorded from stratified archaeological contexts within the central island core of Torres Strait. Ethnohistoric records and the material culture assemblages inventoried from the Torres Strait during the late 19th century indicate that pottery was neither manufactured by Torres Strait Islanders, nor was it included in the customary trade and exchange of goods from Papua New Guinea. Although several references to pottery vessels in the Torres Strait during the early 20th century were identified, the contexts in which they were recorded confirm that European missionaries were largely responsible for their presence. The pottery recovered from the Murray Islands therefore offers new evidence on the nature of trade and exchange between Torres Strait and New Guinea. and one of the first opportunities to investigate these regional networks from an archaeological perspective.

The mineralogical analyses of a limited number of the Murray Islands pottery sherds (ORM1, ORM2, ORM3 and MER2) revealed interesting, but not wholly conclusive results for determining the place of manufacture of the artefacts. The variety of specialist techniques used to determine the mineralogy of the pottery temper, including Energy Dispersal Spectra (EDS) and Scanning Electron Microscope (SEM), demonstrated that the mineral inclusions (for example, hornblende, pyroxene, feldspar, muscovite, quartz and olivine) were derived from igneous and metamorphic rock sources. From the initial elemental composition analysis of a number of selected minerals, a broad association between the pottery mineralogy and the geology of the New Guinea Highlands was identified. The results of a secondary specialist analysis of temper mineralogy and quantitative grain types in ORM2 and MER2 provided more detail on the origin and derivation of the pottery temper.

Firstly, the combined volcanic and metamorphic mineralogy of the tempers was confirmed, as was the New Guinea Highlands volcanic province as their likely source of origin. Secondly, the results of the quantitative counts of grain types demonstrated that the source for the coarser grained sherds (ORM2 and MER2) was different from the source of the finer grained sherds (ORM1 and ORM3). For the coarser grained sherds the Kubor Anticline, and more specifically the Mogono River that passes through the combined granitic and metamorphic bedrock of the volcanic Kubor Range, is suggested as the likely source of pottery temper. For ORM1 and ORM3, it was concluded that due to the fine-grained nature of the sand and the diluted nature of the metamorphic and volcanic mineralogy, a location downstream from the parent rock source was more likely, such as the Kikori River on the southwestern fringe of the Highlands volcanic province.

In the context of the archaeologically documented history of pottery production in the New Guinea Highlands, any suggestion of this region being the place of manufacture of the Murray Islands pottery sherds cannot be substantiated. Research has shown that pottery manufacture was limited to several regions in the Eastern Highlands and currently is known only to have occurred within the last 1000 years (White 1972). However, these archaeological investigations have also revealed the surprising extent of pottery trade in the region, as well as the potentially important role played by riverways in the transfer of goods between interior and more coastal areas (White 1972; McDowell 1989).

Although a combined metamorphic and igneous mineralogy has been illustrated for a number of pottery assemblages from along the southern Papuan coast, the specific mineralogy of the Murray Islands pottery places the source of their tempers west of well-documented pottery producing centers of Port Moresby, Yule Island and the Massim. Significantly, both ethnohistoric and previous archaeological evidence have confirmed the existence of trade networks between the Torres Strait and the New Guinea Highlands (best illustrated by pearl-shell trade), as well as the key role played by coastal hinterland and riverine groups in the dispersal of goods from both the north and the south (McCarthy 1939-1940; Rhoads and Mackenzie 1991; Swadling and Aniamato 1989). As noted in Chapter Two, oral histories from groups situated along the Pahaturi, Binaturi and Oriomo Rivers recorded by Lawrence (1994), also confirm trade contacts between the Torres Strait and New Guinea prior to the settlement of Kiwai groups along the southwestern Papuan coast during the late 19th century.

Collectively, the results of the Murray Island pottery analysis and previously documented evidence for trade and exchange between islanders and groups located along river systems of the southwestern coastal lowlands, support the hypothesis for the existence of previously undocumented trade and exchange networks within the region. In turn, this evidence also implies the possibility of broader networks of pottery production along the southern Papuan coast than has been established by archaeological research in the region. The recent recovery of red-slipped pottery sherds from excavations and surface contexts on Pulu Islet in the Western Torres Strait (David and McNiven 2004), provides further evidence for broader networks of production and distribution than those documented ethnohistorically. The presence of pottery in the Western Islands also suggests that pottery may have played some role in Torres Strait, as well as the occurrence of intra-island trade of this commodity, which by the time of sustained European contact in the region by the late 19th century, had ceased. However, based on the limited data obtained from examination of the Torres Strait pottery sherds to date, as well as the lack of ethnographic data, the role that pottery played and whether it represented an item used purely for domestic purposes or held some form of ceremonial significance, cannot yet be determined.

As the chronology determined for the excavated Murray Islands pottery is virtually contemporaneous with the first archaeologically recorded presence of ceramics on the southern Papuan coast at 2000 cal BP, what is more conclusive is that contact between the two regions was maintained from the time of initial occupation of Dauar at 2600 cal BP. Contrary to the conclusion made by David et al. (2004:76) that the absence of pottery in Torres Strait before 2000 yrs BP ‘indicates that direct contacts with distant pottery producing centres was not intensive’, the evidence more likely demonstrates contact and trade with Austronesian speaking groups upon their immediate arrival in southern Papua, or the intrusion of ‘Austronesian’ items into already established systems.

If the low numbers of pottery sherds recovered from Torres Strait can be interpreted as evidence that links with Austronesians were quickly curtailed (David et al. 2004:76), this can equally, (and perhaps more accurately) support a conclusion that the occupation of Torres Strait not only pre-dated the Austronesian expansion into southern Papua, but also occurred entirely independent of this event. However, as indicated previously and as the above discussion on the non-ceramic material culture assemblage from the Murray Islands has demonstrated, the presence of a number of artefacts commonly associated with the Austronesian tool kit throughout the Western Pacific firmly attests some, direct or indirect, Austronesian influence in Torres Strait.

Conclusions: Development of a Late Holocene Cultural Complex

Of the several significant contributions this thesis has made to the archaeology of Torres Strait, one of the more seminal and timely offerings has been the examination of the archaeology of the Murray Islands within a regional chronological context and broader cultural framework. In the first half of the thesis this comprised a synthesis of the Torres Strait Cultural Complex based predominantly on early historical and ethnographic records for Cape York, the Torres Strait Islands and southern New Guinea. A review of the results of previous archaeological research in Torres Strait, southern New Guinea and northern Queensland, demonstrated major interlinking patterns for late-Holocene human occupation, migration and settlement, subsistence development and change, as well as patterns in the production and distribution of material culture.

The middle section of this thesis provided the results of detailed analyses of the excavated archaeological contexts from the Murray Islands, including the marine and terrestrial subsistence remains, archaeobotanical evidence, and the material culture assemblages. Finally, interpretations of the results of the investigations into occupation, subsistence and trade on the Murray Islands were formulated within a regional setting with reference to supporting evidence from Torres Strait, New Guinea, Island Melanesia and the Pacific.

The major conclusion establishes the occupation of the Murray Islands and the Torres Strait as a late-Holocene event dating from as early as 3000 years ago. Although marine subsistence resources on Dauar date from the time of initial occupation, evidence of the presence of cultigens probably imported from New Guinea and low-level clearance is determined from 2000 cal BP, with the suspected later emergence of the more intensive and ethnohistorically documented horticultural economy by 1650 cal BP. The presence of pottery sherds on Dauar dating from 2000 cal BP supports the interpretation of long-term and ongoing links between the Murray Islands and the southern Papuan coast, while the excavated non-ceramic material culture assemblage similarly confirms Papuan connections and an indirect Austronesian influence from this time.

Previous analysis and quantification of the excavated shell remains from Kurkur Weid and Pitkik on Mer and Sokoli on Dauar have demonstrated salient discontinuities in species composition of the archaeological shell assemblages and the species identified as key dietary sources through observations of contemporary Meriam gathering strategies (Richardson 2000; Bird et al. 2002 and also Bird et al. 2004). The analysis of the excavated Murray Islands shell assemblages conducted as part of this thesis confirmed the archaeological visibility of factors in prey choice, processing and transport behavior observed in the ethnographic present. These results provide a unique insight into past maritime subsistence strategies on the Murray Islands, and an important lesson for identifying and quantifying the contribution of resources to the overall subsistence economy.

The phytolith and starch grain analysis of excavated sediment samples is the first application of this method for the identification of prehistoric horticulture in Torres Strait. The recovery, identification and quantification of microfossil plant remains from archaeological sites is becoming an increasingly utilised and accepted tool for determining past clearance and land use strategies, as well as shifts in human subsistence systems (Bowdery 1998; Boyd et al. 1998; Parr et al. 2001a; Wallis 2001). Although the sample size was limited, the Sokoli and Ormi analyses produced evidence for the remains of common Pacific crops including coconut, *Musaceae* sp., and *Dioscorea* sp., as well as possible shifts in vegetation patterns through clearance and burning and fallow regimes. These results demonstrate the potential of phytolith and starch grain analysis for identifying evidence of past horticultural subsistence practices in Torres Strait. Significantly, they also illustrate the benefit of this technique in the event where excavation fails to recover evidence for horticulture in the form of definite stratigraphic features, artefactual remains, or the macrofloral remains of known edible species.

The results of the mineralogical analysis of the Murray Islands pottery sherds provide the first insight into the origin and chronology of an artefact type previously not recorded for Torres Strait. From the analysis of Melanesian and Pacific pottery assemblages archaeologists have identified networks of production and trade, providing important data to illustrate human settlement patterns and to confirm changes in exchange systems (Ambrose 1992, 1993; Bickler 1997; Dickinson et al. 1979; Summerhayes 2000). The recovery of pottery sherds provided the first ever opportunity for similar investigations in the context of trade and exchange in Torres Strait.

The mineralogies of the Murray Islands pottery tempers were confirmed as exotic to Torres Strait, and were identified as originating from both upstream and downstream contexts within the vicinity of the New Guinea Highlands. Suspected temper sources included sands from the Mogono River and Kikori River systems, suggesting derivation of pottery raw materials west of the archaeologically documented regions of pottery production along the southern Papuan coast. Interestingly, historical, archaeological and oral history evidence confirms the possibility of the presence of groups situated along strategic riverways and coastal hinterlands on the southern Papuan coast prior to European contact in this region. The totality of this evidence supports the hypothesis of more extensive pottery production networks in southern Papua New Guinea than previously documented both ethnohistorically and archaeologically.

This thesis, both in its entirety and in its separate components of investigation, provides an important contribution to furthering and expanding our knowledge on the archaeology of one of Australia's most environmentally and culturally diverse regions. As demonstrated here, it is the archaeology of Torres Strait that firmly connects this region to the late-Holocene cultural expansions that occurred throughout the broader Australian and Western Pacific regions. From the combined ethnohistorical and field archaeological evidence for the Murray Islands, it is concluded that the timing of permanent human occupation, the nature of subsistence and the archaeological material culture are the result and product of late-Holocene human expansion and cultural intensification previously documented for New Guinea, Island Melanesia, the Pacific and northern Queensland. There is no unequivocal evidence that the Austronesian expansion into Island Melanesia had a role in the occupation of Torres Strait. Its influence in subsistence and material culture was felt only indirectly, but nonetheless added some additional 'flavour' to the unique cultural complex of Torres Strait.

Recommendations and Directions for Future Research

Based on the results reported in this thesis, a number of recommendations and directions for future archaeological research on the Murray Islands, as well as in the Torres Strait more generally, are identified. These relate to the three themes investigated; the timing of human occupation, the development of the marine and horticultural subsistence economies and the antiquity of trade and exchange systems.

To provide a broader sample of archaeological assemblages associated with occupation of the Murray Islands, future investigations may benefit from targeting coastal occupation deposits associated with past village sites, ie. Werbadu and Las on Mer (see Figure 4.1). An archaeological survey of inland regions of Mer, particularly the eastern side of the island, may provide important insights into island occupation as well as further evidence for the nature of site use in relation to subsistence practices.

Although excavation of any sites associated with gardening may not be achievable due to traditional ownership issues, detailed survey and recording of sites in the interior of Mer will provide a broader understanding of the nature and distribution of site types on the island. However, if the aim of future archaeological research on the Murray Islands is to attempt to identify evidence of pre-3000 year human occupation in accordance with the early Holocene occupation sequence recently established in the Western Islands (David et al. 2004), excavation of interior regions may prove the most fruitful. This is due to the fact that, as established by Barham (2000), the progradation of beach environments around the small, high islands of Torres Strait commenced approximately 3000 yrs BP, until which time occupation may have been confined to higher interior parts of the islands.

To achieve a more detailed chrono-stratigraphic record of the development of the horticultural subsistence economy of the Murray Islands, a complete column of sediment samples should be taken from any future excavations for the purposes of microfossil plant analysis. The validity of phytolith and starch grain analyses has been demonstrated in this thesis, and as such should be employed in the future when identifying and examining evidence of prehistoric horticulture on the Murray Islands. The results of the sediment analyses revealed the applicability of this technique in the context of the absence of any macrofossil, stratigraphic or topographic evidence of past horticultural subsistence practices, thereby confirming its potential for identifying microscopic evidence for horticulture throughout the Torres Strait. However, if phytolith and starch grain analysis is to be employed regularly in the palaeobotanical analysis of Torres Strait sediments, than there is a necessity for the development of an adequate plant reference collection from the region, specifically of traditional and contemporary cultigens, as well as other indigenous and introduced taxa.

In the context of future examinations of the archaeological evidence for trade and exchange on the Murray Islands, the pottery sherds will remain the focus of research. As only a small percentage of the total number of sherds recovered were subject to mineralogical analysis, there is significant scope for comparative analyses between more samples of the petrology of the Murray Islands pottery assemblage. Although the results may aid in confirming the suspected 2000-year old trade links between the Murray Islands and groups located in the coastal hinterland regions of southwestern New Guinea, they are sure to illuminate in greater detail the geographic origin of pottery recovered from the Eastern Torres Strait. Ultimately, however, a full understanding of this issue will require the availability of more comparative pottery samples from southwestern New Guinea also.

Finally, future considerations of the occupational sequences of the Torres Strait in general, as well as the timing of the development of its subsistence systems in particular, require a more thorough consideration and examination of the archaeology of the entire southern coast of New Guinea extending east to the Fly Estuary and west to Irian Jaya. As this thesis has demonstrated, Torres Strait Islander oral history, linguistic evidence, material culture and the regions historical records all testify to links and origins to the north. Thus as the basic sequences for the prehistory of Torres Strait have now been formulated, what is now required is to build upon these sequences through further research across Torres Strait but also with the added perspective of looking north to New Guinea, to more extensively address the fundamental questions of the region’s occupation, subsistence development and cultural networks.

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Appendix A

Contemporary and alternative names of the Torres Strait Islands

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Names in italics are those in contemporary use (after Lawrence 1994:400)

Appendix B

Data for sediment accumulation rates and age-correlation for stratigraphic Horizons

Horizon	SU	Depth below surface (cm)	Sediment (Kg)	Upper Age (cal BP)	Basal Age (cal BP)	Duration	Sediment (kg/100yrs)	Sediment (cm/100yrs)
I	1 – 4	0 – 15	78.86	0	315	315	25.03	4.76
II	5 – 12	15 – 25	42.88	315	520	205	20.9	4.87
III	13	25 – 110	206.52	520	780	260	79.43	32.69
IV	14	110 – 130	49.68	780	965	185	26.85	10.81

Kurkur Weid

Horizon	SU	Depth below surface (cm)	Sediment (Kg)	Upper Age (cal BP)	Basal Age (cal BP)	Duration	Sediment (kg/100yrs)	Sediment (cm/100yrs)
I	1	0 – 40	147.07	0	380	380	38.7	10.52
II	2	40 – 50	27.71	380	610	230	12.04	4.34
III	3 – 4	50 – 60	76.19	610	775	165	46.17	6.06
IV	5 – 6	60 – 85	129.13	775	800	25	516.52	100.0
V	7 – 8	85 – 110	120.28	800	900	100	120.28	25.0

Pitkik

Horizon	SU	Depth below surface (cm)	Sediment (Kg)	Upper Age (cal BP)	Basal Age (cal BP)	Duration	Sediment (Kg/100yrs)	Sediment (cm/100yrs)
I	1 – 3	0 – 50	481.39	0	900	900	53.48	5.58
II	4 – 6	50 – 100	458.98	900	1400	500	91.79	10.0
III	7 – 11	100 – 150	560.62	1400	1650	250	224.24	20.0
IV	12 – 13	150 – 185	381.42	1650	1800	150	254.28	23.2
V	14	185 – 234	473.16	1800	2600	800	59.14	6.12

Sokoli

Horizon	SU	Depth below surface (cm)	Sediment (Kg)	Upper Age (cal BP)	Basal Age (cal BP)	Duration	Sediment (Kg/100yrs)	Sediment (cm/100yrs)
I	1 – 4	0 – 70	766.49	1600	1800	200	383.24	35.0
II	5 – 7	70 – 110	651.9	1800	1900	100	651.9	40.0
III	8 – 9	110 – 130	341.77	1900	2000	100	341.77	20.0
IV	10 –12	130 – 185	715.69	2000	2250	250	286.27	22.0
V	13	185 – 225	582.84	2250	2600	350	166.52	11.4

Ormi

Appendix C

Molluscan shell recoveries from Kurkur Weid, Pitkik, Sokoli and Ormi

Kurkur Weid, XU1 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	222.75	4455.0	5.9	1
Nerita undata	271.6	5432.0	7.14	11
Strombus luhuanus	87.12	1742.4	2.3	3
Tridacna spp.	3085.1	61702.0	81.1	0
Trochus niloticus	9.08	181.6	0.23	0
OTHER				
Acanthopleura sp.	0.31	6.2	0.008	0
Asaphis violascens	7.21	144.2	0.2	0
Cerithium sp.	0.34	6.8	0.008	2
Cymatiuum vespaceum	0.29	5.8	0.007	1
Cypraea sp.	8.93	178.6	0.23	0
Nassirius sp.	0.26	5.2	0.006	1
Nerita polita	17.73	354.6	0.5	1
Nerita sp.*	0.63	12.6	0.01	0
Paphies striata	0.73	14.6	0.01	1
Patelloida sp.	0.11	2.2	0.001	2
Planaxis sulcatus	15.4	308.0	0.4	0
Polinices sp.	0.3	6.0	0.007	1
Pyrene sp.	0.4	8.0	0.01	1
Turbo argyrostoma	56.99	1139.8	1.5	1
Terrestrial snail	0.92	18.4	0.02	1
Unidentified fragments	19.2	384.0	0.5	-
TOTALS	3805.4	76108.0	100.1	27

Total volume of XU1 deposits = 0.05m³
* Unidentified *Nerita* sp. operculum

Kurkur Weid, XU2 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	82.8	4870.6	19.04	2
Hippopus hippopus	0	0	0	0
Lambis lambis	147.97	8704.11	34.04	1
Nerita undata	7.59	446.5	1.74	9
Strombus luhuanus	45.34	2667.1	10.4	2
Tridacna spp.	122.2	7188.23	28.11	1
Trochus niloticus	0	0	0	0
OTHER				
Asaphis violascens	3.76	221.2	0.9	1
Littorina sp.	0.23	13.52	0.05	1
Nassirius albescens	0.86	50.6	0.2	1
Nerita polita	0.87	51.2	0.2	0
Terrestrial snail	0.07	4.11	0.01	0
Unidentified fragments	23.0	1352.94	5.3	-
TOTALS	434.69	25570.0	99.99	18

Total volume of XU2 deposits = 0.017m³

Kurkur Weid, XU3 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	67.55	6140.9	3.2	1
Hippopus hippopus	69.05	6277.3	3.22	0
Lambis lambis	138.26	12569.1	6.5	1
Nerita undata	4.3	390.9	0.2	7
Strombus luhuanus	25.05	2277.3	1.2	1
Tridacna spp.	1774.7	161336.4	83.0	1
Trochus niloticus	32.97	2997.3	1.54	1
OTHER				
Asaphis violascens	2.81	255.5	0.13	0
Cypraea sp.	1.2	109.1	0.05	0
Cerithium sp.	0.36	32.72	0.01	1
Nerita polita	2.72	247.3	0.12	0
Nerita sp.*	0.42	38.2	0.01	0
Paphies striata	3.27	297.3	0.2	1
Patelloida sp.	0.3	27.3	0.01	1
Planaxis sulcatus	4.32	392.72	0.2	0
Pyrene sp.	1.74	158.2	0.08	0
Tellina palatum	1.02	95.72	0.04	0
Turbo argyrostoma	2.0	181.81	0.1	0
Terrestrial snail	0.56	50.9	0.02	0
Unidentified fragments	6.8	618.2	0.31	-
TOTALS	2139.4	194490.9	100.14	15

Total volume of XU3 deposits = 0.011m³
* Unidentified *Nerita* sp. operculum

Kurkur Weid, XU4 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	1.02	63.8	0.2	0
Hippopus hippopus	201.68	12605.0	40.0	1
Lambis lambis	292.78	18298.8	58.0	2
Nerita undata	2.55	159.4	0.5	2
Strombus luhuanus	0	0	0	0
Tridacna spp.	0	0	0	0
Trochus niloticus	0.63	39.4	0.12	0
OTHER				
Nerita albicilla	0.3	18.8	0.05	0
Planaxis sulcatus	0.31	19.4	0.06	0
Tellina scobinata	1.49	93.12	0.3	1
Turbo sp.^	0.63	39.4	0.12	0
Terrestrial snail	0.26	16.3	0.05	0
Unidentified fragments	3.13	195.62	0.62	-
TOTALS	504.78	31548.8	100.02	6

Total volume of XU4 deposits = 0.016m³
^ Unidentified *Turbo* sp. operculum

Kurkur Weid, XU5 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	1.9	100.0	1.33	0
Hippopus hippopus	0	0	0	0
Lambis lambis	10.72	564.21	7.54	0
Nerita undata	5.38	283.2	3.8	7
Strombus luhuanus	44.7	2352.63	31.44	2
Tridacna spp.	37.35	1965.8	26.3	1
Trochus niloticus	15.28	804.21	10.8	0
OTHER				
Asaphis violascens	2.22	116.8	1.6	0
Acanthopleura sp.	0.16	8.42	0.11	1
Cerithium sp.	2.88	151.6	2.02	2
Cypraea arabica	2.46	129.5	1.73	0
Nerita polita	3.38	177.9	2.4	0
Nerita sp.*	1.22	64.21	0.9	0
Planaxis sulcatus	2.63	138.42	1.84	2
Paphies striata	0.93	48.94	0.7	1
Tellina scobinata	0.72	37.9	0.5	0
Tellina sp.	0.4	21.1	0.3	0
Turbo argyrostoma	4.12	216.84	2.9	0
Terrestrial snail	0	0	0	0
Unidentified fragments	5.72	301.1	4.02	-
TOTALS	142.17	7482.63	100.2	16

