The Prehistory of Buka:

A Stepping Stone Island in the Northern Solomons

Stephen Wickler

TERRA AUSTRALIS

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A joint publication by the

Department of Archaeology and Natural History
and Centre for Archaeological Research

The Australian National University

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Terra Australis reports the results of archaeological and related research within the region south and east of Asia, through mainly Australia, New Guinea and Island Melanesia – lands that have remained *terra australis incognita* to generations of prehistorians.

Its subject is the settlement of the diverse environments in this isolated quarter of the globe by peoples who have maintained their discrete and traditional ways of life into the recent recorded or remembered past and at times into the observable present.

FOREWORD

Steve Wickler was born in Dumaguete City in the Philippines and moved to the United States at the age of 12. He received his BA from the University of Minnesota- Minneapolis in 1980, and his MA in 1985 and PhD in 1995 from the University of Hawai'i at Manoa in Honolulu. Since that time he has split his time between Tromsø in northern Norway, where he now lives, and the Pacific. He worked regularly with International Archaeological Research Institute Inc. (IARII) on projects in Hawai'i and Micronesia up until 1997 when he started his current position as a researcher at the Tromsø University Museum. The contrasts between living within the Arctic Circle and commuting regularly to the tropical Pacific must be extreme, especially around Christmas!

It was at the University of Hawai'i that I first met Steve in 1981. I got to know him well as supervisor for his MA and the early stages of his PhD. His MA research paper involved an analysis of material excavated by me in 1983 from sites on Erromango Island in Vanuatu, and this resulted in a 1989 publication (Spriggs and Wickler 1989).

Originally it had been planned that Steve would follow up on my initial survey and excavation on Erromango for his PhD, but the research ban in Vanuatu instituted in 1985 and not lifted until 1994 put paid to that idea. The next obvious choice of fieldwork location in Island Melanesia was the then North Solomons Province of Papua New Guinea. This had been the site of pioneering work by ANU PhD scholar Jim Specht of ANU in the mid- to late 1960s (Specht 1969) and also by John Terrell of Harvard University at the end of the 1960s (Terrell 1976). I had family connections there and had begun my own research in the province on Nissan Island in 1985. Nissan was a stepping stone island between Buka, where Specht had carried out his research, and the Bismarck Archipelago to the north. This research was part of the ANU-National Geographic Lapita Homeland Project (Allen and Gosden 1991). Extension of the archaeological coverage of the Homeland Project to the south on Buka Island and its environs seemed a logical research choice. Lapita sites had been discovered on Nissan, but apart from the very occasional dentate-stamped sherd at the early end of Specht's Buka pottery sequence, no such sites had been found in the main Solomons chain. Pre-Lapita occupation had been found on Nissan and had been predicted too for the Solomons for some time.

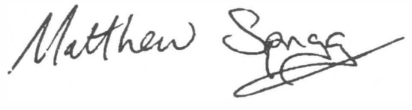
The results of Steve's 1987 Buka field research were immediately spectacular with Lapita sites found on reef flats and the discovery of cultural deposits dating to 29,000 BP at the Kilu Cave site. This pushed back the known human history of the Solomons by a factor of ten. Spin-offs from the Kilu research included the description and naming of two new species of sadly now-extinct rats, *Melomys spechti* – named in honour of Jim Specht's pioneering archaeological work - *and Solomys spriggsarum* – in honour particularly of Ruth Saovana Spriggs for her assistance to Steve when he was beginning field work (Flannery and Wickler 1990). Another milestone was the publication of the identification of preserved aroid starch residues and raphides on some of the earliest stone artefacts from Kilu (Loy et al. 1992), the earliest direct evidence for the exploitation of root vegetables found anywhere in the World.

Pressures of the need to find gainful employment and of raising a family delayed completion of the thesis until 1995, by which time Steve had already re-located from Honolulu to Tromsø. From 1989 to 1997 he was involved in archaeological contract work in the Pacific and northern Norway and produced several major technical reports of a very high standard as well as publishing some of the results of his PhD research.

In 1995 he was invited to ANU as a Visiting Fellow for a month to work on turning his PhD thesis into a *Terra Australis* monograph. This was submitted, refereed, revised and galley proofs of part of the volume were returned to Steve early in 1998. Progress had slowed considerably on production of publications from Archaeology and Natural

History by then because of budgetary stringencies and a threat to the very existence of archaeology in the Research School of Pacific and Asian Studies. Happily, ANH's fortunes have revived considerably since the dark days of 1997-8. A new publications team has revived the *Terra Australis* series and is working strenuously to clear the backlog – this will be the third of the series published within the last year. Production work was taken up again on this volume during the second half of 2000, and now finally here it is.

No-one will be happier to see the volume appear than Steve himself. He has displayed the patience of a saint throughout the last five years, through delays not at all of his making. I am sure all readers will agree that this seminal study has been well worth waiting for. It is destined to be a classic report on sites that from 1988 have been inaccessible to researchers because of the war between the Bougainville independence movement and the Papua New Guinea authorities. International peace monitors have now been deployed and the two sides are moving towards a final peace settlement. At such a hopeful time in Bougainville's chequered history it is fitting that this masterful elucidation of the early chapters of the story of its people should be made available.



Matthew Spriggs

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PREFACE

One of my original motivations for beginning graduate studies at the University of Hawai'i in 1982 was to study Lapita ceramics and the cultural complex associated with this distinctive pottery. I was particularly interested in relationships between Lapita and what came before and after in Island Melanesia. My original plan for PhD fieldwork was to build on my MA analysis of ceramics from southern Vanuatu by constructing a ceramic sequence for this region and examining relationships between Lapita and Mangaasi ceramics. When this proved to be impossible due to a research ban in Vanuatu, my focus shifted to Buka Island at the northern end of the Solomons. This turned out to be a most satisfactory alternative as it enabled me not only to address issues related to Lapita pottery and settlement but to shed additional light on a continuous ceramic sequence spanning approximately 3000 years. Unlike Vanuatu, it was also possible to situate Lapita within the context of preceramic settlement extending back to the late Pleistocene. Providing a more complete picture of Buka's past made it possible for me to examine the critical role of this stepping stone island as a node linking the Bismarcks and the remainder of the Solomons throughout the prehistoric sequence. Unfortunately, the substantial gaps remaining in sequences elsewhere in Island Melanesia, particularly for islands in Near Oceania, are a serious handicap for comparisons on a regional scale. Social and political conflicts leading to what has been termed the "Bougainville Crisis" not long after completion of my PhD fieldwork in 1987 have yet to be fully resolved. This state of affairs has effectively prevented further archaeological research in what was formerly the North Solomons Province of Papua New Guinea.

For a variety of reasons, my PhD dissertation was not completed until 1995. Prior to completion of my dissertation, a series of articles were published on aspects of my Buka research but none providing an overall summary of the final results. I received an invitation to submit my dissertation for publication as a *Terra Australis* monograph at the beginning of 1995 and revised my dissertation for publication several months later. The publication process progressed steadily with completion of initial revisions in early 1996 and proofreading of the revised manuscript by mid 1997. Although galley proofs for the first part of the monograph were sent to me and returned in early 1998, little real progress was made towards final publication until the latter part of 2000.

In the interest of expediency, no attempt has been made to update or revise the original manuscript submitted in 1995 by incorporating additional data or taking into account relevant publications since this time (with the exception of a brief update on the political situation in 1998). Supplemental analyses of my Buka material has been done including direct AMS dating of bone and shell artefacts from the two cave sites with preceramic occupation, obsidian sourcing, and more detailed faunal analysis. Although the analytic results have refined the data presented in the present monograph, no significant revision of the conclusions is necessary. In sum, the results of my Buka field research conducted 13 years ago is of continued relevance and will make available detailed archaeological site data which is sorely needed in Island Melanesia.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ACKNOWLEDGEMENTS

The completion of this monograph has been a long journey which would not have been possible without the assistance of numerous individuals and institutions. Any omissions in acknowledging these contributions is due to my faulty memory rather than intentional disregard.

From the initial planning stages for my PhD dissertation fieldwork on which this publication is based to the completion of the *Terra Australis* manuscript, Matthew Spriggs has been a prime mover and motivator and I owe much to his unflagging support over the years. I also wish to thank my supervisor Michael Graves for his guidance and encouragement, especially during the final stages of writing my dissertation. I am indebted to Jim Specht for his willingness to assist me in following up on his groundbreaking Buka research by sharing his knowledge and field data with me. A special thanks to Steve Athens and others at IARII who have provided undaunted support in many ways for nearly two decades.

My fieldwork on Buka was funded by a National Science Foundation Doctoral Dissertation Improvement Grant and Fulbright-Hays USDOE Research Abroad Grant. The following institutions provided generous support in the field: the Institute of Papua New Guinea Studies, the Papua New Guinea National Museum and Art Gallery, and especially the North Solomons Provincial Government. In Arawa, the assistance provided by Joe Kabui, Eliuda Temoana and many other Provincial Government officials made it possible to accomplish a great deal in a short period. I am especially grateful for the support and friendship of Ruth Saovana-Spriggs who made things much easier for me during my stay in the North Solomons. On Buka, accommodation and support was provided by Kris and Helen Hakena, John Batheras and the residents of Pororan Village and Sohano Island. My excavation crews on Buka did an admirable job and showed considerable enthusiasm in carrying out tasks which were often tedious and sometimes difficult to comprehend.

Following the completion of my fieldwork, the arduous task of analysing the abundant remains of human activity on Buka extending from the recent past back to the Pleistocene was made possible through the considerable efforts of a range of specialists. Peter White at the University of Sydney was responsible for the initial sorting of faunal remains and analysis of a majority of the vertebrate material. Additional faunal identifications were made by Tim Flannery of the Australian Museum (rodents), Sarah Colley who was then at ANU (fish) and Corrie Williams who was then a graduate student at Monash University (birds). At ANU, Doug Yen identified charcoal and Tom Loy analysed plant residues on stone tools from the Kilu cave site. Wal Ambrose supervised the sourcing of obsidian by specific density. Radiocarbon dating at ANU was made possible through the efforts of Matthew Spriggs. At the University of Hawai'i, Alison Kay verified my shell identifications and John Sinton provided petrographic descriptions of stone artefacts. In Hawaii, artefact photographs were taken by Gig Greenwood and Joe Singer, site maps drawn by Patti Spears and pottery illustrations done by Roger Blankfein and Elaine Lee.

Much of the work involved in transforming my dissertation into the present monograph was accomplished as a Visiting Fellow at ANU in 1995. Matthew Spriggs was instrumental in extending an invitation to publish my dissertation as a Terra Australis monograph and serve as a Visiting Fellow. Jack Golson provided numerous useful comments in his thorough review of the manuscript as a referee. Barry Fankhauser had the daunting task of editing and proofreading the revised manuscript. Thanks to Sue O'Connor for helping to get the publication process back on track and especially Lynley Wallis at ANH Publications for her admirable job of piecing together the puzzle and concluding the publication process.

1

INTRODUCTION AND DESIGN OF THE RESEARCH

This study deals with the prehistory of Buka Island and neighbouring areas in the northern Solomon Islands (Fig. 1.1). Although geographically and culturally linked to the Solomon Islands, the islands of the northern Solomons are presently defined politically as the North Solomons, (or more recently-1995-Bougainville), Province of Papua New Guinea. In contrast to the limited amount of archaeology done over much of western Island Melanesia prior to the mid-1980s, significant investigations were initiated by the late 1960s to early 1970s in the northern Solomons on both Buka (Specht 1969) and Bougainville (Terrell 1976) islands. Specht's Buka work focused on the documentation of a continuous ceramic sequence from the late Lapita period to the modern pottery industry and provides a foundation for the present research.

The present study sought to document and explain long-term changes in aspects of settlement, economy and subsistence on Buka during the course of a cultural sequence which proved to extend back at least 28,000 years. Given the lack of evidence for human settlement on Buka pre-dating the late Lapita period (ca. 2500 BP) prior to the present investigations, a major research objective was to extend the prehistoric sequence back to initial settlement. Establishing the temporal framework of the Buka sequence was considered an essential first step in attempting to address more specific problems of change within the archaeological record.

A set of five research problems was developed prior to the initiation of field investigations with specific hypotheses to be tested for each. The first three problems are chronological in nature and deal with specific periods of the Buka cultural sequence and the historical relationships between them. These include the Preceramic, Lapita and post-Lapita periods which are temporal units commonly employed in discussions of human settlement in the region (e.g. Spriggs 1993a). The final two research problems examined relate to long-term changes in patterns of exchange and subsistence. Sets of specific research questions for each of the major problem areas are discussed in a later section of this chapter.

Archaeological investigations on Buka and the small offshore islands of Sohano and Pororan were conducted over an eight month period during 1987. The principal goals of fieldwork were to:

1. test the geographical extent of Specht's ceramic sequence;
2. examine more closely the temporal relationships between Specht's pottery styles;
3. document Lapita occupation more fully;
4. determine if initial human settlement occurred prior to Lapita and if so, when this occurred and how it relates to Lapita; and
5. provide a more detailed understanding of prehistoric settlement through the analysis of non-ceramic artefactual evidence and associated faunal remains from excavated site deposits.

As directed by the overall research design, the location of archaeological sites outside of areas previously surveyed by Specht was given priority in order to investigate the spatial extent of Specht's styles and substyles on Buka and nearby islands. More intensive investigations of selected sites initially recorded by Specht with potential for addressing relevant research problems were also undertaken. The excavation of cave and rockshelter sites with potentially deep, well-stratified cultural deposits was emphasised in the search for pre-Lapita occupation. In contrast, coastal sites with relatively brief occupation spans and a limited number of sequential pottery styles were targeted as having the highest potential for documenting ceramic change from the Lapita and post-Lapita phases and minimal amounts of intrusive material.

This chapter provides an introduction to the research discussed in greater detail in the remaining chapters. The first section provides an overview of major research issues currently being addressed in Island Melanesia and

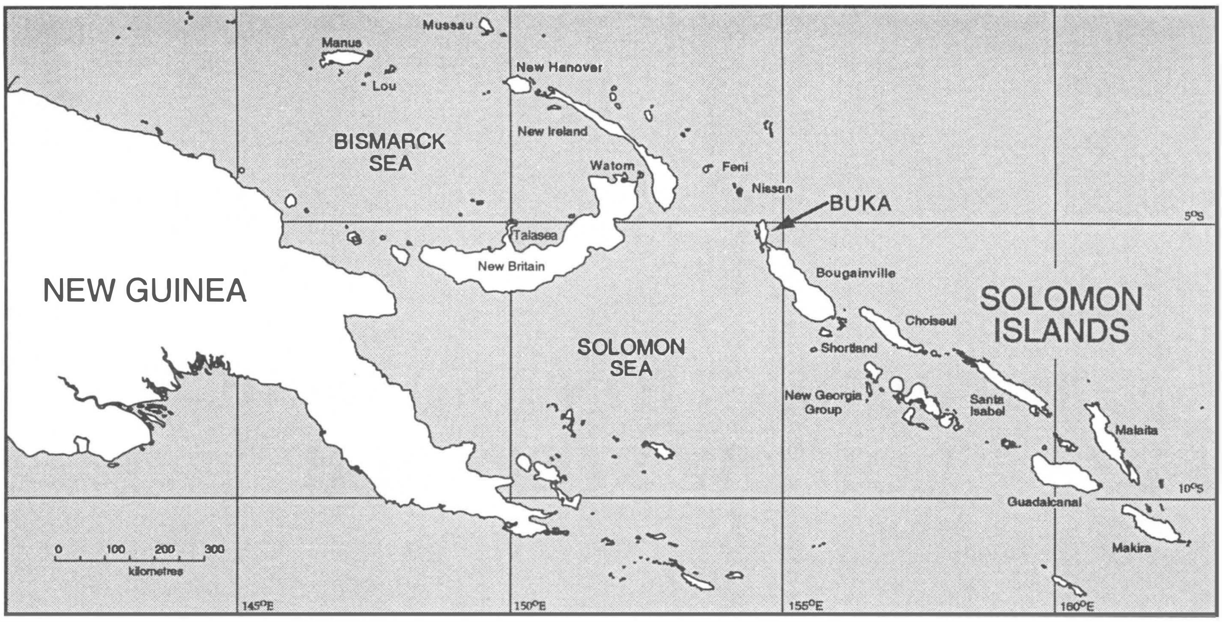


Figure 1.1 The Bismarck Archipelago and Solomon Islands.

their relevance to the present study. This is followed by a review of past archaeological research on Buka and elsewhere in the northern Solomons to provide the necessary background for the specific research questions to be addressed. The chapter concludes with a discussion of the research design, including the five major research goals and specific problems to be addressed for each.

Unless otherwise indicated, radiocarbon dates are reported as conventional ^{14}C ages. 'Spot' dates for phases in the cultural sequence are based on estimates derived from the radiocarbon evidence and the specific dates should be referred to for more accurate age determinations. Calibrated dates reported from outside Buka were done with Revision 2 of the CALIB program and those from Buka were calibrated using Revision 3.0.3 which is based on the most recent and widely accepted curves for secular and ocean reservoir effects (Stuiver and Reimer 1993). Calibrated ages were calculated using Method A which provides intercepts with the calibration curve and are reported at one standard deviation. Calibrated dates are presented in table format within Chapter 3 as both calendric and BP age ranges at one standard deviation with the intercept date or dates placed in parentheses. Shell dates were corrected for the ocean reservoir effect using a geographical correction value (Delta-R) of 0 recommended in locations where specific correction factors have yet to be established (Stuiver and Braziunas 1993; Stuiver et al. 1986).

RESEARCH ISSUES IN NEAR OCEANIA

Green (1991c) has proposed that the distinction between Near Oceania (extending east to include the main Solomons) and Remote Oceania (the islands beyond the main Solomons) provides a more meaningful alternative to the entity of Melanesia from an archaeological perspective. Not only does the boundary between Near and Remote Oceania represent a significant reduction in biological diversity (with the exception of New Caledonia), but the eastern end of the main Solomons marks the limits of evidence for pre-Lapita settlement.

Until a decade ago, archaeological research focused on the establishment of cultural sequences for Remote Oceania with little more than preliminary reports and a handful of radiocarbon dates available from most of the Bismarcks and Solomons. This situation has changed radically in the past ten years with a dramatic increase in the amount of research from Near Oceania. As a result of the Lapita Homeland Project in 1985, which sought the origins of the Lapita cultural complex in the Bismarck Archipelago, a wealth of new data has been obtained, not only from the Lapita and post-Lapita periods, but extending back to the late Pleistocene (Allen and Gosden 1991; Gosden et al. 1989). However, the principal effect of this explosion of data has been to reveal how little we know of the past in the region. This is especially true of the immense amount of time prior to Lapita settlement for which only the most rudimentary chronological framework has been established. A brief review of some of the major archaeological issues currently being examined in the region and their relevance to the present study is presented below using the following temporal divisions; Preceramic (35,000 to 3500/3200 BP), Lapita (3500/3200 to 2500/2000 BP) and post-Lapita (2500/2000 to 100 BP).

Preceramic settlement

Prior to the Lapita Homeland Project, the earliest evidence for human settlement in Near Oceania was a date of 11,000 BP from Misisil Cave on New Britain (Specht et al. 1981). Since the mid-1980s, there has been a dramatic increase in the number of Pleistocene age sites, including a cluster of four cave sites on New Ireland with occupation by about 35,000 BP at one of them, Matenkupkum (Allen 1994; Allen et al. 1988, 1989). In

West New Britain, recent research at the open site of Yombon has documented occupation of the interior by 35,000 years ago (Pavlides and Gosden 1994) and Fredericksen et al. (1993) have demonstrated that Manus was occupied by the terminal Pleistocene with dates prior to 10,000 BP from the Pamwak rockshelter site. The number and geographic extent of sites with occupation during the early to mid-Holocene expands to include Lolmo Cave in the Arawe Islands along the New Britain coast with calibrated dates from 6100 to 5250 BP and the Lebang Takoroi cave site on Nissan Island with a calibrated basal date of 5268-4564 BP (Gosden et al. 1989: Table 2). On Guadalcanal in the central Solomons, Roe (1992a, 1992b) has evidence for occupation by 6000 BP from the Vatuluma Posovi cave site.

The growing body of evidence from pre-Lapita sites in the Bismarcks and Solomons has shed significant light on a range of research issues but also serves to demonstrate the poverty of our present data base for the initial 30,000 years of the prehistoric sequence in the region. Some of the most tantalising evidence has come from the faunal record of the New Ireland sites which suggests human introduction of *Phalanger*, two rat species and a wallaby, as well as the extinction of a rat species attributed to competition with one of the introduced rats (Allen et al. 1989:556). There is also some evidence for pre-agricultural 'management' of wild food resources with the introduction of the important tree species *Canarium* by the late Pleistocene (Spriggs 1993a, 1993b). The presence of obsidian transported from sources on New Britain about 350 km away at the Matenbek site on New Ireland by 20,000 BP demonstrates exchange of this material within the region well before the Lapita period (Allen et al. 1989). Differences in the presence and timing of faunal introductions and obsidian use between the New Ireland sites indicates that intra-island variability must also be accounted for. These contrasts serve as reminders that considerable caution must be exercised in attempting to interpret the nature of change over thousands of years on the basis of a handful of sites.

A shortage of sites with occupational evidence from the final centuries prior to the Lapita period has made it difficult to interpret the changes which are often ascribed to Lapita within the context of earlier settlement. Discussions of the evidence from this period have tended to assess the continuities and discontinuities with Lapita from the perspective of opposing viewpoints regarding what Lapita represents. Thus those who support a gradualist or indigenist model of Lapita search for continuities while supporters of a more intrusive model emphasise discontinuity. A review of the current evidence by Spriggs (1993a) discusses a series of points in favour of each side in this debate which are summarised as follows. Evidence for continuity includes:

1. transport of Talasea obsidian within the Bismarcks;
2. continuity in site location in some areas;
3. a range of similar shell artefact types; and
4. evidence for the early management of plant resources such as *Canarium.*

Discontinuities are more numerous and include:

1. the appearance of pottery;
2. the first definite evidence for agriculture from plant macrofossils, and animal husbandry in the form of dog, pig and chicken;
3. changes in settlement pattern with the advent of large villages and stilt houses built over the water;
4. additions to the range of non-ceramic artefact types including distinctive adzes and a range of shell ornaments; and
5. a much wider transport of obsidian from New Britain and the initial use of Admiralties obsidian outside of that island group.

A major problem in comparisons between these two periods is the much smaller sample of pre-Lapita sites and emphasis on caves and rockshelters as opposed to open sites which are the dominant Lapita site type.

On Buka, initial evidence for pre-Lapita settlement of the island was obtained during the present study from two cave sites, Kilu and Palandraku (Wickler and Spriggs 1988). Initial use of Kilu dates to between 28,000 and 29,000 years ago, the first proof of late Pleistocene age settlement in Island Melanesia outside of the Bismarcks. Kilu was abandoned at about 20,000 BP and reoccupied during the early to mid-Holocene between 10,000 and 5000 BP. Minor use of the cave is also evident during the late Lapita period and again within the past 500 years on the basis of ceramic evidence. Palandraku Cave, located several hundred meters from Kilu, has a relatively brief pre-Lapita occupation dating to around 5000 BP followed by a late Lapita period component.

The archaeological evidence from these sites provides an abundance of new data germane to the research issues discussed above. Faunal assemblages document important changes in subsistence including animal introductions and extinctions. Direct evidence for the processing of taro has been obtained in the form of starch residues on stone tools from initial occupation at Kilu (Loy et al. 1992). Further evidence for the exploitation of plant resources is indicated by the presence of carbonised endocarp fragments of *Canarium* almond by the early Holocene at Kilu, including species which were most likely transported from the Bismarcks and remain economically important in the region today (Wickler and Spriggs 1988). Although occupation evidence from the period immediately preceding Lapita is absent at the Buka sites, the presence of late Lapita components at both Kilu and Palandraku enable some assessment to be made of the changes linked to Lapita (Wickler 1990).

Defining Lapita

A central theme in archaeological research over the past three decades within Island Melanesia and West Polynesia has been defining the entity known as Lapita. Despite these efforts, there is still considerable debate not only over issues such as Lapita origins and development, but what it actually is (Green 1992; Irwin 1992: 33-41; Terrell 1989). Based on probable historical relationships between distinctively decorated pottery assemblages known as the Lapita style from widely dispersed sites, Golson (1971) developed the concept of an early community of culture which he defined as a cultural complex. Green (1978, 1979) expanded and refined Golson's definition of the Lapita cultural complex by emphasising non-ceramic characteristics including settlement pattern, economy, exchange systems and a range of artefact types. Although sites with Lapita style pottery extend from the Bismarck Archipelago to Samoa and date to between ca. 1500 BC and the end of the first millennium BC, Lapita remains an 'uncertain and variable archaeological category with no precise biological or linguistic identification' (Irwin 1992:38).

The question of Lapita origins and expansion has led to the development of two competing models. The first of these is most clearly articulated by Peter Bellwood who has consistently maintained that Lapita represented a rapid movement of Austronesian speaking populations out of island Southeast Asia through Island Melanesia and into West Polynesia (Bellwood 1978, 1992). In the early 1980s, an alternative 'indigenous' or 'homeland' model was proposed which argued for in situ development of Lapita within the Bismarck Archipelago prior to a more rapid dispersal into the remainder of Island Melanesia and beyond (Allen 1984; Spriggs 1984). As a result of the Lapita Homeland Project, we now have much new data with which to assess the validity of these models (Allen and Gosden 1991), but no consensus has emerged. Nevertheless, the lack of evidence for in situ development of Lapita within the Bismarcks from the Homeland Project has provided support for a Lapita origin outside of the Bismarcks (Kirch 1988a; Spriggs 1989). Even so, some project participants continue to maintain that local development of Lapita within the Bismarcks is still possible (Allen and White 1989). A compromise approach utilising elements of both models has also been advocated (Gosden et al. 1989). This model acknowledges that simplistic hypotheses that view Lapita as either wholly intrusive or indigenous are inappropriate.

Attempts to characterise the Lapita cultural complex have, until quite recently, relied largely on data from Remote Oceania (Green 1979, 1982). This has led to a view of Lapita which stresses its colonising aspects and underestimates the complexities of identifying Lapita sites within Near Oceania where human settlement predates Lapita by many millennia (Wickler 1990:143). Green (1991b) has attempted to address these problems by developing a new Lapita model referred to as the Three Is (Intrusion/Innovation/Integration), which applies to Near Oceania. This model takes into account Lapita interactions with resident human populations by distinguishing between the sources of elements archaeologically. While rightly acknowledging the complexities of Lapita in the Bismarcks and Solomons, the assumption that Lapita and non-Lapita elements can be readily distinguished is problematic given the lack of agreement over what Lapita is. The apparent lack of Lapita sites in areas such as the central Solomons (Roe 1993) is also a factor which needs to be incorporated into models of Lapita for this region.

Given the complexities and lack of precise biological or linguistic associations for Lapita in Near Oceania (see Terrell 1989; Welsch et al. 1992:590), the present study stresses the archaeological elements associated with Lapita style pottery. Although there is clearly a need to address the significance of Lapita in historical terms extending beyond artefact assemblages (Spriggs 1992a), at the analytical level it is important to 'decouple' Lapita as pots from Lapita as a language or ethnic group (Graves 1993:62). It is also important to develop a regional model for Lapita within the northern Solomons that emphasises local variability as much as membership in a widespread 'cultural complex' as defined by Green (1992).

Post-Lapita cultural sequences

Due in part to the emphasis placed on the location and excavation of Lapita sites in Island Melanesia, the later portions of cultural sequences remain poorly documented in a number of areas. Unfortunately, post-Lapita sequences have often been viewed against the backdrop of Lapita which can obscure localised innovations and internal change by emphasising the replacement of one stylistic complex with others such as 'Mangaasi-like' incised and appliqué styles (Spriggs 1984, 1993a). Another significant problem is the location and dating of later sites due to the lack of continuous ceramic sequences following the Lapita period. Pottery drops out of use by about 2000 BP in some areas and a general restriction in the number of pottery production centres occurs in most regions. The difficulty in developing cultural sequences is even more pronounced in areas such as the central Solomons where there are no ceramics and a limited range of chronologically sensitive artefact types (Roe 1992b).

There is a general trend towards increased diversification and localisation following the Lapita period with a contraction in exchange systems responsible for the transport of obsidian and other items (e.g. pottery and chert). During the first millennium AD, patterns of exchange develop which resemble those recorded ethnographically in the Vitiaz Strait (Lilley 1988), northern Solomons (Specht 1974a; Spriggs 1991a; Wickler 1990) and elsewhere (Ambrose 1978).

The continuous pottery sequence for Buka documented by Specht (1969), which extends from the late Lapita phase to the present, provides a framework for addressing issues relating to the post-Lapita cultural sequence which is lacking in much of Island Melanesia. A central theme in the present study is the degree to which historical change is characterised by continuity as opposed to discontinuity. Although recognising basic continuities in the Buka sequence, Specht (1969, 1972a) felt that changes in pottery and other items of material culture were abrupt enough to suggest the intrusion of new populations at the end of the Lapita phase and possibly later in the cultural sequence. The validity of these arguments was tested in this study by focusing on the excavation of sites occupied during periods of change between pottery styles. By refining the chronology established by Specht and expanding its geographical extent, a more precise estimation of the nature of change and the mechanisms responsible for it is possible.

At the time of European contact, Buka played a central role in an exchange network stretching from New Ireland to Bougainville (Terrell 1986). The exchange of a wide variety of goods (i.e. foods, raw materials and finished artefacts) within and between language groups on Buka was also well developed by this time (Specht 1974a). Two items of exchange are highly visible in the archaeological record: obsidian and pottery. Obsidian was transported from the Bismarcks to Buka from the Lapita period up until the late prehistoric period. Buka-made pottery was an important export during the past thousand years and evidence for ceramic exchange extends back to the Lapita period. The evidence for intra- and inter-island exchange from Buka is examined in the present study from a historical perspective as a means of addressing the nature and degree of interaction between populations within the northern Solomons and beyond.

ARCHAEOLOGICAL RESEARCH IN THE SOLOMONS

The following section summarises previous archaeological research in the Solomon Islands, including the North Solomons Province of Papua New Guinea and the islands presently comprising the nation of Solomon Islands. This review provides the necessary background for discussion of specific research problems to be addressed in the research design which follows. As archaeological investigations have been concentrated to a significant extent in the northern Solomon Islands (including Nissan, Buka and Bougainville) and this research is most relevant to the present study, a more detailed discussion of this work is provided. Research from the remainder of the Solomons is discussed more briefly in order to provide a broader context for the evidence from the northern Solomons.

Research on Buka

Initial work in the North Solomons was limited to a brief reconnaissance by Ronald Lampert of The Australian National University (ANU) in 1966. Test excavations at a rockshelter site (now designated DAA) on Sohano Island, which is located between Buka and Bougainville in Buka Passage (Fig. 3.1), revealed the presence of several types of pottery and a potential aceramic basal component (Lampert 1966). Surface collections from Malasang village on Buka also confirmed the existence of several ceramic styles.

Lampert's promising results led Specht to redirect his ongoing research from the excavation of Lapita sites on Watom Island at the northern end of New Britain to Buka. Specht spent nearly seven months in 1967 on Buka and smaller offshore islands in Buka Passage where he recorded 73 sites and conducted excavations at four of these. The results of this work provided the basis for his PhD thesis at ANU (Specht 1969). Given the lack of archaeological research in either the Solomons or Bismarcks at this time, Specht was forced to concentrate on fundamental problems related to building a cultural sequence for Buka. These included:

1. describing the modern Buka pottery industry and tracing its development;
2. establishing a ceramic sequence and determining if Lapita pottery was present; and
3. addressing the possibility of aceramic or preceramic occupation raised by Lampert.

Specht's thesis focused on describing a pottery sequence which spanned approximately 2500 years and also recorded modern pottery manufacturing techniques (Specht 1972b). Although excavations were initiated by Specht at Palandraku Cave, illness prevented him from reaching the basal mid-Holocene occupation deposit and human settlement on Buka prior to the late Lapita period was not confirmed until the present study. Specht has also written about various items of traditional material culture on Buka (1974b, 1975a), assessed the impact of European technology (1975b) and discussed ethnographic evidence for trade (1974a).

A brief summary of the pottery styles in Specht's Buka ceramic sequence is presented below in order to provide the necessary background for discussions of the site excavations and chronology in Chapter 3. A more detailed review of the sequence is found in Chapter 6 where the results of pottery analysis from the present study are presented. The dates for each of the styles are those originally assigned by Specht as indicated in Table 1.1. Revisions of these dates as a result of the present study are also discussed in Chapters 3 and 6.

Specht's (1969, 1972a) ceramic sequence for Buka consists of six styles with substyles for four of these. The styles are based on attributes of decoration, vessel form and paste composition. The Buka style (500-200 BC) dates to the late Lapita phase and is dominated by open bowls with calcareous temper which have a minimal amount of decoration including dentate-stamping, incision and applied relief. It overlaps temporally with the Sohano style (200 BC-AD 500) which has restricted bowls with simple decorative motifs and mineral sand temper (which totally replaces calcareous temper in this and all subsequent styles). The Hangan style (AD 500-700) is short-lived in Specht's chronology and dominated by thin walled vessels with vertical sides which are decorated with designs combining incision, applied relief and punctation. Malasang style (AD 700-1200) pottery is predominantly globular with restricted orifices and thicker walls than the Hangan style. Comb incision appears for the first time in the sequence and becomes dominant. The final two styles, Mararing and Recent (AD 1200-1960s), are found only in surface collections and extend up until the modern pottery industry. Pottery is characterised by globular pots decorated with punctation, shell edge impressions and comb incision, and several new vessel forms are introduced.

Bougainville and the Shortland Islands

John Terrell conducted his PhD dissertation research in north and south Bougainville during 1969 and 1970 (Terrell 1976). His work in the north extended Specht's survey eastward along the coast from the Selau area to Numa Numa Plantation in the Wakunai area. Due to Teop's traditional importance as a political and trading center and earlier descriptions of surface pottery from the island in a museum collection (Shutler and Shutler 1964), it was selected for more intensive investigations by Terrell. Buka-made pottery from the Sohano to

Nissan Cultural Sequence (Spriggs 1991a)		Original Buka Ceramic Sequence (Specht 1969)		Revised Buka Ceramic Sequence		Buka Cultural Sequence	
Phase	Dates BP	Style	Dates BP	Style	Dates BP	Phase	Dates BP
Takoroi	ca. 4900					Pleistocene	29,000-10,000
Halika	3650-3200					early to mid-Holocene	10,000-3200
Lapita	3200-2500			Lapita	3200-2500	early Lapita	3200-2500
Yomining	2500-1150	Buka	2500-2200	Buka	2500-2200	late Lapita	2500-2200
		Sohano	2200-1500	Sohano	2200-1400	Sohano	2200-1400
late Hangan	ca. 750	Hangan	1500-1300	Hangan	1400-800	Hangan	1400-800
Malasang	ca. 700-500	Malasang	1300-800	Malasang	800-500	Malasang	800-500
Mararing/Recent	ca. 500-50	Mararing	800-300	Mararing	ca. 500-300	Mararing/Recent	500-0
		Recent	ca. 300-0	Recent	ca. 300-0		

Table 1.1 Ceramic and cultural sequences for Buka and Nissan.

Recent styles was also found on the surface in the vicinity of Teop. Test excavations reported by Black (1977) on Teop documented occupation extending back to Specht's Malasang style and a mixture of pottery from both Buka and the Kieta area on the east coast of Bougainville. A decrease in the abundance of surface collected pottery from both sources was evident with increased distance from the production centres. Buka-made pottery was found as far south as Numa Numa although nothing earlier than the Mararing style was documented. Additional fieldwork by Terrell focused on the Paubake area of Buin at the southern end of Bougainville. Site types in this area included pottery scatters associated with former settlements and distinctive 'megalithic' stone monuments. A local pottery sequence was developed from surface collections along with occasional sherds imported from the Shortland Islands off the southern coast of Bougainville.

Based on his 1970 research, Geoffrey Irwin established a three phase cultural sequence for the Shortlands beginning with the Early period at about AD 500 (Irwin 1972). Similarities between the earliest Buin pottery and that of Irwin's Middle period (AD 1000 to 1800) in the Shortlands have been used as evidence by Terrell (1976: Chapter 7) to suggest that pottery making was introduced to Buin from the Shortland Islands. Buin sherds have also been found in Middle period sites from the Shortlands demonstrating that traditional exchange between the two areas is of considerable antiquity.

Matthew Spriggs conducted a limited survey and test excavations in the vicinity of Kieta and Manetai in central Bougainville during 1987 in an attempt to date the ceramics previously noted by Terrell as far north as Teop, at their source (Spriggs 1992b). Excavations near the pottery producing village of Pidia on the Kieta Peninsula resulted in the documentation of a sequence with three pottery styles beginning at AD 400. According to Spriggs (1992b, 1993a:197), this sequence is exactly parallel to Irwin's for the Shortland Islands and resembles undated sherds from surface collections on Choiseul in the Western Solomons reported by Miller (1979).

Nissan Island

In 1985, Matthew Spriggs initiated research on the atoll of Nissan, 64 km north of Buka, in conjunction with the Lapita Homeland Project. Further excavations were carried out during 1986 and 1987 and a summary report has since been published (Spriggs 1991a). Prior to Spriggs' work, Buka-made surface pottery collected on Nissan by anthropologist Steven Nachman had been analysed by Kaplan (1976). Buka-made pottery from the late Hangan style to the Recent style was noted by Kaplan and importing of Buka pots continued until just after World War II. Eight of the 77 sites recorded by Spriggs on Nissan and the smaller atoll of Pinipir were excavated. As shown in Table 1.1, an eight phase cultural sequence for Nissan beginning at about 4900 BP was developed by Spriggs. The initial Takoroi phase is aceramic and followed by the Halika phase which is contemporary with Lapita sites elsewhere but lacks pottery. This phase has been described as 'Lapita without pots' by Spriggs although he has acknowledged the possibility that it is non- or pre-Lapita in affiliation (Spriggs 1991b:309). Lapita on Nissan is succeeded by the Yomining phase during which pottery appears to have been imported primarily from the north, although the occurrence of a few Sohano style sherds indicates more limited links to Buka as well. Importing of pottery from Buka was re-established by the late Hangan style and the final three phases are distinguished on the basis of pottery from the final four styles defined by Specht.

Research outside of the North Solomons

Archaeological research elsewhere in the main Solomon Islands has been limited to survey and test excavations within Western Province (Miller 1979; Miller and Roe 1982; Reeve 1989) and reconnaissance survey of the main islands, except for Guadalcanal and Makira Province where more extensive work has been done. Radiocarbon dates obtained from deposits at Vatuluma Posovi Cave (erroneously referred to as Poha Cave previously in the archaeological literature) in northwest Guadalcanal excavated between 1966 and 1968 (Davenport 1968; Davenport et al. n.d.) document aceramic occupation from about 3000 BP to the historic period (Black and Green 1978). Additional excavations at this site in 1987 and 1988 by David Roe have extended the sequence back to 6000 BP (Roe 1992b, 1993). A series of other inland and coastal cave and rockshelter sites with occupation as early as 4000 BP were also excavated and all proved to be aceramic. Additionally, Roe has investigated irrigated agricultural systems (Roe 1989) and rock art sites (Roe 1992a) in the region.

As a result of the Southeast Solomons Cultural History Programme during the 1970s (Green and Creswell 1976; Yen 1982), extensive archaeological investigations of the outer islands within Temotu Province were conducted along with a lesser amount of field research on Cristobal, Ulawa and Santa Ana Islands in Makira Province. The earliest dates for settlement in this region are from Lapita sites in the Reef-Santa Cruz Islands (Green 1991a).

DESIGN OF THE RESEARCH

Introduction

In a recent review of archaeological evidence from the past 10,000 years in Island Melanesia, Spriggs (1993a: 188) characterised archaeology in the region as being in a pioneer phase which is data-led rather than theory-led. Over the past decade, archaeological evidence from previously little known archipelagos such as the Bismarcks has been accumulating at a rapid rate but the development of theoretical frameworks with which to interpret this new data has lagged behind. A prime example is the Lapita Homeland Project, which 'possessed no central direction or theoretical focus during the field research or subsequent analyses beyond the general issue of Lapita origins' (Allen 1991:4).

Although not always explicitly acknowledged, the dominant theoretical framework in Oceanic archaeology has traditionally been culture historical. Investigations of Lapita typify this approach through their concern for origins and dispersal and tendency to emphasise mechanisms such as migration and diffusion (see Clark and Terrell 1978; Green 1982, 1992 for discussions of Lapita models). This is not to say that interpretations oriented by other theoretical perspectives have been neglected. For example, approaches which stress adaptive responses to environmental factors and evolutionary theory have become increasingly prevalent (Hunt 1989; Kirch 1984; Kirch and Green 1987). Terrell (1988) has provided a useful distinction between two primary approaches to the past in Oceania. The dominant approach has focused on the search for origins and migration routes and is directed toward searching for similarities rather than the analysis and explanation of diversity in the past. In contrast, the second approach examines patterns of similarity and variation between populations in terms of intersecting historical pathways to explain diversity.

It is not my intention to provide a review of the theoretical perspectives which form the basis for the interpretation of archaeological evidence from past or present research in Island Melanesia. Rather, I wish to focus on the specific set of research problems which the present study was designed to address. My approach is concerned with the establishment of a temporal framework for the prehistoric sequence on Buka, for which substantial gaps existed at the time of my investigations. Establishing cultural sequences is an essential first step in moving from what, when and where questions to addressing how and why things happened in the past and provides the framework upon which these interpretations are based.

Despite Specht's fairly detailed post-Lapita sequence for Buka, substantial gaps and uncertainties remained that needed to be addressed by additional research. Specht's work provided the springboard from which to address a variety of specific questions regarding ceramic period settlement and investigate the possibility of preceramic occupation. Within the context of providing a cultural sequence of greater depth and breadth for Buka, a series of problems were formulated to guide the research.

The research problems to be addressed fall into two main categories. The first of these is concerned with obtaining additional evidence from three broad periods of settlement during the Buka cultural sequence: the Preceramic, Lapita and post-Lapita phases. A set of research questions relating to each of these periods is formulated. The second category of research problem includes questions related to long-term changes in exchange and subsistence from initial settlement to European contact. Rather than compartmentalising the evidence from particular periods of the sequence, broader patterns of change are examined such as the transition from hunting and gathering to agriculture and the introduction of pottery.

In the following discussion of the research problems, questions are presented for each problem, followed by an explanation of the methods by which these problems were approached. Justifications for the methods employed are then presented along with a discussion of the results which were anticipated.

Preceramic settlement

A major research objective was to locate and excavate pre-Lapita site deposits in order to determine when the initial occupation of Buka took place. Despite Specht's failure to document settlement prior to 2500 BP, the discovery of late Pleistocene age sites on New Ireland and aceramic deposits nearly 5000 years old on Nissan prior to the present field investigations strongly indicated that the main Solomons chain had been colonised long before Lapita settlement.

Research questions

1. Does the initial settlement of Buka date to the late Pleistocene as with the Bismarcks or did it occur only a few thousand years prior to Lapita as suggested by the evidence from Nissan Island?
2. What was the nature of settlement during the preceramic period and to what extent is this visible archaeologically?
3. Assuming that pottery did not arrive as unaccompanied baggage, what impact did the arrival of populations which introduced Lapita pottery to Buka have on the previous residents in terms of settlement pattern, economy and subsistence? What archaeological evidence is there for continuity or discontinuity between the preceramic and Lapita phases?

Methods

The abundant rockshelters and caves along the east coast of Buka were targeted as likely locations for early occupation evidence due to their high potential for lengthy sequences and well-preserved remains. A majority of the evidence for preceramic settlement in Island Melanesia has come from cave and rockshelter sites. However, the recent evidence for the occupation of open sites from the interior of New Britain at Yombon dating to 35,000 years ago demonstrates that rockshelter sites alone do not provide an accurate picture of settlement patterns during this period (Pavlides and Gosden 1994).

Although cave and rockshelter sites may not accurately reflect settlement patterns on Buka during the Preceramic period, the likelihood of finding open sites of comparable age is remote. This is due in part to poor preservation in inland locations and the fact that modern coastal beach areas were not formed until after the mid-Holocene high water stand at about 6000 BP when sea level was 1 to 2 m higher than at present.

Lapita in context

The second major research problem was to find more substantial evidence for Lapita occupation than the limited deposits with late Lapita ceramics excavated by Specht. Attempts to locate Lapita sites covered a much broader geographical area than was previously investigated by Specht, including intertidal reef flats, as Lapita pottery and associated artefacts had recently been found in the Bismarcks and on Nissan in such locations.

Research questions

1. To what degree can Lapita settlement patterns be documented from the archaeological record on Buka?
2. What evidence is there for temporal variability in material culture, particularly pottery, during the Lapita phase and what is its cultural significance?
3. What is the nature of the relationship between late Lapita phase Buka style pottery and the subsequent Sohano style, and to what extent are the changes in pottery styles reflected in other items of material culture? Do these changes reflect internal processes or external influences involving population replacement, diffusion or other mechanisms?

Methods

Buka appears to have a high potential for Lapita sites given its relatively small size and the presence of numerous small offshore islands which are favoured locations for Lapita settlement elsewhere in Oceania (Green 1979). The extensive intertidal reef flats along much of the coastline on Buka and its offshore islands were targeted during survey in light of recent discoveries of Lapita ceramics in similar locations from the Bismarcks and on Nissan Island.

To address the question of relationships between the late Lapita phase and subsequent Sohano phase, sites were sought which had both late Lapita Buka style pottery and Sohano style pottery in stratigraphically secure contexts. Ceramic analysis focused on determining if attributes related to temper and paste, vessel form and decoration were shared by the two styles.

Post-Lapita developments

The third research problem was to assess the validity of Specht's pottery sequence following the Lapita style and examine the phases of settlement linked to these pottery styles in terms of the non-ceramic evidence. As Specht (1969:321) acknowledged, his Buka pottery sequence was a first attempt based on evidence from a limited area and additional research was required to evaluate the conclusions reached.

Research questions

1. Is Specht's pottery sequence reliable, and if so, what is the chronological framework of the styles he identified?
2. Does the same sequence of pottery styles and associated non-ceramic evidence apply to the whole of Buka or are there intra-island differences?
3. What trends are evident within the archaeological record in terms of changes in artefacts and non-artefactual remains? What are the mechanisms responsible for changes between pottery styles and phases in the cultural sequence?

Methods

The identification of pottery styles from surface collections made it possible to select sites for excavation which were likely to have pottery of a certain age and type. To reduce the degree of uncertainty in interpreting ceramic variability within the deposits, sites were chosen which had a minimum number of styles represented and bracketed the periods during which styles replaced one another. This approach also helped to insure that accurate dates were obtained for the individual pottery styles to test the validity of Specht's chronology. By excavating sites from each phase of the post-Lapita cultural sequence in locations outside of the areas tested by Specht, a better understanding of general patterns of change over time was possible.

Exchange and interaction

The subject of exchange within Oceania in general and Island Melanesia in particular has been much discussed by ethnographers and prehistorians. Ethnographic treatments of exchange vary considerably in their focus and deal with well known systems such as the *kula* of the Trobriands (Leach and Leach 1983) and a variety of others (e.g. Specht and White 1978). Archaeologists have frequently, and sometimes incautiously, made use of ethnographic accounts in constructing models for past systems of exchange in Melanesia and elsewhere. The modelling of Lapita exchange in particular has been the object of considerable attention. Long-distance exchange is one of the most distinctive features of Lapita and transport of obsidian, chert, metavolcanic rock, pottery and other materials has been documented (Green 1979; Hunt 1989; Kirch 1988b). The geographical extent of the Lapita exchange network was far greater than any ethnographically recorded system in Oceania, covering distances of over 3000 km.

At the time of European contact, Buka was part of an exchange network which moved goods through Nissan and the Feni Islands to New Ireland in the Bismarcks. Buka pottery was also transported along the northern coast of Bougainville (Terrell 1976) and has been found on the Polynesian outlier of Ontong Java to the east (Spriggs pers. comm.). Local exchange of a wide range of items between populations on Buka is also well documented ethnographically (Specht 1974a).

Although much of the material being exchanged is archaeologically invisible, items such as pottery and obsidian offer significant insights into the dynamics of exchange over thousands of years. Documenting changing patterns of exchange through time provides a means of tracing Buka's role within regional networks of interaction linking the Bismarcks to the Solomons.

Research questions

Questions concerning exchange fall into two categories. The first examines long-term trends in the movement of pottery and obsidian. The second takes a broader view of the evidence for exchange during particular phases of the Buka sequence and the changes which occur between these phases.

1. What changes occur in the movement of pottery and obsidian over time following their initial appearance on Buka during the Lapita phase?
2. Is there evidence for pre-Lapita exchange, and if so, how does this compare with Lapita exchange?
3. How does the evidence for exchange reflect continuities and discontinuities between the Lapita and post-Lapita phases on Buka?

Methods

The documentation of exchange archaeologically has relied to a great extent on chemical characterisation of raw materials such as pottery clay and temper, obsidian and other types of stone. The sourcing of obsidian from the Bismarcks has been particularly successful using specific gravity and two techniques of nuclear analysis: proton-induced gamma-ray emission (PIGME) and proton-induced X-ray emission (PIXE). Determining pottery sources through compositional analyses has been more problematic due to the difficulty in knowing all potential sources and obtaining samples of clay and temper from each of them. Despite these difficulties, significant contributions have been made, especially in the sourcing of Lapita ceramics (see Hunt 1989). Summerhayes' (1987) compositional analyses of Buka pottery collected by Specht has also provided a substantial amount of data on potential clay and temper sources for each of the styles in the pottery sequence.

Obsidian and pottery provide the principal evidence for past exchange on Buka and compositional analyses of both artefact types are stressed in the present study. Preliminary sourcing of the majority of obsidian collected was undertaken using the specific gravity technique. As the later Buka ceramics had been analysed by Summerhayes, chemical characterisation was limited to Lapita style pottery and involved energy-dispersive X-ray microanalysis of the clay fraction.

Potential evidence of exchange during the preceramic phase of settlement on Buka is limited to the sourcing of non-obsidian flaked stone artefacts and analysis of faunal and floral remains to determine if humanly introduced species are present. Sourcing of chert and some meta-volcanic rock types has been successful to some extent in Melanesia but is much less precise than for obsidian. Evidence for human transport and introduction of several animal species has been obtained from preceramic sites dating back to the late Pleistocene on New Ireland (Allen et al. 1988). Although not necessarily items of exchange, the presence of faunal and floral introductions documents inter-island interaction.

Subsistence change

Documenting patterns of resource exploitation and trends in subsistence change on Buka was a central focus of the present study. The presence of preceramic sites on Buka presented the opportunity to address issues related to the shift from hunting and gathering to agriculture. Although there is a possibility of preceramic agriculture in Island Melanesia, the first reliable evidence is from the Lapita period.

Specht's work on Buka did not emphasise the analysis of faunal or floral remains as the primary focus of his research was on the construction of a ceramic sequence. In the present study, the analysis of faunal remains from the ceramic period sites was given priority as a means of examining variability in the exploitation of animal resources and its relationship to environmental and cultural factors.

Research questions

1. What is the nature of the shift from hunting and gathering to agriculture on Buka and when does it occur?
2. Is there evidence for the introduction or extinction of plant and animal species and if so, what impact would these have had on subsistence?
3. How does variability in the type and frequency of faunal remains between sites reflect patterns of resource exploitation over time and across space?

Methods

In order to maximise the recovery of faunal and floral remains, field methods stressed the use of relatively small-mesh 1/8" (3.2 mm) screens, wet-screening of excavated deposits and sorting of material from the screens in a field laboratory rather than during excavation. By minimising methodological inconsistencies, substantive issues relating to subsistence could be addressed with greater confidence.

Bone and shell from each of the sites were analysed and bone from the preceramic Kilu Cave site was identified by specialists. Carbonised plant remains from Kilu were also identified and residues from stone tools in the preceramic deposits analysed.

CHAPTER ORGANISATION

In the following chapters, the degree to which the research goals were accomplished is assessed in relation to the various classes of archaeological data recovered.

Chapter 2 presents an overview of the natural and cultural environment on Buka in order to provide the necessary background for interpreting the data presented in the later chapters. Chapter 3 provides descriptions of site survey and excavations at seven site locations.

Chapters 4 and 5 present the results of Lapita pottery analysis from three reef sites and Chapter 6 deals with excavated pottery assemblages from the late Lapita phase Buka style to the Recent style. Non-ceramic portable artefacts recovered during survey and excavation are described in Chapter 7.

Chapter 8 examines the results of faunal and floral analyses which were carried out with the aid of specialists. The primary emphasis is on the rich assemblage of vertebrate remains from the preceramic Kilu Cave deposits.

Chapter 9 synthesises the results presented in the previous chapters and reviews the Buka cultural sequence as it is presently understood. The degree to which the research objectives were successfully addressed is also assessed. The final section examines the changing role of Buka over time from a regional perspective.

2

THE NATURAL AND CULTURAL SETTING

This chapter presents an overview of the natural and cultural environment for Buka and the northern Solomons region to provide the necessary background for understanding the processes of prehistoric change to be discussed in the remaining chapters. The initial section describes the physical environment (geology, topography, climate) and land use patterns. This is followed by an examination of the cultural setting from biological, linguistic, ethnographic and historic sources and its importance in modelling past human settlement.

THE NATURAL SETTING

Island Melanesia is a geographical entity which includes archipelagos extending from the Bismarcks off the New Guinea mainland in the northwest through the Solomon Island chain and southeast as far as Vanuatu and New Caledonia. Despite their overall locational unity, a series of biogeographical boundaries distinguished by increasingly depauperate fauna and flora from north to south separates these island groups. The first division, which lies between mainland New Guinea and the Bismarcks, represents the most dramatic decrease in biological diversity, with further restrictions between the main Solomons and Vanuatu. New Caledonia is an exception to this trend as it is an old fragment of Gondwanaland and massively diverse biologically. As discussed in Chapter 1, the southern end of the main Solomons also marks the boundary between Near Oceania and Remote Oceania (Green 1991c).

The islands of the northern Solomons occupy a pivotal position as stepping stones linking the Bismarcks to the remainder of the Solomons. The water gap between New Ireland and Nissan via the Feni Islands involves open-sea distances of 50 to 60 km, representing a significant biological and cultural barrier. At the time of initial human settlement during the Pleistocene, the open-water crossing between the Bismarcks and the Solomons would have increased significantly (up to 180 km from New Ireland) if the atoll of Nissan had not yet emerged.

Bougainville and Buka lie between latitude 5 and 7 degrees South and longitude 154 and 156 degrees East at the northern end of the Solomon Island chain (Fig. 1.1). The two islands represent a total land area of approximately 9000 km^2 and are separated by a shallow strait up to 800 m wide known as Buka Passage. Buka is about 55 km long from north to south and from 9 to 17 km wide.

Topography and geology

Buka consists of a line of volcanic hills in the southwest, the Parkinson Range, which rise to a maximum elevation of 485 m, and a raised coral reef complex to the north and east (see Fig. 3.1). The south and west coasts are low-lying with extensive mangrove swamps in locations such as Queen Carola Harbour and Ramun Bay. In contrast, the north and east coasts are being tectonically uplifted and have cliffs with several benches rising from 5 m in the vicinity of Buka Passage to 90 m at Cape Iltopan near the northern tip of the island. A chain of smaller raised limestone islands connected by a barrier reef extends along the western coast and much of the remaining coastline has a narrow fringing reef. Drainage in the raised limestone areas is underground with surface streams largely restricted to the Parkinson Range. Underground rivers emerge from limestone caverns and flow into the ocean at Malasang and Lonahan on the east coast.

Following the initial geological descriptions of Buka and Bougainville made by Blake (1967) and Blake and Miezitis (1967), little work was done until the 1986-1988 Bougainville project which resulted in a re-interpretation of the geology (Rogerson et al. 1989). The following description is based on these sources.

The basement volcanic rocks on Bougainville and Buka are Late Eocene to Early Oligocene Atamo Volcanics which are dominated by spilitic, often pillowed, basalt-basaltic andesite and interbedded volcaniclastic breccia, sandstone and siltstone. The earliest exposed unit on Buka is the Late Eocene to late Early-early Middle Miocene Buka Formation which consists of volcanolithic sandstone and siltstone, with minor conglomerate and spilitic basalt (Rogerson et al. 1989:iii). This formation includes the Parkinson Range on Buka as well as hilly areas on Taiof, Madehas and Tanwoa islands to the south.

The shallow marine Plio-Pleistocene Sohano Limestone is an elevated coralline reef formation which covers most of Buka Island away from the Parkinson Range and also crops out on Sohano Island and the north coast of Bougainville. The Sohano Limestone forms an extensive karst plateau with well developed sinkholes that dips at very low angles to the south and west. The unit overlies Buka Formation sediments around the margins of the Parkinson Range and provide a maximum age for the formation in the Middle Miocene. Recent to late Pleistocene ash deposits from volcanoes on Bougainville cover much of Buka and reach depths of up to a metre (Blake and Miezitis 1967).

Climate

There is little variation in the wet tropical or tropical rain forest type climate of Bougainville and Buka Islands with a mean annual temperature of 80°F (26.7°C) at sea level and only three degrees difference in monthly means (Speight and Scott 1967). Annual rainfall ranges from 335 cm on the south coast to 267 cm in the north with a nearly constant relative humidity of about 80%. Prevailing winds come from the northwest between December and April with stronger and more continual winds from the southeast during the remainder of the year. The southeast season is somewhat drier on northern Bougainville and Buka as moisture-laden winds deposit a higher percentage of rain on the southern slopes of Bougainville's mountains during this period. The seasonal changes in wind have little effect on temperatures but do influence patterns of rainfall to some extent, especially in the north.

Land systems

Land units on Bougainville and Buka with similar patterns of topography, soils and vegetation have been grouped into a series of forty land systems by Scott et al. (1967) as part of their resources survey. Four of these land systems occur on Buka and the northern end of Bougainville.

1. Lonahan Land System – this system covers the cliffed coastal portion of north and east Buka as well as the north coast of Bougainville eastwards to Teop Island. It consists of plateaus and scarps of uplifted former atolls and fringing reef, including reef front with occasional benches, reef flat, lagoon slope and patch reefs. Former tidal passages up to 24 m deep and 300 m wide cut through the system in locations such as Malasang near Buka Passage. Soils are mostly clays and vegetation is a mixture of gardens, *Vitex-Pometia* tall forest remnants and scrubby regrowth.
2. Kohino Land System – the Kohino System is comprised of plains of uplifted coral lagoon floors occupying the inland portions of the Sohano Limestone on Buka and the extreme north of Bougainville. The soils and vegetation are similar to the Lonahan System with moderate to minor areas of cultivation and highly visible herbaceous regrowth.
3. Soraken Land System – comprising the western and southern coastal portions of Buka where mangrove flats, coral reefs and low emerged coral platforms of recent geological origin occur, this system contains nearly all of the archaeological sites recorded. The five components of these coastal locations are intertidal reef flats, narrow sand beaches, tidal flats associated with brackish swamps, alluvial-littoral plains with small streams and raised coral platforms from 1.5 to 4.5 m in elevation. Vegetation consists of *Hibiscus-Pandanus* scrub in beach areas with *Rhizophora-Bruguiera* forest and stands of *Nypa* palms on tidal flats. The remaining areas are mainly under cultivation with coconut plantations and secondary vegetation although some patches of *Euodia-Pometia* tall forest remain.
4. Deuro Land System – the final system found on Buka consists of the ridges of the Parkinson Range with their steep slopes and fast-flowing streams. Tall forest species such as *Vitex-Pometia, Neonauclea-Sloanea* occur at higher elevations and *Terminalia brassii* along water courses. Moderate amounts of garden land and secondary regrowth are present in these locations.

Terrell (1977) has incorporated land systems into a configuration of four geographic regions for the North Solomons. Buka and north coastal Bougainville together with northeast coastal Bougainville are sub-regions which together form the north coastal geographic region. In addition to physical features of the landscape, aspects of human settlement including population distribution, language and subsistence are also important components utilised in distinguishing between regions.

THE CULTURAL ENVIRONMENT

The aspects of present human settlement on Buka reviewed in this section provide an important basis for interpreting the archaeological evidence presented in the remaining chapters. These include perspectives gained from the examination of biological, linguistic, ethnographic and historic evidence pertaining to local populations.

Population, language and biology

Based on census figures obtained from the Provincial Government, the population of Buka Island in 1987 was 25,659 persons, a significant increase from the approximately 14,000 individuals reported in 1967 (Specht 1969:21). Census figures from 1980 recorded a population of 40,789 in the Buka District (which includes the smaller offshore islands surrounding Buka), representing 37.5% of the 125,506 individuals living in the North Solomons Province at that time (Government of Papua New Guinea 1980:25). Oliver (1991:6) estimates that the population of Bougainville and Buka at the time of European contact was on the order of 45,000 although this amounts to little more than a guess as there are no reliable population figures from this period. The highest population density figures occur within the lands of the Lonahan System where up to 60 people per km^2 have been recorded (Scott et al. 1967). Settlement is concentrated on the north and east coasts of Buka on narrow beaches at the base of limestone cliffs and along the edge of the cliffs. Traditionally, villages did not usually exceed 200 people with the possible exception of more populous settlements on the north coast of Buka (Blackwood 1935). European accounts from the late 1800s and early 1900s indicate that coastal populations on Buka were large and settlement was focused in the same general locations as today.

Twenty languages are spoken in the North Solomons which are divided into more than 50 dialects, sub-languages and sub-language families (Allen and Hurd 1963). The three languages found in the Buka area are members of the Petats family. Petats language speakers are restricted to the islands off the west coast of Buka, while the Solos language area covers the western and southern portion of the island and Halia is spoken in the east and north. Halia has one sub-language (Selau) and three dialects, and Petats has two dialects. A majority of the languages in the North Solomons are classified as Austronesian (AN), including all of those spoken on Buka and the northern coast of Bougainville. The eight non-Austronesian (NAN) languages are concentrated in south and central Bougainville. Clustering of AN languages in coastal areas suggests that they are more recent than the NAN languages which they would have partially replaced.

The spread of Oceanic AN languages across much of the Pacific has been linked to the movement of Austronesian speaking Lapita populations out of southeast Asia by proponents of an 'intrusive' view of Lapita origins (Bellwood 1978:247). Malcolm Ross (1988, 1989) has proposed that there was a two-phase migration of Austronesian speakers through the North Solomons from a homeland in New Britain. According to his reconstruction, a Meso-Melanesian cluster of languages including ancestral forms of the Nissan language and others presently found on Buka and Bougainville represents a second phase of migration which replaced earlier AN languages more closely related to the languages of the SE Solomons and Central Pacific. Spriggs (1992a, 1992b) has equated Ross's first phase of migration with the spread of Lapita and the second with the replacement of Lapita style pottery with 'incised and relief styles (Mangaasi) which are found from the Bismarcks to Fiji' (1992a:226). However, as Spriggs himself notes, Ross's two-stage model of Austronesian language dispersal is controversial and not without its critics. Alternative explanations for the present distribution of languages, taking into account factors such as geographic and social isolation, also need to be considered.

Biological diversity within the North Solomons is even more pronounced than linguistic variability. An extensive research project dealing with the biology and health of populations in the Solomons, carried out between 1966 and 1980, derived much of its data from the North Solomons (Friedlaender 1987). One finding of these investigations was that biological variability between individuals on Bougainville is much higher than the world-wide average (Rhoads and Friedlaender 1975). Three reasons are cited for this biological diversity: the high degree of village autonomy leading to highly inbred populations, the existence of local language barriers and the small size of villages. Friedlaender and his associates also noted that biological variability is linked to the divisions between AN and NAN speaking populations although contact and intermarriage between the two groups has led to increased genetic assimilation of AN speakers over time.

The ethnographic baseline

European accounts of Buka providing ethnographic information began in the late 1880s following German annexation. The most important of these early German sources was Richard Parkinson (1888, 1899, 1907). More limited accounts are also available from a variety of sources (e.g. Friederici 1910; Frizzi 1914; Zöller 1891). The amount of anthropological research in the North Solomons increased during the late 1920s and 1930s including Beatrice Blackwood's (1931, 1935) fieldwork from 1929 to 1930 on the island of Petats and at the village of Kurtachi on the north coast of Bougainville. By this point in time, prolonged European contact had drastically altered traditional social organisation and economy, particularly in the coastal areas, and Blackwood's findings must be viewed within this context. Other studies from this period cover a variety of topics including mythology and folklore (Blackwood 1932), rituals and ceremonies (Thomas 1931/32) and descriptions of material culture (McLachlan 1938). Additional references can be found in Edridge's (1985) bibliography of publications dealing with the Solomons.

Group identity on Buka and the surrounding areas has traditionally focused on the village. Villages are usually comprised of a string of hamlets that form a nearly continuous linear pattern of settlement along much of Buka's coastline. In contrast, settlements in the interior portion of the island are much smaller and more scattered. At the time of Blackwood's research, hamlets still contained one or more huts called *tobar* reserved for the use of men and boys. Most villages were surrounded by a fence of some sort with traditional huts built on bare earth and thatched with sago palm leaves. Communities were exclusively matrilineal in terms of descent and succession with individuals organised by lineages and clans. Although clan exogamy was generally the rule, exceptions were possible (Blackwood 1935:45). One lineage was always prominent in each village and led by a *tsunaun*, which is roughly translated as a 'person of hereditary rank or importance'.

Traditional subsistence was based on the cultivation of root crops, bananas and coconuts supplemented by fishing and hunting of larger mammals including *Phalanger orientalis* and fruit bats. Taro was the staple crop until World War II, when a blight led to the increased cultivation of sweet potato (Connell 1978). *Canarium* almonds have long been a minor, but significant, component of the diet and constitute a form of arboriculture. Pre-European domesticated animals included the pig, dog and chicken. Fishing was of considerable importance in coastal areas and included the capture of pelagic species, such as tuna, along with smaller reef fish.

Trade and exchange were an important aspect of traditional life on Buka at both local and regional levels. The most important form of local barter was the exchange of fish for taro between coastal and inland populations which involved regular interaction among particular villages. Pottery produced at three villages on the east coast of Buka (Malasang, Lonahan and Hangan) was also an important item of exchange (Specht 1972b). Regular exchange contacts were maintained between Buka and the northern coastal portion of Bougainville. Buka was also an important node in an exchange network extending through Nissan Island to the Feni Islands and New Ireland. Items transported to Nissan included pottery, bows and arrows, spears, tobacco (an early European introduction), pigments, volcanic stone implements, animal tooth necklaces and slit gongs while Nissan's primary exchange items were pigs, fish, coconut water containers, arrows, *Tridacna* rings and shell disc necklaces (Spriggs 1991a:224). In his analysis of exchange and resource distribution on Buka, Specht (1974a) notes that the movement of goods cannot be explained merely in terms of the physical environment (i.e. resource abundance versus scarcity). One possible explanation offered is that trade activity provided 'opportunities for social competition or maintaining the viability of hierarchical social systems among communities whose lands are small in area and often unsuited to intensive cultivation' (Specht 1974a:236).

A brief historical sketch

Although a history of the Solomon Islands between 1800 and 1978 has been written by Bennett (1987), it is restricted to the islands within the present political boundaries of the nation and only makes brief mention of events in the North Solomons. General historical texts on Papua New Guinea are few in number and provide little detailed information on the North Solomons Province (Firth 1982; Griffin et al. 1979; Waiko 1993). More extensive historical summaries for the North Solomons and Buka are found in Specht (1969) and Oliver (1991).

Buka was first sighted by Europeans in 1767, when the British ship *Swallow* under the command of Philip Carteret passed by but did not approach land. The island was given the name Bouka by Louis de Bougainville, whose expedition sailed along its east coast and that of Bougainville Island, anchoring for a brief period off Buka. It was not until 1792 that a shore party from d'Entrecasteaux's expedition visited Buka. Contacts increased after 1800 and were of four primary types: whalers seeking provisions; labour recruiters or 'blackbirders' looking for plantation workers; traders collecting copra; and English and German explorers. In the latter half of the 1800s, large numbers of Buka and Bougainville inhabitants were recruited to work on plantations in Queensland, Fiji, Samoa and New Britain. Buka men had a reputation for being trustworthy and reliable and were given positions as 'police boys'. Some islanders volunteered for plantation work while others were kidnapped or coerced into labour. Although accurate population figures are lacking, the impact of European contact in terms of depopulation from introduced diseases does not appear to have been as serious on Bougainville and Buka as on Polynesian outliers such as the Tasmans (Nukumanu) and Mortlocks (Tauu) to the east and in portions of the Bismarcks (Firth 1982).

The North Solomons were free from formal European control until the 1886 Berlin Declaration when Germany expanded its Melanesian territory of northeast mainland New Guinea and the Bismarck Archipelago to include Buka, Bougainville and some more southerly islands of the Solomons. However, German influence had been present in the region for a number of years prior to this date in the form of explorers, recruiters and traders. One of the best known personages from this period was plantation owner Richard Parkinson, who made numerous trips to Buka and Bougainville and recorded his observations in the book *Dreissig Jahre in der Südsee,* published in 1907.

White-owned plantations were established on Bougainville in the early 1900s and in 1905 the German colonial administration established a post at Kieta. A few planters and traders began to settle along the southern and western coasts of Buka (e.g. Kessa and Buka Passage) during this period but the interior regions continued to have much more limited contact with whites. Missionary activity in the North Solomons began in 1902 with the establishment of a Marist station on Bougainville near Kieta, the first permanent white settlement. In 1910 the Marists set up a base on west Buka and four main stations had been established by 1934. The Marist monopoly was not broken until the arrival of Methodists expanding northwards from the central Solomons after World War I.

From the outbreak of World War I until 1921, the colony of German New Guinea was administered by the Australian military. Following the war, Australian control was maintained through a League of Nations mandate. During World War II, the Japanese occupation forces embarked on a policy of Nipponisation in which Bukas were taught the Japanese language, customs and songs. By 1943, with the position of the Japanese worsening, relations with the native inhabitants became increasingly hostile. After the war, the Australian government returned to administrate the Trust Territory of New Guinea together with Papua until the independence of Papua New Guinea in 1975.

Although the agencies of pre-war colonialism (administrators, missionaries and planters) reasserted themselves following the war, gradual changes towards increased self-government were implemented. District headquarters for administration of the Bougainville District were initially set up on Sohano Island in Buka

Passage and moved to Kieta in 1968. Following independence, the Bougainville District became the North Solomons Province and the provincial administrative centre was moved from Kieta to newly-established Arawa.

From the mid-1960s onward, the degree and rate of social, economic and political change for Buka-Bougainville increased substantially. The most visible change was the development of the Panguna copper mine operated by Bougainville Copper Limited (BCL), which opened in 1972 and was forced to shut down in 1989 by the hostile actions of insurgents. In May of 1990, leaders of the Bougainville Revolutionary Army (BRA) declared independence and set up the Bougainville Interim Government (BIG). The legitimacy of this government has not been recognised by any other countries. In response to this action, PNG troops were progressively deployed in the province and an air and sea military blockade established. The Lincoln Agreement, which calls for a permanent ceasefire to take effect on Bougainville on April 30, 1998, was signed by leaders of the Bougainville factions, the PNG government and the PNG Opposition party as this monograph was going to press. However, this agreement does not address the political issues and aspirations for self-determination which hold the key to a permanent peace on Bougainville (see May and Spriggs 1990; Oliver 1991; Spriggs 1997; Spriggs and Denoon 1992 for a history of the conflict).

3

THE BUKA ARCHAEOLOGICAL SITES: SURVEY AND EXCAVATION

THE SITE SURVEY

Archaeological survey on Buka was oriented towards the discovery of suitable deposits for excavation rather than extensive areal coverage. Survey was restricted to coastal portions of the raised limestone Sohano formation within the Lonahan land system and the adjacent coastal Soraken land system. The inland plain of the Kohino system, mountainous Deuro system and low-lying west coast were not investigated due to limited settlement potential and dense vegetation making location of sites more difficult. The coastal portions of Buka within the Sohano limestone formation are more accessible due to extensive vegetation clearance for cash crops such as coconuts and cocoa. Sites were recorded in four geographical areas:

1. the top of the limestone cliffs along the east coast;
2. uplifted benches along these cliffs;
3. discontinuous narrow beaches at the base of the limestone cliffs and beach deposits outside of the cliff areas; and
4. intertidal reef flats.

Basic site data for all unexcavated sites recorded during the present investigations in 1987 is presented in Table 3.1 and site locations are indicated in Figure 3.1. Site locations in the Malasang area on the east coast of Buka and on the islands of Sohano and Pororan are located on separate maps (Figs 3.5, 3.13 and 3.18 respectively). A total of 30 previously unrecorded sites was located during survey and seven of the 75 sites previously recorded by Specht were examined. Of these 37 sites, the majority are former settlements or occupation foci characterised by surface concentrations of pottery and marine shells located on narrow beaches (n=9) and on top of, or at the base of, limestone cliffs or benches (n=12). A total of 12 wave-cut or solution caves and rockshelters was investigated, four of which had areas in excess of 100 m^2. Three of the sites are artefact scatters on intertidal reef flats, two of which are associated with eroding beach deposits. Other site types include a pottery scatter associated with a freshwater spring and two sites with stone uprights within contemporary and abandoned settlements.

Recorded sites were assigned a three letter site code using the Papua New Guinea (PNG) National Register of Traditional and Archaeological Sites system. Sites recorded by Specht which were originally assigned sequential numbers with the prefix B.P. (for Buka Passage) have since been incorporated into the National Register system and are referred to by their revised designations. Sites were also given local place names for the actual site or general area in which the site was located. The reliability of these names is uncertain in some cases due to conflicting information obtained from local informants concerning the proper name or the existence of multiple names for the same location. If no local name for the site was available, a descriptive name was assigned. Sites were also identified by reference to the nearest village or hamlet. The sequence of site codes is not arranged by geographical area but was assigned in the order that sites were recorded.

Recording and collection procedures during survey were carried out as uniformly as possible. Upon locating a site, a general description of the site and environs was written and a sketch map drawn. This information was recorded on standardised site survey forms which are on file in the Archaeology Division of the National Museum of PNG in Port Moresby. An estimate of total site area was recorded whenever possible based on the spatial distribution of surface artefacts and associated shell midden. The intensity of surface collection varied depending on time constraints and the size of the site

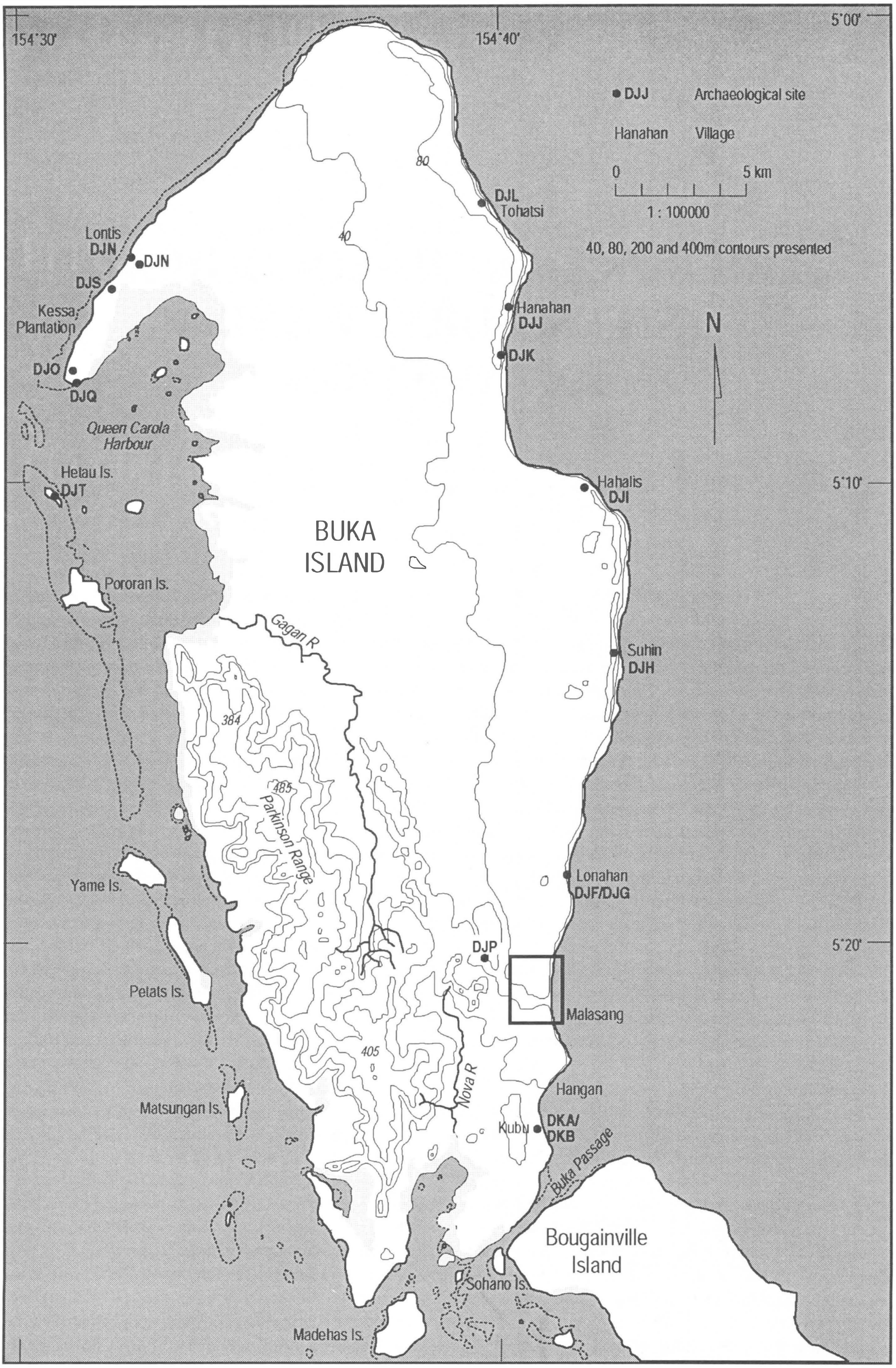


Figure 3.1 Buka Island: Location of villages and archaeological sites (see Fig. 3.5 for sites at Malasang, Fig. 3.13 for those on Sohano and Fig. 3.18 for those on Pororan).

involved. At several of the larger sites and the three reef sites, surface collections were made within designated areas usually representing discrete concentrations of material remains.

Pottery was present on the surface of all sites and provided the principal evidence for human occupation. The ceramic sequence inferred by Specht made it possible to estimate the relative age of sites on the basis of pottery styles present on the site surface. The frequencies of surface pottery for each style by site are presented in Table 3.2. Of the 32 sites from which surface pottery was collected, all have Recent and/or Mararing style pottery but less than 30% have earlier styles represented.

A total of 16 sites was recorded within the initial two weeks of fieldwork on Buka with the assistance of Eliuda Temoana, curator of the North Solomons Province Cultural Centre in Kieta. Survey was first carried out along the east coast beginning at Malasang, moving northward as far as Kessa Plantation. A vehicle provided by the Cultural Centre, and Mr Temoana's familiarity with Buka, made it possible to cover a large area during this period. All major settlements along the densely populated coast were visited and inquiries made as to the location of potential archaeological sites, particularly caves and rockshelters, known to the local inhabitants. Although many caves were visited as a result of these inquiries, the majority did not contain adequate deposits for excavation. Most other sites were located in the vicinity of existing villages or noted en route to other locations with local guides.

It is not an exaggeration to characterise the coastal portion of Buka along the raised limestone formation as a nearly continuous series of archaeological site complexes with similarities to the present settlement pattern. All locations visited in this area contained surface scatters of Recent and/or Mararing style potsherds often accompanied

Site Code	Place/Name	Site Type	Environment	Site Area (m²)	Shell Midden Density	Pottery Density
DJB	Malasang/Palandraku (upper)	cave/sinkhole	top of limestone cliff	50?	M-H	L
DJC	Malasang/Saro	cave	base of cliff	15	M	M
DJD	Malasang/Gonene	open with upright stone	top of bench (25-30 m asl)	600	L	M
DJE	Malasang/Saro 2	cave	base of cliff (50 m n. of DJC)	60	L	VL
DJF	Lonahan/Mamaho club	open	edge of cliff	150	-	L
DJG	Lonahan/Busu	cave	low bench	88	M	M-H
DJH	Suhin/Tumpal	shelter/cave	high bench	100	VL	VL
DJI	Hahalis	open	interior	?	-	L
DJJ	Hanahan Village	open	edge of cliff	500	M	H
DJK	Hanahan/Taliatong	cave complex	low bench	75	L-M	VL
DJL	Tohatsi/Takoruna	open	edge of cliff	900	M	H
DJM	Lontis/Gogonuna	open	beach	2400	M	M
DJN	Lontis/Tama River	spring	top of cliff	450?	-	VL
DJP	Malasang/Reki	large cave	interior	?	-	VL
DJR	Malasang/Mararing	open	interior	3000?	L	L
DJS	Lontis/Opaha	open with stone pillars	beach	?	H	H
DJT	Hetau Island village	open	beach	?	M	M
DJV	Pororan Island/Keketin	open	edge of cliff	5000	H	H
DJX	Pororan Island/Hanou (north)	open	edge of cliff	2400	VL	M
DJY	Hanou (south)	open	edge of cliff	1000	VL	L
DJZ	Pororan Island/Koekoe	open	base of cliff	2500	VL	L
DKA	Buka Passage/Kubu	open	low bench	200?	L	L
DKB	Buka Passage/Kubu	shelter	low bench	30	VL	VL
DKD	Sohano Island	shelter	base of cliff	36	VL	VL
Reef Sites						
DAA	Sohano Island/hospital	beach/reef flat	beach/intertidal	25,300	-	L-M
DAF	Sohano Island/west coast	beach/reef flat	beach/intertidal	39,816	-	M-H
DJQ	Kessa Plantation	reef flat	intertidal	10,020	-	L
DES	Nissan Island/Tarmon	reef flat	intertidal	5110	-	L-M

Table 3.1 Attributes of surface collected sites. (Code: VL - Very Low; L - Low; M - Medium; H - High)

by marine shell midden. Assigning separate site codes to concentrations of surface finds tends to emphasise the discreteness of these units and mask the overall continuity in settlement along the coast. Specht (n.d.:29) noted that separating artefact scatters into sites within the Malasang village area was somewhat arbitrary given the nearly continuous distribution of material on the surface. Terrell (1976:237) also indicated that prehistoric settlement at the southern end of the Sohano limestone formation was nearly continuous along the coast. He characterised the coastal Silao region of northern Bougainville which he surveyed as 'one long archaeological site' where it was difficult to determine boundaries between individual concentrations.

In addition to locating previously unrecorded sites, sites recorded by Specht with excavation potential were inspected at Malasang (DBE), Gogohei (DCQ), Hanahan (DBB) and Kessa (DCW). Following initial survey, a base of operations was set up at Kessa Plantation (Fig. 3.1) where a promising beach midden deposit had been located. During subsequent excavation at this site (DJO), an artefact scatter with Lapita pottery on the reef flat adjacent to the Kessa wharf was discovered (DJQ). Using Kessa as a base, intensive survey of the offshore islands of Hetau (Fig. 3.1) and Pororan (Fig. 3.18) was carried out and seven sites recorded. Limited excavation of two sites on Pororan Island followed. Investigations focused on the Kessa area in order to determine whether Specht's sequence from the Buka Passage area extended to the northern portion of the island. This area was also selected as having a high potential for Lapita sites, which are often located on small offshore islands or in the vicinity of reef passages.

The base of field operations was relocated from Kessa to Kubu in the vicinity of Buka Passage during the final phase of fieldwork in order to investigate the potential for sites with occupation prior to the late Lapita period. Attention was initially directed towards the Malasang area (Fig. 3.5) which Specht had surveyed intensively. In addition to limited survey of the interior portion of Malasang valley, excavations were carried out at the Palandraku Cave site (DBE) where Specht had begun excavation in 1967, and the nearby Kilu Cave site (DJA).

Intensive survey of Sohano Island (Fig. 3.13), where Specht had documented late Lapita occupation, resulted in the location of two reef sites with lithic artefacts and

Site	Area	Buka	Sohano	Hangan	Late Hangan	Malasang	Malasang/ Mararing	Mararing	Recent
DAA	reef	M(22)	L(1)	-	L(3)	-	L(2)	M	M
	beach	L(9)	L(1)	-	M(26)	L(4)	-	M	M
DAF	1-12	H	M	-	-	-	-	M	M
DBE		-	-	-	-	-	L(1)	L	H
DJA	1/2	-	-	-	-	-	-	L	L
DJB		-	-	-	-	-	-	-	L
DJC		-	-	-	-	-	-	M	-
DJE		-	-	-	-	-	-	-	L
DJF		-	-	-	-	-	-	L	M
DJG		-	-	-	-	-	-	M	M
DJH	1/2	-	-	-	-	-	-	L	L
DJI		-	-	-	-	-	-	-	M
DJJ	1/2	-	-	-	-	-	-	-	H
DJK		-	-	-	-	-	L(1)?	M	M
DJL	1/2	-	-	-	-	L	-	M	H
DJM		-	-	-	-	L(3)	-	-	M
DJN		-	-	-	-	L(1)	-	L	L
DJO	A-F	-	-	L(15)	M(38)	H(59)	L(2)	L(2)	-
DJP		-	-	-	-	-	-	-	L
DJQ	reef	M	-	-	L(2)	L(3)	-	L(7)	L(15)
DJR		-	-	-	-	-	-	M	M
DJS		-	-	-	L(1)	-	L?	H	H
DJT		-	-	-	-	-	-	L	H
DJU	1-6	-	L(2) late	M	M	L	L	H	H
DJV		-	-	-	L(1)	L(1)	-	H	H
DJW		-	H	H	-	-	L	H	M
DJX		-	-	H(61)	-	-	-	L	L
DJY		-	-	L(8)	-	-	-	M	M
DJZ		-	-	L(4)	L(2)	M(32)	L(6)	L	L
DKA		-	-	-	-	-	L(3)	L	L
DKB		-	-	-	-	-	L(3)	L	L
DKC		L(1)	L(12)	-	-	-	-	L	L
DKD		L(4)	L(7)	-	-	-	-	L	-
Site total		5	6	6	7	9	10	26	29
% of sites		16	19	19	25	28	31	81	91

Table 3.2 Pottery styles from surface collected sites. (Code: L - low density; M - medium density; H - high density; ( ) - number of sherds collected)

Lapita pottery associated with beach sites recorded by Specht. A rockshelter and open site at the base of the central raised limestone formation on Sohano were also recorded. Following completion of excavations at Malasang, additional collection of material from the reef sites on Sohano and limited testing of the nearby beach and rockshelter deposits were carried out.

Structural remains

Stone uprights were the only architectural remains recorded during survey. A single unmodified upright waterworn volcanic rock was found within the abandoned hamlet of Gonene at the edge of the limestone cliff within Malasang village (Site DJD) (Fig. 3.5). The stone is referred to as *piahalata* by the local inhabitants and was formerly given food offerings. The only other uprights recorded were a group of two volcanic rock pillars and a third broken pillar shaped by pecking that are referred to collectively as *mabesi*. They are located at the edge of Opaha hamlet in the village of Lontis (Site DJS) and were described in the 1970s by J. Womersly, a National Museum trustee. The upright pillars, which now extend approximately 2 m above the ground surface, are said to represent a male and female and the smaller pillar is their offspring. The male pillar has faint linear incisions at the upper end including pairs of vertical parallel lines and diamonds near the tip of the pillar which are said to represent scarification marks used to distinguish kinship groups. The female pillar has a narrow horizontal band near the upper end formed by pecking away the surrounding rock. Similar carved stone uprights have been reported from Saposa Island to the south of Buka by Specht (1975a).

THE REEF SITES

The principal evidence for Lapita occupation was not obtained through site excavation, but rather from scatters of pottery and lithic artefacts found on intertidal reef flats in three locations. Apart from shells that had obviously been dumped recently with refuse from nearby settlements, no shell midden or artefacts were observed in locations where pottery was collected from the reef flats. The absence of shell material, either artefactual or food debris, is attributed to the fact that shell disintegrates much more rapidly than ceramics or lithics in such environments.