Total volume of XU5 deposits = $0.019m^3$
* Unidentified *Nerita* sp. operculum

Kurkur Weid, XU6 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	55.78	1394.5	2.1	1
Hippopus hippopus	15.5	387.5	0.6	0
Lambis lambis	1645.34	41133.5	61.52	8
Nerita undata	9.47	236.8	0.4	7
Strombus luhuanus	168.15	4203.8	6.3	8
Tridacna spp.	137.68	3442.0	5.14	2
Trochus niloticus	489.18	12229.5	18.3	6
OTHER				
Asaphis violascens	3.09	77.3	0.11	1
Cerithium sp.	0.53	13.25	0.01	1
Cypraea arabica	4.98	124.5	0.2	2
Nerita polita	2.45	61.25	0.09	0
Nerita sp. *	1.3	32.5	0.04	0
Paphies striata	0.6	15.0	0.02	1
Planaxis sulcatus	8.89	222.25	0.33	2
Polinices pyriformis	8.15	203.78	0.3	1
Polinices sp.	1.8	45.0	0.1	2
Pyrene sp.	0.36	9.0	0.01	2
Strombus lentiginosus	37.67	941.8	1.4	1
Tellina palatum	0.06	1.5	0.002	0
Tellina scobinata	0.36	9.0	0.01	0
Tellina sp.	2.14	53.5	0.08	1
Turbo argyrostoma	74.74	1868.5	2.8	1
Terrestrial snail	0.46	11.5	0.01	1
Unidentified fragments	5.79	144.75	0.21	-
TOTALS	2674.47	66861.8	100.1	48

Total volume of XU6 deposits = 0.04m³
* Unidentified *Nerita* sp. operculum

Kurkur Weid, XU7 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	615.11	25629.6	52.7	4
Nerita undata	4.89	203.8	0.41	6
Strombus luhuanus	91.72	3821.7	7.9	4
Tridacna spp.	191.35	7972.91	16.4	2
Trochus niloticus	156.37	6515.41	13.4	1
OTHER				
Asaphis violascens	1.0	41.7	0.1	1
Cypraea arabica	2.22	92.5	0.2	0
Cypraea sp.	2.37	98.8	0.2	0
Mactridae sp.	7.7	320.83	0.7	1
Nerita polita	5.24	218.33	0.44	1
Paphies striata	1.71	71.3	0.14	1
Planaxis sulcatus	7.25	302.1	0.62	4
Strombus lentiginosus	41.41	1725.41	3.54	1
Turbo argyrostoma	34.53	1438.8	3.0	1
Terrestrial snail	1.48	61.7	0.12	0
Unidentified fragments	3.7	154.2	0.31	-
TOTALS	1168.05	48668.8	100.2	27

Total volume of XU7 deposits = 0.024m³

Kurkur Weid, XU8 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	4.55	182.0	0.3	1
Hippopus hippopus	0	0	0	0
Lambis lambis	308.1	12324.0	21.6	3
Nerita undata	2.8	112.0	0.2	5
Strombus luhuanus	148.27	5930.8	10.4	7
Tridacna spp.	235.17	9406.8	16.5	0
Trochus niloticus	680.91	27236.4	47.7	4
OTHER				
Asaphis violascens	1.05	42.0	0.07	0
Anadara antiquata	28.87	1154.8	2.02	1
Cerithium sp.	0.6	24.0	0.04	2
Cypraea sp.	0.78	31.2	0.05	0
Littorina pintado	0.14	5.6	0.009	1
Nerita albicilla	0.12	4.8	0.001	1
Nerita polita	0.16	6.4	0.001	0
Planaxis sulcatus	4.77	190.8	0.33	4
Saccostrea cucullata	0.13	5.2	0.009	1
Tellina palatum	0.53	21.2	0.03	0
Turbo argyrostoma	3.04	121.6	0.21	0
Terrestrial snail	4.99	199.6	0.34	3
Unidentified fragments	3.1	124.0	0.21	-
TOTALS	1428.08	57123.2	100.02	33

Total volume of XU8 deposits = 0.025m³

Kurkur Weid, XU9 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m*^{3}	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	679.96	33998.0	34.5	3
Nerita undata	1.6	80.0	0.08	2
Strombus luhuanus	0.68	34.0	0.03	0
Tridacna spp.	395.66	19783.0	20.1	1
Trochus niloticus	816.24	40812.0	41.42	6
OTHER				
Asaphis violascens	0.83	41.5	0.04	0
Paphies striata	2.13	106.5	0.1	1
Tellina palatum	13.12	656.0	0.7	1
Turbo argyrostoma	60.08	3004.0	3.04	1
Terrestrial snail	0.1	5.0	0.005	0
Unidentified fragments	0	0	0	0
TOTALS	1970.4	98520.0	100.01	15

Total volume of XU9 deposits = 0.02m^3

Kurkur Weid, XU10 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	106.5	4630.43	34.04	1
Lambis lambis	157.0	6826.1	50.2	1
Nerita undata	3.15	137.0	1.0	4
Strombus luhuanus	0.22	9.6	0.1	0
Tridacna spp.	0	0	0	0
Trochus niloticus	18.21	791.73	5.82	1
OTHER				
Nerita sp.*	0.12	5.21	0.03	0
Paphies striata	0.44	19.13	0.14	0
Planaxis sulcatus	3.48	151.3	1.11	1
Syrinx auruanus	8.27	359.6	2.64	0
Tellina palatum	0.61	26.52	0.2	0
Turbo argyrostoma	0.35	15.21	0.11	0
Turbo sp.^	7.32	318.3	2.34	0
Terrestrial snail	0.22	9.6	0.07	0
Unidentified fragments	6.91	300.43	2.2	-
TOTALS	312.8	13600.0	100.0	8

Total volume of XU10 deposits = 0.023m³
* Unidentified *Nerita* sp. operculum
^ Unidentified Turbo sp. operculum

Kurkur Weid, XU11 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	191.47	12764.7	48.32	2
Nerita undata	0.59	39.33	0.14	1
Strombus luhuanus	85.59	5706.0	21.6	5
Tridacna spp.	0	0	0	0
Trochus niloticus	92.2	6146.7	23.3	1
OTHER				
Asaphis violascens	4.5	300.0	1.13	1
Nerita sp.*	1.1	73.33	0.3	0
Nerita costata	1.2	13.0	0.04	1
Syrinx auruanus	12.41	827.33	3.13	0
Turbo argyrostoma	1.89	126.0	0.5	0
Terrestrial snail	0.07	4.7	0.01	0
Unidentified fragments	5.18	345.33	1.3	-
TOTALS	396.2	26413.33	99.8	11

Total volume of XU11 deposits = 0.015m^3
* Unidentified *Nerita* sp. operculum

Kurkur Weid, XU12 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	391.47	21748.33	76.4	3
Nerita undata	1.72	95.6	0.33	2
Strombus luhuanus	0	0	0	0
Tridacna spp.	0	0	0	0
Trochus niloticus	24.78	1376.7	4.83	0
OTHER				
Anodonta bullula	0.15	8.33	0.02	1
Conus sp.	16.57	920.6	3.2	1
Garfrarium pectinatum	5.49	305.0	1.1	1
Nerita albicilla	1.39	77.22	0.3	1
Nerita polita	1.13	62.8	0.22	0
Planaxis sulcatus	0.49	27.22	0.09	1
Pyrene sp.	0.25	13.9	0.04	1
Strombus gibberulus	0.64	35.6	0.12	1
Tellina palatum	0.49	27.22	0.09	0
Turbo argyrostoma	65.35	3630.6	12.74	1
Terrestrial snail	1.97	109.44	0.4	1
Unidentified fragments	0.79	43.9	0.2	-
TOTALS	512.68	28482.22	100.1	14

Total volume of XU12 deposits = 0.018m^3

Kurkur Weid, XU13 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	552.53	18417.7	23.84	4
Nerita undata	0.72	24.0	0.03	1
Strombus luhuanus	3.66	122.0	0.2	0
Tridacna spp.	1129.07	37635.7	48.72	3
Trochus niloticus	584.14	19471.33	25.2	4
OTHER				
Asaphis violascens	0.26	8.7	0.01	0
Cerithidae sp.	0.24	8.0	0.01	1
Cypraea arabica	0.39	13.0	0.01	0
Murcidiae sp.	0.36	12.0	0.01	0
Nerita polita	0.3	10.0	0.01	0
Patelloida sp.	0.38	12.7	0.01	2
Planaxis sulcatus	0.55	18.33	0.02	0
Pyrene sp.	0.31	10.33	0.01	1
Syrinx auruanus	41.92	1397.33	1.8	0
Turbo argyrostoma	0.51	17.0	0.02	0
Tellina palatum	0.28	9.33	0.01	0
Tellina scobinata	0.14	4.7	0.001	0
Terrestrial snail	0	0	0	0
Unidentified fragments	1.51	50.33	0.06	-
TOTALS	2317.27	77242.33	99.9	16

Total volume of XU13 deposits = 0.03m³

Kurkur Weid, XU14 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3^*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	14.63	860.6	10.6	0
Nerita undata	0	0	0	0
Strombus luhuanus	20.49	1205.3	14.82	1
Tridacna spp.	0	0	0	0
Trochus niloticus	4.15	244.11	3.00	0
OTHER				
Asaphis violascens	3.61	212.4	2.61	0
Nerita sp.*	0.06	3.52	0.04	0
Planaxis sulcatus	0.52	30.6	0.4	1
Strombus gibberuls	11.26	662.4	8.14	1
Syrinx auruanus	46.48	2734.11	33.62	0
Tellina palatum	6.5	382.4	4.7	1
Turbo argyrostoma	27.79	1634.7	20.1	0
Terrestrial snail	0.41	24.1	0.01	0
Unidentified fragments	2.33	137.1	1.7	-
TOTALS	138.23	8131.2	99.7	4

Total volume of XU14 deposits = $0.017m^3$
* Unidentified *Nerita* sp. operculum

Kurkur Weid, XU15 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	27.66	892.3	0.6	2
Hippopus hippopus	2172.8	70090.32	45.4	1
Lambis lambis	764.38	24657.41	16.0	5
Nerita undata	3.02	97.41	0.06	3
Strombus luhuanus	98.01	3161.61	2.04	4
Tridacna spp.	294.53	9501.0	6.2	2
Trochus niloticus	1275.04	41130.32	26.63	8
OTHER				
Garfrarium australe	0.74	23.9	0.01	1
Garfrarium pectinatum	0.74	23.9	0.01	1
Planaxis sulcatus	0.86	27.74	0.01	1
Strombus gibberulus	5.12	165.2	0.1	1
Strombus lentiginosus	101.54	3275.5	2.12	2
Syrinx auruanus	11.0	354.83	0.22	0
Turbo argyrostoma	0.21	6.8	0.004	0
Trapezium sp.	0.81	26.12	0.01	1
Terrestrial snail	0.08	2.6	0.001	0
Unidentified fragments	30.32	978.1	0.63	-
TOTALS	4786.86	154414.83	100.04	32

Total volume of XU15 deposits = 0.031m³

Kurkur Weid, XU16 Molluscan Shell Recoveries

Species	Weight gm	Density gm/m^3	% of tot. wt.	MNI
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0.84	50.9	0.13	0
Hippopus hippopus	0	0	0	0
Lambis lambis	410.58	24883.63	64.82	5
Nerita undata	2.19	132.72	0.34	3
Strombus luhuanus	82.3	4987.9	13.0	5
Tridacna spp.	8.54	517.6	1.34	0
Trochus niloticus	0	0	0	0
OTHER				
Asaphis violascens	8.52	516.4	1.34	0
Cardita variagata	0.17	10.3	0.02	0
Cypraea sp.	0.55	33.33	0.08	0
Dosinia sp.	0.38	23.03	0.05	1
Garfrarium pectinatum	0.48	29.1	0.07	1
Planaxis sulcatus	2.67	161.8	0.42	1
Pyrene sp.	0.63	38.2	0.09	1
Syrinx auruanus	84.72	5134.54	13.4	0
Tellina scobinata	0.8	48.5	0.12	1
Turbo argyrostoma	3.8	230.3	0.6	0
Terrestrial snail	0	0	0	0
Unidentified fragments	26.16	1585.5	4.13	-
TOTALS	633.33	38383.63	99.9	18

Total volume of XU16 deposits = $0.0165m^3$

Kurkur Weid, XU17 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m*^{3}	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	2.45	116.7	1.4	0
Lambis lambis	63.85	3040.5	36.6	0
Nerita undata	8.78	418.1	5.03	8
Strombus luhuanus	25.54	1216.2	14.63	1
Tridacna spp.	34.31	1633.8	19.7	0
Trochus niloticus	2.6	123.8	1.5	0
OTHER				
Asaphis violascens	4.52	215.23	2.6	0
Cerithium sp.	1.38	65.71	0.8	0
Cypraea sp.	1.82	86.7	1.04	1
Garfrarium pectinatum	2.39	113.8	1.4	1
Murcididae sp.	0.6	28.6	0.34	1
Nerita albicilla	2.24	106.7	1.3	2
Turbo sp.^	4.34	206.7	2.5	0
Terrestrial snail	0.33	15.71	0.2	0
Unidentified fragments	19.35	921.42	11.08	-
TOTALS	174.5	8309.52	99.4	14

Total volume of XU17 deposits = 0.021m^3
^ Unidentified *Turbo* sp. operculum

Pitkik, XU1 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	303.8	2450.0	11.9	0
Lambis lambis	813.71	6562.2	31.8	5
Nerita undata	52.75	425.4	2.05	33
Strombus luhuanus	73.16	590.0	2.9	3
Tridacna spp.	44.03	355.1	1.71	0
Trochus niloticus	719.74	5804.4	28.1	9
OTHER				
Asaphis violascens	0.81	6.53	0.03	0
Cerithium nodulosum	19.8	159.7	0.8	1
Cerithium sp.	0.49	4.0	0.01	1
Cypraea sp.	36.23	292.2	1.41	3
Littorina sp.	0.37	3.0	0.004	1
Melo amphora	74.53	601.04	2.9	0
Nerita albicilla	8.35	67.33	0.32	4
Nerita polita	3.08	24.83	0.12	5
Planaxis sulcatus	5.0	40.32	0.2	1
Strombus gibberulus	8.17	65.9	0.31	2
Tellina palatum	2.7	21.8	0.1	1
Turbo argyrostoma	321.5	2592.74	12.54	4
Turbo crassus	54.56	440.0	2.12	1
Terrestrial snail	1.99	16.04	0.07	0
Unidentified fragments	18.01	145.24	0.7	-
TOTALS	2562.78	20667.58	100.1	74

Total volume of XU1 deposits = $0.124m^3$

Pitkik, XU2 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	4.66	186.4	10.5	0
Nerita undata	3.04	121.6	6.82	2
Strombus luhuanus	0	0	0	0
Tridacna spp.	0	0	0	0
Trochus niloticus	0.9	36.0	2.02	0
OTHER				
Arca sp.	0.45	18.0	1.01	1
Asaphis violascens	0.56	22.4	1.3	0
Cerithium nodulosum	3.37	134.8	7.6	0
Codakia tigerina	2.21	88.4	5.0	0
Columbella sp.	0.46	18.4	1.03	4
Cypraea sp.	1.32	52.8	3.0	0
Nerita albicilla	2.72	108.8	6.1	1
Strombus gibberulus	3.76	150.4	8.44	1
Strombus sp.	0.53	21.2	1.2	0
Tellina palatum	0.4	16.0	0.9	0
Tellina scobinata	1.8	72.0	4.04	0
Trochus erythaeus	0.23	9.2	0.51	0
Terrestrial snail	0	0	0	0
Unidentified fragments	18.13	725.2	40.7	-
TOTALS	44.54	1781.6	100.2	9

Total volume of XU2 deposits = 0.025m³

Pitkik, XU3 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	98.94	2174.5	24.6	1
Hippopus hippopus	0	0	0	0
Lambis lambis	9.53	209.5	2.4	0
Nerita undata	39.47	867.5	9.8	24
Strombus luhuanus	158.42	3481.8	39.4	8
Tridacna spp.	0	0	0	0
Trochus niloticus	0.5	11.0	0.12	0
OTHER				
Columbella sp.	0.16	3.51	0.03	1
Cerithium sp.	9.55	209.9	2.4	1
Cypraea sp.	4.85	106.6	1.2	0
Modiulus sp.	0.31	6.81	0.07	1
Monodonta labio	1.06	23.3	0.3	0
Nerita albicilla	10.84	238.24	2.7	4
Nerita polita	2.36	51.9	0.6	1
Planaxis sulcatus	2.22	48.8	0.6	0
Strombus erythrinus	5.57	122.4	1.4	1
Strombus gibberulus	26.5	582.41	6.6	2
Tellina palatum	1.16	25.5	0.3	0
Turbo argyrostoma	15.93	350.1	4.0	0
Turbo sp.^	15.2	334.1	3.8	0
Terrestrial snail	0	0	0	0
Unidentified fragments	0	0	0	0
TOTALS	402.57	8847.7	100.3	44

Total volume of XU3 deposits = 0.0455m^3
^ Unidentified *Turbo* sp. operculum

Pitkik, XU4 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	16.21	675.41	7.4	0
Nerita undata	39.94	1664.2	18.14	21
Strombus luhuanus	21.81	908.8	9.9	1
Trochus niloticus	27.46	1144.2	12.5	0
Tridacna spp.	11.6	483.33	5.3	0
OTHER				
Antigona sp.	3.69	153.8	1.7	1
Asaphis violascens	0.22	9.2	0.1	0
Cerithium sp.	1.68	70.0	0.8	1
Codakia tigerina	6.0	250.0	2.72	0
Dosinia sp.	0.08	3.33	0.03	1
Murcidae sp.	0.5	20.83	0.22	1
Mytilus sp.	16.53	688.8	7.51	2
Nerita albicilla	1.9	79.2	0.9	2
Paphies striata	0.59	24.6	0.3	1
Patteloida sp.	0.53	22.1	0.24	0
Planaxis palatum	6.75	281.3	3.1	0
Trochus pyramis	12.76	531.7	5.8	1
Trochus virgatus	0.84	35.0	0.4	0
Turbo argyrostoma	0.44	18.33	0.2	0
Vasum turbinellus	29.57	1232.1	13.43	1
Terrestrial snail	0.43	17.91	0.2	0
Unidentified fragments	20.57	857.1	9.34	-
TOTALS	220.1	9170.83	100.2	33

Total volume of XU4 deposits = 0.016m³

Pitkik, XU5 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	246.37	3910.63	32.8	1
Nerita undata	20.58	326.7	2.73	9
Strombus luhuanus	97.16	1542.22	12.92	9
Tridacna spp.	112.9	1792.1	15.02	0
Trochus niloticus	146.87	2331.3	19.54	0
OTHER				
Acanthopleura sp.	0.36	5.71	0.04	0
Asaphis violascens	11.25	178.6	1.5	1
Davila plana	2.53	40.2	0.33	3
Modiolus sp.	2.56	40.63	0.34	0
Planaxis sulcatus	3.25	51.6	0.43	1
Patteloida sp.	0.71	11.3	0.1	1
Strombus gibberulus	32.24	511.74	4.3	4
Tellina palatum	2.1	33.33	0.3	0
Turbo argyrostoma	3.75	59.52	0.5	0
Vasum turbinellus	5.8	92.1	0.8	1
Terrestrial snail	4.06	64.44	0.54	0
Unidentified fragments	59.13	938.6	7.9	-
TOTALS	751.62	11930.5	100.1	30

Total volume of XU5 deposits = $0.063m^3$

Pitkik, XU6 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	26.76	442.31	4.14	1
Lambis lambis	93.05	1538.01	14.4	0
Nerita undata	22.81	377.02	3.53	13
Strombus luhuanus	152.23	2516.2	23.6	10
Tridacna spp.	117.94	1949.42	18.3	0
Trochus niloticus	104.97	1735.04	16.3	0
OTHER				
Anadara antiquata	4.4	72.72	0.7	1
Asaphis violascens	1.02	16.9	0.15	0
Cerithium sp.	4.49	74.2	0.7	1
Conus sp.	2.54	42.0	0.4	0
Bolma aureola	6.06	100.2	0.93	1
Modiolus sp.	3.62	53.23	0.5	0
Murcidae sp.	1.81	29.91	0.3	1
Nassirius sp.	0.44	7.3	0.06	1
Paphies striata	0.68	11.23	0.1	1
Pitar bullula	0.19	3.14	0.02	1
Planaxis sulcatus	1.21	20.0	0.2	1
Strombus gibberulus	28.71	474.54	4.44	3
Tellina palatum	3.7	61.2	0.6	0
Turbo argyrostoma	7.53	124.5	1.2	0
Vasum turbinellus	0	0	0	0
Terrestrial snail	4.11	67.93	0.6	1
Unidentified fragments	57.51	950.1	8.9	-
TOTALS	645.78	10674.04	100.1	36

Total volume of XU6 deposits = 0.0605m³

Pitkik, XU7 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	11.08	162.94	3.0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	101.06	1486.2	27.21	0
Nerita undata	13.06	192.1	3.51	10
Strombus luhuanus	44.37	652.5	11.94	4
Tridacna spp.	50.94	749.11	13.71	1
Trochus niloticus	40.0	588.23	10.8	0
OTHER				
Anadara sp.	3.02	44.41	0.81	1
Bolma aureola	18.7	275.0	5.03	1
Modiolus sp.	1.06	15.6	0.3	0
Nerita polita	1.79	26.32	0.5	1
Strombus gibberulus	33.4	491.2	9.0	3
Terrestrial snail	1.05	15.44	0.3	1
Unidentified fragments	51.77	761.32	13.94	-
TOTALS	371.3	5460.3	100.1	22

Total volume of XU7 deposits = $0.068 m^3$

Pitkik, XU8 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	175.99	4140.94	26.8	0
Nerita undata	22.16	521.41	3.4	14
Strombus luhuanus	152.83	3596.0	23.3	8
Tridacna spp.	73.39	1726.82	11.2	0
Trochus niloticus	26.49	623.3	4.03	0
OTHER				
Asaphis violascens	18.51	435.52	2.81	1
Cypraea sp.	1.9	44.94	0.3	0
Modiolus sp.	1.32	31.1	0.2	0
Paphies striata	0.63	14.82	0.1	1
Patelloida sp.	1.77	41.64	0.3	3
Planaxis sulcatus	2.28	53.64	0.34	1
Strombus gibberulus	18.3	430.6	2.8	2
Strombus lentigonosus	55.95	1316.5	8.5	1
Turbo argyrostoma	2.15	50.6	0.32	0
Turbo sp.^	34.02	800.5	5.2	0
Terrestrial snail	0.8	18.82	0.12	0
Unidentified fragments	68.6	1614.11	10.43	-
TOTALS	657.09	15460.94	100.2	31

Total volume of XU8 deposits = 0.0425m³
^ Unidentified *Turbo* sp. operculum

Sokoli, XU1 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	22.06	774.03	12.41	0
Lambis lambis	15.12	530.52	8.5	0
Nerita undata	6.58	230.9	3.7	3
Strombus luhuanus	4.71	165.3	2.7	2
Tridacna spp.	55.87	1960.4	31.44	0
Trochus niloticus	36.41	1277.54	20.5	0
OTHER				
Acanthopleura sp.	0.21	7.4	0.11	0
Antigona puerpera	1.22	42.8	0.7	0
Davila plana	0.65	22.8	0.4	1
Glycymeris sp.	0.65	22.8	0.4	0
Nerita albicilla	0.85	29.82	0.5	0
Patelloida sp.	0.67	23.5	0.4	1
Tellina scobinata	0.48	16.84	0.3	0
Trochus erythraeus	2.51	88.1	1.41	0
Turbo sp.^	7.79	273.33	4.4	0
Terrestrial snail	4.36	153.0	2.5	0
Unidentified fragments	18.2	638.6	10.24	-
TOTALS	177.69	6234.73	100.6	7

Total volume of XU1 deposits = $0.01m^3$
^ Unidentified *Turbo* sp. operculum

Sokoli, XU2 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	36.97	1212.13	12.04	0
Lambis lambis	28.06	920.0	9.15	0
Nerita undata	2.53	83.0	0.82	0
Strombus luhuanus	52.79	1730.81	17.2	5
Tridacna spp.	137.87	4520.32	44.91	0
Trochus niloticus	15.96	523.3	5.2	0
OTHER				
Acanthopleura sp.	0.09	3.0	0.02	0
Codakia punctata	2.56	83.93	0.83	1
Codakia tigerina	0.22	7.21	0.07	0
Cucullaidae sp.	0.57	18.7	0.2	0
Cypraea sp.	0.38	12.45	0.12	0
Nerita albicilla	0.22	7.21	0.07	0
Nerita polita	0.31	10.2	0.1	0
Nerita sp.*	0.16	5.24	0.05	0
Tellina palatum	4.93	161.63	1.6	0
Tellina scobinata	0.59	19.34	0.2	0
Tellina sp.	0.09	3.0	0.02	0
Trochus erythaeus	3.27	107.21	1.06	1
Terrestrial snail	0.21	6.9	0.06	0
Unidentified fragments	19.2	629.5	6.25	-
TOTALS	306.98	10064.91	99.9	7

Total volume of XU2 deposits = 0.0305m^3
* Unidentified *Nerita* sp. operculum

Sokoli, XU3 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	13.12	452.41	11.7	0
Lambis lambis	19.36	667.6	17.3	0
Nerita undata	5.53	190.7	4.92	3
Strombus luhuanus	25.5	879.31	22.72	1
Tridacna spp.	12.28	423.44	10.94	0
Trochus niloticus	2.87	99.0	2.6	0
OTHER				
Antigona puerpera	0.56	19.31	0.5	0
Codakia tigerina	2.32	80.0	2.1	0
Nerita albicilla	0.21	7.24	0.2	0
Patelloida sp.	0.48	16.6	0.42	1
Syrinx auruanus	14.64	504.82	13.04	0
Tellina scobinata	2.01	69.31	1.8	1
Trochus erythraeus	2.72	93.8	2.42	0
Terrestrial snail	0.23	7.93	0.2	0
Unidentified fragments	10.39	358.3	9.3	-
TOTALS	112.22	3869.7	100.2	6

Total volume of XU3 deposits = 0.029m^3

Sokoli, XU4 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	25.01	406.7	6.31	1
Lambis lambis	209.41	3405.04	52.9	1
Nerita undata	9.46	153.82	2.4	2
Strombus luhuanus	35.82	582.43	9.04	3
Trochus niloticus	1.63	26.5	0.41	0
Tridacna spp.	25.82	419.83	6.51	0
OTHER				
Acanthopleura sp.	0.26	4.22	0.06	0
Asaphis violascens	7.64	124.22	1.92	0
Cardita incrassata	0.51	8.3	0.12	1
Cardita sp.	0.16	2.6	0.04	0
Codakia tigerina	1.05	17.1	0.3	0
Monodonta labio	1.03	16.74	0.3	0
Nerita albicilla	2.26	36.74	0.6	0
Olive sp.	0.5	8.13	0.12	1
Polymesoda coaxans	3.05	49.6	0.8	1
Tellina palatum	5.07	82.4	1.3	1
Tellina scobinata	2.11	34.3	0.53	1
Turbo argyrostoma	1.49	24.22	0.4	0
Turbo crassus	14.13	229.8	3.6	1
Turbo sp.^	2.05	33.33	0.51	0
Terrestrial snail	3.05	49.6	0.8	2
Unidentified fragments	44.58	724.9	11.3	-
TOTALS	396.09	6440.5	100.3	15

Total volume of XU4 deposits = 0.0705m³
* Unidentified *Turbo* sp. operculum

Sokoli, XU5 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	80.13	1470.3	24.0	0
Nerita undata	13.49	247.52	4.03	5
Strombus luhuanus	32.87	603.11	9.84	2
Tridacna spp.	51.19	939.3	15.3	0
Trochus niloticus	60.23	1105.13	18.03	0
OTHER				
Acanthopleura sp.	0.44	8.1	0.13	1
Asaphis violascens	3.16	58.0	0.94	0
Codakia tigerina	2.24	41.1	0.7	0
Melo amphora	9.54	175.04	2.9	0
Nerita albicilla	4.71	86.42	1.41	2
Nerita polita	1.4	25.7	0.41	1
Paphies striata	1.38	25.32	0.41	1
Patelloida sp.	0.91	16.7	0.3	1
Polymesoda coaxans	3.19	58.53	1.0	0
Tellina palatum	2.21	40.6	0.7	0
Tellina scobinata	4.86	89.2	1.5	0
Turbo argyrostoma	46.9	860.6	14.04	1
Turbo sp.^	0.78	14.31	0.23	0
Terrestrial snail	1.62	29.72	0.5	1
Unidentified fragments	12.67	232.5	3.8	-
TOTALS	333.92	6127.0	100.2	15

Total volume of XU5 deposits = 0.0545m^3
^ Unidentified *Turbo* sp. operculum

Sokoli, XU6 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	376.77	6850.4	35.2	3
Nerita undata	16.73	304.2	1.6	6
Strombus luhuanus	165.88	3016.0	15.5	9
Tridacna spp.	331.99	6036.2	31.02	0
Trochus niloticus	24.6	447.3	2.3	
OTHER				
Acanthopleura sp.	0.16	2.9	0.01	0
Asaphis violascens	2.03	36.9	0.18	0
Codakia tigerina	26.05	473.63	2.43	2
Cypraea sp.	0.6	10.9	0.05	1
Melo amphora	49.86	906.54	4.7	1
Monodonta labio	1.38	25.1	0.12	1
Nerita albicilla	2.95	53.63	0.3	1
Paphies striata	1.14	20.72	0.1	1
Patelloida sp.	0.46	8.4	0.04	1
Planaxis sulcatus	2.51	45.63	0.23	1
Polymesoda coaxans	4.74	86.2	0.44	1
Tellina scobinata	1.1	20.0	0.1	0
Tellina sp.	0.29	5.3	0.02	0
Trochus erythraeus	1.04	18.9	0.09	0
Turbo argyrostoma	8.98	163.3	0.83	1
Unidentified bivalve sp 1.	1.25	22.72	0.11	0
Terrestrial snail	4.58	83.3	0.42	1
Unidentified fragments	45.1	820.0	4.21	-
TOTALS	1070.19	19458	100.0	30

Total volume of XU6 deposits = 0.055m³

Sokoli, XU7 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	18.66	373.2	1.94	0
Lambis lambis	132.31	2646.2	13.82	2
Nerita undata	46.79	935.8	4.9	15
Strombus luhuanus	187.35	3747.0	19.6	8
Tridacna spp.	427.05	8541.0	44.61	1
Trochus niloticus	31.46	629.2	3.2	0
OTHER				
Acanthopleura sp.	0.46	9.2	0.04	0
Aroa vertricosa	1.54	30.8	0.2	1
Asaphis violascens	3.30	66.0	0.34	0
Codakia tigerina	0.83	16.6	0.08	1
Cypraea sp.	1.07	21.4	0.11	0
Garfrarium pectinatum	0.68	13.6	0.07	0
Melo amphora	51.23	1024.6	5.4	0
Monodonta labio	3.54	70.8	0.4	1
Nerita albicilla	2.21	44.2	0.23	1
Paphies striata	2.18	43.6	0.22	2
Patelloida sp.	1.29	25.8	0.13	1
Trochus erythraeus	0.66	13.2	0.06	0
Turbo argyrostoma	2.99	59.8	0.31	0
Vasum turbinellus	36.72	734.4	3.83	1
Terrestrial snail	2.63	52.6	0.3	0
Unidentified fragments	2.3	46.0	0.24	-
TOTALS	957.25	19145.0	100.03	34

Total volume of XU7 deposits = 0.05m³

Sokoli, XU8 Molluscan Shell Recoveries

Species	Weight gm	Density gm/m^3	% of tot. wt.	MNI
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	6.07	78.32	0.33	0
Lambis lambis	561.1	7240.0	30.51	3
Nerita undata	52.19	673.41	2.83	18
Strombus luhuanus	84.86	1095.0	4.61	4
Tridacna spp.	738.24	9525.7	40.14	1
Trochus niloticus	42.56	549.2	2.31	0
OTHER				
Acanthopleura sp.	0.27	3.5	0.01	0
Anodonta bullula	0.04	0.51	0.002	1
Asaphis violascens	26.04	336.0	1.41	1
Codakia paytenarum	4.64	59.9	0.3	1
Codakia tigerina	9.42	121.54	0.51	1
Cerithidae sp.	0.3	3.9	0.01	1
Cypraea annulus	2.88	37.2	0.2	1
Cypraea sp.	0.66	8.51	0.03	0
Davila plana	0.59	7.61	0.03	1
Frimbria frimbriata	4.49	57.93	0.24	0
Mactra artensis	0.4	5.2	0.02	1
Melo amphora	15.42	199.0	0.83	0
Monodonta labio	0.98	12.64	0.05	0
Nerita albicilla	1.15	14.83	0.06	1
Nerita polita	1.68	21.7	0.09	0
Nerita sp.*	0.34	4.4	0.01	0
Paphies striata	1.86	24.0	0.1	1
Patelloida sp.	2.23	28.8	0.12	1
Planaxis sulcatus	3.18	41.03	0.2	1
Polymesoda coaxans	10.04	129.54	0.54	2
Saccostrea cucullata	1.56	20.12	0.08	1
Syrinx auruanus	5.13	66.2	0.3	0
Tellina palatum	2.74	35.4	0.14	0
Tellina scobinata	6.56	84.64	0.4	0
Tellina sp.	0.36	4.64	0.01	0
Terebra subulata	87.16	1124.64	4.74	1
Trapezium sp.	0.08	1.03	0.004	1
Turbo argyrostoma	3.2	41.3	0.2	0
Turbo sp.^	6.87	88.64	0.4	0
Unidentified bivalve sp. 3	1.04	13.41	0.05	0
Unidentified bivalve sp. 4	1.30	16.8	0.07	0
Unidentified bivalve sp. 5	0.84	10.83	0.04	0

Terrestrial snail	31.57	407.4	1.71	8
Unidentified fragments	118.7	1531.61	6.5	-
TOTALS	1838.74	23725.7	100.1	51

Total volume of XU8 deposits = 0.0775m^3
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Sokoli, XU9 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	50.14	783.43	2.51	1
Lambis lambis	58.05	907.03	2.91	0
Nerita undata	48.53	758.3	2.43	17
Strombus luhuanus	100.3	1567.2	5.03	4
Tridacna spp.	1373.71	21464.21	68.9	1
Trochus niloticus	147.45	2303.9	7.4	1
OTHER				
Acanthopleura sp.	0.49	7.7	0.02	1
Antigona reticulata	40.22	628.43	2.01	1
Asaphis violascens	4.58	71.6	0.22	1
Barbatia amygolalumtostum	4.49	70.1	0.22	1
Codakia tigerina	6.72	105.0	0.33	1
Conus marmerous	17.05	266.4	0.9	1
Cypraea sp.	1.12	17.5	0.05	1
Frimbria sp.	0.04	0.62	0.001	1
Gari maculosa	0.77	12.03	0.03	0
Nerita albicilla	8.34	130.31	0.41	3
Nerita polita	0.83	13.0	0.04	0
Planaxis sulcatus	0.95	14.84	0.04	0
Tellina palatum	5.44	85.0	0.3	1
Tellina scobinata	3.67	57.34	0.2	1
Tellina sp.	0.51	8.0	0.02	0
Turbo argyrostoma	23.63	197.34	0.63	0
Turbo sp.^	2.56	40.0	0.12	0
Vasum turbinellus	10.53	164.53	0.52	1
Unidentified bivalve sp. 3	1.32	20.62	0.06	2
Unidentified bivalve sp. 4	2.22	34.7	0.11	0
Unidentified bivalve sp. 5	0.3	4.7	0.01	0
Terrestrial snail	9.01	140.8	0.5	3
Unidentified fragments	70.69	1104.53	3.54	-
TOTALS	1993.66	31150.93	99.5	43

Total volume of XU9 deposits = 0.064m³
^ Unidentified *Turbo* sp. operculum

Sokoli, XU10 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	11.17	89.8	2.6	0
Lambis lambis	60.82	488.51	14.03	0
Nerita undata	5.38	43.21	1.24	1
Strombus luhuanus	10.22	82.1	2.4	2
Tridacna spp.	152.91	1228.2	35.3	0
Trochus niloticus	14.44	116.0	3.33	0
OTHER				
Asaphis violascens	5.41	43.5	1.25	1
Acanthopleura sp.	0.38	3.1	0.08	1
Cardid sp.	0.22	1.8	0.05	0
Cerithidae sp.	0.24	1.92	0.05	2
Codakia interrupta	1.55	12.44	0.4	0
Codakia tigerina	7.36	59.11	1.7	0
Cypraea sp.	3.01	24.2	0.7	2
Frimbria frimbriata	0.79	6.34	0.2	0
Melo amphora	32.15	258.23	7.42	1
Nerita albicilla	0.49	3.93	0.11	1
Nerita polita	1.04	8.4	0.24	0
Nerita sp.*	0.08	0.64	0.02	0
Niotha bicolar	0.56	4.5	0.12	1
Polymesoda coaxans	19.44	156.14	4.5	2
Syrinx auruanus	2.06	16.54	0.5	0
Tellina palatum	15.42	123.9	3.6	1
Tellina scobinata	7.76	62.32	1.8	2
Tellina sp.	1.45	11.64	0.33	1
Trapezium sp.	0.25	2.00	0.05	0
Turbo sp.^	1.51	12.12	0.34	0
Terrestrial snail	7.01	56.3	1.61	6
Unidentified fragments	70.14	563.4	16.2	-
TOTALS	433.26	3480.0	100.2	24

Total volume of XU10 deposits = $0.1245m^3$
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Sokoli, XU11 Molluscan Shell Recoveries

Species	Weight gm	Density gm/m^3	% of tot. wt.	MNI
COMMONLY OCCURRING SPECIES				
Cypraea tigris	47.26	716.1	5.3	1
Hippopus hippopus	80.57	1220.8	9.0	0
Lambis lambis	195.59	2963.5	21.8	1
Nerita undata	17.15	259.84	1.9	7
Strombus luhuanus	107.95	1635.6	12.02	9
Tridacna spp.	311.65	4722.0	34.7	1
Trochus niloticus	8.66	131.21	1.0	0
OTHER				
Acanthopleura sp.	0.23	3.5	0.02	0
Antigona reticulata	1.92	29.1	0.21	0
Asaphis violascens	0.67	10.2	0.07	0
Codakia tigerina	21.52	326.1	2.4	1
Cymatium sp.	0.15	2.3	0.01	1
Cypraea sp.	0.76	11.51	0.08	0
Mactra sp.	0.1	1.51	0.01	1
Nerita polita	1.67	25.3	0.2	0
Nerita sp.*	0.57	8.63	0.06	0
Planaxis sulcatus	2.18	33.03	0.24	1
Polymesoda coaxans	4.85	73.5	0.54	0
Syrinx auruanus	1.48	22.42	0.2	0
Tellina palatum	1.86	28.2	0.2	1
Tellina scobinata	8.15	123.5	0.9	0
Tellina sp.	0.44	6.7	0.04	0
Turbo argyrostoma	0.42	6.4	0.04	0
Terrestrial snail	2.5	37.9	0.3	0
Unidentified fragments	79.56	1205.5	8.9	-
TOTALS	897.88	13604.24	100.1	24

Total volume of XU11 deposits = 0.066m^3
* Unidentified *Nerita s*p. operculum

Sokoli, XU12 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	95.2	1081.81	23.2	0
Nerita undata	9.33	106.02	2.3	4
Strombus luhuanus	48.14	547.04	11.72	5
Tridacna spp.	39.42	448.0	9.6	0
Trochus niloticus	18.24	207.3	4.44	0
OTHER				
Asaphis violascens	6.82	77.5	1.7	1
Codakia tigerina	1.8	20.5	0.43	0
Davila plana	1.0	11.4	0.24	1
Littorina pintado	0.51	5.6	0.12	1
Littorina undulata	0.66	7.5	0.2	1
Nerita polita	1.29	14.7	0.31	0
Paphies striata	1.24	14.1	0.3	1
Patelloida sp.	0.41	4.7	0.1	1
Pinctada margaritifera	2.11	24.0	0.51	0
Polymesoda coaxans	0.79	9.0	0.2	0
Syrinx auruanus	96.55	1097.2	23.51	1
Tellina palatum	1.47	16.7	0.4	0
Tellina scobinata	1.86	21.13	0.5	0
Trochus erythraeus	0.62	7.04	0.2	0
Turbo argyrostoma	12.62	143.4	3.1	0
Turbo sp.*	8.49	96.5	2.1	0
Terrestrial snail	3.82	43.4	0.93	3
Unidentified fragments	58.22	661.6	14.2	-
TOTALS	410.61	4666.02	100.3	19

Total volume of XU12 deposits = 0.088m³
* Unidentified *Turbo* sp. operculum

Sokoli, XU13 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	1.07	17.4	0.6	0
Lambis lambis	8.8	143.1	4.72	0
Nerita undata	0	0	0	0
Strombus luhuanus	84.35	1371.54	45.23	3
Tridacna spp.	36.2	588.61	19.41	0
Trochus niloticus	19.82	322.3	10.63	0
OTHER				
Asaphis violascens	1.43	23.3	0.8	0
Cerithidae sp.	0.13	2.11	0.03	1
Codakia interrupta	1.81	29.43	1.0	1
Monodonta labio	2.93	47.64	1.6	1
Nerita polita	2.04	33.2	1.1	0
Polinices sp.	0.8	13.0	0.4	1
Polymesoda coaxans	2.3	37.4	1.23	0
Tellina palatum	0.32	5.2	0.2	0
Tellina sp.	2.11	34.3	1.13	0
Turbo sp.^	2.0	32.52	1.1	0
Terrestrial snail	1.71	27.8	0.91	0
Unidentified fragments	18.63	302.92	10.0	-
TOTALS	186.45	3031.7	100.1	7

Total volume of XU13 deposits = 0.0615m³
^Unidentified *Turbo* sp. operculum

Sokoli, XU14 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	31.08	417.2	31.42	0
Nerita undata	4.17	56.0	4.21	3
Strombus luhuanus	11.45	153.7	11.6	1
Tridacna spp.	32.43	435.3	32.8	0
Trochus niloticus	3.18	42.7	3.2	0
OTHER				
Acanthopleura sp.	0.14	1.9	0.14	0
Antigona reticulata	0.67	9.0	0.7	0
Asaphis violascens	1.04	14.0	1.1	0
Codakia tigerina	0.97	13.02	1.0	0
Nerita polita	1.25	16.8	1.3	0
Terrestrial snail	0.26	3.5	0.3	0
Unidentified fragments	12.27	164.7	12.4	-
TOTALS	98.91	1327.7	100.2	4

Total volume of XU14 deposits = $0.0745m^3$

Sokoli, XU15 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	99.9	1103.9	18.9	1
Nerita undata	52.19	576.7	9.9	16
Strombus luhuanus	32.3	356.9	6.1	4
Tridacna spp.	117.92	1303.0	22.3	0
Trochus niloticus	6.81	75.24	1.3	0
OTHER				
Acanthopleura sp.	0.58	6.4	0.1	1
Codakia tigerina	9.05	100.0	1.7	1
Codakia sp.	4.11	45.41	0.8	1
Conus litteratus	6.0	66.3	1.13	1
Cypraea sp.	0.86	9.5	0.2	0
Nerita polita	1.45	16.02	0.3	0
Nerita sp.*	0.54	6.0	0.1	0
Polinices sp.	0.38	4.2	0.07	1
Monodonta labio	2.27	25.1	0.42	0
Turbo sp.^	18.63	205.9	3.52	0
Veneridae sp.	2.73	30.2	0.51	1
Terrestrial snail	2.25	24.9	0.42	0
Unidentified fragments	171.36	1893.5	32.4	-
TOTALS	529.33	5849.0	100.2	27