Two of the reef sites (DAA and DAF) (Fig. 3.13) are extensions of sites previously recorded by Specht in 1967 on Sohano Island; a description of excavations at the beach component of DAF is presented in a later section of this chapter. The third reef site (DJQ) is located at Kessa Plantation (Fig. 3.1) on the northwest coast of Buka. As Lapita ceramics from the DES reef site on Nissan Island recorded by Spriggs (1991a) were analysed along with the Buka sites, a description of this site is also provided.

Descriptions of the reef sites are presented below, beginning with the Sohano Island sites and followed by Sites DJQ at Kessa and DES on Nissan. Although the distribution of both Lapita and post-Lapita ceramics and lithic artefacts is discussed here, the results of Lapita ceramic analysis are found in Chapters 4 and 5.

Site DAA

As estimated by Specht (1969:37), Site DAA covered an area of approximately 25,000 m^2 extending 250 m south from the base of the limestone cliff where his excavation trenches were located and 100 m west from the shoreline within the hospital grounds at the south end of the island. Although all pottery styles except Hangan were present in the DAA excavations, Specht does not indicate which styles were found on the surface.

During my inspection of Site DAA, 22 sherds of Buka style pottery and seven pieces of obsidian were collected along the beach and inner portion of the reef flat fronting the hospital grounds, designated Area 2 (Fig. 3.2). A small number of Sohano, late Hangan and Malasang style sherds, and more abundant amounts of Mararing and Recent style pottery, were collected in the vicinity of Specht's test excavations along with a single piece of obsidian (see Table 3.2 for sherd frequencies). These pottery styles were also represented on the beach and inner reef flat in similar quantities. Sherds on the reef were concentrated in small discrete piles in the same locations that recent trash was being dumped. This pattern suggests that the sherds had been swept up with refuse from the hospital grounds and discarded on the reef.

Late Lapita ceramics were also found along the beach and broad sandy intertidal reef flat south of Specht's original boundary for Site DAA, which was designated Area 1. Both the beach and inner reef flat are covered with mangroves in this area and a majority of the sherds were small fragments brought to the surface by crab burrowing. Sherds located seaward of the mangroves were larger and associated with volcanic oven stones and stone artefacts including numerous abraders, a few grindstone fragments and a single adze. A majority of the stone artefacts were found in a restricted area indicated in Figure 3.2. Four pieces of obsidian were collected from the inner reef flat in Area 1 but none were found on the outer reef flat. Sherd and obsidian frequencies for Site DAA are presented in Table 3.3.

A small sample of 31 Lapita sherds was collected from Site DAA and no formal ceramic analysis of this material was carried out. Only three of these sherds were decorated; two with linear incision and one with a single applied relief strip. Although a larger sample could have been obtained, the quantity of material was much lower than at DAF and would have required a significantly greater amount of time to collect.

Site DAF

Site DAF, originally designated B.P.6 by Specht, is located on the west coast of Sohano Island in the vicinity of the commercial wharf where the ferry from Buka docks (Fig. 3.13). Specht (1969:324) described the site as a midden strewn with shells and sherds which had been much disturbed by construction of the District Office for the Australian administration and a nearby War Memorial park. Although Specht notes that pottery of all styles was present on the surface, it is unclear

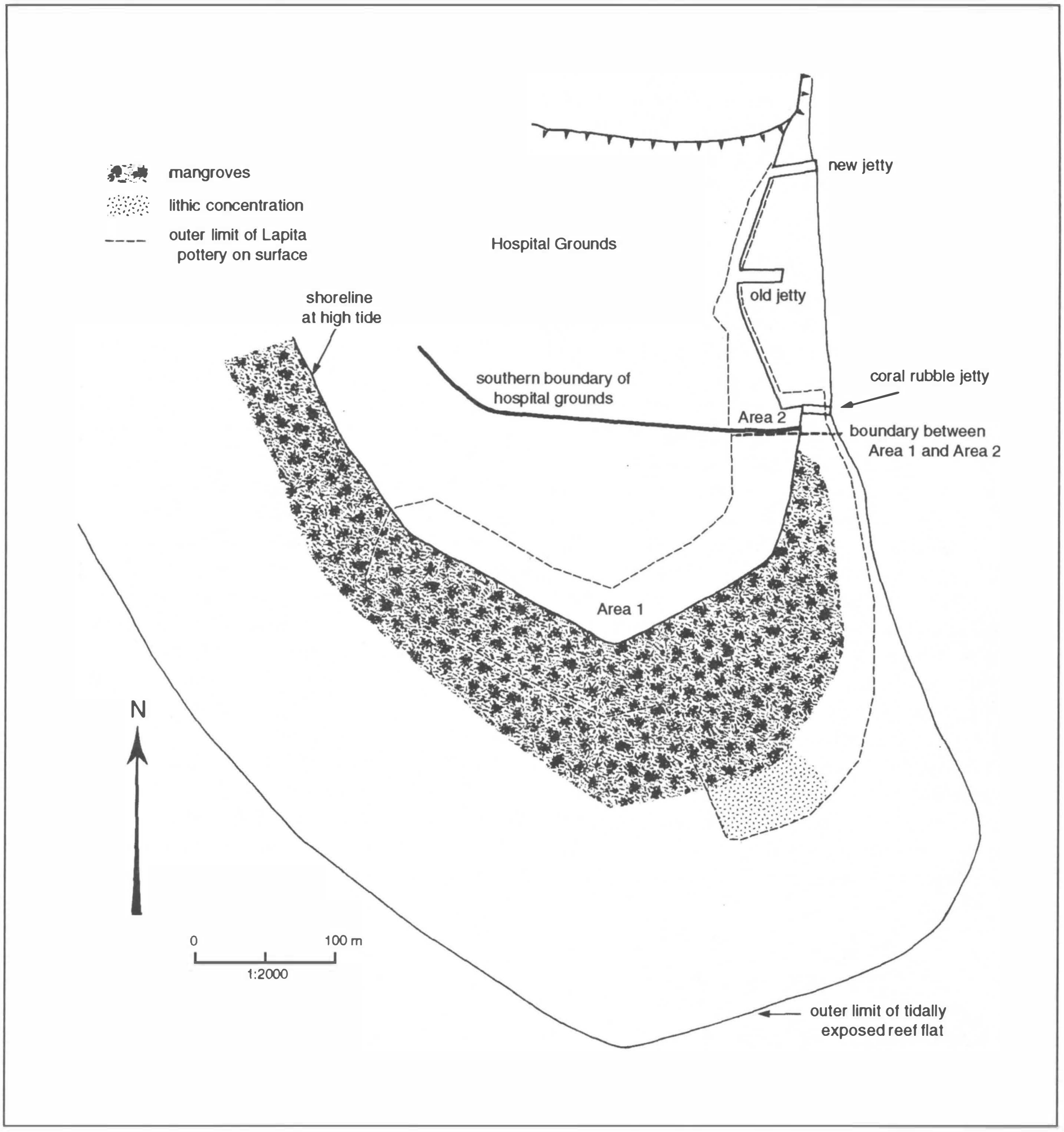


Figure 3.2 Site DAA (Sohano Island): Plan.

whether Hangan style sherds were actually found. Permission to excavate was sought by Specht from the Australian administration but was denied.

The DAF site area, which was originally estimated to be about 75 m by 100 m by Specht, was found to extend approximately 400 m from north to south along the shoreline and cover 39,816 m^2, including 20,830 m^2 of intertidal reef flat and 18,986 m^2 of beach based on the distribution of surface pottery (Fig. 3.3 and Plate 3.1). The site was divided into twelve collection areas: two on the outer reef (Areas 5 and 6), three on the central reef (Areas 1-3), two on the inner reef (Areas 4 and 7) and four on the beach (Areas 9-12). Area 8 extended from the inner reef to the outer reef. A majority of the diagnostic Lapita pottery from this area was found on the outer reef and is most similar to that from outer reef Areas 5 and 6.

The inland extent of surface pottery on the beach portion of the site ranges from about 25 m at Area 12 to 15 m at Area 10 and the northern portion of Area 11 and 80 m for the southern portion of Area 11. The southern portion of Area 11 is low-lying and partially inundated at high tide. Dense mangroves cover the beach and inner reef in this part of the site and extend around the southern end of the island to Site DAA. The width of the reef flat portion of the site ranges from 15 to 30 m north of the wharf to over 150 m at the southern end.

Beach and inner reef pottery distribution

On the beach portion of DAF only a small sample of Lapita sherds was collected from the surface of Areas 11 and 12 due to the low density and small size of the sherds coupled with poor surface visibility in Area 12. A single 1 m^2 test pit (TP 1) was excavated within the War

Location	Area (m^2)	Pottery Sherds			Obsidian		
		Total	%	Density (n/m^2)	Weight (g)	%	Density ($g/100m^2$)
Site DAF							
Outer reef (Areas 5, 6)	357	1194	3.05	3.3	-	-	-
Central reef (Areas 1-3)	19,005	33,662	86.03	1.8	21.61	2.60	0.11
Inner reef and beach (Areas 4, 7-12)	20,454	4271	10.92	-	809.08	97.40	3.96
Area 1	12,600	1706	4.36	0.1	6.65	0.80	0.05
Area 2	400	24,319	62.15	60.8	-	-	-
Area 3	6005	7637	19.52	1.3	14.96	1.80	0.25
Area 4	370	524	1.34	1.4	86.16	10.37	23.29
Area 5	182	340	0.87	1.9	-	-	-
Area 6	175	854	2.18	4.9	-	-	-
Area 7	800	2107	5.39	2.6	136.03	16.38	17.00
Area 8	298	1044	2.67	3.5	351.59	42.33	117.98
Area 9	475	231	0.59	0.5	109.65	13.20	23.08
Area 10	306	343	0.88	1.1	90.00	10.83	29.41
Area 11	8400	19	0.05	-	-	-	-
Area 12	9805	3	0.01	-	35.65	4.29	0.36
Site DAA							
Area 1	2576	22	71.00	-	4.99	27.96	1.09
Area 2	14,800	9	29.00	-	12.86	72.04	0.49

Table 3.3 Lapita pottery and obsidian frequencies and density, Reef Sites DAF and DAA.

Plate 3.1 General view of the reef at Site DAF from north of Area 8 looking south.

Memorial park in Area 12 to determine the nature of the site deposit and attempt to date Lapita occupation. Area 9 is a narrow sloping beach with Lapita and Sohano style sherds actively eroding from the Area 12 site deposit. Area 10 had a high density of small Lapita sherds brought to the surface by crab burrowing. The pottery in Area 4 had apparently eroded on to the reef from the Area 10 beach deposit. Both Area 10 and Area 4 were intensively collected in order to provide an adequate sample of sherds for analysis from the beach and inner reef portion of the site.

As shown in Tables 3.3 and 3.4, the greatest abundance of Lapita pottery from the inner reef portion of DAF occurs at Area 7 (2.6 sherds/m^2) and the inner portion of Area 8 where sherds were actively eroding on to the reef from the beach deposit. The inner reef represents a gap in occupational evidence between the beach and central/outer reef with very few sherds found south of Area 7,

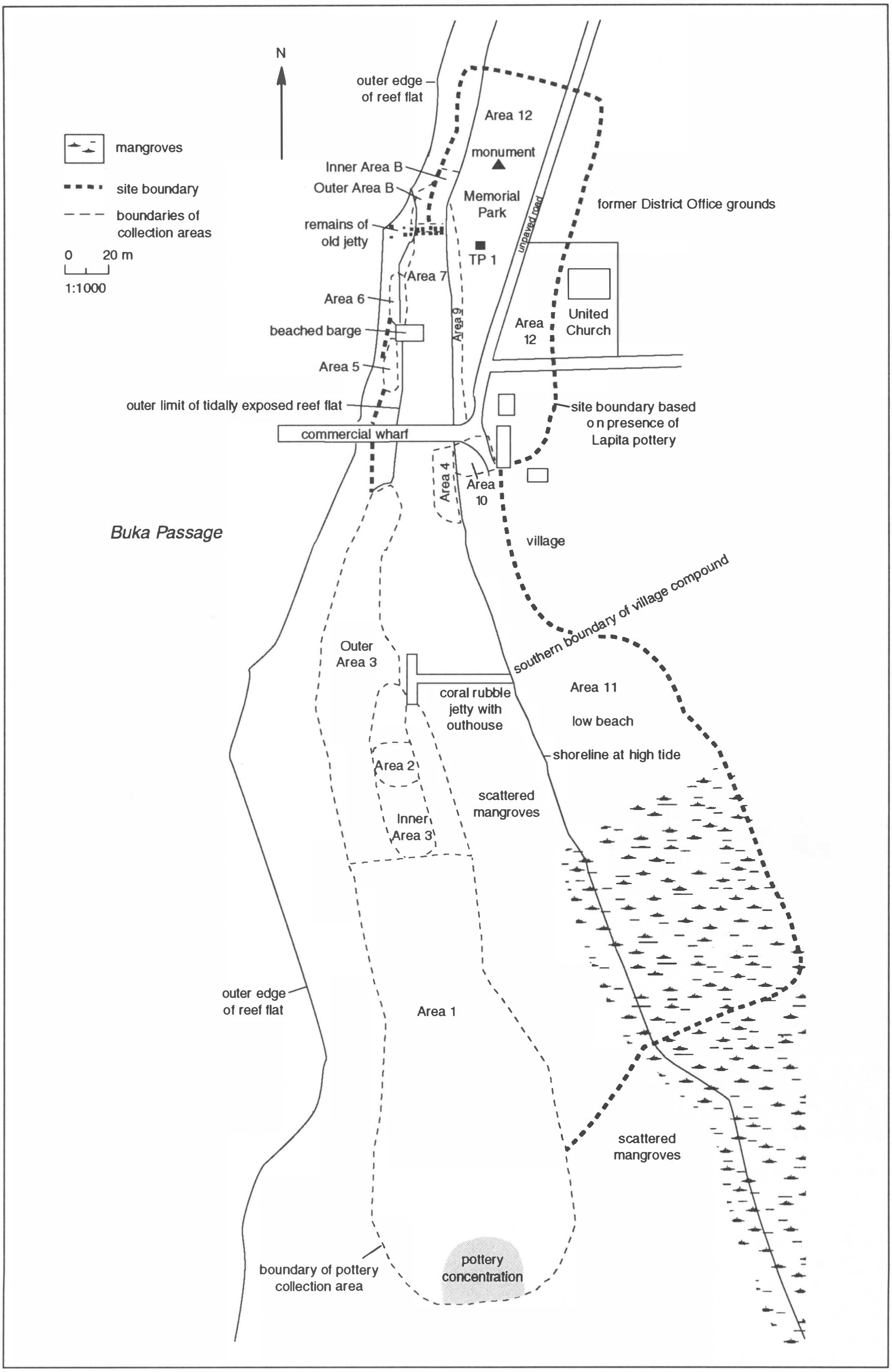


Figure 3.3 Site DAF (Sohano Island): Plan, with location of TP 1 excavation.

apart from Area 4. This gap may indicate a spatial separation of beach settlement from habitation on the outer and central reef in stilt dwellings. Unlike the surface of the outer and central reef which is largely sand covered, the inner reef has patches of sand alternating with exposed reef limestone.

Central and outer reef pottery distribution

The collection areas on the central and outer reef represent spatially discrete concentrations of Lapita ceramics, lithic artefacts and volcanic oven stones suggestive of disposal patterns from stilt dwellings. Sherds from the outer reef are significantly larger and less eroded than those found on the beach and inner reef which suggests more limited impact by storm waves or other sources of disturbance such as trampling that would have occurred on land. The distribution of pottery in Areas 5, 6 and the outer portion of Area 8 is particularly suggestive of stilt house settlement as pottery concentrations are spatially discrete and extend seaward of the outer limit of tidally exposed reef to within several metres of a vertical drop-off into Buka Passage. Considering their present location at the outer margin of the reef, it seems unlikely that the cultural remains in these areas were once part of a beach deposit eroded by storm waves/*tsunami* or drowned as a result of geologic subsidence.

In contrast to the northern outer reef areas, pottery on the southern portion of the reef (Areas 1, 2 and 3) does not extend beyond the central reef which is completely covered with sand in most areas and wholly exposed at low tide. Over 60% of the total Lapita ceramic sample from DAF was collected in Area 2, which is 400 m^2 in area with a sherd density of nearly 61 sherds/m^2. A zone of less concentrated pottery designated as the inner portion of Area 3 extended north and south of Area 2. The outer portion of Area 3 had a much more diffuse scatter of sherds with no discrete concentrations. Area 1 had a low pottery density similar to the outer portion of Area 3 although a relatively dense concentration of sherds was located at its southern end. Pottery collection in Area 1 was non-intensive as the primary objective was to define the outer limits of the site rather than maximise the ceramic sample. In all of the other reef collection areas, with the exception of the outer portion of Area 3, all visible artefacts were collected. An unknown quantity of sherds remained buried in the sand which appeared to be shallow in the north but substantially deeper in the southern half of the site.

Post-Lapita ceramics

In addition to Lapita style pottery, Sohano, Mararing and Recent style sherds were found at DAF. The distribution of these styles by collection area is found in Table 3.5, except for Areas 1, 3, 11 and 12 where sherd frequencies were not calculated. In contrast to Specht's observations, no Hangan or Malasang style ceramics were noted on the beach or reef. Thus there is a substantial hiatus in occupational evidence of at least 1000 years at the site between the Sohano and Mararing phases. The actual number of Mararing and Recent style sherds was only recorded for Areas 4 and 6. These styles were common only on the beach and inner margin of the reef with frequencies comparable to those at Areas 4 and 6. The low quantities and dispersed distribution of this pottery suggests that it was deposited with refuse from habitation areas on the beach.

A total of 352 diagnostic Sohano style sherds was collected from the reef at DAF and frequencies by collection are presented in Table 3.5. There is no clear pattern to the distribution of Sohano style pottery although the highest densities occur in Areas 6 to 8 at the northern end of the reef. Nearly all of the decorated Sohano style sherds have single rows of punctate impressions on or slightly below the lip (n=299; 89.8%) and the remainder have incised or applied relief designs (n=34). Punctation is concentrated on rim lips (n=265) classified by Specht as Lip Motif 2 (LM2) as opposed to below the lip (n=34), Specht's Motif 3 (M3). According to Specht, lip punctation is a later development within the Sohano style which suggests that a majority of the Sohano ceramics at DAF are not from the earliest Sohano substyle. This is supported by the presence of sherds

Site Area	Diagnostic Sherds			Total Diagnostic	Plain Body Sherds		Total Plain	Total Sherds
	Decorated	% of Total	Plain		Large > 2 cm	Small < 2 cm		
1	183	10.73	83	266	-	-	ca. 1440	ca. 1706
2	2462	10.12	1253	3715	-	-	ca. 20,604	ca. 24,319
3	345	4.52	22	367	-	-	ca. 7270	ca. 7637
4	159	30.34	50	209	-	-	315	524
5	107	31.47	33	140	-	-	200	340
6	351	41.10	80	431	258	165	423	854
7	115	5.46	58	173	134	1800	1934	2107
8	191	18.30	85	276	220	548	768	1044
9	9	3.90	6	15	-	-	216	231
10	15	4.37	14	29	-	-	314	343
11	8	-	11	19	-	-	-	19
12	3	-	-	3	-	-	-	3
TP1	66	6.52	45	111	153	748	901	1012
Total	4014	10.00	1740	5754	765	3261	34,385	40,139

Table 3.4 Lapita pottery frequencies by collection area, Reef Site DAF.

Site/Area	Sohano Punctate Decoration		Sohano Incised/Relief	Sohano Plain Rims	Sohano Mica Temper	Sohano Total	Mararing	Recent
	Below Lip (M3)	Lip (LM2)						
DAF								
Area 2	-	18	1	-	-	19	+	+
Area 4	7	45	5	5	7	62	6	20
Area 5	5	5	2	-	-	12	+	+
Area 6	9	48	10	2	-	69	3	10
Area 7	3	49	8	5	3	65	+	+
Area 8	5	57	2	7	-	71	+	+
Area 9	4	34	4	-	5	42	+	+
Area 10	1	9	2	-	2	12	+	+
Total	34	265	34	19	17	352	-	-
			Sohano		Late Hangan	Malasang	Mararing	Recent
DJQ			-		2	3	7	15
DES			2		2	+	+	+

Table 3.5 Distribution of diagnostic post-Lapita ceramics, Reef Sites DAF, DJQ and DES. (Code: + style present but not quantified)

with mica temper, which was also introduced later in the Sohano style. Sohano style pottery from the test unit excavated at DAF also exhibits similar attributes. A full discussion of post-Lapita ceramics is presented in Chapter 6.

Occupation of DAF during the Sohano phase appears to have been restricted to what was at that time the beach. This presently includes the inner portion of the reef where the former beach deposit has eroded. The presence of Sohano style sherds on the central and outer reef is more difficult to interpret. The lack of spatially discrete concentrations of sherds such as those which characterise the distribution of Lapita ceramics argues against habitation on the reef itself. Based on stylistic and compositional attributes of Sohano style pottery on the reef, it is also likely that there was a hiatus in occupation between the late Lapita phase and Sohano phase.

Non-ceramic evidence

Non-ceramic cultural remains from Site DAF consist of volcanic cooking stones and lithic artefacts. The stone artefacts include 53 abraders, 78 grindstones, 12 adzes and flaked obsidian weighing 831 g. Over 93% of the abraders, 73% of the grindstones and 83% of the adzes were collected from Areas 1-3. The remaining abraders and grindstones were scattered among the other reef areas but none were found on the beach. Two adzes were collected from the beach but these were not clearly associated with Lapita ceramics.

A majority of the obsidian collected at DAF originates from the beach deposit which was actively eroding onto the inner reef at the time the field investigations were conducted, in contrast to the other stone artefacts which were concentrated in the central reef area south of the wharf. Of the 336 pieces of obsidian collected from the surface of DAF, 89 (26.5%) were found on the beach and 240 (71.4%) on the inner reef, including the inner portion of Area 8. The remaining seven pieces were collected from Areas 1 and 3 on the central reef. By far the highest density of obsidian by weight occurred on the inner reef portion of Area 8, as indicated in Table 3.3. In addition to small unretouched obsidian flakes, single obsidian blades were collected from Areas 9 and 10 on the beach and two blades from Area 4 on the reef. An incomplete triangular obsidian point collected from Area 4 closely resembles points manufactured on Lou Island in the Admiralties dating to about 2100 BP (Ambrose 1988, 1991). Nearly all of the obsidian from DAF sourced by the density technique originated in the Admiralties.

Site DJQ, Kessa Plantation, Buka Island

Site DJQ is located along the northwest coast of Buka at the southern tip of Cape Dunganon, a large sand spit forming the northern boundary of Queen Carola Harbour, in the vicinity of a canoe passage through the barrier reef that extends along the west coast of Buka (Fig. 3.1). The site consists of a scatter of pottery, lithic artefacts and volcanic oven stones located on an intertidal reef flat in the vicinity of the plantation manager's house and Site DJO at Kessa Plantation (Plate 3.2). Lapita pottery was found scattered over an area of approximately 10,020 m^2 on the central portion of the reef flat extending about 300 m west from the Kessa wharf in a zone ranging from 20 to 60 m in width (Fig. 3.4). The width of the reef flat ranges from 100 m at the wharf to 200 m at the western end of the site and fronts a narrow beach. Most areas of the reef flat are covered with scattered patches of shallow sand although the west end of the site has continuous sand cover. Scattered mangroves are found along the inner portion of the reef west of the wharf and dense mangroves cover the shoreline east of the wharf.

Once the general boundaries of the site were established, intensive collection of ceramics and other artefacts was carried out along transects perpendicular to the shoreline at 5 m intervals beginning at the east end of the site. The distribution of Lapita ceramics and obsidian are found in Tables 3.6 and 3.7. Material collected from the 64 site transects was grouped into units of variable size depending on the density of artefacts in each. As indicated in Table 3.6, 56.6% (n=561) of the

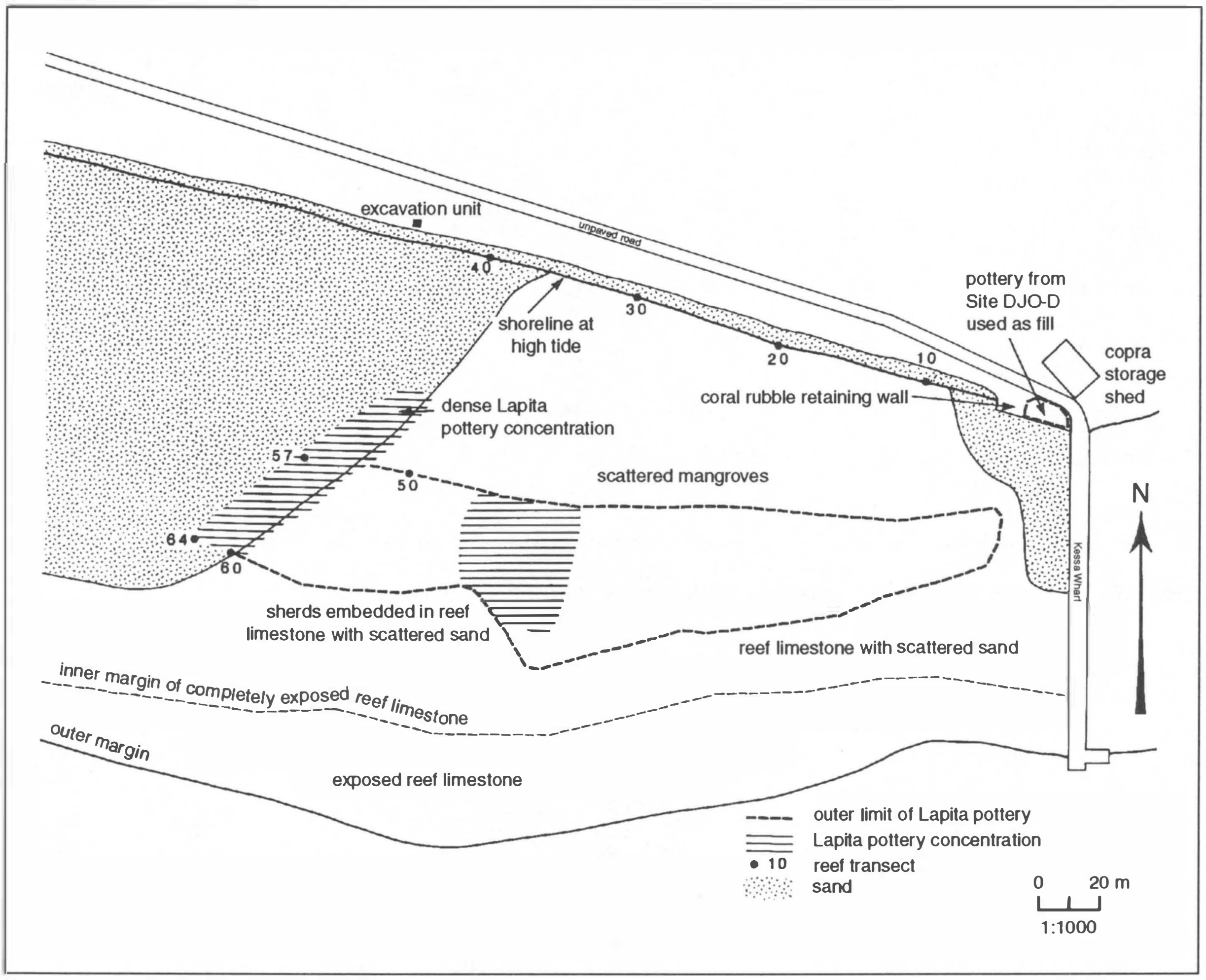


Figure 3.4 Site DJQ (Kessa Plantation): Plan.

Plate 3.2 General view of the reef flat at DJQ looking east from the west end of the site.

Location	Area (m²)	Pottery			Obsidian		
		Total	%	Density (n/m²)	Weight (g)	%	Density (g/100m²)
Site DJQ							
Total reef (Tr.1-64)	10,020	991	-	0.1	18.69	-	0.19
Tr. 1-10	880	39	3.93	0.1	-	-	-
Tr. 11-20	1500	55	5.54	0.0	1.10	5.89	0.07
Tr. 21-30	2200	32	3.23	0.0	-	-	-
Tr. 31-42	1680	147	14.82	0.1	10.02	53.61	0.60
Tr. 43-50	960	67	6.75	0.1	2.04	10.91	0.21
Tr. 51-64 (Lapita concentration)	2800	560	56.55	0.2	5.53	29.59	0.20
General collection	-	91	9.18				
Site DES					Total (n)		Density (n/100m²)
Total site	5110	1632	-	0.3	14	-	0.27

Table 3.6 Lapita pottery and obsidian frequencies and density, Reef Sites DJQ and DES.

Location Code	Location	Diagnostic Sherds			Total Diagnostic Sherds	Total Plain Body Sherds	Total Sherds
		Decoration	% of Total	Plain			
1	general collection	34	37.36	13	47	44	91
3	Tr. 1-7	9	32.14	2	11	17	28
4	Tr. 8-10	3	27.27	1	4	7	11
5	Tr. 11-16	5	16.67	3	8	22	30
6	Tr. 17-20	3	12.00	9	12	13	25
7	Tr. 21-30	14	43.75	5	19	13	32
8	Tr. 31-36	20	43.48	6	26	20	46
9	Tr. 37-38	7	17.95	6	13	26	39
10	Tr. 39-42	9	31.03	3	12	17	29
11	Tr. 39-44 (N)	8	24.24	4	12	21	33
12	Tr. 43-52 (misc.)	8	72.73	3	11	-	11
13	Tr. 43-50	14	25.00	6	20	36	56
14	Tr. 51-54 (S)	16	51.61	5	21	10	31
15	Tr. 55-56 (S)	29	46.03	7	36	27	63
16	Tr. 57-58 (S)	23	44.23	2	25	27	52
17	Tr. 59-60	11	47.83	6	17	6	23
18	Tr. 61-64	13	65.00	-	13	7	20
2	Tr.53-64 (Lapita concentration)	108	29.11	25	133	238	371
Total		334	33.70	106	440	551	991

Table 3.7 Lapita pottery frequencies by transect, Reef Site DJQ. (Code: N - north; S - south)

Lapita ceramics were collected from a 2800 m² area between Transect 51 and Transect 64 at the west end of the site. A minor concentration of Lapita pottery was defined between Transect 31 and Transect 42 (Figure 3.4). Lapita sherds were found cemented into the reef limestone in the seaward portions of the areas with concentrations of Lapita ceramics.

Due to the presence of a few waterworn Lapita sherds along the inner reef, a 2 m² test unit was excavated into the narrow beach at Transect 45 to check for a possible Lapita cultural deposit. The unit was excavated in unconsolidated calcareous sand to the water table at 80 cm below surface at which point collapse of the side walls prevented further excavation. No cultural remains other than recent trash, which extended nearly to the base of excavation, and a single waterworn plain Lapita sherd were recovered. It was concluded that the sherd from the test unit and sherds collected from the inner reef had most likely been displaced from the central reef.

The density of Lapita ceramics at DJQ, even in the main pottery concentration, was much lower than at Site DAF. Pottery outside of the two concentrations was thinly scattered over the reef suggesting limited utilisation of these areas prehistorically. Moderate quantities of volcanic oven stones were associated with the ceramics in all areas of the site. The distributional pattern of ceramics is strikingly similar to the southern portion of Site DAF where sherds were found in several dense clusters surrounded by more dispersed pottery on the central portion of the intertidal reef flat. As with DAF, the distribution of cultural material on the DJQ reef is suggestive of stilt village settlement although erosion of a former beach site cannot be ruled out. The shoreline appeared to be fairly stable with no active erosion of beach deposits and advancing mangrove growth on the inner reef. The presence of sherds cemented into the central and outer reef platform also argues against recent erosion of a beach deposit in this area.

Post-Lapita ceramics

A low amount of Hangan (n=2), Malasang (n=3), Mararing (n=7) and Recent (n=15) style pottery was found scattered over the reef flat at DJQ (Table 3.5). No concentrations of any of these styles were evident although the eastern half of the site near the wharf had the highest density of ceramics. These sherds were probably deposited on the reef as a result of refuse dumping from Site DJO combined with the breakage of occasional vessels during the loading and unloading of canoes beached on the reef flat and beach. Each of these styles were easily distinguished from the Lapita ceramics on the basis of mineral sand as opposed to calcareous sand temper as well as decoration and vessel form. The presence of Mararing and Recent style sherds is notable in that these styles are not represented at Site DJO.

Non-ceramic evidence

The range of lithic artefacts at DJQ is similar to DAF although much lower quantities were collected. Ground stone artefacts, all found west of Transect 40, include a single abrader, three grindstone fragments and four adzes. Only one of the 11 flakes of obsidian found was collected east of Transect 30 and all of the obsidian positively sourced by the density technique is from the Admiralties (Lou). The stone artefacts are almost certainly associated with the Lapita ceramics as indicated by their spatial distribution, and the lack of similar types of ground stone tools and minimal amounts of obsidian found in sites from the late Hangan to Recent phases.

Site DES, Tarmon, Nissan Island

This site consists of a scatter of ceramics, lithic artefacts and volcanic cooking stones on an intertidal reef flat located at the southernmost reef passage into the inner lagoon on the atoll of Nissan. The site was recorded by Spriggs (1991a) during archaeological investigations on Nissan and Pinipir Islands, located 64 km north of Buka. An intensive surface collection of artefacts covering an area of 73 m by 70 m on the reef adjacent to the shoreline was carried out by Spriggs and the author. No spatially discrete artefact concentrations were noted within the reef site area. The density of Lapita ceramics at DES was slightly higher than the area of highest sherd density at the western end of Site DJQ (Table 3.6).

Spriggs (1991a:235) interprets DES as probably representing settlement on a former sand spit which would have provided control of the reef passage during Lapita occupation. The location is still recognised as a traditional landing point for trading canoes from Buka. The beach appears to have eroded, prograded and eroded again since initial occupation. A 1 m^2 test pit located on the beach adjacent to the site had no evidence of a cultural deposit.

Post-Lapita ceramic styles imported from Buka found on the reef at DES include two Sohano style rims, three late Hangan style body sherds, a few Malasang style sherds and numerous Mararing and Recent style sherds. This is the only record of Sohano style pottery from Nissan and may date to a period during which both late Lapita and Sohano style pottery were in use. The Malasang to Recent style pottery on the reef is likely to have eroded from a former beach deposit as indicated by their relative abundance on both reef and beach portions of the site.

Ground stone artefacts found with Lapita ceramics include small adzes with oval cross-sections, several axe fragments, abraders and grindstone fragments. Much of this material is nearly identical typologically to that found at the DAF and DJQ sites which strengthens its association with the Lapita ceramics. The axe fragments are an exception as they resemble artefacts in use during the past century. The 14 flakes of obsidian found at DES have been sourced to the Admiralties.

THE ARCHAEOLOGICAL EXCAVATIONS

As discussed in the research design for this study, excavations had a dual purpose which stressed the location of:

1. cave and rockshelter sites with a high potential for deep, well-stratified deposits that could document preceramic occupation; and
2. coastal ceramic-bearing deposits representing a limited period of use to better understand relationships between sequential pottery styles.

Sites located within the Lonahan land system in areas of raised Sohano limestone were found to have limited potential for excavation due to the relative shallowness of the clay soils and paucity of cultural material. Limited shovel tests at several localities revealed a generalised soil profile characterised by a thin (ca. 10 cm) dark brown humus layer overlying very dense, sticky yellow clay up to 80 cm thick resting on limestone bedrock. Cultural material was confined to the upper humus layer and consisted of Recent and Mararing style pottery sherds mixed with low amounts of shell midden. Specht (1969) made similar observations concerning the low excavation potential of sites within this land system.

The seven sites selected for excavation include four open beach deposits (DAF on Sohano, DJO at Kessa Plantation, and DJU and DJW on Pororan Island) and three cave or rockshelter deposits (DBE and DJA at Malasang and DKC on Sohano). A total area of 16.75 m^2 was excavated representing a volume of 20.1 m^3. Limited testing rather than extensive areal excavation was undertaken in order to maximise the number of sites investigated and sample all phases of the prehistoric sequence. The areal extent of excavation was also limited to allow adequate time for processing the material recovered, especially the abundant molluscan remains.

Multiple component sites with potentially deep deposits were tested in order to determine relationships between the occupation periods represented and date the duration of individual phases. In order to refine and test the ceramic sequence proposed by Specht, four sites (DAF, DKC, DJW and DJO) with temporally consecutive pottery styles found on the surface were tested to determine the nature of relationships between these styles in the deposits. The two cave sites, DJA and DBE, were selected for testing as promising locations for evidence of preceramic occupation. Basic data for the excavated sites is presented in Table 3.8.

Excavation methods

Excavation was by natural stratigraphic layers whenever possible with thicker layers excavated in 10 cm mechanical levels. In practice, natural stratigraphic divisions proved to be difficult to determine during excavation at several of the sites. This was especially true of the coastal midden deposits, which were comprised for the most part of uniform layers of calcareous beach sands. The difficulties in delineating layer divisions within beach deposits in Oceania are well known (e.g. Best 1984:60; Poulsen 1987:10-11; Specht 1969:34-5) and the use of mechanical levels is often necessary in such cases to provide adequate vertical control. At the cave sites, identification of layer divisions was made more difficult by inadequate lighting. Features noted during excavation were isolated and excavated as discrete units. In sites where bedrock was not reached, excavation continued to a significant depth below the basal cultural deposits to insure that culturally sterile matrix had been reached.

Excavation was carried out in 1 m^2 units which were extended horizontally by increments of 1 m to form trenches at five of the seven sites tested. The provenience of all excavated cultural material was recorded by unit, layer and level with three dimensional recording of in situ artefacts. Layers, features and levels were numbered consecutively from the ground surface downward. Layers are designated by roman numerals and levels and features by Arabic numerals. Sublayers are indicated by uppercase letters. Soil colours were recorded using the Munsell system.

All deposits were excavated by trowel and dry-screened through 1/8" (3.2 mm) wire mesh. Larger faunal remains and artefacts were removed from the screens at this time and the remaining material was wet-screened through 1/8" mesh. Wet-screening was not necessary at DKC where the fine sandy matrix was easily dry-screened. Wet-screening was done in the shallow tidal zone where wave action was minimal. All material remaining in the screens following wet-screening was bulk bagged by excavation level and transported to a field laboratory for analysis. Sorting in a controlled environment made it possible to closely examine the material and maximised the recovery of small artefacts, faunal remains and charcoal.

Detailed descriptions of excavations at the seven sites tested on Buka, Pororan and Sohano Islands are presented in the following section followed by a discussion of the site chronology. General comments concerning the distribution of artefacts and faunal material within individual sites are made below with more detailed discussions provided in Chapters 7 and 8. Although brief mention of the pottery styles represented within the site deposits is made in this chapter due to their importance in establishing a chronological framework, more detailed descriptions are presented in Chapter 6.

THE MALASANG CAVE SITES

Excavations within the Malasang area were carried out in two cave sites located at the base of the uplifted Sohano limestone formation (Fig. 3.5). The main cliff is ca. 30 m asl, although a lower cliff/bench ca. 15 m asl is found at the mouth of Malasang valley, an uplifted former reef passage which intersects the village of Malasang. The potential for cave sites with deep deposits in this area was noted by Specht who recorded two cave locations (Sites DCU and DBE) and carried out limited excavations at Palandraku Cave (DBE). A sinkhole at the top of the limestone cliff above DBE recorded as Site DJB was identified as part of the DBE cave complex by local inhabitants, but had insufficient sediment accumulation for excavation. Two additional cave complexes were recorded during the site survey. Sites DJC and DJE are part of a single cave complex located between DCU and DBE with minimal excavation potential due to a lack of sediment. In contrast, Kilu Cave at the southern end of Malasang village (DJA) appeared to contain a deposit which was both substantial

Site Code	Location/Name	Site Type	Site Area (m^2)	Excavated Area (m^2)	% of Site Excavated	Excavated Volume (m^3)
DJA	Malasang/Kilu	cave/shelter	490	3.00	0.61	6.03
DBE	Malasang/Palandraku	cave	80	3.00	3.75	3.28
DAF	Sohano Island/ west coast	open/beach	18,986 (beach)	1.00	-	0.62
DKC	Sohano Island/ primary school	cave/shelter	50	1.00	2.00	0.94
DJW	Pororan Island/Kura	open/beach	6000	2.00	0.05	1.80
DJU-3	Pororan Island/ Pororan village	beach ridge	4400	2.00	0.05	2.06
DJO-A	Kessa Plantation	beach mound	946	0.75	0.08	0.93
DJO-D	Kessa Plantation	beach ridge	9250	4.00	0.04	4.43
Totals			40,202	16.75	0.04	20.09

Table 3.8 Attributes of excavated sites.

and undisturbed. As shown in Figure 3.5, Specht recorded a number of open sites containing ceramics and shell midden within the Malasang area (DAW, DBC, DBD, DBN, DBR and DBT) that represent a nearly continuous site complex. The only open site recorded in 1987 was DJD, a former hamlet within the valley at Malasang known to the local inhabitants. No pottery earlier than the Mararing style was found on the surface at any of the Malasang sites.

Site DJA, Kilu Cave

Kilu is a solution cave located near the southern end of Malasang village at the base of a limestone cliff that rises to ca. 30 m asl. The cave opening is ca. 8 m asl and faces a moderately steep talus slope that extends 65 m seaward to a narrow sandy beach and broad reef flat. Kilu Cave consists of a large dry main chamber and a smaller, wet inner chamber. The main chamber is 33 m wide at the mouth of the cave and extends 17 m into the cliff face with a ceiling height ranging from 4 m at the dripline to 1.5 m at the rear of the main chamber (Fig. 3.6). The ceiling height increases gradually from the back of the cave for ca. 10 m then rises abruptly to the dripline (Plate 3.3). The floor of the main chamber consists of a very fine dry silty matrix with scattered areas of flowstone and limestone columns and stalagmites. The floor slopes gradually towards the mouth of the cave where limestone bedrock is exposed. A passage approximately 7 m wide with a ceiling less than 2 m high leads to the inner chamber which extends about 23 m into the cliff. The inner chamber has a maximum diameter of 9 m and a ceiling up to 3 m high. This portion of the cave is wet and

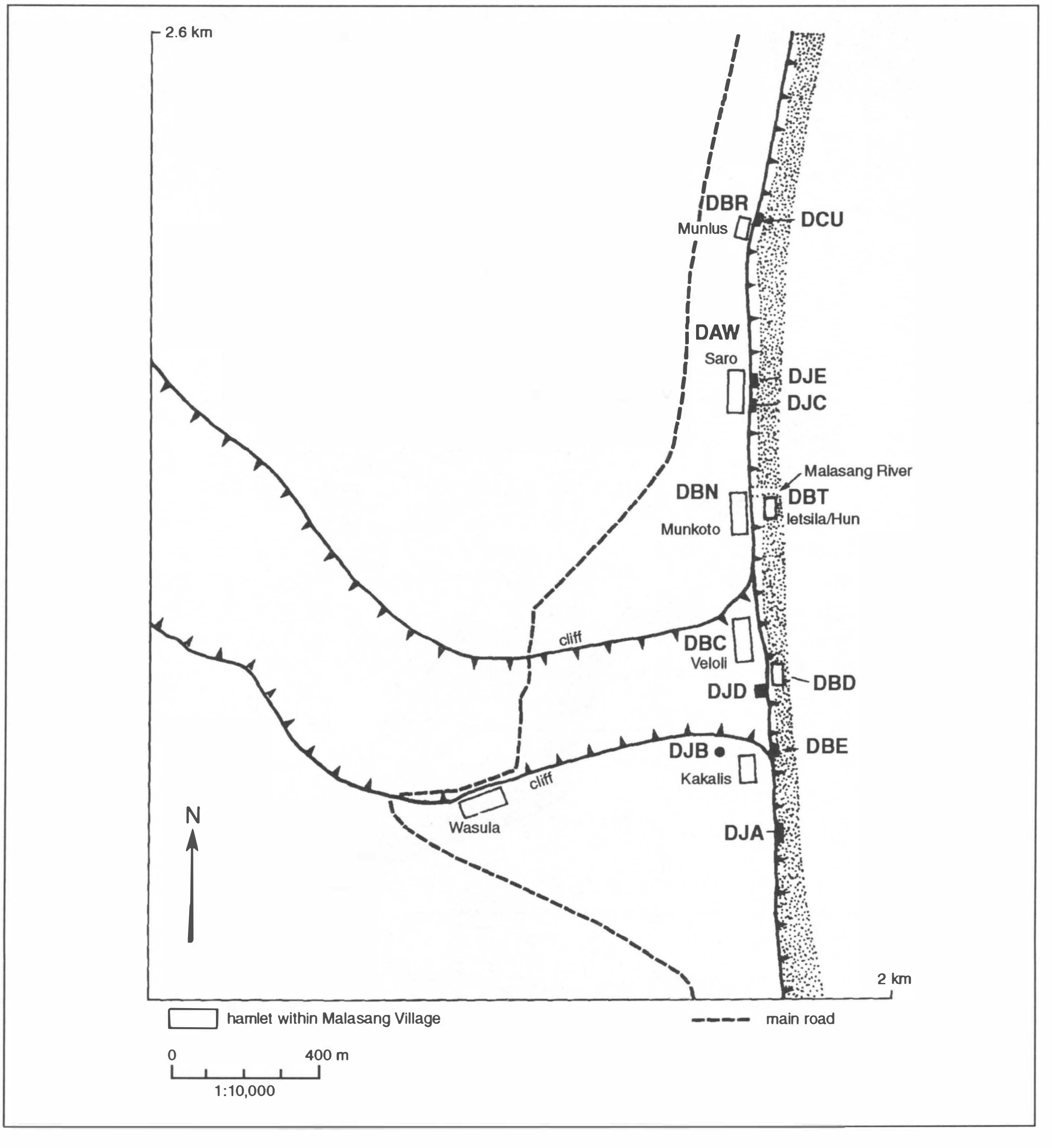


Figure 3.5 Malasang Village: Location of archaeological sites.

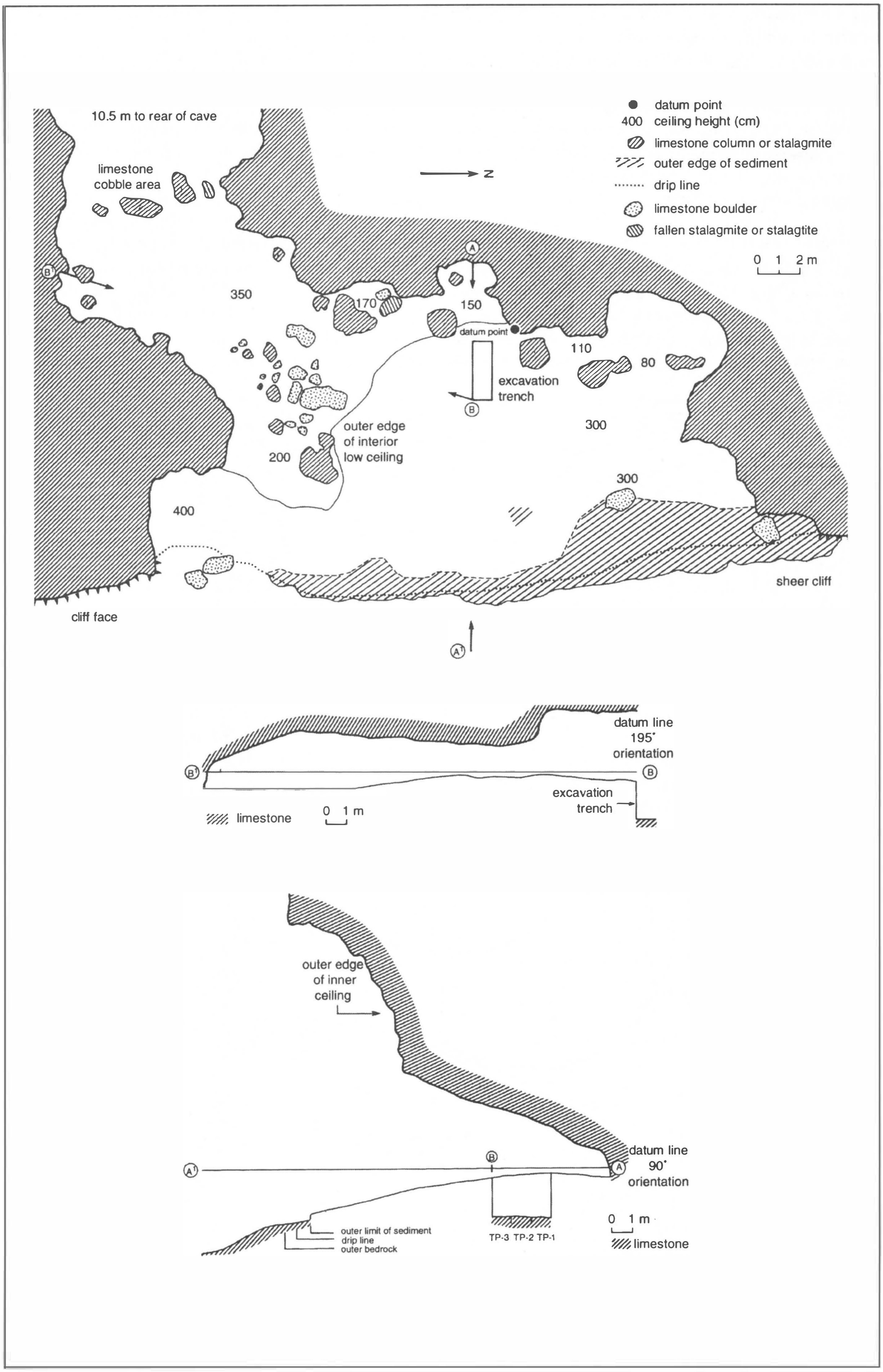


Figure 3.6 Kilu Cave (Site DJA): Plan and profiles.

dark with standing water and small limestone cobbles scattered over the floor.

Cultural material on the cave floor was minimal and restricted largely to the inner chamber. A low number of Mararing and Recent style sherds and a few fragments of marine shell were found along with pieces of metal and a few glass bottles most likely dating to World War II when the Japanese are said to have used the cave as a command post.

Excavation

A three by one metre test trench oriented from west to east was excavated in the central rear portion of the main chamber where the deposit appeared to be thickest and undisturbed (Plate 3.4). This location was also selected based on the likelihood that occupational evidence would be more abundant where refuse accumulated at the margins of the main living area (i.e. the back wall). The floor area within the main chamber for which excavation was feasible is ca. 490 m^2. Based on this estimate, the excavation trench represents less than 1% of the total site area. Excavation was carried out in 1 m^2 units designated TP 1 to TP 3 from west to east with elevations recorded from a datum located on the cave wall northwest of the trench as indicated in Figure 3.6. All units were excavated in 10 cm mechanical levels due to the lack of clearly visible stratigraphic boundaries and poor lighting. Limestone bedrock was reached at an average depth of 2.2 m below surface.

Plate 3.3 Kilu Cave (Site DJA): Cave mouth looking south.

Although some crab burrows were noted during excavation, the minimal amount of non-indigenous historic artefacts and pottery below the uppermost levels suggests that recent disturbance of the site deposits is limited. Historic artefacts from the excavations include a World War II era bullet, copper wire, two pieces of glass and a piece of metal. Only one of these items was found over 30 cm below the surface.

Stratigraphy

The Kilu deposit consists of homogeneous structureless silts distinguished primary on the basis of slight variations in colour. It appears that the sediments are derived primarily from the weathering of limestone off the ceiling and walls of the cave which has been deposited along with material derived from human use of the site. There is no evidence for sediment transport by water or wind and the primary depositional mechanism is most likely accelerated deposition of limestone from the cave itself due to human activity (i.e. fluctuations in humidity and temperature as a result of cooking, etc.). This interpretation is supported by sediment accumulation rates which indicate that deposition was minimal during periods when the cave was not occupied.

Two main layers and a number of sublayers are present within the Kilu Cave deposit and are described in Table 3.9. Stratigraphic profiles are illustrated in Figures 3.7 and 3.8 and Plate 3.5. Layer I was deposited during the Holocene and is shallowest towards the mouth of the cave where it extends to 0.8 m below the surface but dips towards the cave interior to a maximum depth of 1.5 m at the western end of the trench. Internal variability within this stratum at the interior end of the trench is minimal apart from a subtle shift in colour between the upper (IA) and lower (IC) sublayers. Layer I is more complex towards the cave mouth in TP 2 and TP 3 where a series of ash lenses (Layer IB) mixed with silt, interpreted as multiple superimposed hearth features, occur between the upper and lower Layer I deposit. Layer II is a late Pleistocene age deposit which is distinguishable from Layer I primarily on the basis of colour and to a lesser extent texture. It extends to a maximum depth of 2.25 m below surface and is substantially thicker towards the mouth of the cave where five sublayers are present. Only Layer IID is continuous across the excavation trench and is also the most homogeneous in terms of colour and texture.

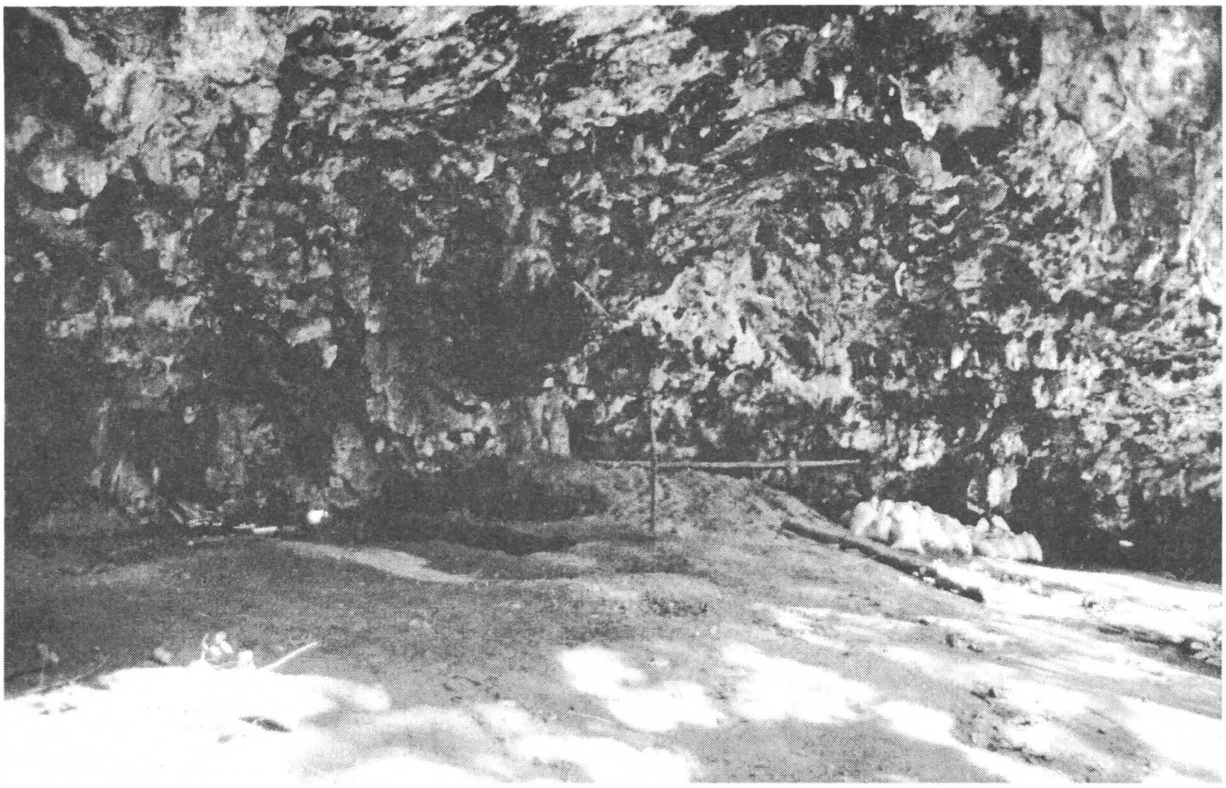


Plate 3.4 View of the main chamber at Kilu Cave facing north.

Layer IA	Dark greyish brown (10YR 4/2) silt in the upper portion grading to very dark greyish brown (10YR 3/2) silt in the lower portion. Structureless, very fine and granular with loose consistency when moist. Boundary indefinite in west half of trench and clear and wavy in east half where Layer IB is present. Moderate amount of gravel to cobble size limestone with highest density in TP 3. Upper cultural deposit with shell midden, bone and scattered charcoal.
Layer IB	Grey (10YR 5/1-6/1) ash mixed with silt and lenses of light grey (10YR 7/1) pure ash. Structureless, very fine and slightly granular with loose consistency when moist. Boundary clear and broken. Discontinuous sublayer restricted to TP 3 and TP 2 consisting of a series of contiguous ash lenses and ash mixed with silt representing multiple hearth features. Low amount of midden in ash mixed with silt and virtually no material in ash lenses. Minimal amount of limestone gravel and cobbles which are often heat-altered.
Layer IC	Greyish brown (10YR 5/2) to dark greyish brown (10YR 4/2) silt. Structureless, very fine and granular with loose consistency when moist. Boundary abrupt to clear and slightly wavy. Lower amount of limestone gravel and cobbles than Layer IA. A number of ash lenses occur although not as numerous as Layer IB. Lower Holocene occupation deposit with higher shell and bone density than Layer IA and IB but lower amount of charcoal and volcanic rock.
Layer IIA	Light yellowish brown (10YR 6/4) silt. Structureless, very fine and granular with loose consistency when moist and clear wavy boundary. Discontinuous upper stratum of Pleistocene cultural deposit found in TP 3 and eastern edge of TP 2. Much lower limestone content than overlying Layer I matrix. Similar density of shell as overlying Layer IC but lower density of bone, charcoal, volcanic rock and coral.
Layer IIB	Yellowish brown (10YR 5/4) silt. Structureless, very fine and granular with loose consistency when moist. Abrupt to clear boundary with Layer IIC but indefinite with Layer IID. Uppermost Pleistocene occupation stratum where Layer IIA is not present and is most likely continuous but could not be discerned in portions of the south face profile. The presence of a fallen stalagmite or stalactite and several limestone boulders in TP 2 suggest one or more episodes of rockfall from the cave ceiling. In TP 1 thin bands of dripstone are present in the vicinity of an in situ stalagmite which began to form in this sublayer and extends upwards as far as the lower Layer IA deposit. A slightly lower density of shell and bone is found than in Layer IIA but a higher density of volcanic rock and coral. Charcoal is absent in this sublayer and all lower strata in Layer II.
Layer IIC	Very pale brown (10YR 8/3) silt in TP 1 and pale brown (10YR 6/3) silt in TP 3. Structureless, very fine and granular with loose consistency when moist. Abrupt to clear smooth boundary. Discontinuous thin cultural sublayer which may actually represent two separate sublayers at each end of the trench. An ash concentration is present in TP 1 and the density of midden is lower than the overlying strata.
Layer IID	Silt ranging in colour from very pale brown (10YR 7/3) in TP 1 to light yellowish brown (10YR 6/4) and brown (10YR 5/3) in the upper and lower TP 3 deposit. Structureless, very fine and granular with loose consistency when moist. Abrupt smooth boundary. Main Pleistocene occupation stratum with lower overall density of shell and bone than overlying strata.
Layer IIE	Very pale brown (10YR 8/4-7/4) silt. Structureless, very fine and granular with loose consistency when moist. Thin basal layer representing weathering limestone mixed with Layer IID cultural deposit.

Table 3.9 Layer descriptions for Kilu Cave (Site DJA).

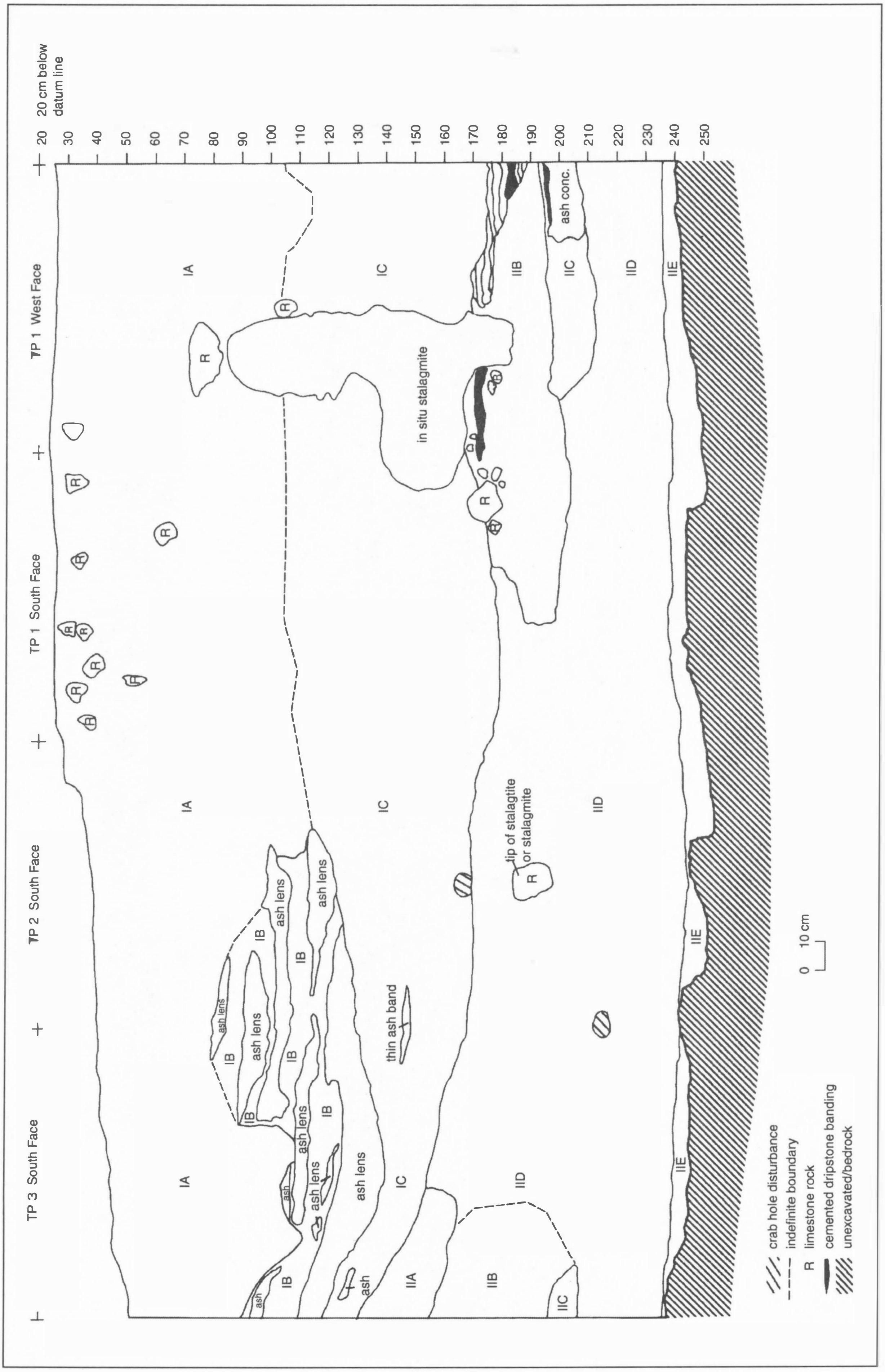


Figure 3.7 Kilu Cave (Site DJA): Stratigraphic profile, south and west face.

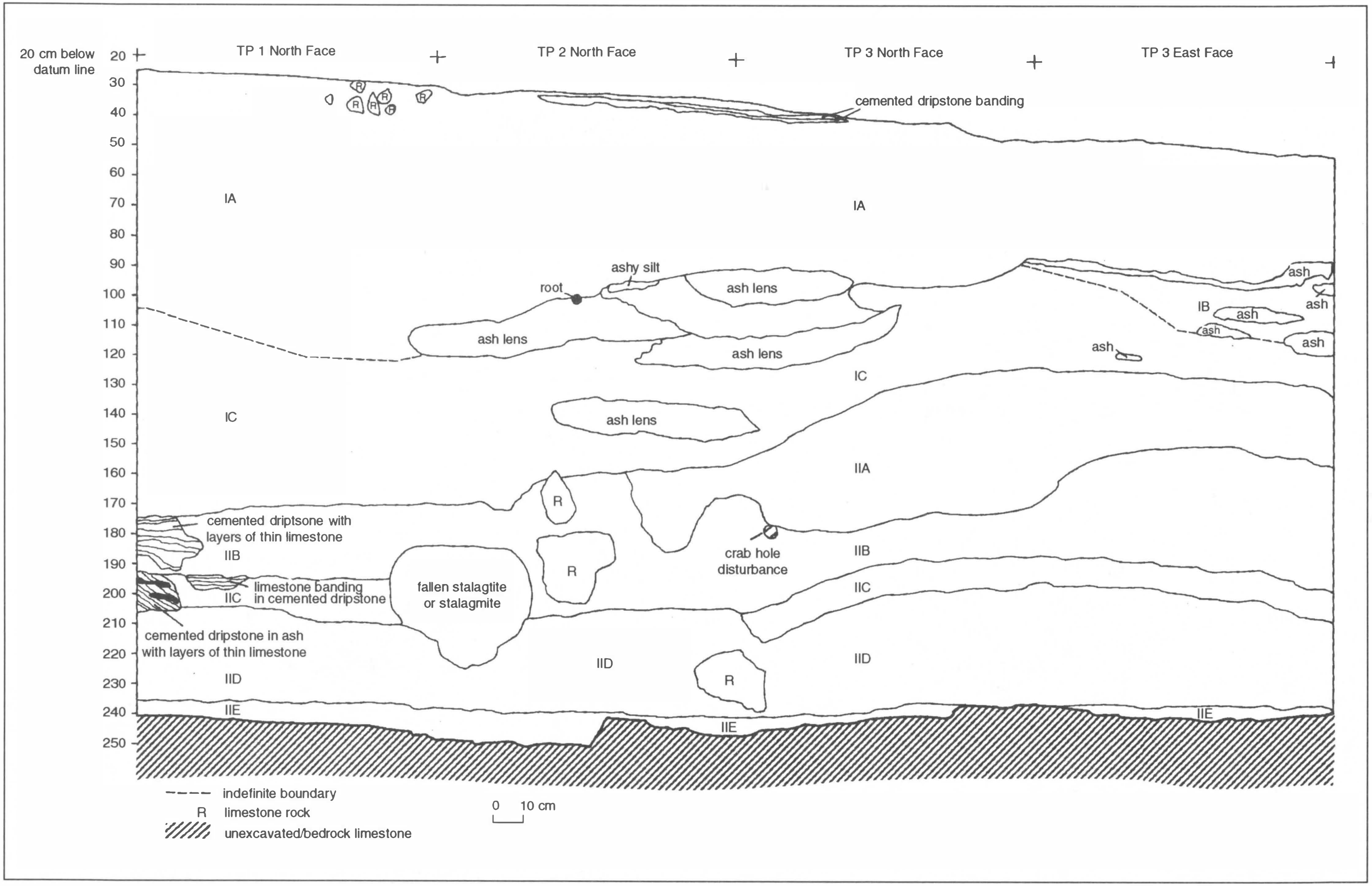


Figure 3.8 Kilu Cave (Site DJA): Stratigraphic profile, north and east face.

Depositional sequence and sediment accumulation rates

The deposit at Kilu represents two main phases of occupation, the first from ca. 29,000 to 20,000 BP (Layer II) and the second between ca. 10,000 and 5000 BP (Layer I). Based on a suite of eight radiocarbon dates which are discussed in the final section of this chapter, rates of sediment accumulation were calculated for the Kilu deposit using a program developed by Maher (1992). The sediment accumulation rates are plotted in cm/year for the Kilu deposit at 10 cm intervals in Figure 3.9. This graph reveals that the accumulation rate for the late Pleistocene Layer II deposit is more than three times slower than for the subsequent early Holocene Layer I deposit. There is a slight increase in the accumulation rate between the lower (220-250 cm b.d.) and upper (190-220 cm b.d.) portion of Layer II with virtually no deposition during the hiatus between Layer I and II (170-190 cm b.d.). There is also some increase in the accumulation rate between the Layer IC deposit from 110 to 170 cm b.d. and the levels containing the Layer IB hearths (70-110 cm b.d.). The decrease in accumulation rate within the Layer IA deposit between the surface (20 cm b.d.) and 70 cm b.d. is marked and coincides with changes in the artefactual and faunal record. Thus the rate of deposition during the late Pleistocene was significantly lower than during the early to mid-Holocene with virtually no sediment accumulation during the 11,000 year hiatus between the two occupation components. There is no evidence for truncation of a formerly more substantial deposit suggesting site utilisation during this period.

At the time Kilu was first occupied during the Pleistocene, sea level was 46 m below its present level and beginning its rapid fall to a low stand of minus 130 m at 17,000 BP (Chappell and Shackleton 1986). Lower sea level combined with tectonic uplift of Buka's east coast would have placed Kilu many tens of metres above the shoreline during the glacial maximum around 17,000 to 20,000 years ago. Although the cave would not have been much farther inland at this time than currently due to the substantial drop-off beyond the present-day reef, its greater elevation above sea level would have made access more difficult than either before or after this period. This may partially explain the hiatus in occupation at Kilu during the glacial maximum with renewed use of the cave as the glaciers retreated and sea level rose during the terminal Pleistocene.

As shown in the stratigraphic profiles for Kilu and Plate 3.5, the presence of dripstone layers and an in situ stalagmite at the boundary between Layer I and II in TP 1 are consistent with the interpretation of a lengthy hiatus in occupation. Brief use of the cave during the late Lapita phase (ca. 2500-2200 BP) is indicated by the presence of Buka style pottery in the upper 30 cm of the deposit. A low amount of late prehistoric Mararing style pottery and artefacts of World War II or more recent age were also found in these levels. However, a date from level 2 at 10 to 20 cm b.s. is preceramic in age indicating that a minimal amount of deposition took place after the site ceased to be utilised at around 5000 BP.

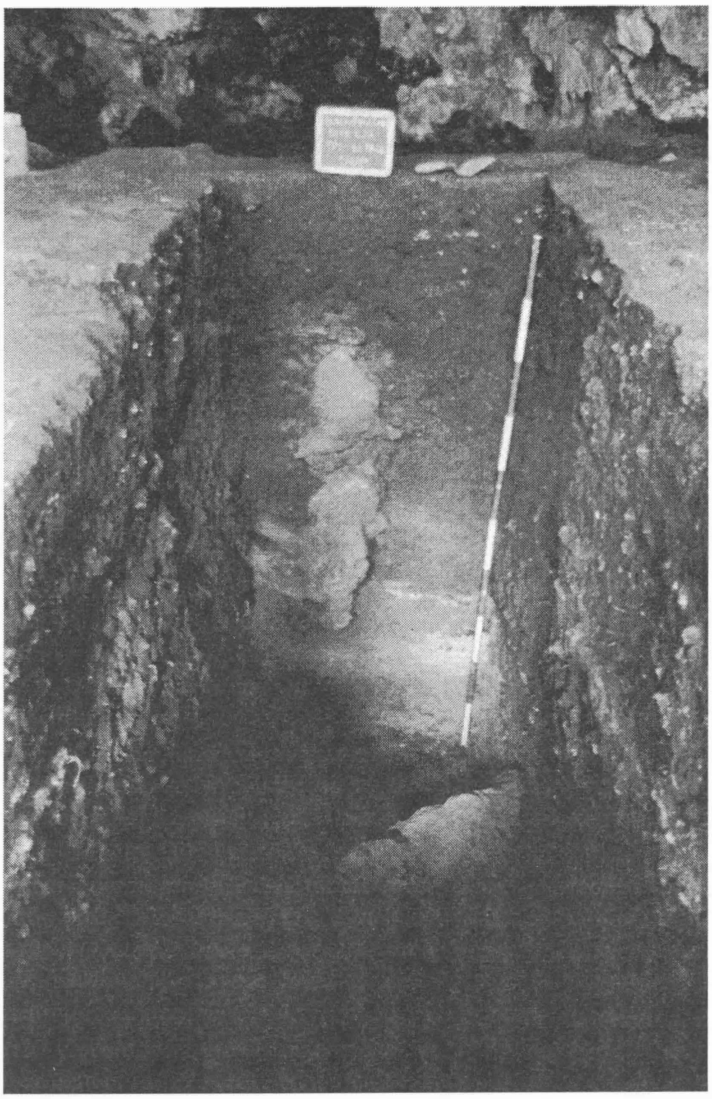


Plate 3.5 West face profile of excavation trench at Kilu Cave.

Midden and artefact distribution

The quantity and density (g/m^3) of midden by weight for each stratigraphic unit at Kilu, including shell, bone, charcoal, volcanic rock and coral, are presented in Tables 3.10 to 3.12. Although the density of the principal midden component, marine shell, drops significantly between Layer II and Layer I, that of bone and volcanic rock increases. Charcoal decreases with greater depth in Layer I and is absent in Layer II which may be due to the much greater age of this stratum, although preservation of shell and bone was excellent throughout the site deposits. Within Layer I, the highest density of shell and bone is found in the basal substratum (Layer IC). In Layer II the density of both shell and bone is uneven with a sharp increase between the basal levels and upper portion of Layer IID, a drop in Layer IIC and

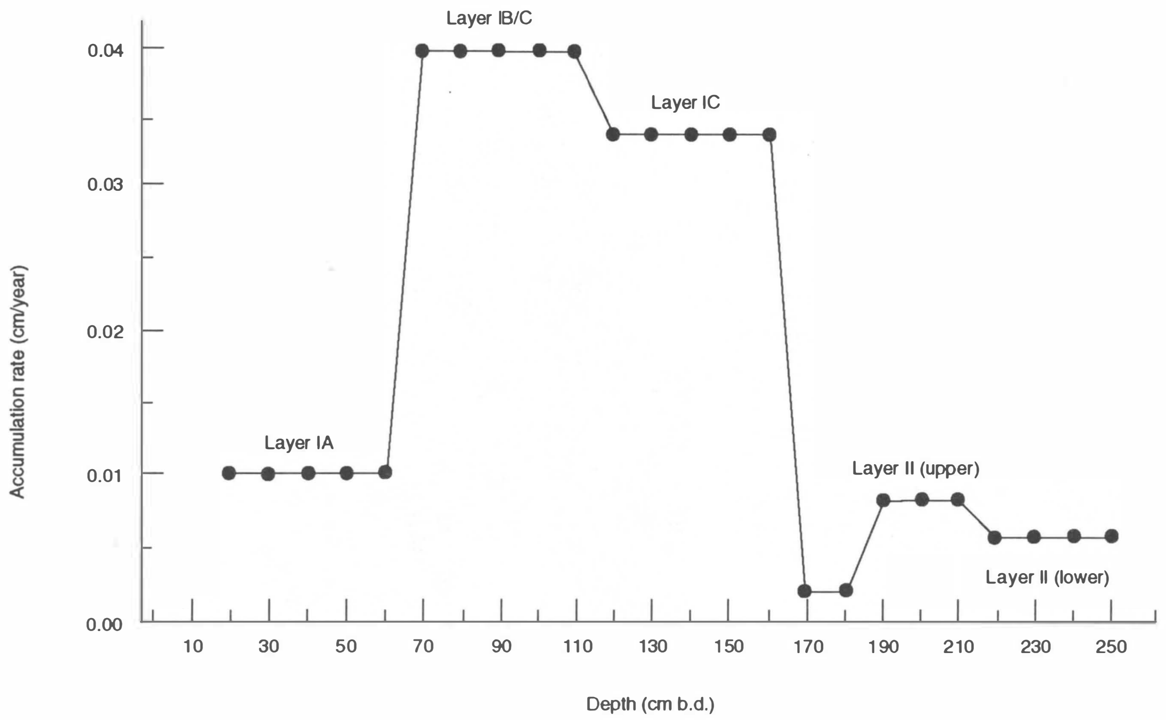


Figure 3.9 Kilu Cave (Site DJA): Sediment accumulation rates.

Layer/ Volume(m^3)	Level	Shell	g/m^3	Bone	g/m^3	Charcoal	g/m^3	Volcanic Rock	g/m^3	Coral	g/m^3
IA(0.30)	1	2096	6987	36	120	47	157	764	2547	750	2500
IA(0.29)	2	4584	15,807	138	476	43	148	707	2438	263	907
IA(0.34)	3	7116	20,929	288	847	35	103	460	1353	332	976
Subtotal 1A (upper)/(0.93)		13,796	14,834	462	497	125	134	1931	2076	1345	1446
IA(0.26)	4	7673	29,512	361	1388	42	162	828	3185	171	658
IA(0.28)	5	7570	27,036	468	1671	60	214	2521	9004	128	457
IA(0.33)	6	6503	19,706	539	1633	55	167	1073	3252	285	864
IA(0.08)	7(TP 1)	2310	28,875	218	2725	12	150	0	0	35	438
IA(0.12)	8(TP 1)	3055	25,458	357	2975	22	183	1565	13,042	172	1433
Subtotal IA (lower)/(1.07)		27,111	25,337	1943	1816	191	179	5987	5595	791	739
Total (IA)/(2.00)		40,907	20,454	2405	1203	316	158	7918	3959	2136	1068
IA/B	7 (.1)	783	7830	123	1230	8	80	782	7820	72	720
IA/B	8 (.1)	180	1800	31	310	8	80	123	1230	38	380
IA/B	9(.11)	625	5682	38	345	5	45	0	0	5	45
Total (IA/B, TP 2)		1588	5123	192	619	21	68	905	2919	115	371
IB/C	7(.1)	773	7730	117	1170	6	60	719	7190	106	1060
IB/C	8(.1)	959	9590	145	1450	4	40	83	830	127	1270
IB/C	9(.1)	2066	20,660	402	4020	3	30	155	1550	243	2430
Total (1B/C, TP 3)		3798	12,660	664	2213	13	43	957	3190	476	1587
TOTAL (2.61 m^3)		46,293	17,737	3261	1249	350	134	9780	3747	2727	1045

Table 3.10 Site DJA midden weight (g) and density (g/m^3) by excavation level for Layers IA and IB.

Layer/ Volume (m³)	Level	Shell	g/m³	Bone	g/m³	Charcoal	g/m³	Volcanic Rock	g/m³	Coral	g/m³
IC(0.08)	9	1051	13,138	150	1875	9	113	132	1650	41	513
IC(0.10)	10	843	8430	189	1890	6	60	146	1460	194	1940
IC(0.09)	11	1420	15,778	210	2333	3	33	37	411	133	1478
IC(0.08)	12	1040	13,000	145	1813	2	25	835	10,438	147	1838
Subtotal IC (upper), TP 1		4354	12,440	694	1983	20	57	1150	3286	515	1471
IC(0.08)	13	1613	20,163	702	8775	8	100	265	3313	150	1875
IC(0.08)	14	1545	19,313	417	5213	2	25	87	1088	413	5163
IC(0.08)	15	2470	30,875	511	6388	2	25	573	7163	183	2288
Subtotal IC (lower), TP 1		5628	23,450	1630	6792	12	50	925	3854	746	3108
IC(0.07)	10	307	4386	86	1229	3	43	78	1114	144	2057
IC(0.12)	11	1799	14,992	260	2167	1	8	195	1625	285	2375
IC(0.12)	12	949	7908	120	1000	4	33	0	0	148	1233
Subtotal IC (upper), TP 2		3055	9855	466	1503	8	26	273	881	577	1861
IC(0.10)	13	2775	29,211	1176	12,379	3	32	161	1695	229	2411
IC(0.09)	14	2471	29,071	1139	13,400	2	24	60	706	149	1753
Subtotal IC (lower), TP 2		5246	29,144	2315	12,861	5	28	221	1228	378	2100
IC(0.10)	10	3180	31,800	544	5440	4	40	21	210	252	2520
IC(0.10)	11	3625	38,158	481	5063	3	32	51	537	63	663
IC(0.11)	12	6560	59,636	769	6991	3	27	39	355	83	755
Subtotal IC, TP 3		13,365	43,820	1794	5882	10	33	111	364	398	1305
TOTAL (IC) (1.39 m³)		31,648	22,768	6899	4963	55	40	2680	1928	2614	1881

Table 3.11 Site DJA midden weight (g) and density (g/m³) by excavation level for Layer IC.

increase in Layer IIA. Shell, bone and other midden components occur in lower quantities within the Layer IB hearth concentration than in levels of comparable depth outside of the hearth zone, raising the possibility that the hearth areas were purposefully kept free of refuse. Coral, which was probably brought into the cave along with marine shell, has peak concentrations in both the upper and basal portions of the deposit but no meaningful pattern to its overall distribution was evident. Volcanic rocks brought into the cave for use in cooking are most common in the upper portion of Layer I (levels 7 and 8) which includes the Layer IB hearth area.

The artefactual assemblage at Kilu is dominated by small unretouched flakes of quartz, calcite, chert and volcanic rock, with only a few formal tools represented. Most of the 204 flaked stone artefacts recovered during excavation are from the late Pleistocene deposit (82.8%; n=169) and the majority occur in the lowest level. Flakes of coarse-grained volcanic rock are predominant in both preceramic occupation components but drop from 80% of the raw material in the late Pleistocene to 43% in the Holocene. Only four flakes were found in the upper portion of the Holocene deposit (Layer IA) suggesting that the production and use of flaked stone were no longer important activities at the site after about 8000 BP. Other lithic artefacts from Kilu are limited to an anvil stone and small fragment of a ground stone implement from Layer IA, a volcanic abrader fragment from Layer IC and several polished volcanic pebbles of unknown function from both periods of occupation.

Non-lithic artefacts from the Pleistocene deposit at Kilu are limited to fragments of worked *Turbo marmoratus* shell waste material from artefact manufacture that are also found in Layer IA. Shell artefacts from the Holocene deposit include a species of marine gastropod (*Terebralia palustris*) with ground surfaces possibly used as a tool and a probable *Tridacna* shell adze fragment. Shell artefacts from the upper portion of the Holocene deposit (Layer IA) that may be associated with either the late Lapita or Mararing to Recent phase occupation include worked pearl shell and *Turbo*, a bivalve scraper, two *Conus* discs, a *Trochus* ring and a small bead. Perforated shark teeth were found primarily in the lower Holocene deposit (Layers IB and IC) and three perforated shark vertebrae were also recovered. No clear pattern was evident in the spatial distribution of artefacts although TP 3, located nearest the cave mouth, had the highest overall density of material of the three excavation units. The inner portion of the trench (TP 1) had a majority of the probable ceramic-age artefacts but only two flakes and a *Tridacna* adze fragment were found in the preceramic Holocene deposit. The general abundance of material from TP 3 suggests that a greater amount of activity, or at least refuse discard, took place towards the mouth of the cave and outside of the hearth area. The greater stratigraphic complexity and thickness of Layer II at this end of the trench may also reflect increased deposition due to patterns of discard. However, a much more extensive area would need to be excavated to provide an accurate picture of spatial patterning within the site.

Layer/ Volume (m³)	Level	Shell	g/m³	Bone	g/m³	Charcoal	g/m³	Volcanic Rock	g/m³	Coral	g/m³
IIA(0.10)	15(TP 2)	4218	42,180	498	4980	1	10	30	300	89	890
IIA(0.10)	13(TP 3)	4204	42,040	254	2540	2	20	32	320	25	250
Subtotal (IIA)		8422	42,110	752	3760	3	15	62	310	114	570
IIB(0.08)	16(TP 1)	2908	36,350	187	2338	0	0	233	2913	28	350
IIB(0.09)	16(TP 2)	3611	42,482	161	1894	0	0	79	929	19	224
IIB(0.10)	14(TP 3)	4082	40,820	106	1060	0	0	88	880	0	0
Subtotal IIB (1)		10,601	40,004	454	1713	0	0	400	1509	47	177
IIB(0.11)	17(TP 1)	4360	39,636	243	2209	0	0	127	1155	19	173
IIB(0.09)	17(TP 2)	3364	37,378	192	2133	0	0	52	578	14	156
IIB(0.11)	15(TP 3)	3287	31,305	121	1152	0	0	173	1648	16	152
Subtotal IIB (2)		11,011	36,102	556	1823	0	0	352	1154	49	161
IIC(0.10)	16(TP 3)	2566	25,660	132	1320	0	0	31	310	4	40
IID(0.08)	18(TP 1)	3618	48,240	158	2107	0	0	67	893	3	40
IID(0.10)	18(TP 2)	4358	43,580	168	1680	0	0	130	1300	22	220
IID(0.10)	17(TP 3)	4357	43,570	207	2070	0	0	86	860	10	100
Subtotal IID (1)		12,333	44,847	533	1938	0	0	283	1029	35	127
IID(0.09)	19(TP 1)	2271	26,718	112	1318	0	0	135	1588	9	106
IID(0.03)	19(TP 2)	706	21,394	18	545	0	0	4	121	0	0
IID(0.10)	18(TP 3)	8339	87,779	107	1126	0	0	0	0	27	284
Subtotal IID (2)		11,316	53,127	237	1113	0	0	139	653	36	169
IID(0.09)	20(TP 1)	2070	23,000	41	456	0	0	17	189	8	89
IID(0.11)	20(TP 2)	3721	35,438	72	686	0	0	48	457	8	76
IID(0.10)	19(TP 3)	3672	36,720	167	1670	0	0	118	1180	26	260
Subtotal IID (3)		9463	32,078	280	949	0	0	183	620	42	142
IID(0.11)	21(TP 1)	1875	17,045	89	809	0	0	138	1255	29	264
IID(0.16)	21(TP 2)	1251	7819	86	538	0	0	12	75	79	494
IID(0.11)	20(TP 3)	1574	14,309	128	1164	0	0	53	482	88	800
Subtotal IID (4)		4700	12,368	303	797	0	0	203	534	196	516
TOTAL (Layer II) (2.03 m³)		70,412	34,635	3247	1600	3	1	1653	813	523	257

Table 3.12 Site DJA midden weight (g) and density (g/m³) by excavation level for Layer II.

Based on the types of artefacts and midden recovered and their distribution patterns, Kilu appears to have been occupied primarily on a temporary or recurrent short-term basis by groups involved in hunting and gathering activity during the Preceramic period. The presence of multiple hearth features in the Holocene deposit and abundant quantities of well-preserved marine shell and bone throughout the depositional sequence attest to the importance of food preparation and consumption at the site. On the basis of midden density figures and sediment accumulation rates, utilisation of the cave seems to have been more sporadic and/or less intensive during the late Pleistocene than early to mid-Holocene period.

Site DBE, Palandraku Cave

Palandraku Cave is located ca. 200 m north of Kilu at the base of a 15 m high limestone cliff at the mouth of Malasang valley. The mouth of the cave faces south and is situated at ca. 5 m asl on a narrow limestone bench from which a talus slope descends to a sandy beach 50 m away (Plate 3.6). Palandraku is a wet solution cave with small pools of standing water and an intermittent flow of water into the main chamber from the entrance during periods of heavy rainfall. As shown on the site plan (Fig. 3.10), three entrances with archways lead to a chamber extending inward an average of 10 m with a width of ca. 6 m. The floor of this chamber slopes downward from the main entrance and has scattered areas of flowstone covering the surface as well as stalagmites and limestone columns. The ceiling is quite low in the side passages but ca. 7 m high in the central chamber. A narrow passage about 10 m long and 1 m high leads northwest to a second chamber but the full extent of the cave has not been determined. The first chamber receives a limited amount of natural light from the entrance and is the only portion of the cave with excavation potential.

Specht recorded the Palandraku site in 1967 as B.P. 31, which was later changed to DBE. In addition to intensive surface collection of artefacts, he began excavation of a two by one metre test trench at the rear of the main chamber which he was unable to complete due to illness. Surface artefacts collected in 1987 include pottery (Recent style, Mararing style and a single late Malasang style sherd), a *Tridacna* trolling lure shank, a stone pestle fragment and several hammer/anvil stones.