Total volume of XU15 deposits = 0.0905m³
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Sokoli, XU16 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	28.99	234.73	1.33	0
Hippopus hippopus	73.56	595.62	3.4	1
Lambis lambis	239.04	1935.54	11.0	0
Nerita undata	68.98	558.54	3.2	22
Strombus luhuanus	448.18	3629.0	20.6	24
Tridacna spp.	340.44	2756.6	15.63	0
Trochus niloticus	227.06	1838.54	10.42	3
OTHER				
Acanthopleura sp.	0.96	7.8	0.04	0
Anadara sp.	0.94	7.61	0.04	0
Cardita variegata	1.82	14.73	0.08	1
Codakia punctata	0.25	2.02	0.01	1
Codakia tigerina	11.07	89.63	0.5	0
Cypraea sp.	2.78	22.51	0.12	1
Monodonta labio	9.12	73.84	0.41	1
Nautilus pompilius	50.46	408.6	2.31	1
Nerita albicilla	3.59	29.1	0.2	2
Nerita polita	22.87	185.2	1.05	6
Nerita sp.*	1.58	12.8	0.07	0
Pinctada margaritifera	2.49	20.2	0.11	0
Polymesoda coaxans	6.06	49.1	0.3	0
Saccostrea cucullata	4.85	39.3	0.22	0
Strombus lentiginosus	58.5	473.7	2.7	1
Tellina scobinata	4.09	33.11	0.2	0
Turbo argyrostoma	7.25	58.8	0.33	0
Trochus erythaeus	22.88	185.3	1.1	0
Turbo crassus	72.87	590.04	3.34	1
Turbo sp.^	34.9	282.6	1.6	0
Terrestrial snail	29.52	239.02	1.4	5
Unidentified fragments	402.92	3262.51	18.5	-
TOTALS	2178.02	17635.8	100.2	70

Total volume of XU16 deposits = 0.1235m³
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Sokoli, XU17 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	72.7	727.0	2.4	2
Hippopus hippopus	8.69	86.9	0.3	0
Lambis lambis	510.48	5104.8	16.91	2
Nerita undata	79.78	797.8	2.64	32
Strombus luhuanus	704.09	7040.9	23.33	38
Tridacna spp.	521.34	5213.4	17.3	1
Trochus niloticus	595.1	5951.0	19.72	5
OTHER				
Anadara antiquata	17.74	177.4	0.6	1
Anodonta bullula	0.07	0.7	0.002	1
Asaphis violascens	18.82	188.2	0.62	1
Cerithidae sp.	0.2	2.0	0.006	1
Codakia tigerina	3.12	31.2	0.1	1
Codakia sp.	0.11	1.1	0.003	1
Cymatium sp.	0.19	1.9	0.006	1
Cypraea sp.	3.07	30.7	0.1	0
Davila plana	0.21	2.1	0.006	1
Nerita albicilla	8.9	89.0	0.3	3
Nerita polita	23.19	231.9	0.8	8
Nerita sp.*	0.16	1.6	0.005	0
Monodonta labio	4.57	45.7	0.2	0
Patelloida sp.	0.47	4.7	0.01	1
Polymesoda coaxans	5.2	52.0	0.2	1
Saccostrea cucullata	0.3	3.0	0.009	1
Tellina scobinata	2.0	20.0	0.06	0
Trochus erythaeus	20.65	206.5	0.7	2
Turbo argyrostoma	73.3	733.0	2.42	1
Turbo setosus	39.32	393.2	1.3	1
Turbo sp.^	7.85	78.5	0.3	0
Vasum turbinellus	0.89	8.9	0.02	0
Terrestrial snail	81.15	811.5	2.7	14
Unidentified fragments	213.59	2135.9	7.1	-
TOTALS	3017.25	30172.5	100.2	120

Total volume of XU17 deposits = $0.1m^3$
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Sokoli, XU18 Molluscan Shell Recoveries

Species	Weight gm	Density gm/m^3	% of tot. wt.	MNI
COMMONLY OCCURRING SPECIES				
Cypraea tigris	14.82	302.44	0.62	0
Hippopus hippopus	161.85	3303.1	6.83	0
Lambis lambis	45.18	922.04	1.9	0
Nerita undata	22.84	466.12	1.0	12
Strombus luhuanus	267.78	5464.9	11.31	11
Tridacna spp.	1658.0	33836.73	70.03	1
Trochus niloticus	36.36	742.04	1.53	0
OTHER				
Acanthopleura sp.	0.72	14.7	0.03	1
Antigona puerpera	0.51	10.4	0.02	1
Asaphis violascens	2.88	58.8	0.12	1
Codakia tigerina	9.38	191.42	0.4	1
Glycymeridae sp. 1	0.47	9.6	0.01	0
Glycymeridae sp. 2	0.57	11.63	0.02	0
Mitridae sp.	0.22	4.5	0.009	1
Morula marginalba	5.16	105.3	0.21	1
Nerita polita	7.15	145.91	0.3	2
Nerita sp.*	0.78	15.91	0.03	0
Pinctada margaritifera	5.16	105.3	0.21	0
Tellina scobinata	0.99	20.2	0.04	0
Turbo argyrostoma	0.46	9.4	0.01	0
Turbo sp.^	8.69	177.34	0.4	0
Vasum turbinellus	8.43	172.04	0.4	1
Terrestrial snail	10.26	209.4	0.43	3
Unidentified fragments	98.59	2012.04	4.2	-
TOTALS	2367.25	48311.22	100.05	36

Total volume of XU18 deposits = 0.049m^3
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Sokoli, XU19 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	3.56	43.7	0.1	0
Hippopus hippopus	71.48	877.1	2.04	0
Lambis lambis	316.98	3889.32	9.04	2
Nerita undata	163.77	2009.44	4.7	73
Strombus luhuanus	1010.07	12393.5	28.83	49
Tridacna spp.	668.88	8207.11	19.1	2
Trochus niloticus	396.11	4860.24	11.3	2
OTHER				
Acanthopleura sp.	4.46	54.7	0.002	3
Anadara antiquata	32.01	392.8	0.91	1
Asaphis violascens	14.28	175.21	0.4	0
Chama sp.	0.22	2.7	0.006	1
Codakia tigerina	6.25	76.7	0.2	1
Cucullaea labiata	0.46	5.64	0.01	0
Davila plana	1.18	14.5	0.03	1
Mactra sp.	0.4	4.9	0.01	1
Monodonta labio	15.61	191.53	0.44	4
Nerita albicilla	11.92	146.3	0.34	5
Nerita polita	8.01	98.3	0.22	1
Nerita sp.*	0.84	10.3	0.02	0
Patelloida sp.	0.99	12.14	0.02	3
Pinctada margaritifera	2.09	25.64	0.05	0
Polinices sp.	0.6	7.4	0.01	1
Polymesoda coaxans	18.35	225.2	0.52	2
Pyrene sp.	0.48	5.9	0.01	1
Saccostrea cucullata	1.41	17.3	0.04	0
Tucetana haylei	0.23	2.82	0.006	1
Turbo argyrostoma	3.84	47.11	0.1	0
Turbo crassus	68.37	838.9	2.0	1
Turbo sp.^	13.68	167.9	0.4	0
Terrestrial snail	24.6	301.84	0.7	3
Unidentified fragments	641.7	7873.61	18.31	-
TOTALS	3502.83	42979.5	99.9	159

Total volume of XU19 deposits = 0.0815m^3
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Sokoli, XU20 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	12.6	105.0	0.11	0
Hippopus hippopus	250.4	2086.7	2.2	0
Lambis lambis	1060.99	8841.6	9.33	12
Nerita undata	722.51	6020.91	6.4	357
Strombus luhuanus	3887.2	32393.33	34.2	206
Tridacna spp.	3338.61	27821.8	29.4	10
Trochus niloticus	1241.45	10345.41	10.92	11
OTHER				
Acanthopleura sp.	3.6	30.00	0.03	14
Amoria sp.	64.77	539.8	0.6	0
Anadara sp.	2.97	24.8	0.02	0
Asaphis violascens	16.86	140.5	0.14	1
Codakia tigerina	0.39	3.25	0.003	0
Cypraea arabica	0.8	6.7	0.007	0
Cypraea sp.	2.75	22.91	0.02	0
Davila plana	1.45	12.1	0.01	2
Monodonta labio	36.97	308.1	0.32	10
Nerita albicilla	34.26	285.5	0.3	13
Nerita polita	12.7	105.83	0.11	4
Patelloida sp.	7.38	61.5	0.06	7
Pinctada margaritifera	19.55	162.91	0.2	0
Pleuroploca filamentosa	112.3	935.83	1.0	1
Polymesoda coaxans	20.06	167.2	0.2	2
Saccostrea cucullata	12.28	102.33	0.1	3
Strombus lentiginosus	64.64	538.7	0.6	1
Syrinx auruanus	24.5	204.2	0.21	0
Trochus sp.	18.7	155.83	0.2	3
Turbo argyrostoma	55.18	459.83	0.5	1
Turbo crassus	36.96	308.0	0.32	1
Turbo virgatus	20.1	167.5	0.2	0
Turbo sp.^	51.55	429.6	0.5	0
Terrestrial snail	97.47	812.3	0.9	0
Unidentified fragments	133.43	1111.91	1.2	-
TOTALS	11365.38	94711.5	100.3	663

Total volume of XU20 deposits = 0.12m³
^ Unidentified *Turbo* sp. operculum

Sokoli, XU21 Molluscan Shell Recoveries

Species	Weight gm	Density gm/m^3	% of tot. wt.	MNI
COMMONLY OCCURRING SPECIES				
Cypraea tigris	29.0	308.51	0.51	1
Hippopus hippopus	165.56	1761.3	2.91	2
Lambis lambis	585.49	6228.61	10.3	1
Nerita undata	413.8	4402.12	7.3	184
Strombus luhuanus	1616.3	17194.7	28.43	62
Tridacna spp.	870.0	9255.31	15.3	3
Trochus niloticus	804.26	8556.0	14.14	5
OTHER				
Acanthopleura sp.	4.77	50.74	0.08	5
Asaphis violascens	2.13	22.7	0.03	0
Barbatia grayana	1.77	18.82	0.03	1
Codakia tigerina	9.01	95.9	0.2	1
Conus marmerous	26.2	278.72	0.5	1
Euchelus atratus	0.25	2.7	0.004	1
Frimbria frimbriata	0.59	6.3	0.01	0
Garfrarium pectinatum	0.58	6.2	0.01	0
Littorina sp.	0.47	5.0	0.008	2
Monodonta labio	16.61	176.7	0.3	4
Nerita albicilla	29.09	309.5	0.51	9
Nerita polita	5.88	62.6	0.1	0
Nerita sp.*	5.34	56.8	0.09	0
Paphies striata	0.9	9.6	0.01	1
Patelloida sp.	6.58	70.0	0.11	9
Pinctada margaritifera	76.52	814.04	1.34	1
Polymesoda coaxans	10.6	112.8	0.2	2
Saccostrea cucullata	38.02	404.5	0.7	7
Spondylus sp.	2.92	31.1	0.05	1
Strombus lentiginosus	95.11	1011.8	1.7	2
Tellina palatum	0.98	10.42	0.01	0
Turbo argyrostoma	5.2	55.31	0.09	0
Turbo sp.^	6.03	64.14	0.10	0
Vasum turbinellus	12.13	129.04	0.21	1
Terrestrial snail	100.36	1067.7	1.8	14
Unidentified fragments	742.5	7898.93	13.1	-
TOTALS	5684.95	60478.2	100.2	328

Total volume of XU21 deposits = $0.094m^3$
*Unidentified *Nerita* sp. operculum
^Unidentified *Turbo* sp. operculum

Sokoli, XU22 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	22.08	279.5	0.3	0
Hippopus hippopus	314.05	3975.31	3.82	2
Lambis lambis	574.07	7266.7	7.0	3
Nerita undata	415.26	5256.5	5.1	154
Strombus luhuanus	2289.8	28984.81	27.9	99
Tridacna spp.	1737.16	21989.4	21.14	8
Trochus niloticus	1054.91	13353.3	12.84	8
OTHER				
Acanthopleura sp.	24.65	312.02	0.3	16
Amoria sp.	38.38	485.82	0.5	1
Anadara sp.	2.14	27.1	0.02	0
Asaphis violascens	3.18	40.3	0.03	0
Codakia tigerina	16.39	207.5	0.2	1
Cypraea annulus	3.35	42.4	0.04	2
Haliotis sp.	5.41	68.5	0.06	1
Modiolus sp.	5.94	75.2	0.07	1
Monodonta labio	27.29	345.44	0.33	7
Nassirius sp.	1.5	19.0	0.01	1
Nerita albicilla	87.96	1113.41	1.07	29
Nerita polita	19.52	247.1	0.23	4
Nerita sp.*	4.93	62.4	0.06	0
Pinctada margaritifera	150.6	1906.32	1.83	3
Patelloida sp.	3.5	44.3	0.04	12
Saccostrea cucullata	115.94	1467.6	1.41	17
Strombus gibberulus	7.6	96.2	0.09	1
Tellina scobinata	25.03	316.83	0.3	1
Trochus virgatus	9.01	114.1	0.1	1
Turbo argyrostoma	63.53	804.2	0.8	2
Turbo chrysostomus	10.29	130.3	0.12	1
Turbo sp.^	15.82	200.3	0.2	0
Vasum turbinellus	34.46	436.2	0.41	1
Terrestrial snail	59.21	749.5	0.72	7
Unidentified fragments	1071.7	13565.82	13.04	-
TOTALS	8214.66	103983.03	100.1	383

Total volume of XU22 deposits = 0.079m^3
*Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Sokoli, XU23 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	116.29	2768.8	2.2	2
Hippopus hippopus	93.73	2231.7	1.8	0
Lambis lambis	1009.19	24028.1	19.12	5
Nerita undata	193.21	4600.23	3.7	89
Strombus luhuanus	633.25	15077.4	12.0	27
Tridacna spp.	1293.39	30795.0	24.51	3
Trochus niloticus	1194.66	28444.3	22.64	10
OTHER				
Anadara antiquata	1.18	28.1	0.02	2
Asaphis violascens	0.21	5.0	0.003	0
Conus sp.	22.94	546.2	0.43	1
Melo amphora	106.36	2532.4	2.01	1
Modiolus sp.	7.58	180.5	0.14	1
Monodonta labio	1.04	24.8	0.01	1
Nerita albicilla	36.48	868.6	0.7	12
Nerita polita	8.99	214.04	0.2	1
Nerita sp.*	1.46	34.8	0.02	0
Niotha bicolar	0.53	12.61	0.01	1
Patelloida sp.	1.08	25.71	0.02	2
Pinctada margaritifera	25.23	600.71	0.5	1
Planaxis sulcatus	1.1	26.2	0.02	1
Saccostrea cucullata	7.29	173.6	0.13	2
Tectus pyramis	58.85	1401.2	1.11	2
Tellina scobinata	12.98	309.04	0.24	1
Trochus erythareus	19.62	467.14	0.4	2
Turbo bruneus	5.31	126.42	0.1	1
Turbo argyrostoma	13.04	310.5	0.24	0
Turbo chrysostomus	6.66	158.6	0.12	1
Turbo crassus	63.85	1520.23	1.21	1
Turbo sp.^	25.39	604.52	0.5	0
Terrestrial snail	96.6	2294.3	1.82	5
Unidentified fragments	218.43	5200.71	4.14	-
TOTALS	5275.92	125617.14	100.1	175

Total volume of XU23 deposits = 0.042m³
* Unidentified *Nerita* sp. operculum ^ Unidentified *Turbo* sp. operculum

Sokoli, XU24 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0.63	10.8	0.02	0
Hippopus hippopus	8.76	149.74	0.4	0
Lambis lambis	101.81	1740.34	4.12	1
Nerita undata	39.04	667.4	1.6	20
Strombus luhuanus	33.2	567.52	1.34	2
Tridacna spp.	1461.07	24975.6	59.3	1
Trochus niloticus	350.87	5997.8	14.22	2
OTHER				
Acanthopleura sp.	0.86	14.7	0.03	0
Asaphis violascens	0.23	3.93	0.009	0
Cardita variegata	1.74	29.74	0.07	1
Cypraea sp.	1.34	22.9	0.05	0
Davila plana	0.82	14.01	0.03	1
Nerita albicilla	7.27	124.3	0.3	2
Nerita polita	7.25	123.93	0.3	3
Pinctada margaritifera	2.27	38.8	0.09	0
Polinices sp.	1.22	20.9	0.04	1
Polymesoda coaxans	1.12	19.14	0.04	0
Saccostrea cucullata	1.9	32.5	0.07	0
Strombus lentiginosus	36.65	626.5	1.5	1
Tellina palatum	1.4	23.93	0.05	1
Turbo argyrostoma	67.11	1147.2	2.72	2
Turbo sp.^	21.65	370.1	0.9	0
Terrestrial snail	29.34	501.53	1.2	3
Unidentified fragments	288.29	4928.03	12.0	-
TOTALS	2465.84	42151.11	100.4	41

Total volume of XU24 deposits = 0.0585m³
* Unidentified *Turbo* sp. operculum

Sokoli, XU25 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	318.96	2398.2	25.1	2
Nerita undata	7.35	55.3	0.6	3
Strombus luhuanus	20.21	152.0	1.6	1
Tridacna spp.	411.8	3096.24	32.4	1
Trochus niloticus	190.62	1433.23	15.0	2
OTHER				
Asaphis violascens	1.81	13.6	0.14	0
Cerithidae sp.	0.29	2.2	0.02	1
Cypraea annulus	2.79	21.0	0.21	2
Cypraea sp.	0.91	6.84	0.07	0
Naticidae sp.	0.57	5.3	0.05	1
Nerita albicilla	4.79	36.01	0.4	1
Pinctada margaritifera	17.86	134.3	1.4	1
Patelloida sp.	0.32	2.4	0.02	0
Acanthopleura sp.	0.26	2.0	0.02	0
Tellina scobinata	3.44	25.9	0.3	0
Trochus erythareus	2.84	21.4	0.22	0
Turbo argyrostoma	140.35	1055.3	11.04	2
Turbo chrysostomus	9.51	71.5	0.74	1
Turbo sp.^	9.78	73.53	0.8	0
Unidentified bivalve sp. 3	5.87	44.13	0.5	0
Terrestrial snail	8.74	65.71	0.7	0
Unidentified fragments	111.58	838.94	8.8	-
TOTALS	1270.65	9553.8	100.1	18

Total volume of XU25 deposits = 0.133m³
* Unidentified *Turbo* sp. operculum

Ormi, XU1 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	975.51	97551.0	32	3
Nerita undata	15.57	1557.0	0.5	7
Strombus luhuanus	59.04	5904.0	1.9	7
Tridacna spp.	1418.2	141830.0	46.5	1
Trochus niloticus	75.29	7529.0	2.5	0
OTHER				
Anadara sp.	1.46	146.0	0.04	0
Asaphis violascens	4.19	419.0	0.1	1
Cerithium colomna	0.39	39.0	0.01	1
Codakia tigerina	10.13	1013.0	0.33	0
Conus sp.	117.6	11760.0	3.9	0
Cypraea sp.	15.03	1503.0	0.5	0
Littorina pintado	0.23	23.0	0.007	0
Nerita polita	6.75	675.0	0.22	1
Patelloida sp.	0.33	33.0	0.01	2
Saccostrea cucullata	0.93	93.0	0.03	0
Turbo argyrostoma	19.59	1959.0	0.6	0
Turbo crassus	1.5	150.0	0.05	1
Turbo sp.^	9.7	970.0	0.3	0
Terrestrial snail	1.94	194.0	0.06	0
Unidentified fragments	322.01	32201.0	10.5	-
TOTALS	3055.4	305540.0	100.0	24

Total volume of XU1 deposits = 0.01m^3
* Unidentified *Turbo* sp. operculum

Ormi, XU2 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	64.2	934.5	0.8	1
Hippopus hippopus	746.9	10871.9	9.2	1
Lambis lambis	1962.8	28570.6	24.2	9
Nerita undata	35.58	517.9	0.4	19
Strombus luhuanus	445.46	6484.1	5.5	29
Tridacna spp.	2290.1	33334.8	28.3	4
Trochus niloticus	240.03	3493.9	3.0	1
OTHER				
Acanthopleura sp.	0.22	3.2	0.002	0
Anadara antiquata	16.5	240.2	0.2	1
Asaphis violascens	3.96	57.6	0.04	1
Cardita sp.	0.42	6.1	0.005	1
Cerithium nodulosum	2.5	36.4	0.03	0
Codakia tigerina	3.5	50.9	0.04	1
Conus sp.	41.88	609.6	0.5	0
Cypraea annulus	1.8	26.2	0.02	1
Littorina pintado	0.4	5.8	0.004	1
Monodonta labio	1.21	17.6	0.01	0
Nerita albicilla	8.67	126.2	0.1	4
Nerita polita	1.61	23.43	0.01	0
Patelloida sp.	0.4	5.8	0.004	1
Planaxis sulcatus	2.3	33.5	0.02	3
Strombus lentigonosus	16.9	246.0	0.2	0
Tellina palatum	8.0	116.4	0.09	0
Tellina scobinata	2.86	41.6	0.03	1
Turbo argyrostoma	9.66	140.6	0.1	1
Turbo crassus	21.5	312.9	0.3	0
Turbo sp.^	50.2	730.7	0.6	0
Vasum turbinellus	3.5	50.9	0.04	1
Unidentified gastropod 1	1.0	14.5	0.01	1
Terrestrial snail	12.71	185.0	0.15	3
Unidentified fragments	2118.9	30842.8	26.14	-
TOTALS	8115.7	118132.45	100.01	85

Total volume of XU2 deposits = $0.0687m^3$
^ Unidentified *Turbo* sp. operculum

Ormi, XU3 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	97.27	1057.3	1.2	1
Hippopus hippopus	137.1	1490.2	1.7	0
Lambis lambis	2047.69	22257.5	25.7	8
Nerita undata	70.94	771.1	0.8	42
Strombus luhuanus	470.64	5115.6	6.0	28
Tridacna spp.	2502.79	27204.2	31.3	2
Trochus niloticus	420.23	4567.7	5.3	7
OTHER				
Acanthopleura sp.	0.63	6.8	0.001	0
Amoria sp.	6.67	72.5	0.08	1
Antigona sp.	0.61	6.6	0.007	0
Asaphis violascens	3.48	37.8	0.04	1
Codakia tigerina	12.82	139.3	0.1	1
Cymatium sp.	0.1	1.08	0.001	1
Cypraea annulus	1.71	18.6	0.02	1
Cypraea sp.	7.53	81.8	0.09	2
Garfrarium sp.	0.28	3.04	0.001	1
Littorina pintado	0.81	8.8	0.01	2
Modiolus sp.	0.39	4.2	0.001	1
Nerita albicilla	18.98	206.3	0.2	7
Nerita polita	4.51	49.02	0.05	3
Patelloida sp.	0.4	5.8	0.006	1
Pinctada margaritifera	20.29	220.5	0.25	0
Planaxis sulcatus	2.18	23.7	0.02	2
Polymesoda erosa	3.12	33.9	0.03	1
Saccostrea cucullata	15.91	172.9	0.5	3
Strombus lentigonosus	22.7	246.7	0.28	1
Tellina palatum	0.35	3.8	0.004	0
Turbo argyrostoma	18.31	199.02	0.2	1
Turbo crassus	11.06	120.2	0.13	2
Turbo sp.^	71.6	778.3	0.9	0
Vasum turbinellus	63.72	692.6	0.8	1
Terrestrial snail	9.41	102.2	0.11	3
Unidentified fragments	1929.4	20971.8	24.2	-
TOTALS	7973.63	86669.9	100.03	124

Total volume of XU3 deposits = 0.092m³ ^ Unidentified *Turbo* sp. operculum

Ormi, XU4 Molluscan Shell Recoveries

Species	Weight gm	Density gm/m^3	% of tot. wt.	MNI
COMMONLY OCCURRING SPECIES				
Cypraea tigris	13.19	187.09	0.3	0
Hippopus hippopus	131.25	1861.7	2.9	1
Lambis lambis	465.98	6609.6	10.33	4
Nerita undata	77.8	1103.5	1.7	47
Strombus luhuanus	369.6	5242.5	8.2	26
Tridacna spp.	486.86	6905.8	10.8	0
Trochus niloticus	287.04	4071.5	6.4	1
OTHER				
Asaphis violascens	4.03	57.16	0.08	0
Codakia tigerina	5.93	84.1	0.13	0
Cypraea annulus	2.3	32.6	0.001	1
Littorina pintado	0.43	6.1	0.009	1
Monodonta labio	2.85	40.4	0.06	1
Nerita albicilla	31.67	449.2	0.7	13
Nerita polita	11.4	161.7	0.25	7
Patelloida sp.	1.14	16.2	0.02	3
Pinctada margaritifera	24.61	349.07	0.54	0
Planaxis sulcatus	2.48	35.2	0.1	2
Saccostrea cucullata	5.22	74.04	0.1	2
Tellina scobinata	0.28	4.0	0.006	0
Turbo sp.^	24.93	353.6	0.6	0
Turbo argyrostoma	9.3	131.9	0.2	1
Vasum turbinellus	2.09	29.6	0.04	0
Unidentified bivalve	0.07	1.0	0.001	1
Terrestrial snail	12.09	171.5	0.3	3
Unidentified fragments	2535.2	35960.2	56.24	-
TOTALS	4507.74	63939.6	99.9	88

Total volume of XU4 deposits = $0.0705m^3$
^ Unidentified *Turbo* sp. operculum

Ormi, XU5 Molluscan Shell Recoveries

Species	Weight gm	Density gm/m^3	% of tot. wt.	MNI
COMMONLY OCCURRING SPECIES				
Cypraea tigris	17.65	205.2	0.3	0
Hippopus hippopus	102.8	1195.3	1.6	0
Lambis lambis	1126.73	13101.5	17.73	3
Nerita undata	186.06	2163.5	2.9	79
Strombus luhuanus	566.23	6584.1	8.9	32
Tridacna spp.	1413.7	16438.4	22.2	1
Trochus niloticus	381.29	4433.6	6.0	2
OTHER				
Acanthopleura sp.	1.76	20.5	0.02	0
Asaphis violascens	4.19	48.7	0.06	0
Circe plana	0.36	4.2	0.005	1
Codakia tigerina	10.39	120.8	0.2	2
Conus sp.	11.78	137.0	0.18	0
Cypraea annulus	17.86	207.7	0.3	5
Littorina pintado	0.2	2.3	0.003	1
Modiolus sp.	2.74	31.9	0.001	1
Monodonta labio	4.65	54.1	0.07	2
Morula granulata	0.68	7.9	0.01	1
Murcidae sp.	7.19	83.6	0.11	1
Nerita albicilla	47.5	552.3	0.74	16
Nerita polita	17.6	204.6	0.3	3
Patelloida sp.	3.65	42.4	0.05	6
Pinctada margaritifera	20.06	233.3	0.3	1
Planaxis decollatus	0.47	5.5	0.007	1
Planaxis sulcatus	3.3	38.4	0.05	1
Polymesoda coaxans	10.62	123.5	0.16	1
Saccostrea cucullata	3.67	42.7	0.05	1
Turbo argyrostoma	38.28	445.1	0.6	1
Strombus lentigonus	7.8	90.7	0.001	0
Tellina palatum	0.51	5.9	0.007	0
Tellina scobinata	3.04	35.4	0.04	0
Turbo chryrostomus	5.27	61.3	0.08	1
Turbo sp.^	104.31	1212.9	1.64	0
Vasum turbinellus	3.32	38.6	0.05	0
Volutidae sp.	17.3	201.2	0.3	1
Unidentified bivalve sp 1.	0.1	1.2	0.001	1
Terrestrial snail	17.71	205.9	0.3	3
Unidentified fragments	2192.8	25497.7	34.5	-

TOTALS	6353.57	73878.72	99.8	168

Total volume of XU5 deposits = 0.086m^3
^ Unidentified *Turbo* sp. operculum

Ormi, XU6 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	15.38	177.8	0.28	0
Hippopus hippopus	131.13	1515.9	2.4	1
Lambis lambis	793.0	9167.63	14.8	2
Nerita undata	213.73	2470.9	4.0	103
Strombus luhuanus	477.58	5521.2	8.9	24
Tridacna spp.	805.92	9317.0	15.02	3
Trochus niloticus	364.25	4211.0	6.8	2
OTHER				
Acanthopleura sp.	2.66	30.7	0.04	1
Codakia tigerina	3.73	43.1	0.001	0
Cypraea annulus	21.84	252.5	0.4	6
Garfrarium pectinatum	2.8	32.4	0.05	1
Pinctada margaritifera	9.44	109.1	0.17	0
Paphies striata	1.54	17.8	0.02	1
Patelloida sp.	6.89	79.6	0.12	10
Planaxis sulcatus	6.0	69.4	0.11	3
Polinices sp.	6.98	80.7	0.13	2
Mimachalamys sp.	0.29	3.3	0.005	0
Modiolus sp.	1.9	22.0	0.03	0
Monodonta labio	9.07	104.8	0.001	2
Nerita albicilla	34.0	393.06	0.63	11
Nerita polita	6.0	69.4	0.11	2
Saccostrea cucullata	15.13	175.0	0.3	1
Turbo argyrostoma	14.59	168.7	0.3	0
Tellina palatum	2.76	31.9	0.05	0
Tellina scobinata	0.82	9.5	0.01	0
Turbo crassus	1.8	20.8	0.03	0
Turbo sp.^	33.9	392.0	0.63	0
Vasum turbinellus	1.36	15.7	0.02	0
Unidentified bivalve sp 1.	0.23	2.6	0.004	2
Terrestrial snail	27.85	322.0	0.51	4
Unidentified fragments	2352.0	27190.7	43.8	-
TOTALS	5364.57	62018.15	99.9	181

Total volume of XU6 deposits = 0.0865m^3
^ Unidentified Turbo sp. operculum

Ormi, XU7 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	67.15	841.5	1.3	1
Hippopus hippopus	167.4	2097.7	3.2	1
Lambis lambis	855.88	10725.3	16.2	3
Nerita undata	173.6	2175.4	3.3	81
Strombus luhuanus	528.28	6620.05	10.0	26
Tridacna spp.	1360.4	17047.6	25.7	2
Trochus niloticus	443.97	5563.5	8.4	1
OTHER				
Acanthopleura sp.	7.73	97.0	0.14	5
Asaphis violascens	4.19	52.5	0.07	0
Barbatia sp.	0.48	6.01	0.009	0
Codakia tigerina	0.9	11.3	0.01	0
Cypraea annulus	17.7	221.8	0.33	3
Modiolus sp.	1.86	23.3	0.03	1
Monodonta labio	3.65	45.7	0.06	1
Nerita albicilla	38.63	484.1	0.73	13
Nerita polita	5.74	71.9	0.1	1
Nerita maxima	2.56	32.08	0.04	1
Paphies striata	1.27	16.0	0.02	0
Patelloida sp.	7.02	88.0	0.13	9
Pinctada margaritifera	11.56	144.9	0.21	0
Polymesoda coaxans	6.76	84.7	0.12	1
Saccostrea cucullata	7.85	98.4	0.14	1
Syrinx auruanus	60.48	757.9	1.14	0
Tellina palatum	5.49	68.8	0.1	0
Turbo argyrostoma	45.23	566.8	0.9	1
Trapezium sp.	0.55	6.9	0.01	1
Trochus erythraeus	11.29	141.4	0.21	1
Turbo sp.^	30.03	376.3	0.6	0
Volutidae sp.	6.74	84.5	0.12	0
Unidentified bivalve sp 1.	0.94	11.8	0.01	5
Terrestrial snail	53.15	666.0	1.0	4
Unidentified fragments	1363.2	17082.7	25.8	-
TOTALS	5291.68	66311.8	100.1	162

Total volume of XU7 deposits = 0.0798m³
^ Unidentified *Turbo* sp. operculum

Ormi, XU8 Molluscan Shell Recoveries

Species	Weight gm	Density gm/m^3	% of tot. wt.	MNI
COMMONLY OCCURRING SPECIES				
Cypraea tigris	12.06	202.7	0.3	0
Hippopus hippopus	215.32	3618.8	4.62	1
Lambis lambis	528.69	8885.5	11.34	4
Nerita undata	138.0	2319.3	3.0	68
Strombus luhuanus	418.07	7026.4	9.0	23
Tridacna spp.	698.16	11733.8	15.0	3
Trochus niloticus	772.32	12980.2	16.6	7
OTHER				
Acanthopleura sp.	5.55	93.3	0.11	3
Anadara antiquata	4.09	68.73	0.08	0
Asaphis violascens	4.35	73.1	0.1	0
Cypraea annulus	9.78	164.4	0.2	4
Littorina sp.	0.4	6.7	0.008	0
Modiolus sp.	1.86	23.03	0.02	1
Monodonta labio	4.54	76.3	0.09	0
Muricidae sp.	1.11	18.6	0.02	1
Nerita albicilla	37.3	626.9	0.8	11
Nerita polita	12.8	215.1	0.3	2
Paphies striata	1.1	18.5	0.02	1
Patelloida sp.	70.9	15.1	0.01	4
Planaxis sulcatus	0.48	8.06	0.01	0
Pinctada margaritifera	10.42	175.12	0.22	0
Strombus lentigonosus	3.04	51.1	0.06	0
Tellina palatum	1.59	26.7	0.03	0
Tellina scobinata	0.67	11.3	0.01	0
Turbo argyrostoma	108.15	1817.6	2.32	2
Turbo sp.^	36.0	605.04	0.8	0
Unidentified bivalve sp 1.	0.22	3.7	0.004	1
Terrestrial snail	24.39	410.0	0.5	3
Unidentified fragments	1538.8	25862.2	33.02	-
TOTALS	4660.16	78322.01	99.2	136

Total volume of XU8 deposits = 0.0595m^3
^ Unidentified Turbo sp. operculum

Ormi, XU9 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	85.23	955.5	1.3	1
Hippopus hippopus	69.7	781.4	1.04	0
Lambis lambis	1169.6	13112.1	17.6	7
Nerita undata	183.5	2057.2	2.8	72
Strombus luhuanus	973.68	10915.7	14.6	48
Tridacna spp.	1867.4	20935.0	28.02	3
Trochus niloticus	618.98	6939.2	9.3	6
OTHER				
Acanthopleura sp.	5.09	57.06	0.07	4
Anodonta bullula	0.11	1.2	0.001	1
Asaphis violascens	2.82	31.6	0.04	0
Cardita variegata	0.23	2.6	0.003	1
Codakia tigerina	6.73	75.4	0.1	0
Cypraea annulus	12.51	140.2	0.2	5
Cypraea sp.	19.37	217.1	0.3	1
Davila plana	0.34	3.8	0.001	1
Dosinia altenai	1.44	16.1	0.02	1
Euchelus atratus	1.57	17.6	0.02	1
Haliotis sp.	0.23	2.6	0.003	1
Modiolus sp.	1.72	19.3	0.02	0
Monodonta labio	5.37	60.2	0.08	1
Nerita albicilla	15.5	173.8	0.23	5
Nerita polita	4.21	47.2	0.06	1
Paphies striata	1.0	11.2	0.001	1
Patelloida sp.	2.94	33.0	0.04	8
Pinctada margaritifera	31.49	353.0	0.5	1
Polymesoda coaxans	14.09	158.0	0.2	1
Pyrene sp.	0.26	2.9	0.003	1
Saccostrea cucullata	26.95	302.13	0.4	1
Strombus lentigonosus	99.06	1110.5	1.5	1
Tellina scobinata	8.7	97.5	0.13	1
Trochus maculatus	17.02	190.8	0.05	1
Trochus pyramis	33.13	371.4	0.5	3
Turbo argyrostoma	104.94	1176.5	1.6	2
Turbo sp.^ (RF)	46.37	519.8	0.7	0
Turbo sp. (RF)	3.68	41.3	0.05	2
Vasum turbinellus	57.1	640.1	0.9	1
Unidentified bivalve sp 1.	0.57	6.4	0.001	5
Terrestrial snail	38.86	435.7	0.6	4

Unidentified fragments	1130.8	12677.1	17.0	-
TOTALS	6662.29	74689.3	100.2	193

Total volume of XU9 deposits = 0.0892m^3
^ Unidentified *Turbo* sp. operculum

Ormi, XU10 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	54.3	509.9	0.7	1
Hippopus hippopus	207.59	1949.2	2.7	2
Lambis lambis	1254.73	11781.5	16.6	5
Nerita undata	196.2	1842.2	2.6	82
Strombus luhuanus	758.39	7121.03	10.04	39
Tridacna spp.	764.3	7176.5	10.12	0
Trochus niloticus	1417.05	13305.63	18.8	14
OTHER				
Acanthopleura sp.	7.23	67.9	0.09	4
Arca ventricosa	2.37	22.3	0.03	1
Asaphis violascens	0.36	3.4	0.004	0
Barbatia sp.	0.66	6.2	0.001	0
Cypraea annulus	5.8	54.5	0.07	1
Frimbria frimbriata	1.77	13.8	0.01	0
Melo amphora	151.25	1420.2	2.0	0
Modiolus sp.	3.46	32.5	0.04	1
Monodonta labio	4.24	39.8	0.05	0
Patelloida sp.	1.04	9.8	0.01	5
Pinctada margaritifera	2.24	21.03	0.02	0
Planaxis sulcatus	2.97	27.9	0.03	1
Nerita albicilla	59.3	556.8	0.8	17
Nerita polita	14.7	138.02	0.2	7
Saccostrea cucullata	3.99	37.46	0.05	1
Syrinx auruanus	180.52	1695.02	2.4	0
Tellina palatum	0.4	3.8	0.001	0
Tonna sp.	1.65	15.5	0.02	1
Turbo argyrostoma	323.39	3036.5	4.3	6
Turbo crassus	106.05	995.8	1.4	3
Turbo sp.^	30.2	283.6	0.4	0
Volutidae sp.	13.3	124.9	0.2	0
Unidentified bivalve sp 1.	4.32	40.6	0.05	17
Terrestrial snail	50.71	476.2	0.7	6
Unidentified fragments	1922.1	18047.9	25.5	-
TOTALS	7546.58	70860.0	99.9	214

Total volume of XU10 deposits = 0.1065m³ ^ Unidentified *Turbo* sp. operculum

Ormi, XU11 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	78.55	849.2	1.0	1
Hippopus hippopus	188.7	2040.0	2.4	0
Lambis lambis	865.96	9361.7	11.03	9
Nerita undata	251.95	2723.8	3.2	115
Strombus luhuanus	912.00	9859.5	11.6	46
Tridacna spp.	1919.53	20751.7	24.5	6
Trochus niloticus	1357.83	14679.2	17.3	12
OTHER				
Acanthopleura sp.	8.32	90.0	0.1	5
Anadara sp.	9.71	105.0	0.12	1
Arca sp.	1.86	20.1	0.02	0
Asaphis violascens	2.06	22.3	0.02	0
Barbatia sp.	0.23	2.5	0.001	1
Cerithium nodulosum	52.56	568.2	0.7	3
Cerithium sp.	0.53	5.7	0.006	1
Codakia tigerina	1.58	17.1	0.02	0
Cypraea sp.	22.74	245.8	0.3	0
Davila plana	0.39	4.2	0.001	0
Garfrarium sp.	0.72	7.8	0.009	0
Melo amphora	42.23	456.5	0.5	0
Modiolus sp.	1.76	19.02	0.02	0
Monodonta labio	6.77	73.2	0.08	3
Nerita albicilla	105.19	1137.2	1.34	38
Nerita polita	8.94	96.6	0.11	4
Nerita costata	1.2	13.0	0.01	1
Patelloida sp.	6.52	70.5	0.08	6
Pinctada margaritifera	50.56	546.6	0.6	0
Planaxis sulcatus	4.57	49.4	0.05	1
Saccostrea cucullata	9.12	98.6	0.11	1
Tectus pyramis	121.4	1312.4	1.5	2
Tellina palatum	1.16	12.5	0.01	0
Tellina scobinata	0.2	2.2	0.002	0
Turbo argyrostoma	100.68	1088.4	1.3	1
Turbo sp.^	29.5	319.0	0.4	0
Volutidae sp.	24.56	265.5	0.3	1
Unidentified bivalve sp 1.	0.98	10.6	0.01	5
Terrestrial snail	33.08	357.6	0.42	3
Unidentified fragments	1620.3	17516.8	20.6	-

TOTALS	7843.9	84799.0	99.8	266

Total volume of XU11 deposits = 0.0925m^3
^ Unidentified *Turbo* sp. operculum

Ormi, XU12 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	8.13	128.03	0.2	0
Hippopus hippopus	507.9	7998.42	11.32	1
Lambis lambis	268.9	4234.64	6.0	3
Nerita undata	261.13	4112.3	5.82	127
Strombus luhuanus	580.2	9137.0	12.93	29
Tridacna spp.	949.46	14952.12	21.2	3
Trochus niloticus	374.59	5899.1	8.34	8
OTHER				
Acanthopleura sp.	7.49	118.0	0.2	4
Amoria sp.	46.98	739.84	1.04	1
Antigona reticulata	2.12	33.4	0.04	0
Asaphis violascens	1.09	17.2	0.02	1
Cypraea annulus	11.1	174.8	0.24	5
Conus sp.	33.7	530.7	0.8	1
Haliotis sp.	0.49	7.71	0.01	1
Modiolus sp.	4.2	66.14	0.09	0
Monodonta labio	0.8	12.6	0.01	0
Nerita albicilla	126.9	1998.4	2.8	41
Nerita polita	6.67	105.03	0.14	1
Patelloida sp.	2.85	44.9	0.06	9
Pinctada margaritifera	75.0	1181.1	1.7	3
Planaxis sulcatus	0.88	13.9	0.01	1
Polymesoda coaxans	13.63	214.64	0.3	2
Saccostrea cucullata	7.76	122.2	0.2	2
Trochus virgatus	7.68	120.9	0.2	0
Turbo argyrostoma	174.71	2751.33	3.9	3
Turbo sp.^	49.68	782.4	1.1	0
Unidentified bivalve sp 1.	0.37	5.82	0.008	3
Land snail	15.76	248.2	0.35	0
Unidentified fragments	946.28	14902.04	21.1	-
TOTALS	4486.45	70652.8	99.9	249

Total volume of XU12 deposits = 0.0635m³
^ Unidentified *Turbo* sp. operculum

Ormi, XU13 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	99.31	1822.2	2.13	0
Lambis lambis	365.8	6711.92	7.9	3
Nerita undata	278.4	5108.3	6.0	103
Strombus luhuanus	308.39	5658.53	6.63	14
Tridacna spp.	2184.8	40088.1	47.03	2
Trochus niloticus	195.12	3580.2	4.2	2
OTHER				
Acanthopleura sp.	9.78	179.44	0.21	3
Asaphis violascens	2.72	50.0	0.05	1
Cypraea annulus	37.64	690.6	0.81	6
Cypraea sp.	48.21	884.6	1.03	0
Frimbria frimbriata	0.98	18.0	0.02	0
Modiolus sp.	10.13	185.9	0.21	2
Morula marginalba	1.66	30.5	0.03	1
Nassirius olivaceus	1.58	29.0	0.03	1
Nerita albicilla	119.69	2196.14	2.6	41
Nerita polita	7.6	139.44	0.2	2
Nerita sp.*	2.54	46.6	0.05	0
Patelloida sp.	3.57	65.5	0.07	6
Pinctada margaritifera	30.75	564.22	0.7	0
Planaxis sulcatus	0.24	4.4	0.005	0
Polymesoda coaxans	1.41	25.9	0.03	0
Saccostrea cucullata	1.26	23.1	0.02	0
Tellina scobinata	2.27	41.7	0.001	0
Turbo argyrostoma	1.76	32.3	0.03	0
Turbo sp.^	17.41	319.44	0.4	0
Unidentified bivalve sp 1.	0.11	2.01	0.002	1
Unidentified bivalve sp. 2.	12.05	221.1	0.3	0
Terrestrial snail	6.84	125.5	0.14	0
Unidentified fragments	893.2	16389.0	19.2	-
TOTALS	4645.22	85233.4	99.9	188

Total volume of XU13 deposits = 0.0545m³
* Unidentified *Nerita* sp. operculum ^ Unidentified *Turbo* sp. operculum