Excavation

A three by one metre trench was excavated in 1 m² increments adjacent and perpendicular to Specht's 1967 trench at the rear of the first chamber where the deposit was relatively dry and undisturbed (see Fig. 3.10 and Plate 3.7 for trench location). The trench represents less

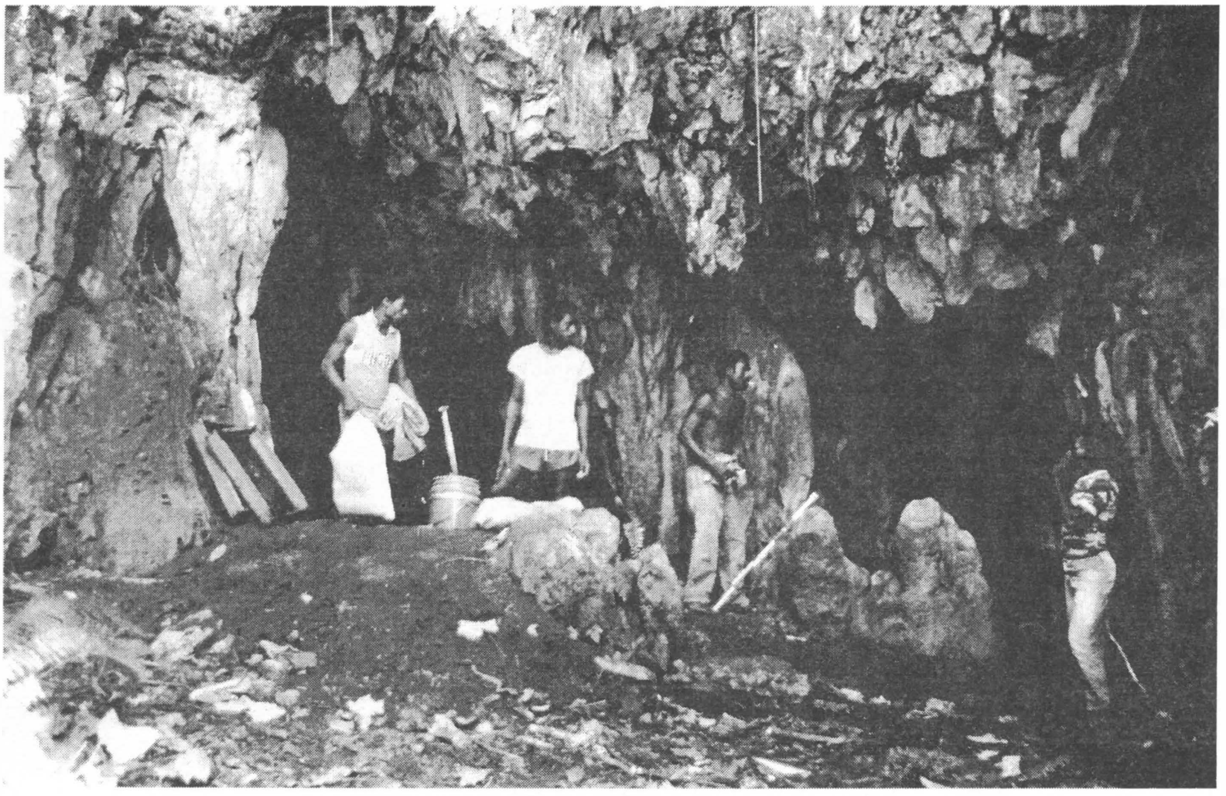


Plate 3.6 View of entrance to Palandraku Cave facing north.

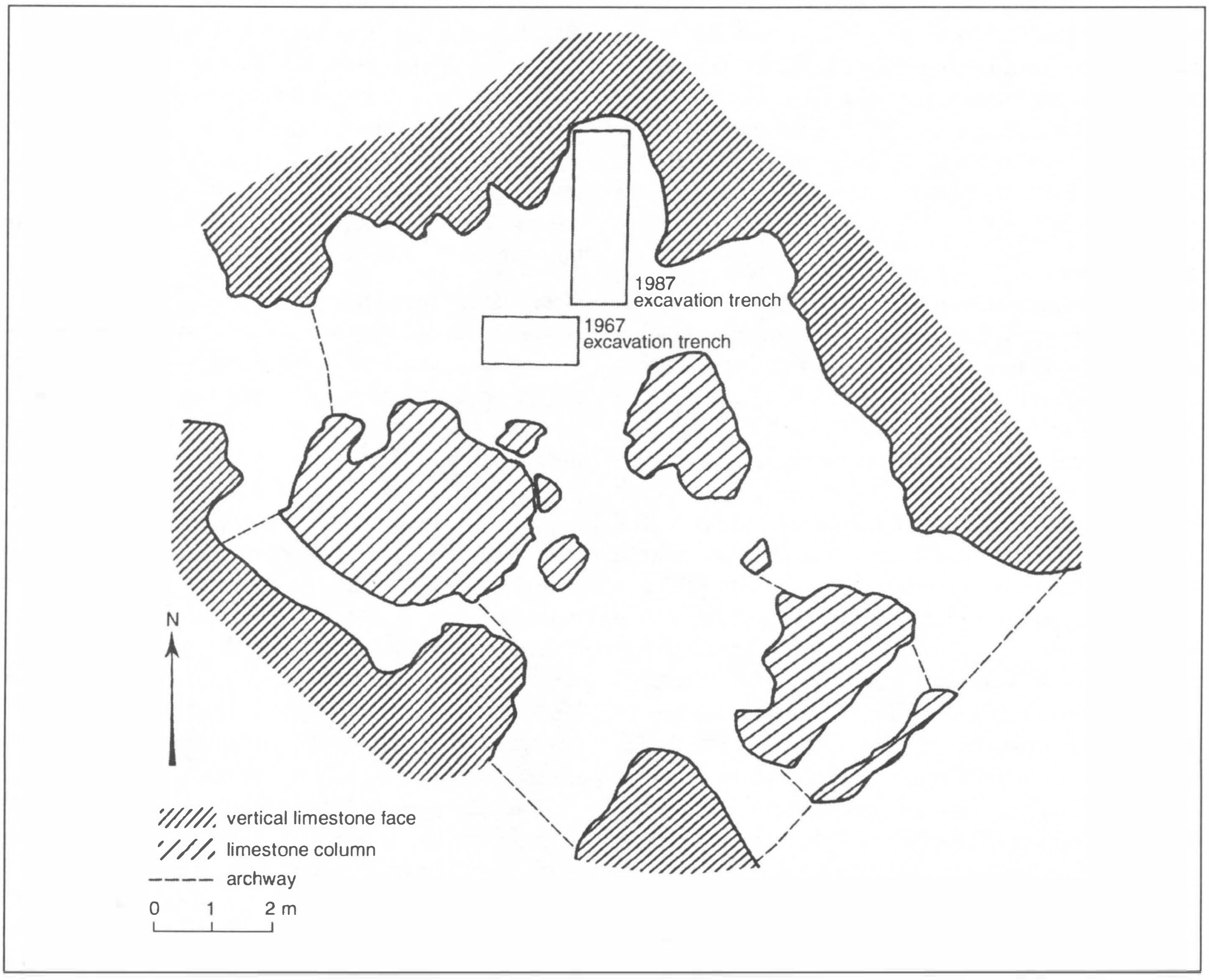


Figure 3.10 Palandraku Cave (Site DBE): Plan (redrawn from Specht 1969: Appendix 3, Fig. 2).

Plate 3.7 Interior of Palandraku Cave facing northeast.

than 3% of the estimated floor area of 80 m^2. All units were excavated in 10 cm mechanical levels due to the lack of clear stratigraphic boundaries and inadequate lighting and depths were recorded from a central datum. Limestone bedrock was reached at a maximum depth of 1.80 m at the southern end of the trench and sloped upward to less than 5 cm below surface at the interior end of the trench.

Stratigraphy

Eleven stratigraphic units were identified within eight layers representing three temporally distinct occupation components within the DBE deposit. Stratigraphic profiles are found in Figures 3.11 and 3.12 and detailed layer descriptions are provided in Table 3.13. The upper 60 cm of the deposit, dating from the Mararing to Recent phase, includes three layers. The lowest of these is a silt loam containing calcareous sand grains (Layers IIIA and B) which appears to have been truncated/replaced by a waterborne silt clay (Layer II) in units TP 1 and TP 2. The uppermost stratum (Layers IA and B) consists of silts with evidence of recent historic disturbance (i.e. pieces of metal, glass and a Japanese coin). Layers I and III contain a series of thin ash bands and Layers I and II have high amounts of charcoal. Layer IV is a clay loam up to 20 cm thick which is separated from Layer II in the southern half of the trench by a layer of limestone fragments cemented together by flowstone. This layer is dated to the late Lapita to early Sohano phase based on the presence of Buka style pottery. The contrast between Layers I and II and the lower strata in terms of colour and texture is clearly visible in Plate 3.8.

The lower 70 to 80 cm of the deposit is preceramic in age and includes two principal strata (Layers V and VI) ranging from silt loam to silt clay in texture and overlying discontinuous fine silts (Layers VII and VIII) extending to bedrock. A concentration of heat-altered volcanic rock was found within Layer V and is visible in the east face profile (Fig. 3.12). It is interpreted as an earth oven feature but was not recognised during excavation and therefore removed with the general deposit. Some mixing of Layers IV and V was evident in the northern portion of the trench.

Depositional sequence

On the basis of radiocarbon dates from the upper and lower preceramic deposit, the initial phase of occupation at DBE took place about 5000 years ago. Occupation of the cave was apparently temporary and non-intensive during this period based on the low density of cultural material recovered. The earth oven feature in Layer V is similar to one found at the Matenbek cave site on New Ireland which is dated to ca. 6000 BP (Allen et al. 1989:550). A hiatus of several thousand years in use of the cave between Layers V and IV has left little trace in terms of sediment accumulation although the upper portion of the preceramic age deposit may have been eroded away. The growth of a stalagmite and deposition of dripstone/flowstone at the south end of the trench occurred during the hiatus in much the same manner as at Kilu.

The second phase of occupation at DBE is estimated to date to the end of the first millennium BC based on the presence of late Lapita phase Buka style pottery. Three Sohano style sherds were also found scattered through the deposits indicating some use of the cave during this phase. Unfortunately, the Lapita stratum (Layer IV) is quite thin and mixing has occurred with both earlier and later strata. Layer III appears to have been deposited

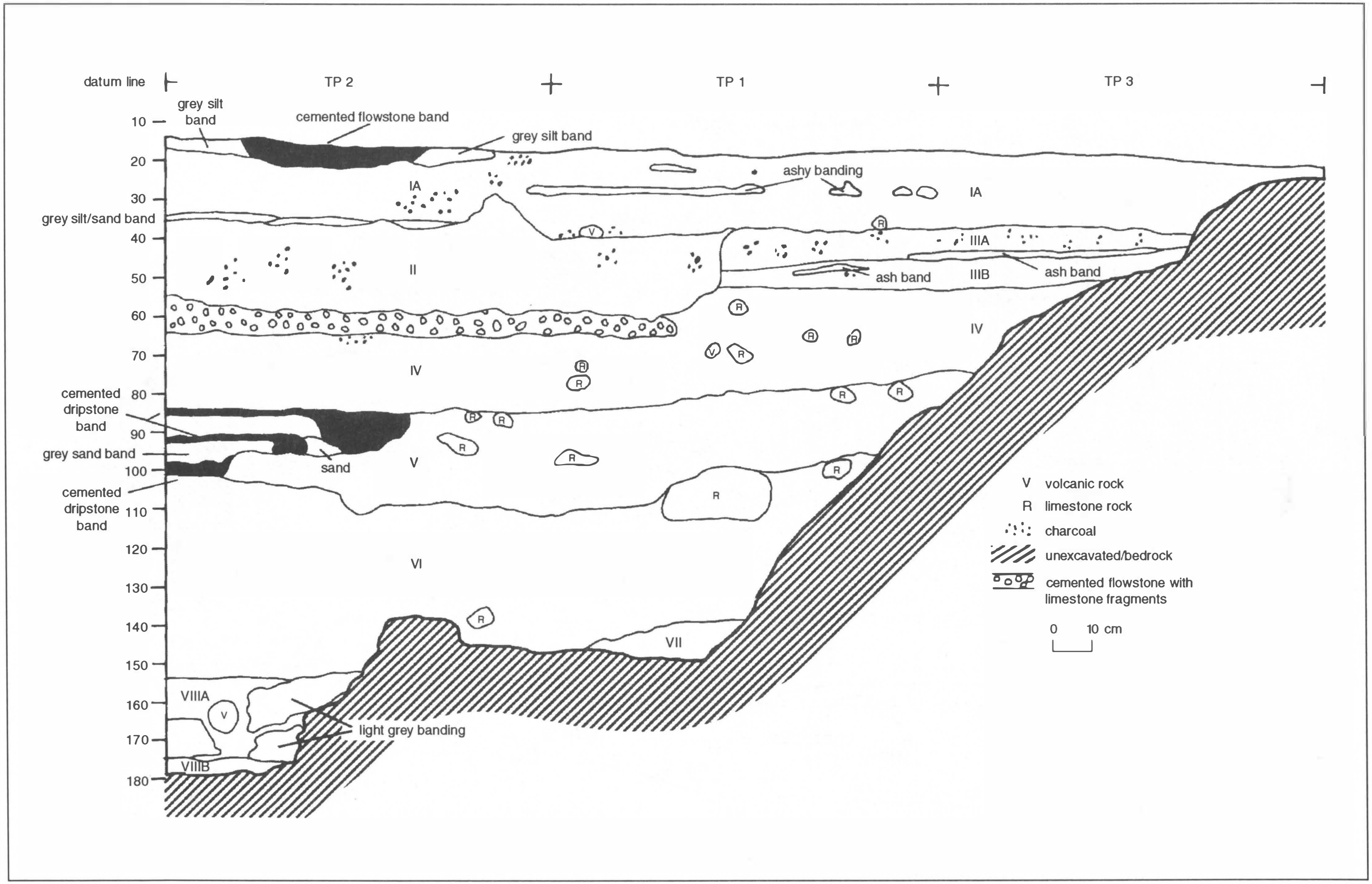


Figure 3.11 Palandraku Cave (Site DBE): Stratigraphic profile, west face.

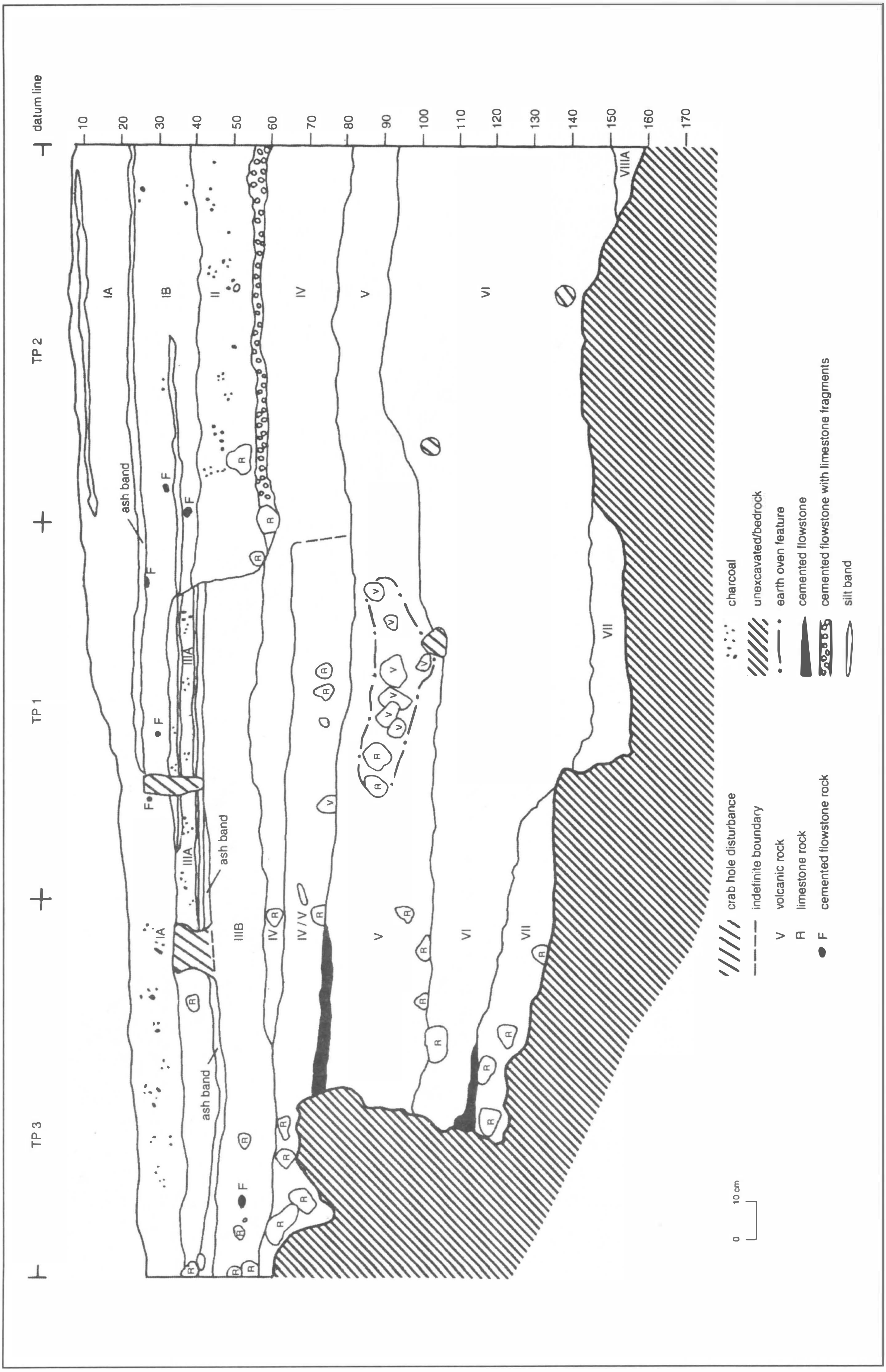


Figure 3.12 Palandraku Cave (Site DBE): Stratigraphic profile, east face.

Layer IA	Dark brown (10YR 3/3) silt with low percentage of fine calcareous sand grains and scattered white (10YR 8/1) ash bands. Weak fine to medium crumb structure with friable consistency when moist. Boundary clear and smooth. Limited amount of gravel to cobble-size limestone and flowstone on surface. Abundant charcoal flecking. Recent cultural deposit with historic material (glass, metal, nails, Japanese coin dating to WW II) and late prehistoric pottery.
Layer IB	Very dark brown (10YR 2/2) silt loam to silty clay loam with slightly higher amount of calcareous sand grains than Layer IA and some sandy loam banding. Weak fine to medium crumb structure with friable consistency when moist. Boundary sharp and smooth. Decrease in amount of charcoal flecking from Layer IA but still abundant. Discontinuous recent cultural deposit similar to Layer IA.
Layer II	Black (10YR 2/1) silty clay with highly compact band of limestone fragments cemented by flowstone forming the lower boundary. Moderate medium to coarse crumb structure with friable to firm consistency when moist. Increase in amount of limestone gravel and cobbles from Layer I and continued dense charcoal flecking and some larger chunks. Stratum interpreted as waterborne sediment which truncated Layer III in the outer portion of the trench. Late prehistoric cultural deposit with high density of pottery and moderate amount of shell midden.
Layer IIIA	Dark yellowish brown (10YR 4/4) silt loam with moderate amount of fine calcareous sand grains and several thin ash and sand bands. Structureless to very weak fine granular structure with loose consistency. Clear smooth boundary. Low amount of cultural material relative to other layers indicating that stratum may represent a hiatus in occupation between the Lapita and late prehistoric Mararing phase deposits.
Layer IIIB	Dark yellowish brown (10YR 3/4) silt loam distinguished from Layer IIIA primarily due to lack of sand and ash banding.
Layer IV	Yellowish brown (10YR 5/6) to dark yellowish brown (10YR 4/6) clay loam with low calcareous sand content. Weak medium crumb structure with very friable to friable consistency and abrupt smooth boundary except where mixing with lower Layer V matrix has occurred. In situ stalagmite in south face of trench at base of layer and band of flowstone sealing underlying Layer V deposit. Noticeable increase in amount of limestone rock in comparison with overlying strata. Late Lapita deposit with moderate amount of midden, intrusive late prehistoric pottery and two pieces of metal.
Layer V	Dark yellowish brown (10YR 3/4) loam with low amount of clay and moderate amount of limestone rock including three large slabs probably fallen from the ceiling. Structureless with loose consistency and distinct slightly wavy boundary. Series of alternating sand and flowstone bands in southwest corner of trench and concentration of heat-altered volcanic rock representing earth oven extending into west face. Upper preceramic deposit with low amount of midden.
Layer VI	Dark brown (7.5YR 3/4-3/2) silty clay loam to silty clay with increasing clay content in lower portion. Weak fine to medium crumb structure with very friable to friable consistency when moist. Moderate amount of small limestone cobbles but no bigger rock except for large slab at upper boundary. Overlying bedrock in much of trench. Lower preceramic deposit with low amount of midden.
Layer VII	Brownish yellow (10YR 6/6) to dark grey (10YR 4/1) silt loam with very little clay. Weak fine to medium crumb structure with loose to very friable consistency. Zone of decomposing bedrock with abundant chunks of limestone and little cultural material.
Layer VIIIA and B	Dark grey (10YR 4/1) in VIIIA to dark yellowish grey (10YR 4/4) in VIIIB fine silt with bands of silt in VIIIA. Structureless to weak very fine granular structure. Pocket of matrix at south end of trench within a bedrock depression. Very low amount of shell, scattered charcoal and some heat-altered volcanic rock.

Table 3.13 Layer descriptions for Palandraku Cave (Site DBE).

between the Sohano and Mararing phase when the cave was seldom used and has been replaced by Layer II in a portion of the trench. The final period of cave use is represented by Layers I and II which were deposited within the last 500 years as indicated by the presence of Mararing and Recent style pottery.

Midden and artefact distribution

The quantity and density (g/m^3) of midden by weight for each stratum at Palandraku including marine shell, bone, charcoal, volcanic rock and coral is presented in Table 3.14. Preservation of bone and shell ranged from good to excellent in the preceramic layers but was fairly poor in the upper two layers. Palandraku has the lowest density of cultural material of the seven sites excavated which may be due not only to preservation factors but the (presently) inhospitably damp and dark location of the cave which would not have been as attractive for human use as dry open caves such as Kilu.

Distribution of shell and bone is uniform between strata with the highest density occurring in Layer IV and Layer II. The taxonomic range of both shell and vertebrate remains in the preceramic phase is similar to Kilu with an emphasis on endemic reptiles (snakes and lizards) and mammals (bats and rats). *Phalanger* and pig first appear in the late Lapita phase Layer IV deposit along with a concentration of human phalanges and teeth from several individuals. The human skeletal remains appear to have been purposefully placed rather than representing disturbed burials.

Charcoal density drops steadily with increasing depth and minimal amounts are found in the preceramic layers. No patterning was evident in the distribution of coral although the highest amounts are found in the basal strata. The preceramic earth oven feature is marked by a peak in volcanic rock density within Layer V where over 15 kg of rock was recovered. A minor concentration of heat-altered rocks was also present just above bedrock in Layer VIII.

Artefacts within the preceramic deposit are primarily unretouched stone flakes as at Kilu. In contrast to Kilu, coarse-grained volcanic rocks are absent and chert is the dominant raw material with lesser quantities of quartz, calcite and fine-grained volcanic rock. The majority of flaked stone occurs in the lower preceramic deposit (Layer VI), although flakes are found throughout the

Layer	Volume (m^3)	Shell	g/m^3	Bone	g/m^3	Charcoal	g/m^3	Coral	g/m^3	Volcanic Rock	g/m^3
I	0.59	3895	6602	170	288	237	551	383	891	883	1497
II	0.33	3727	11,294	280	848	163	494	1091	3306	1047	3173
III	0.26	1109	4265	22	85	39	150	332	1277	548	2108
IV	0.50	4074	8148	451	902	38	76	1153	2306	3965	7930
V	0.62	3441	5550	84	135	13	21	987	1592	15,447	24,915
VI-VIII	0.90	6453	7170	180	200	12	13	10,837	12,041	4842	5380
Total	3.20	22,699	6914	1187	362	502	153	14,783	4503	26,732	8143

Table 3.14 Site DBE midden weight (g) and density (g/m^3) by stratigraphic layer.

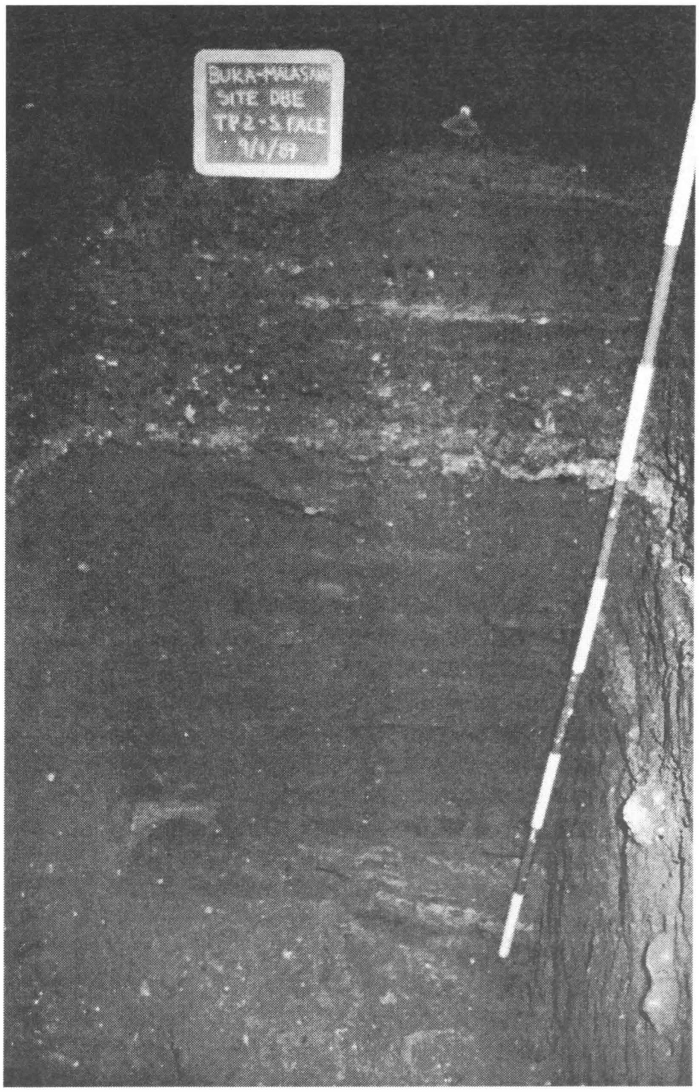


Plate 3.8 South face of excavation trench at Palandraku Cave.

sequence. Single pieces of obsidian were present in Layers IV and II. The presence of siliceous flakes in the upper three layers may be a result of displacement from the lower deposit given the scarcity of flaked stone in other sites of comparable age on Buka. Non-flaked stone artefacts include a variety of highly polished cobble manuports from each occupation component, a single anvil stone with pecked depressions (Layer I), miscellaneous ground stone fragments (Layers III and IV) and block coral and pumice abraders (Layers II to IV). Shell artefacts from the preceramic layers include fragments of worked *Turbo marmoratus* similar to those at Kilu and ornaments including a *Trochus* ring, perforated *Oliva* shell and *Spondylus* beads. Most of these artefact types are also found in the ceramic-age strata. Layer IV has the highest overall artefact density. The post-depositional displacement of artefacts between layers through crab burrowing activity and other disturbance factors is attested to by the presence of Buka style pottery and later ceramics in the preceramic strata and may include other artefact types such as shell ornaments.

THE SOHANO ISLAND SITES

Sohano Island is about 1100 m long from north to south and up to 500 m wide from west to east with a total land area of roughly 0.55 km^2. Geologically, the island consists of a block of Sohano limestone tectonically uplifted approximately 10 m asl which is fringed by a narrow calcareous sand littoral platform. Sohano served as a centre for the Australian civil administration prior to independence and the hospital built during this period was still in operation at the time of the present field investigations.

Specht (1969) recorded five sites on Sohano in 1967 and excavated test trenches at two localities. Two trenches were placed in a narrow beach midden deposit on the east coast recorded as Site B.P. 7 (now Site DAG) and two trenches were also excavated at a rockshelter in the vicinity of the hospital clinic at the south end of the island within Site B.P. 1 (now Site DAA). The remaining sites recorded by Specht were open settlement locations along the shoreline (Sites DAF and DAT) and on the top of the uplifted limestone formation (Site DAS). Site locations on Sohano Island are indicated in Figure 3.13.

During survey of the island in 1987, the boundaries of two sites recorded by Specht, DAA and DAF, were expanded to include intertidal reef areas. Two previously unrecorded sites, DKC and DKD, were also discovered at the base of the limestone cliff northwest of DAF. Site DKD is a 6 m wide limestone overhang projecting about 4 m from the cliff face and is located 24 m east of a church beside an unpaved road. A low number of Buka,

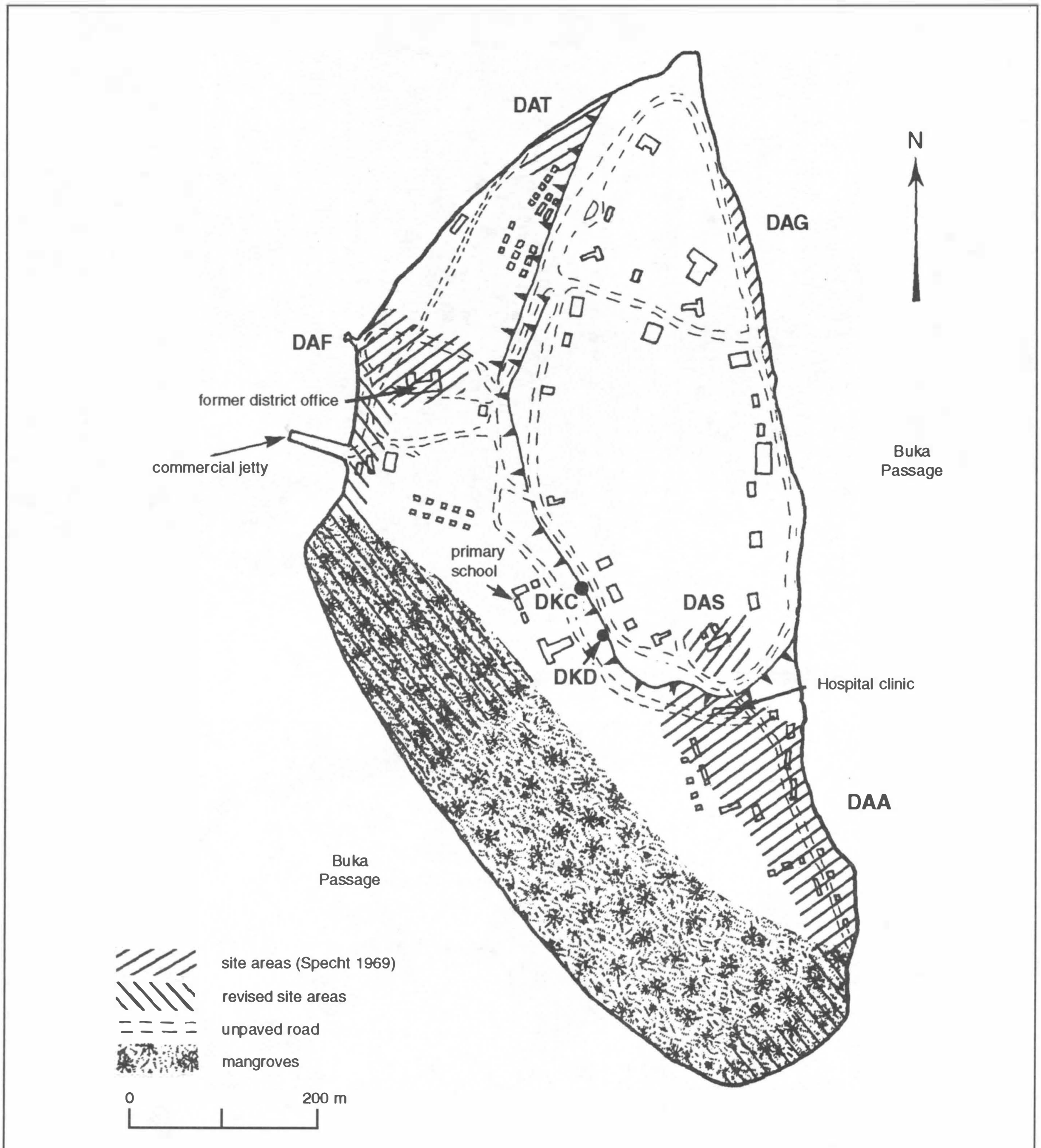


Figure 3.13 Sohano Island: Location of archaeological sites (redrawn from Specht 1969:Fig. III-3).

Sohano and Mararing style sherds were found on the surface below the overhang but the potential deposit did not appear sufficient to warrant excavation.

Site DKC, Sohano Primary School

Site DKC is a small rockshelter located ca. 50 m north of Site DKD and faces southwest towards the Sohano primary school 25 m away on the opposite side of an unpaved road (Plate 3.9). The site is 3 m asl and lies at the foot of an 8 m cliff with an overhang forming a dripline about 4 m above the surface. As shown on the plan view in Figure 3.14, the main shelter extends 11 m inward from the dripline and has a maximum width of 9 m with a low interior ceiling ranging from 70 to 120 cm. Much of the interior floor is exposed limestone bedrock with scattered stalagmites and limestone columns where rubbish had been dumped in several locations. In addition to a low amount of Recent and Mararing style pottery, a number of Sohano style sherds and a single Buka style sherd were collected from the surface in the vicinity of the dripline.

Excavation

Given the potential for a deposit with both Buka and Sohano style pottery, a single 1 m^2 test unit was placed at the centre of the shelter several metres from the dripline where the surface was level and the ceiling 3.6 to 3.7 m high. An estimated two percent of the floor area with sediment (ca. 50 m^2) was excavated representing a volume of 0.93 m^3. Excavation was carried out in natural

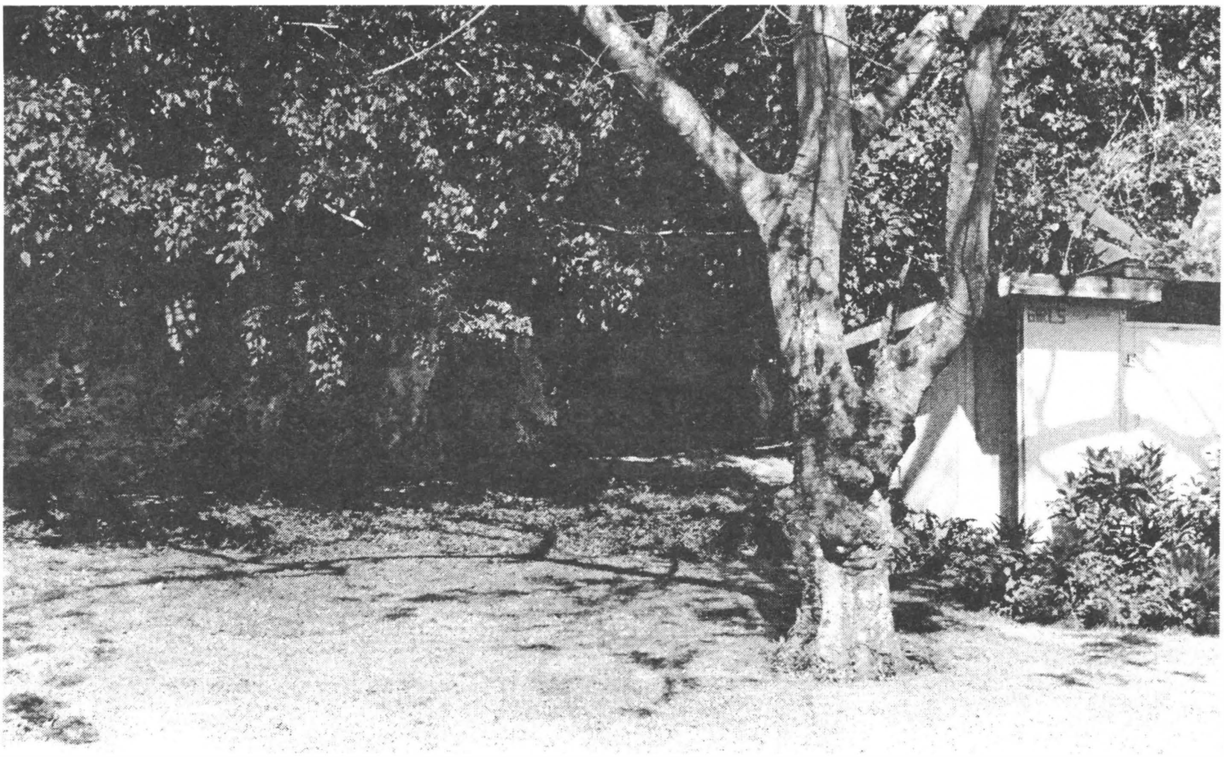


Plate 3.9 DKC rockshelter (Sohano Island): General view looking east.

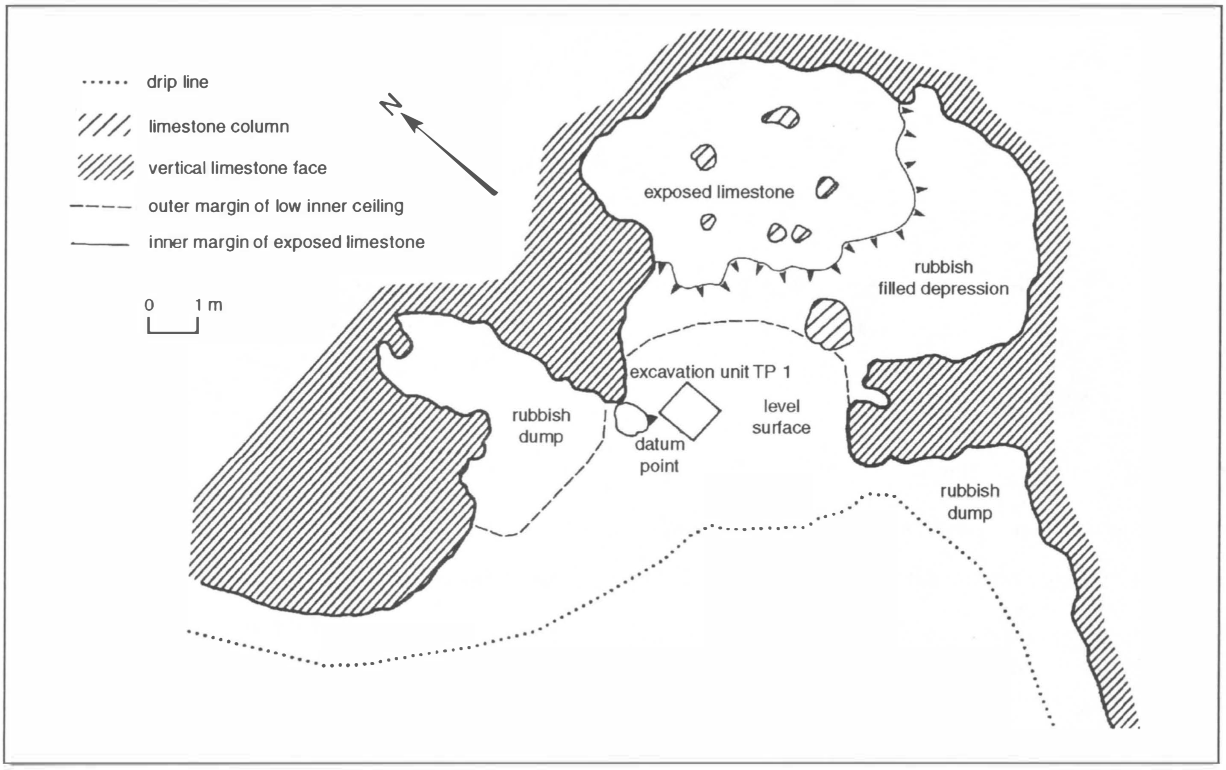


Figure 3.14 Site DKC: Plan.

stratigraphic units with the thicker layers divided into 10 cm mechanical levels and features removed as single units. The deposit ranged in depth from 1.0 to 1.15 m and extended to bedrock.

Stratigraphy

Two primary layers divided into a total of seven sublayers were identified. Layer descriptions are found in Table 3.15 and stratigraphic profiles illustrated in Figures 3.15 and 3.16. Disturbance due to crab burrowing was evident throughout the deposit. Two large historic pit features extending nearly to bedrock had also disturbed a substantial amount of the prehistoric deposit. Fortunately, the historic pit boundaries were clearly visible during excavation and enabled feature fill to be removed separately from the general deposit.

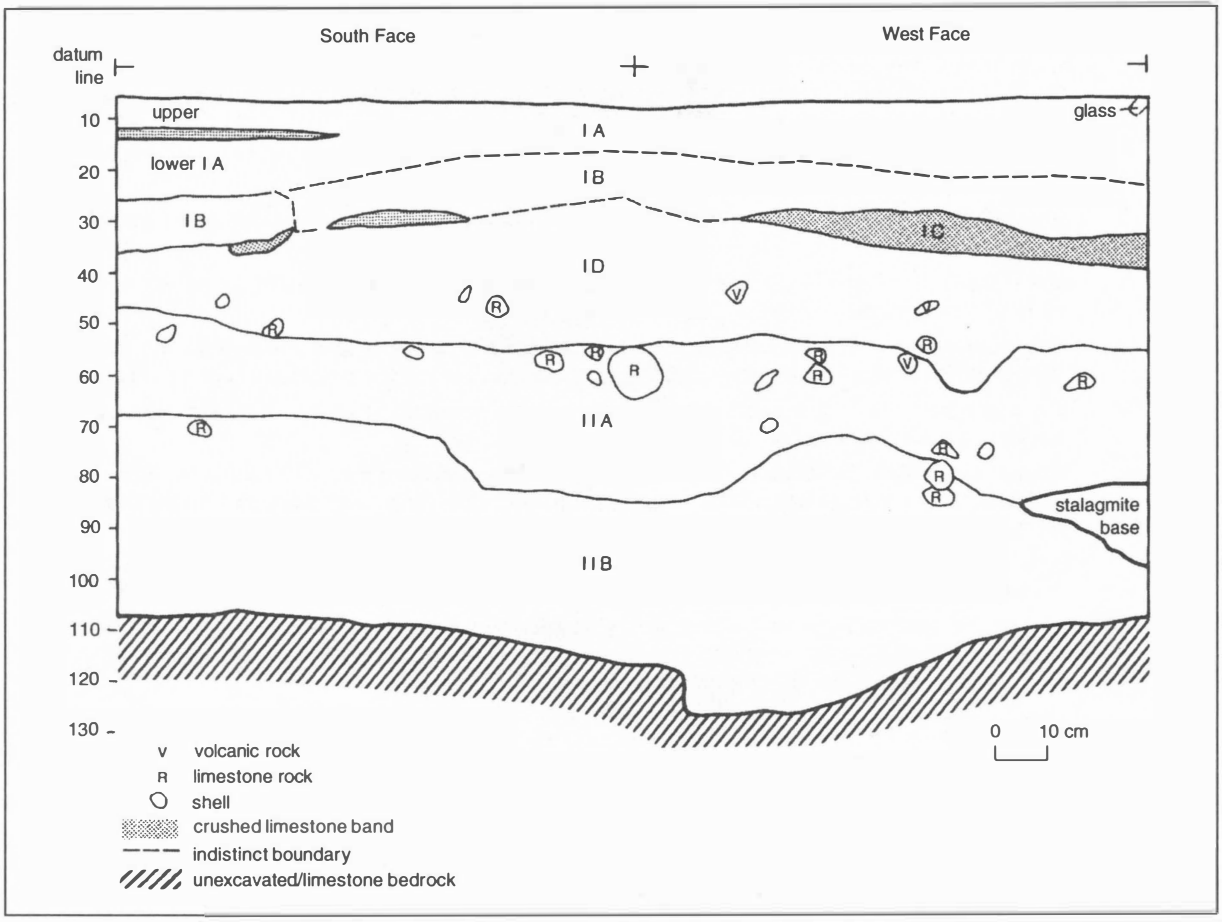


Figure 3.15 Site DKC: Stratigraphic profile, south and west face.

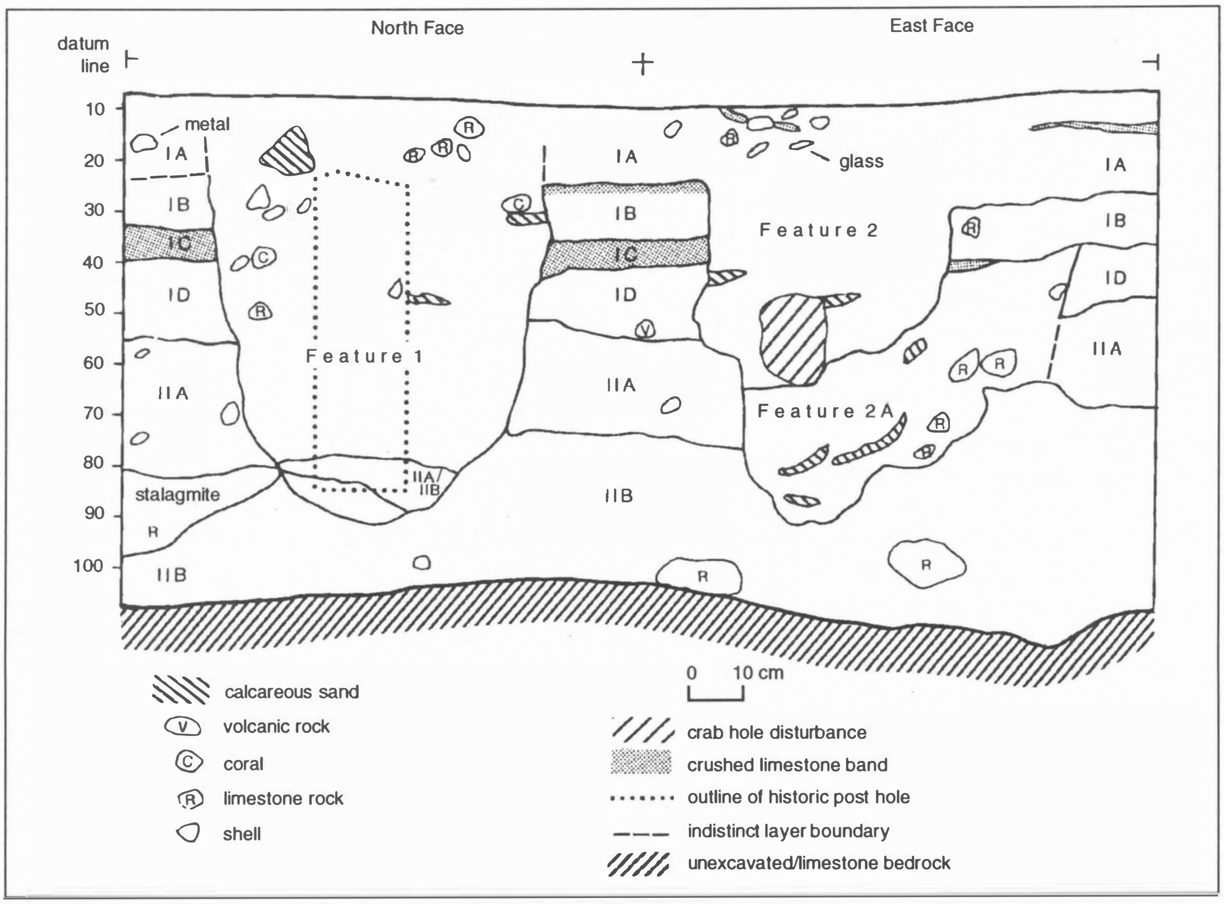


Figure 3.16 Site DKC: Stratigraphic profile, north and east face.

Layer IA	Silt ranging from light brownish grey (10YR 6/2) in the upper portion to yellowish brown (10YR 5/4) in the lower portion with scattered small limestone fragments. Weak to moderate fine granular structure with soft to slightly hard consistency when dry. Boundary indefinite to clear and smooth. Prehistoric cultural stratum with extensive historic disturbance including two large pit features extending into the lower deposit.
Layer IB	Brownish yellow (10YR 6/8) silt with clear slightly wavy boundary. Structureless to weak very fine granular structure with loose consistency when dry. Lower amount of cultural material than surrounding strata.
Layer IC	White (10YR 8/1) structureless crushed limestone powder with loose consistency. Discontinuous sterile band with abrupt smooth boundary.
Layer ID	Dark yellowish brown (10YR 4/4) silt loam with low amount of calcareous sand grains. Moderate fine granular structure with soft to slightly hard consistency when dry. Clear slightly wavy boundary.
Layer IIA	Dark yellowish brown (10YR 4/6) loamy sand with high percentage of calcareous sand grains. Weak very fine granular structure and loose consistency when dry. Upper portion of lower sandy deposit with abrupt slightly wavy boundary.
Layer IIB	Very pale brown (10YR 7/4) fine sand. Structureless with loose consistency when dry. Basal calcareous sand layer overlying uneven limestone bedrock.
Feature 1	Yellowish brown (10YR 5/4) silt loam with low percentage of sand and scattered lenses of sand and silt. Structureless to weak fine granular structure with loose to soft consistency when dry. Abrupt wavy boundary. Historic posthole with remnants of a wooden post.
Feature 2	Upper yellowish brown (10YR 5/4) silt loam and lower brownish yellow (10YR 6/6) sandy loam with frequent sand lenses. structureless to weak fine granular structure with loose consistency when dry. Historic pit feature related to Feature 1.
Feature 2A	Dark yellowish brown (10YR 4/4) silt to silt loam with frequent sand lensing due to mixing with Layer II deposit. Structureless, fine and granular with loose consistency when dry. Lower portion of Feature 2 pit probably representing same event but with different texture due to differential mixing with general deposit.

Table 3.15 Layer descriptions for Site DKC.

Layer I is relatively complex with four substrata consisting primarily of fine silts of variable colour and texture. Layer IA is highly disturbed and contained pieces of glass and metal as well as a recent hearth. It is divided into a lower and upper zone separated by a thin band of finely crushed limestone in a portion of the unit. Both historic features originated in Layer IA and include a posthole pit with the outline of the post and wood fragments preserved (Feature 1), and a more complex pit of unknown function with an upper and lower component (Features 2 and 2A). Layer IB is a fine silt distinguished primarily on the basis of colour and Layer IC is a discontinuous band of fine crushed limestone. Layer ID is a silt loam with a gradual transition to the sandy Layer II deposit. Layer IIA is a loamy sand with the base of an in situ stalagmite at the boundary with Layer IIB which is a calcareous beach sand extending to bedrock.

Depositional sequence

The DKC rockshelter was formerly located closer to the shoreline as indicated by the presence of a basal calcareous beach sand stratum. A single radiocarbon date of late preceramic age with a very large standard deviation obtained from the basal sand deposit (Layer IIB) was rejected as unreliable. The primary period of occupation occurred during the late Lapita to early Sohano phase on the basis of the ceramic evidence. Some use of the site also took place during the last few hundred years as indicated by a low amount of Recent style pottery in Layer I. In addition to the two historic pit features, recent disturbance of the deposit was evident in the form of substantial amounts of glass and metal in Layer IA and much lower amounts in the remaining Layer I substrata.

Midden and artefact distribution

The amount and density (g/m^3) of midden by weight for each excavation level at DKC are presented in Table 3.16. Despite apparently excellent preservation, the density of shell and bone was quite low throughout the deposit with little variation in density between strata. Much of the shell in the Layer II deposit may actually be a natural component of the beach sand matrix as indicated by the presence of very small bivalves and other species not normally eaten. It is also likely that the minimal amount of cultural material recovered from Layer IIB was displaced from the overlying cultural deposit. Unlike the other midden components, the density of volcanic rock actually increases somewhat within Layer II.

Lithic artefacts at DKC are limited to a single polished pebble from Layer IIA and a volcanic stone flake with a triangular cross-section from Layer ID. A number of *Rhinoclavis* shells were found throughout the deposit with single or opposing surfaces ground in the apex region which may have been tools of some sort. Shell ornaments include a *Conus* disc from the historic pit feature and *Trochus* ring fragments from Layer I and Layer II.

The ceramic assemblage at DKC is dominated by early Sohano style sherds mixed with a low amount of Buka style pottery. There is no evident change in the relative frequencies of these two styles stratigraphically, which suggests that occupation of the shelter was limited to a relatively brief period during the transition from the late Lapita to Sohano phase. Although a few Recent style sherds were found in the upper deposit, it is unlikely that DKC was occupied during this period. The pottery could easily have been introduced with the recent refuse found in the uppermost strata and on the surface.

Layer	Level	Volume (m³)	Shell	g/m³	Bone	g/m³	Charcoal	g/m³	Volcanic Rock	g/m³
IA	1	0.12	1284	10,700	5	42	9	75	-	-
IA	2	0.10	1169	11,690	5	50	4	40	555	5550
IB/C	3	0.10	785	7850	5	50	1	10	451	4510
ID	4	0.10	1317	13,170	2	20	4	40	520	5200
ID	5(LI)	0.05	352	7040	1	20	2	40	230	4600
IIA	5(LII)	0.05	924	18,480	3	60	0	0	385	7700
IIA	6	0.08	1618	21,573	8	107	1	13	454	6053
IIB	7	0.10	1853	18,530	0	0	0	0	655	6550
IIB	8	0.09	1073	12,624	0	0	1	12	807	9494
IIB	9	0.10	1076	10,760	0	0	0	0	324	3240
IIB	10	0.05	1351	27,020	0	0	0	0	514	10,280
Total		0.94	12,802	13,619	29	31	22	23	4895	5207

Table 3.16 Site DKC midden weight (g) and density (g/m³) by excavation level.

Site DAF, Sohano Wharf

Site DAF, originally designated B.P. 6 by Specht, is located on the west side of Sohano Island in the vicinity of the commercial wharf where the ferry from Buka docks. As a full description of the site has been provided, discussion here is limited to the beach area where a test unit was excavated. Non-ceramic artefacts collected from the surface of the DAF beach area were limited to obsidian and a single volcanic adze.

Excavation

In order to determine the nature of the beach deposit at DAF and provide a stratigraphic context for pottery collected from the surface of the reef, a single 1 m² test unit was excavated several metres from the beachline within the War Memorial park at the northern end of the site. This location was selected because of the abundance of Buka and Sohano style pottery and obsidian on the surface and eroding onto the reef. Coralline limestone was encountered by 30 cm below surface and occupied most of the unit below this depth although pockets of sediment extended below the general base of excavation in a restricted area. Excavation was carried out in mechanical levels from 10 to 20 cm thick and halted at a depth of 1.3 m b.s., ca. 20 cm below the water table at high tide.

Stratigraphy

Only one stratigraphic unit was present within the test unit consisting of silt mixed with variable amounts of calcareous beach sand. Layer IA, restricted to the upper 5 to 10 cm of the unit, is distinguished by the presence of narrow sand bands probably related to recent disturbance. A thin layer of crushed limestone separates this substratum from the main deposit (Layer IB) and may have been deposited during construction of the War Memorial park by the Australian administration. The entire deposit had been extensively disturbed by crab burrowing and fragments of metal were relatively abundant in the upper 30 cm. A few small pieces of metal were also found below 70 cm. Stratigraphic profiles are illustrated in Figure 3.17 and layer descriptions found in Table 3.17.

Depositional sequence

The DAF deposit was formed during the process of beach formation on reef limestone undergoing tectonic uplift during the emergence of Sohano Island. The coralline bedrock within the excavation unit includes coral head formations. Occupation of the site occurred during both the late Lapita phase and Sohano phase based on the ceramic evidence. Although there is a gradual increase in Sohano style relative to Buka style pottery between the lower and upper levels of the site, this is interpreted as the result of mixing between two temporally distinct occupation components rather than a gradual replacement of one style by the next. A basal date of about 500 BP is attributed to the dating of intrusive charcoal from a minor occupation component during the Mararing to Recent phase.

Midden and artefact distribution

The amount and density (by weight) of midden remains by excavation level from the DAF excavation unit is presented in Table 3.18. Shell density figures are lower than for any of the other open coastal sites excavated with peaks in the upper 30 cm and the base of the deposit. The amount of bone recovered is minimal and uniformly distributed throughout the deposit. The density of volcanic rock, which was imported to the island for use as oven stones, increases substantially below the top 20 cm and peaks in the levels with the highest charcoal density.

The density of pottery sherds at DAF exceeds that of any other excavated site with an overall figure of 4457 sherds/m³, due in large part to the abundance of sherds less than 2 cm in diameter. Pottery distribution is relatively uniform with no apparent patterning between levels. As with shell and bone, pottery was most abundant in the basal excavation level. The most common non-ceramic artefacts are small pieces of flaked obsidian (n=13), which have an overall density of 24 flakes/m³. Other lithic artefacts include a volcanic hammerstone and abrader, two grindstone fragments and a pumice abrader. Most of the lithic material closely resembles that found on the reef portion of DAF in association with Lapita ceramics. Shell artefacts include a piece of worked pearl shell and two *Rhinoclavis* sp. gastropods with ground surfaces similar to those found at Site DKC.

Layer IA	Light yellowish brown (10YR 6/4) banded loamy sand with small fragments of coral. Structureless very fine sand with loose consistency when moist. Lower boundary marked by band of crushed limestone. Upper disturbed cultural deposit.
Layer IB	Dark grey (10YR 4/1) in upper portion to very dark grey (10YR 3/1) in lower deposit. Silt loam with higher percentage of silt than sand. Structureless to weak very fine and granular with loose consistency when moist. Sediment extends into a deep depression within the irregular reef limestone bedrock and below the water table where excavation was halted. Much limestone and coral rubble in the lower portion.

Table 3.17 Layer descriptions for Site DAF.

Layer/ Level	Volume (m^3)	Shell	g/m^3	Bone	g/m^3	Charcoal	g/m^3	Volcanic Rock	g/m^3
IA/1	0.10	1581	15,810	-	-	-	-	267	2670
IB/2	0.10	7541	75,410	9	90	5	50	944	9440
IB/3	0.10	7353	73,530	4	40	12	120	2886	28,860
IB/4	0.10	2380	23,800	6	60	6	60	1109	11,090
IB/5	0.05	2130	42,600	9	180	15	300	1175	23,500
IB/6	0.04	1464	36,600	8	200	7	175	625	15,625
IB/7	0.05	909	18,180	4	80	3	60	695	13,900
IB/8	0.05	733	14,660	10	200	3	60	225	4500
IB/9	0.03	1603	53,433	7	233	4	133	330	11,000
Total	0.62	25,694	41,442	57	92	55	89	8256	13,316

Table 3.18 Site DAF midden weight (g) and density (g/m^3) by excavation level.

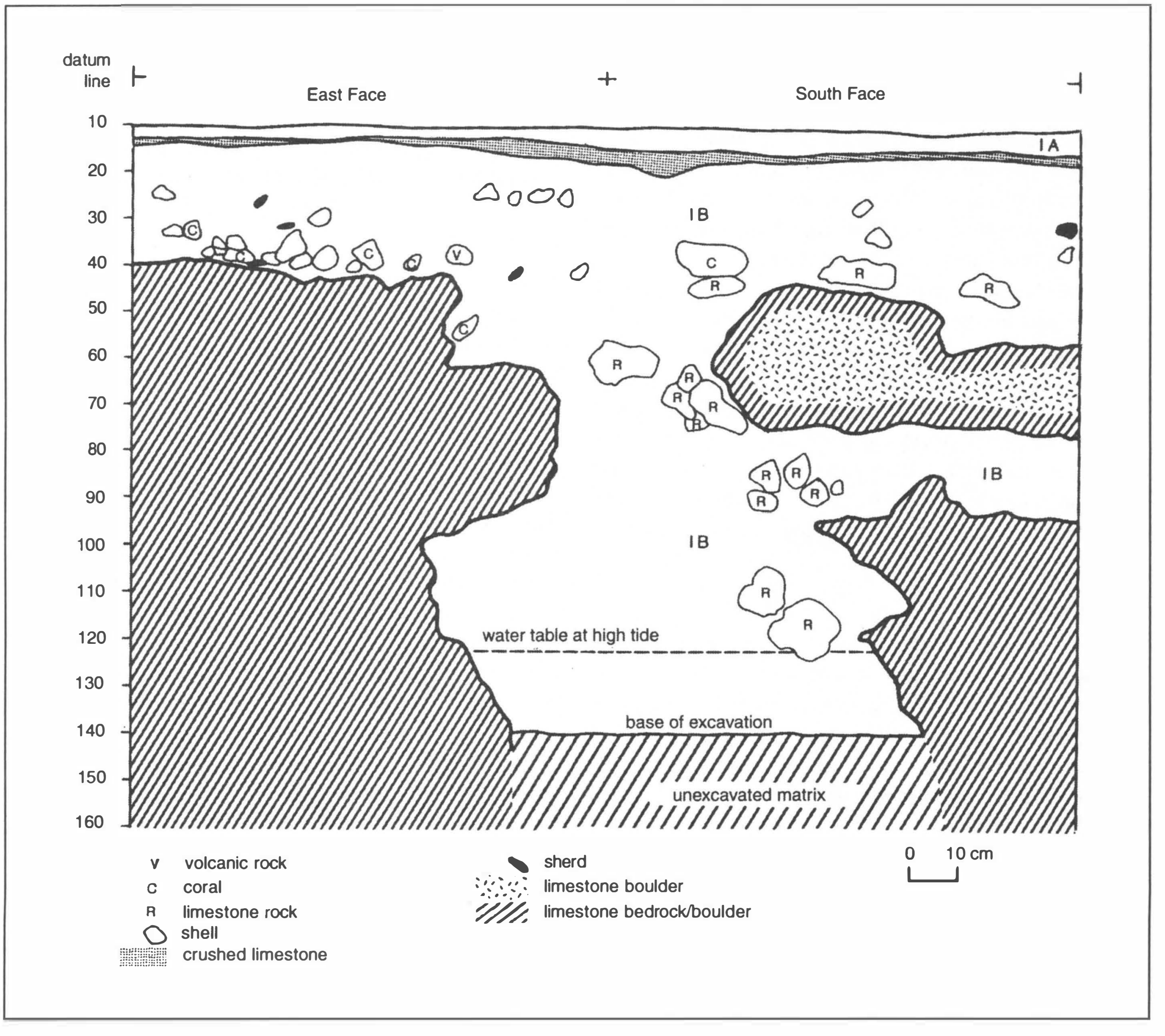


Figure 3.17 Site DAF: Stratigraphic profile, east and south face.

THE PORORAN ISLAND SITES

The islands of Pororan and Hetau, located along the barrier reef that shelters the west coast of Buka, were intensively surveyed in order to extend the range of site locations to include small offshore islands (Fig. 3.1). Hetau is a small low islet with a single village where a series of low mounds with Recent and Mararing style pottery and marine shell midden were noted during survey and designated Site DJT. Pororan lies 7 km due south of Cape Dunganon on Buka and has an area of approximately 1.6 km^2 which is almost entirely planted in coconuts, with the exception of an area of dense mangroves along the east coast. The island has a central elevated limestone core less than 5 m high skirted by unconsolidated calcareous beach sands. The shoreline consists of gradually sloping sand beaches except in the southwest where a sea cliff rises abruptly from the reef flat to an elevation of 2 to 3 m asl. The lack of undergrowth in most locations planted in coconuts made it possible to locate ceramic sites with relative ease.

As shown on the Pororan site map (Fig. 3.18), a total of six coastal sites was located during survey and excavation was carried out at two of these, DJW and DJU. Three of the sites, DJV, DJX and DJY, are located on the margins of the uplifted limestone formation and have Hangan, Mararing and Recent style sherds on the surface. DJZ is located at the foot of the raised limestone directly south of DJU and has Hangan to Recent style pottery on the surface, with a predominance of Malasang style sherds.

Site DJW, Kura

DJW is an open beach site located west of Yaparu village on a small bay along the south central coast of Pororan. The site lies within an area known as Kura and was identified by the presence of shell midden and pottery on the ground surface where a great deal of disturbance from pig rooting was evident. As indicated on the site map (Fig. 3.19), a scatter of surface pottery was found over an area of approximately 100 by 60 m extending to within 5 to 10 m of the high tide line. The main

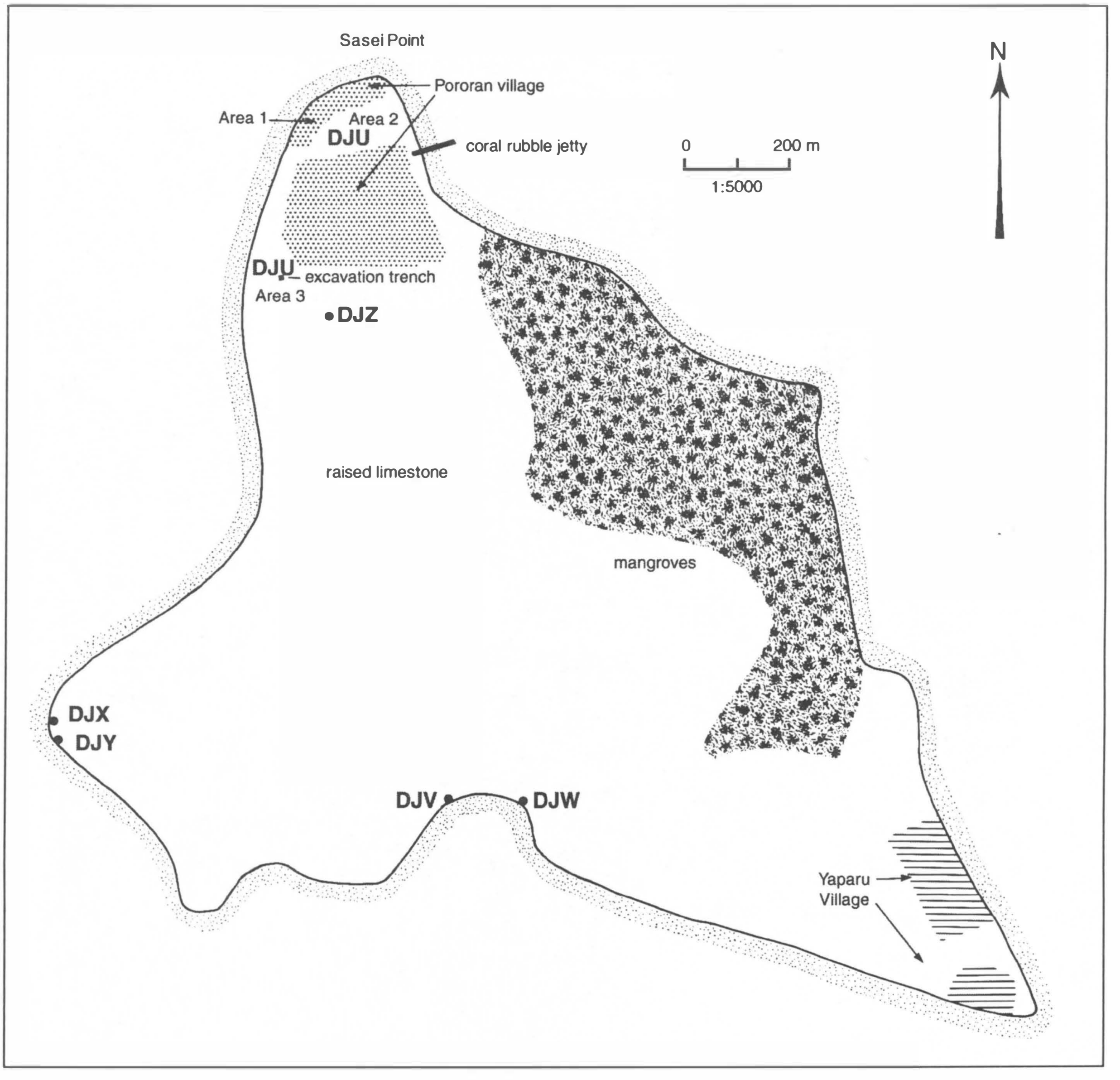


Figure 3.18 Pororan Island: Location of archaeological sites.

concentration of pottery covered an area of ca. 250 m^2. The site is located directly east of a low limestone cliff in a low-lying area behind a narrow gradually sloping calcareous sand beach fronting an extensive intertidal reef flat. Vegetation in the site area consists of rows of coconut palms with little undergrowth, permitting good visibility of the ground surface.

Collection of pottery and other artefacts from the surface of DJW was carried out prior to excavation in order to ascertain the range of pottery styles present and select a suitable location for subsurface testing. Surface pottery is dominated by Mararing style and, to a lesser extent, Recent style sherds over most of the site, although a concentration of Hangan and Sohano style sherds is present in the central portion of the site. A few sherds with decoration transitional from the Malasang to Mararing style were collected but no Malasang style sherds were found. In addition to pottery, a range of shell artefacts were collected including *Tridacna* adzes and rings, *Trochus* rings and a *Spondylus* scraper. Several coral and pumice abraders and a volcanic grindstone were also collected. Most of the artefacts were located outside of the Hangan and Sohano style pottery concentration suggesting that they are from the Mararing to Recent phase.

Excavation

A two by two metre test trench was excavated at the centre of the Hangan and Sohano style pottery concentration where pig rooting disturbance was minimal. The trench was oriented from north to south and excavated in two 1 m^2 units. Excavation was carried out in 10 cm levels due to the lack of clear stratigraphic boundaries within the cultural deposit.

Stratigraphy

The stratigraphic sequence at DJW is comprised of a basal calcareous sand (Layer III) on which a shell midden deposit with several sublayers formed (Layer II). A thin A horizon has developed over the midden deposit (Layer I). This three layer sequence is similar to those in the other two coastal midden sites, DJO and DJU.

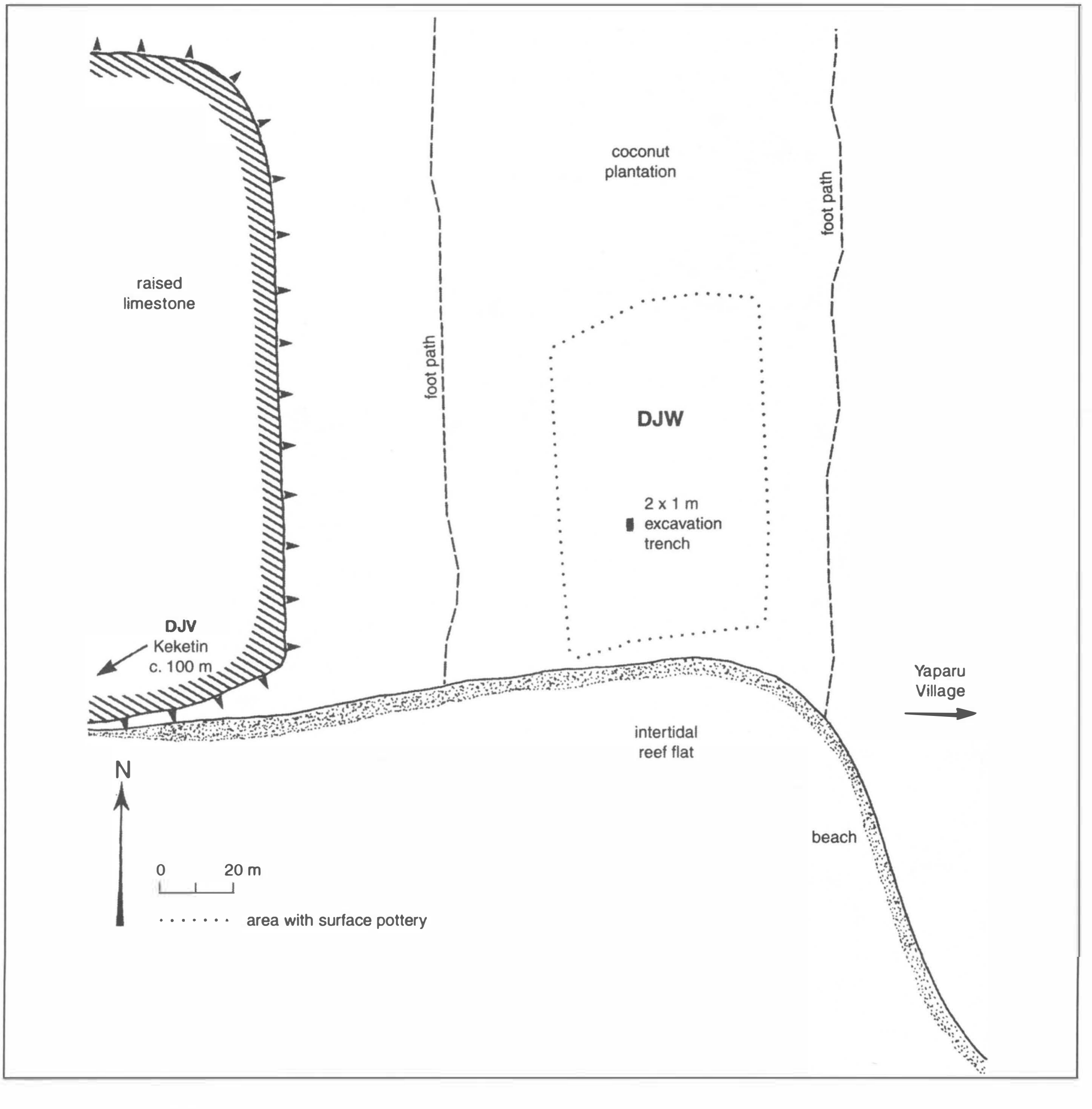


Figure 3.19 Site DJW: Plan.

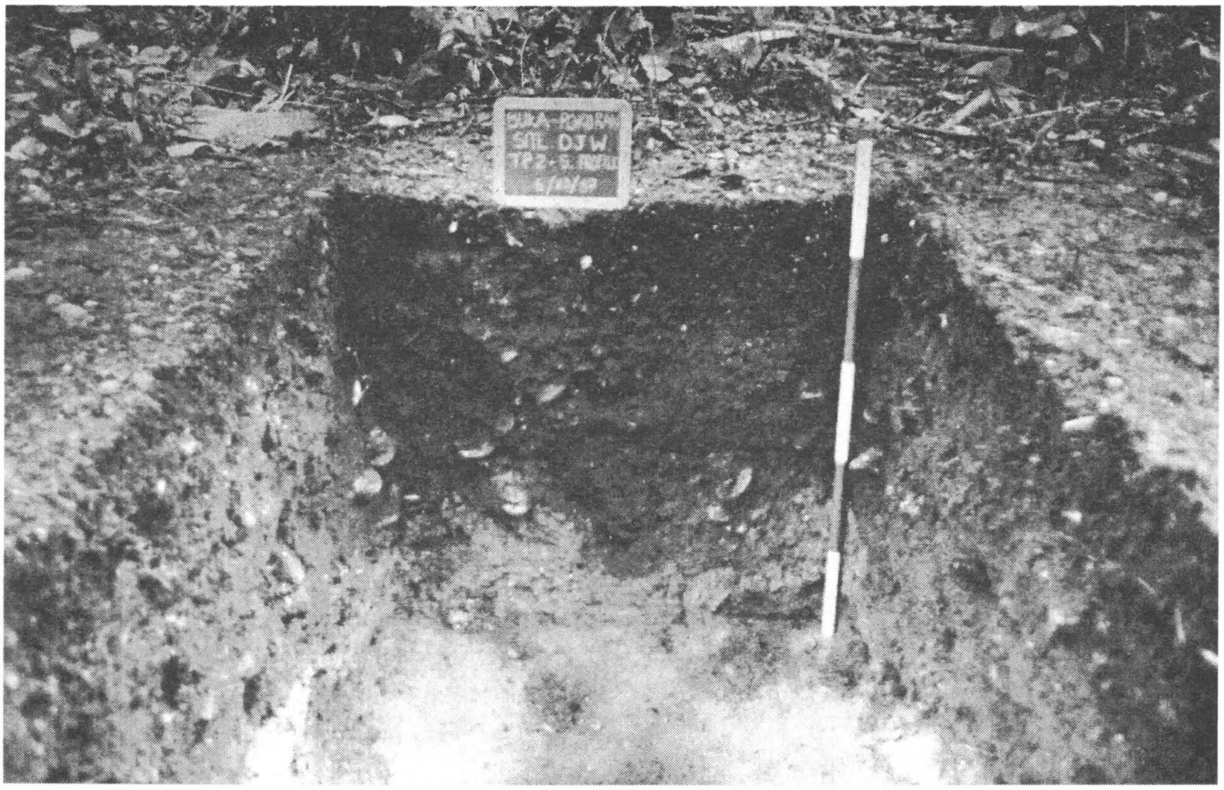


Plate 3.10 South face of excavation trench at Site DJW.

The cultural deposit at DJW is up to 85 cm deep and grades into a culturally sterile calcareous sand substrate (Plate 3.10). A 1 by 0.5 m shovel test was excavated within the trench an additional 35 cm below the cultural deposit to insure that culturally sterile matrix had been reached. Extensive crab disturbance was present throughout the deposit as indicated by recently active crab burrows and extensions of Layer II matrix into the sterile sand substrate following the outline of abandoned crab burrows. Stratigraphic profiles of the trench are found in Figure 3.20 and layer descriptions in Table 3.19.

Depositional sequence

As with sites DJO and DJU, initial occupation at DJW took place on a low calcareous sand beach. DJW was occupied from ca. 1400 BP at the end of the Sohano phase until the early Hangan phase as indicated by a gradual transition from Sohano to Hangan style pottery within the site deposit. Although a date has not been obtained for the upper deposit, the ceramic evidence indicates that limited use of the site occurred during the later Hangan phase with more intensive occupation during the Mararing to Recent phase. Local informants identified Kura as the location of a former village although no estimate of when the site was last occupied could be given.

Midden and artefact distribution

The quantity and density (by weight) of midden remains by level from DJW is presented in Table 3.20. Although shell preservation was relatively poor at DJW due to weathering by humic acids giving the shell a chalky appearance, the deposit had the highest overall shell midden density of any site excavated (154.8 kg/m^3). Shell density was uniformly high in all levels above the basal sand layer but decreased between the lower (Layer II) and upper (Layer I) midden deposit as was also the case with bone and other midden components. Bone weights were also quite high although much of it was white and chalky due to decalcification. A concentration of pig bone representing at least two individuals, including a partially articulated immature specimen, was present in Layer I. Charcoal was abundant throughout the deposit and volcanic oven stones were common in all levels but declined markedly in the basal portion of the deposit.

Pottery density at DJW is second only to DAF with 2980 sherds/m^3. The highest density occurs in Layer I and declines steadily with depth. There is a clear shift from a predominance of Sohano style pottery to Hangan style pottery between the lower and upper deposit. Lithic artefacts include five small flakes of obsidian, three volcanic abraders and a block coral abrader. Shell artefacts consist of a finished shell adze and several adze blanks plus ornaments ranging from *Trochus*, *Tridacna* and *Conus* rings to small gastropods with suspension holes and beads. Two pieces of worked bone were also recovered.

Site DJU, Pororan Village

Site DJU is located within the village of Pororan which lies at the northern tip of Pororan Island called Sasei Point. The village has been in this location since the Australian administration period and was formerly situated along the south coast at a location known as Keketin (Site DJV). Sasei point is a level, low-lying area of calcareous sand with scattered low mounds situated around the perimeter of the main village compound which is enclosed by a low coral rubble wall to keep out pigs (Fig. 3.21). The mounds contain midden deposits which are actively

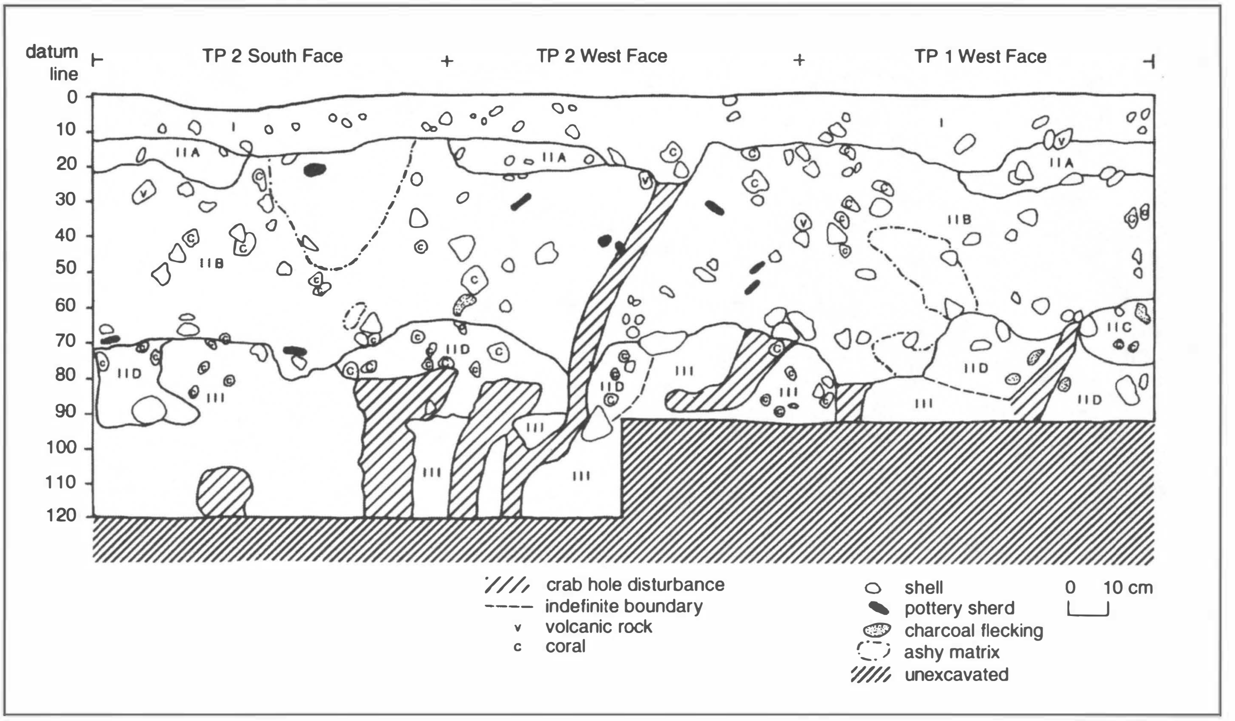


Figure 3.20 Site DJW: Stratigraphic profile, south and west face.

Layer I	Black (10YR 2/1) silt with branch and block coral and very low amount of pumice. Weak fine crumb structure with very friable consistency when moist. Boundary clear and wavy. Developing humus horizon with many coconut roots and some pig rooting disturbance. Midden containing the highest concentration of charcoal, volcanic oven stones and pottery, along with dense shell and a low amount of bone. The high midden density may be due in part to introduction of material from Layer II due to crab disturbance.
Layer IIA	Very pale brown (10YR 7/3 - 7/5) loamy sand. Discontinuous sublayer with fine silt mottles. Structureless, very fine and granular with loose consistency when moist. Boundary clear and slightly wavy. Very low amount of cultural material.
Layer IIB	Very dark grey (10 YR 3/1) loam grading to sandy loam near base. Abundant branch coral and much lower amount of block coral increasing in density with depth. Scattered small mottles of very pale brown (10YR 7/3) calcareous sand and area of very dark greyish brown (10YR 3/2) loam with low amount of ash in south profile, TP 2. Structureless, very fine and granular with loose consistency when moist. Boundary clear to diffuse and wavy to irregular. Main cultural deposit with concentrated midden reaching its highest density at the base of the sublayer. Range of midden similar to Layer I with highest concentration of shell of all sites excavated.
Layer IIC	Dark greyish brown (10YR 4/2) sandy loam with abundant coral. Structureless, fine and granular with loose consistency when moist. Boundary diffuse and slightly wavy. Lower cultural deposit sublayer with higher percentage of sand than Layer IIB and decrease in midden density.
Layer IID	Pale brown (10YR 6/3) loamy sand with great increase in amount of branch coral from overlying sublayer. Structureless, coarse and granular with loose consistency when moist. Extensions of cultural deposit into Layer III representing former crab burrows and gradational transition to sterile sand. Low amount of cultural material.
Layer III	Very pale brown (10YR 7/3) coarse calcareous sand with high amount of branch coral. Structureless, coarse and granular with loose consistency when moist. Sterile calcareous sand substrate.

Table 3.19 Layer descriptions for Site DJW.

eroding due to extensive pig rooting and other disturbance. The site was subdivided into four spatially discrete areas during survey.

DJU covers an area of approximately 8000 m^2 based on the distribution of artefacts on the surface. Vegetation within the site area is limited to coconut palms and scattered trees with a minimal amount of undergrowth. The mounds are under 1 m except for the beach ridge in Area 3 which is 1.5 m high. Areas 1, 2 and 4 have mounds which are roughly circular while Areas 1A and 3 have more linear mounds. Although some cultural material was found on the surface between the mound areas, the main deposits appear to be limited to the mounds themselves. Initially, pottery and other artefacts were collected from the surface of each site area, followed by excavation of a test trench located at the centre of Area 3 (DJU-3).

Mararing and Recent style pottery is most common on the surface of DJU but lower amounts of Hangan style and a few late Malasang style sherds were also collected. Concentrations of Hangan style pottery were present in Areas 2 and 3. Two late Sohano style sherds were brought to the surface during excavation of a post hole for a new house within the main village compound

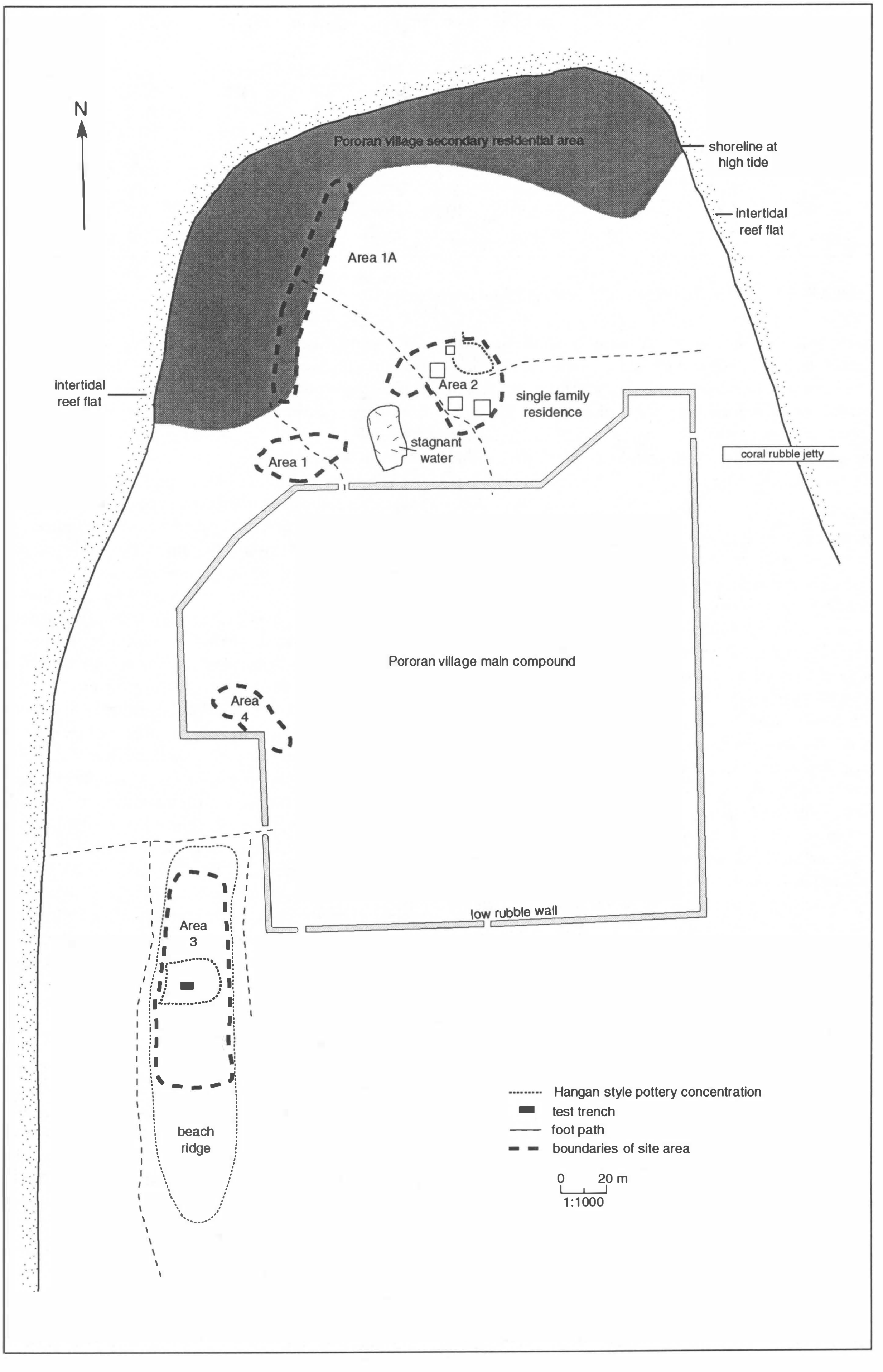


Figure 3.21 Site DJU: Plan.

Layer/ Level	Volume (m^3)	Shell	g/m^3	Bone	g/m^3	Charcoal	g/m^3	Volcanic Rock	g/m^3
I/1	0.20	30,907	154,535	185	925	56	280	4500	22,500
I/2	0.20	27,898	139,490	493	2465	35	175	3300	16,500
II/3	0.20	30,509	152,545	81	405	32	160	2550	12,750
II/4	0.20	40,038	200,190	65	325	40	200	2600	13,000
II/5	0.20	34,490	172,450	93	465	24	120	1000	5000
II/6	0.20	34,958	174,790	122	610	37	185	1350	6750
II/7	0.24	41,653	173,554	207	863	35	146	1300	5417
II-III/8-9	0.36	38,246	106,239	66	183	30	83	763	2119
Total	1.80	278,699	154,833	1312	729	289	161	17,363	9646

Table 3.20 Site DJW midden weight (g) and density (g/m^3) by excavation level.

but not found elsewhere. A range of shell artefacts including adzes, ornaments and a single trolling lure shank were also collected. Stone artefacts on the surface include one complete lugged axe and two axe lug fragments, a large pumice abrader and two obsidian flakes. Fragments of European ceramic trade pipes were found in Areas 1, 1A and 3.

Excavation

A two by one metre test trench was excavated at the centre of the linear mound within Area 3 southwest of the village compound. Surface pottery extended over the northern 110 m of the 165 m long mound covering an area of about 4400 m^2. The excavation trench was placed within a 500 m^2 surface concentration of Hangan style pottery where disturbance was minimal. The long axis of the trench was oriented from west to east across the mound slightly west of the crest which was fairly flat. The western slope of the mound is much steeper than that to the east which is shorter and more gradual due to a general rise in the ground surface from west to east. Although the maximum height of the mound is 1.5 m, much of it is lower than this with a gradual decrease in elevation from north to south. The test trench was excavated as two 1 m^2 units. All matrix was removed by trowelling in 10 cm levels except for Layer I which was excavated as a single unit. The cultural deposit is 95 cm thick and an additional 15 cm of basal sand was excavated to check for cultural material with negative results.

Stratigraphy

As with the other coastal midden sites, the stratigraphic sequence at DJU is relatively simple and has three major components. A midden deposit with several sublayers (Layer II) formed on a basal calcareous beach sand (Layer III) and is capped by a shallow developing A horizon (Layer I). A single pit feature was identified within the Layer II midden. Stratigraphic profiles of the trench are illustrated in Figure 3.22 and layer descriptions provided in Table 3.21.

Depositional sequence

A single basal radiocarbon date from the DJU deposit indicates that initial occupation of Area 3 took place not long after 1300 BP during the Hangan phase. At this time a low beach ridge existed where the linear mound recorded as Area 3 now stands. Disposal of food remains and other refuse from a habitation site on or near the ridge resulted in the accumulation of a dense midden deposit giving the mound its present form. The absence of pottery or other cultural material from the surface at the southern end of the mound suggests that this may not have been utilised.

The high concentration of midden in Layer IIC suggests that the most intensive use of the site took place during the initial period of occupation. The amount of midden tapers off towards the outer edge of the mound where Layer IIC is no longer present. Less intensive use of the area over time is indicated by a decline in midden between Layer IIC and IIB although a second zone of concentrated midden is present at the top of Layer IIB. Abandonment of the site is indicated by a sharp drop in midden between Layer II and Layer I. Much of the cultural material in Layer I may have been introduced through post-depositional disturbance of Layer IIA by pig rooting and other activity.

There is an abundance of Mararing and Recent style pottery on the site surface in all areas indicating extensive use of the location presently occupied by Pororan village during this phase. A few potsherds with decorative elements characteristic of later Malasang style pottery were also found on the surface in several locations. Malasang style pottery is dominant in surface collections from Site DJZ, located less than 100 m southeast of Area 3 at DJU. Thus occupation of the general DJU area extends from the Hangan to Recent phase with a marked expansion following the Malasang phase.

Midden and artefact distribution

As shown in Table 3.22, Layer IIC has by far the highest density of both shell and bone although charcoal density decreases in this layer. Layer IIB has considerably less midden although a clear peak in shell, bone, charcoal and volcanic rock occurs in the middle portion of the stratum (level 4). Overall shell density is slightly lower than for Site DJO but higher than all other sites except DJW. The vertebrate remains are dominated by pig as at Site DJW and bone density is also similar. Most bone at DJU is also decalcified to some extent. There is a concentration of sea mammal (most likely dolphin) vertebrae, ribs and long bones in Layers IIB and IIC.

The range of artefacts is quite similar to sites DJW and DJO with an emphasis on the use of shell. Pottery density is similar to DJW although somewhat lower at

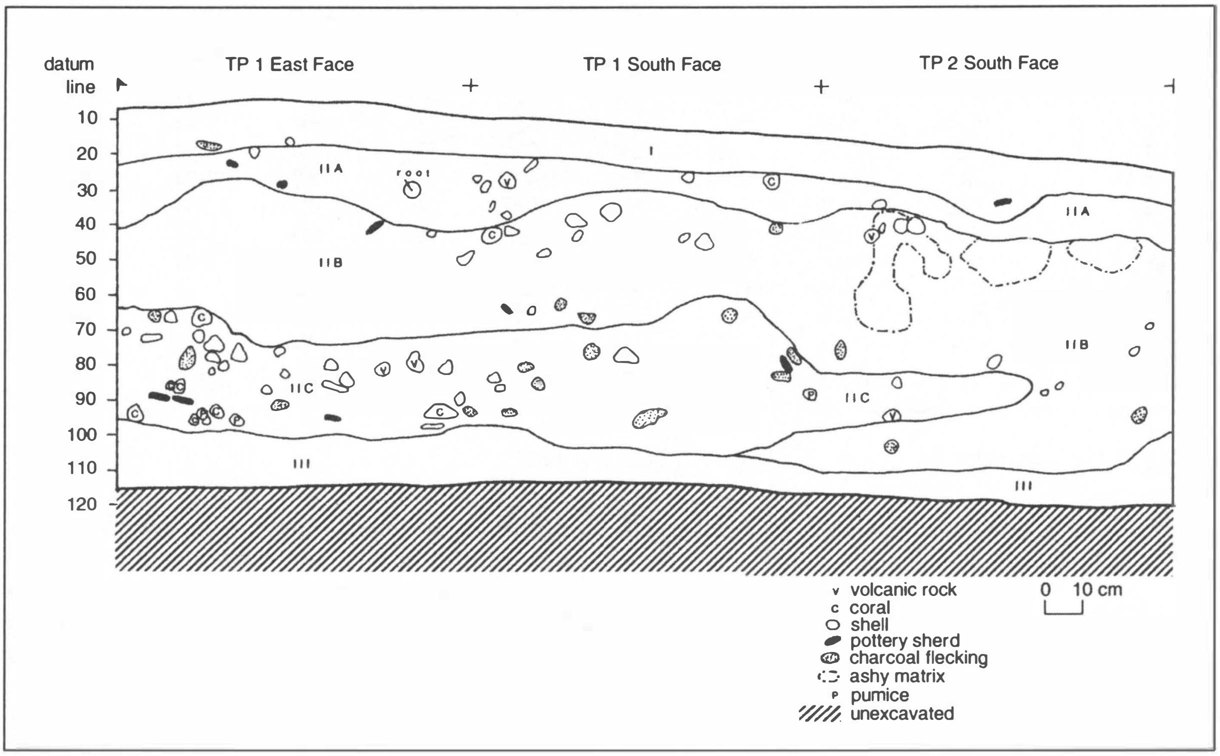


Figure 3.22 Site DJU-3: Stratigraphic profile, south and east face.

Layer I	Very dark grey (10YR 3/1) silt with a low amount of fine calcareous sand grains increasing with depth. Variable amount of branch coral from 275 g in TP 1 to 1600 g in TP 2. A much greater amount of coral was present throughout the stratigraphic profile in TP 2 than TP 1. Weak, very fine crumb structure with very friable consistency when moist. Boundary clear and slightly wavy. Developing humus layer with many coconut roots. Low amount of midden containing heat-altered volcanic oven stones, charcoal flecks, shell, bone, pottery and other artefacts. Minor disturbance of upper portion due to recent pig rooting.
Layer IIA	Very dark grey (10YR 3/1) loam with scattered inclusions of ash. Drop in amount of coral from Layer I. Structureless, very fine, and granular with loose consistency when moist. Boundary clear and very wavy related to increase in ash more than changes in texture or colour. Decline in amount of midden from Layer I. Upper cultural deposit with less ash and midden than lower deposit.
Layer IIB	Dark greyish brown (10YR 4/2) loam in upper portion to yellowish brown (10YR 5/4) sandy loam near base. A few scattered mottles of very pale brown (10YR 7/4) coarse calcareous sand surrounding Feature 1. White (10YR 8/1) amorphous ash concentrations throughout layer with some associated charcoal flecking. Marked increase in amount of block and branch coral. Structureless, fine to very fine and granular with loose consistency when moist. Boundary clear and wavy with some diffuse staining into Layer III sand. Marked increase in amount of midden from Layer IIA with highest concentration of material at top of sublayer. Midden includes same range of material as Layer I. Cultural deposit with moderately dense midden and ash.
Layer IIC	Brown (10YR 5/3) to dark brown (10YR 4/3) loam to sandy loam with increasing percentage of sand with depth. Structureless, fine and granular with very friable consistency when moist over majority of sublayer with presence of scattered weakly cemented friable peds. Similar amount of block and branch coral to Layer IIB. Boundary clear and slightly wavy with some diffuse staining of Layer III sand. Highest midden density in deposit with dense concentration of shell associated with ash, charcoal, volcanic oven stones, pottery and other artefacts. Midden highly compacted in some areas, particularly near base. Dense lower cultural deposit present in TP 1 and tapering off in northern half of TP 2.
Layer III	Very pale brown (10YR 7/4) calcareous sand with detrital shell and coral and low amount of pumice. Structureless, coarse and granular with loose consistency when moist. Sterile basal calcareous sand underlying cultural deposit.
Feature 1	Dark greyish brown (10YR 4/1) loam. Pit feature extending from Layer IIA into Layer IIB matrix in west face of TP 2. Round-bottomed with conical shaped possible posthole projecting from base below dense ash concentration. Coarse calcareous sand mottles around edge of feature fill. Diameter 60 cm with maximum depth of 40 cm including possible posthole projection. Function unknown. No visible contrast in cultural content from surrounding matrix.

Table 3.21 Layer descriptions for Site DJU-3.

2247 sherds/m^3 with the highest figures in the middle of Layer IIA as with faunal remains. Unlike other midden components, sherd density decreases in Layer IIC and is highest in Layer I. Pottery sherds with ground margins occur throughout the DJU deposit and also at Site DJO. No stone tools were recovered but shell artefacts include an adze and trolling lure shank, worked pearl shell fragments, many *Trochus* ring fragments in various stages

Layer/ Level	Volume (m^3)	Shell	g/m^3	Bone	g/m^3	Charcoal	g/m^3	Volcanic Rock	g/m^3
I/1	0.21	3979	18,948	17	81	67	319	1550	7381
IIA/2	0.20	4609	19,895	103	515	78	390	1100	5500
IIA/3	0.20	13,236	23,045	250	1250	104	520	1600	8000
IIB/4	0.20	11,314	66,180	328	1640	110	550	2100	10,500
IIB/5	0.18	6759	37,550	100	556	94	522	660	3667
IIB/6	0.22	9201	41,823	246	1118	119	541	1300	5909
IIB/7-8(TP2)	0.20	13,005	65,025	139	695	83	415	1800	9000
IIC/7-8(TP1)	0.20	28,318	141,590	360	1800	80	400	1950	9750
IIB-C/9	0.20	2235	11,175	12	60	46	230	217	1085
III/10	0.25	558	2232	0	0	6	24	23	92
Total	2.06	93,214	45,250	1555	755	787	382	12,300	5971

Table 3.22 Site DJU midden weight (g) and density (g/m^3) by excavation level.

of manufacture, perforated *Nassarius* shell ornaments and small beads.

SITE DJO, KESSA PLANTATION

Although Specht (1969:338) was informed by mail in 1968 of potential archaeological deposits at Kessa Plantation by the plantation manager, J. Barry Laver, he did not actually visit Kessa. Pottery had been noted in three locations at Kessa which Specht designated Site B.P. 72 in his thesis and later subdivided into three separate sites (Specht n.d.). These sites were recorded as DCT, DCV and DCW within the PNG National Site recording system. Although the DJO site area probably incorporates collection Area C of B.P. 72 (DCW), it was decided that a new site designation was warranted due to the lack of a precise site location for DCW in Specht's description.

Site DJO consists of prehistoric midden deposits within a ridge and two nearby mounds at Kessa. The ridge is oriented roughly west to east parallel to the mangrove-covered coastline immediately east of the southern tip of Cape Dunganon, the sand spit on which Kessa Plantation is located (Fig. 3.23). The overall site dimensions are 490 m from west to east and between 20 and 30 m from north to south with a total area of about 12,250 m^2. The main ridge rises above the low-lying shoreline (i.e. less than 1 m asl) from 0.8 m at the western end to 4.4 m near the eastern end but only exceeds 2 m in the eastern half. The top of the ridge is irregular with several small hillocks and a slope of 5 to 20 degrees (the north slope is 2 to 4 degrees steeper than the south). Two smaller mounds located at the western end of the ridge have a combined area of ca. 1000 m^2.

The entire site area is planted with regular rows of coconut palms with a grassy undergrowth that ranged from knee to waist height during survey and excavation. A track for plantation vehicles runs along the length of the site and intersects the deposit at two points. Heavy mangrove growth exists along the coastline extending to within 140 m of the site at its western end and 35 m at the eastern end. No beach has formed in this area and the interior extent of the mangroves approximates the coastline with an intertidal inner mangrove mud flat and outer reef flat extending seaward from this point.

Although there is currently no memory of a settlement at Kessa among the current residents of the area, Parkinson notes the presence of a village called Kessa in the late 1800s (cited in Specht n.d.:66). According to Thomas Bini, assistant manager of Kessa Plantation and a traditional landowner in the Lontis/Kessa area, people from the vicinity of Punen within the Solos language area were the first settlers of Kessa, from where they subsequently spread to Lontis and farther north along the coast. When asked about possible settlement in relation to the DJO site area, Mr Bini replied that the ridge was probably natural and that people traditionally lived in such locations in order to gain a vantage point from which they could note the approach of potentially hostile groups from neighbouring areas.

Intensive survey of DJO and the surrounding area, including numerous shovel tests, revealed that the main cultural deposit was limited to the ridge and two adjacent mounds. The site was divided into five collection areas (A-E) delineated by physical features as indicated in Figure 3.23. Controlled test excavations were carried out in Area A (0.75 m^2) and Area D (4 m^2) and stratigraphic profiles of the deposit were recorded in Areas B and D along the ridge where recent disturbances had cut into the deposit. Several shovel tests within the deposit provided supplemental stratigraphic details.

Mound Areas A and E

Area A is a low mound from 0.8 to 1.6 m high with an area of 945 m^2. The mound is spatially distinct from the main ridge which lies 20 m to the east and a shovel test between the two areas (ST 1) indicated a break in the cultural deposit between the two areas. Directly west of Area A is a second mound approximately 800 m^2 in area and up to 2.8 m high designated Area E. A low amount of pottery and shell midden was present on the surface of this mound and extended westward to a small garden area at the base of the mound. No excavation was carried out in this area due to disturbance of the cultural deposit by landscaping associated with construction of the nearby plantation manager's home. Area E represents the westernmost extent of the DJO deposit and is most likely an extension of the Area A deposit.

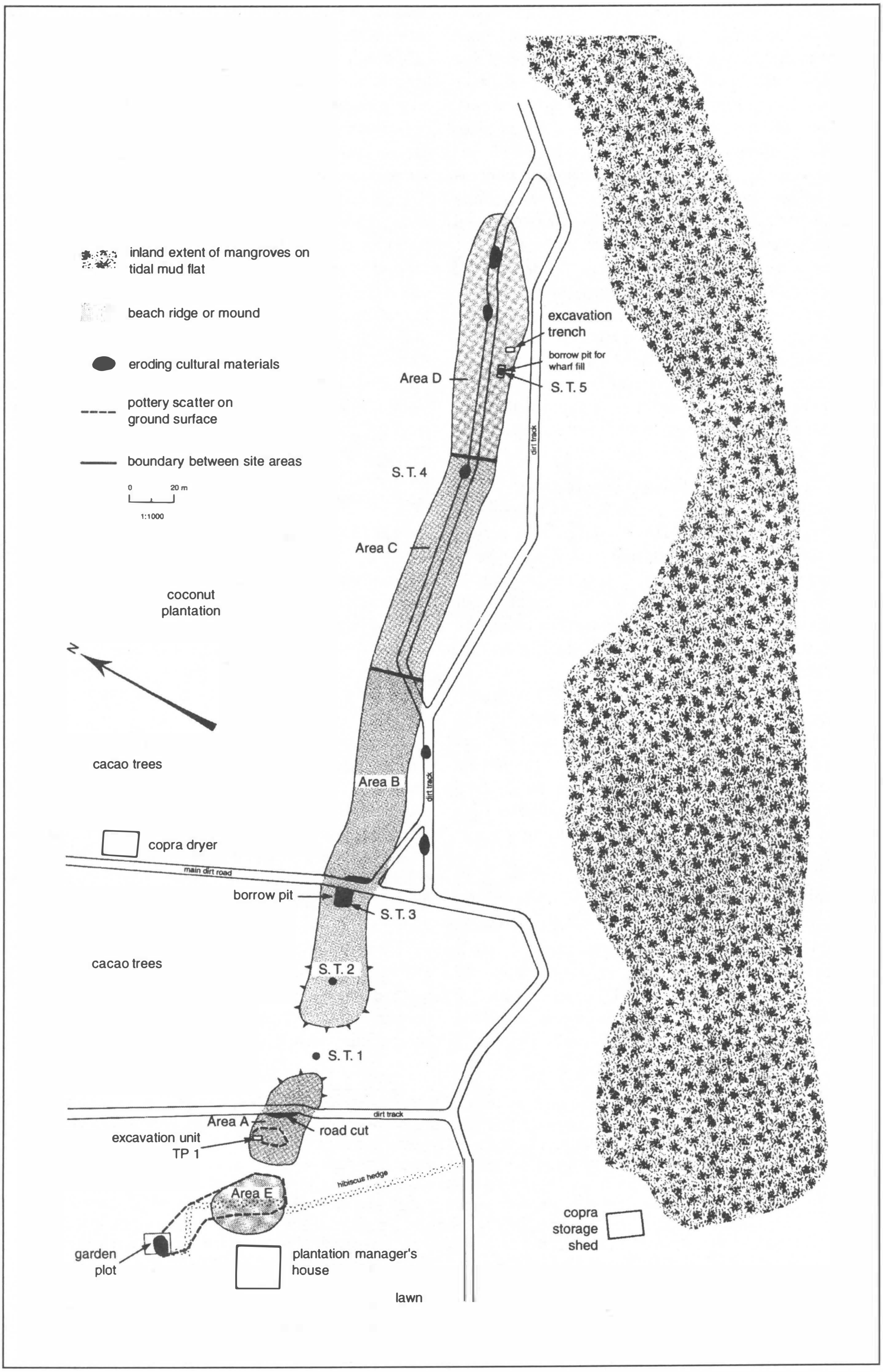


Figure 3.23 Site DJO: Plan.

A moderate amount of pottery and shell midden was present on the surface of Area A where it had been brought to the surface by crab burrowing. Sherds and shells were also found eroding out of an exposed face where a vehicle track had been cut through the mound. Additional disturbance of the deposit had taken place along the northern edge of the mound where a pit had recently been dug to plant a coconut seedling. A concentration of Hangan style pottery was found covering ca. 150 m^2 of the mound surface in the vicinity of the pit and sherds were also eroding from the pit profile. The west face of the pit was cut back to reveal the undisturbed deposit and a 1.5 by 0.5 m test unit designated TP 1 was excavated along this profile.

Excavation was in mechanical 10 cm levels throughout the undifferentiated midden deposit (Layer II) but the upper A horizon stratum (Layer I) was removed as a single unit. A small pit was dug an additional 35 cm below the general base of excavation within this layer to confirm that culturally sterile matrix had been reached.

Stratigraphy and depositional sequence

The stratigraphic sequence within TP 1 includes a thin topsoil stratum (Layer I) overlying the cultural deposit (Layer II) with extensive coconut root disturbance of the upper portion. The cultural deposit ranges from 85 to 115 cm in thickness and grades into a sterile calcareous sand substrate (Layer III). A stratigraphic profile of the trench is found in Figure 3.24 and layer descriptions are located in Table 3.23.

Based on the ceramic evidence, the DJO-A deposit represents a relatively brief occupation during the late Hangan phase at about the same time that the lower portion of the DJO-D deposit was formed. No internal stratigraphic divisions were noted within the Layer II cultural deposit although disturbance of the upper portion by coconut roots and the coconut seedling pit was marked.

Main ridge Areas B to D

The main ridge deposit at DJO was divided into three areas designated B, C and D from west to east. Area B includes the lowest portion of the ridge and also has the lowest density of cultural material. Shovel tests (ST 2 and 3) and an exposed road cut and borrow pit profile revealed a stratigraphic sequence similar to that in Area A. A thin developing A horizon layer overlies the main midden deposit which grades gradually into a sterile calcareous sand substrate. While cleaning off the exposed face of the deposit to the west of the road cut, an intact hearth feature was revealed with Malasang style pottery and some heat-altered shell and bone. The exposed profile extended to a depth of 150 cm below surface where the loamy sand matrix became increasingly wet and cemented. Area C included the central portion of the ridge where a series of five hillocks are located. Pottery and shell midden were found eroding from the deposit at several points within this area although no subsurface testing was carried out apart from a single shovel test (ST 4). Area D is located at the eastern end of the ridge where the elevation increases steadily from Area C. The recent removal of soil from the southern ridge slope had exposed a portion of the cultural deposit from which pottery and shell midden were actively eroding. The soil which had been removed was used as fill for a retaining wall adjacent to the Kessa wharf. A shovel test (ST 5) along the face of the borrow pit confirmed the presence of a substantial intact cultural deposit.

Area D excavation

A four by one metre trench was excavated 6 m east of the borrow pit in Area D between two rows of coconuts. The trench was located just above the base of the ridge with the long axis extending northward to within 5 m of the ridge crest. The ridge reaches a height of approximately 3.2 m in the vicinity of the trench with a slope of 14 degrees to the south and 18 degrees to the north.

Excavation was carried out in a series of contiguous 1 m^2 units designated TP 1 to TP 4. The first three units excavated extended downward to the base of the ridge and the fourth was placed adjacent to the first near the ridge crest. Excavation was in natural stratigraphic units when these were evident and mechanical levels of 10 cm or less were excavated within layers or in portions of the deposit where stratigraphic boundaries were not noted during excavation.

The depth of the cultural deposit ranged from 170 cm at the northern end of the trench to between 65 and 85 cm in the south. A 1 by 0.5 m shovel test at the north end of the trench was excavated an additional 80 cm below the base of the cultural deposit to a maximum depth of

Layer I	Dark greyish brown (10YR 4/2) silt to silt loam with low amount of rounded calcareous sand grains. Weak to moderate fine crumb structure with soft consistency when moist. Boundary with Layer II abrupt and wavy. Many fine to medium roots along with decomposing organic matter. Developing humus horizon with prehistoric midden containing marine shell, heat-altered volcanic oven stones, scattered charcoal flecking, pottery and other artefacts.
Layer II	Very dark grey silt (10YR 3/1) mixed with very pale brown calcareous sand (10YR 7/4). Loam to sandy loam with fine, well-rounded calcareous sand grains. Structureless, very fine and granular with loose consistency when dry. Gradational contact with Layer III over ca. 10-15 cm with irregular to wavy boundary. Evidence of extensive crab disturbance in the form of active burrows and extensions of Layer II matrix into Layer III following the outline of infilled burrows. Very fine to medium roots common in upper 20-30 cm with few below this depth. Prehistoric midden deposit with dense marine shell, moderate to high density of heat-altered volcanic oven stones, moderate charcoal flecking, pottery and other artefacts.
Layer III	Very pale brown (10YR 7/4) fine grained calcareous sand. Inclusions of waterworn shell and coral fragments. Structureless, fine and granular with loose consistency when dry. Sterile basal sand of unknown depth underlying cultural deposit. Some Layer II mottles due to crab disturbance. Increasing dampness of matrix with depth due to close proximity to the water table.

Table 3.23 Layer descriptions for Site DJO-A.

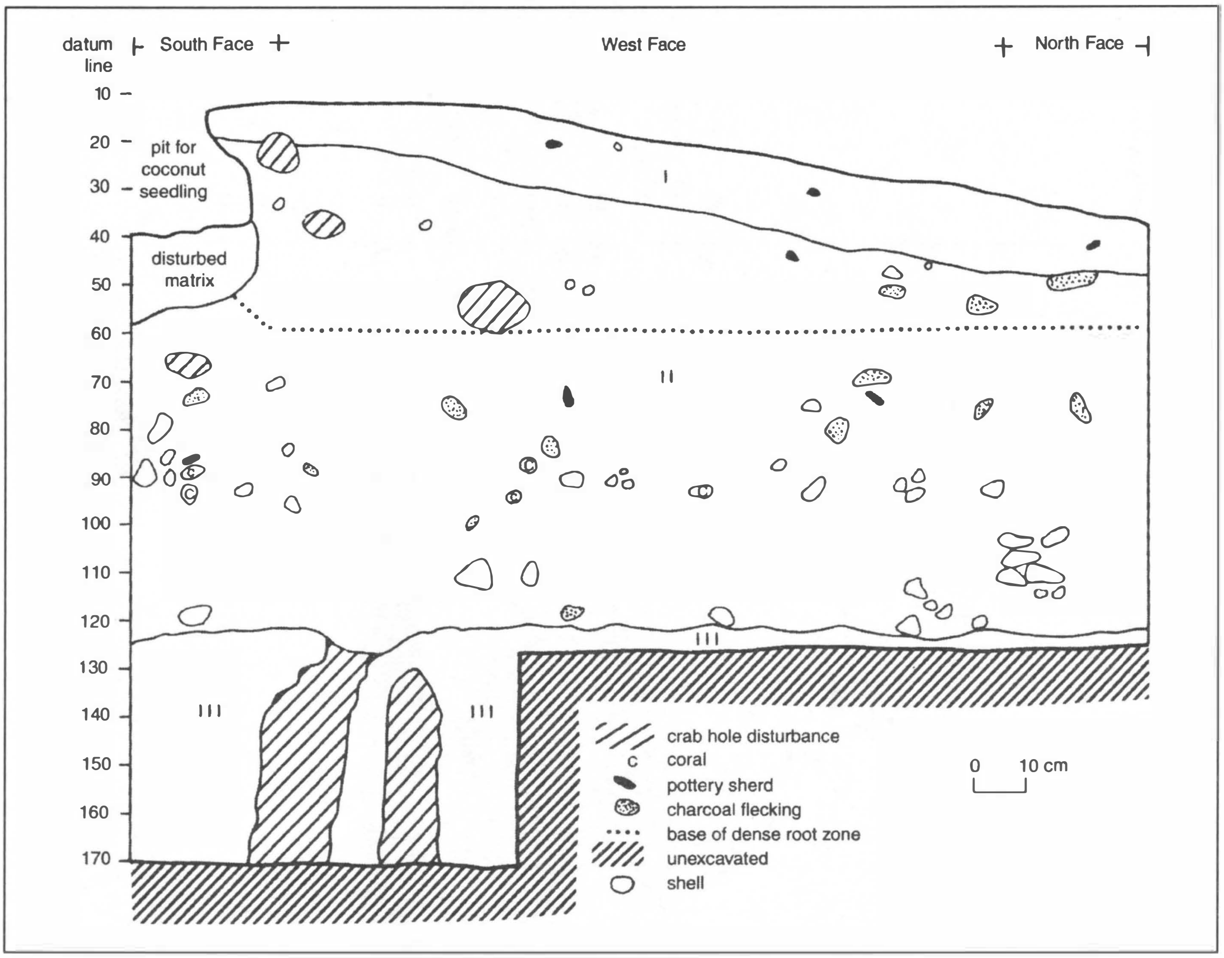


Figure 3.24 Site DJO-A: Stratigraphic profile, south, west and north face.

250 cm to insure that sterile matrix had been reached. Excavation was halted at this depth due to cementation of the sand matrix. The sand became increasingly damp with greater depth and the water table was reached at the base of excavation. Two recent crab burrows were encountered during excavation and extensions of the cultural deposit into sterile matrix representing infilled burrows were also common.

Stratigraphy

The stratigraphic profile of the Area D excavation trench is similar to TP 1 in Area A but somewhat more complex with a number of sublayers and a more gradual transition to sterile sand (Plate 3.11). Nine stratigraphic units within four layers were identified as well as a double pit feature. A substrate of calcareous sand (Layer IV) underlies an upper and lower midden deposit (Layers II and III) and a shallow A horizon stratum has developed since abandonment of the site (Layer I). Stratigraphic profiles of the east and west trench face are illustrated in Figures 3.25 and 3.26 and layer descriptions are presented in Table 3.24.

Depositional sequence

At the time of initial occupation of DJO, only a slight rise along the low beachline would have been present where the ridge and mounds now stand. The present surface profile is at least partially the result of midden accumulation during occupation of the site. On the basis of two radiocarbon dates, occupation of Area D at DJO occurred between ca. 1000 BP near the end of the Hangan phase and 650 BP during the Malasang phase. There is a clear shift in the relative frequencies of pottery styles within the DJO-D deposit with a predominance of Hangan style sherds in the lower deposit and Malasang style pottery in the upper deposit above Layer III. Evidence of later occupation is lacking with neither Mararing nor Recent style pottery present in the deposit or on the surface.

Utilisation of Area D apparently intensified following the Hangan phase as indicated by an increase in midden density in the upper cultural deposit. The minimal amount of Malasang style pottery from Area A and absence of Hangan style pottery from Area B may account for the lower height of these areas relative to Area D.

Midden and artefact distribution for DJO-A and DJO-D

The distribution of midden remains is presented by excavation level for the DJO-A deposit in Table 3.25. The Area D deposit was divided into stratigraphic zones based on the distribution patterns of artefacts and midden in relation to stratigraphic divisions as shown in Table 3.26. A discussion of the manner in which these zones were defined is presented in Chapter 6.

Shell density at DJO is second only to DJW and ranges from 67.4 kg/m^3 at DJO-D to 50.3 kg/m^3 at DJO-A.

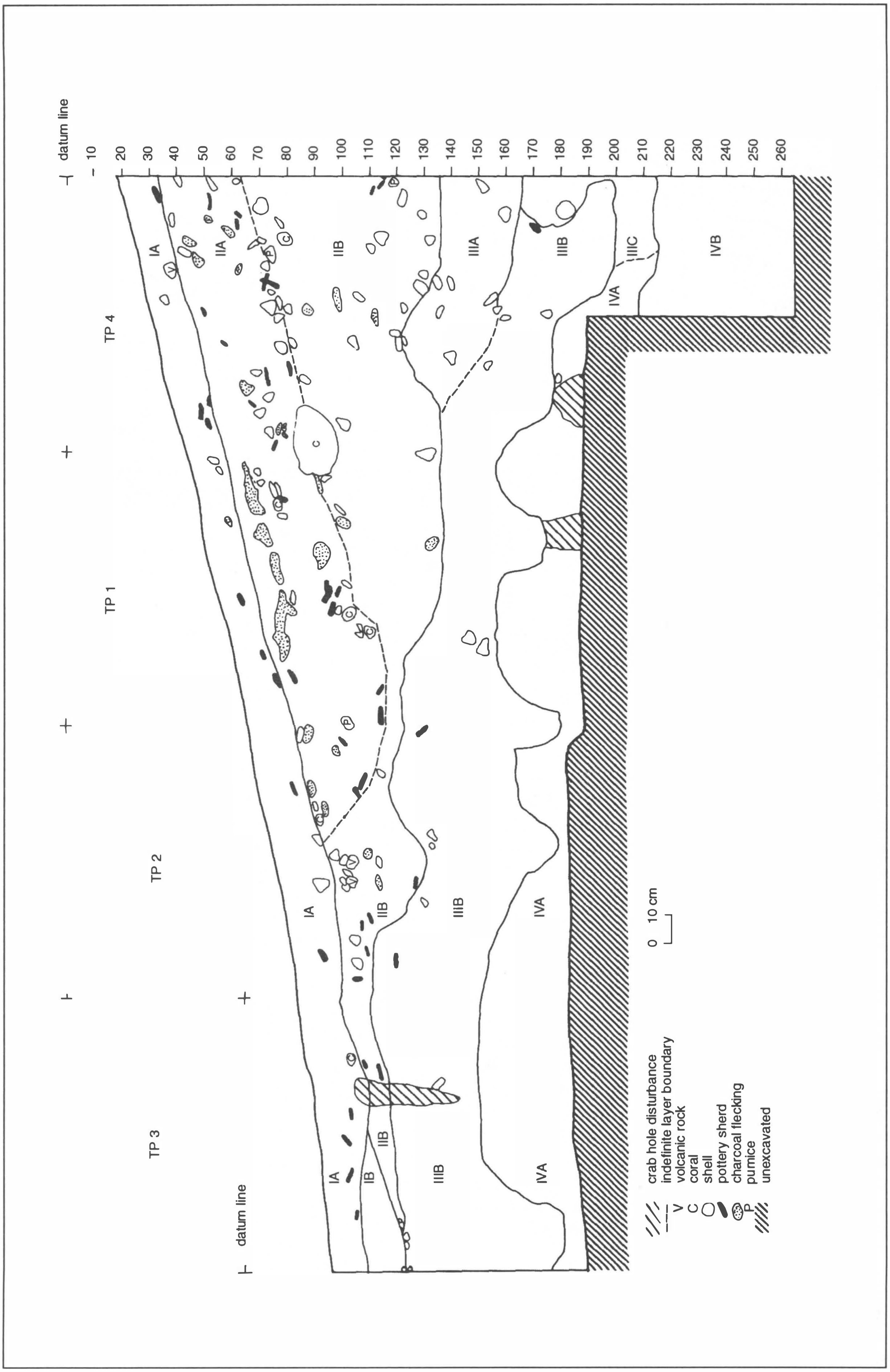


Figure 3.25 Site DJO-D: Stratigraphic profile, west face.

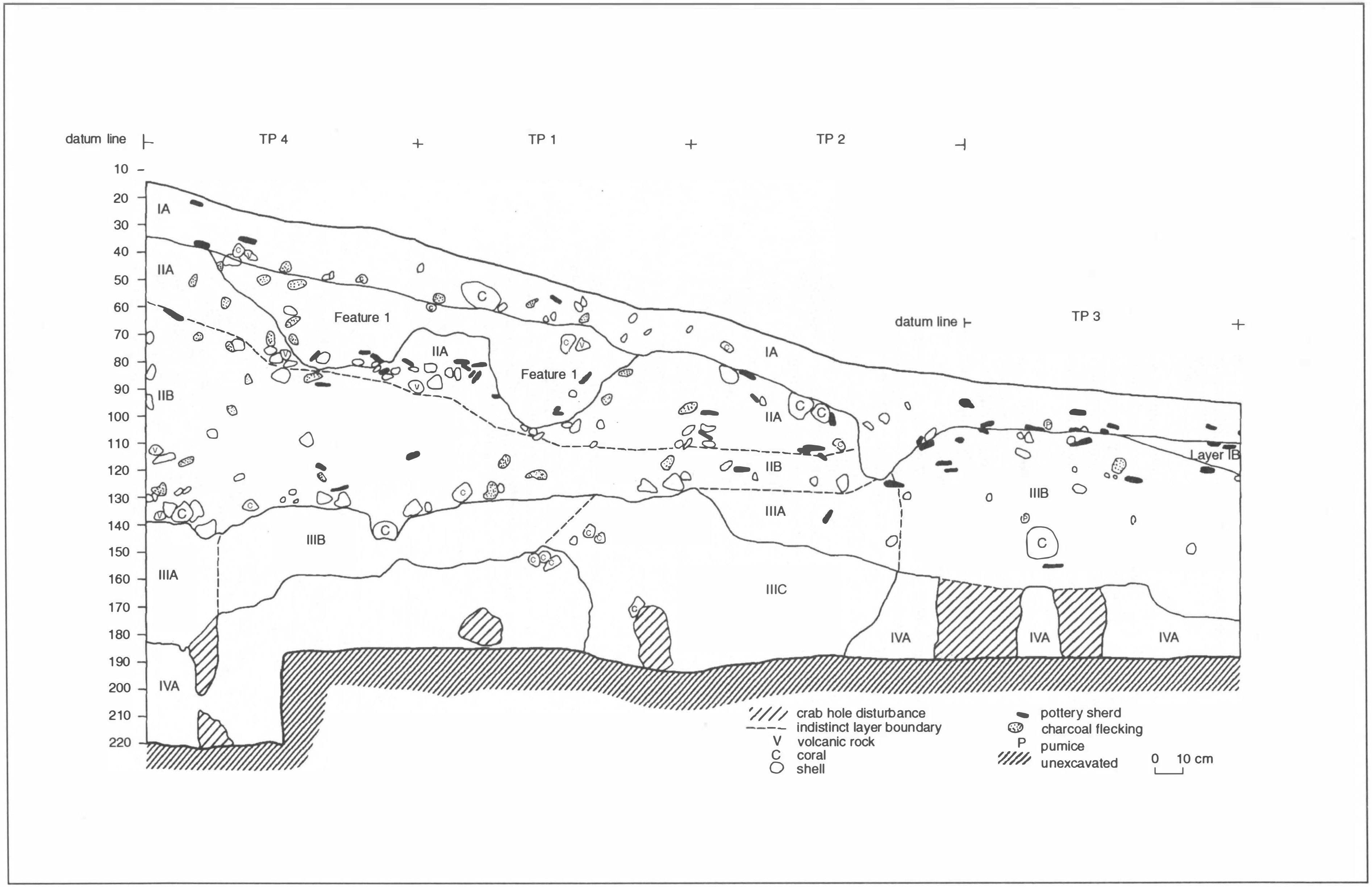


Figure 3.26 Site DJO-D: Stratigraphic profile, east face.

Layer IA	Black (10YR 2/1) silt with blocks of coral up to 10 cm in diameter. Low amount of branch coral and pumice. Weak, fine crumb structure with very friable consistency when moist. Boundary with Layer II abrupt and slightly wavy. Humus layer with many fine to medium size coconut roots. Prehistoric midden with moderate amount of charcoal flecking, heat-altered volcanic oven stones and marine shell.
Layer IB	Olive brown (2.5Y 4/4) silt loam with pale yellow (2.5Y 7/4) mottles containing a higher percentage of sand. Low amount of branch and block coral with increase in amount of pumice from Layer IA. Structureless to very weak fine granular structure with loose consistency when moist. Boundary with Layer II abrupt and smooth. Transition from humus to Layer II loam with decline in quantity of roots and increase in density of midden from Layer IA. Restricted to south end of trench where it replaces Layer II.
Layer IIA	Dark yellowish brown (10YR 4/4) loam to sandy loam with mottles of brownish yellow (10YR 6/6) calcareous sand. Moderate amount of block coral up to 15 cm in diameter and low amount of branch coral. Quantity of pumice ranging from very low to moderate between units with weights up to 50 g for pumice within a single 10 cm level. Structureless, very fine and granular with loose consistency when moist. Lower boundary diffuse and indistinct. Dense midden deposit with peaks in amount of heat-altered volcanic oven stones, charcoal, shell and pottery. Highest density of material near base of sublayer. General decline in midden below this sublayer except in TP 4.
Layer IIB	Dark yellowish brown (10YR 3/4) to yellowish brown (10YR 5/4) sandy loam with minimal sand mottling. Coral blocks continue up to 25 cm and low amount of branch coral. Low amount of pumice with occasional large pieces. Structureless, very fine and granular with loose consistency when moist. Lower boundary abrupt and wavy. Midden deposit similar to Layer IIA with decrease in density except in TP 4 where peaks in density of most midden components occur.
Layer IIIA	Yellowish brown (10YR 5/4) loamy sand. Similar amounts of coral and pumice as Layer IIB. Structureless, very fine and granular with loose consistency when moist. Boundary abrupt to diffuse and irregular. Extensions of matrix into Layer IV sterile sand within infilled burrows. Moderately dense midden with decline from Layer IIB although same range of material. Lower cultural deposit found primarily in TP4 with highest midden density in Layer III.
Layer IIIB	Light yellowish brown (10YR 6/4) to brownish yellow (10 YR 6/6) loamy sand. Great increase in amount of branch coral (over 7.7 kg in a single 10 cm level). Slight increase in amount of block coral and decline in amount of pumice from previous layer. Structureless, very fine and granular with loose consistency when moist. Boundary abrupt to diffuse and wavy to irregular. Pit shaped extensions of matrix into Layer IV sterile sand. Sharp decline in amount of midden from previous layer. High amount of worn natural shell fragments in addition to shell midden. Calcareous sand concretions on artefacts and shell midden.
Layer IIIC	Very pale brown (10YR 7/4) loamy sand. Similar to Layer IIIB with increase in branch and block coral and a low amount of pumice. Very high percentage of sand. Discontinuous lower extension of cultural deposit into sterile sand within TP 4 with minimal cultural material.
Layer IVA	Very pale brown (10YR 8/3) calcareous sand with waterworn coral and shell fragments and low amount of pumice. Inclusions of yellowish brown (10YR 5/4) sandy loam from former crab burrows filled with upper cultural deposit matrix. Structureless to fine, weakly cemented sand grains. Sterile basal calcareous sand with very low amount of intrusive cultural material from overlying cultural deposit.
Layer IVB	Pale brown (10YR 6/3) highly cemented calcareous sand with waterworn shell and coral fragments and low amount of pumice. Lower sterile sand layer found only in TP4 shovel test extending to base of excavation. No cultural material.
Feature 1	Very dark grey (10YR 3/1) loam with low amount of distinct calcareous sand grains. Structureless, fine and granular. Two joined round bottomed pits excavated into Layer IIA along east face of TP 4 and TP 1 with diameter of 160 cm and maximum thickness of 40 cm. Feature could not be isolated during excavation so was not removed separately. Lower midden density than Layer IIA and no visible concentration of material or distinctive elements to indicate function. Pits represent activity prior to or during the formation of Layer I.

Table 3.24 Layer descriptions for Site DJO-D.

There is a peak in shell abundance near the base of the deposits in both excavation areas with the sharp drop in the basal levels where the cultural deposit grades into sterile sand. Both excavation units have low amounts of bone which is dominated by pig. Charcoal is abundant in both areas and increases in the upper portion of the deposits.

Pottery density (sherds/m^3) at DJO is lower than at the other open sites and ranges from 1026 at Area A to 1658 at Area D. The highest concentration of pottery at DJO-A occurs in the lower deposit with a decline in the upper portion of Layer II and increase in Layer I. At DJO-D, pottery density increases steadily from the basal portion of the deposit with peaks in Zone 5 and Zone 3 followed by a decrease in the upper two zones. Pottery sherds with ground margins are scattered through the deposits in both areas.

Stone tools are limited to abraders of pumice and branch or block coral and eight small pieces of flaked obsidian from both areas. Shell artefacts are abundant in both excavation units and include tools (a single adze, bivalve scraper and trolling lure shank from Area D), worked pearl shell from Area A and a variety of ornaments. The ornaments include a *Conus* ring and disc from Area D, numerous *Trochus* ring fragments from all stages of manufacture, a variety of small gastropods with suspension holes and shell beads throughout the deposits in both areas. A number of worked bone artefacts were also recovered. The overall range and abundance of artefact types are remarkably similar between the two excavation areas and exhibits a clear emphasis on shell.

CHRONOLOGY OF THE EXCAVATED SITES

A chronological sequence for the seven sites excavated in 1987 is provided by a suite of sixteen radiocarbon dates. Half of the dates were obtained from the extensive preceramic deposit at DJA, two from the preceramic deposit at DBE and the remainder from the five ceramic-age sites. Dating of the ceramic sites focused on supplementing and refining the radiocarbon chronology established by Specht (1969).

The radiocarbon sequence discussed in this section is presented within the general framework of the eight phase Buka cultural sequence (see Table 1.1). The initial two phases of the sequence, the late Pleistocene and early to mid-Holocene, are defined by geological rather than archaeological time periods due to the lack of more precise chronological control for preceramic occupation on Buka. The next two phases cover the period during which Lapita pottery was in use on Buka for which no radiocarbon dates were obtained from the present study. Evidence from the early Lapita phase is limited to pottery and associated artefacts on reef sites. The late Lapita phase is bracketed by radiocarbon dates from Specht (1969). The radiocarbon chronology for the final four phases of the Buka sequence, which are named after the pottery styles defined by Specht, has been revised by radiocarbon dates from the present study. These dates will be discussed in relation to Specht's earlier radiocarbon sequence below.

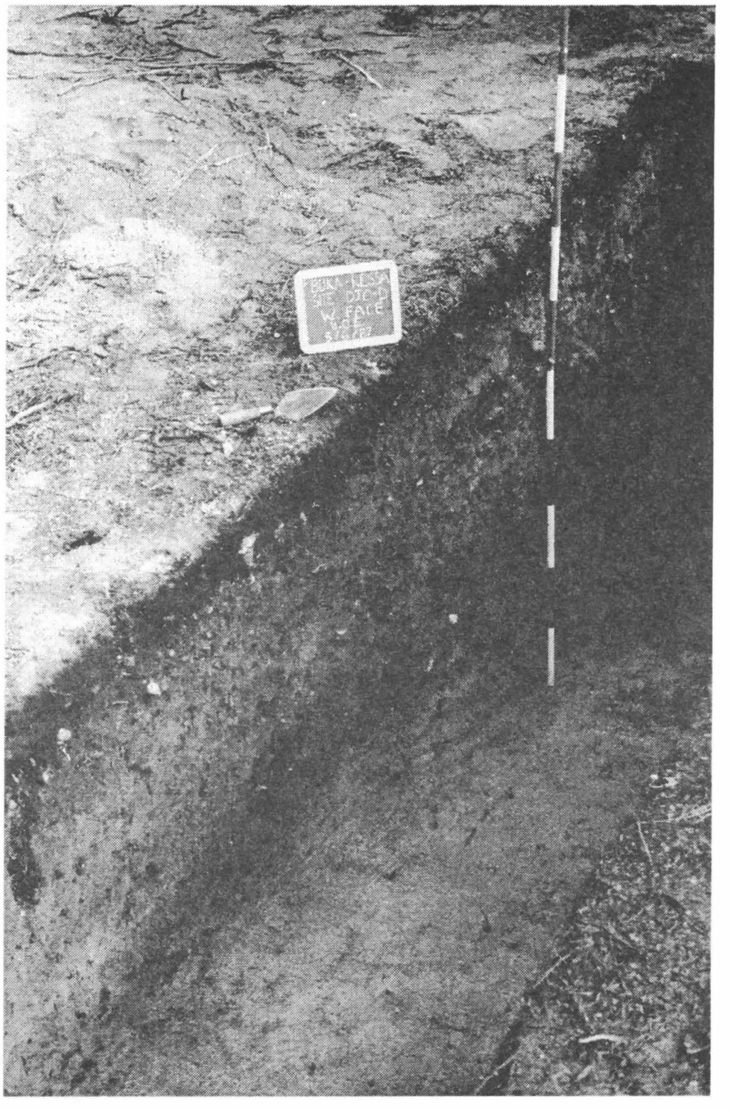


Plate 3.11 West face of the DJO-D excavation trench facing northwest.

Charcoal was submitted for radiocarbon dating in all instances except for the preceramic dates from DBE and late Pleistocene dates from DJA which utilised marine shell. All samples were collected from excavation levels with an average thickness of 10 cm within 1 m^2 test units. The amount of charcoal submitted greatly exceeded the minimal weight necessary for normal processing except for the samples from DAF and DKC which required extended counting time. Shell samples utilised the gastropod species *Turbo crassus* and *Nerita undata* which were the largest and most abundant food taxa in the preceramic cave deposits. Ten of the radiocarbon samples were processed by Beta Analytic and the remainder by The Australian National University (ANU) radiocarbon laboratory.

Layer/ Level	Volume (m^3)	Shell	g/m^3	Bone	g/m^3	Charcoal	g/m^3	Volcanic Rock	g/m^3
I/1	0.11	2176	19,342	4	36	41	364	556	4942
II/2	0.04	1145	30,533	4	107	31	827	250	6667
II/3	0.08	1859	24,787	9	120	40	533	540	7200
II/4	0.08	1079	14,387	7	93	38	507	489	6520
II/5	0.08	1525	20,333	8	107	36	480	407	5427
II/6	0.04	1724	45,973	11	293	35	933	401	10,693
II/7	0.06	3116	51,933	13	217	51	850	603	10,050
II/8	0.08	5759	76,787	10	133	36	480	700	9333
II/9	0.08	8748	116,640	6	80	30	400	900	12,000
II/10	0.08	6721	89,613	13	173	21	280	900	12,000
II/11	0.11	8438	75,004	3	27	31	276	800	7111
Total	0.84	42,290	50,345	88	105	390	464	6546	7793

Table 3.25 Site DJO-A midden weight (g) and density (g/m^3) by excavation level.

Zone	Volume (m3)	Shell	g/m³	Bone	g/m³	Charcoal	g/m³	Volcanic Rock	g/m³
1	0.55	18,058	32,833	83	151	149	271	2298	4178
2	0.46	25,622	56,312	138	303	167	367	1739	3822
3	0.37	33,180	89,676	222	600	126	341	1529	4132
4	0.45	34,205	76,011	144	320	151	336	1512	3360
5	0.60	55,514	92,523	276	460	167	278	2503	4172
6	0.70	48,621	69,459	310	443	129	184	2668	3811
7	0.30	44,491	148,303	170	567	68	227	2418	8060
8	0.43	20,585	48,435	42	99	47	111	1090	2565
9	0.50	12,783	25,566	57	114	34	68	238	476
Total	4.35	293,059	67,370	1442	331	1038	239	15,995	3677

Table 3.26 Site DJO-D midden weight (g) and density (g/m³) by stratigraphic zone.

Preceramic chronology

Radiocarbon dates of preceramic age are presented in Table 3.27. Eight of the ten dates, graphically displayed in Figure 3.27, are from Kilu Cave (DJA) where samples were collected at regular intervals throughout the deposits. The three shell dates obtained from the Layer II Pleistocene deposit at Kilu were collected at 20 cm intervals from the base of the deposit upward and have an uncalibrated age range from ca. 29,000 to 20,000 BP. As previously discussed, an extremely slow sediment accumulation rate of less than 0.01 cm/year has been calculated for the late Pleistocene deposit based on these dates. The complete absence of charcoal in Layer II is most likely due to the much greater age of this stratum which is supported by the steady reduction in charcoal density between the upper and lower Layer I deposit. A similar absence of charcoal through chemical weathering has been reported from Pleistocene sites on New Ireland in the Bismarcks (Allen et al. 1988, 1989).

A hiatus in occupation of approximately 10,000 years between Layer II and Layer I is indicated by dates from level 13 (Beta-25619) and level 15 (ANU-6178) at the base of Layer IC in TP 1. These dates overlap at two standard deviations and are therefore statistically indistinguishable. A weighted average of the two dates produces a date of 9284±130 BP which has a calibrated range of 10,381 to 10,043 BP. The other three dates from Layer I document occupation up to between 5587 and 5285 BP (cal.) (ANU-6757) when the site was apparently abandoned for several thousand years. Limited use of the cave during the late

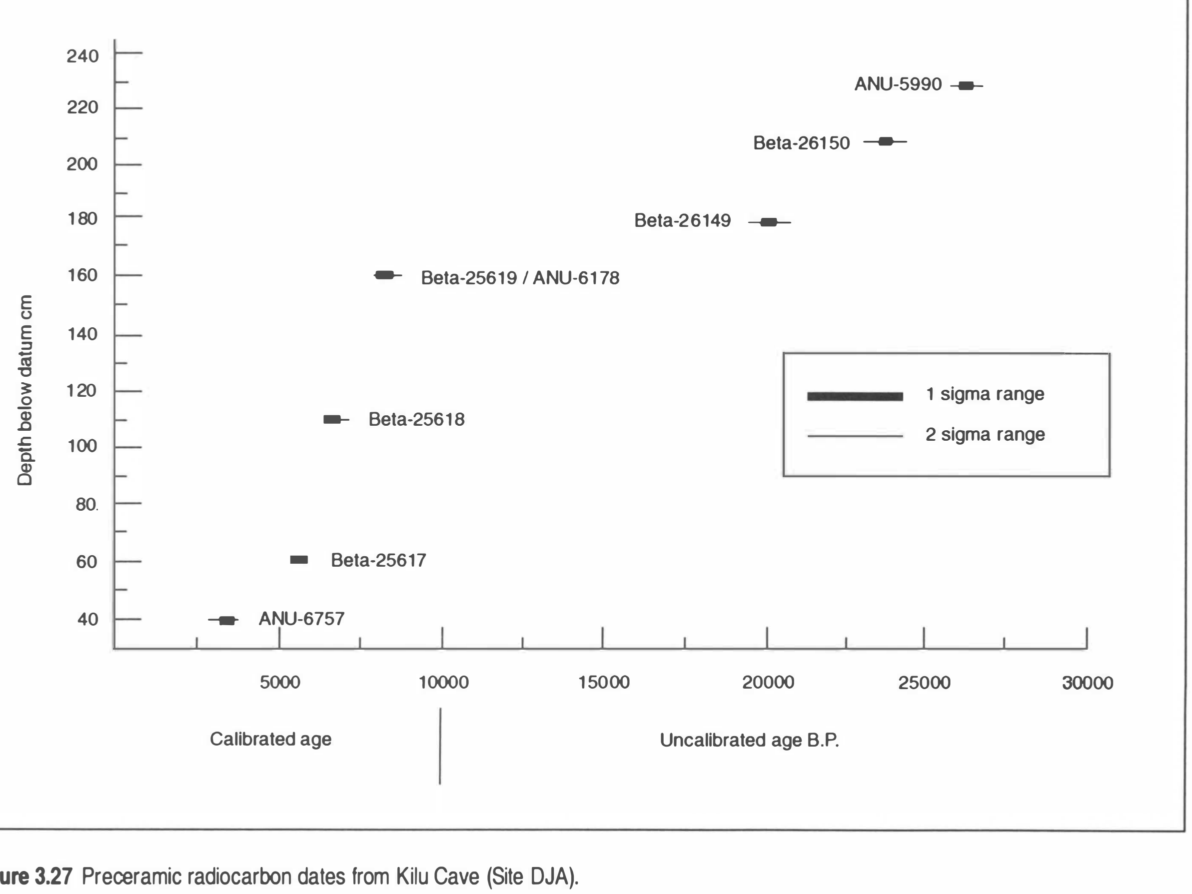


Figure 3.27 Preceramic radiocarbon dates from Kilu Cave (Site DJA).

Site	Laboratory Number	Provenience Unit, Layer/Level	Material	Radiocarbon Years BP	$^{13}C/^{12}C$[a]	Conventional ^{14}C age BP	Calibrated age range BC and BP at 1 sigma (intercepts)[b]
DJA	ANU-5990	TP1, IID/21	*Nerita*	28,340±280			
DJA	Beta-26150	TP3, IID/18	*Turbo*	23,820±290			
DJA	Beta-26149	TP3, IIB/15	*Nerita*	20,140±300			
DJA	ANU-6178	TP1, IC/15	Charcoal		-24.0 (E)	8950±230	8130 (8010) 7701 BC 10080(9959) 9651 BP
DJA	Beta-25619	TP1, IC/13	Charcoal	9460±150	-26.8	9430±150	8908 (8437) 8267 BC 10858(10386)10217 BP
DJA	ANU-6178 and Beta-25619	Weighted Average	Charcoal			9284±130	8431(8341,8301,8270)8093 BC 10381(10290,10250,10219)10043 BP
DJA	Beta-25618	TP1, IC/9	Charcoal	7930±110	-26.7	7900±110	7004(6694,6680,6661)6559 BC 8954(8643,8629,8610)8509 BP
DJA	Beta-25617	TP1, IA/4	Charcoal	6700±80	-26.7	6670±80	5598(5575,5543,5528)5449 BC 7548(7524,7492,7477)7399 BP
DJA	ANU-6757	TP1, IA/2	Charcoal		-24.0 (E)	4680±140	3637(3498,3455,3379)3335 BC 5587(5447,5404,5328)5285 BP
DBE	ANU-6110	TP1, VI/13	*Turbo*	4340±80	0.0 (E)	4740±80	3103 (3013) 2896 BC 5053 (4962) 4846 BP
DBE	Beta-25824	TP1, V/8	*Turbo*	4850±90	0.0 (E)	5250±90	3744 (3648) 3594 BC 5694 (5597) 5544 BP

Table 3.27 Buka preceramic radiocarbon dates. (Code: [a] Adjusted for isotope fractionation using measured or estimated (E) values. [b] Dates calibrated using CALIB 3.0.3 intercept method. Charcoal calibrated using the bidecal atmospheric curve and marine shell using an ocean reservoir correction factor of Delta-R = 0)

Lapita phase is documented by the presence of Buka style pottery in the upper 30 cm of the deposit. Some form of occupation also took place during the last 500 years as indicated by the presence of Mararing style pottery in the upper three excavation levels of TP 3 and some recent historic items including a World War II bullet, two pieces of metal and a single piece of glass.

Shell dates from the lower and upper preceramic deposit at Palandraku Cave (DBE) document initial occupation of the cave at about the same time as Kilu was abandoned. The dates are stratigraphically inverted with the basal sample having a calibrated age of calBP 5053-4846 at two sigma (ANU-6110), which is 491 years younger than the age range for the upper date of calBP 5694-5544 at two sigma (Beta-25824). Although the dates are inverted, they bracket the approximate age range of occupation for the preceramic component of the site.

A single radiocarbon date from the base of the DKC rockshelter deposit on Sohano Island produced a late preceramic to early Lapita phase date with a calibrated age range of calBP 3981-2959 (ANU-6756) (Table 3.29). The date comes from Layer IIB, a calcareous sand substrate on which the Layer I cultural deposit formed. The minimal amount of cultural material from this layer is believed to have infiltrated from Layer I which dates to the late Lapita to early Sohano phase. The small size of the charcoal sample submitted for dating (2 g) resulted in a standard deviation of 400 years. Given the large standard deviation for this date spanning around 1000 years and the much later age of the cultural deposit at DKC based on the ceramic evidence, this date is considered to be unreliable and is therefore rejected.

Ceramic-age site chronology

As outlined in Chapter 1, the ceramic sequence for Buka proposed by Specht (1969) included six temporally distinct and consecutive styles spanning some 2500 years from the Buka style to the Recent style. It is worth reiterating at this

Site	Laboratory Number	Provenience - Trench, Layer	Material	Conventional ^{14}C age BP [a]	Calibrated age range BC/AD and BP at 1 sigma (intercept) [b]	Phase
DAA	ANU-272	Tr. 2, V	Charcoal	2480±140	801 (755,686,540) 395 BC 2751 (2704,2635,2489) 2345 BP	late Lapita
DAI-B	ANU-234	Tr. 1, VI	Charcoal	2190±140	393 (199) 40 BC 2343 (2148) 1990 BP	late Lapita
DAI-B	ANU-233	Tr. 1, IVB	Charcoal	1860±85	73 (141) 312 AD 1877 (1809) 1638 BP	Sohano
DAI-B	ANU-273	Tr. 1, III	Charcoal	1350±80	640 (668) 772 AD 1310 (1282) 1178 BP	Hangan
DAI-B	ANU-323	Tr. 1, II	Charcoal	1215±75	710 (814,848,852) 940 AD 1240 (1136,1102,1098) 1010 BP	Hangan
DAI-A	ANU-322	Tr. 1, VI	Charcoal	940±75	1018 (1046,1097,1115,1144,1153) 1212 AD 932 (904,853,806,797) 738 BP	late Hangan
DAI-A	ANU-271	Tr. 1, II	Charcoal	720±80	1251 (1288) 1379 AD 699 (662) 571 BP	Malasang

Table 3.28 Buka ceramic-age radiocarbon dates from Specht (1969). (Code: [a] Adjusted for isotope fractionation using an estimated value of –24.0. [b] Dates calibrated using CALIB 3.0.3 intercept method and bidecal atmospheric curve)

point that the final five phases of the Buka cultural sequence presented here are based on pottery styles defined by Specht, although they are not identical. Thus, the late Lapita phase is linked to Specht's Buka style and the Sohano, Hangan and Malasang phases are based on the pottery styles of the same name. The final phase incorporates two of Specht's styles, the Mararing and Recent, which overlap temporally. The use of pottery styles is viewed as a convenient means of dividing the Buka cultural sequence into phases given the lack of other chronologically sensitive markers in the archaeological record. Spriggs has also utilised Specht's pottery styles to define three phases of his Nissan Island cultural sequence (Table 1.1).

The chronology for Specht's pottery sequence was based on a suite of seven radiocarbon dates. These dates are presented in Table 3.28. The cultural phases associated with each of the dates based on the revised Buka sequence are also presented in this table. As Specht (1969:215-16) pointed out:

> the ^{14}C dates provide an acceptable chronology for the ceramic sequence, yet they apply to selected stages only. Further excavations and series of dates may alter this picture in detail, but probably will support the broad outline.

Despite the fact that Specht's age estimates for some of the styles have been shown to be in error, the precision of his chronology remains impressive.

The primary goal in dating the ceramic sites excavated during the present study was to provide a more precise chronology for the ceramic phases proposed by Specht and determine the nature of temporal relationships between pottery styles (e.g. the degree of temporal overlap between styles and the question of gradual transitions versus rapid replacement). As directed by the research design, the excavation of site deposits with relatively brief periods of occupation and a limited number of pottery styles enabled the submission of radiocarbon samples securely associated with particular ceramic styles and their related cultural remains. Excavation of sites from locations at the opposite end of Buka from those excavated by Specht enabled the applicability of his sequence to be tested for a larger portion of Buka.

One of the research problems to be addressed by the present study was the temporal relationship between Buka style and subsequent Sohano style pottery. Although recognising that the Buka style most likely preceded the Sohano style, Specht was unable to clarify whether a gradual transition or rapid replacement occurred between the two styles as the basal deposits of each site excavated contained both styles. A similar situation occurred during the present investigations at three of the four site excavations (DAF, DKC and DBE), which had a mixture of Buka and Sohano style ceramics in the same levels. Unfortunately, the DBE deposit was too thin and disturbed for collection of a secure radiocarbon sample and attempts to date the deposits at DAF and DKC were unsuccessful. Although the temporal

Site	Laboratory Number	Provenience Unit, Layer/Level	Material	Radiocarbon Years	$^{13}C/^{12}C$ [a]	Conventional ^{14}C age BP	Calibrated age range BC/AD and BP, 1 sigma (intercept) [b]	Phase
DKC	ANU-6756	TP 1, IIB/8	Charcoal		-24.0 (E)	3270±400	2031 (1520) 1009 BC 3981 (3469) 2959 BP	rejected
DJW	Beta-25825	TP 1, II/8	Charcoal	1530±60	-25.9	1520±60	454 (553) 620 AD 1496 (1397) 1330 BP	late Sohano
DJU	Beta-25826	TP 1, IIB/9	Charcoal	1350±40	-27.6	1310±40	667 (685) 772 AD 1283 (1265) 1178 BP	Hangan
DJO	Beta-25828	TP 4, III/13	Charcoal	1120±50	-27.7	1080±50	895 (984) 1014 AD 1055 (966) 936 BP	late Hangan
DJO	Beta-25827	TP 4, IIA/2	Charcoal	760±50	-28.3	710±50	1279 (1290) 1303 AD 671 (660) 647 BP	Malasang
DAF	ANU-6755	TP 1, IB/9	Charcoal		-24.0 (E)	450±110	1405 (1444) 1627 AD 545 (506) 323 BP	Mararing/Recent ?

Table 3.29 Buka ceramic-age radiocarbon dates from the present study. (Code: [a] Adjusted for isotope fractionation using measured or estimated (E) values. [b] Dates calibrated using CALIB 3.0.3 intercept method and bidecal atmospheric curve)

relationship between the two styles remains somewhat unclear, the existing evidence indicates that there was a temporal overlap of unknown duration between the styles.

Ceramic-age radiocarbon dates from the present investigations are found in Table 3.29 and graphically displayed together with Specht's dates in Figure 3.28. The earliest secure ceramic-age date from the present study is from the termination of the Sohano phase. It was collected from the base of the DJW deposit and has a calibrated age range of calBP 1496-1330 (Beta-25825). A shift from Sohano to Hangan style pottery occurs within this site between the lower and upper deposit.

Dates for the Hangan phase were obtained from the base of the DJU and DJO-D site excavations. The DJU date is from the earlier portion of the Hangan phase and has a calibrated age of calBP 1283-1178 (Beta-25826) which is nearly identical to a date obtained by Specht of calBP 1310-1178 (ANU-273) associated with Hangan style pottery. As with the DJW deposit, occupation at DJU probably lasted for a few hundred years. The termination of the Hangan style is estimated to have occurred at ca. 800 BP on the basis of a calibrated date of calBP 1055-936 (Beta-25828) from the base of Site DJO-D associated with late Hangan style pottery. Two calibrated dates associated with late Hangan style pottery from Nissan sites excavated by Spriggs (1991a: Table 2) of calBP 920-680 (ANU-5142) and calBP 907-688 (ANU-5230) support the DJO-D evidence. There is a clear change from Hangan to Malasang style pottery within the DJO-D deposit. A date from the upper deposit calibrated to calBP 671-647 (Beta-25827) is securely associated with Malasang style pottery. Although the Area A deposit at DJO was not dated, the pottery is nearly identical to the late Hangan style pottery from the base of DJO-D.

Specht estimated that the Hangan style had ended by 1300 BP on the basis of a calibrated date of calBP 1240-1010 (ANU-323) from the DAI-B site which he associated with late Hangan style ceramics. A calibrated date of calBP 932-738 (ANU-322) from the DAI-A deposit was interpreted by Specht as coming from the peak of the Malasang style. However, the association of this date with Malasang style pottery can be questioned on the basis of paste distributions within this site (Specht 1969: Table VII:1) which reveals that Hangan style pottery (paste 6R) accounts for 6% of the pottery in this layer and is present in numbers equal to the later styles in overlying strata. Sohano style sherds are also present in the upper layers and an earlier date (ANU-232) from the same layer as ANU-322 was rejected as aberrant. The presence of Hangan style sherds throughout the DAI-A deposits supports the evidence from the present investigations which indicates that ANU-322 dates to the late Hangan phase.

Secure dates associated with Mararing or Recent style pottery have yet to be obtained from Buka. However, a calibrated date from the base of the DAF test unit of calBP 545-323 (ANU-6755) appears to be associated with the scattered intrusive Mararing and Recent style sherds mixed with the dominant Sohano and Buka style pottery within the deposit. It is unlikely that Mararing pottery

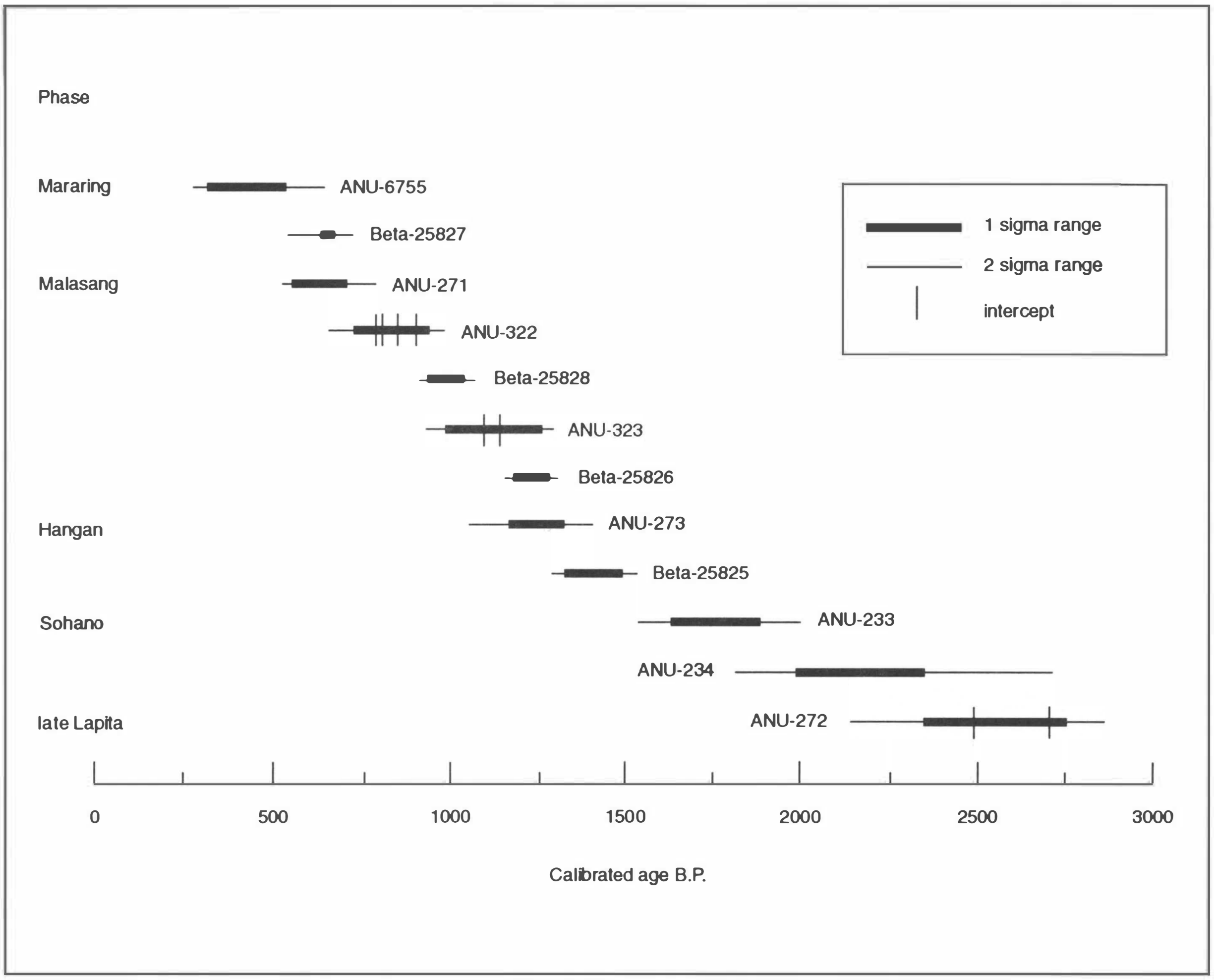


Figure 3.28 Calibrated radiocarbon dates for Buka ceramic-age sites from Specht (1969) and the present study.

was being produced much earlier than 500 BP given the calibrated date for Malasang style pottery from DJO-D of 647-671 BP. The presence of both Mararing and Recent style pottery at most of the surface collected sites as well as the DAF and DBE excavations indicates that there is a considerable temporal overlap between the two styles. Spriggs (1991a:239) was also unable to isolate the two styles stratigraphically on Nissan and estimates that the Mararing style was being produced by 500 B.P. Although both styles are present throughout the undated upper deposit at DBE, Recent style pottery replaces the Mararing style as the dominant style over time.

Specht obtained a single date of calBP 699-571 (ANU-271) from the upper DAI-A deposit which he associated with the early Mararing style. On the basis of the DJO-D evidence, this date is contemporary with the Malasang style. The percentages of post-Hangan style ceramics at the DAI-A site cannot be determined on the basis of Specht's paste distribution figures as the same paste was used in each of these styles. However, the presence of Sohano, Hangan and post-Hangan styles in the upper portion of the site from which ANU-271 was obtained casts doubt on the reliability of the dates association with Mararing style ceramics. Specht's estimated date of 300 BP for the termination of the Mararing style has not been revised but its reliability remains uncertain as there are still no absolute dates for the late Mararing or Recent styles.

CONCLUSION

This chapter's primary objective has been to provide the necessary background information from which the research objectives of this study are addressed in the remaining chapters. The extensive suite of radiocarbon dates presented in this chapter have made it possible to clarify the chronology of the previously known sequence for Buka as well as extend it by almost 90% to 29,000 years ago.

Unfortunately, the excavated sites yielded far less information than was hoped on Lapita settlement. The few sites which did contain Lapita pottery have no reliable radiocarbon dates for these deposits which were either quite limited or badly disturbed. However, two sites on Sohano Island (DAF and DKC) do have pottery from both the late Lapita phase and subsequent Sohano phase. The question of how Lapita and Sohano style pottery relate to one another has not been completely resolved by these excavations but a temporal overlap is definitely established between them.

The excavations discussed in this chapter and the radiocarbon sequence from them have gone a considerable distance towards the establishment of a secure, well-dated sequence for the past 2000 years on Buka. This sequence is based not only on ceramics but a wide range of other artefact types and non-artefactual evidence such as faunal remains. The sites excavated not only fill in the gaps in the initial Buka ceramic sequence proposed by Specht, but verify that the same sequence applies to the whole of Buka and its offshore islands. The selection of ceramic site deposits with limited occupation spans and a minimum number of pottery styles made it possible to provide precise age estimates for each of the styles represented.

4

LAPITA CERAMIC ANALYSIS: FORM AND COMPOSITION

This chapter discusses the analysis of Lapita ceramic assemblages from three reef sites; DAF on Sohano Island, DJQ on Buka Island and DES on Nissan Island. Site DAA on Sohano was excluded from formal analysis due to the low amount of pottery recovered from the reef there. The analysis of Lapita decorative techniques and motifs is presented in Chapter 5.

Although some post-Lapita ceramics, especially of the Sohano style, were present at the reef sites, the frequencies represented are much lower than for the Lapita sample. The bulk of this pottery could also be separated from the earlier Lapita ceramics on the basis of formal, stylistic and compositional attributes. The post-Lapita ceramics were not formally analysed but their distribution has been discussed in Chapter 3.

Analysis of Lapita ceramics from the reef sites was of central importance in addressing several of the research problems outlined in Chapter 1. The lack of significant undisturbed deposits with Lapita components increased the importance of the reef ceramics as the principal evidence for Lapita on Buka. The ceramic analysis focused on addressing research questions related to two of the general research problems:

1. providing a fuller picture of Lapita occupation; and
2. examining evidence for ceramic exchange.

By examining the distribution of pottery on intertidal reefs, insights into Lapita settlement patterns and temporal change in ceramics were gained. The question of ceramic change between the late Lapita and Sohano phases was also addressed at one of the reef sites (DAF) where both Buka and Sohano style pottery are present. In order to document potential ceramic exchange, compositional analysis of a representative sample of Lapita sherds from each of the reef sites was undertaken.

ANALYTICAL METHODOLOGY

The ceramic sample

A total of 42,762 Lapita sherds was recovered from surface collections at reef sites DAF, DJQ and DES and a single test pit excavated at DAF. Nearly all of the ceramic sample comes from Site DAF (n=40,139; 93.9%), including an estimated 38,531 sherds from the reef, 596 from the surface of the beach and 1012 sherds from a single excavation unit. A total of 1632 sherds was collected from DES and 991 from DJQ. The overall density of surface pottery at DAF is 1.0 sherd/m^2 but only 0.1 sherd/m^2 at DJQ and 0.3 sherd/m^2 at DES. However, there is a considerable amount of variability between the collection areas at DAF ranging from 60.8 sherds/m^2 at Area 2 to only 0.1 sherd/m^2 at Area 1, which is adjacent to Area 2. The distribution and density of Lapita pottery by site and collection areas within sites is found in Tables 3.3, 3.4, 3.6 and 3.7.

Diagnostic pottery, which includes rims, neck and carination angles, flat bases, handles and other attachments such as lugs and legs in addition to decorated sherds, account for 15.2% (n=6519) of the total pottery sample and range from 44.4% (n=440) of the sample at Site DJQ to 19.9% (n=325) at DES and 14.3% (n=5754) at DAF. Decorated sherds represent 10.7% (n=4597) of the total ceramic sample with the highest percentages at Site DJQ (n=334; 33.7%) followed by DES (n=249; 15.3%) and DAF (n=4014; 10.0%). There are significant differences in the percentages of decorated sherds between collection areas at DAF ranging from 38.4% (n=458) on the northern outer reef (Areas 5 and 6) to 8.9% (n=2990) on the southern central reef (Areas 1 to 3), 10.4% on the inner reef (Areas 4 and 7) and 5.9% (n=35) for surface collections on the beach (Areas 9 to 12). As will be discussed, these patterns are interpreted as having chronological significance with earlier site areas having higher percentages of decorated sherds.

Plain body sherds

Counts for plain body sherds from Areas 1 to 3 at DAF were estimated from weight totals due to time constraints in the field which permitted only the recording of weights. Sherd counts were estimated from weights using a figure of 5 g per sherd which was arrived at by calculating average sherd weights for large samples of plain body sherds collected from different areas of DAF. The overall average weight for sherds over 3 cm in diameter was about 9 g, while sherds under 3 cm averaged between 2 and 3 g. Given the relative abundance of larger sherds on the outer reef portion of Site DAF, the figure of 5 g per sherd probably underestimates the total number of sherds present.

Plain body sherds were separated into large and small size categories for three reef collection areas and the single excavation unit at DAF in order to examine the relative proportion of small to large sherds for the beach deposit as compared to the reef. Small sherds were defined as those with maximum diameters of less than 2 cm. As shown in Table 3.4, small sherds outnumber large sherds by a ratio of 13.4:1 on the inner reef Area 7 and 4.9:1 in excavation unit TP 1 on the beach. Area 8, which includes a mixture of sherds from the outer and inner reef, has a lower ratio of 2.5:1. In contrast, large sherds outnumber small sherds by a ratio of 1.6:1 in Area 6 on the outer reef.

Plain body sherds from DJQ and DES were also separated by size classes based on maximum sherd diameter. Of the 1116 plain body sherds sorted by size at DES, 36% are less than 2 cm, a figure quite close to that of Area 6 on the outer reef at DAF. The number of small sherds at DJQ is much lower than DAF representing only 6.2% of the sample of 551 sherds while 7.6% of the sherds are over 6 cm.

The collective evidence indicates that sherds from reef areas are significantly larger than those from beach deposits. It is unlikely that these differences are the result of inadequate sampling of smaller sherds from reef areas as these areas were collected intensively. As previously discussed, the higher percentage of large sherds on the outer reef may be explained by differences in the type of occupation represented between the reef and beach. For example, ceramics from stilt structures on the reef would not have been subject to post-depositional breakage due to trampling and agricultural activity unlike those in the beach deposits.

Analytical procedures

Intensive collection of all visible ceramics was carried out at sites DJQ and DES but some areas of DAF were sampled less intensively than others. Only small samples of sherds were collected from beach areas at DAF where ceramic density was low. The southern portion of the reef flat was not covered as thoroughly outside of the main pottery concentration zones. Lapita sherds were grouped into 12 collection areas of variable size at DAF while sherds from DJQ were initially divided into 17 groups collected from contiguous transects as well as a group of sherds collected from the general site area (see Table 3.7 for distribution). The quantities of sherds at DJQ outside of the main Lapita ceramic concentration were too dispersed and limited in number for an analysis of spatial variability in ceramic attributes within the site. The ceramic assemblage from DES was also analysed as a single unit.

The first step in analysis for each of the sites was to separate diagnostic and non-diagnostic sherds. All of the 6519 diagnostic sherds from the three reef site assemblages were included in the analysis. This included 5754 sherds from DAF, 440 from DJQ and 325 from DES. A sample of plain body sherds from DAF and DJQ was also included in the analysis. Almost all (n=537; 97.4%) of the 551 non-diagnostic sherds from DJQ were analysed.

At DAF all non-diagnostic sherds were counted except for the three collection areas where total weights rather than counts were recorded. A total of 766 large non-diagnostic sherds from the DAF reef was retained for analysis including samples from Areas 5 (n=71) and 6 (n=220) on the outer reef, Areas 1 (n=47) and 2 (n=227) on the central reef, and Area 7 (n=201) on the inner reef. Of the 901 plain body sherds recovered from excavation unit TP 1, 569 were of adequate size and sufficiently well-preserved to be included in the analysis. Thus a sample of 1335 plain body sherds from DAF was analysed. The Site DES pottery was analysed during a brief visit to The Australian National University where the assemblage is presently stored. Due to time constraints, analysis of plain body sherds did not extend beyond sherd counts and a quick separation of calcareous tempered Lapita sherds from the mineral sand tempered post-Lapita ceramics.

After the separation of diagnostic and non-diagnostic sherds, all diagnostic pottery from DAF and DJQ was first organised by site and sherd type and then catalogued using a three component code. The code included:

1. a three letter site designation;
2. a numeric code for the collection area or excavation level (in the case of the TP 1 sample from DAF); and
3. a unique numeric code for each sherd beginning with 1.

Thus if the first sherd coded was from Area 2 at Site DAF, the catalogue code would be DAF.2.1. The plain body sherds were not catalogued but kept in lots by collection area. Diagnostic pottery from DES was numbered in a separate sequence from the other sites for data entry but catalogue numbers were not written on the sherds due to time constraints.

A number of sherds were in danger of disintegrating due to the presence of salts and required extended immersion in distilled water for desalination. This was followed by consolidation of friable sherds through immersion in a 5-10% solution of Butvar B-98 (polyvinyl butyral) in ethanol. The advantage of B-98 is that removal of the consolidation agent by immersion in ethanol is possible.

Following cataloguing, discrete and continuous attributes related to vessel morphology, manufacturing and finishing techniques, paste composition and decoration were selected for analysis of the diagnostic sherds. Attributes recorded for non-diagnostic sherds were restricted to sherd thickness and temper type. An attribute based analysis enabled a broad characterisation of the ceramics from each site as well as inter- and intra-site comparisons. Examination of the ceramics during cataloguing provided an adequate degree of familiarity with the range of variability to select appropriate attributes and attribute values for analysis. Attributes were assigned numeric value codes for data entry into the database program dBase. A list of the attributes recorded for diagnostic sherds is found in Table 4.1.

Once the ceramic data had been entered, the database files were converted into system files within the statistical package SPSS/PC+ for analysis (SPSS, Inc. 1990). The primary statistical procedures utilised were descriptive statistics for discrete and continuous variables (procedure FREQUENCIES) and crosstabulations to examine relationships between variables (procedure CROSSTABS).

The principal goals of statistical analysis were to:

1. broadly characterise each site assemblage and potential sub-assemblages; and
2. examine intra- and inter-site variability to determine the degree to which pottery from individual site areas and overall site assemblages were related.

The significance of these relationships was then examined to determine the underlying mechanisms responsible for the observed similarities and differences. Given the lack of an absolute chronology for the reef sites, one of the objectives of ceramic analysis was to provide a relative chronology for the sites by attempting to seriate the assemblages using variables which were most likely to be temporally sensitive. The degree to which functional variability was responsible for differences in vessel forms, decoration and technology within and between sites was also assessed.

VESSEL FORMS

Based on the examination of rim sherd attributes and to a lesser extent carinations, neck and shoulder sherds and flat bases, ten vessel forms and nine subforms were recognised within the ceramic assemblages. As outlined in Table 4.2, the vessel forms were defined on the basis of contour using a shape classification system devised by Shepard (1956:228-32). Vessels were separated into two major structural classes, unrestricted and restricted, which were further subdivided by contour type as defined by reference to characteristic points on the vessel. Similar vessel forms from Western Lapita sites recorded by Parker (1981:Fig. 30) and published by Green (1990:39) are also presented in Table 4.2. These forms are based on the analysis of ceramic assemblages from three Reef-Santa Cruz Lapita sites in the southeast Solomons. In Table 4.3, the distribution of vessel forms between assemblages is presented in relative chronological order beginning with Site DJQ. The DAF site is divided into three areas which are thought to represent chronologically discrete occupational episodes. Based on a range of attributes to be discussed below, the outer reef portion of DAF (Areas 5, 6 and the outer portion of Area 8) appears to have the earliest ceramics, followed by the central reef (Areas 1 to 3) and finally, inner reef (Areas 4 and 7) and beach (Areas 9 to 12) assemblages. Estimated rim diameters for vessel forms by site are shown in Table 4.4. Decorative techniques associated with vessel forms by site are found in Table 4.5 and selected sherd profiles for each vessel form are presented in Figures 4.1 to 4.15. Proveniences of individual sherds illustrated in these figures are designated by means of a code consisting of:

1. the site designation (DAF, DJQ or DES);
2. the collection area for DAF and codes for transects from DJQ (see Table 3.7); and
3. the catalogue number.

Pottery from Site DES was collected as a single unit so no collection areas are included in the provenience code.

1	provenience (site, collection area, catalogue number)
2	sherd type (rim, neck, carination, handle, body, base, foot)
3	surface colour (hue, value, chroma using Munsell system)
4	temper (ranked importance of calcareous and mineral sand inclusions)
5	temper density percentages based on Bennett (1974:105)
6	surface treatment (polish, possible slip, impression by paddle, anvil or other means)
7	rim orientation (everted, vertical, inverted – extent of inversion or eversion recorded in 20° increments if measurable)
8	rim course (outcurved or concave, straight, incurved or convex)
9	lip form (reduced, parallel, or expanded with a range of forms within each category)
10	estimated rim diameter (cm)
11	rim percentage (amount of rim represented by rim sherd)
12	rim thickness (mm)
13	body thickness (mm)
14	neck inclination angle (100-170°)
15	carination angle (90-170°)
16	decoration technique (stamping, incising, carving, impression, punctation, perforation, applied relief)
17	decoration location (coded as part of the motif attribute)
18	individual motif attributes with separate codes for decorative technique, general zone markers and decoration location
19	Lapita motif attributes (design zone, total restricted zone markers, total motifs)

Table 4.1 List of attributes recorded for the analysis of Lapita pottery from the reef sites.

	Form	Parker (1981) Form
I. Unrestricted Vessels		
A. simple vessel contours (includes flat bottomed vessels)		
1. vertical and slightly everted rims	1	
a. thin walled	1A	
b. thick walled	1B	
2. strongly everted rims	2	2, 5?, 1?
a. multiple rim	2A	
b. angled rim	2B	
c. thick walled – includes paddle impression/flat base (DAF)	2C	3?
B. composite vessel contours		
1. rim diameter = carination diameter	3	
II. Restricted Vessels		
A. simple vessel contours		
1. slightly inverted rims	4	6
2. strongly inverted rims (includes lidded vessels)	5	
B. composite vessel contours (carinated)		
1. inverted rim	6	7
C. inflected vessel contours		
1. everted rim	7	13, 14?
2. upturned inverted rim	8	
a. rim parallel, direct	8A	11?
b. rim thickened/rolled, thick wall	8B	
3. inverted rim with everted lip	9	
a. narrow neck	9A	
b. wide neck	9B	
4. constricted neck (with handle?)	10	

Table 4.2 Classification of Lapita Vessel Forms.

Site	Vessel Form														
	1A	1B	2A	2B	2C	3	4	5	6	7	8A	8B	9A	9B	10
DAF (inner reef and beach)	✧✧		✧	✧										?	
DAF (central reef)	✧✧	✧	✧	✧	✧	✧	✧✧	✧	✧	✧	✧	✧	✧	✧✧	✧
DAF (outer reef)	✧✧	✧	✧	✧✧		✧	✧✧	✧	✧	✧	✧		✧	✧	
DES	✧✧	✧	✧✧	✧✧		✧	✧✧	✧	✧	✧	✧		?	?	?
DJQ	✧	✧	✧✧	✧✧		✧			✧	✧	✧✧				

Table 4.3 Distribution of Lapita Vessel Forms between reef sites. (Code: ✧✧ Common; ✧ Present)

Simple vessel contours

Vessel Form 1

This form includes uncarinated bowls and a few cups with vertical to slightly everted rims. There are two subforms. Form 1A vessels are thin walled and generally small with a mean diameter of 20 cm (Fig. 4.1:a-l). These vessels are common at DAF and DES but only two examples were identified at DJQ suggesting that they may be late forms as DJQ appears to be the earliest of the three sites. Vessel Form 1B (Fig. 4.1:m-q) is a thick walled shallow bowl with decoration restricted to lip impression and a single example with nubbins, unlike Form 1A which is associated with a wide range of decorative techniques. Form 1B bowls have moderately large diameters ranging from 24 to 38 cm with a mean of 30 cm. Lips on Form 1 rims are usually parallel and flat or rounded in form.