Ormi, XU14 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	50.19	702.0	0.4	1
Hippopus hippopus	401.85	5620.3	3.3	5
Lambis lambis	2690.05	37623.1	22.0	25
Nerita undata	337.5	4720.3	2.8	160
Strombus luhuanus	1841.92	25761.11	15.02	78
Tridacna spp.	2939.3	41109.0	24.0	18
Trochus niloticus	1739.73	24331.9	14.2	34
OTHER				
Acanthopleura sp.	8.28	115.8	0.06	5
Amoria sp.	32.19	450.2	0.26	0
Conus sp.	28.7	401.4	0.23	1
Cypraea annulus	6.95	97.2	0.05	2
Cypraea sp.	43.1	602.8	0.35	2
Haliotis sp.	2.47	34.54	0.02	0
Modiolus sp.	12.11	169.4	0.09	3
Monodonta labio	1.56	21.8	0.01	0
Nerita albicilla	42.64	596.4	0.34	12
Nerita polita	0.66	9.2	0.005	0
Nerita sp.*	0.91	12.72	0.007	0
Patelloida sp.	2.11	29.5	0.01	10
Pinctada margaritifera	74.4	1040.6	0.6	2
Planaxis sulcatus	0.63	8.8	0.005	1
Plueroploca filamentosa	165.81	2319.02	1.35	2
Saccostrea cucullata	48.63	680.1	0.4	5
Strombus lentigonosus	116.54	1630.0	0.9	2
Turbo argyrostoma	347.6	4861.5	2.8	8
Turbo chrysostomus	8.2	114.8	0.06	1
Turbo crassus	33.45	467.8	0.3	2
Turbo sp.^	43.9	614.0	0.35	0
Turbo sp.	3.71	51.9	0.03	1
Unidentified bivalve sp 1.	1.44	20.13	0.01	5
Terrestrial snail	23.8	332.9	0.2	2
Unidentified fragments	1211.71	16947.0	99.9	-
TOTALS	12262.04	171497.1	100.0	387

Total volume of XU14 deposits = 0.0715m³
* Unidentified *Nerita* sp. Operculum ^ Unidentified *Turbo* sp. operculum

Ormi, XU15 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	108.18	1335.6	0.84	3
Hippopus hippopus	1115.82	13776.0	8.7	4
Lambis lambis	2036.46	25141.5	15.84	24
Nerita undata	465.1	5742.0	3.6	104
Strombus luhuanus	4123.7	50910.0	32.1	193
Tridacna spp.	1086.54	13414.1	8.5	2
Trochus niloticus	1939.32	23942.22	15.1	34
OTHER				
Acanthopleura sp.	5.5	67.9	0.04	3
Amoria sp.	125.85	1553.7	1.0	3
Anadara antiquata	37.28	460.24	0.3	1
Antigona reticulata	15.63	193.0	0.12	0
Asaphis violascens	0.46	5.7	0.003	0
Cassis sp.	20.05	247.5	0.2	1
Conus sp.	19.8	244.4	0.2	0
Codakia tigerina	0.7	8.64	0.005	0
Cypraea annulus	3.43	42.34	0.02	0
Haliotis sp.	6.3	77.8	0.04	2
Turbo argyrostoma	400.6	4945.7	3.11	7
Melo amphora	53.26	657.53	0.4	0
Nerita albicilla	24.43	301.6	0.2	9
Nerita polita	17.6	217.3	0.13	5
Nerita sp.*	2.6	32.1	0.02	0
Paphies striata	3.2	39.5	0.02	1
Patelloida sp.	2.54	31.4	0.01	6
Pinctada margaritifera	89.5	1104.9	0.7	2
Plueroploca filamentosa	25.83	318.9	0.2	1
Modiolus sp.	28.8	355.6	0.22	4
Monodonta labio	7.71	95.9	0.06	1
Saccostrea cucullata	9.14	112.8	0.1	1
Strombus lentigonosus	12.74	157.3	0.09	0
Turbo chrysostomus	36.7	453.1	0.3	2
Turbo crassus	116.46	1437.8	0.9	1
Turbo sp.^	26.82	33.11	0.02	0
Vasum turbinellus	14.48	178.8	0.11	0
Unidentified bivalve sp 1.	1.06	13.1	0.008	3
Terrestrial snail	13.22	163.2	0.1	0

Unidentified fragments	853.11	10532.2	6.63	-
TOTALS	12849.92	158641.0	99.9	417

Total volume of XU15 deposits = $0.081m^3$
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Ormi, XU16 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	13.63	194.7	0.3	1
Hippopus hippopus	29.91	427.3	0.7	0
Lambis lambis	745.73	10653.3	17.03	6
Nerita undata	231.82	3311.7	5.3	87
Strombus luhuanus	551.18	7874.0	12.6	31
Tridacna spp.	912.72	13038.9	20.9	9
Trochus niloticus	391.18	5588.3	8.9	4
OTHER				
Acanthopleura sp.	8.28	118.3	0.2	0
Asaphis violascens	1.31	18.7	0.02	0
Cypraea sp.	8.39	119.9	0.2	1
Haliotis sp.	3.09	44.14	0.07	1
Modiolus sp.	24.39	348.42	0.6	4
Monodonta labio	7.81	111.6	0.2	3
Nerita albicilla	9.71	138.7	0.22	3
Nerita polita	5.54	79.1	0.1	1
Nerita sp.*	0.7	10.0	0.01	0
Patelloida sp.	6.29	89.9	0.14	10
Pinctada margaritifera	207.15	2959.3	4.7	1
Saccostrea cucullata	16.35	233.6	0.4	0
Tellina palatum	0.85	12.14	0.01	0
Turbo argyrostoma	96.62	1380.3	2.2	2
Turbo laminferus	12.25	175.0	0.3	1
Turbo sp.^	90.84	1297.7	2.07	0
Unidentified bivalve sp 1.	0.12	1.7	0.002	1
Terrestrial snail	1.04	14.9	0.02	0
Unidentified fragments	996.3	14232.9	22.8	-
TOTALS	4377.2	62531.4	99.9	166

Total volume of XU16 deposits = 0.07m³
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Ormi, XU17 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	64.63	1027.5	1.63	1
Hippopus hippopus	81.5	1295.7	2.1	1
Lambis lambis	590.69	9390.9	15.0	1
Nerita undata	144.16	2291.9	3.7	47
Strombus luhuanus	174.71	2777.6	4.42	7
Tridacna spp.	851.1	13531.0	21.6	5
Trochus niloticus	836.03	13291.4	21.2	8
OTHER				
Acanthopleura sp.	3.32	52.8	0.08	3
Antigona reticulata	2.51	40.0	0.1	0
Codakia tigerina	2.6	41.3	0.1	0
Cypraea annulus	82.51	1311.8	2.1	1
Cypraea sp.	1.01	16.05	0.02	1
Haliotis sp.	0.45	7.15	0.01	0
Modiolus sp.	1.0	15.9	0.02	0
Monodonta labio	0.25	4.0	0.001	0
Murcididae sp.	1.58	25.11	0.04	1
Nerita albicilla	10.01	159.14	0.3	3
Nerita polita	16.18	257.23	0.4	3
Patelloida sp.	1.44	22.9	0.03	3
Pinctada margaritifera	19.65	312.4	0.5	1
Tellina palatum	0.77	12.24	0.01	0
Tellina scobinata	2.55	40.5	0.1	0
Turbo argyrostoma	47.69	75.8	0.12	1
Turbo sp.^	9.1	144.7	0.23	0
Terrestrial snail	5.72	90.93	0.14	1
Unidentified fragments	997.2	15853.73	25.3	-
TOTALS	3948.4	62772.6	99.25	88

Total volume of XU17 deposits = 0.0629m³
^ Unidentified *Turbo* sp. operculum

Ormi, XU18 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m^3*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	3.29	33.1	0.2	0
Hippopus hippopus	6.41	64.4	0.33	0
Lambis lambis	281.6	2830.2	14.9	4
Nerita undata	104.44	1049.64	5.52	58
Strombus luhuanus	37.55	377.4	2.0	2
Tridacna spp.	130.4	1310.6	6.9	0
Trochus niloticus	87.09	875.3	4.6	2
OTHER				
Acanthopleura sp.	2.84	28.5	0.14	2
Amoria sp.	7.7	77.4	0.4	0
Anadara sp.	2.0	20.1	0.1	1
Asaphis violascens	1.74	17.5	0.1	0
Cypraea annulus	14.03	141.0	0.74	10
Davila plana	0.8	804.0	4.22	1
Haliotis sp.	0.64	6.43	0.03	1
Melo sp.	7.8	78.4	0.4	0
Modiolus sp.	6.1	61.3	0.32	1
Monodonta labio	1.0	10.1	0.05	0
Nerita albicilla	4.78	48.04	0.3	1
Nerita polita	2.99	30.05	0.2	1
Nerita sp.*	1.47	14.8	0.1	0
Patelloida sp.	2.4	24.12	0.12	3
Paphies striata	1.0	10.05	0.05	1
Pinctada margaritifera	3.59	36.1	0.2	1
Tellina palatum	6.78	68.14	0.35	0
Tellina scobinata	4.0	40.2	0.21	0
Trochus erythraues	9.4	94.5	0.5	1
Turbo argyrostoma	38.42	386.1	2.03	1
Turbo crassus	10.2	102.5	0.53	0
Turbo sp.^	16.1	161.8	0.9	0
Terrestrial snail	3.66	36.8	0.2	0
Unidentified fragments	1091.2	10966.8	57.7	-
TOTALS	1891.42	19009.24	fucked	91

Total volume of XU18 deposits = 0.0995m^3
* Unidentified *Nerita* sp. operculum ^ Unidentified *Turbo* sp. operculum

Ormi, XU19 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	7.58	73.6	0.4	0
Hippopus hippopus	89.68	870.7	4.5	1
Lambis lambis	324.65	3151.9	16.3	0
Nerita undata	63.91	620.5	3.2	43
Strombus luhuanus	106.11	1030.2	5.32	5
Tridacna spp.	450.5	4373.8	22.6	2
Trochus niloticus	29.32	284.7	1.5	0
OTHER				
Acanthopleura sp.	0.1	1.0	0.005	1
Antigona reticulata	3.9	37.9	0.2	0
Asaphis violascens	0.66	6.4	0.005	0
Cardita sp.	0.28	2.71	0.01	1
Codakia tigerina	0.5	4.9	0.02	0
Cypraea annulus	7.34	71.3	0.4	2
Davila plana	3.09	30.0	0.2	1
Monodonta labio	1.85	18.0	0.09	0
Nerita polita	4.3	41.7	0.2	1
Nerita sp.*	0.49	4.8	0.005	0
Paphies striata	1.42	13.8	0.07	1
Patelloida sp.	2.97	28.83	0.14	8
Pinctada margaritifera	72.32	702.13	3.62	1
Planaxis sulcatus	0.1	1.0	0.005	0
Polymesoda coaxans	14.39	139.7	0.72	0
Tellina palatum	0.6	5.82	0.03	0
Tellina scobinata	2.69	26.11	0.13	0
Turbo argyrostoma	4.0	38.8	0.2	0
Turbo sp.^	0.24	2.33	0.01	0
Unidentified bivalve sp. 1	0.21	2.03	0.01	1
Unidentified bivalve sp. 2	0.23	2.23	0.01	1
Terrestrial snail	5.52	53.6	0.3	1
Unidentified fragments	794.7	7715.53	39.9	-
TOTALS	1993.65	19355.82	100.1	70

Total volume of XU19 deposits = 0.103m³
* Unidentified *Nerita* sp. operculum
^ Unidentified *Turbo* sp. operculum

Ormi, XU20 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	5.64	46.2	0.4	0
Hippopus hippopus	11.5	94.3	0.8	0
Lambis lambis	128.76	1055.4	9.43	0
Nerita undata	68.73	563.36	5.03	45
Strombus luhuanus	95.83	785.5	7.02	5
Tridacna spp.	154.03	1262.54	11.3	1
Trochus niloticus	124.88	1023.6	9.14	3
OTHER				
Acanthopleura sp.	0.61	5.0	0.04	8
Asaphis violascens	2.65	21.7	0.2	0
Codakia tigerina	2.46	20.1	0.2	0
Cypraea annulus	5.49	45.0	0.4	2
Haliotis sp.	2.97	24.3	0.2	1
Modiolus sp.	2.33	19.1	0.2	1
Monodonta labio	2.16	17.7	0.2	1
Nerita polita	4.7	38.5	0.34	1
Paphies striata	2.8	23.0	0.2	1
Patelloida sp.	1.74	14.3	0.12	5
Pinctada margaritifera	96.0	786.9	7.03	0
Polymesoda coaxans	10.14	83.1	0.74	1
Tellina scobinata	2.07	17.0	0.2	0
Turbo argyrostoma	4.02	33.0	0.3	0
Turbo sp.^	41.69	341.7	3.05	0
Terrestrial snail	1.24	10.2	0.1	0
Unidentified fragments	592.4	4855.73	43.4	-
TOTALS	1364.84	11187.21	100.04	75

Total volume of XU20 deposits = 0.122m³
^ Unidentified *Turbo* sp. operculum

Ormi, XU22 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	14.06	161.6	0.5	0
Hippopus hippopus	0	0	0	0
Lambis lambis	1526.56	17546.7	50.84	5
Nerita undata	53.05	609.8	1.8	46
Strombus luhuanus	197.11	2265.63	6.6	8
Tridacna spp.	73.1	840.22	2.43	1
Trochus niloticus	523.91	6022.0	17.44	3
OTHER				
Acanthopleura sp.	0.74	8.5	0.02	1
Asaphis violascens	4.02	46.2	0.13	0
Astraea stellare	3.56	40.9	0.11	1
Cypraea annulus	8.55	98.3	0.3	5
Davila plana	0.65	7.5	0.02	1
Haliotis sp.	0.41	4.7	0.01	0
Modiolus sp.	0.54	6.2	0.01	0
Melo amphora	9.0	103.44	0.3	0
Nassirius albescense	0.74	8.5	0.02	1
Nerita polita	2.4	27.6	0.07	1
Paphies striata	0.85	9.8	0.02	1
Patelloida sp.	1.58	18.16	0.05	5
Pinctada margaritifera	8.71	100.1	0.3	0
Polymesoda coaxans	5.91	67.93	0.2	2
Saccostrea cucullata	12.6	144.82	0.41	1
Spondylus sp.	9.91	113.9	0.33	1
Tellina palatum	0.83	9.54	0.02	0
Tellina scobinata	1.08	12.41	0.03	0
Turbo laminferus	26.1	300.0	0.9	2
Turbo sp.^	34.9	401.14	1.2	0
Terrestrial snail	0	0	0	0
Unidentified fragments	481.77	5537.6	16.04	-
TOTALS	3002.64	34513.1	100.1	85

Total volume of XU22 deposits = $0.087m^3$
^ Unidentified *Turbo* sp. operculum

Ormi, XU23 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	133.95	2029.54	14.1	4
Nerita undata	5.63	85.3	0.6	3
Strombus luhuanus	12.66	191.81	1.33	1
Tridacna spp.	127.22	1927.6	13.4	2
Trochus niloticus	369.19	5593.8	38.8	3
OTHER				
Cypraea annulus	2.35	35.6	0.24	2
Cypraea sp.	3.7	56.1	0.4	1
Garfrarium sp.	0.27	4.1	0.02	1
Modiolus sp.	4.12	62.42	0.43	0
Morula sp. 1	0.94	14.24	0.09	1
Morula sp. 2	0.8	12.12	0.1	1
Nerita albicilla	4.24	64.24	0.44	2
Nerita polita	3.52	53.3	0.4	1
Ostrea sp.	1.7	25.8	0.2	0
Patelloida sp.	0.7	10.6	0.1	3
Pinctada margaritifera	62.43	945.9	6.6	1
Polymesoda coaxans	6.84	103.63	0.71	1
Tellina scobinata	1.29	19.54	0.13	0
Terrestrial snail	0	0	0	0
Unidentified fragments	209.83	3179.24	22.1	-
TOTALS	951.38	14414.84	100.1	27

Total volume of XU23 deposits = 0.066m³
^ Unidentified *Turbo* sp. operculum

Ormi, XU24 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	28.1	214.5	1.7	0
Lambis lambis	434.74	3318.6	26.7	3
Nerita undata	3.02	23.05	0.2	4
Strombus luhuanus	19.97	137.2	1.1	2
Tridacna spp.	429.34	3277.4	26.32	1
Trochus niloticus	205.86	1571.5	12.6	5
OTHER				
Arca ventricosa	8.69	66.33	0.53	1
Asaphis violascens	1.33	10.2	0.1	1
Astrea stellara	2.1	16.03	0.12	1
Cypraea annulus	5.08	38.8	0.31	2
Melo amphora	8.88	67.8	0.5	1
Nerita albicilla	1.66	12.7	0.1	1
Nerita polita	2.31	17.6	0.14	2
Paphies striata	1.18	9.0	0.1	1
Patelloida sp.	5.26	40.1	0.32	4
Pinctada margaritifera	2.45	18.7	0.2	0
Polymesoda coaxans	8.98	68.54	0.6	0
Tellina scobinata	5.36	40.9	0.32	1
Turbo argyrostoma	5.12	39.1	0.3	0
Turbo sp.^	19.21	146.64	1.2	0
Terrestrial snail	0	0	0	0
Unidentified fragments	432.23	3299.5	26.5	-
TOTALS	1630.87	12449.4	99.9	30

Total volume of XU24 deposits = 0.131m³
^ Unidentified *Turbo* sp. operculum

Ormi, XU25 Molluscan Shell Recoveries

Species	*Weight gm*	*Density gm/m³*	*% of tot. wt.*	*MNI*
COMMONLY OCCURRING SPECIES				
Cypraea tigris	0	0	0	0
Hippopus hippopus	0	0	0	0
Lambis lambis	228.59	2539.9	14.8	2
Nerita undata	0.69	7.7	0.04	0
Strombus luhuanus	5.17	57.4	0.33	0
Tridacna spp.	1012.39	11248.8	65.5	3
Trochus niloticus	84.49	938.8	5.5	2
OTHER				
Cerithium nodulosum	18.2	202.22	1.2	1
Clypeomarus conicus	2.0	22.22	0.12	1
Cypraea annulus	3.84	42.7	0.24	3
Cypraea sp.	3.56	39.6	0.23	0
Ostrea sp.	1.2	13.33	0.07	0
Patelloida sp.	2.98	33.11	0.2	3
Pinctada margaritifera	3.22	35.8	0.2	0
Polinices sp.	0.59	6.6	0.03	1
Polymesoda coaxans	3.14	34.9	0.2	0
Turbo sp.^	17.39	193.22	1.1	0
Unidentified bivalve sp. 1	0.42	4.7	0.02	2
Terrestrial snail	0	0	0	0
Unidentified fragments	157.33	1748.11	10.2	-
TOTALS	1545.2	17168.9	99.9	18

Total volume of XU25 deposits = 0.09m³
^ Unidentified *Turbo* sp. operculum

Appendix D

Size tables for commonly-occurring marine shell species

	N	Minimum	Maximum	Mean	Std. Deviation
Horizon I					
Nerita undata	22	0.55	2.35	1.3050	0.45998
Strombus luhuanus	5	4.8	5.57	5.142	0.28711
Lambis lambis	1	11.77	11.77	11.765	-
Tridacna spp.	1	10.45	10.45	10.445	-
Trochus niloticus	0				
Hippopus hippopus	1	12.58	12.58	12.575	-
Horizon II					
Nerita undata	7	1.10	1.72	1.4921	0.20652
Strombus luhuanus	2	4.68	5.28	4.9775	0.42780
Lambis lambis	1	9.0	9.0	9.0	-
Tridacna spp.	1	6.0	6.0	6.0	-
Trochus niloticus	0				
Hippopus hippopus	1	13.26	13.26	13.26	-
Horizon III					
Nerita undata	25	0.75	2.6	1.4663	0.47269
Strombus luhuanus	27	4.1	5.93	4.9873	0.50301
Lambis lambis	25	8.2	14.05	11.4932	1.38757
Tridacna spp.	7	7.6	18.30	11.7973	3.75212
Trochus niloticus	20	4.6	10.64	7.7372	1.80681
Hippopus hippopus	2	10.04	17.1	13.57	4.99217
Horizon IV					
Nerita undata	3	1.26	1.81	1.5533	0.27388
Strombus luhuanus	6	4.5	6.62	5.31	0.75805
Lambis lambis	4	9.2	10.88	9.91	0.69956
Tridacna spp.	0				
Trochus niloticus	0				
Hippopus hippopus	0				

Table 1. Size data for commonly occurring species at Kurkur Weid

	N	Minimum	Maximum	Mean	Std. Deviation
Horizon I					
Nerita undata	30	1.15	3.05	2.0040	0.48280
Strombus luhuanus	3	4.67	5.82	5.4217	0.65135
Lambis lambis	3	9.87	11.2	10.7367	0.75539
Tridacna spp.	0	-	-	-	-
Trochus niloticus	9	3.58	8.95	6.0822	1.62471
Hippopus hippopus	1	13.38	13.38	13.3750	-
Horizon II					
Nerita undata	2	0.76	1.95	1.3525	0.84499
Strombus luhuanus	0	-	-	-	-
Lambis lambis	0	-	-	-	-
Tridacna spp.	0	-	-	-	-
Trochus niloticus	0	-	-	-	-
Hippopus hippopus	0	-	-	-	-
Horizon III					
Nerita undata	40	1.48	2.70	2.0980	0.31876
Strombus luhuanus	7	5.05	5.69	5.3521	0.24298
Lambis lambis	0	-	-	-	-
Tridacna spp.	0	-	-	-	-
Trochus niloticus	0	-	-	-	-
Hippopus hippopus	0	-	-	-	-
Horizon IV					
Nerita undata	17	1.57	2.55	1.9721	0.28883
Strombus luhuanus	7	3.98	5.58	4.9136	0.56077
Lambis lambis	1	10.47	10.47	10.47	-
Tridacna spp.	0	-	-	-	-
Trochus niloticus	0	-	-	-	-
Hippopus hippopus	0	-	-	-	-
Horizon V					
Nerita undata	14	0.8	2.31	1.7839	0.35657
Strombus luhuanus	9	4.51	6.2	5.4244	0.48592
Lambis lambis	0	-	-	-	-
Tridacna spp.	1	5.06	5.06	5.055	-
Trochus niloticus	0	-	-	-	-
Hippopus hippopus	0	-	-	-	-