Vessel Form 2

Form 2 vessels are shallow bowls or basins with highly everted rims and include some flat bottomed specimens. Vessel forms from Parker (1981) which are similar include Forms 2 and 5 with curved bottoms and Forms 1 and 3

Vessel Form	Site DJQ	Site DAF	Site DES	Mean Diameter
Unrestricted Bowl				
1A	20/38	8/10/20/22/26	18/20/22	20
1B	N/A	24(2)/34/38	30(2)	30
Unrestricted Shallow Bowl				
2	38	18/20/24/30/32	26/30	27
2A	34/36/38/40	20(2)/32(3)	30(2)	31
2B	14/28/30/50(2)	48	30(2)	35
2C	N/A	18/24/30(2)/38	N/A	28
Unrestricted Carinated Bowl				
3	24	14/20(4)/22(2)/24/26/32	30	23
Restricted Bowl				
4	26/38	10/38	16/24/30	26
Strongly Restricted Jar				
5	N/A	12/14/16(2)/20(2)	16	16
5 (lid)	N/A	10/20	N/A	15
Restricted Carinated Bowl				
6	-	20/26/32	26/30(2)	27
Large Jar - Constricted Neck				
7	-	20	-	-
8A	24/38/40(2)	10/24/30/34/36	34	31
8B	N/A	24	N/A	-
Large Jar - Constricted Neck, Everted Lip				
9A	N/A	14(2)/16/22/24(3)/28/32/36	N/A	23
9B	N/A	18/26/32/38	N/A	29
Small Mouth Jar				
10	N/A	4(4)/6(2)/10	-	5

Table 4.4 Estimated rim diameters (cm) for Lapita Vessel Forms from reef sites DAF, DJQ and DES. (Code: N/A = vessel type not present; ( ) = total examples; - = no diameters recorded)

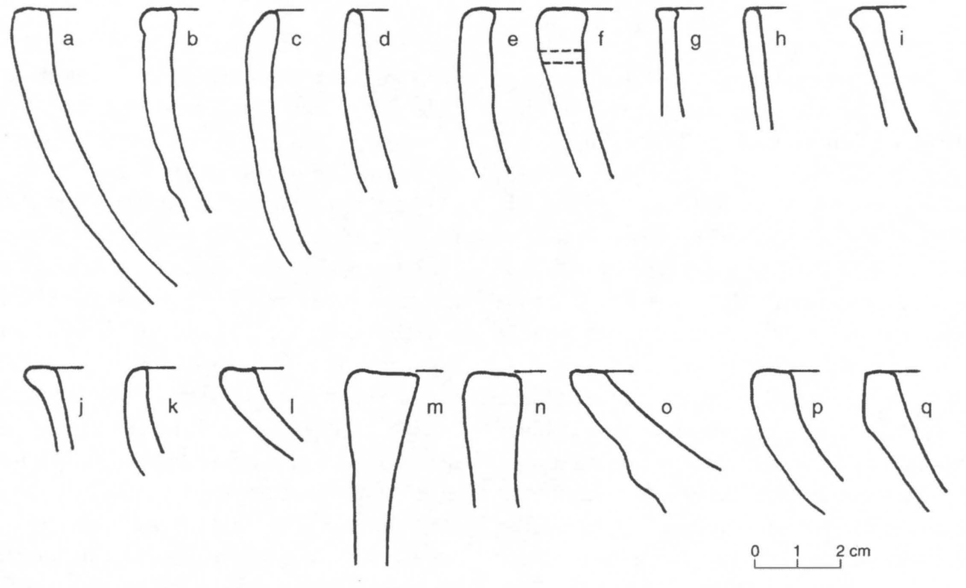


Figure 4.1 Lapita rim profiles: Vessel Forms 1A (a-l) and 1B (m-q). **Code** – Letter Designation: Provenience Code (Site, Collection Area/ Transect, Cat. No). **Data** – a: DAF.8.6075; b: DAF.8.900; c: DAF.8.1048; d: DJQ.11.345; e: DES.312; f: DES13; g: DAF.8.?; h: DJQ.2.6213; i: DJQ.8.309; j: DES.231; k: DJQ.15.427; l: DES.221; m: DAF.7.1479; n: DES.209; o: DAF.3.606; p: DAF.5.1518; q: DAF.3.622.

with flat bottoms. Parker's Forms 1 and 2 are widely distributed among Western Lapita sites while Forms 3 and 5 are more restricted. The three Form 2 variants are differentiated primarily by rim form and wall thickness.

Form 2A is distinguished by the presence of double everted rims as shown in Figure 4.2. Double rims were formed by the addition of an extra strip of clay to everted rims giving the original rim lip a flange-like appearance.

Vessel Form	Stamped	Bounded Fine Incision	Free Form Incision	Relief Strips	Nubbins	Perforated	Impressed Below Rim	Notched/ Impressed Rim	Plain
Unrestricted Bowls									
1A	+	++	+	+	+	+	+	++	++
1B	0	0	0	0	+	0	0	+	++
Shallow Bowls									
2	+	0	0	+	+	+	+	+	+
2A	++	0	0	+	+	++	0	++	0
2B	++	+	+ (1)	0	++	++	+ (1)	+	+
2C	0	0	+ (1)	+ (2)	0	0	0	+	+
Carinated Bowls									
3	+	0	++	0	0	0	++	++	+
Restricted Bowls									
4	+	++	+	++	+	+	0	++	+
Strongly Restricted Jars									
5	+	0	+	++	0	+ (1)	0	0	+
5 (lid)	0	0	+	+	0	0	0	+	+
Restricted Carinated Bowl									
6	+ c	0	+	+ c	+ c	0	++	+	+
Large Jar - Constricted Neck									
7	0	++	?	? s	? n/s	+ (1)	0	++	0
8A	+	++	? s	? s	+	0	+	++	+
8B	0	0	0	0	0	0	0	0	+
Large Jar - Constricted Neck, Everted Lip									
9A	0	0	++	+ s	0	0	0	++	+
9B	0	0	? s	? n/s	? n	0	? n	++	++
Small Mouth Jar									
10	0	0	+ (2)	0	0	0	+ (5)	+ (1)	+ (2)
Total Types	9	5	9(3?)	8(3?)	8(2?)	7	7(1?)	14	14

Table 4.5 Decoration associated with Lapita Vessel Forms from reef sites DAF, DJQ and DES. (Code: + = present; ++ = common; 0 = absent; + ( ) = present (number of examples); ? = probably present but not found on rims; s = shoulder; n = neck; c = carination)

The junction between the two rims is clearly visible in many sherds due to poor bonding and the presence of air voids where the upper strip was connected. One double rim (Fig. 4.2:i) apparently had a third upper rim attached originally. Many of the upper rims are angled sharply outward with square or rounded lips (Lip Form 5). Form 2A is found at each site and is common at Sites DJQ and DES. At DAF the highest percentage of double rims which are diagnostic of 2A vessels occur on the outer reef. Reconstructed rim diameters range from 20 to 40 cm with a mean of 31 cm.

The most frequent decorative techniques associated with Form 2A are notched or impressed upper and lower rim lips often associated with dentate-stamping and lip perforations. A single rim was found with stamping on the exterior and a row of nubbins on the lip interior (Fig. 4.2:c). Single rows of carved triangles are found on the lips of the probable triple rim sherd and another rim (Fig. 4.2:j) from DAF which also has vertical relief strips on the exterior. Published references to vessels with multiple rims from Lapita sites are scarce. Five such rims with dentate-stamping have been reported from the Natunuku site in Fiji (Davidson et al. 1990:143) and a single rim with bounded incision was found at the Kreslo reef site on the southwest coast of New Britain (Specht 1991:193).

Vessel Form 2B has an everted rim and angled Form 5 lip similar to the upper lip form of many Form 2A rims (Fig. 4.3:a-c, e-h, l, p-r). Form 2B is common at DES and dominant at DJQ but of minor importance at DAF where the highest relative frequency of Lip Form 5 occurs on the outer reef north of the wharf. Rim diameters range from 14 cm to over 50 cm with a mean of 31 cm and the largest vessels are from DJQ. The single flat base angle from DES (Fig. 4.5:f), which has dentate-stamping and carved triangle decoration, and two plain flat base sherds from DJQ may be from Form 2B vessels resembling Parker's Form 1 or Vessel Type A from the Sigatoka site in Fiji (Birks and Birks 1975:9).

The most common Form 2B decorative technique is dentate-stamping which is often associated with lip perforations and nubbins located on the lip interior and exterior immediately below the lip. Stamped motifs commonly extend from the lip downwards in a series of zones on the exterior while interior motifs are usually restricted zone markers found directly below the lip angle. The high frequency of dentate-stamping suggests that these vessels may have served a social as well as utilitarian function. One of the two sherds with fine needlepoint-like dentate-stamping typical of the Early Western Lapita style is a Form 2B rim (Fig. 4.3:a).

The Form 2C variant is a thick walled bowl which includes curved and flat bottomed forms. It occurs only at Site DAF on the central reef in Areas 1 to 3 (Figs. 4.4 and 4.5). These vessels are plain except for a few examples with lip impressions and two rim sherds with notched

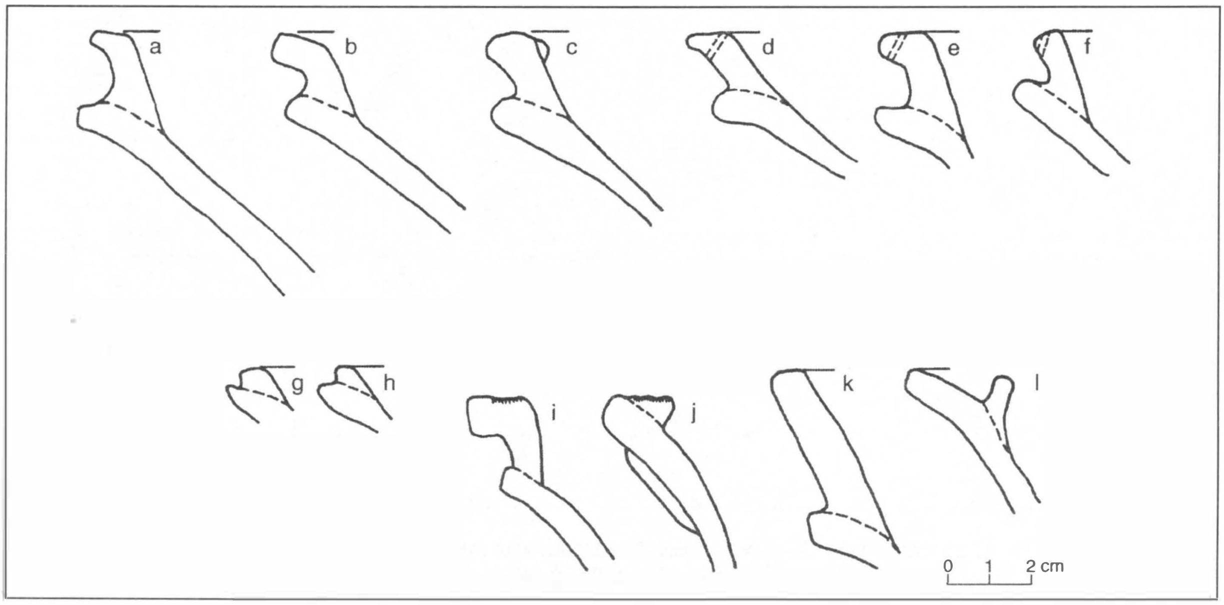


Figure 4.2 Lapita rim profiles: Vessel Form 2A. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a:DAF.8.780; b: DES.109; c: DJQ.2.83; d: DES.308; e: DAF.2.1651; f: DJQ.2.84; g: DAF.10.5961; h: DAF.10.5960; i: DAF.1.550; j: DAF.1.551; k: DAF.7.1429; l: DES.110.

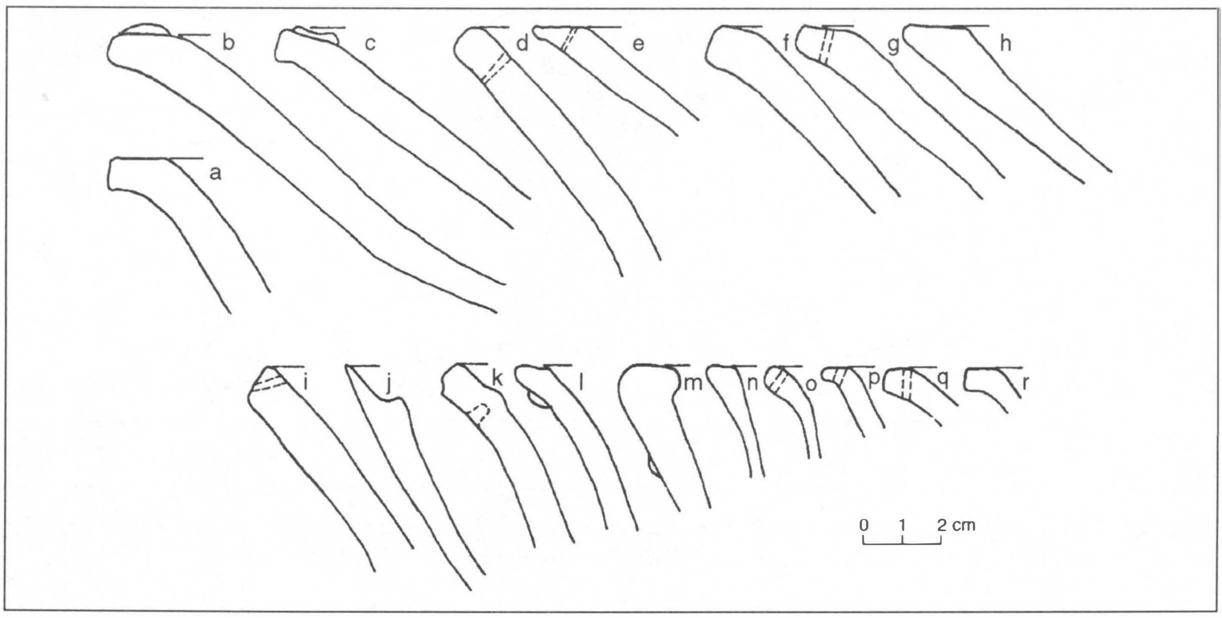


Figure 4.3 Lapita rim profiles: Vessel Forms 2 (d, i-k, m-o) and 2B (a-c, e-h, l, p-r). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DJQ.1.203; b: DJQ.1.201; c: DJQ.8.297; d: DAF.6.1089; e: DJQ.2.190; f: DAF.6.19; g: DES.16; h: DAF.8.784; i: DAF.3.607; j: DAF.3.605; k: DES.44; l: DJQ.4.254; m: DAF.2.1732; n: DAF.6.3300; o: DES.22; p: DAF.4.2142; q: DAF.4.2141; r: DAF.10.5959.

relief strips or incision (Fig. 4.4:a, b) on the interior surface. Several roughly finished rims have plain paddle impressions on the exterior forming a pattern of intersecting perpendicular lines (Fig. 4.4:c, d). The paddle impressions appear to be a finishing technique rather than decorative in nature and also occur on a number of flat base sherds and flat base angles with vertical walls (Fig. 4.5:a, d). The flat based vessels are similar in appearance to Parker's Vessel Form 3 and the curved base form resembles Form 5. The five reconstructed rim diameters for Form 2C range from 18 to 38 cm with a mean of 28 cm. The function of such massive vessels, with walls up to 30 mm thick, was undoubtedly of a utilitarian nature.

Vessel Forms 4 and 5

These vessel forms are restricted bowls and jars with simple contours distinguished from one another by the degree of rim inversion. Form 4 is generally similar to Form 1 in shape but has an inverted rather than unrestricted rim (Fig. 4.6). Like Form 1, it is common at DAF and DES but not DJQ. Both small and large bowls are present with diameters ranging from 10 to 38 cm and walls range from very thin to moderately thick. A wide range of decorative techniques occur on Form 4 vessels and the most common are bounded incision and vertical relief strips extending downwards from the outer lip margin. Several strongly incurved body sherds with dentate-

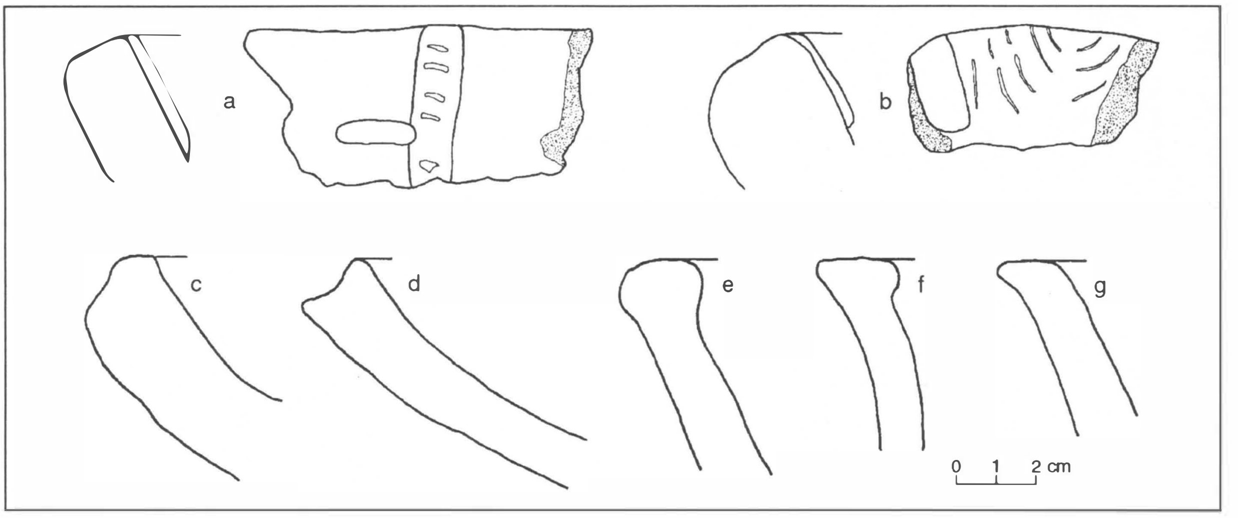


Figure 4.4 Lapita rim profiles: Vessel Form 2C. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.2.1593; b: DAF.2.1594; c: DAF.2.1614; d: DAF.2.1605; e: DAF.2.1575; f: DAF.6.3322; g: DAF.6.3320.

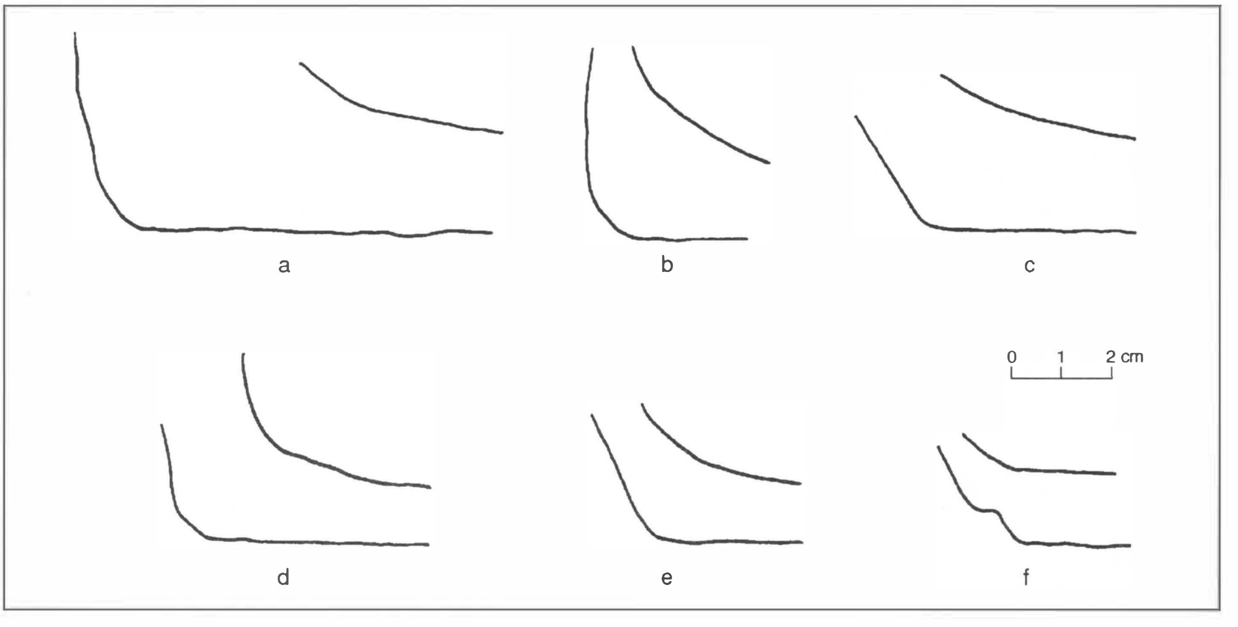


Figure 4.5 Lapita flat base profiles: Vessel Form 2. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.3.645; b: DAF.2.1590; c: DAF.1.563; d: DAF.2.1589; e: DAF.2.1596; f: DES.30.

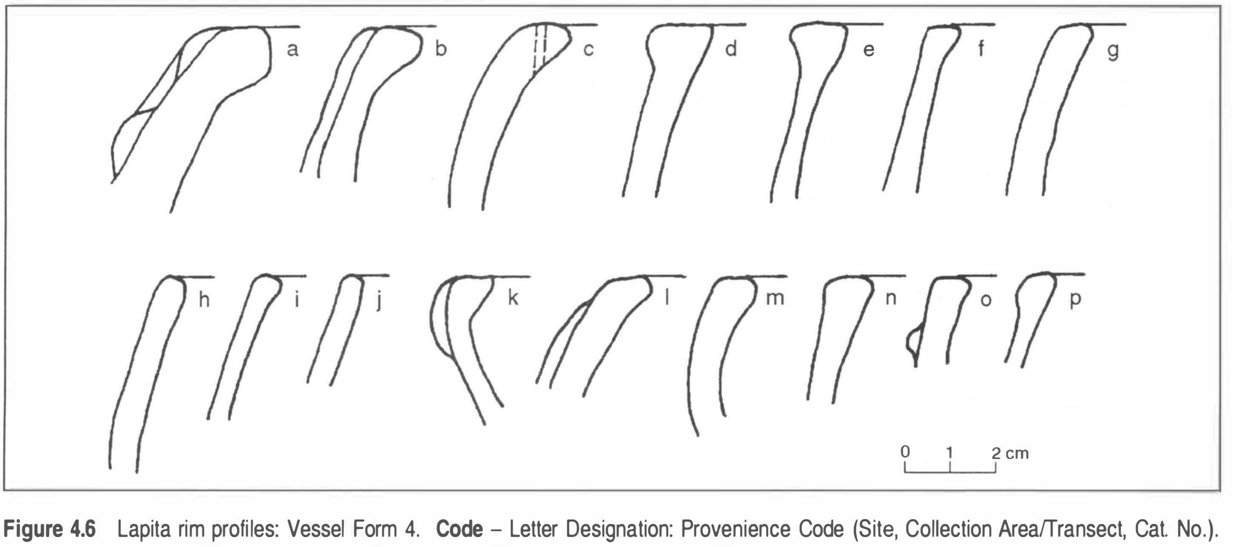


Figure 4.6 Lapita rim profiles: Vessel Form 4. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.5.1423; b: DAF.2.1661; c: DAF.6.1095; d: DAF.6.?; e: DAF.6.3340; f: DAF.6.1145; g: DES.208; h: DJQ.2.194; i: DAF.6.3327; j: DJQ.2.6212; k: DAF.5.1424; l: DES.55; m: DAF.2.?; n: DJQ.16.456; o: DES.56; p: DES.323.

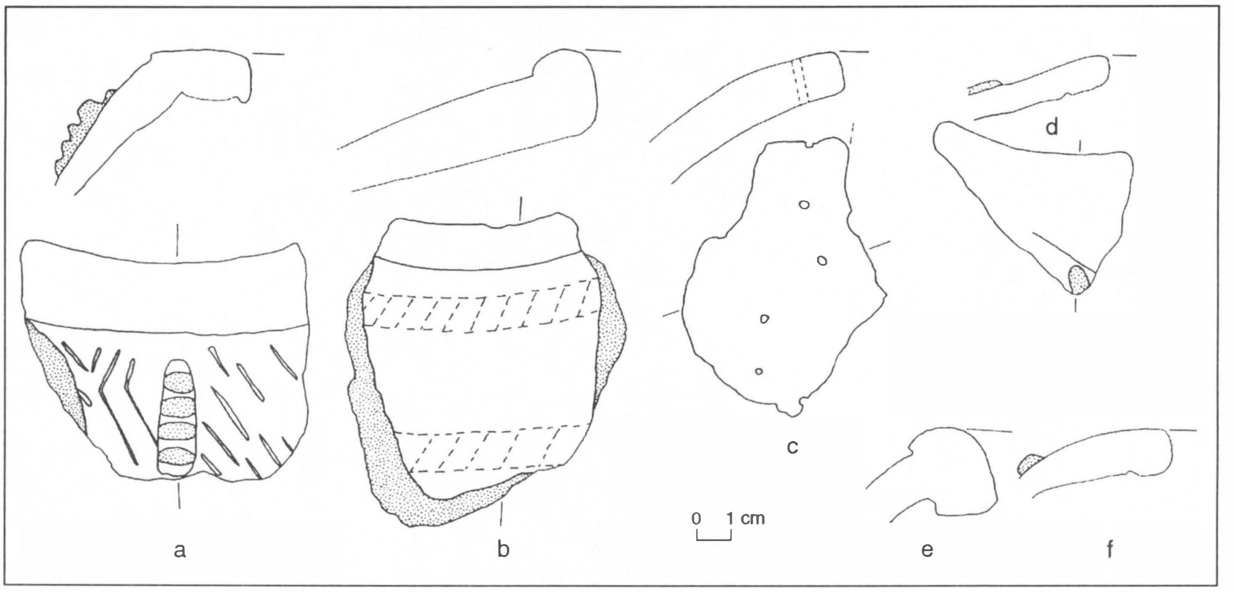


Figure 4.7 Lapita rim forms: Vessel Form 5. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.2.1727; b: DES.83; c: DAF.6.1040; d: DAF.2.1766; e: DAF.2.1587; f: DAF.2.4083.

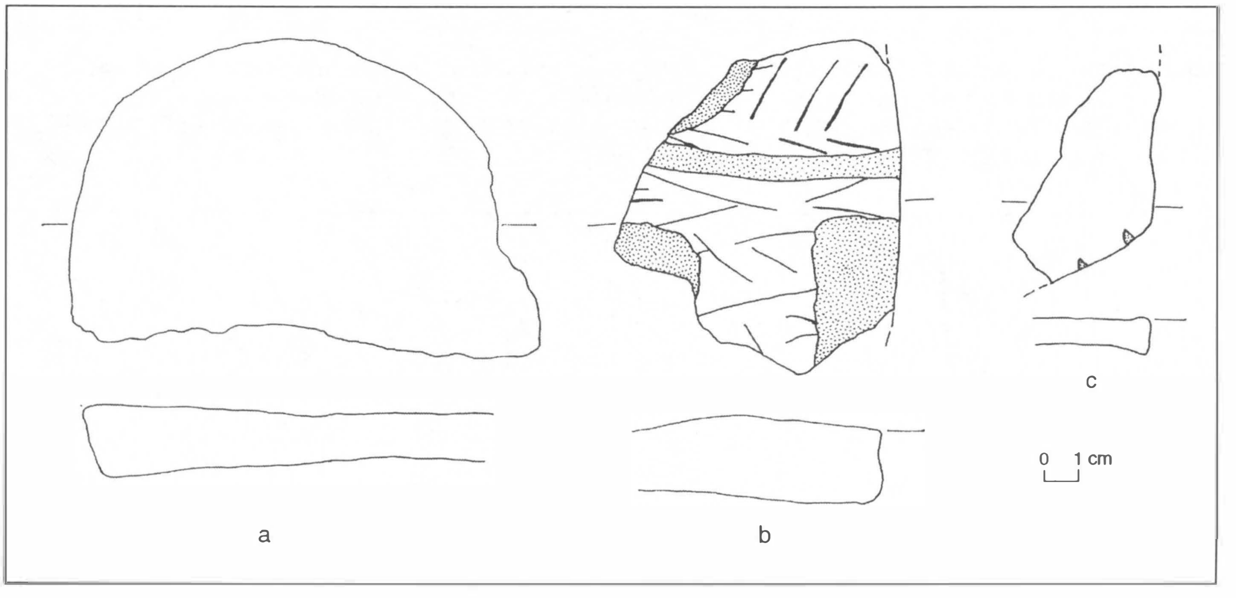


Figure 4.8 Lids from Lapita Form 5 vessels. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.3.970; b: DAF.2.1725; c: DAF.2.3927.

stamping associated with a vertical row of nubbins or incision (Fig.4.10:c, d, f) may be from Form 4 vessels.

Form 5 vessels are highly restricted jars with rim inversion of over 45 degrees and include seven examples from DAF and two probable examples from DES (Fig. 4.7). Three circular lid fragments from DAF may be from Form 5 vessels as they have diameters similar to Form 5 rims, which range from 12 to 20 cm. A fourth possible lid or irregular rim with two finished sides and impressed lip decoration was also found (Fig. 4.8:c). One of the Form 5 rims (Fig. 4.7:a) has the same diameter and incised and applied relief decoration as a lid found in the same collection area (Fig. 4.8:b). None of the other lids are decorated and additional decorative techniques on rim sherds include single examples of dentate-stamping (Fig. 4.7:b) and random perforations which may be utilitarian rather than decorative (Fig. 4.7:c). There is also a rim with an eroded modelled protrusion below the lip that may be a lug or handle attachment point. It is uncertain whether Form 5 vessels include carinated forms as no sherds of sufficient size for complete vessel reconstruction were found.

Composite (carinated) vessel contours

Vessel Forms 3 and 6

Both of these vessel forms are carinated bowls where the rim diameter equals the carination diameter (Form 3) or the rim is inverted with a smaller diameter than the carination (Form 6). Distinguishing between the two forms was somewhat difficult when precise rim orientations could not be determined. Many of the carinations are best described as complex in that they were constructed by the addition of an upper strip of clay at an angle to

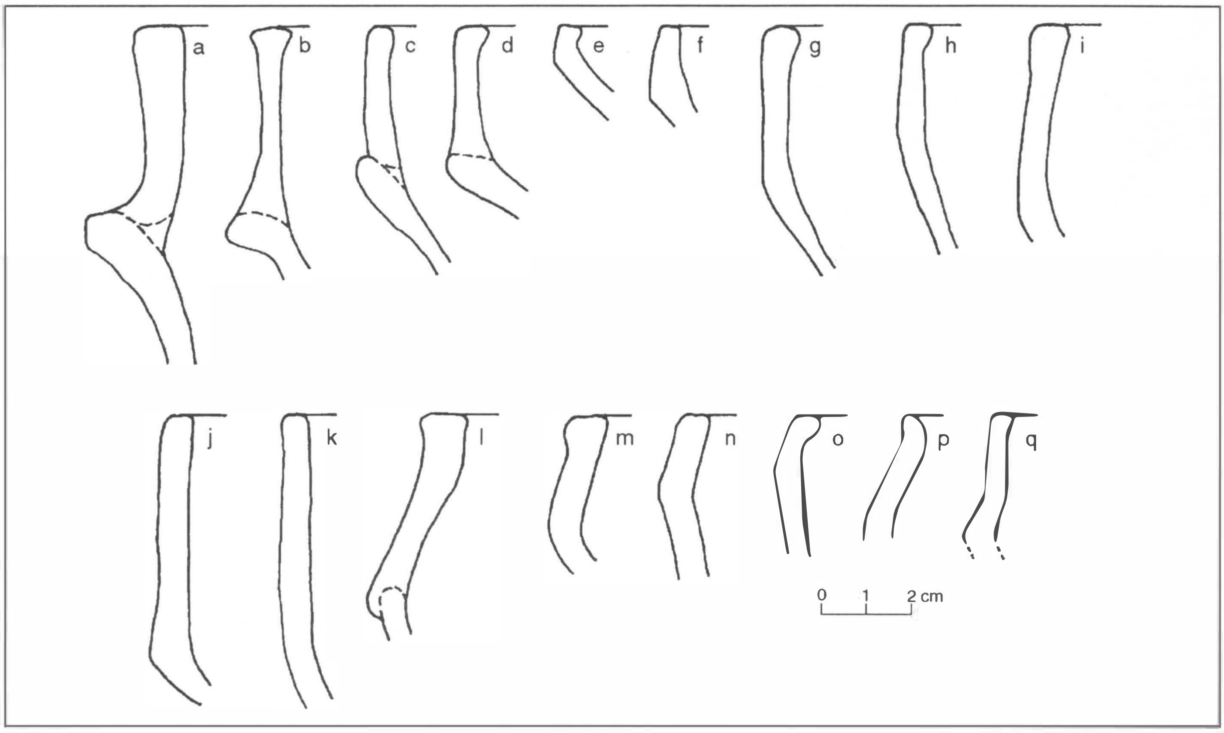


Figure 4.9 Lapita rim profiles: Vessel Forms 3 (a-k) and 6 (l-q). **Code** – Letter Designation: Provenience Code (Site, Collection Area/ Transect, Cat. No.). **Data** – a: DAF.6.1050; b: DAF.7.1445; c: DAF.7.1251; d: DAF.6.1049; e: DAF.5.1527; f: DES.222; g: DAF.6.1053; h: DAF.6.1055; i: DAF.7.1263; j: DAF.6.1081; k: DJQ.2.175; l: DAF.7.1249; m: DAF.8.802; n: DES.74; o: DES.246; p: DAF.5.1470; q: DES.76.

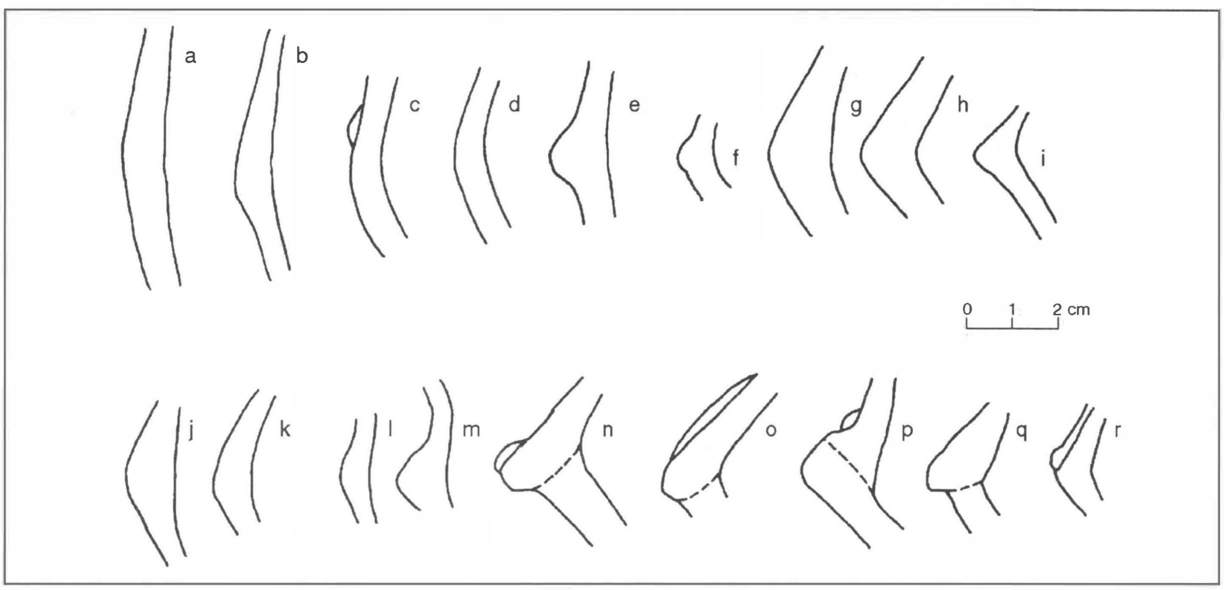


Figure 4.10 Lapita carination profiles: Vessel Forms 3?, 4 (c, d, f) and 6. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DJQ:13.6227; b: DAF.6.1080; c: DJQ.2.140; d: DAF.2.2279; e: DAF.2.1738; f: DJQ.3.252; g: DJQ.14.398; h: DAF.7.1259;; i: DAF.2.3843; j: DJQ.2.134; k: DAF.2.2095; l: DAF.2.1910; m: DES.71: n: DAF.2.1662; o: DAF.2.1734; p: DAF.2.1722; q: DAF.2.1733; r: DAF.8.68.

the original vessel wall to form the rim (Fig. 4.9:a-d, l and Fig. 4.10:n-q). Protrusion of the lower vessel wall or upper clay strip at the carination often results in a flanged appearance. As with Form 2A double rims, the junction formed at the carination is visible in some sherds due to incomplete joins and the presence of air voids along the contact surface. Simple carinations were formed by angling the vessel wall rather than addition of a separate clay strip. Rim height above the carination ranges from 10 to 60 mm for Form 3 and up to 40 mm for Form 6.

Neither Form 3 nor 6 are common but both are found at each site. Based on a higher frequency of complex carinations, these vessel forms appear to be most common on the outer reef at DAF. Form 3 diameters range from 14 to 32 cm with a mean of 23 cm and Form 6 rims range from 20 to 32 cm with a mean diameter of 27 cm. Form 6 is similar to Parker's Vessel Form 7 which is found at Site

RF-2 in the southeast Solomons, Malo in Vanuatu and Vatcha in New Caledonia. Decoration on Form 3 vessels includes a few examples with dentate-stamping and both forms have incision between the lip and carination together with impressions along the carination angle. As with most vessel forms, a majority of rims have lip impressions.

Carination angles include some examples which are likely to be from Form 3 vessels but a majority have Form 6 characteristics (Fig. 4.10). The range of decoration on these sherds includes dentate-stamping both above and below the carination angle, incision and relief strips above the carination, nubbins on or slightly above the carination, and impressions on the carination angle.

A possible carinated bowl form with everted rim has been tentatively identified on the basis of carinations with outcurved walls above the carination angle from each site (Fig. 4.10:a, l, m). However, not enough information was obtained to reconstruct the vessel form.

Inflected (necked) vessel contours

Vessel Forms 7 and 8

Both Forms 7 and 8 are large necked jars that may include carinated as well as globular vessels (Fig. 4.11). Form 7 has a broad constricted neck and an everted rim; the only estimated rim diameter is 20 cm. If globular in form, it would be similar to Vessel Type F from the Sigatoka site (Birks and Birks 1975:Fig. 1.6) and if carinated, much like Forms 13 or 14 described by Parker (1981:Fig. 30). This vessel form appears to be uncommon at the reef sites although a number of small rim fragments could potentially come from Form 7 pots. Decoration on rim sherds, apart from lip impressions, is restricted to bounded incision on the exterior of the neck below the lip except for a single rim with a row of perforations 1.5 cm below the lip (Fig. 4.11:g). Lips are either pointed or rounded and include flat parallel forms.

Form 8 is most likely globular or subglobular and has two variants as illustrated in Figure 4.11. Form 8A has a straight neck and a rim which is either slightly inverted or vertical. Lips are unthickened and usually rounded or flat. It is a common form at DJQ but relatively uncommon at DES and DAF. The wide range of rim diameters, ranging from 10 to 40 cm with a mean of 31 cm, indicates that several size classes of Form 8A were in use. As with Form 7, bounded incision on the neck region is the most common decorative technique although single rows of impressions are also found on the neck and nubbins occur on the neck and neck/shoulder angle. Neck to shoulder angles shown in Figure 4.13 (a-g), which are probably from Form 8A vessels, have bounded incision on the shoulder region and applied relief strips and nubbins on the neck/shoulder angle. Several rims from DJQ are highly decorated with dentate-stamping covering the entire neck exterior as well as the upper ca. 2 cm of the interior surface. Plain and lip impressed vessels are also found at each site. Form 8B is a large thick walled globular jar with restricted rim identified on the basis of three rims from Area 2 at DAF (Fig. 4.11:p-r) with a single recorded diameter of 24 cm. The vessels are undecorated and have thick rolled or braced lips.

Vessel Form 9

This vessel form is a large globular jar with straight to slightly concave neck and slightly inverted rim (Fig. 4.13). A characteristic feature of both Form 9 variants is an

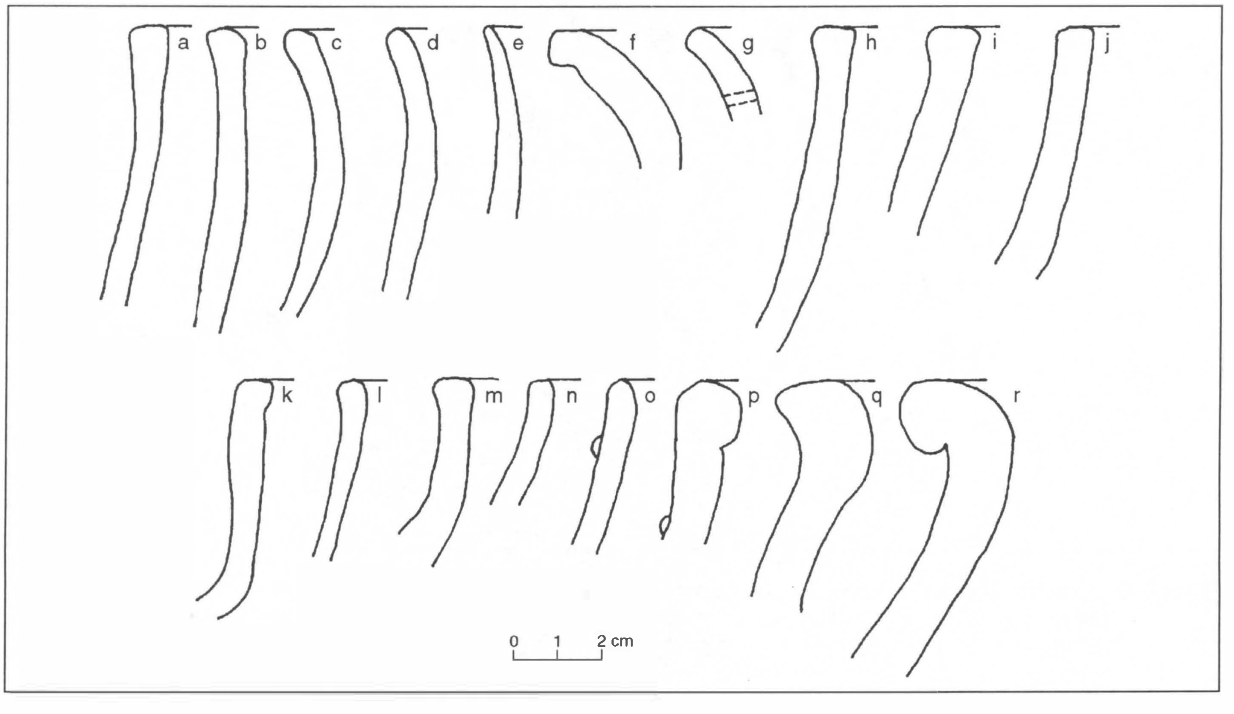


Figure 4.11 Lapita rim profiles: Vessel Forms 7 (a-g), 8A (h-o), and 8B (p-r). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DJQ.15.406; b: DJQ.14.395; c: DES.320; d: DJQ.16.442; e: DJQ.15.404; f: DAF.2.3916; g: DES.20; h: DAF.6.1044; i: DES.199; j: DAF.5.1495; k: DJQ.18.6238; l: DAF.7.1305; m: DAF.1.3286; n: DES.220; o: DAF.5.?: p: DAF.2.1570; q: DAF.2.1576; r: DAF.2.2248.

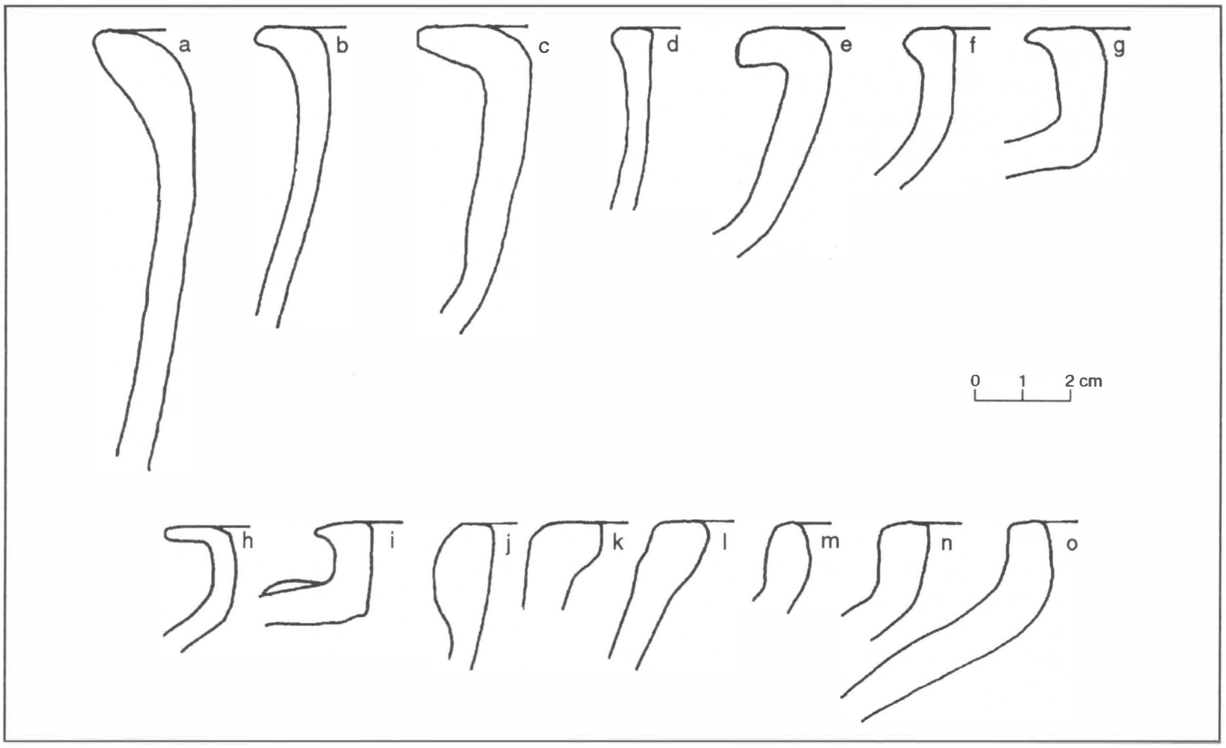


Figure 4.12 Lapita rim profiles: Vessel Forms 9A (e-i), 9B (a-d), and 10 (j-o). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.2.4041; b: DAF.2.4190; c: DAF.8.950; d: DAF.8.791; e: DAF.6.3409; f: DAF.2.1649; g: DAF.2.1643; h: DAF.2.3976; i: DAF.2.1669; j: DAF.2.4104; k: DAF.2.1673; l: DAF.2.1763; m: DES.180; n: DAF.2.1761; o: DAF.2.1760.

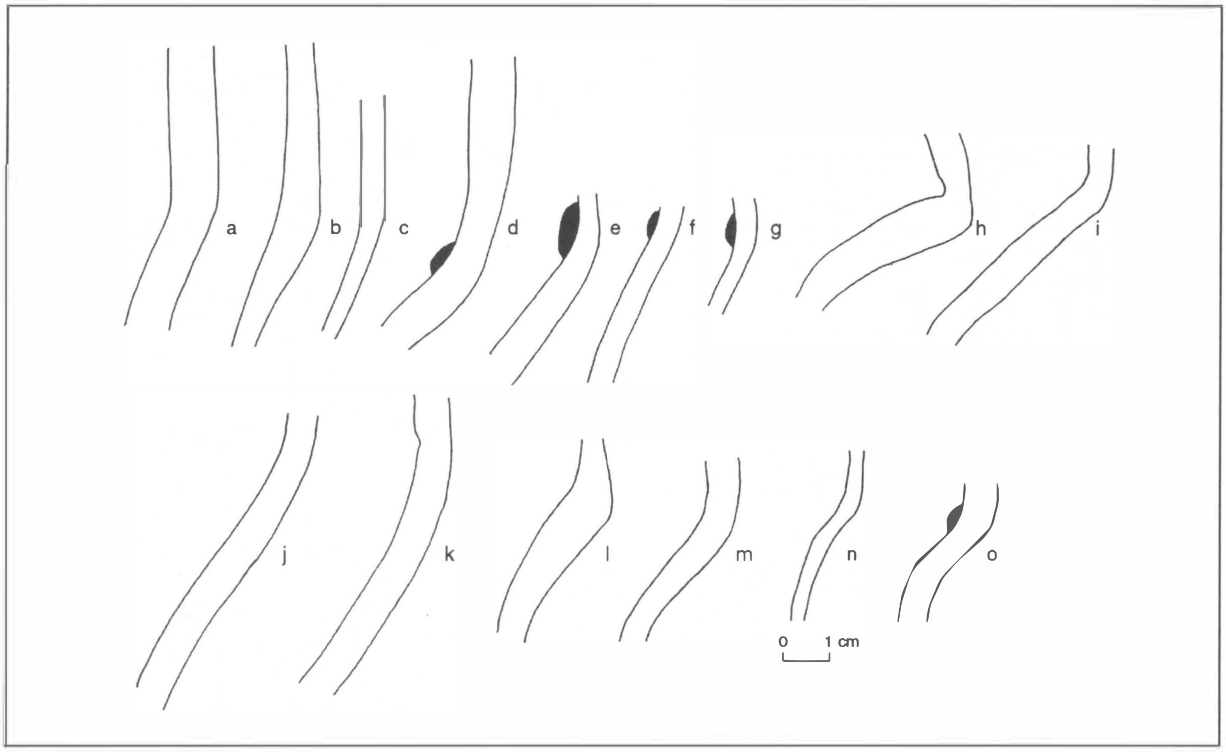


Figure 4.13 Lapita neck and shoulder profiles: Vessel Forms 8A (a-g) and 9 (h-o). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.6.1150; b: DJQ:18.473; c: DAF.5.1552; d: DJQ.3.242; e: DAF.2.1832; f: DES.49; g: DJQ.2.143; h: DAF.6.1141; i: DAF.6.1161; j: DAF.2.1936; k: DAF.2.2032; l: DJQ.2.126; m: DES.299; n: DAF.7.1392; o: DES.50.

everted lip. Form 9 is dominant at DAF but absent from the DJQ assemblage. The presence of some rims with everted lips at DES indicates that Form 9 is present although not common.

Form 9A has a narrow neck ranging from less than 1 to 4 cm and an abrupt to gradual neck/shoulder angle. Most lips are wide and horizontal (Lip Form 7) or pointed and gradually everted (Lip Form 11). Minor lip forms include wide and possibly very wide (up to 3.5 cm) lips with over 90 degree eversion (Lip Forms 8 and 9). Most lips are impressed and incision and relief strips are found on the top of wide and especially very wide lips. Rim diameter ranges from 14 to 40 cm with a mean of 32 cm. Decoration below the lip consists of a variety of incised motifs, particularly cross-hatching and groups of oblique lines, on the shoulder region. Incision is often found in association with relief strips which are usually notched. Neck/shoulder angles from Form 9A vessels, as shown in Figure 4.13, are very common at DAF with higher percentages on the reef north of the wharf. Wide lip rims from 9A vessels at DAF are most abundant on the central reef, and Area 2 in particular.

Form 9B has a much wider neck than Form 9A and is dominated by pointed gradually everted lips (Lip Form 11), the most common lip form at DAF. The mean rim diameter of 29 cm is slightly lower than that of Form 9A. Almost all vessels are undecorated or have decoration restricted to lip impressions. Incision and applied relief may be present on the lower neck and shoulder region (Fig. 4.13). The abundance of Form 9B at DAF and lack of decoration suggests that it was a common utilitarian vessel used for storage or cooking. Lip Form 11 rims typical of Form 9B vessels are almost all from Area 2 (80.5%) and Area 1 (7.8%) on the central reef at DAF indicating that domestic activities were an important aspect of occupation on this portion of the reef.

Vessel Form 10

Vessel Form 10 is a small mouthed jar presumably used to carry water or other liquids (Fig. 4.12). Nine rim sherds of this vessel form were found at DAF and one rim sherd with a small but unrecordable diameter from DES. The seven rim diameters recorded range from 4 to 10 cm with a mean of 5 cm. All but two of the rims from DAF were found at Area 2. Although the precise vessel form is difficult to reconstruct due to the small size of the rim sherds, it is likely that Form 10 vessels were large globular jars similar to the handled jars found at Sigatoka (Birks 1973) and other Fijian and Western Polynesian Lapita sites. At least some of the handles found at DAF and DES may be associated with this vessel form although no definite evidence of handle attachment locations was noted.

Two forms of small mouthed vessels are apparently present at DAF. Vessels with upturned rims are the dominant form but at least one rim is inverted and straight rather than upturned (Fig. 4.12:l). Decoration includes incision on the shoulder portion of two sherds, impressions on the exterior surface directly below the lip on five rims and a single example of lip impression.

ATTRIBUTES RELATED TO VESSEL FORM

The following section discusses attributes recorded in the analysis of diagnostic pottery which relate to vessel morphology and enabled the determination of vessel forms presented in the previous section. The frequencies and inter-site distribution of various discrete and continuous attributes are presented below and relationships between attributes discussed.

Sherd type

The frequencies of each sherd type for the 6519 diagnostic Lapita sherds analysed are presented by site in Table 4.6. Rims are the most common sherd type, representing 58.2% of the sample, including lip and lower rim fragments. Incomplete wide lip rims (Lip Forms 7 to 9) make up a significant proportion of the sample (n=1277; 22.2%) at DAF and include angle and outer lip fragments most common in Areas 1 and 2. Totals for complete and incomplete double rim sherds are displayed separately for each of the sites.

The principal diagnostic sherd types from below the rim include necks, which are often associated with uncarinated shoulders, and carinations. Carinations include rims with carinated transverse bars or flanges often produced by the addition of an upper strip of clay to form complex carinations as in Form 3 and 6 vessels. Complex carinations are found only at DAF but regular carinations occur at each of the sites and are most common at DJQ, followed by DES and DAF, where they are concentrated on the reef north of the wharf. Neck and shoulder sherds are primarily associated with Vessel Forms 7 and 8 at DES and DJQ and Form 9 at DAF.

Base sherds could only be distinguished for flat bottomed vessels, which appear to be limited to a few Form 2 shallow bowls. The single dentate-stamped flat base angle from DES and three plain base sherds from DJQ are presumably from Form 2A and 2B, while the 37 base sherds at DAF are from Form 2C utilitarian vessels. All but four bases at DAF (from Area 8) are from Areas 1 to 3 providing further evidence for a focus on domestic activities at the south central portion of the reef. The bases from DAF are undecorated although a majority have paddle impressions on the exterior surface. Sherds were also found which could be bases with incomplete angles or thick rims with incomplete lips from Form 2C vessels.

Three undecorated sherds from DAF were tentatively identified as fragments of pedestal bases or ring feet. They are relatively thick (14 to 18 mm) with roughly made lips, smooth exteriors and uneven interior surfaces. Similar sherds have been found at Lapita sites in the Bismarck Archipelago including the Kreslo reef site on New Britain (Specht 1991:Fig. 8) and the ECA site on Eloaua Island (Egloff 1975:Fig. 12). Ring foot bases are recorded at Site SZ-8 in the southeast Solomons (Parker 1981:78), on Lakeba in Fiji (Best 1984) and the Ha'apai Islands in Tonga (Dye 1987). Three sherds with fairly smooth convex exteriors and rough concave interior surfaces from Area 2 at DAF are interpreted as possible legs from the base of a vessel or alternatively, potstand feet projecting upwards (Fig. 4.14:e, f). The end of one foot fragment is tapered and finished while the other two sherds are apparently midsection fragments. One roughly modelled probable leg or lug fragment with a semi-triangular cross-section was collected from DES. Pottery legs and/or potstands have been reported from a

Sherd Type	Site DJQ		Site DAF		Site DES		Total Sample	
	n	%	n	%	n	%	n	%
rim with intact lip	123	28.0	1443	25.1	170	52.3	1736	26.6
rim lip only	-	-	51	0.9	1	0.3	52	0.8
lower rim without lip	75	17.1	418	7.3	8	2.5	501	7.7
wide lip rim (angle fragment)	-	-	599	10.4	-	-	599	9.2
wide lip rim (lip fragment)	-	-	678	11.8	1	0.3	679	10.4
Regular Rim Subtotal	198	45.0	3189	55.4	180	55.7	3567	54.7
complete double rim	6	1.4	10	0.2	5	1.5	21	0.3
upper double rim only	-	-	5	0.1	7	2.2	12	0.2
lower double rim only	7	1.6	51	0.9	36	11.1	94	1.4
Double Rim Subtotal	13	3.0	66	1.2	48	14.8	127	2.0
rim with transverse bar below	3	0.7	34	0.6	3	0.9	40	0.6
rim with transverse bar below (carinated)	-	-	14	0.2	1	0.3	15	0.2
rim with carination	-	-	10	0.2	3	0.9	13	0.2
carination angle	38	8.6	76	1.3	16	4.9	130	2.0
complex carination angle	-	-	21	0.4	-	-	21	0.3
Carination Subtotal	38	8.6	121	2.1	20	6.2	179	2.8
rim with neck and shoulder	2	0.5	33	0.6	-	-	35	0.5
neck	63	14.3	120	2.1	20	6.2	203	3.1
neck angle and shoulder	26	5.9	383	6.7	9	2.8	418	6.4
Neck/Shoulder Subtotal	91	20.7	536	9.3	29	8.9	656	10.1
flat base	1	0.2	18	0.3	-	-	19	0.3
flat base with angle	2	0.5	19	0.3	1	0.3	22	0.3
incomplete thick flat base angle or everted rim	1	0.2	23	0.4	2	0.6	26	0.4
Base Subtotal	4	0.9	60	1.0	3	0.9	67	1.0
pedestal base ?	-	-	3	0.1	-	-	3	0.1
modelled leg/foot	-	-	3	0.1	1	0.3	4	0.1
applied lug or disc	-	-	3	0.1	-	-	3	0.1
detached applied relief disc (n=1) or strip	-	-	7	0.1	-	-	7	0.1
coil or strap handle	-	-	16	0.3	11	3.4	27	0.4
lid	-	-	4	0.1	-	-	4	0.1
disc shaped ground body sherd	-	-	10	0.2	-	-	10	0.2
Miscellaneous Subtotal	-	-	46	0.9	12	3.7	58	0.8
body sherd	93	21.1	1702	29.6	30	9.2	1825	28.0
Total	440	100.0	5754	100.0	325	100.0	6519	100.0

Table 4.6 Sherd frequencies by type for diagnostic Lapita pottery.

number of Lapita sites in Fiji (Best 1984; Birks 1973; Davidson et al. 1990) and Tonga (Poulsen 1987).

An undecorated sherd with a pointed projection extending ca. 2 cm from the vessel surface is tentatively identified as a lug but may be a foot (Fig. 4.14:d). Holding devices with a similar appearance are noted in Tonga by Poulsen (1987:134) although most are situated at the rim. An undecorated rim sherd with an ovoid disc attached to the rim exterior and a similar unattached disc were collected from Area 2 at DAF. The rim disc is undecorated and has a slight groove around the margin suggestive of a utilitarian function although no sign of wear is evident. The detached disc has a highly eroded incised pattern which appears to be a simplified 'Lapita face' (see Spriggs 1990a for a discussion of Lapita face motifs).

A variety of handles were found at sites DAF and DES although none are complete or attached to vessels (Fig. 4.15). Twenty-one strap type handles with rectangular cross-sections were collected from DAF and DES and six coil type handles were found at DAF. Although a majority of the DAF handles are from Area 2, they occur in most collection areas. Nine of the 11 strap handles at DES and three of the ten at DAF are decorated with perforations, usually occurring in two parallel rows and accompanied by edge impressions. One handle also has a dentate-stamped motif between the perforation rows (Fig. 4.15:c). The remaining strap handles are narrower and undecorated except for a single pinched nubbin on one handle and edge impressions on several others. Coil handles include a single example with two intertwined coils, two fragments of coils ca. 15 mm in diameter and three miniature coil handles only ca. 5 mm in diameter from TP 1 and Area 4 at DAF. Which vessel forms are associated with the handles is difficult to ascertain although a Form 5 vessel has a possible projecting handle attachment near the rim and Form 10 small mouthed vessels may have had handles attached in the same manner as similar types of vessels from other Lapita sites. Handles have been recorded at Lapita sites from the Reef-Santa Cruz Islands, New

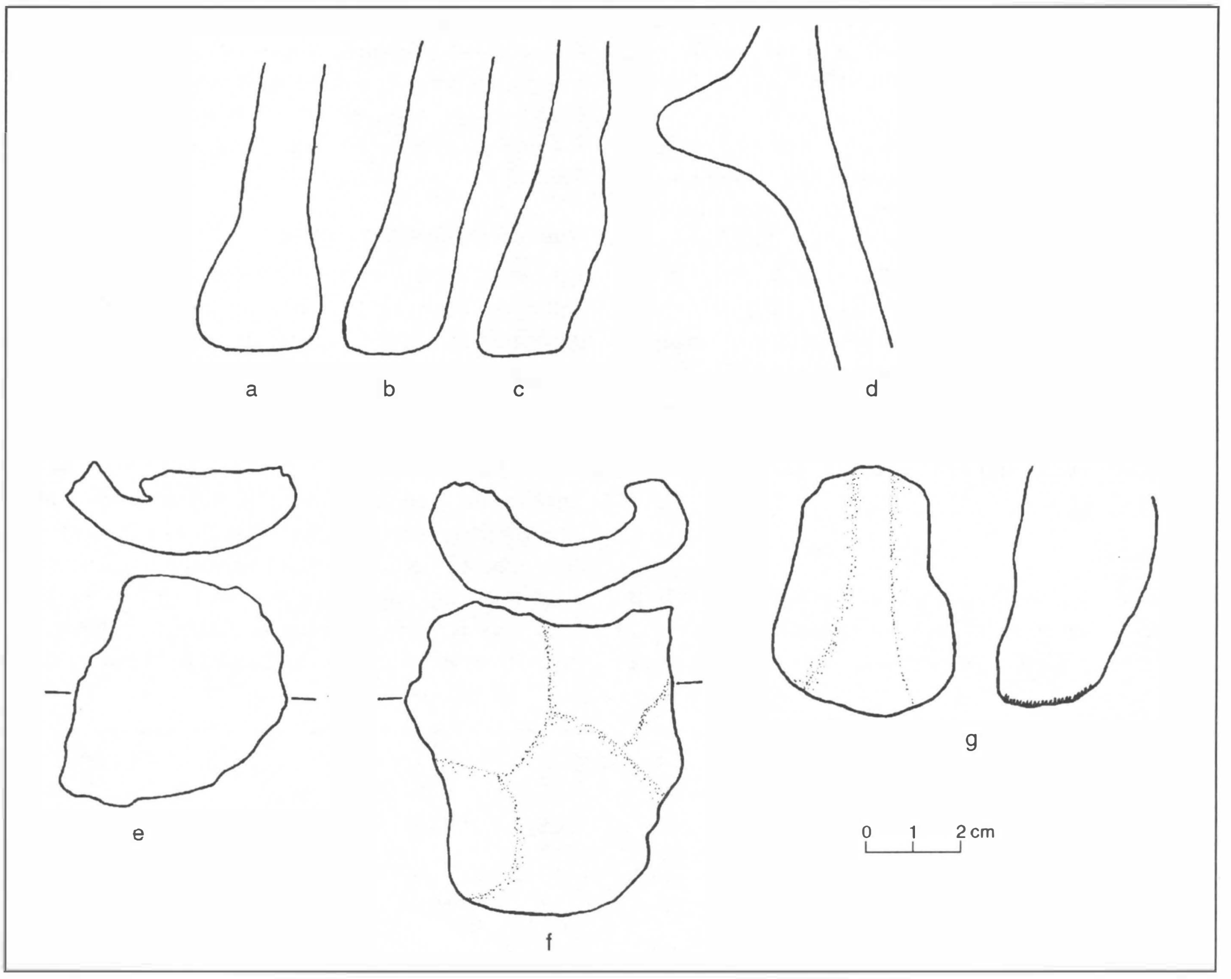


Figure 4.14 Lapita pedastal bases (a-c), legs (e-g) and lug (d). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.2.1620; b: DAF.1.564; c: DAF.1.560; d: DAF.6.1104; e: DAF.2.1620; f: DAF.2.1619; g: DES.12.

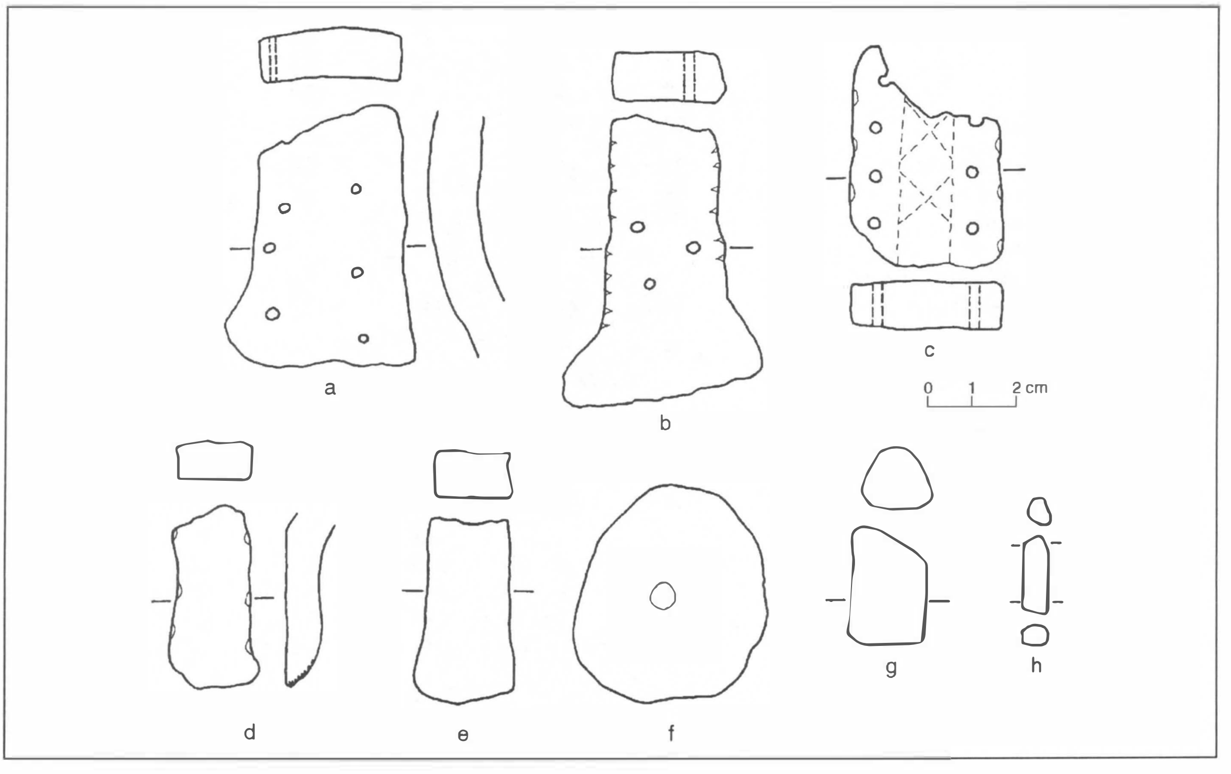


Figure 4.15 Lapita strap (a-e) and coil (g,h) handles and ground disc (f). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.6.1085; b: DES.6; c: DES.3; d: DAF.6.1086; e: DES.10; f: DAF.6.6076; g: DAF.7.1299; h: DAF.4.2178.

Caledonia, Fiji and Tonga but are apparently restricted to coil forms. Miniature coil handles have been noted at several Lapita sites in Tonga (Dye 1987:Fig. 54; Poulsen 1987:134).

Ten ground disc-shaped body sherds from DAF were included in the diagnostic sherd sample although only one is decorated (with incision). The discs range from 30 to 50 mm in diameter and one has a drilled depression at the centre on the exterior surface (Fig. 4.15:f). Ground discs are reported from Lakeba in Fiji (Best 1984) and a drilled disc was found at the To.1 site on Tongatapu (Poulsen 1987:Fig. 55). Parker reports a 'flat disc-like object somewhat resembling a "coin" in pottery' at the RF-2 site in the southeast Solomons (1981:79). The discs may have been used as ornaments, gaming pieces or children's toys.

Rim form

Discrete attributes recorded on rim sherds which are related to rim form include rim orientation, rim course and lip form. Continuous attributes measuring the degree of rim eversion or inversion as well as estimated rim diameters and the percentages of rims represented by rim sherds were recorded as interval level variables. Frequencies for discrete attributes are presented in Table 4.7 and continuous attribute frequencies are shown in Table 4.8.

Rim orientation and course

Rim orientation is the angle between the rim course axis and a line bisecting the centre of a symmetrical vessel described as outward (everted), inward (inverted) or vertical. Orientation was recorded for 2328 rim sherds, 83% of which are from DAF. Everted rims are dominant at DAF and DJQ and vertical rims are most common at DES. The high percentage of everted rims at DJQ is linked to the predominance of Form 2 open bowls at this site whereas Form 1 direct vertical rim bowls are dominant at DES. Inverted rims are of minor importance at each site although some rims recorded as vertical at DAF may actually be inverted, particularly those from Form 9 vessels which were difficult to orient precisely.

	Site DJQ		Site DAF		Site DES	
	n	%	n	%	n	%
everted	146	70.5	1276	66.1	67	34.9
vertical	45	21.7	524	27.2	94	49.0
inverted	16	7.7	129	6.7	31	16.1
Rim Orientation Total	207	100.0	1929	100.0	192	100.0
outcurved/concave	72	34.0	1049	55.9	53	29.8
straight	131	61.8	741	39.5	106	59.6
incurved/convex	9	4.2	85	4.5	19	10.7
Rim Course Total	212	100.0	1875	100.0	178	100.0
1 flat-sharp or rounded margins	53	27.2	244	10.7	78	35.8
2 rounded	4	2.1	25	1.1	28	12.8
3 channeled	1	0.5	3	0.1	-	-
4 scalloped	10	5.1	9	0.4	5	2.3
Parallel Lip Subtotal	68	34.9	281	12.3	111	50.9
5 angled, abrupt inner angle	83	42.6	54	2.4	14	6.4
6 rounded, gradually everted	8	4.1	12	0.5	1	0.5
7 horizontal wide lip	1	0.5	417	18.3	4	1.8
8 wide lip, >90 degree eversion	-	-	22	1.0	-	-
9 very wide lip, >90 degree eversion	-	-	37	1.6	-	-
Everted Parallel Lip Subtotal	92	47.2	542	23.8	19	8.7
10 rounded pointed or pointed	6	3.1	18	0.8	3	1.4
11 pointed, gradually everted	-	-	863	38.0	3	1.4
12 pointed, interior notch	-	-	3	0.1	-	-
13 bevelled, outward or inward	7	3.6	17	0.7	14	6.4
Reduced Lip Subtotal	13	6.7	901	39.6	20	9.2
14 flat, horizontal, asymmetric to exterior	1	0.5	194	8.5	9	4.1
15 flat, horizontal, asymmetric to interior	-	-	41	1.8	-	-
16 flat, horizontal, exterior angle	13	6.7	113	5.0	12	5.5
17 gradually expanded	2	1.0	104	4.6	23	10.6
18 abruptly expanded, narrow projection	6	3.1	79	3.5	23	10.6
19 abruptly expanded, wide projection	-	-	10	0.5	1	0.5
20 rolled	-	-	3	0.1	-	-
21 collared	-	-	5	0.2	-	-
Expanded Lip Subtotal	22	11.3	549	24.2	68	31.3
Lip Form Total	195	100.0	2273	100.0	218	100.0

Table 4.7 Rim orientation, rim course and lip form frequencies.

The degree of rim eversion or inversion is presented by intervals in Table 4.8. At DAF and DES, slightly everted rims (up to 30 degrees) are most common followed by moderately everted (30-50 degrees) and highly everted (50-60 degrees) rims. The reverse is true of DJQ where slightly everted rims account for only 10% of the total. This agrees well with the predominance of highly everted Form 2 vessels at DJQ. Slight to moderately inverted rims (less than 40 degrees) are equally represented at DJQ and DES while the former is dominant at DAF. Only single cases of highly inverted rims (60-90 degrees) typical of Form 5 vessels exist at DJQ and DES.

Rim course, which describes rim appearance in profile as outcurved (concave exterior), incurved (convex exterior) or uncurved (straight), was recorded for 2265 rim sherds. Straight courses account for over half the sample at DJQ and DES while outcurved rims are more common at DAF. Incurved rims are of minor importance at each site.

The relationship between rim orientation and rim course was examined by means of contingency tables (crosstabulations) for each site. Everted rims are most commonly outcurved at DAF and DES but straight at DJQ. Vertical rims are predominantly straight at each site. A majority of inverted rims have straight courses at DJQ and DES but similar amounts of outcurved and straight rim courses at DAF. The overall results indicate a high degree of similarity in rim form and rim course between the sites except for the higher percentage of everted straight rims at DJQ. The most convincing explanation for this is the greater importance of large Form 2 open bowls with straight rim courses below angled lips at DJQ.

Lip form

Lip shape is an attribute with a great deal of variability. The difficulty lies in determining which lip forms are significant in terms of the objectives of the ceramic analysis. In the present analysis, a comparison of lip forms was considered to be a potentially important means of discriminating between ceramic assemblages for the purpose of determining chronological or functional differences between them. Lip form also provided a means of identifying and quantifying vessel forms with distinctively formed lips. A total of 21 lip forms was identified (Fig. 4.16) and these are separated into parallel, reduced and expanded lip profiles (Table 4.7). Subtotals for parallel lips that are curved or angled to the exterior are presented as everted parallel lips.

Considerable inter-site variability in lip form is evident. As would be expected given its large sample size, DAF is the only site with the complete range of lip forms, DES has 14 forms and DJQ has 12. Despite the diversity of lip forms represented, only a few account for significant percentages of the total sample. This pattern is likely to be related in part to the small size of the samples at DJQ and DES. The most common lip form overall is Form 1, which is flat with sharp or rounded corners and a parallel profile. This form is dominant at DES where it is commonly found on Form 1A and Form 4 bowls. The dominant lip form at DJQ is Form 5, which is diagnostic of Vessel Form 2B everted bowls. Lip Form 16 is similar to Form 5 except for a thickened rather than parallel profile. It is also associated with Form 2B vessels and has similar percentages at each of the sites. The most common lip form at DAF is pointed and gradually everted (Form 11) and is diagnostic of Form 9B necked jars. Horizontal wide lips (Form 7)

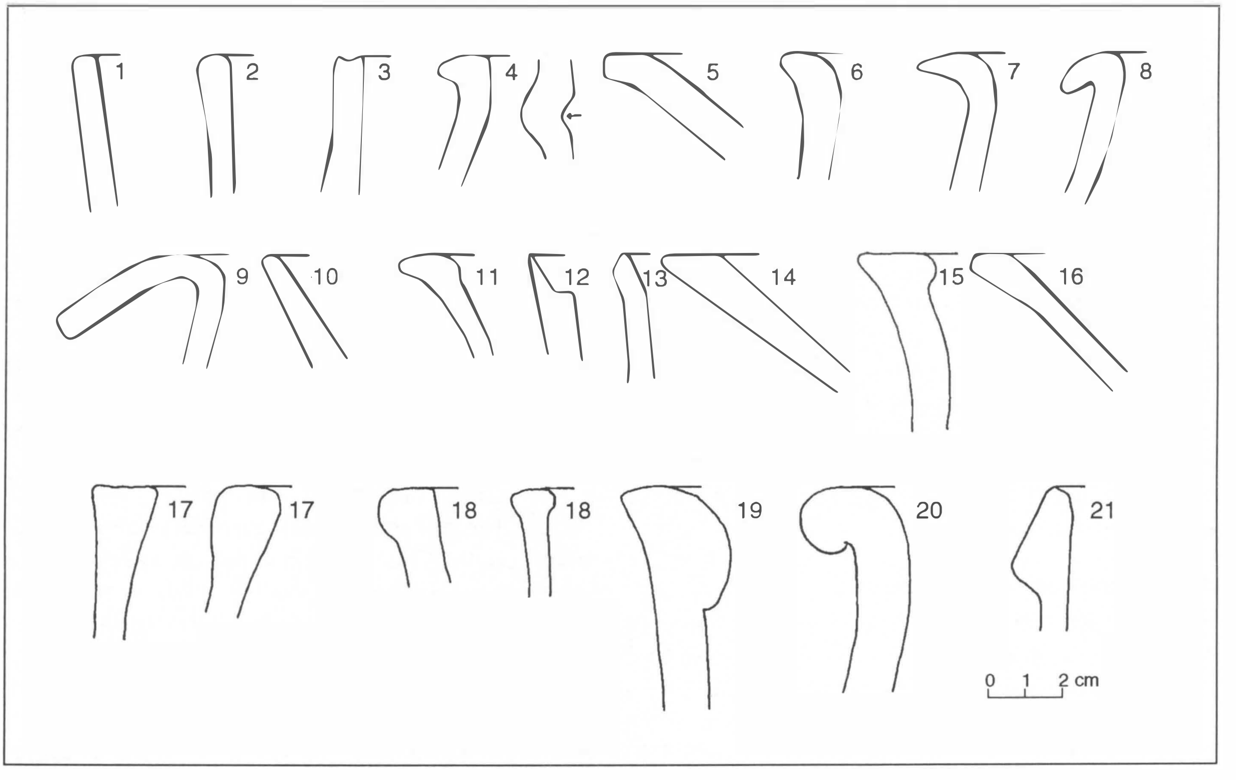


Figure 4.16 Lapita lip form profiles.

	Site DJQ		Site DAF		Site DES	
	n	%	n	%	n	%
Rim Eversion						
0-30 degrees	12	11.0	218	62.1	13	39.4
30-50 degrees	48	44.0	123	35.0	10	30.3
50-60 degrees	49	45.0	10	2.9	10	30.3
Total	109	100.0	351	100.0	33	100.0
Rim Inversion						
0-20 degrees	6	42.9	27	53.0	8	44.4
20-40 degrees	7	50.0	17	33.3	9	50.0
60-90 degrees	1	7.1	7	13.7	1	5.6
Total	14	100.0	51	100.0	18	100.0
Neck Inclination						
150-170 degrees	26	74.3	49	52.7	2	66.7
130-150 degrees	9	25.7	33	35.5	-	-
110-130 degrees	-	-	7	7.5	1	33.3
100-110 degrees	-	-	4	4.3	-	-
Total	35	100.0	93	100.0	3	100.0
Carination Angle						
90-110 degrees	-	-	5	7.9	-	-
110-130 degrees	4	14.3	13	20.6	1	11.1
130-150 degrees	8	28.6	12	19.1	5	55.5
150-170 degrees	16	57.1	33	52.4	3	33.3
Total	28	100.0	63	100.0	9	100.0
Estimated Rim Diameter						
4-10 cm	-	-	8	2.3	-	-
10-20 cm	7	10.9	50	14.5	5	13.5
20-30 cm	13	20.3	124	36.0	13	35.1
30-40 cm	19	29.7	117	34.0	19	51.4
40-50 cm	17	26.6	45	13.1	-	-
> 50 cm	8	12.5	-	-	-	-
Total	64	100.0	344	100.0	37	100.0
Percentage of Rim Represented						
5 %	29	45.3	71	20.8	18	69.2
5-10 %	34	53.1	247	72.2	8	30.8
10-15 %	1	1.6	21	6.1	-	-
15-25 %	-	-	3	0.9	-	-
Total	69	100.0	356	100.0	27	100.0

Table 4.8 Continuous attribute interval class frequencies for diagnostic Lapita pottery.

typical of Form 9A vessels are also important at DAF but rare at the other sites. The other lip forms associated with Vessel Form 9A (Forms 8 and 9) are only present at DAF. Expanded lips are commonest at DES and thickening occurs most frequently on the lip interior of gradually expanded lips (Form 17) and exterior of lips with narrow abrupt thickening (Form 18). All but one of the Form 19 lips with wide abrupt thickening, usually on the vessel exterior, are found at DAF. Lip Forms 19 and 20 are found on thick walled vessels of Form 2C and 9B vessels, respectively.

Rim diameter and percentage

Estimated rim diameters were recorded on the interior of rim sherds of adequate size through the use of a template with diameters ranging from 2 to 50 cm in 2 cm increments. The percentage of the total rim represented by each rim sherd was recorded at intervals of 5% in order to assess the reliability of the rim diameters recorded. Rim sherds representing less than 5% of the total rim were not measured. A total of 445 rim diameters was recorded and percentages assigned to 452 rims sherds. Only 25 rim sherds at DAF and one at DJQ represent over 10% of the rim. For sherds representing short rim segments with a range of potential diameters, the smallest diameter was recorded. Grouping diameters within 10 cm intervals as shown in Table 4.6 more accurately reflects the degree of precision in recording diameters.

Diameters of less than 10 cm are found only at DAF and come from Form 10 small mouthed jars and a single Form 1A cup. Vessels with rim diameters of over 50 cm are restricted to Form 2B shallow bowls at DJQ. The largest diameter at DES is 34 cm. The highest frequency of rim diameters is between 30 and 40 cm, belonging to relatively large everted rim vessels. As would be expected, rims with the smallest diameters have the highest percentage of rim represented. All rims under 10 cm are over 15% and very few rims over 40 cm have segments greater than 5% of the total rim.

Neck inclination and carination angle

The angle between neck and body was measured at the inflection point on necked vessels as was the angle between the upper and lower body on carinations in order to provide more detailed information on vessel form. Neck inclination on the 131 sherds measured, as shown in Table 4.8, ranged from 100 degrees on sharply angled vessels to 170 degrees on vessels with very gradual angles. The 100 carination angles measured ranged from an abrupt 90 degrees to gradual 170 degrees. Abruptly angled necks and carinations between 90 and 110 degrees are found only at DAF. Such sharply angled necks are diagnostic for Form 9 vessels. Nearly all neck and carination angles are gradual with no significant variation in percentages between sites. Gradual carinations appear to be from necked vessels but no sherds with an intact neck and carination were collected.

Rim and body thickness

Continuous attributes related to vessel form include rim and body thickness measured to the nearest tenth of a millimetre. Rim thickness was recorded at the point of maximum lip expansion or reduction. Body thickness was measured below the point of expansion or reduction on rim sherds and at a point of average thickness on body sherds with intact uneroded surfaces. Rim thickness was measured for 2004 rims with complete lips and body thickness recorded for 1440 decorated body sherds as well as other diagnostic sherds. Thickness was also recorded on a sample of 1335 plain body sherds from DAF (including 569 sherds from excavation unit TP 1) and 536 sherds from DJQ. Descriptive statistics for rim and body thickness are summarised in Table 4.9.

Mean rim thickness is similar between sites and ranges from 7 to 8 mm. The range in rim thickness (2.2 to 31.5 mm) includes very thin as well as very thick examples. Thick rims represent outliers clearly separated from the main group of rims as demonstrated by the higher standard deviation figures for DAF and DES relative to DJQ which has no thick rims. Nearly all thick rims are from DAF which has 15 rims over 20 mm, while DES has only four rims thicker than 15 mm.

Both decorated and plain body sherd thicknesses were recorded to determine if significant differences existed. Histograms of decorated and plain body thickness frequencies by site are found in Figures 4.17 to 4.19. The difference in average thickness between decorated and plain body sherds of 1 mm or less at DAF and DJQ is not significant. Variation in the mean body thickness of surface sherds between sites is also minor with thickness ranging from 5.8 to 7.4 mm for decorated sherds and 5.9 to 7 mm for plain sherds. The distribution of plain body sherds at DAF is slightly bimodal due to the presence of thick sherds from Form 2C vessels.

The greatest variation in body thickness occurs between collection areas at DAF where the thickness range and mean from the beach and inner reef areas are considerably lower than for the outer and central reef areas. Plain body sherds from the TP 1 excavation are

	Rim Thickness (mm)				Decorated and Plain Body Thickness (mm)			
Site DAF	n	Range	Mean	sd	n	Range	Mean	sd
diagnostic	1620	2.2-29.5	7.95	3.21	1124	2.6-18.2	5.79	1.60
plain body	-	-	-	-	766	2.5-16.4	5.88	1.85
plain/paddle imp. base	-	-	-	-	17	5.3-22.1	16.07	4.08
Individual DAF Areas								
Area 1 - diagnostic	142	3.0-25.0	9.18	3.73	38	2.7-9.7	5.77	1.31
- plain body	-	-	-	-	47	2.7-8.9	5.40	1.50
Area 2 - diagnostic	844	2.9-29.5	7.70	3.22	693	2.6-13.7	5.79	1.44
- plain body	-	-	-	-	227	2.7-16.4	6.56	2.25
Area 3 - diagnostic	62	2.8-27.2	9.28	4.46	72	4.5-13.0	7.14	1.92
Area 4 - diagnostic	61	2.2-15.3	7.07	2.45	77	2.8-8.5	4.91	1.13
Area 5 - diagnostic	78	4.0-15.0	8.14	2.45	20	4.4-14.0	6.89	2.61
- plain body	-	-	-	-	71	3.3-14.2	6.09	1.92
Area 6 - diagnostic	203	3.7-19.5	8.24	2.74	89	2.8-9.6	5.98	1.53
- plain body	-	-	-	-	220	2.7-12.1	5.95	1.52
Area 7 - diagnostic	68	3.1-17.2	7.21	3.04	33	2.6-6.7	4.94	.93
- plain body	-	-	-	-	201	2.6-12.5	5.07	1.34
Area 8 - diagnostic	114	4.2-19.5	8.64	2.94	46	3.5-9.5	5.69	1.44
Areas 9-12 - diagnostic	26	2.8-10.0	5.95	1.86	13	3.3-7.1	4.69	1.04
TP1 - diagnostic	22	3.0-9.0	5.84	2.97	43	2.7-8.3	4.93	1.34
- plain body	-	-	-	-	569	1.8-8.2	4.04	1.20
Site DJQ								
diagnostic	164	3.5-12.3	6.90	1.81	79	3.7-12.4	7.38	1.86
plain body	-	-	-	-	536	2.7-13.6	6.15	2.01
Site DES								
diagnostic	220	3.5-31.5	7.92	3.15	26	3.2-10.4	6.50	1.86
body thickness 2	-	-	-	-	22	4.5-11.6	6.99	1.92

Table 4.9 Rim and body sherd thickness (mm) frequencies for Lapita pottery.

the thinnest with a mean of 4 mm and the central reef Area 3 decorated sherds are thickest at 7.1 mm. The potential significance of this variability is discussed in greater detail below.

CERAMIC PRODUCTION ATTRIBUTES

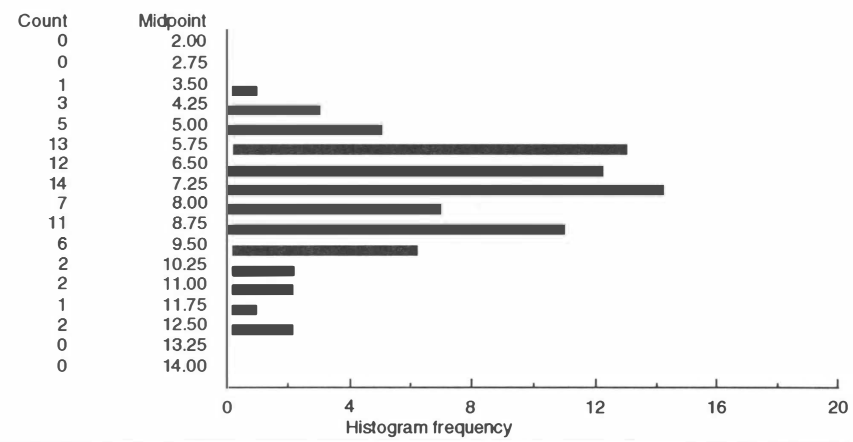
The ceramic sample from the reef sites had been altered to varying degrees by the effects of salt water and weathering, making it difficult to record attributes related to ceramic production such as surface colour and treatment and the presence of carbon cores. Despite these factors, it was possible to record surface treatments and colour for a sample of well-preserved sherds to provide a quantitative assessment of the range of variability present. Surface treatment was not recorded for DES due to time constraints. Frequencies of attributes related to ceramic production are found in Table 4.10.