Table 2. Size data for commonly occurring species at Pitkik

	N	Minimum	Maximum	Mean	Std. Deviation
Horizon I					
Nerita undata	51	1.53	3.2	2.3561	0.36730
Strombus luhuanus	25	4.11	6.03	5.2102	0.46925
Lambis lambis	5	8.55	12.39	11.0340	1.47339
Tridacna spp.	2	9.05	14.38	11.7125	3.76534
Trochus niloticus	1	7.78	7.78	7.78	-
Horizon II					
Nerita undata	6	1.9	2.68	2.2702	0.33318
Strombus luhuanus	6	3.2	6.68	5.0342	1.16632
Lambis lambis	1	11.29	11.29	11.2900	-
Tridacna spp.	1	17.9	17.9	17.9000	-
Trochus niloticus	0	-	-	-	-
Horizon III					
Nerita undata	136	0.93	3.0	2.1542	0.34902
Strombus luhuanus	90	4.52	6.2	5.3087	0.43347
Lambis lambis	4	7.53	15.4	10.315	3.52429
Tridacna spp.	3	6.34	9.3	7.4533	1.61051
Trochus niloticus	6	5.19	9.4	7.1192	1.52014
Horizon IV					
Nerita undata	652	1.02	3.1	2.1004	0.37511
Strombus luhuanus	321	3.25	6.86	5.4449	0.53091
Lambis lambis	1	13.18	13.18	13.18	-
Tridacna spp.	18	6.86	12.4	9.7658	1.81101
Trochus niloticus	14	2.94	9.25	6.0893	2.01043
Horizon V					
Nerita undata	118	1.13	3.15	1.9978	0.38734
Strombus luhuanus	29	4.43	6.2	5.4024	0.44149
Lambis lambis	5	8.48	14.73	11.922	2.66011
Tridacna spp.	2	8.15	8.92	8.535	0.54447
Trochus niloticus	5	6.99	9.16	7.836	0.85514

Table 3. Size data for five commonly occurring species from Sokoli

	N	Minimum	Maximum	Mean	Std. Deviation
Horizon I					
Nerita undata	363	0.95	3.26	1.9784	0.4075
Strombus luhuanus	132	3.58	7.7	5.1547	0.59205
Lambis lambis	10	6.93	12.94	9.8785	1.98685
Tridacna spp.	13	4.7	10.78	8.4458	1.89126
Trochus niloticus	10	3.2	7.86	5.127	1.67624
Horizon II					
Nerita undata	441	1.15	3.06	2.0536	0.38045
Strombus luhuanus	141	3.87	6.55	5.2186	0.50291
Lambis lambis	9	7.72	12.17	10.0428	1.47468
Tridacna spp.	11	6.76	12.75	9.9914	2.15958
Trochus niloticus	20	4.22	9.78	6.7893	2.06312
Horizon III					
Nerita undata	292	1.14	3.11	2.2281	0.37827
Strombus luhuanus	291	3.81	6.95	5.2858	0.59150
Lambis lambis	30	7.4	11.72	9.0533	1.24534
Tridacna spp.	49	4.46	14.76	9.1288	2.41011
Trochus niloticus	48	3.95	9.2	5.9578	1.41434
Horizon IV					
Nerita undata	210	0.69	3.2	1.8412	0.49687
Strombus luhuanus	15	4.40	6.57	5.1810	0.60658
Lambis lambis	2	7.6	8.05	7.8250	0.31820
Tridacna spp.	3	8.29	10.53	9.72	1.24582
Trochus niloticus	12	3.72	9.65	6.6242	1.91116
Horizon V					
Nerita undata	49	0.99	2.86	1.6052	0.42927
Strombus luhuanus	7	4.9	6.18	5.6286	0.49084
Lambis lambis	5	11.25	12.55	11.84	0.58284
Tridacna spp.	4	5.59	15.97	11.3688	4.36523
Trochus niloticus	12	2.5	11.47	6.1213	2.63305