Surface colour

The surface colour of a newly-fired vessel reflects paste composition as modified by finishing techniques and

SITE DJQ DECORATED BODY SHERDS

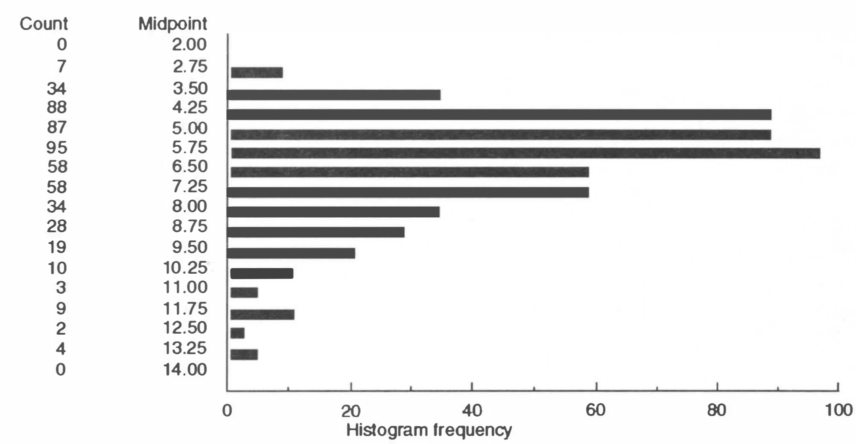
BODY THICKNESS



Mean	7.378	Std Err	0.209	Median	7.100
Mode	6.100	Std Dev	1.861	Variance	3.465
Kurtosis	0.189	S E Kurt	0.535	Skewness	0.600
S E Skew	0.271	Range	8.700	Minimum	3.700
Maximum	12.400	Sum	582.900		
Valid Cases	79	Missing Cases	4		

SITE DJQ PLAIN BODY SHERDS (1 sherd removed - 29.7 mm)

BODY THICKNESS



Mean	6.151	Std Err	0.087	Median	5.700
Mode	5.400	Std Dev	2.005	Variance	4.022
Kurtosis	1.038	S E Kurt	0.211	Skewness	1.021
S E Skew	0.106	Range	10.900	Minimum	2.700
Maximum	13.600	Sum	3297.000		
Valid Cases	536	Missing Cases	0		

Figure 4.17 Lapita decorated and plain body sherd thickness (mm) histograms for Site DJQ.

aspects of firing such as temperature, firing time and amount of oxygen available (Rye 1981). Vessel use and post-depositional factors such as leaching and erosion of the pottery surface alter the original surface colour reducing its reliability as an indicator of firing conditions.

Despite these caveats, surface colour can provide useful information when analysed in relation to other related variables and therefore exterior surface colour was recorded on a sample of 509 sherds collected from each of the sites (see Table 4.10 for distribution). Colour was recorded on representative samples chosen from a wide range of transects at DJQ and collection areas at DAF including the outer, central and inner portions of the reef. Hue, value and chroma values recorded using Munsell soil colour charts ranged from dark reddish brown and red to yellowish red and greyish brown (2.5YR to 2.5Y, 3-7/2-8) as shown in Table 4.10. There is little colour variation between sites with a majority of sherds ranging from brown to yellowish brown (7.5YR to 10YR). No apparent relationship between surface colour and other ceramic attributes was revealed by crosstabulations.

Surface treatment

Techniques of vessel manufacture related to forming and finishing stages were inferred through surface characteristics of ceramics recorded as surface treatment. Laminar

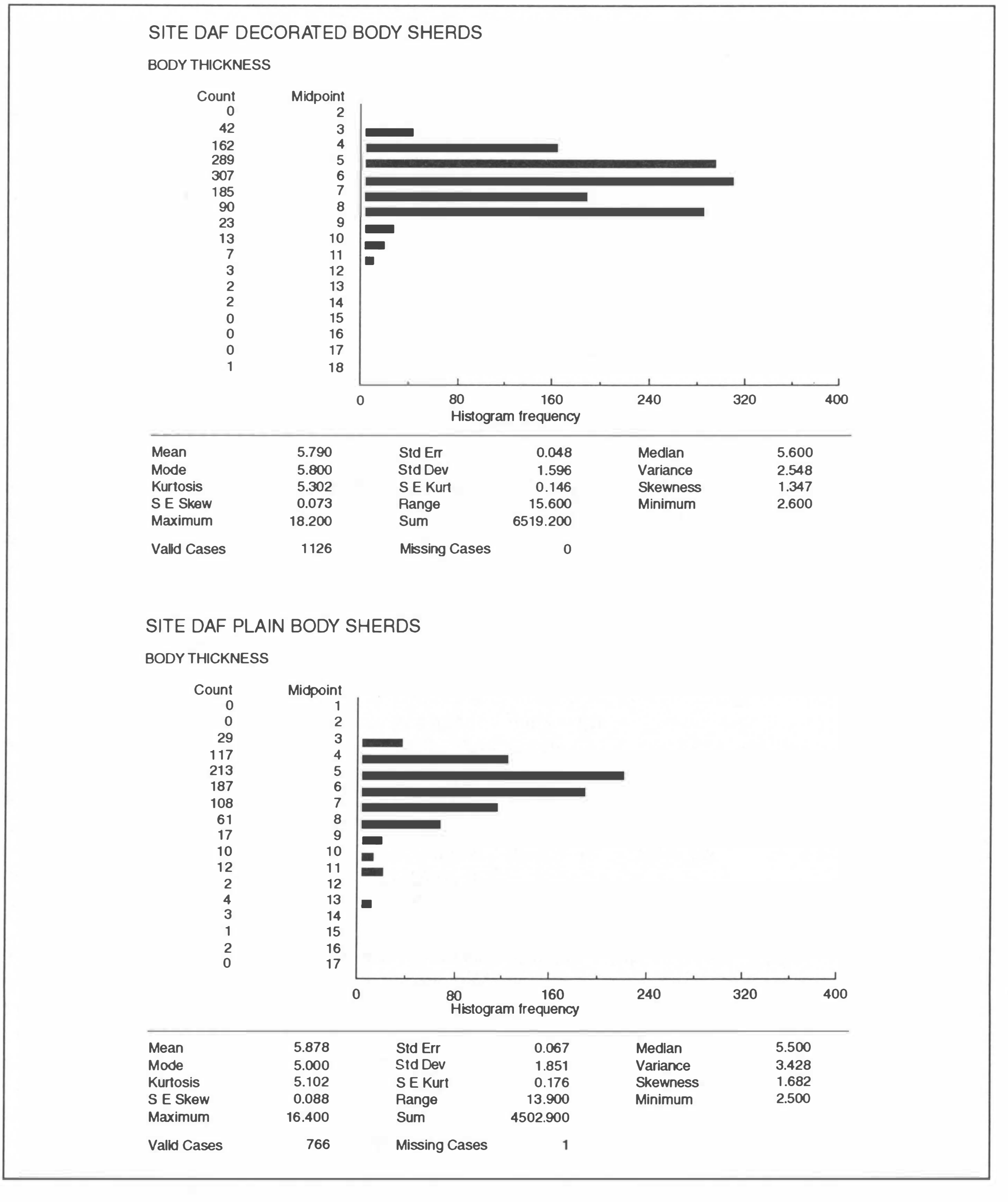
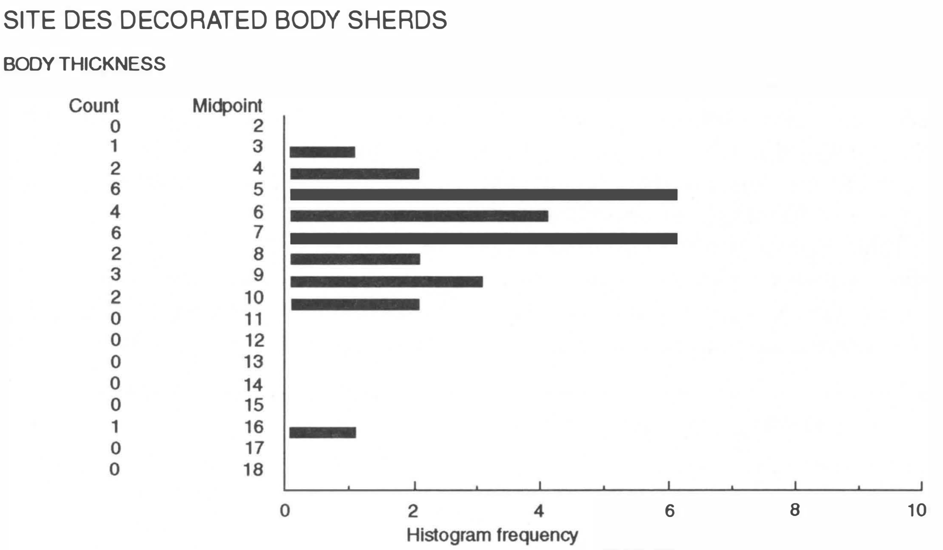


Figure 4.18 Lapita decorated and plain body sherd thickness (mm) histograms for Site DAF.



Mean	6.856	Std Err	0.499	Median	6.500
Mode	3.200	Std Dev	2.593	Variance	6.726
Kurtosis	5.165	S E Kurt	0.872	Skewness	1.801
S E Skew	0.448	Range	12.900	Minimum	3.200
Maximum	16.100	Sum	185.100		
Valid Cases	27	Missing Cases	1		

Figure 4.19 Lapita decorated body sherd thickness (mm) histogram for Site DES.

fractures parallel to the surface were noted on nine sherds from DJQ and 58 sherds from DAF. These fractures give the sherd margin a stepped appearance and can be indicative of slab manufacture where fractures occur along junctions between slabs or if strong pressure was used to form slabs (Rye 1981:72). Evidence of coil construction was found on several sherds which had separated at the point where the coils had originally been joined. Shallow impressions apparently made by fingers, which were recorded only for diagnostic sherds, occur most often on the interior surface and are indicative of the use of pinching as a secondary forming technique without subsequent smoothing. Finger impressions at DAF are found primarily on rims (86.4%) which have only lip impressions as decoration (65.6%) or are undecorated (29.2%). This suggests an association with utilitarian vessels where complete smoothing of the vessel surface during finishing was not as important as for highly decorated vessels.

Surface modifications associated with the use of a paddle and anvil as a secondary finishing technique occur in the form of anvil impressions on the interior surface of sherds. Anvil impressions, recorded only for the sample of plain body sherds analysed from DJQ and DAF, are rare on most diagnostic sherds and present on 19.8% of the 1154 body sherds analysed, occurring most often on incurved sherds typical of large globular vessels. Laminar sherd-edge fractures are also characteristic of the paddle and anvil technique. Paddle impressions which have produced a rough chequered pattern are found only on the exterior surface of undecorated thick rims, flat bases and the lower walls of Form 2C vessels at DAF, none of which have interior anvil impressions. Paddle-impressed pottery contemporary with Lapita ceramics has been recorded in New Caledonia and Fiji and Anson (1983:30) claims that striated pottery from Watom is very much like the ribbed paddle-impressed ceramics from these islands and Vanuatu. However, the DAF paddle impressions do not resemble either the ribbed or striated paddle-impressed wares.

Surface finishing techniques were difficult to record on many sherds due to weathered surfaces although it was clear that a majority of the sherds had been smoothed to some extent. A number of diagnostic sherds have surfaces with a uniform lustre characteristic of polishing although the actual number of polished sherds was undoubtedly underestimated due to weathered surfaces. Polishing is limited to the exterior surface except for five sherds with interior and exterior polish. It is found primarily on rims (including two double rims) but also on the neck/shoulder region, carinations and body. All but five of the polished sherds are decorated, 52 (57.1%) with dentate-stamping, 28 (30.8%) with bounded fine incision, 6 (6.6%) with unbounded incision and the rest with applied relief or lip impressions. Although no definite examples of slipped sherds were found, five dentate-stamped sherds with probable red slip were identified including a single carination, one neck and three body sherds. Two dentate-stamped sherds from DJQ are polished and possibly slipped, including a rim with a transverse bar below the lip. Both polishing and red slip are often associated with Lapita vessels extending from Western Melanesia to Western Polynesia.

	Site DJQ		Site DAF		Site DES	
	n	%	n	%	n	%
Temper Class						
100 - calcareous sand	61	13.9	4910	85.3	238	73.2
123 - calcareous, ferromagnesian, feldspathic	119	27.0	792	13.8	46	14.2
132 - calcareous, feldspathic, ferromagnesian	246	55.9	-	-	18	5.5
200 - ferromagnesian sand	7	1.6	14	0.2	18	5.5
210 - ferromagnesian, calcareous	3	0.7	27	0.5	5	1.5
230 - ferromagnesian, feldspathic	3	0.7	5	0.1	-	-
300 - feldspathic sand	-	-	2	0.0	-	-
310 - feldspathic, calcareous	-	-	3	0.1	-	-
320 - feldspathic, ferromagnesian	1	0.2	1	0.0	-	-
Total	440	100.0	5754	100.0	325	100.0
Temper Density						
5 %	5	1.1	41	1.7	-	-
10 %	71	16.3	260	11.1	-	-
20 %	280	64.4	1456	62.1	-	-
30 %	63	14.5	518	22.1	-	-
40 %	16	3.6	68	2.9	-	-
Total	435	100.0	2343	100.0	-	-
Surface Treatment						
polished	29	6.6	69	1.2	-	-
probable red slip	2	0.5	3	0.1	-	-
finger or other impressions	3	0.7	96	1.7	-	-
paddle impressions (exterior)	-	-	25	0.4	-	-
anvil impressions (interior) - plain body sherds only	87	15.8	141	23.4	-	-
Exterior Surface Colour						
2.5 YR 3-5/4-8	16	4.9	3	4.0	5	4.6
5 YR 3-6/2-8	66	20.4	12	15.8	23	21.1
7.5 YR 3-6/2-8	66	20.4	23	30.3	17	15.6
10 YR 3-7/2-8	169	52.2	38	50.0	43	39.4
2.5 Y 4-5/2-4	7	2.2	-	-	21	19.3
Total	324	100.0	76	100.0	109	100.0

Table 4.10 Temper class, surface treatment and surface colour frequencies for diagnostic Lapita pottery.

COMPOSITIONAL ANALYSIS

Analysis of ceramic composition consisted of a two-step process involving initial recording of non-plastic inclusions (temper) for the entire ceramic sample followed by elemental microanalysis of the clay component for a small sub-sample of diagnostic sherds from each of the reef sites. The principal objective of compositional analysis was to characterise each ceramic assemblage and examine intra- and inter-site variability in terms of potential clay and temper sources. Distinguishing between local and exotic ceramic provenience was also addressed as a means of identifying potential Lapita inter-island pottery exchange. Petrographic temper analysis and elemental characterisation of both temper and clay components previously conducted on samples of late Lapita phase Buka style sherds collected by Specht is discussed in relation to the present compositional analysis.

Temper

Petrographic analysis of temper from two Buka style potsherds collected by Specht was carried out by Key (1969) as part of a larger analysis of Buka ceramics in conjunction with Specht's ceramic analysis. No information is provided regarding sherd provenience or the sampling design employed in selecting the sherds for this analysis. The sherds, which are from Specht's Paste 1 category, have a high frequency (87.2%) of calcareous grains with minor amounts of feldspar (10.3%) and dolerite rock fragments (2.4%) and a temper density of 31.2%.

Additional temper analysis was undertaken by Summerhayes (1987) who utilised an electron microprobe to analyse four Paste 1 Buka style rim sherds from Specht's excavations at the DAI and DAA sites. Results indicated a predominance of well-sorted rounded calcium carbonate inclusions comprised of shell and skeletal foraminifera in a clean smooth textured paste. Mineral inclusions include plagioclase feldspar and low amounts of quartz as well as ilmenite, epidote hornblende and pyroxene. Both calcareous and mineral inclusions are characteristic of a beach sand origin.

Unfortunately, the analyses by Key and Summerhayes suffer from very small sample sizes and a failure to insure that the sherds selected for analysis were representative of the range of variation present within the ceramic assemblages. As Hunt (1988) points out, inadequate sampling strategies represent a serious problem in interpretations of Lapita ceramic assemblage characteristics based on compositional analysis.

Non-plastic inclusions in the clay body, referred to as temper regardless of whether they are naturally occurring or manually added, were recorded for both diagnostic and non-diagnostic sherds during the present analysis. Temper was recorded in the laboratory from freshly exposed sherd cross-sections with the aid of a 10 to 30 x hand lens. Initial observations of ceramics in the field revealed that calcareous sand particles comprised primarily of shell and coral fragments were the dominant temper class at each of the sites. Most sherds have a predominance of calcareous sand particles often associated with lesser amounts of volcanic sand inclusions and a small minority have only volcanic sand inclusions. Although frequencies of calcareous and non-calcareous temper were recorded for non-diagnostic sherds, more detailed temper analysis was only undertaken for the diagnostic sample.

The presence of calcareous sand was an important criterion in separating non-diagnostic Lapita sherds from pottery of post-Lapita styles found on the reef which have no calcareous temper. Other variables such as paste texture, surface treatment and surface colour were also used to separate out plain Lapita body sherds, particularly the few that had non-calcareous temper. Although it is obviously difficult to be certain that the separation of non-diagnostic Lapita sherds from post-Lapita styles was completely reliable, the characteristics of later pottery styles are sufficiently distinctive that they could be identified with reasonable confidence. The most obvious problem was the identification of Lapita ceramics with non-calcareous temper. However, given the low incidence of non-calcareous temper in the diagnostic Lapita sample, the same pattern would be expected for non-diagnostic sherds. There was also a clear predominance of dense ferromagnesian temper among the non-calcareous tempered Lapita sherds which is not found in post-Lapita styles.

In order to assess the relative proportions of temper types within sherds, a means was devised to record various classes of temper based on abundance ranking of inclusions. Three distinct temper types were recognised and each was assigned a numeric code (1 to 3) for data entry. The temper class attribute was therefore three columns long in order to record the relative abundance of each type of inclusion for individual cases (sherds). The first column designated the temper type with the greatest relative abundance followed by the second and third most abundant temper type in the appropriate column. The use of abundance rank categories enabled sherds with mixed temper types to be separated rather than lumped with the dominant type of temper. The three temper types defined were:

1. calcareous sand comprised of calcium carbonate particles from reef detritus;
2. black sand grains with opaque particles identified as ferromagnesian minerals; and
3. translucent to transparent white sand grains consisting primarily of plagioclase feldspars with lesser quantities of quartz.

Volcanic rock fragments were present in both calcareous and non-calcareous tempered sherds but not classified as a temper type due to their widespread distribution and consistently low abundance.

No evidence of temper types which could not have been obtained on Buka was encountered during analysis. The abundance of recent ash deposits and range of exposed volcanic rocks present on Buka provide ready access to mineral sands of the sort used as temper (Blake and Miezitis 1967; Speight 1967). All ceramics from DES and DAF are of necessity exotic as neither Nissan nor Sohano islands have clay sources due to their elevated limestone geology.

Frequencies of the nine temper classes and temper densities recorded for diagnostic sherds are presented in Table 4.10. Temper Class 100 contains only calcareous sand grains and is dominant at DAF and DES. The sherd total for DAF is actually somewhat lower for this category as many sherds had very low amounts of mineral sands but were included in Class 100 due to the difficulty in determining the relative abundance of the two mineral temper components. Temper Classes 123 and 132 are predominantly calcareous sand tempered but have minor amounts of ferromagnesian and feldspathic volcanic mineral sands. The low amount of mineral sands indicate that they are natural components of the clay body in contrast to the calcareous grains which were manually added. Sherds with a greater abundance of feldspathic minerals (Class 132) are clearly dominant at DJQ but of minor importance at DAF and DES where ferromagnesian inclusions are more abundant (Class 123).

Eighty-nine of the diagnostic sherds analysed have mineral sands as the dominant temper representing 0.9% of the total sample at DAF, 3.2% at DJQ and 7% at DES. Thirty-eight (42.7%) of these sherds have minor amounts of calcareous sand grains. Ferromagnesian dominant temper is more common than feldspathic and includes Temper Class 200 sherds with only black sand grains and a few mixed mineral sand (Class 230) and calcareous sand (Class 210) sherds. All but one of the seven feldspathic dominant temper sherds are from DAF. Similar percentages of non-calcareous dominant tempers occur in the plain body sherd sample including 47 (4.1%) of 1150 sherds at DES, 24 (4.4%) of 537 sherds at DJQ and 21 (3.5%) of 603 sherds at DAF. However, there is a possibility that a few of these sherds may be from post-Lapita styles as previously discussed.

Sherd types with non-calcareous temper are principally body sherds and rims, including double rims at each site, but also include necks and associated curved shoulders from globular vessels, carinations, flat base sherds from DAF and DES, and a single modelled leg from DAF. The most common lip form associated with non-calcareous dominant temper is the Form 1 flat, parallel lip. Other lip forms include Form 5 angled lips, Form 6 gradually everted lips, Form 18 abruptly expanded lips and single examples of Lip Forms 4, 13, 17 and 21.

Sherds with dentate-stamping account for 11 (24.4%) of the 45 non-calcareous temper decorated sherds at DAF while only 64 (1.6%) of the 3968 calcareous temper decorated sherds are dentate-stamped. This indicates a potential relationship between mineral sand temper and dentate-stamping which is most evident for the feldspathic Temper Classes (300, 320 and 310) as all but one of the seven decorated sherds in these categories, an incised Class 310 sherd, are stamped. Five of the 12 decorated Class 200 ferromagnesian temper sherds are stamped but none of the Class 210 mixed temper sherds. The distribution of non-calcareous temper sherds at DAF is noteworthy in regard to their association with stamping. No non-calcareous temper sherds were found on the beach (Areas 9 to 12) or in Area 4 on the inner reef where the incidence of dentate-stamping is low. This suggests that the frequency of both dentate-stamping and non-calcareous pottery decreased over time as the ceramics from the beach and inner reef portions of DAF appear to be later than those on the central and outer reef based on attributes related to vessel form and decoration.

Although the sample sizes are quite small, higher frequencies of dentate-stamping are also found on non-calcareous than on calcareous temper pottery at DJQ and DES. Of the 12 decorated non-calcareous temper sherds at DJQ, 8 (66.7%) are dentate-stamped while 180 (55.9%) of 322 calcareous temper sherds are dentate-stamped. At DES, 4 (33.3%) of 12 non-calcareous temper sherds are stamped but only 25 (10.5%) of the 239 calcareous temper sherds. Decoration techniques other than stamping at DJQ associated with non-calcareous tempers are restricted to rims with lip impressions and a single sherd with bounded incision. Incision, perforation, punctation and lip impression occur on mineral temper sherds at DES.

In order to determine if a relationship exists between decoration and temper attributes, chi-square values were obtained for contingency tables from each site. Temper categories were collapsed into calcareous and mineral sand classes to reduce the number of empty cells. The results indicate that the attributes are related at DAF (chi-square=139.18, p=0.000) but independent at DJQ (chi-square=1.50, p=0.68) and DES (chi-square=4.53, p=0.11). The chi-square values were undoubtedly influenced by the small sample sizes of non-calcareous temper sherds at DJQ and DES.

Temper density was recorded for diagnostic sherds from DAF and DJQ using diagrams of sherd cross-sections showing varying percentages of inclusions taken from Bennett (1974). Densities are very similar for both sites with nearly all sherds having densities between 10% and 30% and the majority at about 20%. Non-calcareous temper sherds at DJQ have higher frequencies of high temper density (30 to 40% density) at 42.9% than calcareous temper at 17.3% of the total sample. The reverse is true at DAF where 48.0% of the non-calcareous sherds have temper densities of less than 20% as compared with 12.1% of the calcareous sherds. The significance of these associations is difficult to interpret in light of the small sample sizes of non-calcareous sherds.

Summary of results

The results of temper analysis clearly demonstrate that tempering with calcareous sand was dominant at each of the sites. However, the small number of sherds with mineral sands as the principal tempering agent display some interesting patterns between site assemblages and within the DAF site. Ferromagnesian sand is by far the most common mineral temper and significant numbers of sherds are tempered exclusively with high concentrations of this mineral. Feldspar, the other mineral sand tempering agent, is dominant in only six sherds at DAF and one at DJQ. The relative percentage of non-calcareous temper is significantly higher at DES than the other two sites which suggests an emphasis on different temper sources than those utilised at the Buka sites. The potential correlation between dentate-stamping and non-calcareous temper at each site is intriguing although chi-square values indicate a relationship only at DAF. Not only are a high percentage of the non-calcareous sherds at DAF dentate-stamped, but the inner reef and beach areas of the site where dentate-stamping is found on only a few sherds have no non-calcareous temper pottery. So it appears that mineral sand tempers were most common in vessels that were dentate-stamped and utilised during the earliest phase of occupation at the site. Although the mineral sand tempers could have easily been obtained on Buka, it is possible that the early mineral sand tempered vessels with dentate-stamping were being imported. This possibility was investigated by microanalysis of the clay fraction in a sample of these sherds.

Elemental microanalysis

Temper analysis has several shortcomings in determining potential pottery manufacturing centres and the role of ceramics in exchange. These include a lack of adequate resolution in terms of geologic variability for mineral sand tempers and the inability to source calcareous inclusions; the dominant temper type in the present analysis and in many other Lapita ceramic assemblages (see Hunt 1988 for a critical discussion of these factors). Unlike petrographic temper analysis, elemental microanalysis of the clay matrix allows all sherds to be grouped by elemental characteristics which may relate to different clay sources.

Previous analyses

Summerhayes (1987) utilised proton-induced X-ray emission (PIXE) and electron microprobe energy dispersive X-ray microanalysis to analyse both temper and clay portions of sherds collected by Specht from the entire Buka ceramic sequence. Nine major elements were selected for analysis (Na, Mg, Al, Si, K, Ca, Ti, Fe and Cr) and hierarchical clustering techniques used to define discrete groupings of sherds based on elemental similarity defined as chemical paste compositional reference units (CPCRU). Microprobe and PIXE CPCRUs were then compared in an attempt to differentiate the spatial and temporal distribution of clay and mineral exploitation areas.

Due to the fact that PIXE CPCRUs are based on measurement of both clay and non-plastic inclusions while microprobe CPCRUs relate to the clay portion alone, Summerhayes (1987:317-18) assumed that single microprobe CPCRUs which form multiple CPCRUs with

PIXE represent a single clay source with multiple temper sources. Buka style sherds from Specht's Paste Type 1 formed three microprobe CPCRUs but only two PIXE CPCRUs which Summerhayes interpreted as indicating the use of three clay sources during this period. It is interesting to note that the Paste 1 microprobe CPCRUs include paste types associated with Sohano to Recent style ceramics indicating continuity in the utilisation of clay sources. However, the single clay source associated with modern Buka ceramics did not cluster with any of the CPCRUs from earlier ceramic styles. Based on the results of compositional analysis, Summerhayes concludes that all ceramics analysed were locally produced. Unfortunately, Summerhayes' data cannot be compared or incorporated into the present analysis due to differences in analytical techniques and the presentation of elemental data. The PIXE results are particularly problematic as both clay and temper are characterised as a single unit.

Sample selection

Initial compositional analysis based on temper classes was carried out for the total Lapita ceramic sample from each of the three reef sites. Undecorated body sherds were grouped by calcareous and non-calcareous tempers while diagnostic sherds were analysed more thoroughly in terms of temper mixtures. This provided a quantitative assessment of the range of non-plastic inclusions present in each site assemblage.

Following completion of the general ceramic analysis, sherds representative of the range of variation for a variety of attributes including sherd type, rim form and decoration, in addition to temper, were selected from each of the three reef sites for elemental microanalysis. Selection of sherds representative of the spatial distribution of ceramics within sites was also emphasised. The sample from DES was limited to a portion of the diagnostic sherd assemblage although the number of sherds available was adequate to permit analysis of a representative sample.

The number of sherds selected for analysis was restricted by the amount of time required for processing of samples and use of an analytical technique which is partially destructive. A total of 44 sherds was analysed from DAF (n=20; 45.5%), DES (n=13; 29.5%) and DJQ (n=11; 25.0%). The distribution of attributes represented in this sample is discussed in relation to the results of analysis below.

Energy-dispersive X-ray microanalysis

Microanalysis of the clay portion of sherds from the reef sites was undertaken with a scanning electron microscope (SEM) used in conjunction with an X-ray analyser. An important advantage of this technique is the ability to selectively analyse elements present in the clay matrix or individual inclusions, as well as surface modifications such as slips and residues. It is also the most widely used technique for microanalysis of Lapita ceramics, having first been employed by Anson (1983) on limited sherd samples from four Bismarck Archipelago sites and more recently by Hunt (1989) on a sample of 172 sherds from five sites in the Mussau Islands. Following preparation of mounted sherd thick-sections from site DAF, DJQ and DES by the author, analysis was carried out by Dr Terry Hunt on a JEOL model JSM-840A SEM fitted with a Tracor Northern energy-dispersive X-ray detector housed at the University of Washington's Department of Botany.

Quantitative analysis of clay elemental composition involves transformation of X-ray counts into quantities of elements present at the point of contact between the sherd surface and electron beam. The ZAF correction method was applied during analysis to compensate for factors affecting X-ray emission (Goldstein et al. 1981). Most samples were measured several times to increase the reliability and validity of the data. The accuracy and precision of measurement was assessed by use of the chi-square test. Element percentages for each of the 44 sherds analysed are found in Table 4.11 along with the site and area from which each sherd was collected. Although 12 elements were measured, four of these (Na, Cl, P and Ca) were not included in the subsequent cluster analysis due to various problems affecting their reliability as compositional indicators. Only eight elements (Mg, Al, Si, K, Ti, Cr, Mn and Fe) were therefore included in the multivariate analysis as all other elements were found in inadequate quantities for reliable measurement.

Cluster analysis

In order to maximise the comparability between elemental microanalysis undertaken by Hunt (1989) and the present analysis, the elemental data was analysed utilising the same two agglomerative hierarchical clustering procedures within the SPSS/PC+ statistical package. The two methods for combining clusters used were the complete linkage or 'furthest neighbour' method and average linkage between groups method. In complete linkage the distance between two clusters is measured using the distance between their two furthest points, while average linkage defines distance between two clusters as the average distance of all pairs of cases where one member of the pair is a member of each cluster (SPSS, Inc. 1990:167). The city-block or Manhattan distance measure, which for two cases is 'the sum of the absolute differences of the values for all variables' (SPSS, Inc. 1990:166), was used for both methods.

Results for each of the clustering methods are presented as dendrograms with rescaled distance (Figs 4.20 and 4.21). In order to insure the validity of the groups formed, only clusters with identical cases (sherds) in both dendrograms were recorded. All other cases were designated as unassigned to any particular cluster. The 44 sherds analysed form 14 clusters with three sherds placed in the unassigned category. The site provenience and identification number for each sherd are found in the label and sequence columns of the two dendrograms and individual clusters are marked in numeric sequence from 1 to 14.

Unlike Hunt's (1989) elemental microanalysis, no samples of clay known to be used by potters were available for comparison with ceramics in the present analysis. Clay samples from two modern sources (Tetehi and Tenapono) in the vicinity of Malasang village on Buka Island were collected by Specht (1969) and analysed

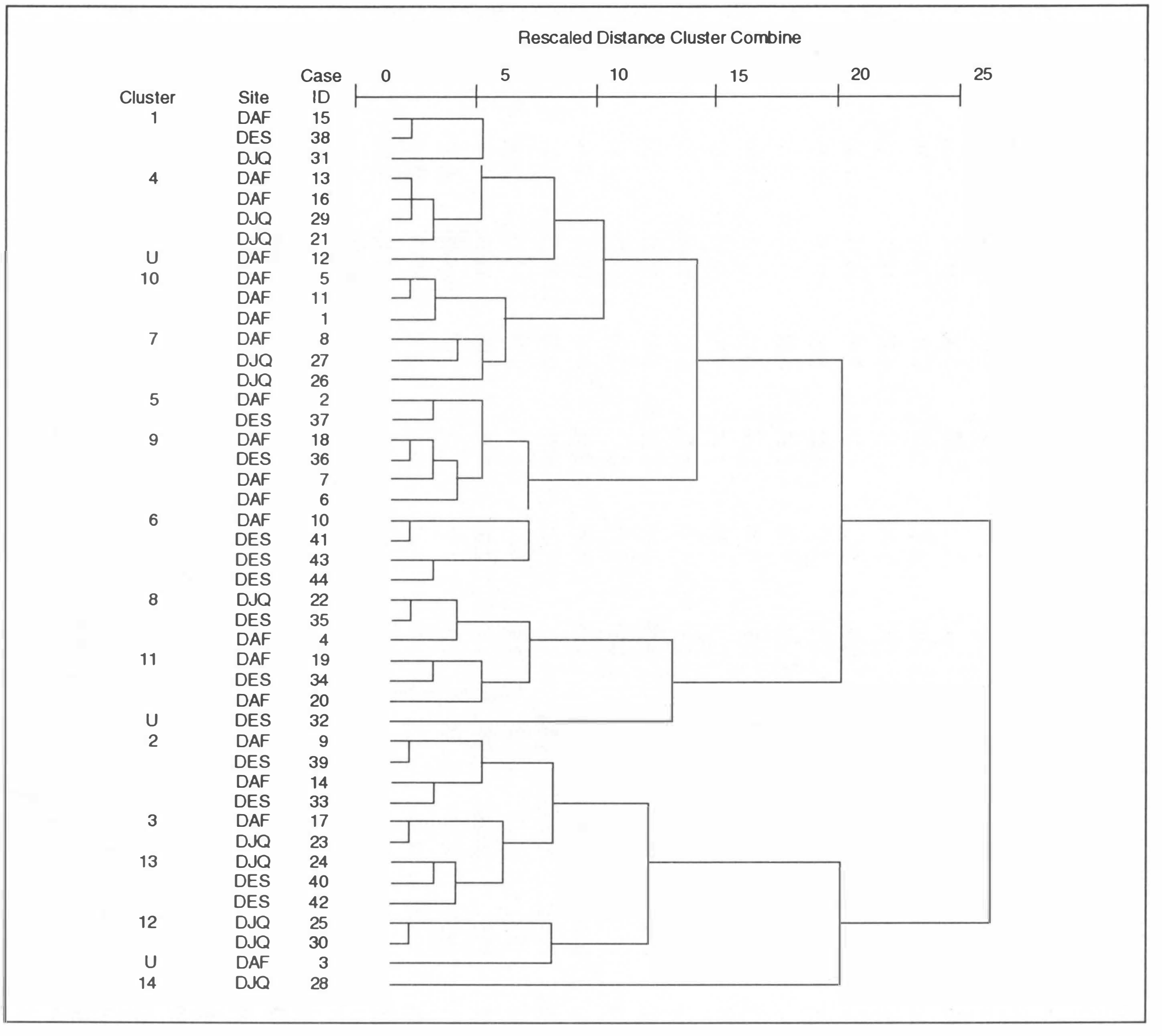


Figure 4.20 Dendrogram of total ceramic sample clusters using the complete linkage method. (Code: U = unassigned case)

compositionally by Summerhayes (1987). The Tetehi clay source was in use during the late 1960s and the Tenapono clay source was reportedly used prior to Tetehi. Based on microprobe and PIXE analysis, Summerhayes (1987:323) concluded that a single clay source unlike those associated with earlier ceramic styles was used in the manufacture of modern ceramics on Buka. Due to lack of comparability in data presentation, the modern clay samples could not be included in the present analysis for comparison with Lapita pottery clay composition groups.

Cluster distribution by site

As clay sources are absent on Nissan and Sohano Island, all ceramics from sites DES and DAF must of necessity have been imported. The predominance of calcareous temper sherds at each of the three reef sites made it difficult to assess compositional similarities between sites and determine the potential source of exotic sherds from temper analysis alone. By analysing the clay component, elemental microanalysis was able to define groups representing potential clay sources. However, without the analysis of clay from potential pottery-making sources as well as the pots themselves, it is not possible to identify the source of the clay groups defined for the reef site Lapita ceramics. Although it is plausible that that both temper and clay were obtained on Buka, sources further afield are also possible.

In examining the inter-site distribution of clusters presented in Table 4.12, the high frequency of clay groups with sherds from more than one site is noteworthy. Of the 14 clay group clusters, nine have two sites represented and two have all three sites represented. Sites DAF and DES have the most clusters in common followed by DAF and DJQ. The overlap in clay groups representing potential sources between the sites suggests a common source for at least some of the ceramics despite the geographic and probable chronological separation of the sites. Given the sharing of clay groups between sites, it is considered likely that some percentage of the ceramics found at DES and DAF were being imported from Buka. However, half of the clusters are defined solely by DES and DAF which raises the possibility of an alternative source for these ceramics. To test the hypothesis that clay sources on Buka were being used in the manufacture of pottery found at all three of the reef sites will require compositional analysis of clay sources from Buka for comparison with ceramic clay groups. A discussion of compositional group distribution on a site by site basis is presented below in relation to variables including sherd type, temper and

Sample Number	Catalog Number	Site	DJQ Area	DAF Area	Cluster Number	Na %	Mg %	Al %	Si %	P %	K %	Ca %	Ti %	Mn %	Fe %	Cl %	Cr %
3	4	daf	0	2	0	1.03	20.64	18.37	20.70	0.38	0.53	1.80	3.01	0.00	31.21	1.80	0.53
12	1729	daf	0	2	0	2.01	19.90	25.80	36.61	0.42	2.67	5.22	1.25	0.00	4.51	1.50	0.11
32	219	des	0	0	0	0.59	6.99	7.67	68.14	0.00	0.47	1.25	0.55	0.00	13.10	1.23	0.01
15	759	daf	0	3	1	1.31	16.68	27.54	35.61	0.68	0.99	2.51	1.53	0.00	11.33	1.83	0.00
31	458	djq	16	0	1	1.44	14.36	27.36	31.14	0.89	0.90	3.55	3.39	0.26	13.96	2.75	0.00
38	217	des	0	0	1	1.24	17.08	27.89	37.40	0.46	1.67	1.66	1.11	0.00	10.07	1.41	0.00
9	13	daf	0	2	2	0.88	20.72	25.55	28.00	0.36	0.60	3.01	2.32	0.40	16.16	2.00	0.00
14	1605	daf	0	2	2	1.19	21.24	31.71	29.39	0.64	0.23	1.35	1.83	0.00	11.30	1.11	0.00
33	218	des	0	0	2	0.48	21.01	26.63	29.92	1.00	2.17	2.06	0.91	0.27	11.86	3.30	0.38
39	224	des	0	0	2	1.03	17.65	27.54	30.17	0.60	0.36	0.95	2.29	0.56	17.04	1.80	0.00
17	767	daf	0	3	3	0.86	18.87	19.93	33.22	0.80	0.59	1.35	2.46	0.00	20.25	1.67	0.00
23	97	djq	2	0	3	0.79	17.46	21.47	34.60	0.07	0.78	1.73	1.68	0.51	19.68	1.23	0.00
13	1754	daf	0	2	4	1.65	14.66	22.43	36.57	0.17	2.26	0.93	0.94	0.43	18.00	1.94	0.02
16	687	daf	0	3	4	0.79	16.24	22.93	37.95	0.22	0.84	0.80	0.22	0.56	18.28	1.18	0.00
21	87	djq	2	0	4	0.60	17.50	22.07	37.09	0.15	1.19	1.48	2.59	0.10	16.10	0.99	0.14
29	290	djq	7	0	4	0.89	15.12	24.54	38.58	0.36	1.01	1.00	0.95	0.00	16.23	1.32	0.01
2	39	daf	0	6	5	0.58	12.81	19.61	39.77	0.37	1.41	0.67	1.78	0.34	21.53	1.02	0.12
37	223	des	0	0	5	1.64	11.09	23.81	36.98	0.28	1.17	2.06	1.15	0.00	19.28	2.11	0.42
10	1248	daf	0	7	6	1.77	2.91	21.73	41.01	0.00	1.20	4.13	1.25	0.66	24.43	0.52	0.39
41	226	des	0	0	6	1.79	3.39	19.89	44.21	0.00	1.49	1.27	2.18	0.00	24.80	0.69	0.28
43	227	des	0	0	6	1.15	7.56	22.10	35.63	0.52	1.11	1.67	1.25	0.00	28.05	0.97	0.00
44	228	des	0	0	6	0.90	10.20	22.75	33.25	0.54	1.03	0.87	2.18	0.69	26.71	0.89	0.00
8	60	daf	0	8	7	1.55	8.08	33.80	42.48	0.46	1.30	1.92	1.29	0.00	7.91	1.22	0.00
26	84	djq	2	0	7	1.38	12.24	29.96	40.07	0.24	2.84	1.35	1.19	0.66	8.79	1.30	0.00
27	94	djq	2	0	7	1.67	4.78	34.51	39.92	0.44	1.57	1.06	1.43	0.69	12.11	1.81	0.00
4	780	daf	0	8	8	1.80	3.98	20.58	55.33	0.05	1.06	2.42	1.57	0.56	11.51	1.13	0.00
22	88	djq	2	0	8	1.03	3.06	21.78	54.54	0.00	0.54	1.81	1.08	0.00	15.01	0.51	0.65
35	216	des	0	0	8	1.01	1.92	24.14	53.86	0.00	0.41	1.13	1.43	0.00	15.80	0.29	0.00
6	1104	daf	0	6	9	1.14	7.91	21.52	42.43	0.24	1.52	1.44	1.86	0.96	19.51	1.47	0.00
7	1085	daf	0	7	9	1.16	10.14	24.49	40.84	0.30	1.38	1.12	2.52	0.57	15.90	1.37	0.21

Table 4.11 Compositional data for Lapita ceramics from reef sites DJQ, DES and DAF.

18	876	daf	0	8	9	1.89	10.06	21.13	41.66	0.41	2.09	4.72	1.22	0.00	15.71	0.57	0.55
36	222	des	0	0	9	0.85	12.72	22.70	41.95	0.00	0.92	1.25	1.75	0.37	16.62	0.86	0.00
1	61	daf	0	8	10	0.95	8.37	27.28	42.05	0.07	1.44	1.96	2.59	0.00	13.51	0.96	0.81
5	1657	daf	0	2	10	1.90	6.62	26.81	44.69	0.20	1.45	1.41	1.66	0.00	14.32	0.95	0.00
11	661	daf	0	3	10	1.24	7.10	27.15	47.18	0.00	2.13	0.78	1.26	0.00	11.65	1.52	0.00
19	879	daf	0	8	11	2.06	7.24	24.10	44.10	0.04	2.37	1.64	1.26	0.60	15.41	0.95	0.22
20	886	daf	0	8	11	3.05	9.16	16.92	47.52	0.04	0.76	4.68	1.37	0.33	15.23	0.61	0.34
34	221	des	0	0	11	1.96	4.53	23.63	47.17	0.00	1.56	1.32	1.88	1.75	15.47	0.58	0.15
25	344	djq	11	0	12	0.58	27.27	25.17	19.44	0.32	0.54	1.39	1.82	0.86	21.23	1.00	0.40
30	403	djq	15	0	12	0.84	26.32	24.57	17.46	0.53	0.80	4.86	2.26	0.04	19.43	2.89	0.00
24	163	djq	2	0	13	0.95	18.90	21.97	26.41	0.13	0.71	6.64	1.30	1.40	19.98	0.94	0.66
40	225	des	0	0	13	1.30	21.09	20.15	26.28	0.51	0.95	2.11	1.38	0.00	23.25	2.81	0.16
42	220	des	0	0	13	1.18	20.31	25.86	23.91	0.25	1.45	1.22	2.17	0.12	21.74	1.77	0.00
28	131	djq	2	0	14	1.66	3.18	14.53	31.62	0.00	1.66	0.62	4.52	0.32	40.99	0.86	0.04

Table 4.11 cont.

Cluster	DAF	Sites DJQ	DES	Row Total
1	1	1	1	3
2	2		2	4
3	1	1		2
4	2	2		4
5	1		1	2
6	1		3	4
7	1	2		3
8	1	1	1	3
9	3		1	4
10	3			3
11	2		1	3
12		2		2
13		1	2	3
14		1		1
Unassigned	2		1	3
Column Total	20	11	13	44
%	45.5	25.0	29.5	100.0

Table 4.12 Crosstabulation of clay groups by site.

decoration. The distribution of these variables between clusters is presented in Tables 4.13 to 4.15.

Site DAF

Almost half of the sherds selected for analysis were from DAF (n=20). Sherds from outer reef Area 6 (n=3) and the outer portion of Area 8 (n=5), central reef Areas 2 (n=6) and 3 (n=4), and inner reef Area 7 (n=1) were analysed. Sherds from the beach portion of the site were not included as a majority of these appear to be from the late Lapita Buka style which has been analysed compositionally by Summerhayes. Pottery from the inner reef is represented in five clay clusters with single sherds in Clusters 1 and 3 and two sherds in each of Clusters 2, 4 and 10. The outer reef sherds are distributed between six clay clusters with three sherds in Cluster 9, two in Cluster 11 and single examples in Clusters 5, 6, 8 and 10. Only Cluster 10 has sherds from both reef areas. The lack of shared clusters between the two reef areas tends to strengthen the argument that they represent chronologically distinct occupational episodes at DAF. A representative range of sherd types, decorative techniques and tempers was included in the sample from both reef areas at DAF. There is no consistent pattern to the clustering of sherds for any of the attributes represented. Only two of the incised sherds and none of the dentate-stamped examples occur in the same clusters.

The majority of sherds analysed from DAF are rims (40%), including three double rims and a wide lip horizontal rim, along with three neck and curved shoulder sherds, eight body sherds and a single handle. Non-calcareous temper sherds (70% of the DAF sample) occur in all but one of the clay groups and single examples of ferromagnesian sand temper sherds are found in five groups (Clusters 1, 2, 4 and 10). There is no apparent association between clay groups and temper type at DAF or for the combined ceramic sample where no clusters with more than a single sherd have exclusively non-calcareous temper sherds.

A representative range of decorative techniques are found in the DAF sample and two plain sherds were also

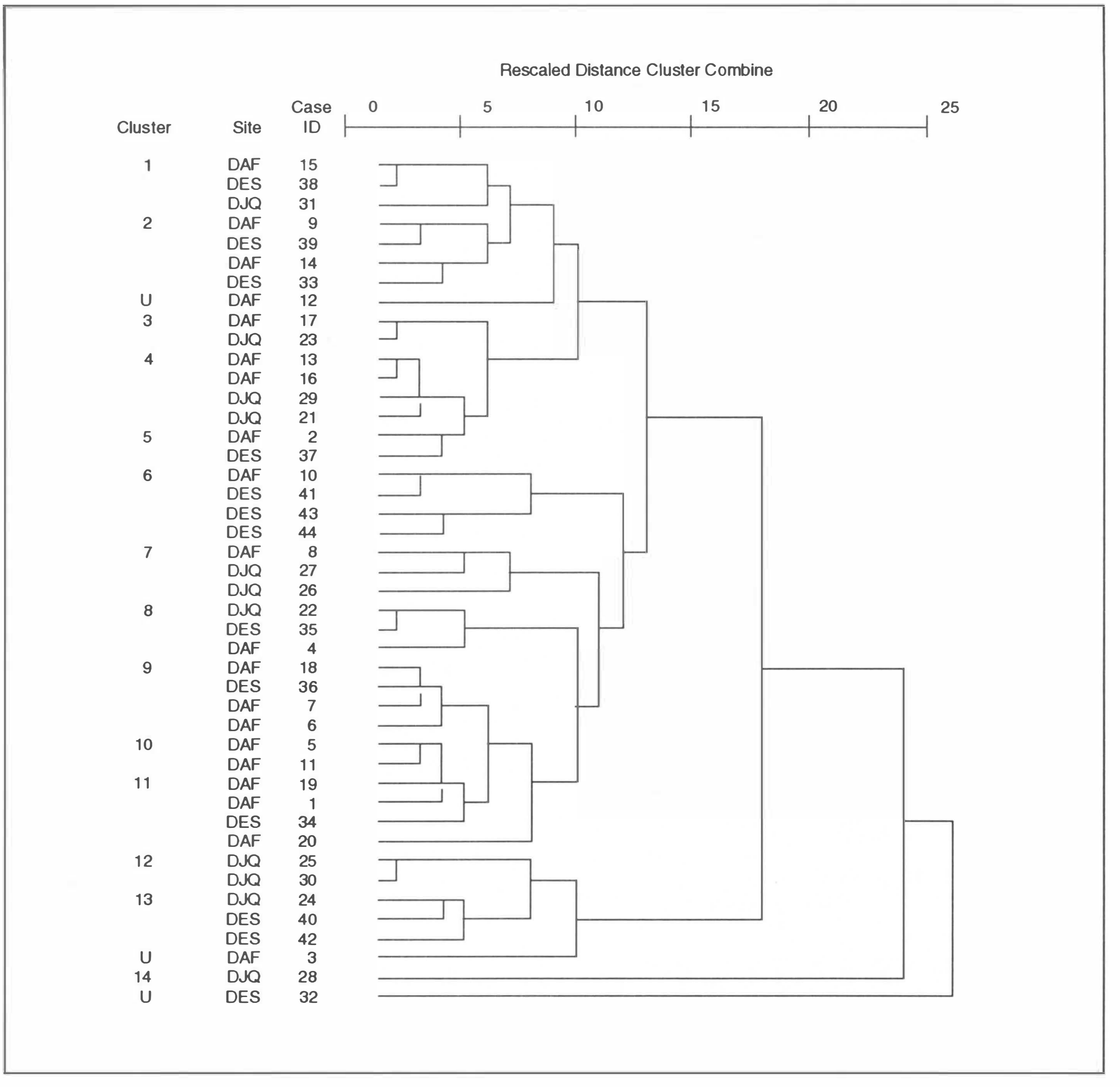


Figure 4.21 Dendrogram of total ceramic sample clusters using the average linkage (between groups) method. (Code: U = unassigned case)

Cluster			Sherd Type			Row Total
	Rim	Double Rim	Neck/ Shoulder	Carination	Body (1 handle)	
1	2				1	3
2	2			1	1	4
3					2	2
4	2	1	1			4
5	1				1	2
6	2	2				4
7			1		2	3
8	1	2				3
9				1	3 (1 h)	4
10	1	1			1	3
11	1		1		1	3
12		1	1			3
13	1	1	1			3
14	1					1
Unassigned	2			1		3
Column Total	16	8	5	3	12	44
%	36.4	18.2	11.4	6.8	27.3	100.0

Table 4.13 Crosstabulation of clay groups by sherd type.

included, a paddle-impressed thick rim (Cluster 2) and a double rim (Cluster 6). Dentate-stamped (Clusters 2, 5, 7 and 10; n=5) and incised (Clusters 1, 3, 4, 9 amd 11; n=6) sherds account for 61.2% of the decorated sample and no clusters have both techniques represented. Stamped sherds include a single body sherd with needlepoint-like dentate-stamping from the outer reef (Cluster 10) and one of the incised sherds has an applied relief strip (Cluster 11). Other decorative techniques include two sherds with applied relief strips (Cluster 10, unassigned), a body sherd with a leg or lug attachment and handle with two rows of perforations (Cluster 9), and a double rim with perforated lip (Cluster 10). Two rims are undecorated except for lip impressions (Clusters 4 and 8).

Site DJQ

The 11 sherds from Site DJQ included in the analysis are distributed between eight clay groups. Six of the sherds are rims, including two double rims (Clusters 4 and 12). The remaining sherd types are necks (n=2) and body sherds (n=3). Eight of the 11 sherds are calcareous tempered and the remainder have ferromagnesian sand temper (Clusters 4, 7 and 14). All but one (Cluster 14) of the mineral sand temper sherds are from clay groups which include calcareous temper sherds. Cluster 14, the only clay group comprised of a single sherd, forms a clear outlier in both clustering methods. As with DAF, non-calcareous temper sherds apart from Cluster 14 do not cluster together.

All of the DJQ sherds are decorated, eight of them with stamping (Clusters 3, 4, 7, 8, 12 and 14). The remaining three sherds are decorated with bounded incision (Cluster 13), nubbins and perforations (Cluster 12) and lip impressions found on a rim sherd (Cluster 1). As with the DAF sample, stamped and incised sherds are not found in the same clay groups although one cluster has a stamped neck sherd and double rim with nubbins and perforations (Cluster 12).

Site DES

As with DJQ, the DES sherds form eight clusters, and one sherd is unassigned. Sherd types represented are limited to seven regular rims, three double rims and three carinations. Nine of the sherds are calcareous tempered and the rest have dense ferromagnesian sand temper. Unlike the DAF and DJQ samples, non-calcareous temper sherds do not share clusters with calcareous temper sherds.

Two of the DES sherds are undecorated, a carination and rim (Cluster 2). The decorated ceramics include a stamped sherd (Cluster 11), a stamped double rim with lip perforations (Cluster 8), two incised sherds (Cluster 6, unassigned) and single examples of a carination with an impressed transverse bar (Cluster 9), a row of nubbins placed below a rim (Cluster 6) and a double rim with perforated lip (Cluster 13). The remaining decorated sherds are lip impressed rims (Clusters 1, 5, 6 and 13). As with the other reef sites, stamped and non-stamped sherds do not occur in the same clusters.

Cluster	Temper Class				Row
	1000/1230	2000	2100	2300	Total
1	1	1	1		3
2	1	1	1	1	4
3	2				2
4	2	1		1	4
5	2				2
6	4				4
7	2			1	3
8	3				3
9	4				4
10	2		1		3
11	2	1			3
12	2				2
13	3				3
14		1			1
Unassigned	1	1	1		3
Column total	31	6	4	3	44
%	70.5	13.6	9.1	6.8	100.0

Table 4.14 Crosstabulation of clay groups by temper class.

Cluster			Decoration			Row
	Stamped	Bounded Incision	Free Incision	Lip Impression	Relief/Perforation	Total
1			1	2		3
2	1					1
3	1		1			2
4	2		1	1		4
5	1			1		2
6			1	1	1	3
7	3					3
8	2			1		3
9			1		3	4
10	1				2	3
11	1	1	1			3
12	1				1	2
13		1		1	1	3
14	1					1
Unassigned	1		1		1	3
Column Total	15	2	7	7	9	40
%	37.5	5.0	17.5	17.5	22.5	100.0

Table 4.15 Crosstabulation of clay groups by decoration technique. (Number of missing observations = 4)

Summary of results

Cluster analysis of 44 sherds from the three reef sites produced a total of 14 clay groups. A majority of the clay groups included sherds from more than one site and some groups have each of the three sites represented. No clay samples were available for analysis and the specific clay sources utilised for pottery production remain unknown. The dispersed geographic distribution of pottery within individual clay groups demonstrates a close association between the sites in terms of potential ceramic exchange with pottery most likely produced on Buka and transported at least as far as Nissan Island, 64 km to the north. This pattern most closely approximates a model of Lapita ceramic exchange proposed by Hunt (1988:57) which specifies that pottery was primarily locally produced but frequently transferred (relatively) short distances. Such transfers may be especially frequent between islands with pottery production resources and those without such resources.

The distribution of temper and decorative techniques between sites in relation to clay groups was analysed in order to examine the nature of inter-site variability. No relationship was evident between temper classes and clay groups for sites DAF, DJQ or the general ceramic sample, with both calcareous and non-calcareous tempers occurring in the same clay groups. In contrast, the DES sample exhibited a clear separation between the two temper types in relation to clay groups. Ceramics representing the full range of decorative techniques in addition to a sample of undecorated diagnostic sherds were selected for elemental microanalysis. At each of the sites, a majority of the sherds decorated with dentate-stamping were associated with different clay groups than sherds with incision and other forms of decoration. However, clustering for the combined sample produces quite different results with half of the clay groups comprised of sherds with stamping combined with those utilising other techniques (Table 4.15).

Potential intra-site variability within Site DAF was examined by separating the sherds from the outer and central portions of the reef. Of the 12 clay groups with sherds from DAF, only one (Cluster 10) has pottery from both outer and central portions of the reef. This supports other ceramic evidence which indicates that occupation of the outer reef was earlier and temporally distinct from that on the central reef at DAF.

5

LAPITA CERAMIC ANALYSIS: DECORATION

This chapter presents the results of analysis of Lapita style decoration from the DJQ, DAF and DES reef site assemblages. Following a discussion of the individual decorative techniques represented in these assemblages, results of design analysis are presented and extra-areal comparisons made with other Lapita sites. The relationships between decoration, vessel form and pottery composition were examined in the previous chapter and are not dealt with in detail here.

DECORATIVE TECHNIQUES

As shown in Table 3.7, DJQ has the highest frequency (33.7%; n=334) of decorated pottery of the three reef site assemblages. The frequency of decorated sherds varies from 12% to 65% between transects at DJQ although only the Lapita pottery concentration area (Tr. 53-64), where 29.1% of the pottery is decorated, has enough sherds to provide a reliable sample. The other sites have considerably lower decoration frequencies of 15.3% (n=249) at DES and 10.0% (n=4014) at DAF.

Not surprisingly considering its much larger sample size, the DAF assemblage is more complex than the other sites with considerable variability in the frequency of decoration between collection areas (Table 3.4). There is a marked contrast between the outer reef (Areas 5 and 6) where 38.4% (n=458) of the sample is decorated, southern central reef (Areas 1 to 3) with 8.9% (n=2990) decoration and beach (Areas 9 and 10) where 4.2% (n=24) of the surface collected sample is decorated. Inner reef Area 7 has a similar frequency of decorated pottery as the beach areas (5.5%; n=115) but Area 4 has a much higher frequency of decoration (30.3%; n=159).

Similar distributional patterns are displayed at DAF in terms of decoration techniques with higher frequencies of dentate-stamping occurring in areas with a higher percentage of decorated pottery. Based on evidence from other Lapita sites which indicates that both the amount of decoration and use of dentate-stamping decreases over time, spatial variability in the amount of decoration at DAF suggests that the earliest occupation at DAF occurred on the outer reef with subsequent occupation of the southern central reef and finally the beach. This hypothesis is examined in more detail below.

Seven decorative techniques are represented within each of the three reef site assemblages. Frequencies of each technique are presented by site in Table 5.1 and the relative frequencies of the principal techniques illustrated in Figure 5.1. Decorative techniques include stamping, bounded and unbounded incision, applied relief (nubbins, strips or bars, and discs), impressions formed with fingers/fingernails or other objects found on lips and below the rim, carving in the form of recessed triangles and lip notching, punctation and perforation. Lip impression is widespread and associated with each of the decorative techniques so frequencies are presented (combined with lip notching) separately after the totals for individual techniques in Table 5.1. Each technique is discussed below in terms of distribution, associated techniques, location on vessels and associated vessel forms. The techniques of stamping and bounded incision are treated in more detail in the following section on Lapita design analysis. Examples of dentate-stamped and bounded incision designs are illustrated in Figures 5.2 to 5.5. Pottery with unbounded incision and other decorative techniques is illustrated in Plates 5.1 to 5.4.

Decoration location was recorded primarily through reference to diagnostic regions of the vessel although the design zone concept developed by Mead (Mead et al. 1975) for Fijian Lapita ceramics and adapted by Parker (1981) in the analysis of Reef-Santa Cruz Lapita ceramics was employed to some extent. Lip decoration was recorded in relation to positioning (i.e. outer lip, inner lip, top of lip) with more detailed terminology for rims with everted

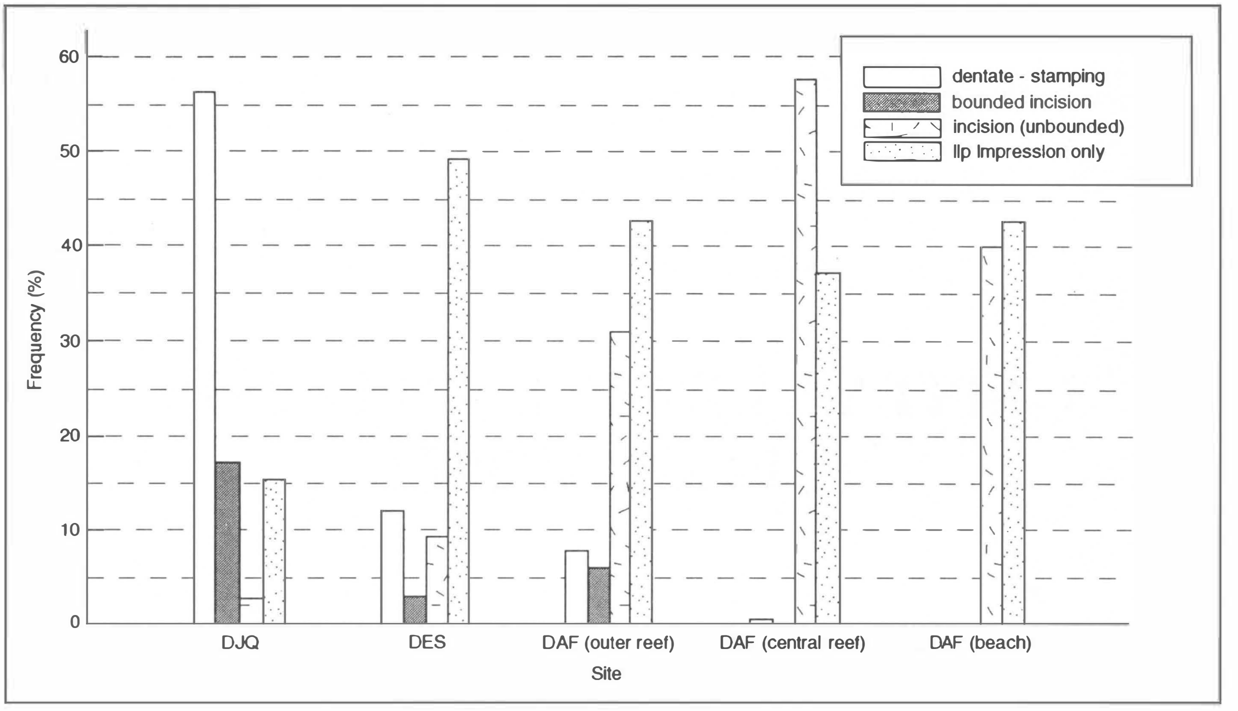


Figure 5.1 Relative frequencies of principal Lapita decoration techniques by site.

angled lips (Lip Form 5). The upper surface of angled lips is referred to as Zone F and the outer lip as Zone G using Mead's terminology (1975:27). The placement of decoration on and below the interior lip angle was also noted. The exterior and interior vessel surface below the rim lip was divided into two decoration zones. Zone 1 extends from the lip margin downward approximately 2 cm, where Zone 2 begins. This distinction was useful in separating decoration found immediately below the rim lip from that on the vessel body. Other decoration locations include the neck and angle between the neck and curved shoulders, carination angle (above, below or on the angle), handle and body. A more detailed discussion of stamped and bounded incision design zones based on the Mead system is found in the Lapita design analysis section. Tables with ceramic frequencies for individual designs and motifs by decorative technique for each site are located in Appendix A.

Stamping (dentate and untoothed)

Dentate-stamping is the hallmark of Lapita ceramics and has received considerably more attention than other associated decorative techniques. This technique involves impression of a stamp of wood, shell, bone or some other material into the damp clay surface. Stamps most often had a series of evenly spaced teeth although plain or untoothed stamps were also employed, particularly a small, hollow, circular stamp.

The DJQ decorated ceramic assemblage has the highest proportion of stamped sherds of the three reef sites representing 56.4% (n=188) of the sample. This includes 67 sherds (20.0%) with worn surfaces on which traces of probable stamping were identified. Stamping combined with other techniques accounts for 9.6% of the DJQ decoration. The other sites have much lower frequencies of stamping comprising 12.0% (n=30) of the decorated sherds at DES and only 1.9% (n=77) at DAF. Worn sherds with probable stamping are less common than at DJQ due to better preservation conditions and account for 1.2% of the decoration at DES and 0.1% at DAF. Stamping combined with other decoration accounts for 2.8% of the decoration at DES and 0.4% at DAF.

A majority of the 72 definite dentate-stamped sherds from DAF come from the outer reef Areas 6 (41.4%), 8 (20%) and 5 (4.3%). Central and inner reef locations with stamped sherds include Area 2 (17.1%) and single sherds from Areas 3, 4 and 7. A single dentate sherd found at the beach/reef margin between Area 9 and 7 was waterworn and encrusted with coral suggesting that it had been displaced from the outer reef. The only beach location with stamped decoration is test unit TP 1 which contained small (2 cm or less) dentate-stamped rim (n=5) and body (n=3) sherds. The percentage of stamped sherds by area is also highest on the outer reef in Areas 6 (8.3%), 8 (7.3%) and 5 (2.8%). Stamping represents less than 1% of the decoration in all other areas except TP 1 which has the highest percentage (12.1%). The majority of stamped sherds in TP 1 were badly worn and identified only after close inspection in the laboratory. The overall evidence indicates a marked concentration of dentate-stamped pottery in the outer reef area at the north end of the site.

Associated decorative techniques

Stamping is found in combination with each of the six other decorative techniques. The most frequently associated technique is lip notching or impression, followed by applied relief nubbins and perforations. This is especially true at DJQ where stamping with nubbins and stamping with perforations each account for 4.5% of the decorated assemblage. Both nubbins and perforations are arranged in single rows and a majority (i.e. 59% of nubbins and

Decoration Techniques (without/with lip impression or notching)	Site DJQ n	%	Site DAF n	%	Site DES n	%
dentate or untoothed stamp	74/16 (5 notch)	26.9	46/8 (1 notch)	1.3	14/6	8.0
probable stamped ? (weathered sherds)	60/7 (1 notch)	20.0	5/0	0.1	1/2	1.2
Stamp and Stamp? Subtotal	134/23	47.0	51/8	1.5	15/8	9.2
bounded incision	48/8	16.8	44/7	1.3	5/1	2.4
unbounded incision	7/2	2.7	1903/81	49.4	16/7	9.2
Incision Subtotal	55/10	19.5	1947/88	50.7	21/8	11.6
applied relief strip or transverse bar	5/0	1.5	82/33	2.9	10/6	6.4
applied relief nubbin	9/0	2.7	31/2	0.8	6/2	3.2
applied relief disc (1)/modelled lug (1)	-	-	2/0	-	-	-
Applied Relief Subtotal	14/0	4.2	115/35	3.7	16/8	9.6
impression on rim lip	0/51	15.3	0/1503	37.4	0/123	49.4
impression below rim	3/0	0.9	72/29 1 handle	2.5	6/2	3.2
Impression Subtotal	3/51	16.2	72/1532	40.0	6/125	52.6
carved triangles	1/0	0.3	2/0	-	-	-
cut notches	0/7	2.1	2/8	0.2	0/10	4.0
Carving Subtotal	1/7	2.4	4/8	0.3	1/10	4.0
punctation	-	-	6/0	0.1	1/1	0.8
perforation	1/1	0.6	8/6	0.3	14/5 5 handles	7.6
Single Technique Subtotal	208/92 (n=300)	89.8	2203/1677 (n=3880)	96.7	73/165 (n=238)	95.6
stamping and bounded fine incision	1/0	0.3	4/1	0.1	-	-
stamping, incision and perforations	-	-	0/1	-		
stamping and nubbins	14/1	4.5	5/1	0.1	1/0	0.4
and carved triangles above base	-	-	-	-	1/0	0.4
and lip punctation	1/0	0.3	-	-	-	-
and perforation	11/4	4.5	2/2	0.1	3/1	1.6
and perforation and nubbins on lip	-	-	2/0	-	-	-
and perforation and impressions on handle	-	-	-	-	1/0	0.4
Stamping Subtotal	27/5	9.6	13/5	0.4	6/1	2.8
bounded incision and perforation	-	-	-	-	0/1	0.4
unbounded incision and relief strips	-	-	99/0 (84 notch)	2.5	-	-
and nubbin or lug/disc	-	-	4/1	0.1	-	-
and impressions on carination	-	-	7/0	0.2	-	-
and lip punctation	-	-	1/0	-	-	-
Unbounded Incision Subtotal	-	-	111/1	2.8	-	-
nubbins and perforation on lip	1/1	0.6	-	-	-	-
relief strips and impressions below rim	-	-	2/0	-	-	-
relief strips and carved triangles on lip	-	-	1/0	-	-	-
handle with perforations and edge impressions	-	-	-	-	3/0	1.2
relief strips with punctation and perforation on lip	-	-	1/0	-	-	-
Multiple Techniques Subtotal	28/6	10.2	128/6	3.3	9/2	4.4
Total	236/98 (n=334)	70.7/29.3	2331/1683 (n=4014)	58.0/42.0	82/167 (n=249)	32.9/67.1

Table 5.1 Decoration technique frequencies for Lapita pottery.

78.3% of perforations) are found on the top (Zone F) of Lip Form 5 (Fig. 4.3:b, e, g, l, p, q; Fig. 5.3:e, f) and double rims (Fig. 4.2:c, d, f). Single examples of double and regular rims from DAF have nubbins and perforations combined on Zone F (Fig. 5.3:f). Two sherds from DJQ have perforations below the rim in Zone 1 including a single large perforation apparently drilled as a suspension hole. A strap handle from DES has perforations with stamping and edge impressions (Fig. 4.15).

In addition to rim lips, nubbins are located on the exterior surface of Zone 1 in 31.8% of the cases (Fig. 5.3:c), on constricted necks (13.6%) and single instances are found on a neck/shoulder angle and above a carination. Nubbins are circular and resemble Mead's (1975:25) N1.1 form although single rows of short vertical bars (Mead's VB2.1) with nubbins attached at both ends to form a barbell shape are also included in the nubbin category. Two rims with such 'barbells' are found on

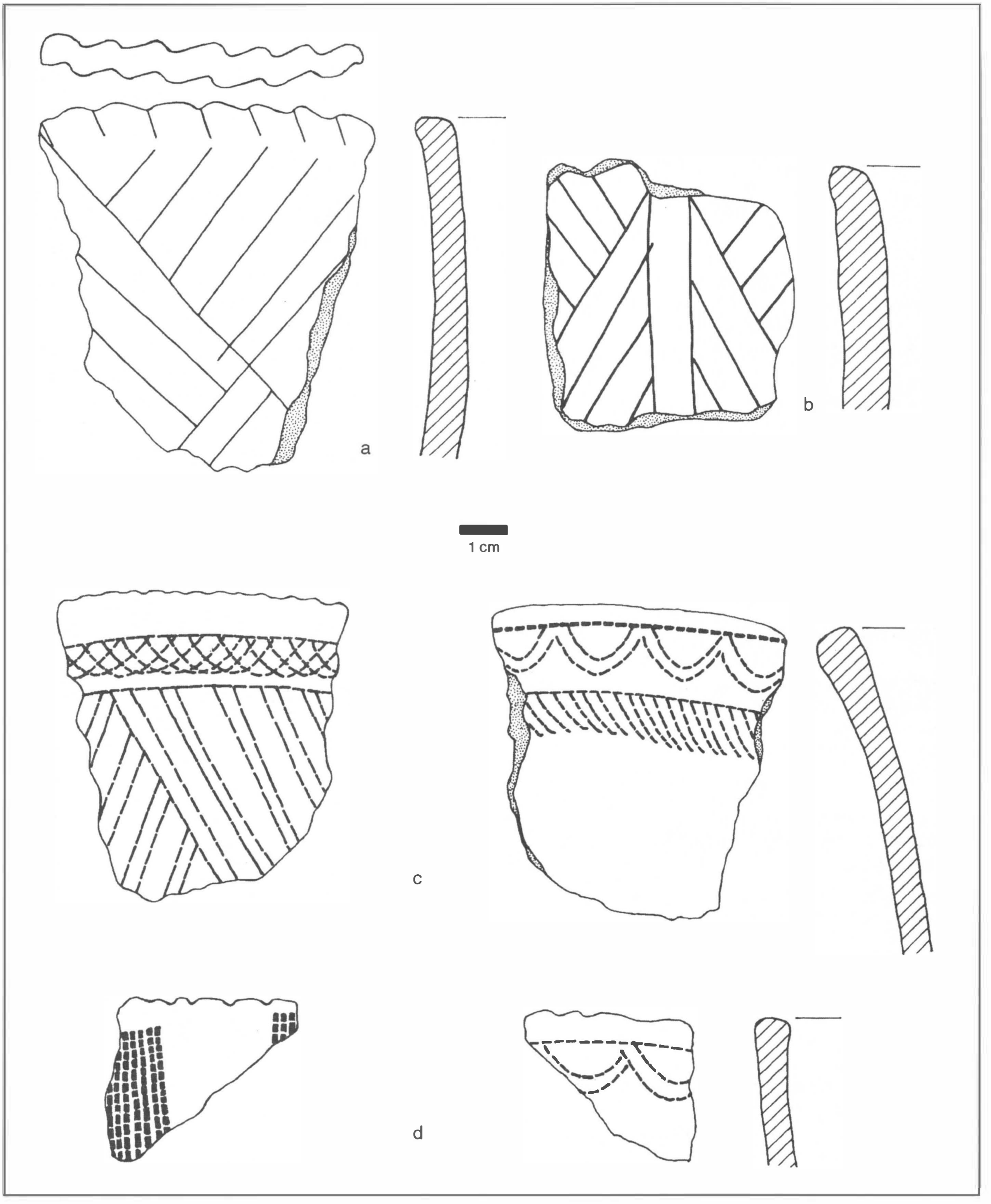


Figure 5.2 Lapita bounded incision and dentate-stamped designs on rims from Site DJQ (vessel exterior to left for c and d). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.): Collection Area/Transect (Tr.). **Data** – a: DJQ.14.395: Tr. 51-54 (south); b: DJQ.15.414: Tr. 55-56 (south); c: DJQ.15.406: Tr. 55-56 (south); d: DJQ.2.92: Lapita Concentration (Tr. 53-64).

the top of angled rim lips (Zone F) at DJQ (Fig. 4.3:c) and the single instance from DAF occurs above a carination angle with stamping below (Fig. 4.10:r).

Other techniques associated with stamping include incision, carving and lip punctation. Fine rectilinear incision occurs with stamping on a single neck/shoulder angle at DJQ and on five sherds from DAF with decoration located on the interior and exterior surface in Zones 1 and 2, above a carination and on a body sherd. One rim from DAF has incision and lip perforation. The only example of carving combined with stamping is a flat base angle from DES with a row of carved triangles at the base angle and a dentate-stamped restricted zone marker above (Fig. 4.5:f). Adjacent triangles are reversed in orientation producing an appearance similar to Design Element 8.3 described by Mead (1975:29) as being best represented by notching on rims from Fijian Lapita sites. Spriggs (1991a:Plate 3) illustrates this base

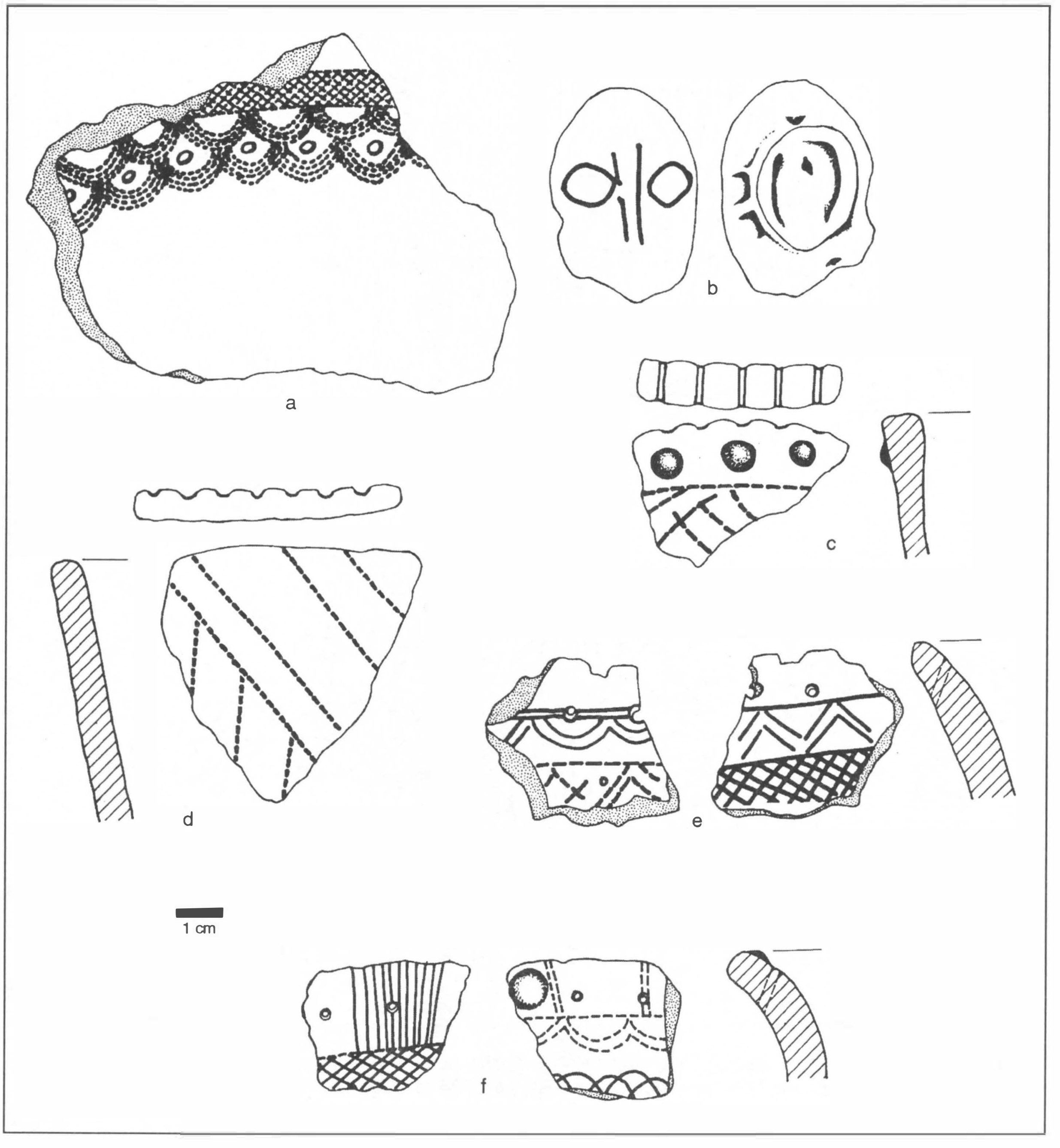


Figure 5.3 Lapita incised disc (b) and stamped designs on body (a) and rim (c-f) sherds from Site DAF (vessel exterior to left for e and f). **Code** – Letter Designation: Provenience Code (Site, Collection Area, Cat. No.). **Data** – a: DAF.8.61; b: DAF.2.65; c: DAF.2.10; d: DAF.6.25; e: DAF.2.8; f: DAF.8.53.

but describes the carved designs as rectangular rather than triangular. A single rim sherd from DJQ has dentate-stamping on the exterior on Zone 1 and a single row of small punctations on the top of the lip.

The presence of nubbins and perforations with stamping is widely documented in Lapita ceramic assemblages but no references were found to handles with perforations combined with stamping. Although incision is reported as occurring with dentate-stamping in Lapita sites, its occurrence is rare and rarely quantified (Anson 1983:21). As discussed above, carved triangles are a recognised lip decoration associated with stamping in both Western and Eastern Lapita sites. Although no references were found to lip punctation associated with stamping, punctation is a decorative technique which occurs in Lapita assemblages and potential punctations may have been recorded as lip impressions, which are common on stamped rims.

Vessel form

Stamping is found on seven of the ten vessel forms identified and ten of the 16 variants (Table 4.5). It is found on restricted and unrestricted bowls, including carinated forms, and is most common on Form 2 shallow everted bowls/dishes. Only one of the large globular to subglobular jar forms has evidence of stamping (Form 8A). This pattern indicates that stamping was restricted primarily to vessels utilised for serving or storage rather than food preparation or other domestic activities. In terms of rim form, stamping is dominant on double rims

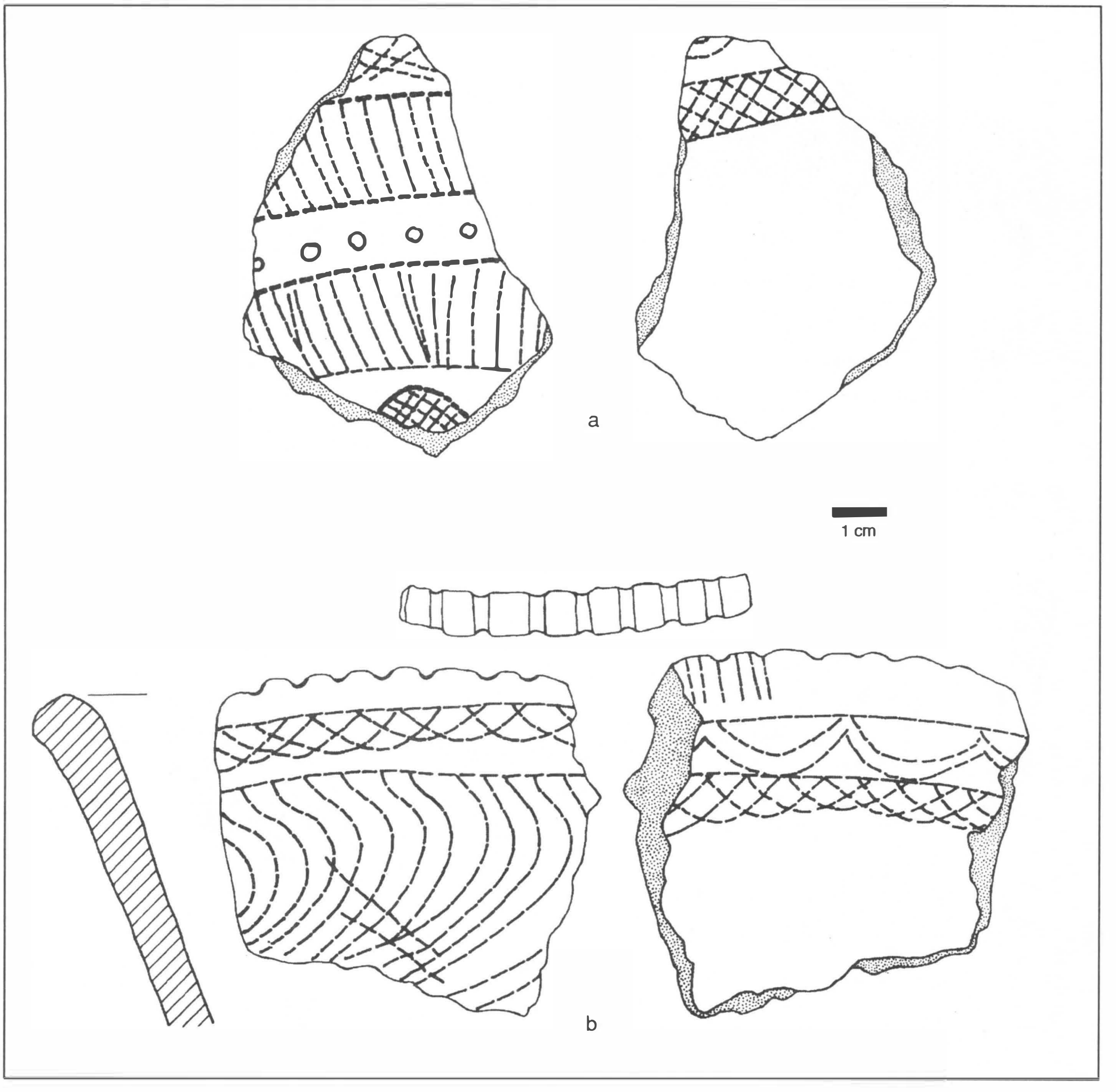


Figure 5.4 Lapita dentate-stamped designs on body (a) and rim (b) sherds from Site DAF (vessel exterior to left). **Code** – Letter Designation: Provenience Code (Site, Collection Area, Cat. No.). **Data** – a: DAF.6.41; b: DAF.6.19.

of Form 2A shallow bowls and is also often found on carinations and strongly convex body sherds, particularly at DJQ. Neck sherds of Form 8A jars are frequently stamped at DJQ with lower frequencies at DAF and DES. Gradually and abruptly angled lips (Lip Forms 5 and 6) from Form 2B bowls have a high frequency of stamping as do flat expanded Lip Form 16 rims. A high percentage of stamped rims are everted (82.1% at DAF, 80.5% at DJQ and 76.9% at DES) with straight rim courses (67.9% at DAF, 73.3% at DJQ and 50.0% at DES), a characteristic of Form 2 vessels.

An examination of body thickness by decoration technique revealed that stamped sherds have a consistently higher mean thickness than any other form of decoration or the total sample of decorated sherds. Mean body thickness (mm) for stamped sherds is 8.1 (n=171) at DJQ, 7.7 (n=68) at DAF and 7.3 (n=25) at DES. Mean thickness (mm) for the entire sample of decorated body sherds is 7.4 at DJQ, 5.8 at DAF and 6.5 at DES as shown in Table 4.9.

Incision (bounded and unbounded)

Two forms of incision are present at the three reef sites, referred to as bounded and unbounded. Bounded incision is characterised by well executed finely incised diagonal (oblique) lines enclosed by horizontal boundary lines or a natural boundary such as a rim lip or carination. Some motifs also have vertical boundary lines associated with the diagonals within the horizontal boundaries. A number of bounded incised motifs also occur using dentate-stamping and the bounded structure of the designs is identical to that employed in stamped motifs. Bounded incision and stamped motifs are discussed below in the Lapita design analysis section. Unbounded incision is generally broader and less structured than bounded incision with no incised boundaries although some designs are bounded by neck or carination angles.

As shown in Table 5.1, bounded incision is most common at DJQ where it comprises 16.8% of the decoration but is only of minor importance at DAF (1.3%) and DES

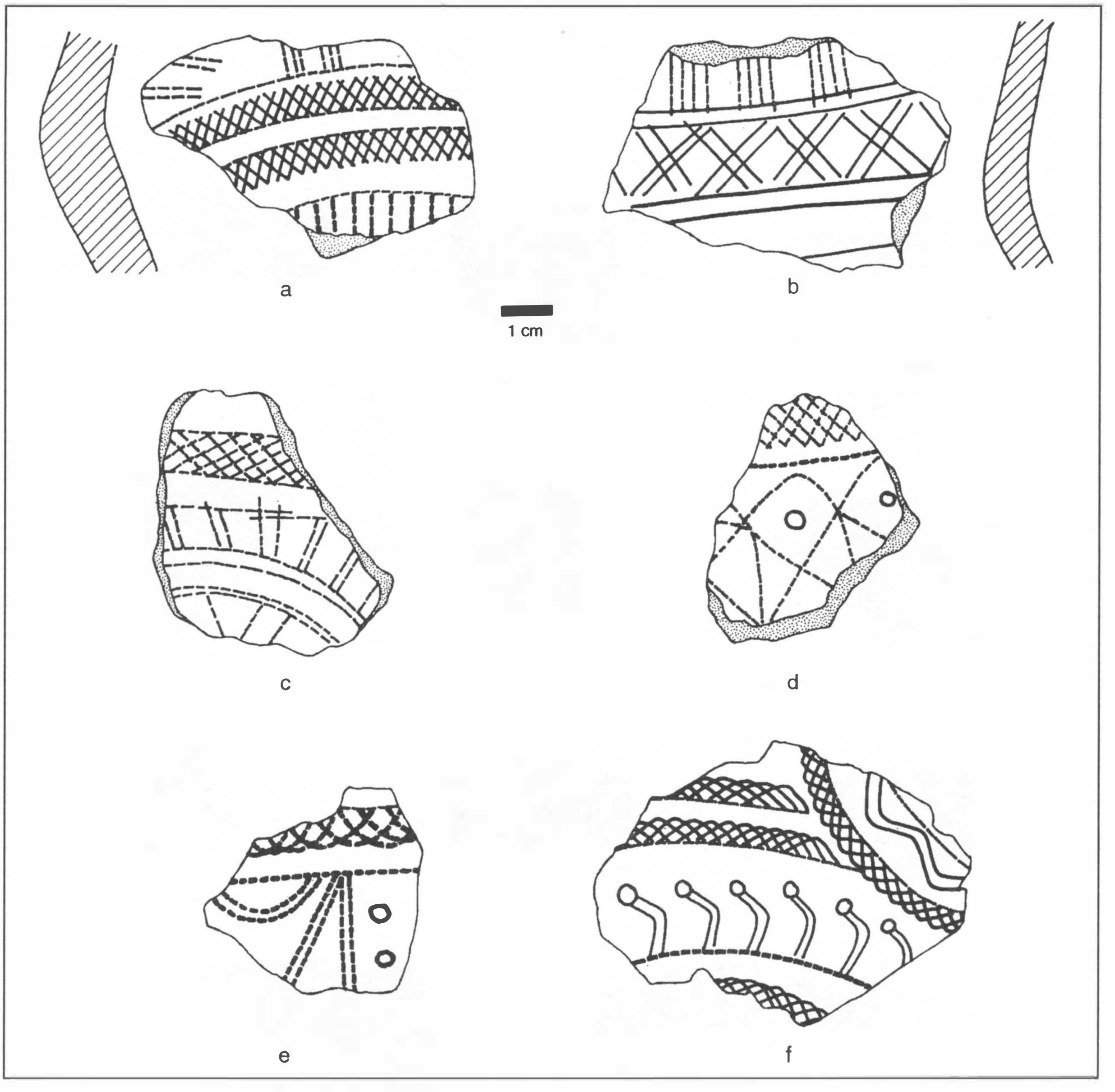


Figure 5.5 Lapita incised and stamped designs on carinations (a, b), complex rim (c), neck (e) and body sherds (d, f) from Site DAF. **Code** – Letter Designation: Provenience Code (Site, Collection Area, Cat. No.). **Data** – a: DAF.6.37; b: DAF.6.38; c: DAF.8.57; d: DAF.2.12; e: DAF.6.34; f: DAF.5.18.

(2.4%). These frequencies display a similar pattern as those for stamping with high amounts at DJQ and very low amounts elsewhere. In contrast, unbounded incision is the dominant technique at DAF (49.4%) but of minor importance at DES (9.2%) and DJQ (2.7%). If both types of incision are grouped together as a single category, DAF has the highest amounts followed by DJQ and DES.

The percentage of decorated sherds with bounded incision at DAF was greatest on the reef at the northern end of the site where it ranged from 13% at Area 7 to 4.7% at Area 6. The other areas had no bounded incision or percentages less than 1%. This pattern is very similar to that of dentate-stamping and all sherds with combined stamping and bounded incision come from Area 6. Unbounded incision has a distinctly different distribution pattern at DAF with the highest percentages on the central reef at the south end of the site in Area 3 (83.8%), Area 1 (63.9%) and Area 2 (55.9%). Inner reef Area 4 (53.5%) and TP 1 (59.1%) on the beach also have high percentages. The outer reef areas have less than 35% unbounded incision with the lowest frequency in Area 5 (25.2%).

Associated decorative techniques

In addition to its association with stamping, bounded incision is found with perforation on a single Form 1 vessel rim sherd at DES (Fig. 4.1:f). As only a single isolated perforation immediately below the rim is present, it may represent a utilitarian rather than decorative function although the diameter is quite small (3 mm).

Unbounded incision occurs in combination with three other techniques at DAF led by applied relief representing 2.6% of the decoration. Incision usually consists of groups of parallel lines located between relief strips or bands of variable length. In 82.3% of the cases, the relief strips have a series of impressions made with a finger or other object giving a notched appearance. This form of decoration is most often found on curved shoulders of Form 9 jars usually extending down from the neck angle although two examples occur on the top of very wide lip rims from

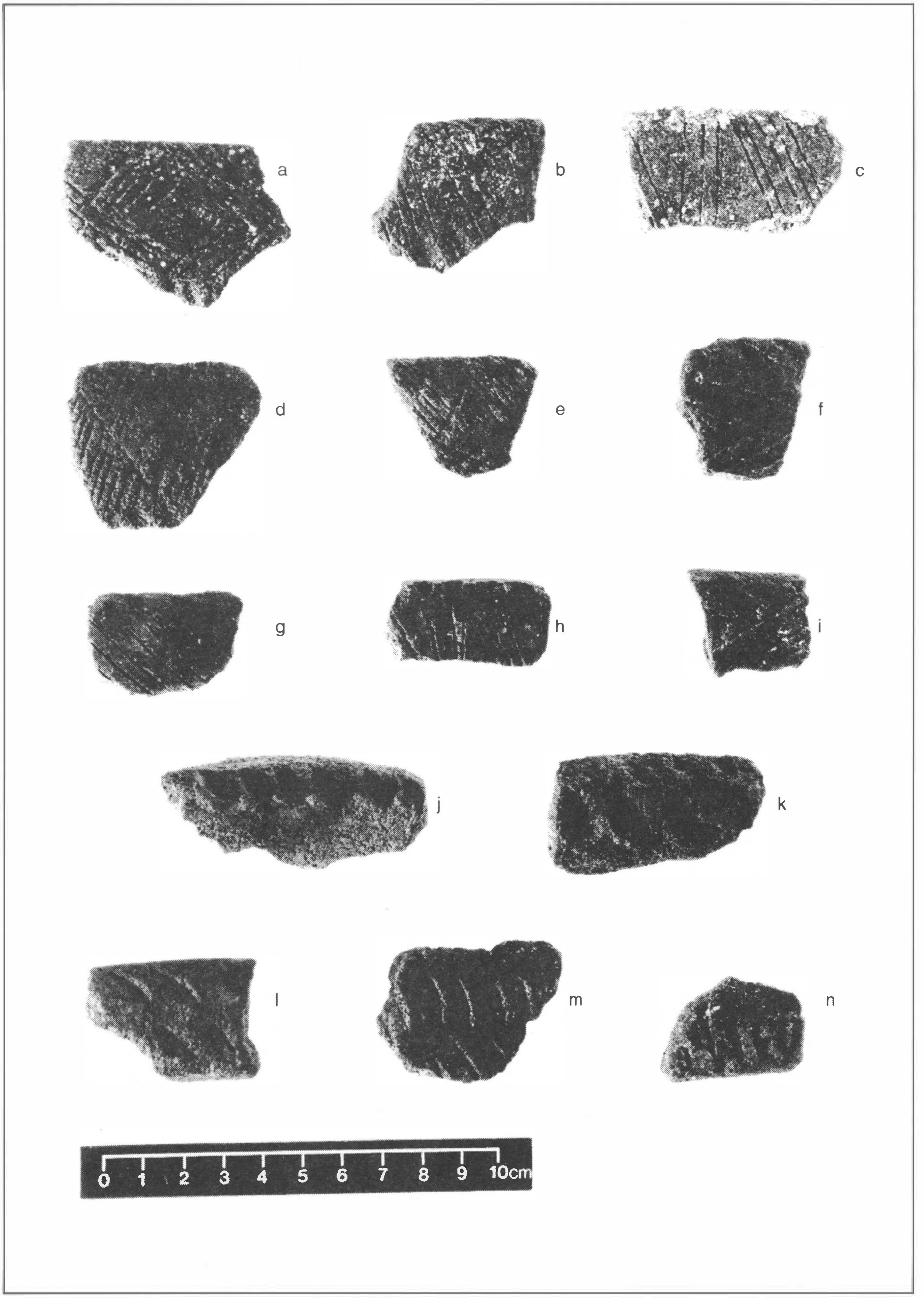


Plate 5.1 Lapita wide lip rims with incision (a-i) and shallow impressions (j-n) from Reef Site DAF). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.2.1690; b: DAF.2.1787; c: DAF.1.541; d: DAF.2.1676; e: DAF.2.1674; f: DAF.2.1768; g: DAF.2.1800; h: DAF.2.1684; i: DAF.3.593; j: DAF 2.2239; k: DAF 3.585; DAF.3.1682; m: DAF.2.1680; n: DAF.2.2240.

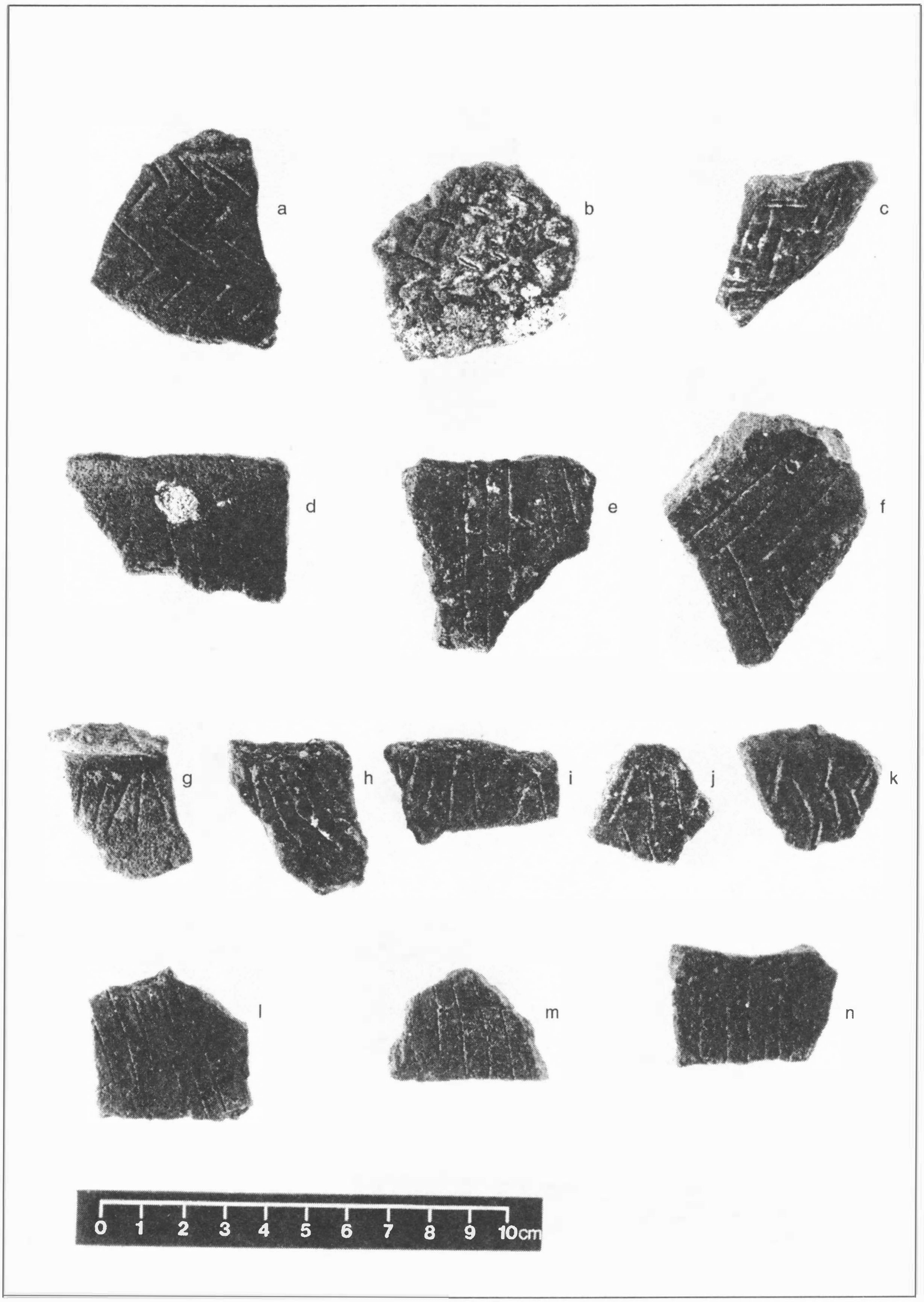


Plate 5.2 Lapita rim (c), neck (a, d, g-i), carination (k) and body (b, e, f, j, l-n) sherds with unbounded incision from Reef Site DAF. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a:DAF.2.1996; b:DAF.2.1995; c: DAF.2.1655; d: DAF.2.2037; e: DAF.3.696; f: DAF.3.697; g: DAF.2.2062; h: DAF.2.2005; i: DAF.2.2103; j:DAF.3.721; k: DAF.2.1998; l: DAF.2.2096; m: DAF.2.2111; n: DAF.2.2099.

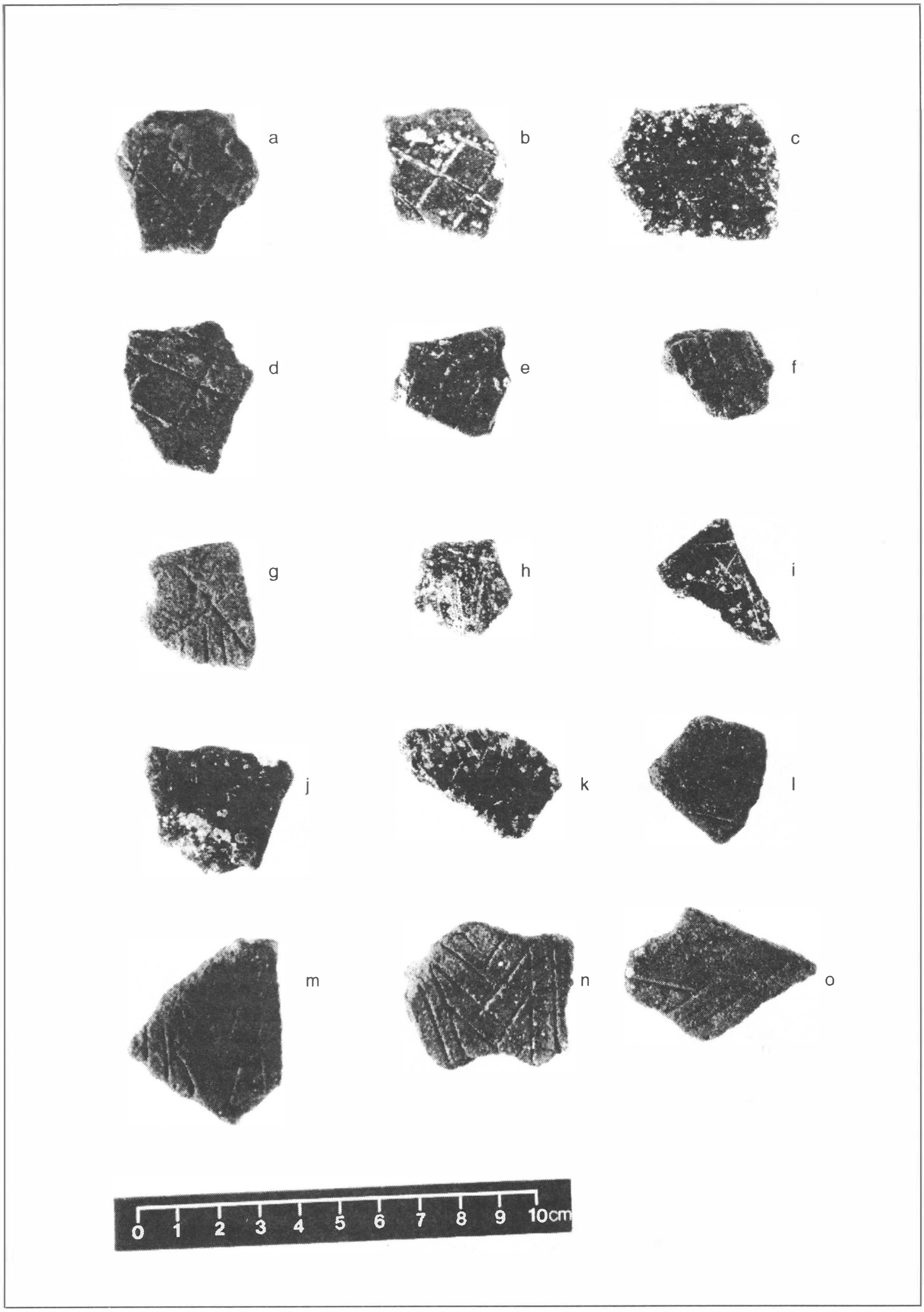


Plate 5.3 Lapita neck (m, n), shoulder (a, b) and body (c-l, o) sherds with incision from Reef Site DAF. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.3.718; b: DAF.3.719; c: DAF.2.1985; d: DAF.3.712; e: DAF.2.1967; f: DAF.3.727; g: DAF.2.1997; h: DAF.3.725; i: DAF.6.1151; j: DAF.6.1152; k: DAF.6.1213; l: DAF.2.2023; m:DAF.2.2007; n: DAF.1.533; o: DAF.1.507.

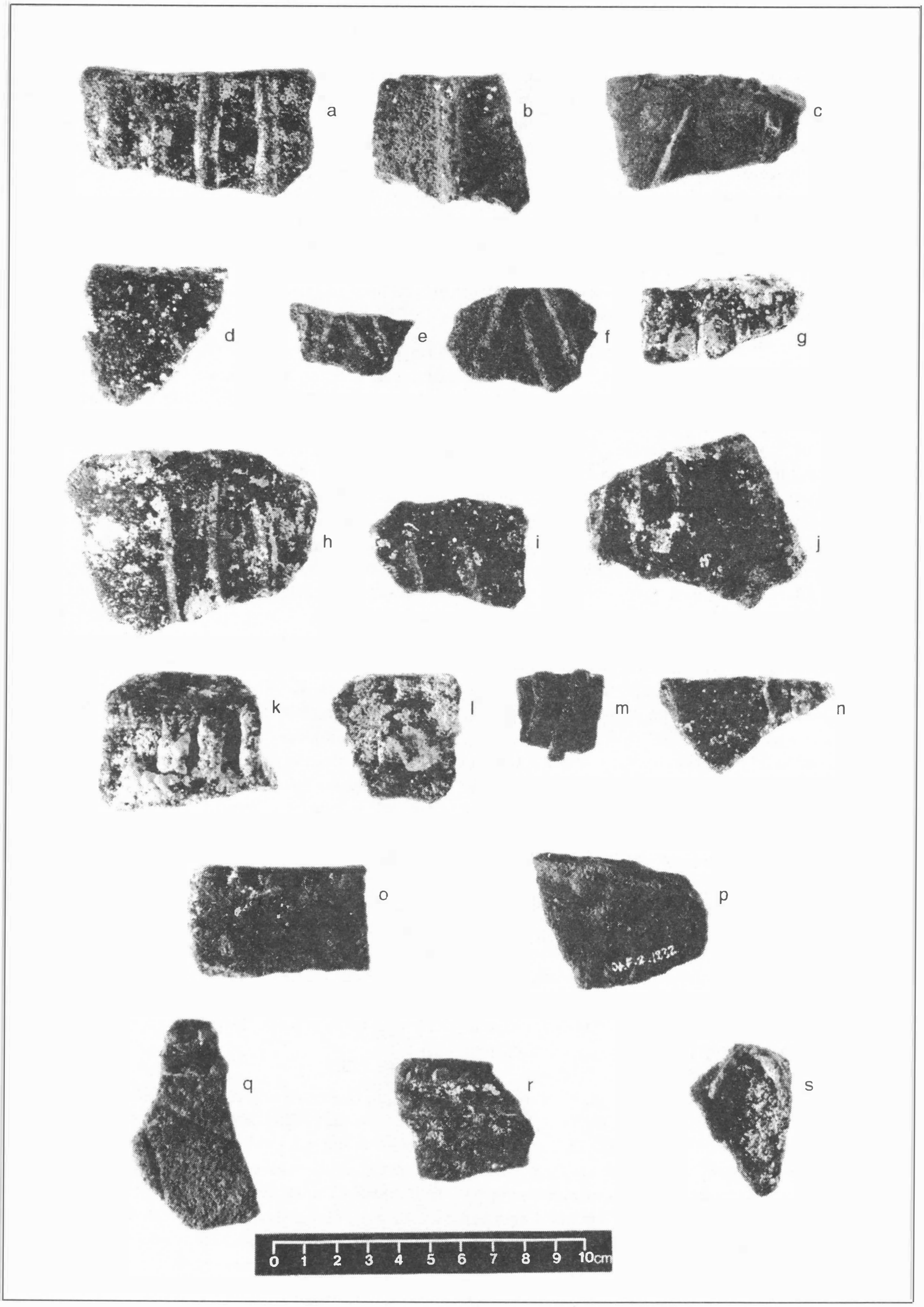


Plate 5.4 Lapita pottery with applied relief strips (a-n, q-s) and nubbins (o, p) from Reef Site DAF. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect, Cat. No.). **Data** – a: DAF.2.1661; b: DAF.1.549; c: DAF.2.1734; d: DAF.6.1095; e: DAF.1.548; f: DAF.3.610; g: DAF.5.1426; h: DAF.8.883; i: DAF.6.1097; j: DAF.6.1103; k: DAF.5.1423; l: DAF.5.1425; m: DAF.2.1730; n: DAF.5.1424; o: DAF.2.1732; p: DAF.2.1832; q: DAF.2.1718; r: DAF.2.1717; s: DAF.3.667.

Form 9A jars. It also occurs on the interior of Form 2C bowls (Fig. 4.4:b) and on a lid and the exterior of Form 5 jars at DAF (Figs 4.7:a and 4.8:b).

Unbounded incision is combined with other forms of applied relief including single rows of nubbins on three sherds directly below the rim (Zone 1), on a neck/shoulder angle and on the body. Two other sherds have incision and relief; a rim with a probable lug or handle attachment and a loose applied disc with a worn 'face' design discussed earlier. Seven rims from Form 3 bowls with complex carinations (i.e. an upper clay strip added to form the rim) have incised designs bounded by the rim and carination with a row of impressions along the carination angle (see Fig. 4.9). The final technique found with unbounded incision is two rows of lip punctations on the top of a Form 9A vessel rim (Fig. 4.12:g).

Design frequencies

Unbounded incised design frequencies are presented by decoration location for each of the sites in Appendix A (Tables A.1 to A.5). Four categories of incision were identified; simple rectilinear lines, chevrons and cross-hatching, short deeply incised slash incision and miscellaneous designs employing curvilinear incision. Sherds with similar designs were grouped together within each of the general categories although no attempt was made to provide motif designations.

Non-intersecting rectilinear incised lines are the most common design category and include isolated and grouped vertical, horizontal and diagonal incisions as well as more complex patterns with multidirectional groups of lines (Tables A.1, A.4 and A.5). The most complex design is a row of incised triangles infilled with oblique incising found on the top of two wide lip rims (Plate 5.1:d, e). These designs are found predominantly on body sherds (Plate 5.2:e, l, m) and also common on curved shoulders of globular jars and the top of wide lip rims (Plate 5.1: b, c, g-i). Lower frequencies occur on necks (Plate 5.2:m, n), carinations and below the rim.

Cross-hatched incision is very common at DAF but only four examples are found at DES (Spriggs 1991a: Plate 3, row 1) and none at DJQ (Tables A.2, A.4 and A.5). Cross-hatching occurs primarily on body sherds and shoulders of Form 9 jars (Plate 5.3:a-f) but also carinations and a single wide lip rim and neck. The most common chevron design is a row of tightly spaced chevrons forming a herringbone pattern (Plates 5.1:f and 5.2:f). Minor chevron designs include one or more rows of single chevrons placed adjacent to one another (Plate 5.2:i, j), groups of opposed chevrons (Plate 5.1:a), rows of connected chevrons forming a zigzag pattern (Plate 5.2:a, c) and a more complex pattern with a row of chevrons placed between parallel lines (Plate 5.3:m, n). Chevrons are found on similar portions of the vessel as cross-hatching.

A distinctive short and deep slash type of incision is used to form designs with rows of unidirectional and multidirectional isolated and grouped lines and several chevron motifs (Table A.3). Examples of a zigzag design similar to that employing regular incision are found in Plate 5.2 (b and k). Slash type incision is a minor technique which is found predominantly on body sherds with lesser amounts on shoulders, carinations, decoration Zones 1 and 2 below the rim including the interior surface and a single example on a relief transverse bar.

The final type of incision is a broad category including all designs with curvilinear elements. Six sherds from this category are found at DAF and single cases occur at DJQ and DES. The most common designs have parallel and intersecting crescents separated by horizontal lines in single cases at DAF and DES (Spriggs 1991a:Plate 3, rows 2 and 4). Other unique designs include a straight line with a row of short intersecting lines enclosed by an oval incised line forming a 'leaf' pattern and the use of curved lines to form the eyes of the Lapita 'face' motif on an applied disc (Fig. 5.3:b).

Vessel form

Bounded incision is found on five vessel forms and definite unbounded incision occurs on at least ten, and probably three additional, forms or variants as shown in Table 4.5. All of the vessel forms with bounded incision except one (Form 7) also have stamping although the two techniques are not commonly found on the same vessel form. Unlike stamping, bounded incision is common on several necked large jar forms (Forms 7 and 8A) where it often covers the entire neck region from the lip downwards, but is less common on shallow unrestricted bowls (Form 2). Lip forms associated with bounded incision are similar to those found with stamping. Bounded incision is dominant on scalloped rims (Lip Form 4) associated with Vessel Form 8A at DJQ and the only technique (other than lip impression) found with this lip form at DAF.

The distribution of unbounded incision includes all of the vessel forms with bounded incision and a number of others. It appears to be most common on the shoulders of Form 9 jars and the top of wide and very wide lip rims (Lip Forms 7 to 9) characteristic of Form 9A vessels. Unbounded incision is also common on unrestricted carinated bowls (Form 3) and is found on all other bowl forms. Two examples occur below the rims of Form 10 small mouthed jars. In terms of sherd type, unbounded incision is the dominant decoration on carinations (45%), neck angles (93%) and body sherds (92.9%) at DAF but of minor importance at the other two sites.

Applied relief

Appliqué is a relatively minor decorative technique at each of the sites with DES having the highest frequency (10.0%) followed by DJQ (9.3%) and DAF (6.4%). These frequencies include relief combined with other techniques. The most common forms of applied relief are strips of clay at DAF and DES and nubbins at DJQ (Tables A.6 to A.9). Other types of relief only occur at DAF and include transverse bars, two applied discs and a plain modelled lug or leg.

The combination of nubbins with stamping, unbounded incision and incision with relief strips has been discussed above. Other combinations are rare and include two cases of nubbins and perforations on Lip Form 5 at DJQ which likely come from stamped vessels, two sherds from DAF with relief strips in association with impressions on carination angles (Fig. 4.10:o) and a rim with vertical relief strips below the lip and a row of alternating perforations and punctations on the lip (Fig. 4.9:c; Plate 5.4:h).

Nearly all sherds with relief strips are from DAF. The strips are primarily linear although a low number of curvilinear examples are found at DAF and DJQ (Tables A.6, A.7 and A.8; Plate 5.4). Both short and long linear strips exist and almost always occur in groups oriented in a single (Plate 5.4:a-d, g-j) or multiple directions (Plate 5.4:e, f). Those with a known orientation are most often horizontal although multidirectional strips, usually opposed diagonals, are nearly as common. Impressions which produce a notched appearance are found on a majority of the relief strip decorated sherds at DAF (55.8%) but not at DJQ or DES (Fig. 4.4:a). Applied relief strips or bands are absent at most Lapita sites but are present in late contexts at Watom where notched strips very similar to those at DAF occur at the SAD locality (Anson 1983:Fig. XII). The majority of linear strips are found on body sherds which appear to be from Form 9 vessels at DAF. Other decoration locations in order of relative importance include the top and edges of rim lips (usually on wide lip rims), Zones 1 and 2 directly below the rim, curved shoulders, necks and above carinations (see Figs. 4.10 and 4.13).

More pronounced linear relief is found in the form of transverse bars, using Mead's (1975) terminology, on a low number of sherds at each site. Nearly all transverse bars are applied at carination angles and the remainder are found below the rim in Zone 1 and 2 and on body sherds. Two transverse bars at DAF were formed by eversion of the origin rim lip and addition of an extra strip of clay above in the same manner as double rims were formed. A unique form of relief found at DAF consists of two long parallel horizontal bands directly below the rim with short coil relief strips suspended vertically between the two strips (Fig. 4.9:a; Plate 5.4:k). Similar vertical coil-shaped raised strips occur on several rims without the horizontal strips (Plate 5.4:m, n; Fig. 4.9:k).

Curvilinear strips are a minor form of applied relief. They are predominantly short and grouped although some are longer and occur singly (Plate 5.4:s). Only two examples (from DJQ) occur outside of DAF. Most are found on body sherds with lesser amounts on the top or exterior of wide lips and a single example on Zone 1 (Table A.6).

Nubbins are a well-documented form of Lapita decoration with a broad temporal and geographic range. All examples of nubbins at the reef sites are circular pieces of clay attached to the vessel surface except for four examples of deep impressions or notching which resulted in the formation of nubbin-shaped relief on body sherds, and a transverse bar at DAF (Plate 5.4:q, r). A majority of the nubbins occur in a single horizontal row (Plate 5.4:o, p) although isolated nubbins are not uncommon and two sherds with vertical nubbin rows occur at DJQ. Most single nubbins recorded are undoubtedly from rows, particularly those with more widely spaced nubbins. DJQ has the highest percentage of nubbins with many examples associated with stamping and found on the top of everted lips (Zone F). Other locations at DJQ and DES include Zone 1 below the rim, necks and neck/shoulder angles, carinations and the vessel body. At DAF most nubbins are found on body sherds but also occur on wide lip margins, Zones 1 and 2 below the rim, neck/shoulder angles and necks, carinations and a strap handle which has a single nubbin.

Although nubbins and relief strips are both represented on eight vessel forms or variants, they are not found together on the same forms. Nubbins are most clearly associated with the rims of Form 2 shallow bowls, particularly at DJQ, while relief strips are common directly below the rims on restricted bowls and jars (Forms 4 and 5). Both types of relief are found on carinated bowls (Form 6). Although both forms of relief appear to be present on jars with inflected contours (necks), it is difficult to establish this with certainty for some vessel forms due to the high frequency of decoration on necks and curved shoulders which were not usually found with intact rims. The presence of applied relief strips on wide lip rims confirms their association with Form 9A vessels.

Impression

Impressions formed by fingers, fingernails and other objects on rim lips are common at each of the reef sites and occur in combination with all other decorative techniques as shown in Table 5.1. Low frequencies of rim lips are notched rather than impressed and this form of decoration is discussed with the carving technique below. Lip impression or notching is least common at DJQ where it occurs on 43.4% of all rims but more frequent on rims at DAF (50.3%) and DES (71.1%). Of all complete rim sherds (i.e. not lip or lower rim fragments), the frequency of sherds decorated with lip impression alone is again lowest at DJQ (31.3%) and considerably higher at DES (59.3%) and DAF (72.7%). Impressed lip rims are common in all areas of DAF. Impressions below the rim, usually found on carinations, are a minor form of decoration at each of the sites (i.e. 0.9% to 3.2%) and occur with relief strips as well as unbounded incision at DAF.

The frequencies by site and location of impressions on and below lips are presented in Tables A.10 to A.13. Lip impressions are categorised primarily by size (width and depth) and the way in which the original lip form was modified. At DAF, paddle-like wide shallow impressions are found primarily on the top of wide horizontal lips and may be a finishing technique rather than decoration although the regularity of execution suggests otherwise. Paddles were also apparently used to produce scalloping along the outer edge of rims, primarily everted Lip Form 11 from Form 9B vessels which have no other decoration. Wide and often relatively deep impressions apparently made with fingers (Plate 5.1:j and k) are often found on the top and edges of wide lip rims but also upper and lower double rims, including a majority of those with lipping on the margins.

Narrow lip impressions often made with fingernails are the dominant form of lip modification at each site and found predominantly on lip margins except at DJQ where more occur on the top of lips. Multiple rows of narrow, long impressions are sometimes found on the top of wide lip rims (Plate 5.1:l-n). Some very narrow lip impressions with the appearance of deep incision as well as pairs of opposed crescent-shaped fingernail impressions are found at DAF and DES. Impressions formed by applying pressure to the exterior or interior edge of lips giving rims a scalloped or wavy appearance when viewed from above are found at each site. These impressions include both discrete and continuous examples and those which displace the opposite vessel surface producing a wavy appearance are designated Lip Form 4. Impressed or notched rims are widespread in Lapita assemblages and tend to be most frequent in late contexts (e.g. Anson 1983:Fig. VIII).

Impressions below the rim are most often found in single horizontal rows on complex and regular carination angles of unrestricted and restricted bowls (Forms 3 and 6) at DAF. These are usually wide finger impressions which often have lipped margins due to clay displacement. Wide impressions are found directly below the rim in Zone 1 and on a few necks and shoulders of jars with inflected contours. Single rows of narrow impressions, most often made with fingernails, occur on carinations, within Zone 1 below the rim and on one neck sherd. Impressions are also found on the margins of four strap handles at DES and one at DAF (Fig. 4.15:b, c, d). Multiple horizontal rows of single or paired fingernail impressions are found on two shoulders and a single body sherd at DAF and on a body sherd and above a carination at DES (Spriggs 1991a:Plate 3, row 2). Similar impressions occur on late Lapita pottery from Watom (Anson 1983:Fig. XI) and the Kreslo Lapita reef site where they are associated with stamping (Specht 1991).

Simple carving

Rice (1987:146) defines simple carving as a process in which clay is cut or gouged from the vessel surface to create a design. This technique is present but rare at each site and includes single rows of v-shaped notches and gouged-out triangles (Tables A.14 to A.16). Triangles with a single orientation occur on the lower rim lips of two incomplete multiple rims at DAF (Fig. 4.2:i, j). One of these is a probable triple rim and the other has vertical relief strips below the rim. A row of shallow triangles typical of Mead's Design Element 8.1 occur on a rim lip at DJQ and the single triangle design recorded from DES is located above a flat base angle with stamping.

The second form of carving is shallow or deep v-shaped notching of rim lips as well as two carination angles and a transverse relief bar at DAF. Lip notching is found predominantly on both upper and lower double rims at each site and often occurs with stamping. Two examples of deep u-shaped impressed lip 'notches' are included in the carving category at DAF due to their similarity in appearance to deep carved notches. The term 'rim or lip notching' as commonly used by Lapita ceramic analysts is broader than the usage employed here in that it often includes both impressed and carved decoration.

Punctation and perforation

These are minor decoration techniques at each of the sites (Tables A.14 to A.16). A majority of punctation occurs on the top of rims in association with stamping, unbounded incision and relief strips with perforation. Lip punctation includes single and double rows and one shallow irregular band. Punctation below the rim at DAF includes a single row on a transverse relief bar and an irregular band in Zone 1 below the rim. Two ground discs with shallow drilled depressions are included in the punctation category. A distinctive form of punctation found on two sherds at DES consists of single rows of deep impressions made with a pointed object into the exterior vessel surface causing the interior surface to protrude in the form of a boss. These occur in Zone 1 below the rim (Fig. 4.3:k) and on one body sherd. A similar form of punctation is found directly below the rim in Lapita assemblages from the Bismarcks on Ambitle (Anson 1983:Fig. X) and at the EKQ site on Mussau Island (Kirch et al. 1991:Fig. 4).

Perforation is somewhat more common than punctation and located primarily on angled Lip Form 5 rims (Zone F) associated with Form 2A and 2B vessels. Lip perforations occur most often in single rows of closely or more widely spaced holes although isolated pairs and single perforations are also found. Isolated single drilled perforations with larger diameters suggestive of suspension holes are present on the rim and in Zone 1 below the rim. Other types of perforations located below the rim include single pairs of holes and single horizontal rows in Zone 1 and on constricted necks and neck/shoulder angles. A unique rim from vessel Form 5 at DAF has an apparently random arrangement of perforations below the rim (Fig. 4.7:c). Perforations also occur on a single strap handle from DAF and nine from DES. They are usually arranged in two parallel rows but an isolated pair and triangular pattern with three perforations were found at DES (Fig. 4.15:b). As previously discussed, perforation is often combined with other decorative techniques including stamping, bounded incision and applied relief nubbins and strips.

Extra-areal decorative comparisons

A general trend towards a reduction in decoration and the range of vessel forms is now widely recognised in both Western and Eastern Lapita pottery sequences (Green 1979; Spriggs 1984). Early assemblages have complex vessel forms and a high percentage of dentate-stamped decoration while late assemblages are often predominantly plainware and dentate-stamping is replaced by incision and lower frequencies of applied relief and impression in some areas (Gosden et al. 1989). Thus the amount and types of decoration on Lapita ceramics can be used as a rough chronological indicator for ordering sites. Dentate-stamping ends everywhere, except possibly New Caledonia, by 2000 years ago. Pottery production carries on into the first few centuries AD in western Polynesia and perhaps as late as AD 800 on Niuatoputapu in Tonga (Kirch 1988c:246). In Island Melanesia, pottery appears to cease at around 2000 BP in southern Vanuatu (Spriggs 1990b) but continues well into the first millennium AD in the Bismarcks (Gosden et al. 1989). Variability in the frequency and type of decoration between contemporaneous Lapita occupation areas at sites in the Bismarcks demonstrates that both spatial differentiation and temporal change must be considered in the interpretation of decoration frequencies (Gosden et al. 1989:572).

Although the specific frequencies for decorated pottery within Lapita assemblages vary widely, there is a clear trend towards reduced decoration over time both within and between sites. At the Natunuku site in Fiji, for example, decoration drops from 40% in the basal layer to 20% in the upper strata (Davidson et al. 1990:135). Roughly one third of all ceramics are decorated at the three Reef-Santa Cruz Lapita sites excavated by Green (1976:261) although the frequency of decorated pottery for the individual sites has not been reported. One of the best documented reductions in decoration occurs at the Reber-Rakival Lapita site on Watom Island where decoration at locality SDI declines from 28% in the basal layer, which dates to between 914 and 770 BC, to 3.8% some 500 years after initial occupation. A reduction in dentate-stamping from 14% to 0.4% accompanies the drop in decoration (Green and Anson 1991:Table 1).

Decorative techniques other than stamping are well-documented in Lapita assemblages and the most common of these is bounded incision which often shares motifs with dentate-stamping. A shift from dentate-stamping to incision over time has been documented for a number of Lapita sites in the Bismarck Archipelago. This has been viewed as a continuous process of stylistic change rather than the advent of an intrusive style by the excavators (Gosden et al. 1989:570; Kirch et al. 1991:151). This is not the case at the Reef-Santa Cruz Lapita sites, as stamping actually increases between the early sites SZ-8 and RF-2 (1200-900 BC) where it ranges from 64 to 69% and the later site RF-6 (800-650 BC) which has 75% stamping. Incision declines from 30-35% to 22% between the early and late sites while other techniques increase slightly from less than 1% to 2.5% (Donovan 1973).

In a review of Lapita, Green (1979) identifies impressing, modelling, applied relief and cut-away relief (excising) as decorative techniques found in addition to stamping and incision on Lapita ceramics. These minor decorative techniques have until recently received relatively little attention comparative to dentate-stamping, which is viewed as the definitive criterion for identifying Lapita assemblages. At the Reef-Santa Cruz Lapita sites, minor decorative techniques include applied relief nubbins (found only on rim lips) and transverse bars, lip perforations associated with dentate-stamping and lip impressions and carving in the form of 'notched' triangles on lips, and excising associated with dentate-stamped motifs (Donovan 1973; Parker 1981). Impressions formed by plain stamps and shell edges or other objects are the sole decoration on 30% of the rims at the RF-2 site (Parker 1981:12).

In the Bismarcks, evidence from late Lapita assemblages on Watom and the Arawes reveal an increase in incision, applied relief and impressed pottery which can be viewed as transitional to post-Lapita industries found on New Britain, New Ireland (Lossu and Lasigi) and Mussau (Gosden et al. 1989:571). The undated Ambitle Island assemblage has sherds with shell impressions, applied relief and punctation (Anson 1983:Fig. X) and the Kreslo Lapita reef site on New Britain has a high frequency of incising (49%) and other techniques (20%) including relief, impressions on and below rims, rim perforation and wide excised grooves (Specht 1991:Table 1).

The reef site assemblages

How do the Lapita reef site assemblages at DJQ, DAF and DES compare with other Lapita sites in terms of decoration? If frequency of decoration and major decorative techniques are used as a means of ordering the sites chronologically, DJQ is clearly the earliest and DAF the latest of the reef assemblages. However, there appear to be three chronologically distinct phases of occupation at DAF reflected by spatially discrete clusters of ceramics on the reef. The collective evidence strongly indicates that the ceramics on the outer reef at the northern end of the site are earliest (Areas 5, 6 and 8) and followed by the southern central reef (Areas 1 to 3) with later occupation of the beach (Areas 9 to 12). Pottery on the inner reef Areas 4 and 7 and the interior portion of Area 8 is derived for the most part from eroding beach deposits.

Early traits exhibited by DJQ include a frequency of decoration similar to that of early Lapita assemblages discussed above (33.7%) and a high frequency of dentate-stamping (56.3%), although this figure is somewhat lower than a number of early Lapita sites. DES (15.3%) and DAF (10.0%) have less than half the frequency of decorated sherds as DJQ and stamping is a minor decorative technique ranging from 12% at DES to only 1.9% at DAF, percentages similar to those for the Watom site between 800 and 300 BC.

As shown in Table 5.2, there is a definite seriation between DJQ and the three occupation areas at DAF from the outer reef to the central reef and beach for frequencies of decoration, dentate-stamping and bounded incision. The frequency of unbounded incision increases in importance, as stamping and bounded incision decreases, from a minor technique at DJQ (2.7%) to 57.6% of the decoration on the beach at DAF (Areas 9 to 12). The DES assemblage did not seriate consistently with DJQ and the DAF areas. For dentate-stamping and unbounded incision, DES falls between DJQ and the outer reef at DAF but for the percentage of decoration and bounded incision, it seriates between the outer and central reef at DAF. The reason for this lack of consistency may be due to the fact that DES is not from the same local area as the other two sites, which is one of the recognised conditions that groups for seriation must meet (Dunnell 1970). Moving from the seriation chronology to estimates of the actual age for each of the reef site assemblages is a matter of speculation but the following date ranges seem to fit best with the evidence presently available:

Site /Area	Frequency (%) Decoration	Dentate Stamping	Bounded Incision	Unbounded Incision
DAF (beach)	5.9	-	-	40.0
DAF (central reef)	8.9	0.4	0.1	57.6
DAF (outer reef)	29.0	7.7	5.9	31.0
DES	15.3	12.0	2.8	9.2
DJQ	33.7	56.3	17.1	2.7

Table 5.2 Frequency seriation of decorative techniques for reef sites and areas.

1. DJQ - 1000 to 800 BC;
2. DES and DAF (outer reef) - 800 to 500 BC;
3. DAF (central reef) - 500 to 300 BC;
4. DAF (beach) - 300 to 100 BC.

Apart from dentate-stamping and incision, the decoration techniques found in the Buka and Nissan reef assemblages most closely resemble late assemblages from the Bismarcks discussed above, particularly those on Watom and the undated Kreslo reef site. Much of the non-stamped decoration at the Buka/Nissan reef sites until recently might have been described as 'non-Lapita' or 'atypical' of Lapita but recent data from the Bismarcks and elsewhere has expanded the range of Lapita decoration to the point where this material is no longer unusual. Despite general similarities with Lapita ceramics in the Bismarcks and elsewhere, there is a distinctiveness to the reef site assemblages that may prove to be characteristic of Lapita in the northern Solomons region.

Although chronological differences may explain much of the intra-site variability at DAF, there is also evidence for functional differences between ceramics spatially across the site. These differences may reflect the presence of spatially discrete activity areas or structures in which different types of pottery were in use (e.g. domestic versus specialised or high-status wares). Evidence from the reef sites indicates that unbounded incision, applied relief and plain impressed rims are common on large necked globular jars associated with cooking or other domestic activities. In contrast, dentate-stamping is most often found on shallow serving bowls and dishes which most likely had specialised non-domestic functions. However, it should be noted that at least 14 of the 16 vessel forms and variants have undecorated examples suggesting multiple functions for a range of vessel types. A concentration of utilitarian vessels occurs on the central southern reef at DAF (Areas 2 and 3) including Form 8B and 9B globular jars, Form 2C flat bottomed plain shallow bowls and modelled legs which may have supported cooking vessels.

LAPITA DESIGN ANALYSIS

Mead was the first to devise a rigorous structural approach for the analysis of Lapita decorative design which attempted 'to reveal the steps and rules by which patterns were constructed' (1975:19) for Fijian pottery. Mead's system was extended by Donovan (1973) in an analysis of large pottery assemblages from three Lapita sites in the Reef-Santa Cruz Islands. Anson (1983) revised the Mead-Donovan system in his analysis of Lapita sites in the Bismarck Archipelago by focusing on the alloform rather than motif level of design structure. Sharp (1988) has attempted to resolve some of the problems of existing approaches to design analysis by developing formal rules for the structure of motifs using a minimal set of design elements employed in their construction. Unlike Mead and Donovan, Anson and Sharp restricted their analysis to dentate-stamped motifs excluding incised and three-dimensional decorative techniques. A detailed review of the history of Lapita design analysis is provided by Green (1990). Although the present design analysis is based primarily on the Mead-Donovan system, Anson's motif categories are employed principally for external comparisons.

Design elements, zone markers and design zones

Mead (1975:28) identified eight two-dimensional design elements used in the construction of Fijian Lapita motifs which were expanded to 17 elements in Donovan's (1973:86) analysis of the Reef-Santa Cruz ceramics. Sharp (1988:Fig. 5.1) increased the number of elements to 25 and substantially revised Donovan's corpus in her re-analysis of Fijian and Reef-Santa Cruz material. All of Mead's original elements are found in the Buka/Nissan reef site assemblages but only three of Donovan's additional elements (DE 11, 14, 16) and three of Sharp's (E 14, 20, 23). Three-dimensional design elements defined by Mead, including nubbins, vertical bars and transverse bars, have been discussed with other forms of applied relief.

The concept of zonation is central to the Lapita perception of design in which vessels were viewed as a space on which transverse bands of bounded decoration could be placed. As defined by Mead (1975), zone markers are design elements which serve both as decoration and boundaries confining designs within a restricted space, thus dividing the design field into characteristic design zones. Two categories of zone markers, general and restricted, were identified by Mead.

General zone markers divide the design field into primary, secondary and tertiary zones and include four types; GZ1-double dentate lines, GZ2-single dentate line, GZ3-single incised line and GZ4-single rubbed line. Donovan (1973) redefined Mead's GZ4, which is absent in the Reef-Santa Cruz and Buka/Nissan assemblages, as a double incised line and this type is designated GZ5 in the present analysis to maintain Mead's original categories. The frequencies of general zone markers in the present analysis are presented by motif category for each site in Appendix A (Tables A.20 to A.31). General zone markers for bounded incision motifs are restricted to GZ3 (Tables A.17 to A.19). GZ2, a single horizontal dentate line, is the most common general zone marker and often occurs both above and below motifs. In the Appendix A tables, totals for double GZ2 markers are presented as a second number following single GZ2 totals.

Restricted zone markers are more elaborate than general zone markers and occur only as primary horizontal boundaries. Two of the three types recorded by Mead (1975:26) are present at the reef sites; RZ1-multiple transverse lines and RZ3-multiple intersecting oblique lines forming a diamond pattern. Donovan (1973:87) recorded an additional two types: RZ4-superimposed crescents and RZ5-a single row of short oblique lines. Frequencies of restricted zone markers for the reef sites are found in Tables A.20 to A.22 and examples are illustrated in Figures 5.2 to 5.5. Nearly all restricted zone markers are bounded by general zone marker GZ2 and DAF is the only site in which incised or plain stamped markers (RZ3, 4 and 5) are present. For RZ4, a distinction was made between loose/widely-spaced (Fig. 5.4:b) and tight/dense markers (Fig. 5.2:c; Fig. 5.5:f). Widely-spaced RZ4 markers are designated as motifs by Donovan (M3.1) and Anson (M35). A variant of RZ5 with s-shaped oblique lines is found on a few sherds at DJQ and DES.

The number of restricted zone markers on individual sherds, as shown in Table 5.3, is most often one although a number of cases have two, often one on the exterior and one on the interior surface (see Fig. 5.4 for examples of RZ3 and RZ4). A few sherds with up to five RZ markers occur. Restricted zone markers are located predominantly on the exterior surface in Zone 1 directly (2 cm) below the rim or farther below in Zone 2 and are also common on interior or interior and exterior surfaces in these zones. The remaining examples are located on necks, above carinations, on body sherds and on a single rim lip.

As discussed, Mead (1975:26) defined a number of design zones into which the design field is rearranged by zone markers. Of Mead's design zones A to H, only one (Zone D) is absent at the reef sites. Only one example of Zone E, in which one of the boundaries is the vessel base, is present – at DES. Zones F and G pertain to locations on lips or transverse bars and frequencies are presented with individual motifs. Definitions of the remaining design zones and their frequencies for exterior and interior surfaces are found in Table 5.3. About one-quarter of the sample at each site has no boundaries between exterior motifs and the most common design zone is A2 in which a series of borders occur below one another. Vertical zone markers found in design zones B and C are relatively uncommon on the exterior and absent on interiors which are less often decorated and have simpler designs, most often restricted zone markers.

	Site DJQ		Site DAF		Site DES		Total Sample	
	n	%	n	%	n	%	n	%
Exterior Design Zone Type								
no border between motifs	23	28.8	11	29.7	-	-	34	28.8
single border with one general zone marker	7	8.7	3	8.1	1	100.0	11	9.3
A1 - single border with upper and lower zone marker	5	6.3	4	10.8	-	-	9	7.6
A2 - series of borders below one another	34	42.5	14	37.8	-	-	48	40.7
B - single border divided by vertical zone markers	4	5.0	2	5.4	-	-	6	5.1
C - series of type B borders below one another	3	3.7	1	2.7	-	-	4	3.4
H - extending from rim downward without lower boundary	4	5.0	2	5.4	-	-	6	5.1
Total	80	100.0	37	100.0	1	100.0	118	100.0
Interior Design Zone Type								
no border between motifs	6	17.1	1	5.0	-	-	7	12.3
single border with one general zone marker	9	25.7	4	20.0	-	-	13	22.8
A1 - single border with upper and lower zone marker	6	17.1	2	10.0	1	50.0	9	15.8
A2 - series of borders below one another	14	40.0	13	65.0	1	50.0	28	49.1
Total	35	100.0	20	100.0	2	100.0	57	100.0
Restricted Zone Markers								
1 RZ marker	48	64.0	33	68.7	11	84.6	92	65.7
2 RZ markers	26	34.7	12	25.0	6	15.4	44	31.4
3 RZ markers	-	-	2	4.2	-	-	2	1.4
4 or 5 RZ markers	1(5RZ)	1.3	1(4RZ)	2.1	-	-	2	1.4
Total	75	100.0	48	100.0	17	100.0	140	100.0
Total Motifs								
1 motif	66	67.3	80	80.0	21	84.0	167	74.9
2 motifs	22	22.5	14	14.0	3	12.0	39	17.5
3 or 4 motifs	10 (3m)	10.2	5(3m) 1(4m)	6.0	1	4.0	16 (3m) 1 (4m)	7.6
Total	98	100.0	100	100.0	25	100.0	223	100.0

Table 5.3 Lapita design zones, restricted zone markers and total motif frequencies.

Anson Motif Designation	DJQ	%	DAF	%	DES	%	Total	%
	Buka/Nissan Motif Occurrence Totals							
2	26	14.5	10	7.8	5	22.7	41	12.4
5	7	3.9	3	2.3	-	-	10	3.0
6	-	-	3	2.3	-	-	3	0.9
15	1	0.6	-	-	-	-	1	0.3
16 (DE 2.2)	2	1.1	-	-	-	-	2	0.6
25	1	0.6	-	-	-	-	1	0.3
35 (RZ 4)	4	2.2	6	4.7	3	13.6	13	3.9
37	1	0.6	-	-	-	-	1	0.3
44	1	0.6	2	1.6	-	-	3	0.9
45	1	0.6	1	0.8	-	-	2	0.6
73	2	1.1	2	1.6	-	-	4	1.2
159	-	-	-	-	1	4.6	1	0.3
160	-	-	1	0.8	-	-	1	0.3
161	1	0.6	1	0.8	-	-	2	0.6
162	-	-	2	1.6	-	-	2	0.6
187 or 188	17	9.5	10	7.8	-	-	27	8.2
191?	1	0.6	-	-	1	4.6	2	0.6
192	2	1.1	-	-	-	-	2	0.6
196	1	0.6	-	-	-	-	1	0.3
206 and 207	1	0.6	1	0.8	-	-	2	0.6
231	-	-	-	-	1	4.6	1	0.3
239?	-	-	1	0.8	-	-	1	0.3
260	-	-	-	-	1	4.6	1	0.3
271 or 274	1	0.6	-	-	-	-	1	0.3
316	2	1.1	-	-	-	-	2	0.6
323	-	-	1	0.8	-	-	1	0.3
370?	2	1.1	1	0.8	-	-	3	0.9
387	-	-	1	0.8	-	-	1	0.3
390	3	1.7	1	0.8	-	-	4	1.2
394	1	0.6	-	-	1	4.6	2	0.6
399?	-	-	1	0.8	-	-	1	0.3
421 (DE 3)	13	7.3	4	3.1	-	-	17	5.2
433	1	0.6	-	-	2	9.1	3	0.9
435 (DE 6)	31	17.3	42	32.6	4	18.2	77	23.3
436 (DE 6.1)	14	7.8	2	1.6	-	-	16	4.9
441 (DE 5)	6	3.4	2	1.6	2	9.1	10	3.0
442?(DE 5)	-	-	-	-	1	4.6	1	0.3
444 (DE 5)	3	1.7	4	3.1	-	-	7	2.1
448 (DE 5)	4	2.2	4	3.1	-	-	8	2.4
463	1	0.6	1	0.8	-	-	2	0.6
464	1	0.6	2	1.6	-	-	3	0.9
469?	1	0.6	1	0.8	-	-	2	0.6
470	1	0.6	-	-	-	-	1	0.3
497 (DE 1.1)	4	2.2	3	2.3	-	-	7	2.1
499	1	0.6	-	-	-	-	1	0.3
New Motifs								
B1	1	0.6	1	0.8	-	-	2	0.6
B2	1	0.6	1	0.8	-	-	2	0.6
B3	-	-	1	0.8	-	-	1	0.3
B4	1	0.6	-	-	-	-	1	0.3
B5	-	-	1	0.8	-	-	1	0.3
B6	-	-	1	0.8	-	-	1	0.3
B7	2	1.1	1	0.8	-	-	3	0.9
B8	1	0.6	1	0.8	-	-	2	0.6
B9	-	-	1	0.8	-	-	1	0.3
B10	12	6.7	8	6.2	-	-	20	6.1
B11	2	1.1	-	-	-	-	2	0.6
Total Motif Occurrence	179	100.0	129	100.0	22	100.0	330	100.0
Motifs Present	41	73.2	37	66.1	11	19.6	56	100.0

Table 5.4 Lapita motif frequencies for the reef sites.

Stamped and incised Lapita motifs

Classification of motifs was made through comparison with motifs illustrated by Mead et al. (1975), Donovan (1973) and Anson (1983). The Mead-Donovan system utilises a different set of motif designations than that of Anson and when possible the motif numbers from both systems were recorded for individual designs during analysis. Sherd frequencies by location for incised and stamped designs including identifiable motifs as well as motif fragments are presented for each of the reef sites in Tables A.17 to A.31. No attempt was made to write out the pattern-making rules for motifs as developed by Mead although descriptions are provided and motifs are organised into categories based on the type and arrangement of design elements.

Using Anson's (1983:Table XII) illustrated table of 516 motifs found in Lapita assemblages from the Bismarck Archipelago to Fiji, a total of 51 definite and five probable motifs was recognised at the three reef sites, including 11 previously unrecorded motifs from DAF and DJQ. The total occurrences of each motif by site are presented in Table 5.4. Due largely to a lower relative frequency of weathered sherds, DAF has a higher number of motif occurrences and motifs than DJQ, which actually has more stamped sherds. DES has much fewer motifs and motif occurrences than either of the other sites. A number of Anson motif designations found at the reef sites are identified as design elements (DE 1-6) and one as a restricted design zone (RZ4) by Mead (1975).

The most common motifs (i.e. greater than 5% of the sample) in order of descending importance are 435, 2, 187/188, 421 and new motif B10. There is a basic unity in design between the sites with little variation in common motif percentages. Common motifs are relatively simple and include oblique lines in M435 (Fig. 5.2:c), a single row of double crescents in M2 (Fig. 5.2:c, d), opposed groups of diagonal/oblique lines as in M187 (Fig. 5.3:d) and single rows of circle stamps (DE3) in M421 (Fig. 5.4:a). Several of these motifs are made with untoothed as well as dentate stamps, such as M2 (Fig. 5.3:e), or are often incised as in M188 and similar motifs (Fig. 5.2:a). A few sherds have combinations of dentate-stamped and incised motifs (Fig. 5.5:b) or dentate and untoothed stamping with incision (Fig. 5.5:f) and sometimes nubbins, perforation and lip notching as well (Fig. 5.3:e, f). As shown in Table 5.3, most sherds (74.9%) have only one motif represented, although a number have two motifs and some have three or four.

New motifs described in Table 5.5 are numbered in sequence from 1 to 11 and given the prefix B for Buka. The first six motifs are similar to alloforms of motifs in the Mead-Donovan system. These include paired incised lines (B1) and discrete paired crescents (B2) similar to M1 (Anson's M2). B3 is a unique fine needlepoint-like dentate-stamped motif with joined triple crescents similar to M2.4 (Fig. 5.3:a). The only other example of such fine stamping occurs in an incomplete crescent motif similar to M1.3 on the top of Lip Form 5 at DJQ (Fig. 4.3:a). Two motifs, B4 and B5, consist of paired connecting or intersecting oblique lines very similar to alloforms of Donovan's M24 and M30 (Fig. 5.5:b). B6 is formed by a combination of DE3 and DE14 using untoothed stamps and occurs on the same sherd as B1 (Fig. 5.5:f). B7 and B8 represent combinations of Donovan's M77.1 and M99.1 while B9 is closest to Anson's M142. The final two motifs represent the only examples of curvilinear

Motif Code	Motif Description	Motif Alloform (Donovan) (n)	GZ No. (n)	Location	DJQ Total (D/I)	DAF Total (D/I)	Sample Total (D/I)
B1	pair of incised wavy lines similar to joined crescents	1	2 (1) 2-2x (1)	(1) body (1) int. zone 1	0/1	0/1	0/2
B2	discrete paired crescents	1(2).6	2 (1) 2-2x (1)	(1) zone 1 (1) int. zone 1	1/0	1/0	2/0
B3	joined triple crescents with DE3 in center	2(2).4	2 (1)	body	-	1/0	1/0
B4	paired oblique lines forming diamond pattern	24	2-2x (1)	body	1/0	-	1/0
B5	row of paired intersecting oblique lines (DE16) forming Xs	30	5-2x (1)	car. angle	-	0/1	0/1
B6	row of paired crescents (DE14) with single circle stamp (DE3) at end	56	2 (1)	body	-	1/0	1/0
B7	group of single vertical lines (DE5) next to group of single vertical crescents (DE1)	-	2 (2)	(1) zone F (1) zone 2 (1) above car.	2/0	1/0	3/0
B8	group of paired vertical lines next to group of paired vertical crescents	-		(2) zone F	1/0	1/0	2/0
B9	pair of vertical lines (DE5) with group of vertical crescents (DE1) on both sides	-		zone F	-	1/0	1/0
B10	concentric curvilinear lines (single or paired) connected by paired lines	-		(3) neck (1) above car. (6) zone 2 (10) body	12/0 (fragment)	8/0 (fragment)	20/0
B11	circle with or without DE3 inside and paired lines radiating outward	-		(2) zone 2	2/0	-	2/0
Total Sherds/Occurrences		-	-	-	19/1	14/2	33/3

Table 5.5 New Lapita motifs and alloforms from reef sites DJQ and DAF. (Code: D/I = Dentate/Incised totals)

designs. B10 actually represents fragments of several motifs which were grouped together on the basis of overall similarities in which concentric curvilinear lines are connected to single or paired short lines giving the appearance of spoked wheels (Fig. 5.5:c). The two examples of B11 are also probably part of larger curvilinear motifs enclosed within horizontal and vertical zone markers. Additional new motifs may be present but could not be confirmed due to their fragmentary nature.

Anson Motif Designation	Buka/Nissan Totals (Dentate/Incised)	Other Lapita Sites (% from Anson 1983: Table XII) Early R/SC RF2,SZ8, SZ45	Late R/SC RF6	Watom	New Caledonia	Vanuatu	Fiji	Ambitle (A) Eloaua (E) Talasea (T)
2	41/0	0.66-2.94	10.80	2.6	0.35	X	X	A2.6
5	10/0	0.33-0.52	1.21	-	-	-	-	-
6	2/1	0.13-0.49	0.40	-	-	-	-	-
15	1/0	-	-	1.2	0.18	-	-	-
16 (DE 2.2)	1/1	-	-	1.2	2.3	-	-	-
25	1/0	0.26	-	-	1.2	-	-	-
35 (RZ 4)	13/0	X	X	2.4	0.53	X	X	-
37	1/0	0.78-4.9	0.40	1.2-2.6	0.35-1.2	-	X	A2.5-3.2 T5.3
44	3/0	0.26-1.32	1.21	-	-	X	-	-
45	2/0	0.99-3.9	6.48	1.2	-	-	-	-
73	3/1	0.16-4.6	1.62	2.4-2.6	1.53	-	-	-
159	0/1	0.13-0.16	-	-	-	X	-	-
160	0/1	0.13-0.16	-	-	-	-	-	-
161	0/2	0.13-0.16	-	-	-	-	-	-
162	2/0	0.16	-	1.2	-	-	-	A1.9-3.2
187 or 188	2/25	1.56-4.9	2.83	-	1.1	-	X	-
191?	1/1	0.33	-	-	-	-	-	-
192	2/0	0.16	-	1.2	3.5	-	-	-
196	1/0	0.65-1.58	-	1.2-9.0	1.8	X	X	A .6
206 and 207	2/0	0.13-0.16	-	-	1.2	-	-	A5.0-6.5 T5.3/E10
231	1/0	0.91-1.96	0.40	-	1.2-1.4	X	X	-
239?	1/0	0.53	-	-	-	-	-	-
260	1/0	0.49-1.96	0.40	-	.7	-	-	A2.5-5.3 T5.3
271 or 274	1/0	0.39-1.32	0.81	-	-	-	-	-
316	2/0	0.33	-	-	-	-	-	-
323	1/0	1.3	-	-	-	-	-	-
370?	0/3	0.39	-	-	-	-	-	-
387	1/0	0.26	-	-	-	-	-	-
390	4/0	0.16	0.40	-	-	-	-	-
394	2/0	0.39	-	-	-	-	-	-
399?	1/0	-	-	-	-	X	-	-
421 (DE 3)	17/0	2.94-26.5	7.69	5.2-9.0	1.2	X	X	A2.5
433	0/3	0.13	-	-	-	-	-	-
435 (DE 6)	11/66	0.26-0.33	-	-	1.1	-	-	-
436 (DE 6.1)	16/0	0.13	-	-	-	X	-	-
441 (DE 5)	9/1	0.82-3.92	1.21	2.6	1.1-3.5	-	-	-
442?(DE 5)	1/0	0.98	-	-	0.53-1.2	-	-	A1.9
444 (DE 5)	7/0	0.13-1.3	0.66	-	0.53	X	X	-
448 (DE 5)	8/0	0.98-2.97	1.21	-	4.7-5.2	X	X	-
463	0/2	0.39-0.49	0.40	-	-	X	-	-
464	2/1	0.16	-	-	-	-	-	-
469?	2/0	0.13	-	-	-	-	-	-
470	1/0	-	0.4	-	-	-	-	-
497 (DE 1.1)	6/1	0.16	-	2.6-3.6	1.2-6.5	-	-	-
499	0/1	0.16	-	-	-	-	-	-
Total Motifs	204/87 294 occurences	371	79	79	135	81	129	A69/T16/ E10
Total Shared Motifs		41	19	13	20	12	9	A8/T3/E1
% of shared motifs for total motifs at reef sites (n=56)		73	34	23	36	21	16	14/5/2

Table 5.6 Lapita motif frequencies from the Buka/Nissan reef sites compared with other Lapita sites.

Of the 56 motifs identified, nine have both incised and stamped examples and nine are restricted to incision (Table 5.6). Incised motifs account for 27.3% (n=90) of the 330 total motif occurrences and occur most often as diagonal lines with or without boundary lines (Tables A.17 to A.19). The majority of incised diagonals are unidirectional and bounded by diagnostic portions of the vessel (i.e. rims and carinations) or a single horizontal line (Anson's M435). Another common incised motif is Anson's M187/188 with multidirectional connecting diagonals. The most complex diagonal incised motif (Anson's M370) has horizontal and vertical boundary lines (Fig. 5.2:b). Bounded diagonal incised motifs are found predominantly on the necks of Vessel Forms 7 and 8 jars at DJQ but more common in Zones 1 and 2 below the rims of bowls at DAF and DES. Some motifs extend from the neck onto the curved shoulders of large jars and a few cases occur above and below carinations.

Other categories of motifs are located on the top of Lip Form 5 (Zone F), the exterior and/or interior surface below the rim in Zones 1 and 2, on necks and curved shoulders, above/below or on carinations, and on body sherds. Circular untoothed stamps (DE3.1) occur most often on body sherds and one example is found on the top of a Form 5 lip. Motifs with crescent stamp design elements are dominant at each site and include single and paired crescents (DE1) oriented horizontally or vertically, vertical crescents combined with vertical lines (DE5) and DE4 opposed crescents (Tables A.23 to A.26). The most common crescent motif is Anson's M2 which is usually found just below the rim interior in Zone 1. Several motifs combine DE3 with horizontal or opposed crescents. Motifs comprised of groups of single or paired short vertical or oblique lines (DE5 or DE6) are found in a variety of locations including Zone 1 and 2 on exterior and interior surfaces (Fig. 5.2:c, d), Zone F on rim lips (Fig. 5.3:f), body sherds (Fig. 5.4:a) and above and below carinations (Fig. 5.5:a, b). Single and paired opposing and intersecting oblique line motifs use DE8 and DE16 to form triangles or Xs (Tables A.27 to A.29).

Complex curvilinear and other motifs are often fragmentary and found only at DJQ and DAF (Tables A.31 to A.32). The curvilinear motifs (B10 and B11) do not match any illustrated by Donovan or Anson and none are complete. Most are located on body sherds or on the exterior in Zone 2 (Fig. 5.5:c) but a few occur on necks and above carinations. The majority of non-curvilinear complex motifs have the appearance of rows of 'houses' or 'shields' such as Anson's M469 (Fig. 5.5:d) comprised of a variety of design elements including horizontal crescents, circle stamps, vertical lines and intersecting diagonals.

Extra-areal Lapita design comparisons

Lapita design analysis has enabled assemblages to be grouped geographically and ordered relative to one another temporally within design regions. Green (1978) was the first to distinguish the design provinces of Western and Eastern Lapita based on differences in motifs between Fiji-Western Polynesia and Vanuatu, New Caledonia, Reef-Santa Cruz and Watom. Anson (1983, 1986) provided additional evidence to support this division and proposed the existence of a Far Western Lapita style represented by three site locations in the Bismarcks (Talasea, Eloaua and Ambitle), which was earlier and more elaborate than the Western Lapita style.

Although the validity of Anson's Far Western Lapita design province has been questioned on the basis of inadequate sample size (Kirch et al. 1987), there is growing support for the reality of a distinctive Lapita style in the Bismarcks (Anson 1987). Based on a review of Lapita radiocarbon dates, Spriggs (1990b:20) argues that Lapita settlement is earlier in the Bismarcks/Far Western area and does not reach the Western Lapita area (i.e. the Solomons) before about 3200 BP. The presence of Western Lapita designs associated with late Lapita occupation on Watom within the Far Western region supports Anson's contention that there is a temporal as well as geographical element distinguishing Western from Far Western Lapita. Spriggs (1993a:187) has renamed Anson's Far Western Lapita as Early Western Lapita in recognition of its chronologically earlier position relative to Western Lapita and this usage is also adopted here.

Spriggs (1991a:239) argues that on Nissan, Early Western style Lapita pottery probably imported from Ambitle is found at excavated sites while Western style pottery from Buka occurs only at the DES reef site. It remains uncertain whether the Early Western style was replaced by Western style pottery or the two styles represent overlapping parallel sequences on Nissan. The restriction of Western style pottery to a reef flat location may indicate that distinctive settlement patterns are associated with each style. The restriction of Sohano style pottery on Nissan to two sherds on the DES reef while Lapita pottery is succeeded by plainwares elsewhere on the island suggests that the separation of sites utilising Buka ceramics from those importing pottery from the Bismarcks was maintained for some time following the Lapita period.

As part of his comparative Lapita design analysis, Anson (1983: Table XII) provides presence/absence data for motifs at the Malo sites in Vanuatu and the Fijian sites of Natunuku and Yanuca in addition to percentage frequencies for motifs from all other assemblages analysed including Talasea, Eloaua, Ambitle, Watom, four Reef-Santa Cruz sites, and Ile des Pins and Site 13 in New Caledonia. Anson's motif frequencies from these sites for motifs found at the Buka/Nissan reef sites are presented in Table 5.6. Early Reef-Santa Cruz sites (RF-2, SZ-8 and SZ-45) are grouped separately from the later RF-6 site based on data from Green (1991a) and the Watom, New Caledonia and Fiji sites are combined to form single regional entities. The early Reef-Santa Cruz sites have the highest number of shared motifs with Buka/Nissan although only M421 (DE3) accounts for more than 5% of the sample at any site. The New Caledonia sites and RF-6 have the next highest number of shared motifs followed by Watom, Vanuatu, Fiji and the three Early Western Lapita sites.

In order to provide a more detailed comparison of motifs from the Buka/Nissan reef sites and sites analysed by Anson (1983), percentages of shared motifs between

Sites (Total/%)	RF-2	SZ-8	SZ-45	RF-6	Watom 6/SAD	NC:Ile des Pins	NC:13	Vanuatu: Malo	Fiji	Ambitle	Talasea: FCR/FCS	Eloaua: ECA
Total Motifs	178	133	60	79	53	46	89	89	107	69	16	10
DJQ (41 motifs)	24/59	25/61	6/15	16/39	12/29	9/22	13/32	9/22	8/20	5/12	2/5	1/2
DAF (37 motifs)	22/59	22/59	5/14	14/38	8/22	5/14	10/27	9/24	6/16	4/11	1/3	1/3
DES (11 motifs)	9/82	8/73	5/45	5/45	3/27	3/27	7/64	4/36	3/27	3/27	1/9	-
Total Buka-Nissan Sample (56 motifs)	31/55	32/57	9/16	19/34	13/23	11/20	16/29	12/21	9/16	8/14	3/5	1/2

Table 5.7 Shared motif percentages for the Buka/Nissan Lapita reef sites and Lapita sites analysed by Anson (1983).

Site	DAF	DES	SZ8	RF6	RF2	SZ45	Watom	NC:Ile des Pins	NC:13	Malo	Fiji Y/N	Ambitle	Talasea	Eloaua
DJQ	0.49	0.17	0.18	0.19	0.13	0.09	0.20	0.17	0.14	0.09	0.07	0.07	0.09	0.06
DAF	1.00	0.11	0.15	0.16	0.12	0.07	0.13	0.09	0.10	0.09	0.05	0.05	0.04	0.05
DES		1.00	0.06	0.06	0.05	0.08	0.06	0.07	0.08	0.04	0.03	0.04	0.06	-
Combined Sample			0.24	0.21	0.16	0.13	0.20	0.19	0.16	0.12	0.08	0.10	0.11	0.05

Table 5.8 Equal Weighting Coefficients (Jaccard) for Buka/Nissan and other Lapita pottery design assemblages. (Code: NC = New Caledonia; Y/N = Yanuca/Natunuku)

each of the reef sites and each of the other site samples were calculated and are found in Table 5.7. The early Reef-Santa Cruz sites RF-2 and SZ-8 have by far the highest percentage of shared motifs with the combined Buka/Nissan sample (55-57%) as well as the individual reef sites. The late RF-6 site ranks third in shared motifs for the entire sample and between second and fourth for the individual reef sites. Surprisingly, the early SZ-45 site shares much fewer motifs (14-16%) with DAF, DJQ and the combined reef site sample although it shares the same number of motifs with DES as RF-6 (45%). This pattern is at odds with motif comparisons made by Anson (1987:Table 1) which show high percentages of shared motifs between RF-2 and the other Reef-Santa Cruz sites.

Another interesting pattern is the relatively high percentage of shared motifs between each of the reef sites and Site 13 (27-64%) compared to the Ile des Pins site in New Caledonia (14-27%) and site locality SAD on Watom (22-29%) which is closer geographically. In fact, SAD shares fewer motifs with DAF and DES than either Site 13 or the Vanuatu sites. As with Watom, the motifs at the Kreslo site belong to the Western Lapita style (Specht 1991:197) and three of the five motifs (using Anson's system) identified are also present in the Buka/Nissan reef assemblages. Despite shared motifs, the curvilinear arrangement of designs at Kreslo is quite distinct from the Buka/Nissan ceramics.

Percentages of shared motifs with Eastern Lapita sites in Fiji are lower than any of the Western Lapita sites analysed with the exception of Iles des Pins. The three Early Western Lapita assemblages from the Bismarcks have the fewest shared motifs (2-14%). This confirms a Western Lapita affiliation for the Buka/Nissan reef sites which is supported by other decoration characteristics including less complex designs and only two examples of fine needlepoint-like dentate-stamped motifs which are characteristic of the Early Western style (Anson 1983, 1986). The fact that Buka/Nissan motifs are more similar to those in the Southeast Solomons than Western Lapita style assemblages in the Bismarcks (i.e. Watom and Kreslo) suggests that Western style motifs within the Early Western region are distinct from those in the northern Solomons and on Nissan.

Additional quantified comparison of motifs to test the validity of associations between assemblages was carried out utilising two coefficients of similarity, Jaccard and Robinson, previously employed in comparative Lapita design analyses (Anson 1983; Best 1984; Green 1979). The equal weighting or Jaccard coefficient is designed for qualitative presence/absence data and counts only agreement scores using the formula $S_j = P/P+M$, where P is the frequency of positive matches (shared motifs) and M is the frequency of mismatches (unshared motifs) (Doran and Hodson 1975:141). Higher coefficients indicate a greater degree of similarity between assemblages. The unequal weighting or Robinson coefficient compares

Site	DAF	DES	SZ8	RF6	RF2	SZ45	Watom: 6/SAD	NC: Ile des Pins	NC: Site 13
DJQ	133	131	43	66	48	25	26	24	27
DAF	200	112	79	48	52	20	20	16	31
DES		200	67	101	120	45	6	23	75

Table 5.9 Unequal Weighting Coefficients (Robinson) for Buka/Nissan and other Lapita pottery design assemblages. (Code: NC = New Caledonia)

assemblages in terms of frequencies rather than simple present/absence data by totalling the percentage differences between defined categories (in this case motifs) for pairs of assemblages (Doran and Hodson 1975:139). The resulting index has a maximum similarity score of 200 and total dissimilarity is zero.

Jaccard and Robinson coefficients for each of the reef sites in relation to one another and the sites analysed by Anson are presented in Tables 5.8 and 5.9. As expected, the highest similarity indexes occur between the reef sites with DJQ and DAF most closely related followed by DJQ and DES. DAF and DES are the least similar in terms of motifs. Both DJQ and DAF appear to be more similar to several Reef-Santa Cruz sites and Watom than DES using the Jaccard coefficient although not with the Robinson coefficient.

As with the percentages of shared motifs between sites, each of the Buka/Nissan sites is most similar to Reef-Santa Cruz assemblages and SZ-45 is the least similar of the sites for both coefficients. Although Watom is closely related to the reef sites in reference to the Jaccard coefficient, this is not the case with the Robinson coefficient which supports the lack of similarity indicated by percentages of shared motifs. The two New Caledonia sites have similar indexes using Jaccard but Site 13 is more similar using Robinson as with the shared motif percentages. Jaccard similarity coefficients are very low for the Vanuatu (Malo), Fiji and Early Western Lapita sites of Ambitle, Talasea and Eloaua. The similarity coefficients generally support the comparisons made between assemblages using percentages of shared motifs. Inconsistencies between the two coefficients are most likely a result of less reliable indices for the Jaccard coefficient due to the use of presence/absence data rather than frequencies. The low number of motifs at DES may also have affected the reliability of comparisons with this site.

6

ANALYSIS OF EXCAVATED CERAMIC ASSEMBLAGES

The primary goal of the pottery analysis discussed in this chapter, which deals with a ceramic sequence spanning more than 2000 years, is to assess the validity of and further refine the ceramic sequence established by Specht (1969, 1972a). This includes a more precise determination of geographical and chronological parameters for each of the pottery styles and an assessment of Specht's interpretations regarding the nature of ceramic change and the mechanisms responsible.

Following a review of the ceramic sequence established by Specht and a discussion of the sampling design and methodology used in the present analysis, the results of analysis are presented for each pottery style and substyle in chronological order from eight excavation locations. The distribution of styles and substyles by site assemblage is presented in Table 6.1. In the following discussions, the styles are grouped into a sequence of five chronological periods for which site deposits were excavated. The initial group includes late Lapita phase Buka style ceramics and the first two substyles of the Sohano style from Sites DJA, DBE, DAF and DKC. This is followed by an examination of the transition from late Sohano style to Hangan style pottery at Site DJW in the second group and later Hangan style pottery from Site DJU and DJO (Areas A and D) in the third group. The final two groups cover transitional Hangan to Malasang and Malasang style pottery from DJO-D and Mararing and Recent style pottery from DBE. In the concluding section, the general results of analysis are summarised and assessed in relation to Specht's original Buka ceramic sequence.

SPECHT'S BUKA CERAMIC SEQUENCE

Specht (1969, 1972a) constructed a sequence of six pottery styles and a number of substyles on Buka between about 500 BC and the ethnographic present based on attributes of decoration, vessel form and paste composition. The identification of paste groups played a major role in pottery classification at the substyle level by orienting the examination of attribute distributions. Chemical characterisation of Specht's paste groups has since been carried out by Summerhayes (1987) for both clay and temper components. Specht (1969:216) readily acknowledges that the establishment of the various styles was 'an essentially subjective process' and that he therefore examined hypotheses concerning relationships between styles in fairly general terms. The dates for each of the styles described below have been adjusted to reflect revisions made as a result of the present study, as discussed in Chapter 3.

Buka style (2500 to 2200 BP)

The earliest of the styles recognised by Specht, Buka style pottery, is characterised by a paste heavily tempered with finely crushed shell (paste 1). Some sherds with less temper (paste 1A) are also included in this style. Unlike the other styles, evidence for slab building is present from some thick sherds. Use of the paddle and anvil finishing technique is well documented. The dominant vessel form is an open bowl and less common forms include restricted bowls and necked vessels with flaring rims. The most common form of decoration is the impression (notching) of rim lips although plain rims are also present. Decoration below the rim lip is limited to rectilinear incision and relief motifs with the exception of two sherds possessing dentate-stamped designs.

Although somewhat guarded in his conclusions due to the limited nature of the evidence recovered from his two site excavations, Specht (1969:257) was convinced that the Buka style was a part of the Lapita pottery tradition. However, he was unable to clearly establish the chronological relationship between the Buka style and subsequent Sohano style. Although the restriction of Buka style sherds to the basal levels of the excavated

Style/Substyle	Site							
	DJA	DBE	DKC	DAF	DJW	DJU	DJO-A	DJO-D
Buka	✓	✓	✓	✓				
Sohano								
plain lip		?	✓					
incised				✓				
incised and relief					✓			
Hangan								
punctate and incised					✓			
punctate and relief					?			
incised and relief						✓	✓	✓
Malasang								
incised						?		✓
comb incised								✓
Mararing	✓	✓		✓	✓	✓		
Recent		✓	✓	✓		✓		

Table 6.1 Distribution of pottery styles and substyles by site.

deposits argued that this style was the earliest, the presence of both styles in the same levels suggested that they could be contemporary aspects of the same tradition or a mixing of two styles of different traditions.

Sohano style (2200 to 1400 BP)

Three substyles of this style were recognised by Specht (Plain Lip, Incised, and Incised and Relief) and are interpreted as representing a process of gradual and continuous change. Evidence of a possible link between the Buka style and earliest Sohano substyle was noted by Specht from the presence of some early shell tempered Sohano style sherds (classified as paste 1A). All of the other paste types had mineral sands and rock fragments as the primary temper component. In the initial substyle, a paste distinguished by its red colour and lamellar structure is dominant (pastes 2 and 2A). In the second substyle, paste 3 is used early with the later addition of pastes 4 and 5 which continue to be utilised until the termination of the Sohano style. Pastes 3 and 4 appear to represent variants of the same temper source while paste 5 is distinguished on the basis of its mica inclusions.

Vessels were made by strip or coil construction with subsequent use of the paddle and anvil technique. The dominant vessel form throughout the style is a bowl with restricted orifice and rim courses are predominantly direct or incurving. Lips are generally symmetrically rounded and there is a shift from parallel and gradually thickened rims to abruptly thickened or braced forms over time.

The earliest Sohano substyle (Plain Lip) was found only at Site DAF on Sohano Island and is characterised by a lack of lip decoration coupled with the dominance of a single row of punctations on the rim exterior. Other decorative techniques include wavy incised lines, applied relief strips and relief knobs. During the Incised substyle, there is a change from plain lips to those decorated with punctate rows and an increase in incised motifs. In the Incised and Relief substyle, notching becomes the principal lip decoration and applied relief knobs and strips and incised pendent triangles are diagnostic. Rare new techniques include circle stamping and cutouts.

Hangan style (1400 to 800 BP)

As with the Sohano style, three substyles of the Hangan style were identified by Specht (Punctate and Incised, Punctate and Relief, and Incised and Relief) although the independence of the first is uncertain and there is a temporal overlap between the final substyle and the following Malasang style. Hangan style pottery is made exclusively of paste 6R which is characterised by a rough surface texture. Pottery construction techniques are the same as for the Sohano style but wall thickness is significantly reduced. Vessel forms are generally vertical-sided to slightly restricted without angles or abrupt changes in direction and have rounded bases. Rims are predominantly direct with simple rounded lips.

Changes between the substyles are primarily decorative although minor changes occur in attributes such as rim course (increased eversion over time), lip form and orifice size. Lip decoration (primarily notching) is common in all substyles but declines in the final one. The decoration of rim interiors with simple incised motifs is an innovation of the Hangan style. Rim interior decoration increases between the first and second substyle with the increase in outcurved rim courses and drops during the final substyle. Distinctions in decoration between the substyles is based on variations in the complexity and organisation of three dominant techniques: incision, relief and punctation, which are often combined in motifs.

Malasang style (800 to 500 BP)

This style is technologically identical to the Hangan style except for the smoothing of interior and exterior surfaces to produce what is termed paste 6S by Specht. Although Specht states that red pigments or slips appear during this style, this was not confirmed by the analysis of pottery from the present study. Three substyles are suggested by Specht (Incised, Early Comb and Late Comb), but the distinctions between them are admittedly imprecise. Vessels are predominantly globular with thicker walls than the Hangan style and have restricted orifices. Rims are usually direct and slightly thickened with simple rounded lips. Outcurved rim courses and everted lips become more common in the final substyle.

There is a major change in decoration from the Hangan style with the appearance of comb incision as a dominant technique. Motifs with regular incision, some of which is curvilinear, are most common in the first substyle and decrease in the latter two. Unlike the Hangan style, incised motifs are generally restricted to a narrow band around the rim rather than extending to the point of maximum vessel diameter. Exterior motifs in the final substyle are bolder and cover a larger area than the earlier substyles. Combinations of comb incision with punctation are a trait of the final substyle which suggest links with the subsequent Mararing style. Rim interior motifs, consisting of simple comb incised bands, reappear in the second substyle and increase in popularity in the final substyle. Plain lips are most common during the first substyle with an increase in lip notching in the two later substyles.

Mararing style (ca. 500 to 300 BP)

As with the preceding style, Mararing style pottery is characterised by smooth surfaced paste 6S and manufactured by strip or coil construction in conjunction with the paddle and anvil technique. No substyles were defined by Specht and much of the pottery was obtained from surface collections. Globular pots with slightly restricted orifices and rounded to pointed bases are typical although direct and unrestricted vessels are also common. A lipped bowl form known ethnographically as *kepa* makes its initial appearance during this style as do thick coil or loop handles whose associated vessel form(s) remain(s) uncertain. Rims are usually parallel with incurved or straight courses and slightly everted lips are typical.

The most distinctive decorative trait of this style is the presence of wavy rows of punctation, short slash incision or shell edge impressions around the rim. Comb incision motifs which are different from those of the Malasang style appear to increase during the later part of this style and anticipate similar motifs in the next style. Bold applied relief bands are also a characteristic feature of the style and are often notched by shells and other objects or combined with incised decoration. Lip decoration in the form of notching and shell edge impressions are common. There are few completely plain vessels.

Recent style (ca. 300 to 0 BP)

Found only in surface collections, this style extends from the late prehistoric or protohistoric period through to the modern pottery industry which was almost completely abandoned by the time Specht made his observations of pottery manufacture on Buka in 1967. The term 'modern' is defined as post-dating the increased spread of European trade goods which took place by around 1885 and pottery of this time is viewed as a possible substyle of the Recent style by Specht. Pottery manufacture was traditionally restricted to the three contiguous villages of Malasang, Hangan and Lonahan on the east coast of Buka.

Recent style pottery is much like the previous two styles in terms of manufacturing technology with use of paste 6S and evidence for strip or coil building. Red slip or pigment was noted on some sherds by Specht. Vessel forms range from unrestricted bowls to vertical sided and restricted pots along with the spouted *kepa*. Bases are rounded to partially flattened and pointed. Rim courses are exclusively direct and a variety of lip forms are found. The upper vessel walls of modern pottery are generally thinner than those of the earlier Recent style.

Comb incision is the dominant decorative technique and is combined with incision in rare instances. Motifs are concentrated in narrow bands extending downward from the rim lip. Many of the designs persist to the present day and the modern industry is distinguished by an emphasis on particular motifs.

CERAMIC ANALYSIS – METHODOLOGY

Previous analysis

Specht's analysis of pottery from Buka was directed at providing a general description of the material for culture historical purposes and inferring a sequence of styles which could be compared with one another. Although he rejected pottery types as too broad to document minor changes through time, Specht's approach reflected a concern for typology typical of the culture-historical approach in North American archaeology of the time (cf. Trigger 1989:202-3). A hierarchy of classificatory units was employed extending downwards from traditions through styles, substyles and finally attributes. In this approach, style was defined as 'the total content and appearance of a pottery industry at selected points of time' and substyles as 'developmental stages within a style' (Specht 1969:64). Although computer-aided analysis was initially considered, it was rejected as unnecessary because 'many of the styles are singularly distinctive and easily-defined by inspection' (Specht 1969:66). However, it should also be kept in mind that computer analysis was a far more daunting proposition at that time than it is today.

The recognition of paste groups, which were assumed to have 'great chronological importance' (Specht 1969:69), was one of the primary elements in Specht's analysis and provided a framework for examining the distribution of attributes. Due to the presumably restricted geographical importance of pastes, they were utilised in the definition of substyles but not styles. The latter were viewed as having more regional validity (Specht 1969:192). Compositional analysis of both temper and clay from the eight paste categories defined by Specht was later carried out by Summerhayes (1987) using the methods discussed in Chapter 4 and the results of this analysis are examined in greater detail below.

Specht (1969:85) recovered more than 67,000 sherds from his two primary site excavations on Buka and Sohano islands in 1967. Approximately 11,000 sherds (16.4% of the total sample) were selected for the identification of paste categories including all diagnostic pottery as well as a sample of plain body sherds from Site DAI.

The ceramic sample

Although providing lengthy pottery sequences, Specht's two primary site deposits posed significant problems in terms of clearly separating and dating pottery styles stratigraphically. In order to rectify this situation, sites with relatively short occupation sequences and a limited number of pottery styles were purposefully chosen for excavation during the present study. Through the identification of pottery styles from surface collections during initial survey, locations where a single style or two sequential styles predominated were selected for test excavation. These deposits were considered to have the most potential for addressing the research questions by representing relatively short periods of occupation during which ceramic change was evident.

A total of 22,768 excavated sherds, weighing in excess of 152 kg, was analysed. The only sherds excluded from analysis were non-diagnostic fragments less than 2 cm in diameter from DJO-D which was justified on the basis of the large sample size from this deposit (7294 sherds). Other sites with large quantities of pottery include DJW (n=5812), DJU (n=4628) and the single test pit from DAF (n=2741). The remaining excavated deposits had less than 1000 sherds each including DJO-A (n=922), DBE (n=908), DKC (n=403) and DJA (n=60).

The initial step in analysis was to separate diagnostic pottery from plain body sherds and provide sherd counts for each excavation unit by excavation level and stratigraphic layer. Non-diagnostic pottery was further sorted into thin and thick categories based on differences in wall thickness which were an important means of separating sherds of particular ceramic styles. Within each of the thickness categories, totals were calculated for both smaller (less than 2 cm maximum diameter) and larger sherds. This enabled the relationship between sherd thickness and size to be examined as well as variability in sherd size distribution between sites. Not surprisingly, a higher percentage of small sherds were thin walled rather than thick at each site. The correlation is most pronounced at DKC where 88.8% (n=79) of the thin sherds are small in comparison with 66.7% (n=14) of thick sherds.