Table 4. Size data for commonly occurring species at Ormi

Appendix E

Size graphs for commonly-occurring species

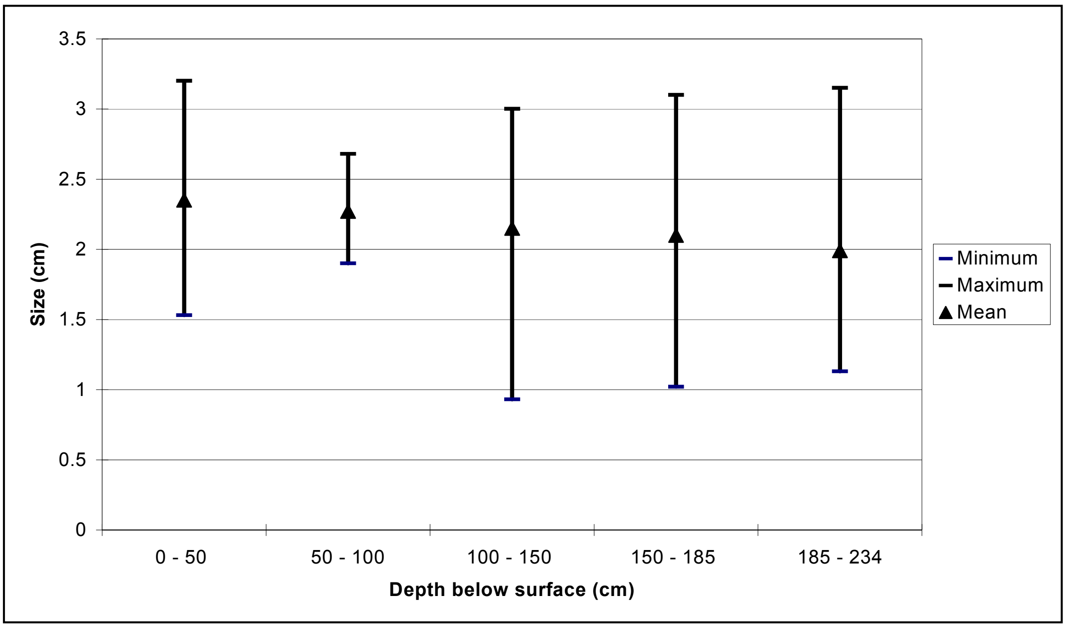

Figure 1. Sokoli *Nerita undata* sizes

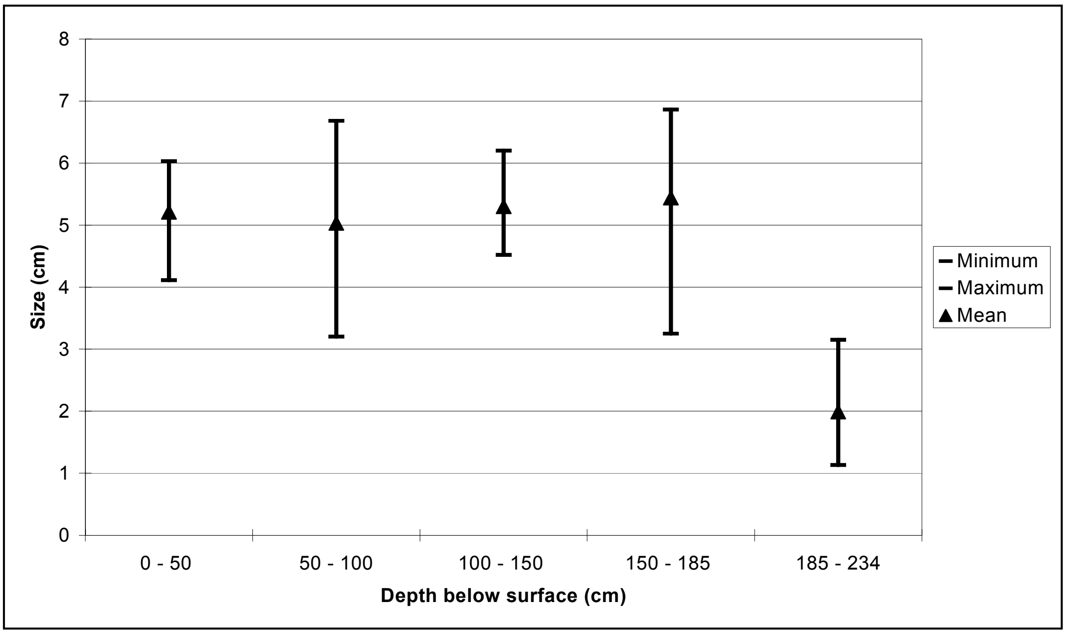

Figure 2. Sokoli *Strombus luhuanus* sizes

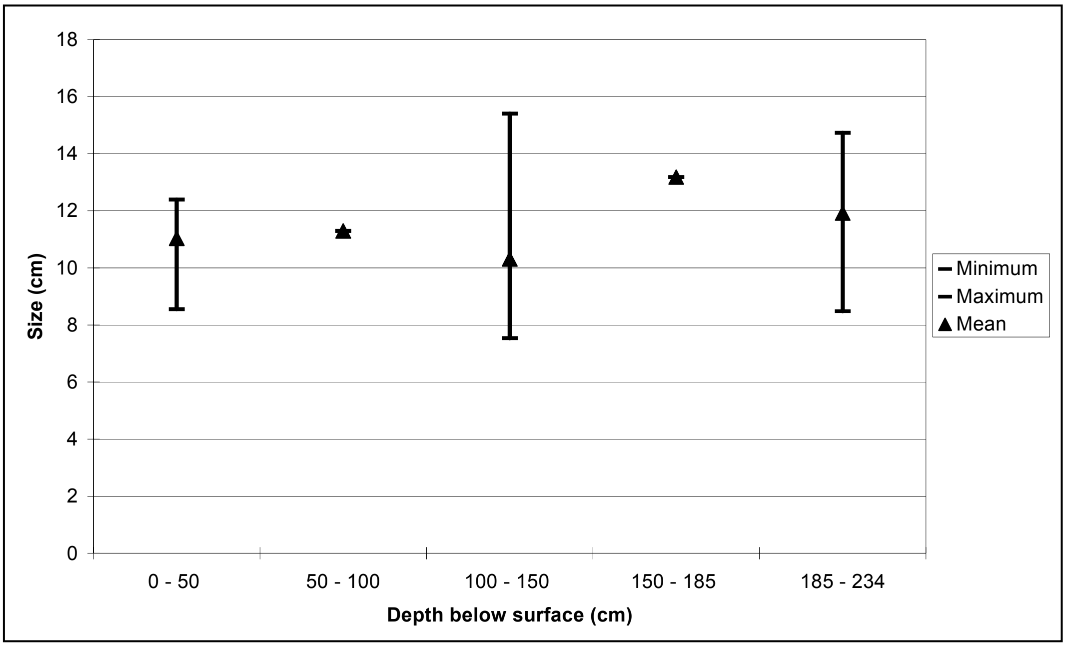

Figure 3. Sokoli *Lambis lambis* sizes

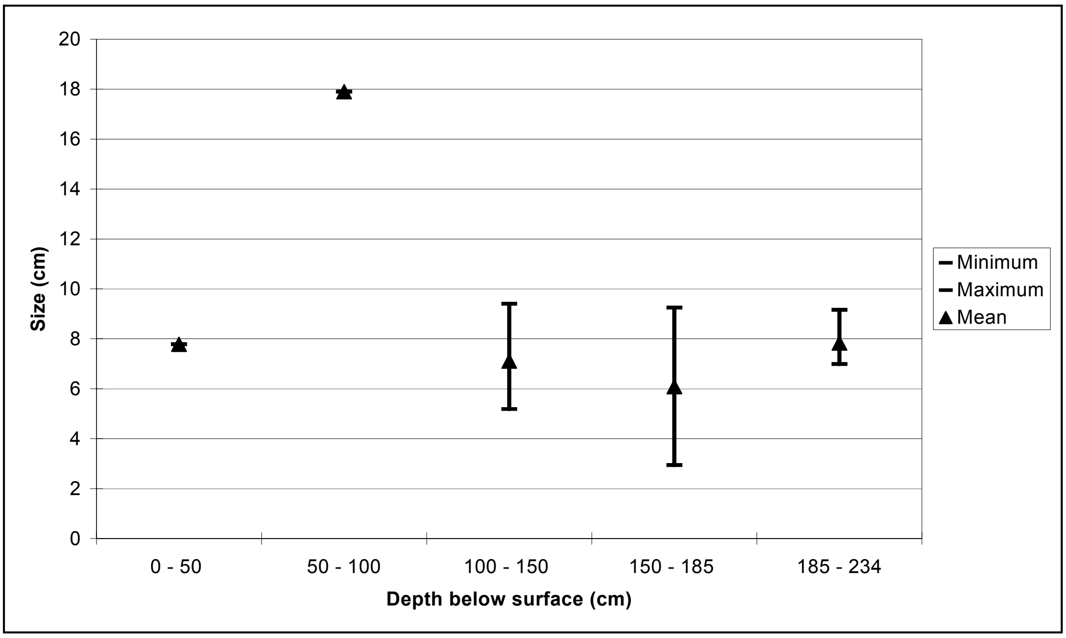

Figure 4. Sokoli *Tridacna* spp. sizes

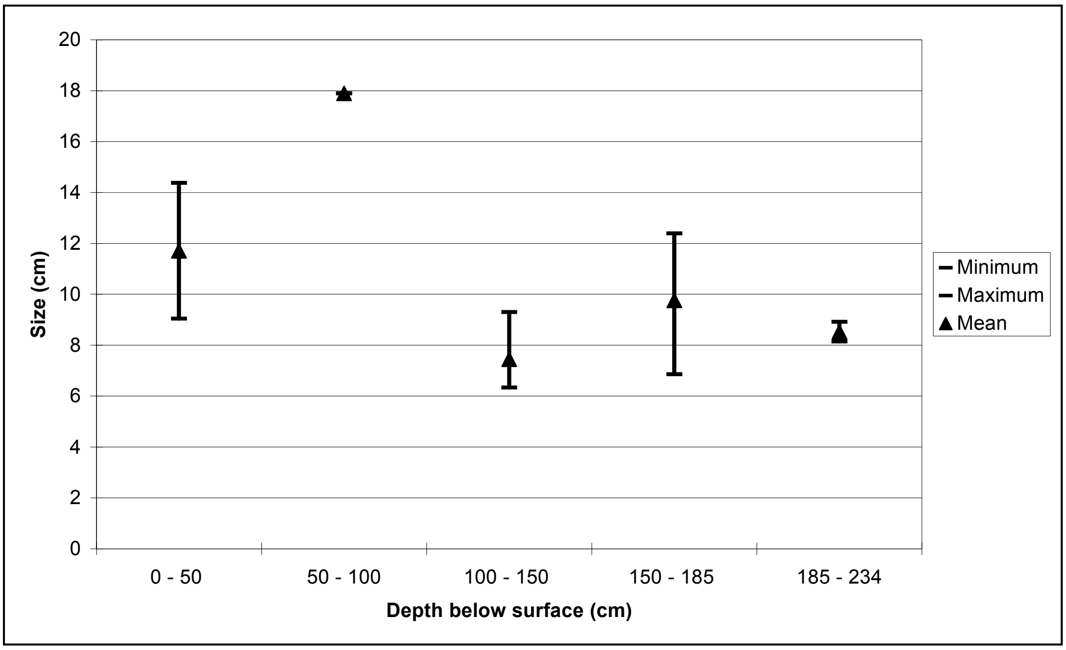

Figure 5. Sokoli *Trochus niloticus* sizes

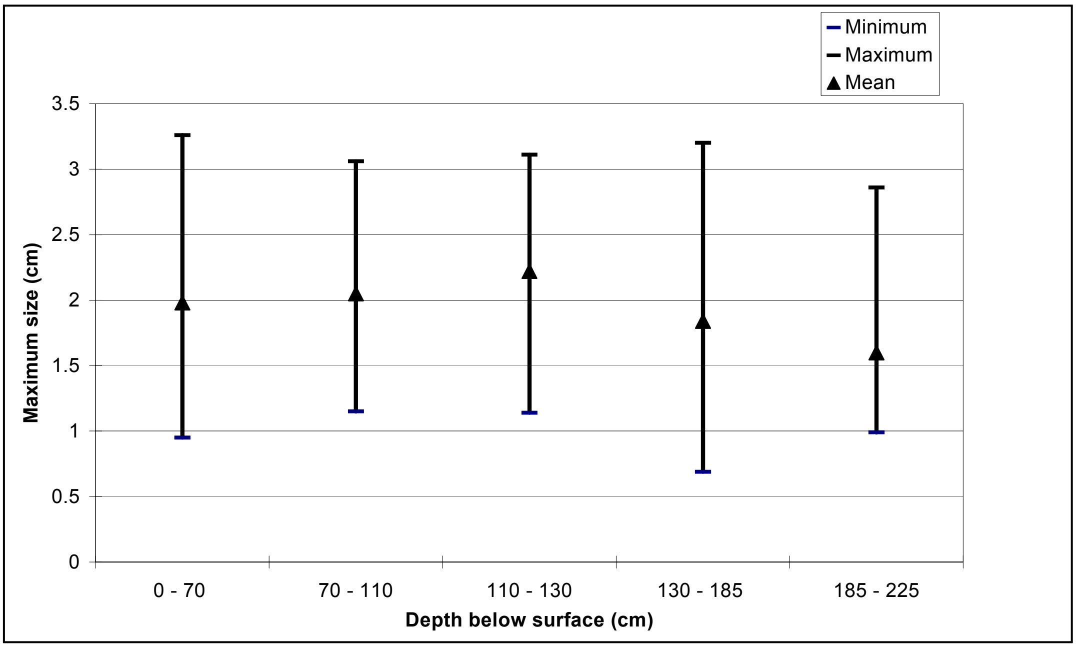

Figure 6. Ormi *Nerita undata* sizes

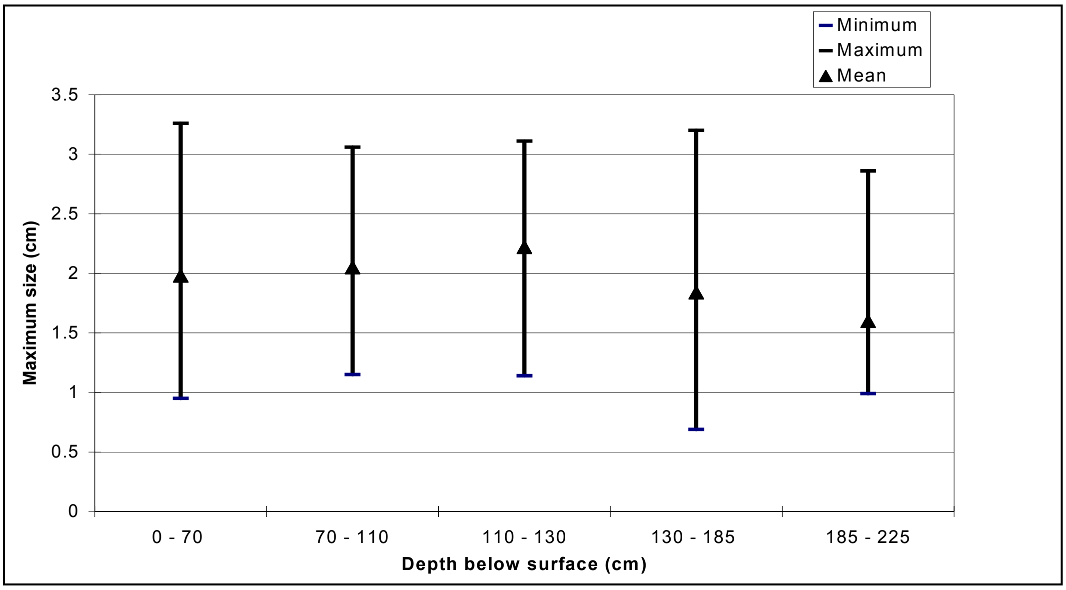

Figure 7. Ormi *Stromhus luhuanus* sizes

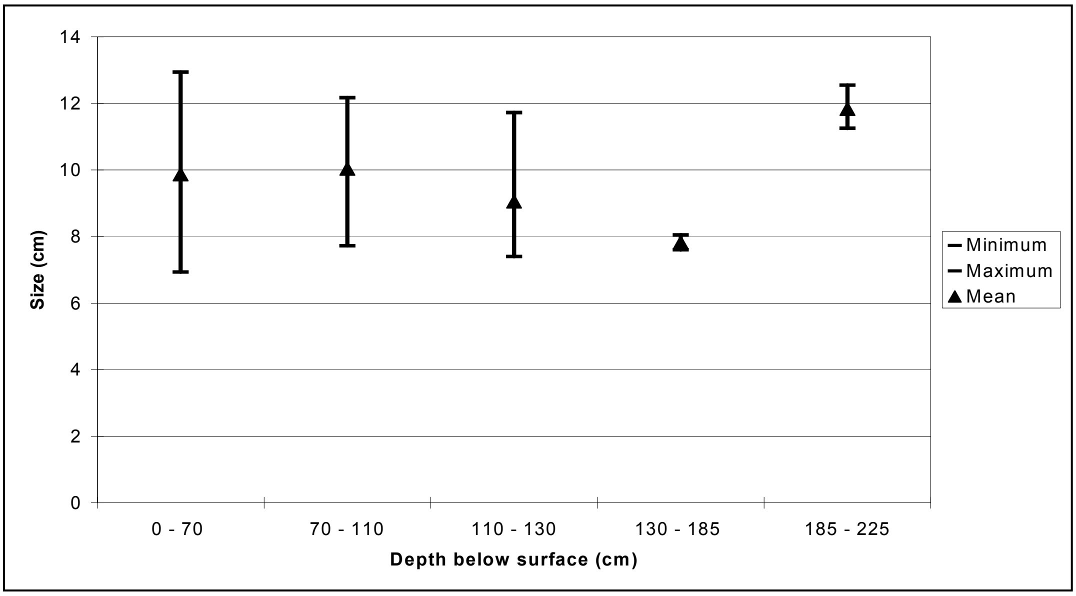

Figure 8. Ormi *Lambis lambis* sizes

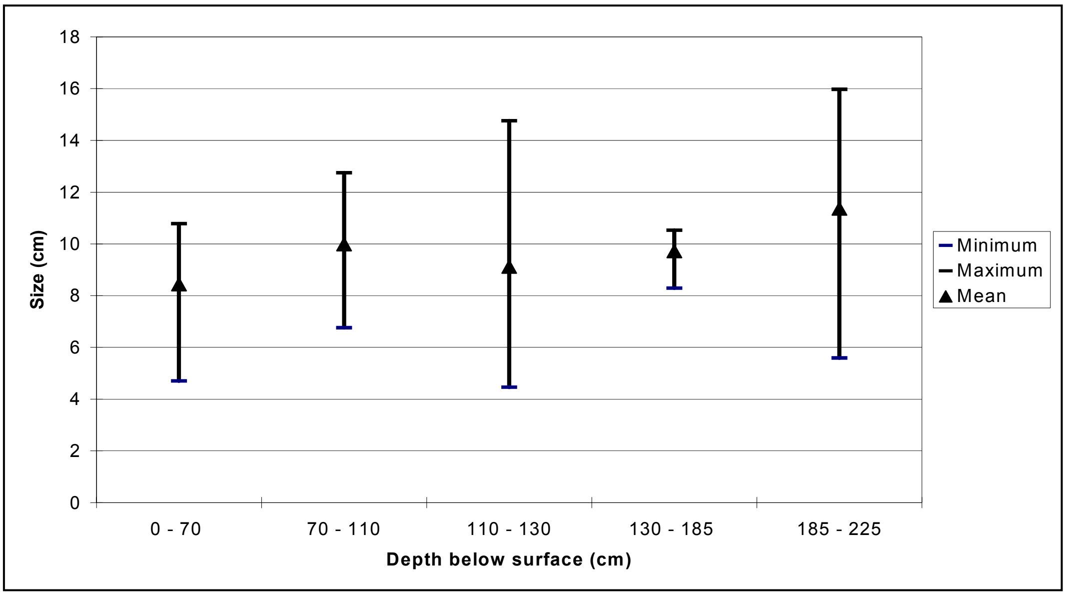

Figure 9. Ormi *Tridacna* spp. sizes

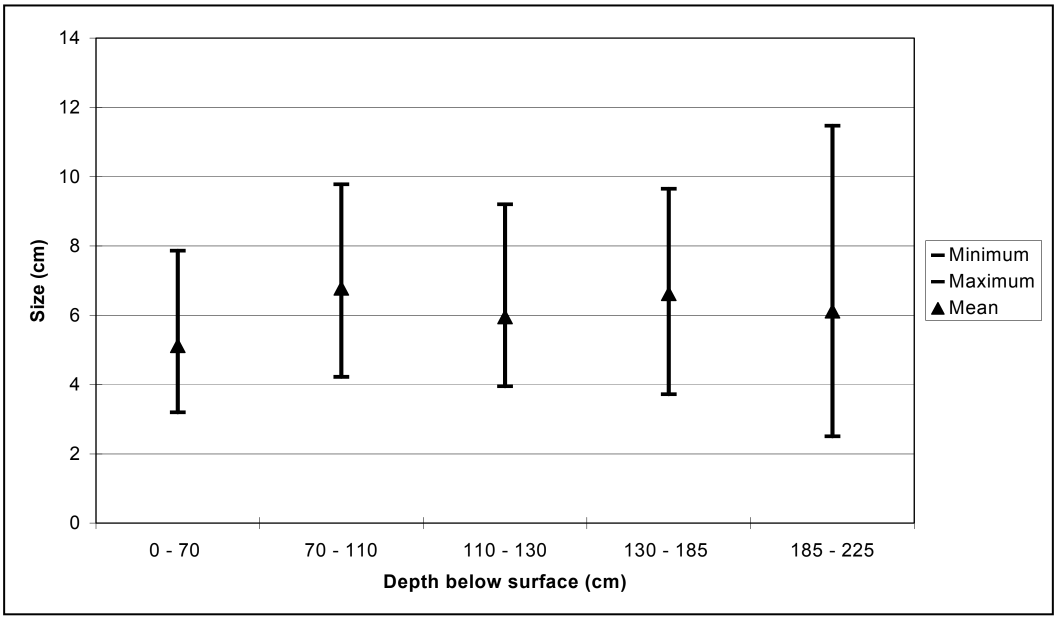

Figure 10. Ormi *Trochus niloticus* sizes

Appendix F

Faunal tables for vertebrate remains from Sokoli

Sample ID (Horizon / XU. No.)	Sample Description	Species	Common name
Sok, HI/5.1	Pharyngeal plate	*Scarus* sp.	Parrotfish
Sok, HI/9.1	Tooth plate	*Scarus* sp.	Parrotfish
Sok, HII/12.1	Jaw and teeth	*Scombridae* sp.	Mackeral
Sok, HII/12.2	Tooth plate	*Scarus* sp.	Parrotfish
Sok, HII/12.3	Tooth	*Carcharhinus* sp.	Shark
Sok, HII/13.1	Otolith	*Lethrinus* sp.	Emperor
Sok, HIII/16.1	Upper jaw fragment	*Caranx* sp.	Treveally
Sok, HIII/17.1	Pharyngeal plate	*Scarus* sp.	Parrotfish
Sok, HIII/17.2	Upper jaw fragment	*Labridae* sp.	Wrasse
Sok, HIII/19.1	Otolith	*Lethrinus* sp.	Emperor
Sok, HIII/19.2	Tooth plate	*Scarus* sp.	Parrotfish
Sok, HIII/19.3	Teeth	*Lethrinus* sp.	Emperor
Sok, HIV/21.1	Teeth	*Labridae* sp.	Wrasse
Sok, HIV/21.2	Teeth	*Labridae* sp.	Wrasse
Sok, HIV/21.3	Teeth	*Labridae* sp.	Wrasse
Sok, HIV/22.1	Pharyngeal plate	*Choerodon* sp.	Tuskfish
Sok, HIV/22.2	Tooth plate	*Scarus* sp.	Parrotfish
Sok, HIV/22.3	Pharyngeal plate	*Scarus* sp.	Parrotfish
Sok, HV/23.1	Pharyngeal tooth fragment	*Labridae* sp.	Wrasse
Sok, HV/23.2	Jaw	*Labridae* sp.	Wrasse
Sok, HV/23.3	Upper jaw	*Labridae* sp.	Wrasse
Sok, HV/23.4	Tooth plate	*Scarus* sp.	Parrotfish
Sok, HV/23.5	Pharyngeal plate	*Scarus* sp.	Parrotfish
Sok, HV/24.1	Tooth	*Labridae* sp.	Wrasse
Sok, HV/24.2	Pharyngeal plate	*Labridae* sp.	Wrasse
Sok, HV/24.3	Molar tooth	*Lethrinus* sp.	Emperor

Table 1: Fish bone sample species identification

Taxon	Horizon I	Horizon II	Horizon III	Horizon IV	Horizon V
Rat (small)	-	1FR, 1FL, 2 I	2MANR(l) 1MANL(l)	1MANR(l)	1MANR
Dog	6VTfr, 3MANL (l) fr, 1P, 2M, 2I	1P	-	1P	-
Goanna (small)	-	3VT	-	-	1VT
Lizard (small)	-	1VT	-	-	1VT
Snake (small)	-	4VT	-	1VT	1VT
Bird	2UD, 1PHAL	-	2MT, 1U, 2UD	2UD	1MT, 4UD
Macropod	-	-	-	-	-
Unidentified	26	15	59	82	14

VT- Vertebra, MAN – Mandible (L – Left, R – Right, (l) – lower, (u) – upper), M – Molar, P – Premolar, I – Incisor, F – Femur, PHAL – Phalanges, U – Ulna, MT – Metatarsus, T – Tibia, C – Caracoid, S – Sesamoid bone, PB – Pelvic bone, LVT - Lumbar vertebra, CVT – Caudal vertebra, R – Rib, H – Humerus, UD – Undiagnostic

Table 2: Skeletal components of terrestrial vertebrate assemblage

XU	Number and skeletal component	Total weight (g)	MNI
1	-	-	-
2	-	-	-
3	-	-	-
4	-	-	-
5	-	-	-
6	-	-	-
7	-	-	-
8	-	-	-
9	-	-	-
10	-	-	-
11	-	-	-
12	1 right femur	0.13	-
13	1 left femur 2 upper incisors	0.29	-
14	-	-	-
15	-	-	-
16	1 broken lower right mandible (with intact incisor)	0.07	1
17	-	-	-
18	-	-	-
19	1 broken lower left mandible 1 broken lower right mandible (with intact incisor)	0.16	1
20	-	-	-
21	1 broken lower right mandible	0.09	1
22	-	-	-
23	1 broken lower right mandible (with intact incisor)	0.08	1
24	-	-	-
25	-	-	-

Table 3: Skeletal components of *Rattus rattus* assemblage

Appendix G

Faunal tables for vertebrate remains from Ormi

Sample ID (Horizon / XU. No.)	Sample Description	Species	Common name
Orm, HI/2.1	Pharyngeal tooth	*Scarus* sp.	Parrotfish
Orm, HI/2.2	Pharyngeal plate	*Labridae* sp.	Wrasse
Orm, HI/2.3	Pharyngeal tooth	*Scarus* sp.	Parrotfish
Orm, HI/3.1	Pharyngeal plate	*Labridae* sp.	Wrasse
Orm, HI/5.1	Pharyngeal plate	*Scarus* sp.	Parrotfish
Orm, HI/6.1	Pharyngeal plate	*Labridae* sp.	Wrasse
Orm, HI/7.1	Pharyngeal teeth	*Scarus* sp.	Parrotfish
Orm, HI/7.2	Tooth fragment	*Scarus* sp.	Parrotfish
Orm, HI/7.3	Pharyngeal teeth	*Scarus* sp.	Parrotfish
Orm, HI/7.4	teeth	*Choerodon* sp.	Tuskfish
Orm, HI7/5	Pharyngeal plate	*Scarus* sp.	Parrotfish
Orm, HI/8.1	Pharyngeal plate	*Labridae* sp.	Wrasse
Orm, HI/8.2	otoltih	*Lethrinus miniatus*	Emperor
Orm, HII/10.1	maxilla	*Labridae* sp.	Wrasse
Orm, HII/10.2	Pharyngeal teeth	*Scarus* sp.	Parrotfish
Orm, HII/10.3	Otolith	*Lethrinus laticaudus*	Emperor
Orm, HII/13.1	Pharyngeal plate	*Labridae* sp.	Wrasse
Orm, HIV/17.1	Pharyngeal teeth	*Scarus* sp.	Parrotfish
Orm, HIV/19.1	Pharyngeal plate	*Choerodon* sp.	Tuskfish
Orm, HIV/21.1	teeth	*Labridae* sp.	Wrasse
Orm, HV/24.1	otolith	*Lethrinus laticaudus*	Emperor
Orm, HV/24.2	Pharyngeal plate	*Scarus* sp.	Parrotfish
Orm, HV/24.3	Pharngeal teeth	*Scarus* sp.	Parrotfish

Table 1: Fish bone sample species identification

Taxon	Horizon I	Horizon II	Horizon III	Horizon IV	Horizon V
Rat	1MANR(l)fr	-	-	1MANR(l)fr	-
Dog	1I	1I	-	-	-
Goanna (small)	4VT	1VT	3VT	-	-
Lizard (small)	1VT	1VT	2VT	-	-
Snake (small)	14VT	-	-	-	-
Bird	1F, 1F(fr), 1PHAL, 2T, 1T(fr), 1C, 1M,	5UD	1UD	9UD, 1MT, 1S	1UD, 1T
Macropod	-	-	-	-	1PM
Unidentified	19UD	15UD	27UD	18UD	3UD

VT- Vertebra, MAN – Mandible (L – Left, R – Right, (l) – lower, (u) – upper), M – Molar, P – Premolar, I – Incisor, F – Femur, PHAL – Phalanges, U – Ulna, MT – Metatarsus, T – Tibia, C – Caracoid, S – Sesamoid bone, PB – Pelvic bone, LVT - Lumbar vertebra, CVT – Caudal vertebra, R – Rib, H – Humerus, UD – Undiagnostic

Table 2: Skeletal components of terrestrial vertebrate assemblage

XU	Number and skeletal component	Total weight (g)	MNI
1	-	-	-
2	-	-	-
3	-	-	-
4	-	-	-
5	1 broken lower right mandible (with intact incisor)	0.07	1
6	-	-	-
7	-	-	-
8	-	-	-
9	-	-	-
10	-	-	-
11	-	-	-
12	-	-	-
13	-	-	-
14	-	-	-
15	-	-	-
16	-	-	-
17	-	-	-
18	-	-	-
19	-	-	-
20	-	-	-
21	1 broken lower right mandible (with intact incisor)	0.11	1
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-

Table 3: Skeletal components of *Rattus rattus* assemblage

Appendix H

Faunal tables for vertebrate remains from Kurkur Weid

Sample ID (Horizon / XU. No.)	Sample Description	Species	Common name
Kkw, HIII/13.1	Pharyngeal plate	*Labridae* sp.	Wrasse

Table 1: Fish bone sample species identification

Taxon	Horizon I	Horizon II	Horizon III	Horizon IV
Rat	1MANL(l)fr, 1MANR(l) 1FL	-	4TIR, 2FL, 3PBR, 18LVT, 6CVT, 3R, 1HR, 2MANL, 1MANRfr, 2SCL, 1SCR, 1VT, 2PBL, 2PHAL, 1UD	1TR, 1LV, 1UD
Dog	-	-	-	-
Goanna (small)	-	-	-	-
Lizard (small)	-	-	-	-
Snake (small)	-	-	3VT	-
Bird	1UD	-	-	-
Macropod	-	-	-	-

VT- Vertebra, MAN – Mandible (L – Left, R – Right, (l) – lower, (u) – upper), M – Molar, P – Premolar, I – Incisor, F – Femur, PHAL – Phalanges, U – Ulna, MT – Metatarsus, T – Tibia, C – Caracoid, S – Sesamoid bone, PB – Pelvic bone, LVT - Lumbar vertebra, CVT – Caudal vertebra, R – Rib, H – Humerus, UD – Undiagnostic

Table 2: Skeletal components of terrestrial vertebrate assemblage

XU	Number and skeletal component	Total weight (g)	MNI
1	1 broken lower left mandible	0.09	1
2	1 left femur	0.06	-
3	1 right lower mandible (intact incisor)	0.29	-
4	-	-	-
5	-	-	-
6	2 right tibia/fibula 1 right pelvic girdle 4 lumbar vertebrae 3 tail vertebrae 1 rib	0.69	-
7	1 right humerus	0.09	-
8	1 left lower mandible (incisor intact) 1 broken lower right mandible 1 left scapula 1 lumbar vertebra	0.72	1
9	2 left pelvic girdles 2 right tibia/fibula 1 lumbar vertebra	0.73	-
10	1 left femur 2 right tibia/fibula 1 lumbar vertebra 1 unidentified fragment	0.65	-
11	1 tail vertebra 1 phalange bone	0.06	-
12	1 lumbar vertebra	0.05	-
13	6 lumbar vertebra 2 tail vertebra 1 rib 1 phalange bone	0.42	-
14	1 left femur 1 lumbar vertebra 1 rib	0.3	-
15	1 right pelvic girdle	0.3	-
16	1 right tibia/fibula 1 unidentified fragment	0.3	-
17	1 lumbar vertebra	0.03	-

Table 3: Skeletal components of *Rattus rattus* assemblage

Appendix I

Faunal tables for vertebrate remains from Pitkik

Sample ID (Horizon / XU. No.)	Sample Description	Species	Common name
Pk, HI/1.1	Pharyngeal plate	*Labridae* sp.	Wrasse

Table 1: Fish bone sample species identification

Taxon	Horizon I	Horizon II	Horizon III	Horizon IV	Horizon V
Rat	-	-	-	-	-
Dog	-	-	-	-	-
Goanna (small)	-	-	-	-	-
Lizard (small)	1VT	-	-	-	-
Snake (small)	-	-	-	-	-
Bird	-	-	-	-	-
Macropod	-	-	-	-	-
Unidentified	5UD	-	-	4UD	1UD

VT- Vertebra, MAN – Mandible (L – Left, R – Right, (l) – lower, (u) – upper), M – Molar, P – Premolar, I – Incisor, F – Femur, PHAL – Phalanges, U – Ulna, MT – Metatarsus, T – Tibia, C – Caracoid, S – Sesamoid bone, PB – Pelvic bone, LVT - Lumbar vertebra, CVT – Caudal vertebra, R – Rib, H – Humerus, UD - Undiagnostic

Table 2: Skeletal components of terrestrial vertebrate assemblage

Appendix J

Parr, J. F. and M. Carter 2003 Phytolith and starch analysis of sediment samples from two archaeological sites on Dauar Island, Torres Strait, northeastern Australia. *Vegetation History and Archaeobotany* 12(2):131-141.

Appendix K

Photographs of mineral inclusions in Murray Island pottery sherds

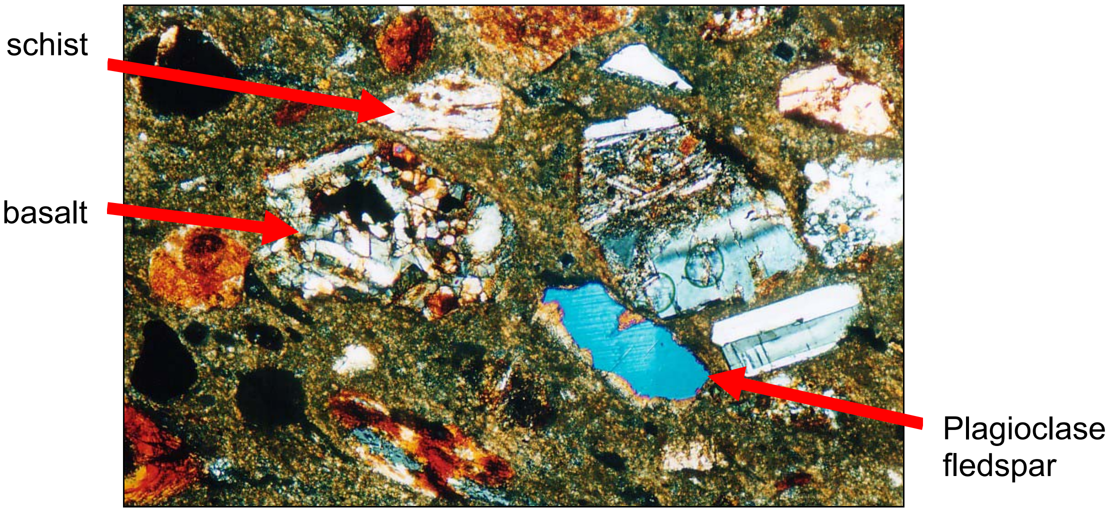

Figure 1. Sherd ORM2 (length of photo = 2.8 mm)

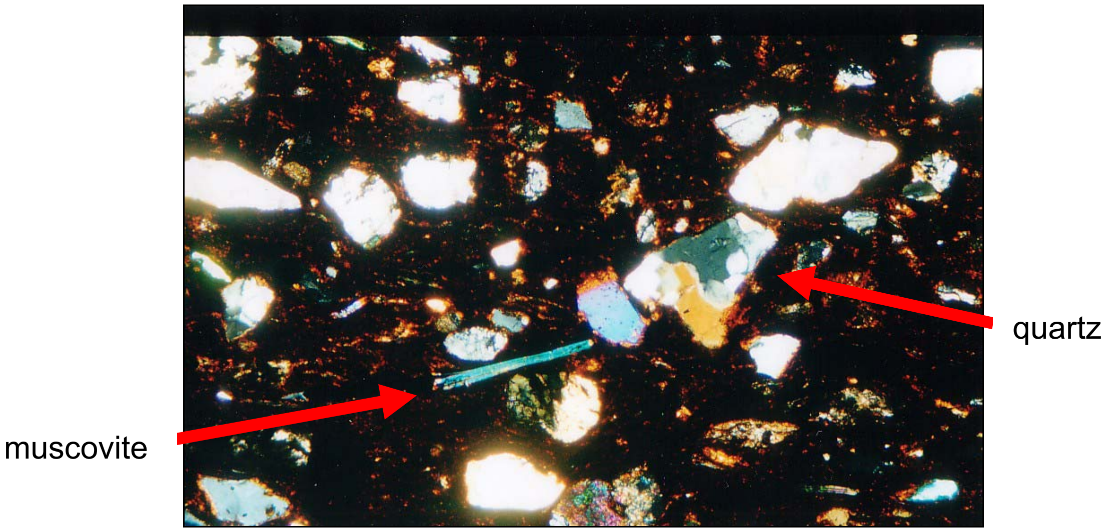

Figure 2. Sherd MER2 (length of photo = 5.6mm)

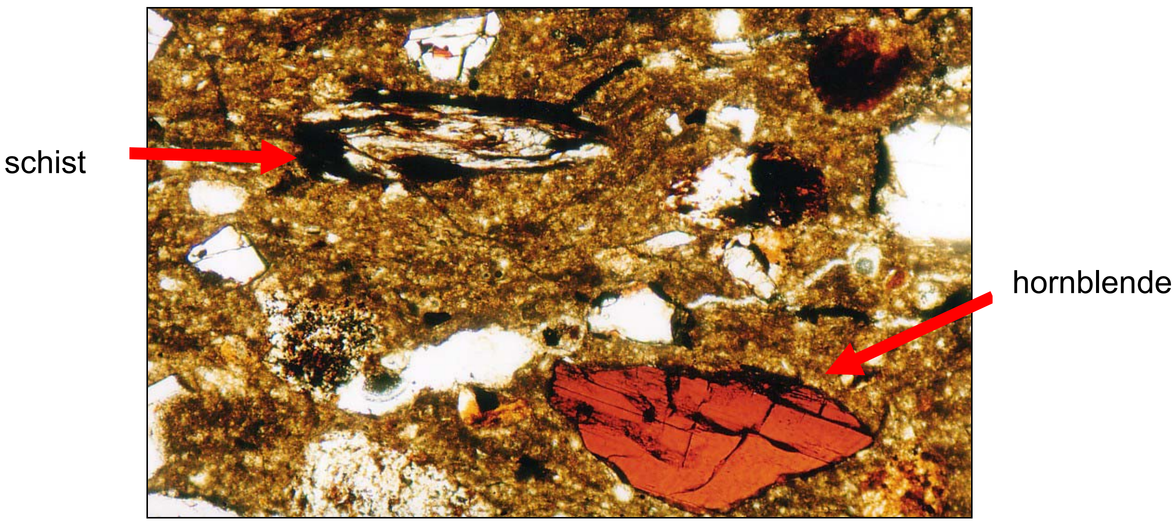

Figure 3. ORM2 (length of photo = 2.8 mm)

Appendix L

Report on the results of analysis of the Murray Islands pottery tempers by W.R.D. Dickinson (January 2003)