At most of the sites, small sherds predominate in the non-diagnostic sample although there is considerable inter-site variation in terms of percentages. When only thin-walled pottery is considered, the percentage of sherds less than 2 cm in diameter ranges from a low of 30.8% at DBE (n=79) to 50.7% at DJU (n=1785), 79.4% at DJW (n=2288), 83.0% at DAF (n=748) and 88.8% at DKC (n=79). The low frequency at DBE may be explained by less intensive usage of the site and therefore less trampling of discarded pottery due to its less than optimal location inside a dark, wet cave.

Following initial sorting, the 3515 diagnostic sherds recovered from excavations (15.4% of the total pottery sample) were selected for detailed attribute-based computer analysis. Diagnostic sherd types include rims, neck and shoulder angles, and decorated body sherds. Site DJO-D has by far the largest sample of diagnostic sherds (n=1667; 47.2%) followed by DJU (n=751) and DJW (n=511). The remaining sites have less than 250 diagnostic sherds each with only 22 at DKC and six at DJA. Diagnostic ceramics collected from the surface of Sites DJO, DJU, DJW, DJX and DJZ were also included in the analysis.

Attribute selection

The selection of attributes to be included in the analysis of excavated diagnostic sherds followed procedures utilised in the analysis of Lapita ceramics from the reef sites as closely as possible. A number of attributes were also included which had been utilised by Specht in order to maximise comparability with his 1967 material. Some attributes from Specht's analysis were dropped for a variety of reasons. These included various aspects of vessel size and form and the identification of paste categories.

In addition to provenience information, groups of attributes were selected which addressed three broad aspects of ceramic variability: vessel morphology, manufacturing technology and style. Examination of the pottery during initial sorting combined with information from Specht's analysis provided a sufficient degree of familiarity with the sample to select appropriate attributes to be recorded during the analysis.

Attributes were assigned numeric value codes for entry into the database program dBase in the same manner as the reef site pottery and followed by conversion of the dBase files into SPSS/PC+ format for statistical analysis. A list of the attributes recorded is found in Table 6.2 and more detailed descriptions are provided below grouped into more general categories of form, technology and decoration.

Vessel morphology

Four main vessel forms were identified by Specht (1969:75, Fig. IV-1) primarily on the basis of the upper body morphology as reconstructable vessels were rare in the excavated assemblages. Each of the forms is

1	provenience (site, unit, level, layer)
2	sherd type (rim, neck, shoulder, body)
3	surface treatment (textured, anvil or other impressions)
4	rim orientation (everted, vertical, inverted)
5	rim course (outcurved or concave, straight, incurved or convex)
6	lip form (based on categories identified by Specht)
7	estimated rim/orifice diameter (cm)
8	rim percentage (amount of rim represented by rim sherd)
9	rim thickness (mm)
10	body thickness (mm)
11	exterior decoration technique (linear and comb incising, carving, cutouts, impression, punctation, applied relief)
12	lip decoration technique (incising, carving, impression, punctation, applied relief)
13	rim interior decoration technique (linear and comb incising, shell edge impression)
14	exterior motif (based on Specht's coding system)
15	Pottery style (Buka, Sohano, Hangan, Malasang, Mararing, Recent)

Table 6.2 List of attributes recorded in the analysis of excavated post-Lapita ceramics.

simple and evenly contoured with a continuous profile. Bases are rounded to subconical until the Mararing style when pointed conical bases were introduced. The vessel forms include three unrestricted forms with everted (Forms 1 and 2) or vertical rims (Form 3) and a single restricted vessel type (Form 4). Only one additional form, a rare small mouthed jar similar to Lapita vessel Form 10 which appears during the Mararing style (Form 5), was identified during the present analysis. A majority of the forms are represented in the Lapita assemblages although there is significant variation in vessel sizes and rim morphology. Form 1 vessels are strongly everted and generally similar to Lapita Form 2. Form 2 is only slightly everted and closely resembles Lapita Form 1 simple bowls. Form 3 vessels are generally larger pots with thin walls that are not directly comparable to any of the Lapita forms. Form 4 is a highly restricted bowl with two subforms distinguished by lip form. Form 4A has direct or inverted lips and Form 4B lips are everted. Several additional forms are present in the modern Buka pottery industry, although these are less common and have more specialised uses.

Vessel forms are illustrated for each of the styles in the post-Lapita sequence based on reconstructed vessels illustrated by Specht (1969). As with the vessel forms, diagnostic sherd types are more restricted than in the Lapita reef assemblages with no carinations or angled bases identified. Rim sherds were separated into those with intact lips, lip fragments and lower rim fragments without lips. Apart from a limited number of neck and neck to shoulder sherds, the remaining diagnostic sherds are decorated body sherds.

Aspects of rim form provided the most important morphological attributes and include rim orientation, rim course and lip form. All three of these variables were recorded in the same manner as for the Lapita reef site assemblages discussed in Chapter 4. Lip form proved to be highly variable although the significance of this variation is often minimal with a relatively small number of forms accounting for most of the lips. The 40 lip profiles identified are listed in Table 6.3 and grouped within the more general categories of parallel, reduced and expanded or thickened rims. Of the 29 lip forms and 11 subforms defined by Specht, 33 were identified during the present analysis and are indicated by Specht's original lip form codes in parentheses in Table 6.3. Seven previously unrecorded lip forms were identified but grouping of lips by subforms was not attempted and each form received a unique numeric code. A majority of the lip form profiles are illustrated in Figure 6.1 which is largely based on Specht's lip profiles (1969:Fig. IV-7).

Orifice diameters were estimated for rim sherds of sufficient size by use of a template with diameters ranging from 2 to 50 cm in 2 cm increments. Percentages of the total rim represented by rim sherds were also recorded in 5% intervals to judge the reliability of the estimated rim diameters.

Continuous attributes related to vessel form include rim and body thickness measured to the nearest tenth of a millimetre. Rim thickness was recorded at the point of maximum lip expansion or reduction. Body thickness was measured below the point of expansion or reduction on rim sherds and at a point of average thickness on body sherds with intact uneroded surfaces. Rim and body thickness frequencies for each pottery style by site are presented in Table 6.4.

Parallel Rim Profile	
1	flat-sharp edges (3)
2	rounded (2)
3	rounded with narrow channel (2A)
4	sharp bevel, interior (3A)
5	sharp bevel, exterior (3B)
6	rounded interior bevel (6/6A)
7	rounded exterior bevel (8A)
8	interior channel with narrow external lip (17)
9	wide channel with lipping on margins (19)
10	exterior flat face with slight groove below (27)
11	exterior channel with interior pointed lip (17 to interior)
12	everted/ "flanged" (22)
13	everted/"flanged" with pointed lip (23)
Reduced Rim Profile	
14	rounded, gradually reduced
15	pointed (gradual)-dull point (4)
16	pointed (gradual) with narrow channel (4A)
17	pointed (abrupt)-sharp point (5)
18	sharp interior bevel forming point (15)
19	narrow everted point (28/28A)
Expanded/Thickened Rim Profile	
20	rounded - gradually expanded to interior
21	rounded - gradually expanded to exterior
22	rounded - exterior and interior expansion (10/18)
23	rounded - abrupt, massive expansion (20)
24	rounded - interior bracing
25	rounded - exterior bracing (25)
26	rounded - folded to interior (12B)
27	rounded - folded to exterior (16/16A)
28	rounded - interior narrow lip (24)
29	rounded - exterior beaded lip expansion
30	gradually pointed - slight exterior expansion (12)
31	pointed - interior expansion (12)
32	flat - gradually expanded to interior (29?)
33	flat - gradually expanded to exterior
34	flat - exterior and interior expansion (13/13A)
35	flat - interior bracing (12A)
36	flat - exterior bracing
37	flat - interior pointed lip (7/14)
38	flat - exterior bevelled expansion (7 to exterior but expanded)
39	flat - exterior transverse bar below lip (32)

Table 6.3 Rim lip forms recorded on post-Lapita ceramics. (Code: # - Lip form from Specht [1969])

Technology and composition

Attributes related to pottery production and use were limited to non-decorative surface modifications and compositional analysis was restricted to noting the presence of distinctive temper types with chronological significance such as mica and foraminifera. Recording of temper and paste types was not included in the analysis as it was would have been redundant in light of the thorough analyses undertaken by Specht (1969) and Summerhayes (1987) for each of the post-Lapita pottery styles. The minimal amount of variability in mineral sand tempers following the Buka style was also a factor in making this decision.

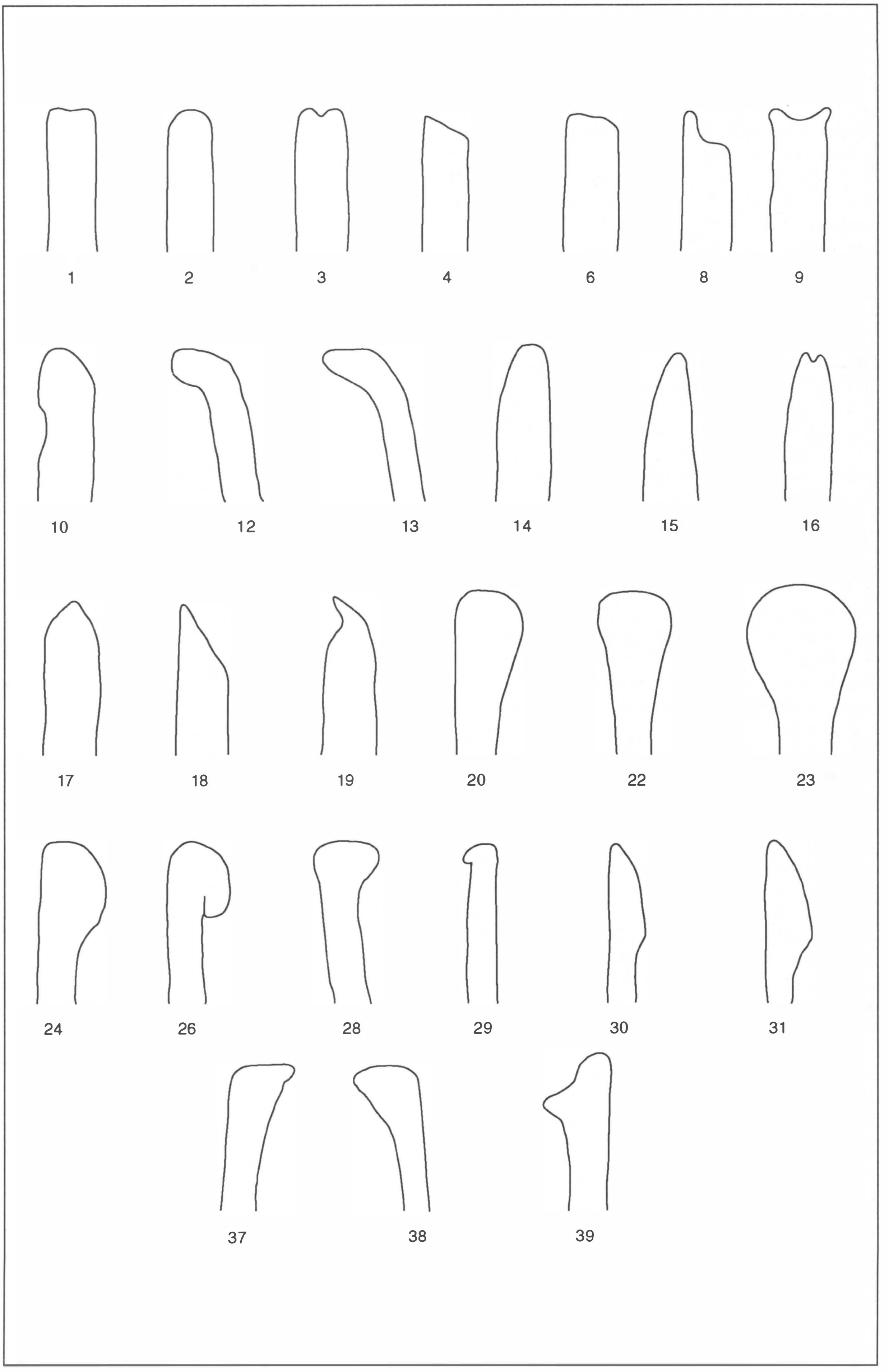


Figure 6.1 Rim lip forms recorded on post-Lapita ceramics (vessel interior to right).

Style/Site	Rim Thickness (mm) n	Range	Mean	sd	Diagnostic (d) and Plain (p) Body Thickness (mm) n	Range	Mean	sd
Buka Style								
DJA	-	-	-	-	39(p)	2.7-7.5	5.04	1.10
DBE	2	9.8-10.0	-	-	9	2.9-5.7	3.60	1.10
DAF	22	3.0-9.0	5.84	2.97	569(p)	1.8-8.2	4.04	1.20
DKC	1	9.8	-	-	20	2.5-4.8	3.86	1.12
Sohano Style								
DKC	10	4.8-11.9	8.16	2.61	296(p)	2.5-8.8	4.17	0.87
DAF	93	5.8-14.8	9.81	1.70	660(p)	3.1-9.5	5.62	1.05
DJW	133	6.8-14.5	10.94	1.55	140(d)	5.0-10.5	7.18	1.25
DJW (transitional)	8	7.2-10.8	8.61	1.19	20(d)	4.4-9.5	7.04	1.23
Hangan Style								
DJW	129	3.8-8.8	6.03	1.24	306(d)	3.0-8.5	4.91	1.04
DJU	326	3.2-9.0	5.58	0.93	729(d)	2.5-7.3	4.37	0.78
DJO-A	84	3.4-8.1	5.32	0.98	175(d)	2.9-7.8	4.56	0.89
DJO-D	174	3.0-8.0	5.32	0.91	374(d)	2.9-8.0	4.60	0.84
Hangan to Malasang Transition								
DJU (surface)	16	4.2-10.5	7.49	1.66	16(d)	4.2-7.3	5.89	0.82
DJO-D	367	3.9-12.2	6.99	1.25	414(d)	3.3-9.2	5.80	0.99
Malasang Style								
DJU (surface)	15	7.5-12.8	9.67	1.37	19(d)	3.9-9.2	7.24	1.60
DJO-D	361	5.2-15.3	8.84	1.76	780(d)	3.7-13.0	7.44	1.38
DJZ (surface)	26	6.9-13.1	9.21	1.45	32(d)	5.5-11.8	8.01	1.45
DJO-D (transitional)	13	6.5-11.7	8.83	1.79	13(d)	5.0-10.5	8.13	1.63
Mararing Style								
DBE	45	6.7-15.0	9.83	2.10	85(d)	5.4-14.1	9.39	1.75
Recent Style								
DBE	24	5.8-12.3	9.14	1.57	42(d)	6.3-13.0	9.33	1.62

Table 6.4 Rim and body sherd thickness (mm) frequencies for pottery from excavated sites.

Single Decoration Technique

1 linear incision
2 comb incision (use of an implement which has multiple points to create groups of parallel striations)
3 carving (removal of clay by a series of cuts to form a design)
4 cutouts (cuts made through vessel wall and clay removed)
5 circular impressions (patterns made with a hollow tube)
6 shell edge impressions (patterns made with the serrated margin of a bivalve)
7 punctation and short slash or jab strokes
8 applied relief:
  strips or bands (notched or plain)
  nubbins/knobs (notched or plain)
  strips combined with nubbins

Combined Decoration Technique

1 linear incision with:
  comb incision
  carving
  circular impressions
  punctation
  applied relief strips or nubbins
  applied relief and cutouts
  applied relief strips and punctation
2 comb incision with:
  shell impressed applied strips
  punctation
3 punctations with:
  carving
  applied relief strips or nubbins
4 applied relief with cutouts

Table 6.5 Decoration techniques recorded on post-Lapita ceramics.

Surface modifications in most instances were produced during the finishing stage of pottery manufacture and include smoothing, wiping and finger or other impressions. Some vessels were also roughly finished with uneven surfaces. Although not quantified, the presence and frequency of anvil impressions on interior surfaces were noted as evidence for use of the paddle and anvil technique in secondary forming of vessels. The use of coils and strips of clay in pottery construction is evident in all styles but slab building has only been recorded on some thicker Buka style ceramics. Isolated drilled perforations interpreted as probable suspension holes were recorded on Sohano and Hangan style rims and also noted by Specht (1969:83).

Decoration

Stylistic attributes were recorded for post-Lapita pottery at levels of description ranging from specific (decorative techniques) to general (style and motif). Decorative technique attributes were recorded separately for vessel exteriors, rim lips and rim interiors as done by Specht, in order to facilitate comparisons between decoration locations. The eight techniques identified during analysis were also noted by Specht (1969:82) and the terminology employed follows Rice (1987:144-8). Both single and combined techniques are listed in Table 6.5.

Lip decoration

Decoration of rim lips is common throughout the Buka ceramic sequence and was recorded as a separate attribute during analysis. Specht (1969:80, Plate IV-8) identified seven major forms of lip decoration and three variants which were referred to as lip modifications. Although categorised somewhat differently in the present analysis, each of Specht's lip modifications are present and one additional technique, linear incision, recorded. Decoration is found on the top as well as exterior and interior lip margins and was often made with the same techniques as exterior motifs. The only two instances of combined techniques are lips with linear incision on the top and impressions on the margins or deep cutout notches with plain impressions. Lip decoration techniques are listed in Table 6.6 with Specht's original lip modification codes (Lm) placed in parentheses to the left of the technique descriptions.

Linear incision is most commonly found on the top of lips and consists of unidirectional and opposing groups of diagonal or vertical lines. Comb incision is found on the top of lips and can be either linear or wavy. Although Specht employs the term 'notching' to cover both plain impressions and notches cut into lips, a distinction was made in the present analysis between plain impressions from fingers, fingernails or other implements and notches cut into the lip surface. Shell edge impressions are distinguished by serrated margins but vary significantly in appearance, from shallow and flat to deep and narrow indentations. The most common form of punctation is a single horizontal row of jab and drag slashes on the exterior lip margin. The only applied relief technique consists of clay attached to the original lip surface to form a wavy 'notched' margin. Although Specht (1969: Plate IV-14) illustrates rim sherds with this form of lip modification, it was not recognised as a distinct type of lip decoration.

	Rim Lip Decoration Technique
1	linear incision (groups of short lines)
	occurs with plain impressions
2	comb incision (wavy or straight) (8)
3	deep cut notches
	occurs with plain impressions
4	plain impressions (deep or shallow) (3,4,7)
5	'pie-crust' impressions or scalloping (5)
6	shell edge impressions (6,6A)
7	punctation (2)
8	applied relief 'notching'
	(#) Lip modification (Lm) code from Specht (1969)
	Rim Interior Decoration Technique/Motif
Linear Incision	
1	crescents - single to triple row (1,2)
2	short slash lines - double or triple row (2,3)
3	diagonal lines - opposing groups (2A,3A,4A)
4	diagonal lines - unidirectional (7)
5	misc. minor motifs including one example with punctation
Comb Incision	
6	wavy comb incision (5/6)
7	single row of horizontal or vertical chevrons
Shell Edge Impressions	
8	single or double row of shallow impressions (7/8)
	(#) Interior Motif (IM) from Specht (1969)

Table 6.6 Rim lip and interior decoration recorded on post-Lapita ceramics.

Rim interior motifs

Decoration also occurs on a restricted area of the interior rim surface directly below, and sometimes on, the lips of Hangan to Recent style vessels. Designs are most often found on vessels with everted lips and outcurved rim courses where both accessibility and visibility are maximal. Specht (1969:81, Plate IV-9) identified eight rim interior motifs with three variants produced by linear incision, comb incision or shell edge impressions. The corpus of motifs was expanded significantly during the present analysis but a coding system such as Specht's was not developed. The principal motifs identified are listed in Table 6.6 by decorative technique with Specht's motif codes (IM) found in parentheses.

Vessel exterior motifs

Specht originally identified 186 motifs on pottery from excavation and surface collections. However, 43 of these motifs were later combined with others leaving 143 motifs and five variants in the final corpus. Due to the high quantity of motifs represented, Specht (1969:Plates IV-10 to IV-21) relied on photographs of sherds rather than providing descriptions of individual designs. In his original classification system, motif code numbers were assigned on an arbitrary basis so that sequential numbers were not necessarily similar in terms of technique or design. According to Specht (1969:83), a 'middle of the road' approach was used in which the number of motifs was restricted by ignoring minor variations in complex designs as well as avoiding overly broad initial groupings which could potentially obscure 'significant motif changes'.

Rather than further complicating matters by adopting a new motif coding system in the present analysis, Specht's codes were followed as closely as possible. This approach had the advantage of enabling direct comparisons with Specht's motif frequencies. During the process of recording motifs, it became apparent that Specht's classification system suffered from a lack of explicit criteria which describe the manner in which design elements are combined to form motifs. Unfortunately, a revision of the existing system was beyond the scope of the present analysis.

A majority of the motifs recognised by Specht (n=86; 60.1%) were also recorded during the present analysis. In addition, 35 new motifs and 58 variants of previously recorded motifs were added to the corpus. In order to limit the number of new motif codes utilised, numeric codes originally assigned by Specht but left unused were reassigned to ten of the new motifs (Motifs 5, 64, 66, 67, 79, 81, 83, 101, 102 and 109). The original corpus of motif codes was also expanded by the addition of 25 new motif codes (M187 to M210). The distribution of new motifs by style includes a single motif for the Sohano style, six motifs for the Hangan style, four motifs for the Hangan to Malasang style transitional pottery, 17 motifs for the Malasang style, two motifs for the Mararing style and five motifs for the Recent style. Descriptions of the new motifs are found in Appendix B.

The remainder of this chapter discusses the results of analysis in terms of attributes related to vessel form, technology and style for each of the six pottery styles identified from excavations.

BUKA TO SOHANO STYLE – SITES DJA, DBE, DKC and DAF

One of the questions unresolved in Specht's ceramic analysis was the nature of the relationship between the late Lapita phase Buka style and subsequent Sohano style. Specht (1969:195) was unable to 'conclusively demonstrate' that the two styles were distinct non-contemporary entities although Buka style sherds were restricted to the basal levels of the excavation at sites DAA and DAI indicating that the Buka style predated Sohano style pottery. Despite the inconclusive nature of his evidence, Specht (1969:307) suggests that the Sohano style represents an entirely new pottery tradition introduced by a population that replaced the producers of Buka style pottery. This view has been challenged by Summerhayes (1987) based on a compositional analysis of Buka and Sohano style pottery. Summerhayes concluded that the same clay sources were used in the manufacture of both pottery styles suggesting continuity between them rather than abrupt replacement by a new ceramic tradition.

Although Sohano style pottery was mixed with Buka style sherds in the same excavation levels at three of the four sites with Buka style pottery (DBE, DKC and DAF), attempts to date these deposits were unsuccessful so the precise temporal relationship between the two styles remains somewhat unclear. The available evidence strongly suggests that production of the two styles overlapped in time but the duration of this overlap is unknown.

Site DJA (Kilu Cave)

As shown in Table 6.7, all but one of the 44 Buka style body sherds recovered from DJA were found in the upper 30 cm of the deposit. Although only one decorated sherd was found (with linear incision), identification of plain body sherds from the Buka style was possible based on the presence of calcareous sand temper which does not occur in later styles. Unfortunately, the Buka phase occupation at DJA remains undated.

Forty of the Buka style sherds were of sufficient size to be included in the analysis. A majority of these (n=32) are relatively densely tempered (30 to 40%) and anvil impressions were noted on the interior surface of five sherds. As shown in Table 6.4, the mean body thickness at DJA is greater than at the other three excavated sites. In general terms, the DJA assemblage is most similar to Lapita pottery from the inner reef and beach at DAF which has a minimal amount of decoration and lacks dentate-stamped designs.

Site DBE (Palandraku Cave)

The small sample of Buka style pottery from DBE, consisting of ten non-diagnostic and three diagnostic sherds, was insufficient to accurately characterise the site assemblage. Due to its shallowness and evidence of disturbance, no attempt was made to date the Buka phase deposit (Layer IV). As indicated in Tables 6.8 and 6.9, the majority of Buka style sherds occur in the Buka phase deposit (Layer IV), but some are also found in the overlying Mararing to Recent phase deposit (Layer III) and basal preceramic deposit (Layer V and VI) where they were displaced by crab burrowing or other disturbance. Evidence for displacement includes the presence of two rim sherds from above and below the Buka phase deposit which could be joined. This rim is from an unrestricted shallow bowl decorated with shallow impressions along the exterior of a gradually expanded flat lip. This vessel form was also recognised in Specht's excavations (Fig. 6.2:a). The only other diagnostic pottery is a 13 mm long miniature coil handle fragment similar to those found in TP 1 at DAF. Although the mean body thickness of Buka style pottery is lower than at the other sites (3.60 mm) (Table 6.4), the sample of nine sherds is insufficient to attach much weight to these results.

Three sherds identified as Sohano style based on attributes of form, composition and decoration were found in the Mararing to Recent phase and preceramic deposits at DBE (Table 6.8). Two of the sherds are rims with direct to slightly inverted orientations and the third is an incurved body sherd from just below the rim. The rims are decorated with single rows of punctation (Motif 3) and the body sherd has an incomplete motif with incised chevrons. Although no Sohano style sherds were found in the Buka phase deposit, their presence at DBE documents a brief period of occupation which

Unit	Level	Decorated Buka Style	Plain Buka Style	Total Buka Style	%	Decorated Mararing Style	Plain Mararing Style	Total Mararing Style	%	Sherd Total	n/m^3
1	1	0	5	5	100	0	0	0	0	5	33
1	2	0	1	1	100	0	0	0	0	1	10
1	5	0	1	1	100	0	0	0	0	1	10
2	1	0	17	17	100	0	0	0	0	17	243
2	2	1	11	12	100	0	0	0	0	12	133
2	3	0	2	2	100	0	0	0	0	2	20
3	1	0	5	5	71	1	1	2	29	7	93
3	2	0	1	1	14	4	2	6	86	7	70
3	3	0	0	0	0	0	8	8	100	8	57
Total		1	43	44	73	5	11	16	27	60	65

Table 6.7 Stratigraphic distribution of pottery by style, Kilu Cave (Site DJA).

probably occurred not long after or may have been contemporary with use of Buka style pottery.

Site DKC (Sohano Island rockshelter)

As the single radiocarbon date from the base of DKC (level 8) with a calibrated age of calBC 2031 (1520) 1009 (ANU-6756) has been rejected as unreliable, the time frame for site occupation remains uncertain. The low number of sherds and overall pottery density (764 sherds/m^3) at DKC together with substantial late historic disturbance in the form of two large pit features, limits the potential interpretive value of the pottery assemblage. Pottery distribution by excavation level and style reveals a concentration of sherds in the uppermost stratum (Layer IA) with a sharp drop below the top 20 cm (see Tables 6.10 and 6.11). Pottery from the disturbed feature fill is noted separately in the tables. Despite the low sample size, the evidence strongly suggests that occupation of the site took place during the period in which both Buka style and Sohano style pottery were in use. A minor amount of intrusive Recent style pottery is also present in the deposit. Non-diagnostic sherds were sorted by style on the basis of temper and paste characteristics.

The 21 diagnostic Buka style sherds from DKC include five decorated examples and a plain outcurved neck angle. A single body sherd with both exterior and interior dentate-stamped designs (including Donovan's Motif 8[2].8) found in excavation level 1 was analysed with the DAF reef ceramics. The remaining decorated sherds include three small body sherds with parallel incised lines and a rim with lip impressions. The rim is from an unrestricted bowl with direct orientation and incurved course. All Buka style sherds come from thin walled vessels with a mean body thickness similar to the DAF and DBE assemblages.

Layer	Buka Style	%	Sohano Style	%	Mararing Style	%	Recent Style	%	Diagnostic Total	%	Sherd Total
I	0	0	1	2	19	40	28	58	48	14	340
II	0	0	0	0	50	69	22	31	72	21	349
III	1	7	1	7	11	73	2	13	14	15	94
IV	0	0	0	0	13	93	1	7	14	12	117
V	1	100	0	0	0	0	0	0	1	33	3
VI	1	33	1	33	0	0	1	33	3	60	5
Total	3	2	3	2	93	61	54	35	152	17	908

Table 6.8 Stratigraphic distribution of diagnostic pottery by style, Palandraku Cave (Site DBE).

Layer	Buka Style	%	Mararing/ Recent Style	%	Plain Total	%	Sherd Total	n/m^3
I	0	0	292	100	292	86	340	576
II	0	0	277	100	277	79	349	1058
III	1	1	79	99	80	85	94	361
IV	7	7	96	93	103	88	117	234
V	2	100	0	0	2	67	3	26
VI	0	0	2	100	2	40	5	15
Total	10	1	746	99	756	83	908	425

Table 6.9 Stratigraphic distribution of plain body sherds by style, Palandraku Cave (Site DBE).

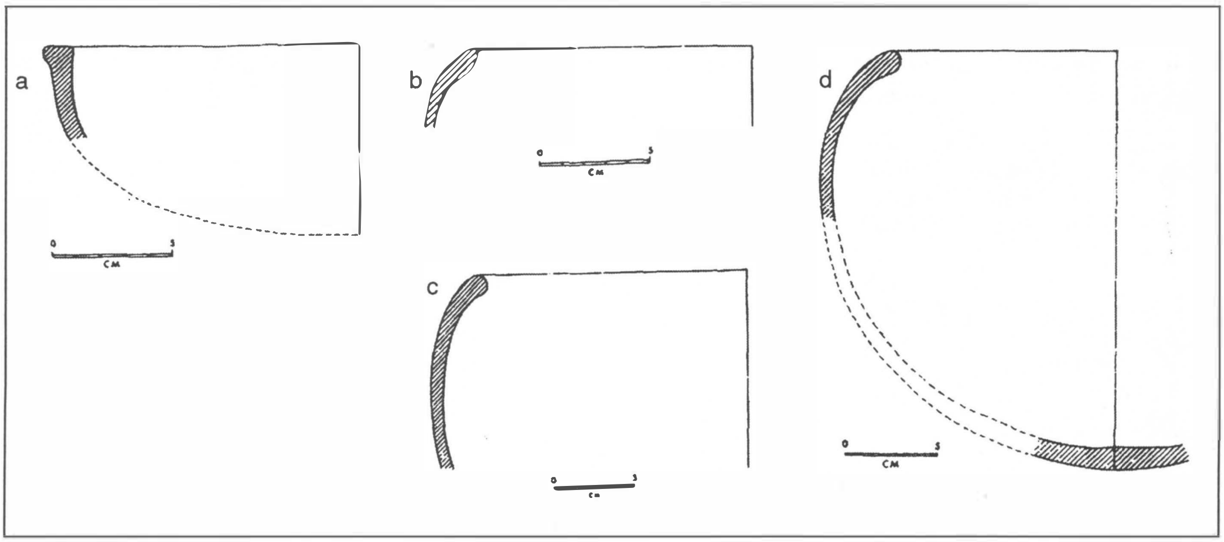


Figure 6.2 Buka (a) and Sohano (b-d) styles: Vessel forms (from Specht 1969:Figs. XI-1, 3, 7, 9).

Sohano style sherds are predominant (n=360; 89.3%) in the DKC assemblage and for each of the excavation levels. The combined attributes of the Sohano assemblage at DKC are characteristic of the early Plain Lip substyle (see Table 6.12). Inverted and incurved rims from restricted vessels with rounded bases are dominant and unrestricted vessels with everted rims absent (see Fig. 6.2). A majority of the rims are parallel and the remainder are gradually expanded. Mean body thickness is slightly higher than for Buka style sherds at 4.17 mm (Table 6.4). This is consistent with Specht's (1969:196) observation that mean body thickness (which averages between 4 and 7 mm) and rim expansion increases over time during the Plain Lip substyle.

Perhaps the most convincing evidence for the early age of the Sohano style assemblage at DKC is the presence of sherds with typical Sohano style vessel form and decoration but calcareous rather than mineral sand temper. Specht noted similar sherds in the Site DAA excavations on Sohano Island which he classified as paste 1A and differentiated from paste 1 on the basis of a lower density of calcareous inclusions. Both pastes occur in the Buka style and low numbers of paste 1A sherds are also associated with the earliest Sohano Plain Lip pottery. Of the five paste 1A Sohano style rims at DKC, three are decorated with punctate motif M3, one with M6 and the third is plain. The presence of early Sohano style sherds with calcareous temper represented obvious problems in the accurate separation of non-diagnostic Buka style pottery on the basis of calcareous temper. Although the number of Sohano style sherds may have been underestimated because of this factor, the frequency of such sherds is likely to be as low as for the diagnostic sample.

Summerhayes' (1987:319) compositional analysis of paste 1A pottery grouped two of the four sherds analysed with paste 2 which is diagnostic of the Sohano Plain Lip substyle and the remaining two with paste 1 Buka style pottery. These results were interpreted as suggesting continuity between the two styles. Microprobe analysis supported these findings by demonstrating that the three clay sources used in the manufacture of Buka style pottery were also utilised for Sohano style vessels (Summerhayes 1987:332).

External decoration on Sohano style sherds is restricted to rims with punctation as indicated in Table 6.13 and Figure 6.3. Nine of the rims have a single row of punctates (M3) just below the rim lip and two of these have an additional punctate row on the lip. Two rims have a double row of punctates below the lip (M6) and one has a previously unrecorded motif consisting of a single row of punctates with a punctate triangle extending below it (M5). The two rims with lip punctation may actually represent M6 as it is difficult to separate punctations on the lip from those slightly below. The characteristic features of the Sohano Plain Lip substyle, which include a lack of lip decoration and the predominance of M3 (Specht 1969:196), are reflected in the DKC assemblage.

Site DAF (Sohano beach test pit)

Sherd frequencies for each of the pottery styles from TP 1 at DAF by excavation level are found in Tables 6.14 and 6.15. A total of 2741 sherds was recovered from TP 1 which has the highest pottery density of any excavated site deposit (4457 sherds/m^3). However, this figure is inflated substantially by an abundance of small sherds. The pottery assemblage consists of similar

Layer	Level	Buka Style	%	Sohano Style	%	Recent Style	%	Diagnostic Total	%	Sherd Total	Total n/m^3
IA	1	5	45	6	55	0	0	11	7	153	1275
IA	2	0	0	3	75	1	25	4	4	110	1100
IB/C	3	0	0	1	100	0	0	1	2	61	610
ID	4	1	25	2	50	1	25	4	14	28	140
IIA	6	0	0	1	100	0	0	1	6	16	140
Feature 1/2	8(D)	0	0	1	100	0	0	1	10	10	-
Total		6	27	14	64	2	9	22	6	378	764

Table 6.10 Stratigraphic distribution of diagnostic pottery by style, Site DKC (Sohano Island).

Layer	Level	Buka	%	Sohano	%	Recent	%	Plain Total	%	Sherd Total	n/m^3
IA	1	6	4	131	92	5	4	142	93	153	1275
IA/B	2	4	4	96	91	6	6	106	96	110	1100
IB/C	3	3	5	51	85	6	10	60	98	61	610
ID	4	0	0	23	96	1	4	24	86	28	280
IIA	5	1	14	6	86	0	0	7	100	7	140
IIA	6	0	0	15	100	0	0	15	94	16	213
Feature 1/2	6	0	0	6	86	1	14	7	100	7	-
Feature 1/2	7	0	0	8	89	1	11	9	100	9	-
Feature 1/2	8	0	0	9	100	0	0	9	90	10	-
Feature 1/2	9	0	0	1	100	0	0	1	100	1	-
IIB	10	1	100	0	0	0	0	1	100	1	20
Total		15	4	346	91	20	5	381	95	403	3638

Table 6.11 Stratigraphic distribution of plain body sherds by style, Site DKC (Sohano Island).

	Site DKC		Site DAF	
	n	%	n	%
Sherd Type				
rim with lip	10	71.4	60	54.1
lip only	1	7.1	25	22.5
rim without lip	3	21.4	12	10.8
Rim Total	14	100.0	97	87.4
decorated body	-	-	14	12.6
Total	14	100.0	111	100.0
Rim Orientation				
direct	2	18.2	9	13.8
inverted	9	81.8	56	86.2
Total	11	100.0	65	100.0
Rim Course				
straight	1	7.1	2	2.5
incurved/convex	13	92.9	78	97.5
Total	14	100.0	80	100.0
Lip Form				
1 - flat-sharp margins	-	-	1	1.1
2 - rounded	3	37.5	8	8.4
3 - rounded with channel	1	12.5	1	1.1
4 - sharp bevel	1	12.5	-	-
Parallel Lip Subtotal	5	62.5	10	10.5
20/21 - rounded, gradual expansion	2	25.0	52	54.7
10 - rounded, abruptly expanded/braced	-	-	4	4.2
32 - flat, gradual expansion	1	12.5	27	28.4
35 - flat, abruptly expanded/braced	-	-	2	2.1
Expanded Lip Subtotal	3	37.5	85	89.5
Total	8	100.0	95	100.0
Estimated Rim Diameter				
18 cm	-	-	1	12.5
20-28 cm	1	50.0	4	50.0
30-36 cm	1	50.0	3	37.5
Total	2	100.0	8	100.0
Mean Rim Diameter (cm)	30.0	-	27.3	-

Table 6.12 Sherd type and rim attribute frequencies for Sohano style diagnostic pottery, Sites DKC and DAF (Sohano Island).

	Site DKC		Site DAF	
	Total	%	Total	%
Exterior Decoration Technique				
linear incision	-	-	13	12.5
linear incision and punctation	-	-	6	5.8
wavy incision	-	-	3	2.9
punctation	13	100.0	81	77.9
applied relief nubbins	-	-	1	1.0
Total Decorated	13	100.0	104	100.0
Lip Decoration Technique				
plain impressions (lip only)	-	-	1	1.5
punctation (single row)	2	100.0	64	98.5
Total Lip Decoration	2	100.0	65	100.0

Table 6.13 Decoration technique frequencies for Sohano style pottery, Sites DKC and DAF (Sohano Island).

amounts of Buka style (n=1012) and Sohano style (n=1696) pottery mixed with a low number of Mararing and Recent style sherds (n=36). A calibrated date of calBP 545 (506) 323 (ANU-6755) from the base of the unit appears to be associated with limited occupation of the site during the Mararing to Recent phases.

The main occupation component at TP 1 spans an undetermined amount of time during production of the Buka and Sohano styles. Sohano style pottery from TP 1 has traits which are typical of the Incised substyle indicating a hiatus in occupation of the site following the Lapita phase. This is also the case with Sohano style

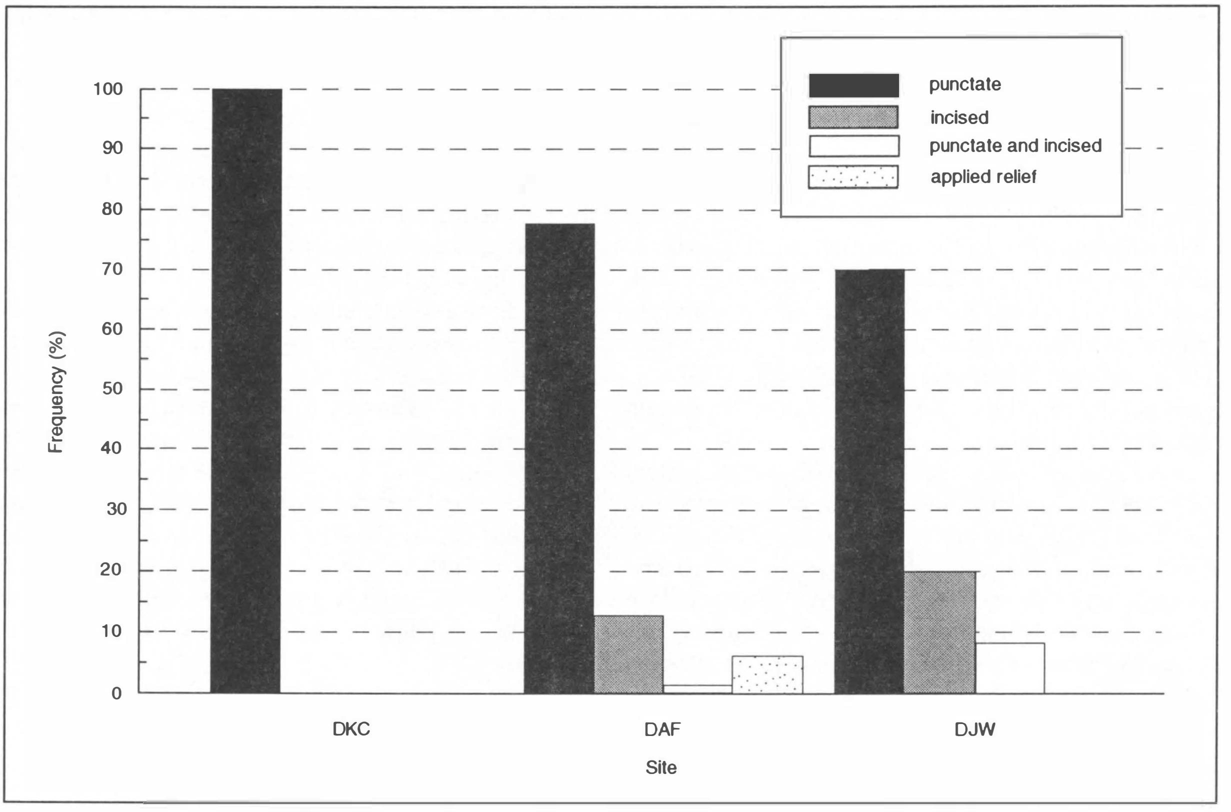


Figure 6.3 Sohano style: Relative frequencies of decoration techniques by site.

Level	Buka Style	%	Sohano Style	%	Mararing Style	%	Recent Style	%	Diagnostic Total	%	Sherd Total	n/m^3
1	11	100	0	0	0	0	0	0	11	9	119	1190
2	18	43	21	50	0	0	3	7	42	7	583	5830
3	16	26	45	74	0	0	0	0	61	10	625	6250
4	3	16	15	79	1	5	0	0	19	8	230	2300
5	20	63	11	34	0	0	1	3	32	8	409	8180
6	12	75	4	25	0	0	0	0	16	8	198	4950
7	11	69	4	25	1	6	0	0	16	11	144	2880
8	13	62	8	38	0	0	0	0	21	11	187	3740
9	7	70	3	30	0	0	0	0	10	4	246	9840
Total	111	49	111	49	2	1	4	2	228	8	2741	4457

Table 6.14 Stratigraphic distribution of diagnostic pottery by style, Site DAF, TP 1 (Sohano Island).

Level	Buka Style	%	Sohano Style	%	(Mica Temper)	Mararing/ Recent	%	Plain Total	%	Sherd Total
1	4	5	73	84	0	10	11	87	73	119
2	193	36	344	64	1	4	1	541	93	583
3	143	25	414	73	7	7	1	564	90	625
4	63	30	148	70	1	0	0	211	92	230
5	160	42	217	58	6	0	0	377	92	409
6	74	41	107	59	4	1	1	182	92	198
7	53	39	80	59	2	3	2	136	94	144
8	89	49	90	49	2	3	2	182	97	187
9	122	52	112	47	6	2	1	236	96	246
Total	901	36	1585	63	29	30	1	2516	92	2741

Table 6.15 Stratigraphic distribution of plain body sherds by style, Site DAF, TP 1 (Sohano Island).

pottery from the reef at DAF. A decrease in the ratio of Buka style to Sohano style sherds was observed between the basal and upper deposit in TP 1. Although this initially suggested a temporal overlap between the Buka and Sohano style ceramics as at DKC, the apparent hiatus in occupation between the Lapita and Sohano phases indicates that mixing of two originally distinct deposits is a more probable explanation. The presence of Mararing and Recent style sherds scattered through the deposit and the late radiocarbon date from the unit supports this interpretation.

The high proportion of Buka style pottery at DAF is due in part to the predominance of sherds less than 2 cm in diameter (n=933; 92.2%). Although the TP 1 sample is large, the number of diagnostic Buka style sherds is fairly low (n=111; 11.0%) and only 66 sherds (6.5%) are decorated. As with the other sites, identification of plain body sherds from Buka style vessels was possible, based on the presence of shell temper in contrast to the mineral sand tempers found in all other pottery styles. The excavated Buka style pottery from DAF was included in the analysis of Lapita ceramics collected from the surface of the site.

Although generally similar to Sohano style pottery from DKC in vessel form given the predominance of restricted vessels with inverted and incurved rims (Form 4A), a range of attributes indicates that the TP 1 assemblage is more characteristic of the Sohano Incised substyle rather than the earlier Plain Lip substyle. As shown in Tables 6.4 and 6.12, these traits include a higher frequency of gradually expanded as opposed to parallel rims and the appearance of braced lips as well as increased mean body and rim thickness. The eight reconstructed Sohano style rim diameters range from 18 to 36 cm with a mean of 27.3 cm.

According to Specht (1969:197), the presence of sherds which have distinctive mica inclusions (recorded as paste 5 by Specht) is a hallmark of the late Sohano Incised substyle when pastes 4 and 5 are added to paste 3, which characterises the early Incised substyle. Although the percentage of mica tempered sherds in TP 1 was low (n=32; 3.2%) they occurred throughout the deposit and include plain and decorated rims and a decorated body sherd (see Table 6.15 for frequencies). Based on microprobe analysis, Summerhayes (1987:332) concluded that paste 3 included two clay sources, while pastes 4 and 5 are made from the same clay sources but have different tempers.

Decorative techniques are also typical of the Sohano Incised substyle including the presence of incised motifs and a single sherd with applied nubbins in addition to punctation, which remains the dominant technique (see Table 6.13 and Fig. 6.3). The percentage of rims with punctate lip decoration also increases dramatically in comparison to the DKC assemblage and this technique is most commonly found with exterior punctation (n=58; 90.6%) plus a few examples of linear and wavy incision. Punctate motif M3 is dominant with much lower numbers of linear incised motifs including chevrons and zigzags (M8, M11, M12) and triangles filled with incised diagonals (M18). Several rims have incised triangles filled with punctations (M19) and three have wavy incision (M7). According to Specht (1969:198), there is a trend toward increased lip punctation in the late Sohano Incised substyle accompanied by a decrease in M3 and rise in incised motifs such as M7.

Discussion

Although handicapped by low sample sizes, disturbed deposits and a lack of reliable radiocarbon dates, the available evidence indicates a temporal overlap in the production of Buka and Sohano style ceramics and a gradual replacement of the former by the latter. At DKC the presence of Sohano pottery with shell temper in the same levels as Buka style sherds demonstrates that aspects of production technology were shared between the two styles. Summerhayes' (1987) compositional analysis also demonstrates that the same clay sources were utilised for both styles.

As discussed in Chapter 5, there is a trend towards reduced decoration and a more limited range of vessel forms over time for Lapita pottery and the Sohano style can be viewed as an extension of this process. Sohano style vessel forms are restricted to pots with simple contours and direct to inverted rims similar to Lapita Vessel Forms 1A and 4 at the reef sites. The limited amount of decoration on early Sohano pottery is also typical of Buka style pottery although punctation, the exclusive Sohano style decorative technique at DKC, is found on only a few Lapita sherds at DAF.

LATE SOHANO TO EARLY HANGAN STYLE – SITE DJW

A transition from Sohano to Hangan style pottery, closely paralleling that described by Specht from his excavations, was documented within the DJW deposit at the south coast of Pororan Island. A calibrated basal date of calBP 1496 (1397) 1330 (Beta-25825) was obtained from TP 1 at this site associated with late Sohano style pottery. With 5812 sherds and 2980 sherds/m^3, DJW ranks second among the site deposits in both absolute sherd quantity and density. In addition to the 492 excavated late Sohano to early Hangan style diagnostic sherds analysed, 252 diagnostic sherds collected from the surface of DJW in the vicinity of the excavation trench were also cursorily examined.

As shown in Tables 6.16 and 6.17, there is a statistically significant shift in the relative frequency of pottery styles for both diagnostic and plain pottery at DJW. For diagnostic sherds this is represented by a change from a predominance of Sohano style pottery in the basal levels, ranging from 89.5% in Layer IIC to 52.4% in level 4 of Layer IIB, to a Hangan style majority of 58.3% in level 3 of Layer IIB and 84.2% in level 1, Layer I. A low number of sherds with traits shared by both styles, interpreted as transitional, were present in all but one of the excavation levels. Plain body sherds from Sohano and Hangan style vessels could also be separated on the basis of differences in paste and wall thickness, although a low number of Mararing style sherds were probably grouped with the plain Sohano style pottery in the upper deposit (Table 6.17). Nineteen diagnostic Mararing style sherds were present in the upper three levels of the site indicating minor occupation of the site during this phase. No significant internal chronological change in attributes was evident for either Sohano or Hangan styles at DJW.

Pottery from DJW is discussed below, beginning with the late Sohano style assemblage and followed by sherds with a mixture of Sohano and Hangan traits and finally Hangan style pottery. The concluding section discusses general characteristics of the transition between the two styles as documented at DJW.

Sohano style pottery

Vessel form and paste

As previously documented by Specht, there is a basic continuity in vessel form and paste between the Sohano Incised substyle and subsequent Incised and Relief substyle to the extent that they should probably be thought of as a single entity (J. Specht, pers. comm.). As shown in Table 6.18, the most notable difference in attributes related to vessel form at DJW compared with earlier Sohano style assemblages is the increase in abundance of inverted incurved rims relative to direct straight rims and the dominance of braced lips (n=76; 58.0%). In contrast, braced lips are absent at DKC and only two occur in TP 1 at DAF. There is also a significant increase in mean rim (10.94 mm) and body (7.18 mm) thickness compared with Sohano style pottery at DAF (Table 6.4). Estimated rim diameters range from 18 to 32 cm with only three rims over 26 cm and a mean of 24.5 cm which is slightly lower than at DAF. The collective attributes fit Specht's (1969:198) description of Sohano Incised and Relief substyle pottery quite closely.

	Count Row Pct Col Pct	Sohano	Hangan	Sohano-Hangan	Row Total
Layer I, 1	1	22.0	139.0	4.0	165.0
		13.3	84.2	2.4	33.5
		14.1	44.1	19.0	
Layer I, 2	2	15.0	54.0	9.0	78.0
		19.2	69.2	11.5	15.9
		9.6	17.1	42.9	
Layer IIB, 1	3	19.0	47.0	1.0	67.0
		28.4	70.1	1.5	13.6
		12.2	14.9	4.8	
Layer IIB, 2	4	26.0	30.0	1.0	57.0
		45.6	52.6	1.8	11.6
		16.7	9.5	4.8	
Layer IIB, 3	5	7.0	14.0	3.0	24.0
		29.2	58.3	12.5	4.9
		4.5	4.4	14.3	
Layer IIB, 4	6	22.0	19.0	1.0	42.0
		52.4	45.2	2.4	8.5
		14.1	6.0	4.8	
Layer IIB, 5	7	28.0	10.0	2.0	40.0
		70.0	25.0	5.0	8.1
		17.9	3.2	9.5	
Layer IIC	8	17.0	2.0		19.0
		89.5	10.5		3.9
		10.9	0.6		
	Column Total	156.0	315.0	21.0	492.0
		31.7	64.0	4.3	100.0

Table 6.16 Stratigraphic distribution of diagnostic Sohano to Hangan style pottery, Site DJW (Pororan Island). (Number of missing observations = 0)

Specht (1969:104, 127) concluded that pastes 3, 4 and 5, which are associated with the Sohano Incised and Incised and Relief substyles, display a basic similarity in attributes. Paste 3 occurs earliest and pastes 4 and 5 were added later. Paste 5, with its distinctive mica temper, is described by Specht as a minor but persistent entity and occurs throughout the DJW deposit in very low quantities (n=14; 0.5%) as at DAF (see Table 6.17). As previously noted, Summerhayes (1987) identified two clay sources for paste 3 but only a single source for pastes 4 and 5.

Decoration

Of the 2576 excavated Sohano style sherds from DJW, 139 (5.4%) are decorated below the rim and an additional seven have lip impressions alone. Decoration appears to be restricted to the upper portion of vessels and most often occurs directly below the lip, with relatively few decorated body sherds (n=17). Five rim sherds with lips, three lower rims without lips and one lip fragment are undecorated and include gradually expanded or braced lips and a single mica tempered sherd.

The most significant changes from early to late Sohano style pottery are in decorative techniques and motifs. As shown in Table 6.19 and Figure 6.3, punctation is the predominant technique (n=97; 69.8%) followed by linear incision (n=29; 20.8%) and a relatively minor amount of applied relief short strips and/or nubbins (n=11; 7.9%). This represents a decrease in the relative frequency of punctation, a slight rise in incision and significant increase in relief from the DAF Sohano style

Layer/ Level	Plain Hangan Style	%	Plain Sohano? Style	%	Plain (Mica Temper)	Plain Total	%	Diagnostic Mararing Style	Diagnostic Total	%	Sherd Total	n/m^3
I/1	998	65	540	35	0	1538	90	12	177	10	1715	8575
I/2	625	72	238	28	1	863	91	5	83	9	946	4730
IIB/3	421	61	270	39	3	691	91	2	69	9	760	3800
IIB/4	374	56	289	44	1	663	92	0	57	8	720	3600
IIB/5	169	43	228	57	0	397	94	0	24	6	421	2105
IIB/6	181	38	291	62	2	472	92	0	42	8	514	2570
IIB/7	80	20	325	80	2	405	91	0	40	9	445	1854
IIC/8-12	33	12	239	88	1	272	93	0	19	7	291	571
Total	2881	54	2420	46	10	5301	91	19	511	9	5812	2980

Table 6.17 Stratigraphic distribution of plain body sherds and diagnostic Mararing style pottery, Site DJW (Pororan Island).

	Sohano Style		Sohano/Hangan Transition		Hangan Style	
	n	%	n	%	n	%
Sherd Type						
rim with lip	119	76.3	7	33.3	117	37.1
lip only	10	6.4	1	4.8	24	7.6
rim without lip	10	6.4	-	-	5	1.6
Rim Total	139	89.1	8	38.1	146	46.3
neck	-	-	-	-	4	1.3
decorated body	17	10.9	13	61.9	165	52.4
Total	156	100.0	21	100.0	315	100.0
Rim Orientation						
direct	4	3.1	1	12.5	84	68.9
inverted	126	96.9	7	87.5	38	31.1
Total	130	100.0	8	100.0	122	100.0
Rim Course						
outcurved/concave	-	-	-	-	21	17.2
straight	2	1.5	-	-	71	58.2
incurved/convex	128	98.5	8	100.0	30	24.6
Total	130	100.0	8	100.0	122	100.0
Lip Form						
1 - flat-sharp margins	2	1.5	-	-	22	17.3
2 - rounded	7	5.3	-	-	58	45.7
4,5,6 - bevelled	-	-	-	-	7	5.5
Parallel Lip Subtotal	9	6.8	-	-	87	68.5
14 - rounded pointed	1	0.8	-	-	1	0.8
15 - gradual dull point	-	-	-	-	1	0.8
19 - narrow everted point	-	-	-	-	5	3.9
Reduced Lip Subtotal	1	0.8	-	-	7	5.5
20,21 - rounded, gradual expansion	19	14.5	3	37.5	30	23.6
24 - rounded, abruptly expanded/braced	40	30.5	1	12.5	-	-
26 - rounded, folded to interior	-	-	-	-	1	0.8
32 - flat, gradual expansion	13	9.9	2	25.0	2	1.6
35/36 - flat, abruptly expanded/braced	36	27.5	-	-	-	-
31 - pointed, gradual expansion	13	9.9	2	25.0	-	-
Expanded Lip Subtotal	121	92.4	8	100.0	33	26.0
Total	131	100.0	8	100.0	127	100.0
Mean Rim Diameter	24.5 (n=17)	-	-	-	18.7 (n=3)	-

Table 6.18 Sherd type and rim attribute frequencies for diagnostic pottery, Site DJW (Pororan Island).

assemblage. Three sherds with wavy incision and one with linear incision and circular impressions were also recovered.

Lip decoration is found on 127 excavated rims and consists primarily of punctation (n=112) with a minor amount of plain impressions both with and without additional decoration. Only two of the rims with intact lips have plain lips and all but two of the rims with punctate exterior motifs have punctate lip decoration. The predominance of punctate lip decoration is somewhat at odds with Specht's observation that notching (i.e. plain impression) is the modal lip modification for the Sohano Incised and Relief substyle (1969:198).

A total of 121 Sohano style diagnostic sherds was collected from the surface of DJW and includes 67 rims with lip decoration only and four with plain impressions, while the remainder are decorated with punctation. Of the 54 sherds with decoration below the lip, linear incision is dominant (n=21; 38.9%), followed by applied relief (n=12; 22.2%) and punctation (n=10; 18.5%). Three sherds have combinations of linear incision and punctation, six have wavy incision and two have circular impressions. Although not classified as decoration, a drilled perforation 3 mm in diameter was present below the lip of a rim collected from the surface and is associated with applied relief nubbins (M22). A plain body sherd with a 6 mm wide perforation was also found near the base of the deposit (TP 2, level 9).

Sixteen decorative motifs previously recorded by Specht and a new variant of M22 were identified on excavated sherds (see Table 6.20). Twelve previously recorded motifs were found on sherds from the surface along with several new variants of M22. Two of these motifs, M19 and M21, were not present in the excavated sample. Incised motifs are the most common and dominated by the triangle motif M18 (n=8; 19.5%) for the

	Sohano Style		Sohano/Hangan Transition		Hangan Style	
	n	%	n	%	n	%
External Decoration Technique						
linear incision	28	20.1	15	83.3	99	32.1
and circular impressions	1	0.7	-	-	-	-
and carving	-	-	-	-	9	2.9
and punctation	-	-	1	5.5	7	2.3
and applied relief	-	-	-	-	46	14.9
Linear Incision Subtotal	29	20.8	16	88.8	161	52.3
wavy incision	2	1.4	-	-	-	-
simple carving	-	-	-	-	4	1.3
punctation	97	69.8	1	5.5	86	27.9
and relief strips	-	-	-	-	13	4.2
Punctation Subtotal	97	69.8	1	5.5	99	32.1
applied relief strips	5	3.6	1	5.5	41	13.3
applied relief nubbins	4	2.8	-	-	3	1.0
relief nubbins and strips	2	1.4	-	-	-	-
Applied Relief Subtotal	11	7.9	1	5.5	44	14.3
Total	139	100.0	18	100.0	308	100.0
Lip Decoration Technique						
linear incision and impressions	-	-	-	-	1	1.0
plain impressions with exterior motif	8	6.3	5	62.5	94	92.1
lip impressions only	7	5.5	3	37.5	2	2.0
Impression Subtotal	15	11.8	8	100.0	97	95.1
punctation (single row)	112	88.2	-	-	1	1.0
applied relief 'notching'	-	-	-	-	4	3.9
Total Lip Decoration	127	100.0	8	100.0	102	100.0
Rim Interior Motifs						
incised crescent row	-	-	-	-	1	50.0
incised short slash rows	-	-	-	-	1	50.0
Total Interior Motifs	-	-	-	-	2	100.0

Table 6.19 Decoration technique frequencies for excavated pottery, Site DJW (Pororan Island).

excavated assemblage and horizontal chevron motif M11 (n=8; 14.8%) for the surface collection. Motif M22, which has rows of relief nubbins or knobs, is also important with eight excavated examples and seven from the surface. Specht's (1969:199) observation that a shift from relief motifs to incised decoration (especially triangle motifs) took place over time within the Sohano Incised and Relief substyle is supported by the DJW evidence. Although punctate motif M3 is still somewhat common with four examples from excavation and seven from the surface, it is clearly less important than in the earlier Sohano style assemblages. However, lip punctation increases markedly. Specht (1969:110) also noted this trend and stated that M3 may be ancestral to punctate lip decoration. Two examples of the circular impression motif M14, previously identified by Specht on late Sohano style pottery, were found on the surface and one example combined with incised motif M14 in the deposit.

Transitional pottery

A number of sherds from the DJW deposit (n=21) and surface collection (n=7) display attributes of form and decoration common to both Sohano and Hangan style pottery. Although initial recognition of these sherds was based on subjective criteria, subsequent quantitative analysis revealed attribute frequencies with transitional characteristics. The high percentage of decorated body sherds in this sample is more characteristic of Hangan than Sohano style pottery but rim forms are typical of the Sohano style with inverted orientations, incurved courses, and gradually expanded lips. Mean rim thickness (8.61 mm) is midway between the Sohano and Hangan style assemblages while mean body thickness (7.04 mm) is only slightly less than the Sohano style but significantly higher than the Hangan style assemblage (Table 6.4).

The predominance of linear incision on the transitional ceramics, including all of the body sherds and four rims, is most like the Hangan style assemblage. Single examples of applied curvilinear relief (M24), incised triangles filled with punctation (M19) and punctate decoration also occur. The other three motifs identified are vertical and/or horizontal incised chevrons (M11, 17, 61). Two motifs were shared by Sohano and Hangan style vessels, two restricted to Sohano style pottery, and one was only found on Hangan style sherds. Although grouped with Hangan style pottery, a number of rims with a combination of incised (M11, 17) and carved (M48, 49, 73) motifs are more similar to the Sohano style in terms of form. Specht places the initial occurrence of carved motifs within the Hangan Punctate and Relief substyle.

Motif	Sohano Style		Transitional		Hangan Style	
	n	%	n	%	n	%
Linear Incision						
8,9,10	6	14.5	-	-	-	-
11	1	2.4	1	12.5	3	1.9
12	-	-	-	-	6	3.8
13,15	1	2.4	-	-	2	1.3
17	-	-	4	50.0	4	2.5
18	8	19.5	-	-	2	1.3
55	3	7.3	-	-	15	9.4
61	1	2.4	1	12.5	-	-
62	-	-	-	-	1	0.6
65	1	2.4	-	-	-	-
wavy incision (M7)	3	7.3	-	-	-	-
Incision and Punctation						
19	-	-	1	12.5	2	1.3
31,33	-	-	-	-	2	1.3
Incision and Relief						
42	-	-	-	-	2	1.3
44	-	-	-	-	35	21.9
12/47	-	-	-	-	1	0.6
Incision and Carving						
48	-	-	-	-	2	1.3
49	-	-	-	-	4	2.5
49/11	-	-	-	-	2	1.3
73	-	-	-	-	4	2.5
incision and circular impression (M17/14)	1	2.4	-	-	-	-
Punctation						
3	4	9.8	-	-	1	0.6
4	1	2.4	-	-	-	-
6	-	-	-	-	27	17.0
26	-	-	-	-	1	0.6
35	-	-	-	-	14	8.8
Applied Relief						
22	8	19.5	-	-	1	0.6
24	3	7.3	1	12.5	-	-
36	-	-	-	-	2	1.3
47	-	-	-	-	13	8.2
71	-	-	-	-	4	2.5
Punctate and Relief						
34,80,45 (with incision)	-	-	-	-	9	6.7
Total	41	100.0	8	100.0	159	100.0

Table 6.20 Exterior motif frequencies for excavated pottery, Site DJW (Pororan Island).

Hangan style pottery

Pottery characteristic of the Hangan Punctate and Incised substyle is dominant in the upper portion of the DJW deposit and also common on the site surface. Specht states that this substyle 'seems to bridge the gap between the Sohano Incised and Relief substyle and the main stage of the Hangan style' (1969:201). Of the 2881 Hangan style sherds excavated at DJW, a majority of the 315 diagnostic sherds analysed are decorated body sherds rather than rims (Table 6.18). Hangan style sherds collected from the surface of the site (n=117) were also examined but not included in the computer analysis.

Vessel form and paste

There is a notable change in vessel form from markedly restricted Form 4A Sohano style pots (Fig. 6.2) to more gradually restricted Form 4 (Fig. 6.4:a), unrestricted Form 2 (Fig. 6.4:c) and vertical Form 3 (Fig. 6.4:b) Hangan Punctate and Relief substyle vessels. Most Hangan rim courses are straight with significantly fewer incurved and outcurved examples. Outcurved rim courses and the presence of a few restricted lower rim or neck angles signal the appearance of slightly inflected vessel contours (Form 4B) not found during the Sohano style. Although inflected pots are present, the majority of vessels have straight sides and rounded bases. Most lips are round or flat and come from parallel rims. No braced lips occur but gradually expanded rim lips are common and a few pointed lips are present.

Due to the small size of most rim sherds, only three orifice diameters could be reconstructed (Table 6.18), ranging from 16 to 24 cm. Specht (1969:200) recorded orifice diameters ranging from 18 to 46 cm with means of 25 to 28 cm in the Punctate and Incised substyle. Mean

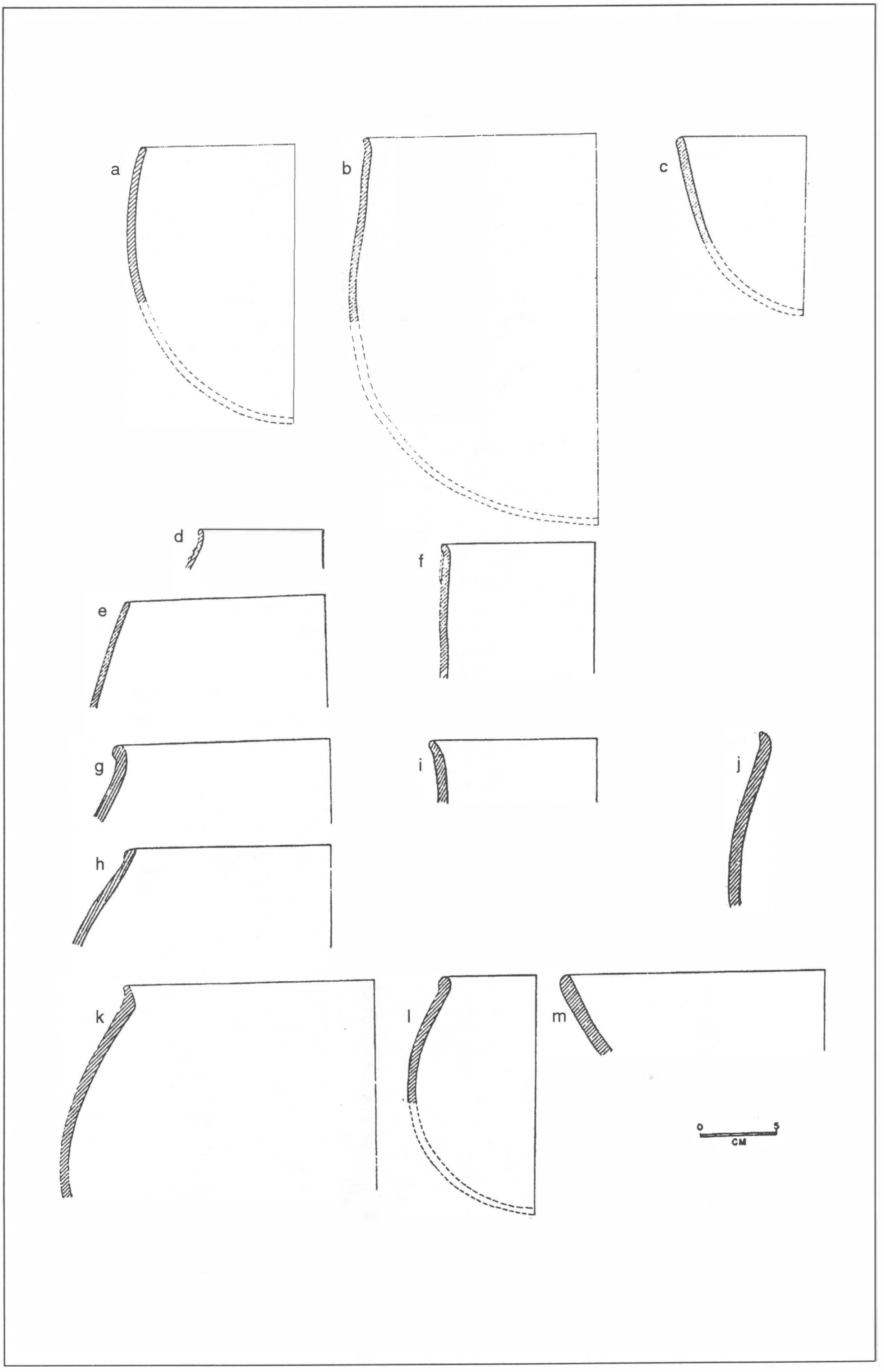


Figure 6.4 Hangan (a-f) and Malasang (g-m) styles: Vessel forms (from Specht 1969:Figs XI-16, 21, 27, 32, 34).

rim (6.03 mm) and body (4.91 mm) thickness are significantly lower than for Sohano style pottery and close to the later Hangan style assemblages (Table 6.4).

Unlike Sohano style pottery, anvil impressions are found on the interior of most sherds indicating the use of the paddle and anvil technique in vessel construction. According to Specht (1969:199-200), Hangan style pottery is made from paste 6R which is distinguished by a rough and 'sandy' surface in contrast to the smooth surfaces which characterise paste 6S and typify Malasang style pottery. Summerhayes' (1987) microprobe analysis of paste 6R sherds indicates that a single clay source was utilised which is the same as for paste 3 Sohano style pottery from DAA. The collective compositional evidence reveals a considerable degree of uniformity in both clay and temper sources over the more than six hundred years during which Hangan style vessels were being produced.

Decoration

No undecorated rims with intact lips were found although four plain lip fragments and a plain rim without a lip were recovered during excavation. The frequencies of decorative techniques are listed in Table 6.19 and illustrated in Figure 6.5. Linear incision is the most common decorative technique (n=161; 52.3%) and was often found in combination with applied relief and carving or punctation in a few cases. Punctation is second in importance (n=106; 34.4%) and occurs most often as multiple strips or bands which are combined with relief strips in a number of cases. Applied relief is almost as important as punctation (n=103; 33.4%) and, with the exception of three sherds with nubbins, consists of linear strips or bands most often associated with incision. Notched relief strips occur on 15 sherds but were not treated as a distinct technique. The final technique recorded was carving consisting of triangles or rectangles usually associated with incision. Percentage frequencies of decorative techniques for Hangan style sherds from the surface are similar to the excavated sample with incision most common (44.5%), followed by punctation (39.4%), applied relief (26.5%) and carving (7.7%).

Lip decoration consists almost exclusively of shallow or deep plain impressions (i.e. notching). Other techniques include single examples of punctation and incised chevrons found on the top of a channelled lip and combined with lip edge impressions and punctate motif M35. Although not classified as such by Specht, the addition of clay to original lip surfaces creating a wavy appearance was included with lip decoration and occurs on four rims with incised motif M55. Two excavated rims and eight from the surface collection are undecorated except for lip impressions. Lip impressions are also found on 67.6% of the 135 excavated rims with lips that have exterior decoration. The percentage of rims with lip impression and additional decoration from the site surface is substantially higher (n=74; 88.1%). Incised motifs occur on the interior surface of two excavated outcurved rims and include a single row of crescents (Specht's IM1) and double row of short slashes (Specht's IM2). One of the rims has lip impressions and both are decorated with punctate designs including M35. Three examples of each internal motif also occur on rims collected from the surface with lip impressions and exterior motifs M34, M35, M45 and M71.

Of the 37 Hangan style motifs present at DJW, 28 occur on sherds from excavation and 29 from the surface

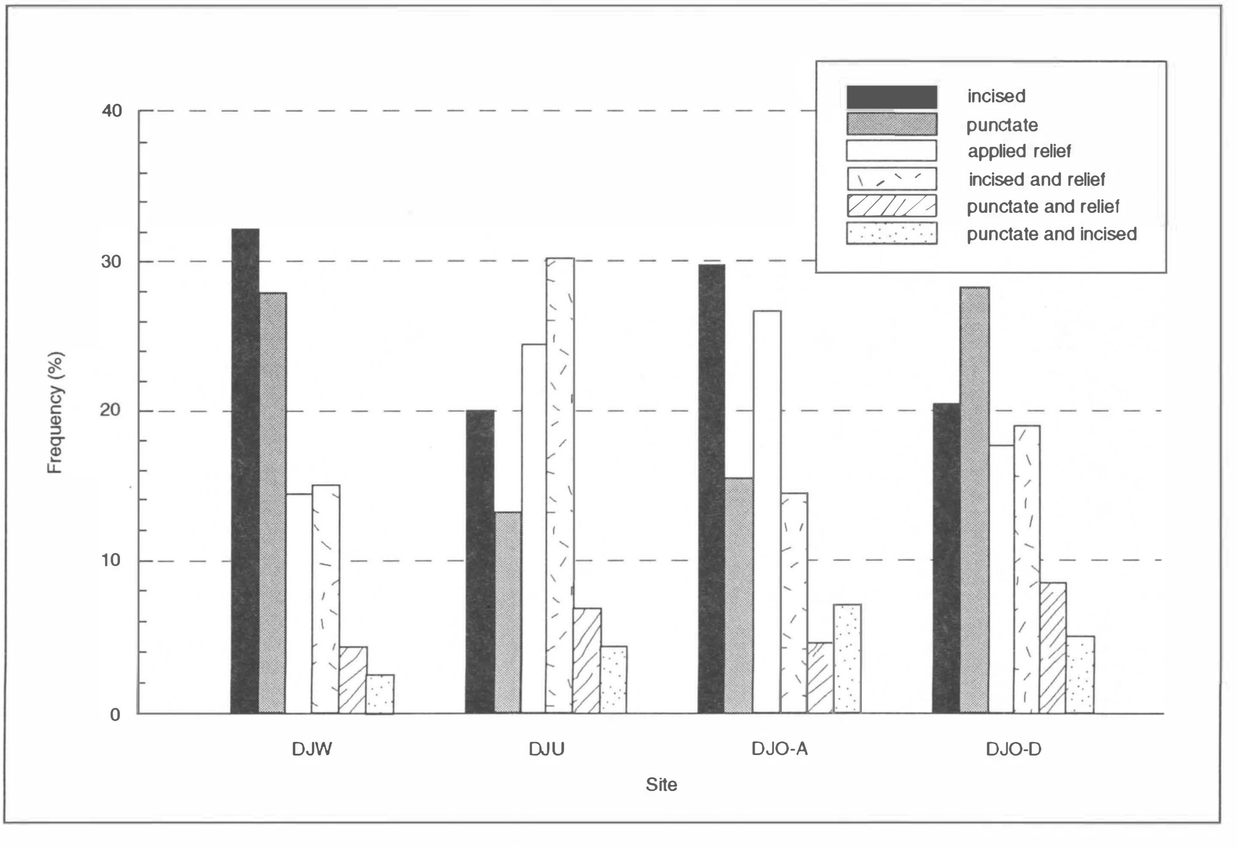


Figure 6.5 Hangan style: Relative frequencies of decoration techniques by site.

collection with 21 shared motifs between the two samples. Motifs restricted to the surface sample include incision both alone (M27, M52, M57 and M61) and combined with punctation (M32 and M77) or relief (M43). Only six motifs are shared with the Sohano style assemblage from DJW and all but one of these motifs decrease in importance over time. Two of the shared motifs, M18 and M22, are dominant in the Sohano style. Although no new motifs were recognised, additional variants of three motifs from excavation (M3, M15 and M45) and four from the surface (M43, M48, M61 and M71) occur.

A majority of the motifs from excavation are incised or combine incision with punctation, relief strips or carving (Table 6.20). The most important motif from the deposit is M44 which consists of horizontal relief strips with parallel incised lines between them. Other common motifs include two (M6) or more (M35) rows of punctates, a single row of short vertical incised lines (M55) and pairs of horizontal relief strips (M47). These motifs are also the most common in the surface collection with M6 (n=18; 17.3%) and M44 (n=13; 12.5%) co-dominant. Additional motifs accounting for more than 5% (n=6) of the total sample include M17, M34 and M48.

Specht (1969:123) found that M6 was the most common motif during the Hangan Punctate and Incised substyle representing from 58% to 68% of the sample with identifiable motifs in the layers where it was present at Site DAI. Triangle motifs M18 and M19 were also important and motifs M34, M35 and M36 increased in importance over time to become dominant in the subsequent Punctate and Relief substyle. Although nearly all of the motifs recognised by Specht from the Hangan Punctate and Incised substyle occur at DJW and similar motifs are common, a number of Specht's minor motifs are more important at DJW. One example is the high frequency of M44 and M55, which Specht associated with the later Hangan Incised and Relief substyle. The restriction of M44 to the upper three excavation levels, with 68.6% in the uppermost level, combined with its importance in the surface collection suggest the potential mixing with pottery from limited occupation later in the Hangan phase. The lack of radiocarbon dates from the upper DJW deposit makes it difficult to determine precisely when the main occupation phase ended. Another contrast with Specht's Site DAI Hangan style assemblage is the lower percentage of impressed lips at DJW. At DAI notching declines over time but never drops below 83.0% (Specht 1969:120).

Discussion

The DJW site provided an excellent opportunity to examine the transition from Sohano to Hangan style pottery within a deposit representing a relatively brief period of occupation. This eliminated much of the difficulty in documenting subtle changes in ceramic attributes over short periods of time which occurs within site deposits with long sequences and numerous pottery styles. Although there was some intrusive late Hangan and Mararing style pottery in the upper portion of the DJW deposit, disturbance appeared to be minimal apart from some relatively minor displacement of material by crab burrowing activity.

A gradual shift from Sohano to Hangan style pottery is documented between the lower and upper portion of the deposit and potential transitional sherds displaying elements common to both styles were also recognised. The collective evidence from DJW confirmed Specht's claim for continuity between the Sohano Incised and Relief substyle and Hangan Punctate and Incised substyle. Based on the calibrated date of calBP 1496 (1397) 1330 from the base of the DJW deposit associated with late Sohano style ceramics, it appears that the beginning of the Hangan style occurred slightly later than estimated by Specht, at about 1400 BP rather than 1500 BP.

HANGAN INCISED AND RELIEF SUBSTYLE – SITES DJU AND DJO

Hangan style pottery postdating the DJW assemblage was found in excavations and on the surface at DJU, and in both of the DJO excavation locations. A basal calibrated date of calBP 1283 (1265) 1178 (Beta-25826) was obtained from the DJU deposit, which overlaps at two standard deviations with the date from DJW. Although no dates were processed from the upper deposit, the occupation of DJU appears to be of relatively short duration. A calibrated date of calBP 1055 (966) 936 (Beta-25828) associated with late Hangan style ceramics from the base of the Site DJO-D deposit provides an age estimate for termination of the style. The undated deposit at DJO-A has pottery which is similar to both DJU and DJO-D assemblages and appears to straddle the chronological gap between the two sites. The date from the base of DJO-D is supported by dates of similar age from late Hangan style deposits on Nissan Island (Spriggs 1991a) and extends Specht's original estimate for the end of the style by some 500 years to about 800 BP. Based on Specht's descriptions of Hangan style pottery, the assemblages at each of the three site locations have traits which are most characteristic of the Hangan Incised and Relief substyle.

In the following section, Hangan style pottery from each of the three site deposits is discussed in relative chronological order beginning with DJU and followed by DJO-A and DJO-D. Transitional pottery from DJO-D is discussed with the Malasang style in the subsequent section. Surface pottery from DJU is also considered in relation to the excavated sample. The concluding discussion provides an overview of the Hangan style as it is presently understood from Specht's work and the present analysis.

Site DJU (Pororan Island north)

The overall density of pottery in the DJU deposit, 2247 sherds/m^3, ranks third among the excavated sites. Of the 4628 sherds recovered during excavation, 84% are plain body sherds which were sorted into thin and thick categories (see Table 6.21 for frequencies). Although

Layer	Level	Plain Thick	%	Plain Thin	%	Total Plain	%	Total Diagnostic	%	Sherd Total	n/m³
I	1	51	9	547	91	598	86	101	14	699	3329
IIA	2	22	7	311	93	333	84	62	16	395	1975
IIA	3	57	9	600	91	657	84	128	16	785	3925
IIB	4	53	8	577	92	630	83	128	17	758	3790
IIB	5	32	8	371	92	403	80	98	20	501	2783
IIB	6	32	8	347	92	379	87	59	13	438	1991
IIB	TP2,7-10	47	15	275	85	322	86	53	14	375	938
IIC	TP1,7-10	64	12	491	88	555	82	122	18	677	1504
Total		358	9	3519	91	3877	84	751	16	4628	2247

Table 6.21 Stratigraphic distribution of Hangan style pottery, Site DJU (Pororan Island).

	Site DJU		Site DJO-A		Site DJO-D		Site DJO-D (Hangan-Malasang)	
	n	%	n	%	n	%	n	%
Sherd Type								
rim with lip	283	38.1	69	38.8	131	34.8	296	67.9
lip only	45	6.1	19	10.7	37	9.8	68	15.6
rim without lip	9	1.2	1	0.6	9	2.4	4	0.9
Rim Total	337	45.4	89	50.0	177	47.1	368	84.4
neck angle	3	0.4	1	0.6	4	1.1	11	2.5
neck and shoulder	17	2.3	-	-	-	-	2	.5
decorated body	386	51.9	88	49.4	195	51.9	55	12.6
Total	743	100.0	178	100.0	376	100.0	436	100.0
Rim Orientation								
everted	2	0.6	-	-	-	-	-	-
direct	281	85.7	55	72.4	172	97.7	351	97.2
inverted	45	13.7	21	27.6	4	2.3	10	2.8
Total	328	100.0	76	100.0	176	100.0	361	100.0
Rim Course								
outcurved/concave	55	16.7	37	46.3	62	35.2	303	84.2
straight	268	81.5	40	50.0	95	54.0	48	13.3
incurved/convex	6	1.8	3	3.8	19	10.8	9	2.5
Total	329	100.0	80	100.0	176	100.0	360	100.0
Lip Form								
1 - flat-sharp margins	89	27.3	11	13.3	49	28.0	10	2.8
2 - rounded	121	37.1	44	53.0	80	45.7	133	36.5
6,7 - bevelled	-	-	1	1.2	2	1.1	2	0.6
9 - wide channel	1	0.3	-	-	1	0.6	-	-
Parallel Lip Subtotal	211	64.7	56	67.5	132	75.4	145	39.8
15 - pointed (gradual)	7	2.1	6	7.2	6	3.4	68	18.7
17 - pointed (abrupt)	2	0.6	3	3.6	5	2.9	37	10.2
19 - narrow everted point	12	3.7	1	13.3	2	1.1	2	0.6
Reduced Lip Subtotal	21	6.4	10	12.0	13	7.4	107	29.4
20,21 - rounded, gradual expansion	69	21.2	16	19.2	23	13.1	73	20.1
25 - rounded, braced	-	-	-	-	-	-	3	0.8
28,29 - rounded, beaded lip	2	0.6	-	-	1	0.6	2	0.6
32,33,34 - flat, gradual expansion	22	6.7	1	1.2	5	2.9	3	0.8
38 - flat, interior pointed lip	1	0.3	-	-	1	0.6	1	0.3
27,35 - pointed, gradual expansion	-	-	-	-	-	-	30	8.2
Expanded Lip Subtotal	94	28.8	17	20.5	30	17.1	112	30.8
Total	326	100.0	83	100.0	175	100.0	364	100.0
Estimated Rim Diameter								
10-18 cm	4	33.3	1	25.0	6	42.9	16	31.4
20-28 cm	5	41.7	3	75.0	6	42.9	32	62.7
30-38 cm	3	25.0	-	-	2	14.2	3	5.9
Total	12	100.0	4	100.0	14	100.0	51	100.0
Mean Rim Diameter (cm)	23.5	-	20.0	-	22.3	-	20.2	-

Table 6.22 Sherd type and rim attribute frequencies for excavated Hangan style pottery, Sites DJU (Pororan Island) and DJO (Kessa Plantation).

both categories consist almost entirely of Hangan style pottery, some of the thick sherds (which range from 5.5 to 7.5 mm) are from later styles and probable thickened bases. There is no significant change in the relative frequencies of thick versus thin sherds or non-diagnostic pottery stratigraphically. Diagnostic sherds are exclusively from the Hangan style with the exception of a single Malasang style rim from excavation level 6, one Mararing style sherd from level 1 and three from levels 6 and 7 in TP 1, and a Recent style rim from level 1. The low frequency of these post-Hangan style sherds suggests that they most likely entered the deposit as a result of crab burrowing.

As with Hangan style pottery from DJW, decorated body sherds outnumber rims at DJU. A low number of gradually angled neck sherds with outcurved courses occur which most likely come from immediately below the inverted rims of restricted Form 4B vessels similar to those illustrated by Specht (1969:Fig. XI-27) for the Incised and Relief substyle (Fig. 6.4:d). As indicated in Table 6.22, the percentage of Vessel Form 3 direct rims, which are dominant in each of the Hangan style assemblages, increases in comparison with the early Hangan style assemblage at DJW. Straight rim courses continue to dominate and increase in importance relative to incurved courses, which are scarce. As at DJW, parallel rims with rounded or flat lip forms are the most common although gradually expanded rounded lips are also significant. Reconstructed rim diameters range from 16 to 40 cm with a mean of 23.5 cm although only three exceed 22 cm. Both mean rim (5.58 mm) and body (4.37 mm) thickness are lower than at DJW and almost identical between stratigraphic units within the deposit (Table 6.4). There is no apparent change in composition or manufacturing technology from DJW although anvil impressions seem to be more common. A single drilled suspension hole was found on a rim with lip impressions.

Sixteen percent (n=728) of the excavated sherds from DJU are decorated. Of the complete rim sherds, 4.6% (n=13) are plain and the majority are found in the uppermost

	Site DJU		Site DJO-A		Site DJO-D (Hangan)		Site DJO-D (Hangan-Malasang)	
	n	%	n	%	n	%	n	%
External Decoration Technique								
linear incision	134	19.7	50	30.8	72	20.4	40	16.7
and carving	-	-	-	-	1	0.3	-	-
and punctation	28	4.1	11	6.8	17	4.8	15	6.3
and applied relief	205	30.1	23	14.2	67	19.0	3	1.3
with relief and punctation	14	2.1	3	1.9	3	0.9	1	0.4
with relief and cutouts	-	-	-	-	1	0.3	-	-
Linear Incision Subtotal	381	56.0	87	53.7	161	45.6	59	24.7
comb incision	-	-	-	-	-	-	161	67.4
and punctation	-	-	-	-	-	-	8	3.4
punctation	89	13.1	25	15.4	99	28.0	9	3.8
and carving	-	-	-	-	1	0.3	-	-
and relief strips	45	6.6	7	4.3	29	8.2	-	-
Punctation Subtotal	134	19.7	32	19.8	129	36.5	9	3.8
applied relief strips	165	24.2	43	26.5	62	17.5	2	0.8
and nubbins	1	0.2	-	-	-	-	-	-
and cutouts	-	-	-	-	1	0.3	-	-
Applied Relief Subtotal	166	24.4	43	26.5	63	17.8	2	0.8
Total	681	100.0	162	100.0	353	100.0	239	100.0
Lip Decoration Technique								
cutout notching	1	0.3	-	-	-	-	-	-
and plain impressions	2	0.7	-	-	-	-	-	-
plain impressions with ext. motif	225	78.1	38	80.9	128	88.9	12	9.8
lip impressions only	47	16.3	5	10.6	12	8.3	108	88.5
Impression Subtotal	272	94.4	43	91.5	140	97.2	120	98.3
applied relief 'notching'	13	4.5	4	8.5	4	2.8	2	1.7
Lip Decoration Total	288	100.0	47	100.0	144	100.0	122	100.0
Rim Interior Motifs								
incised crescent row(s)	5	83.3	4	100.0	9	42.9	-	-
short slash incision row(s)	1	16.7	-	-	9	42.9	1	25.0
Unidirectional diagonal lines	-	-	-	-	1	4.8	-	-
opposed diagonal lines	-	-	-	-	2	9.5	-	-
wavy comb incision	-	-	-	-	-	-	2	50.0
comb incised chevrons	-	-	-	-	-	-	1	25.0
Interior Motif Total	6	100.0	4	100.0	21	100.0	4	100.0

Table 6.23 Decoration technique frequencies for excavated Hangan style and transitional pottery, Sites DJU (Pororan Island) and DJO (Kessa Plantation).

Motif	Site DJU		Site DJO-A		Site DJO-D	
	n	%	n	%	n	%
Linear Incision						
11	12	2.5	-	-	4	1.6
12	4	0.8	4	3.6	5	1.9
17	1	0.2	-	-	6	2.3
52	4	0.8	2	1.8	3	1.2
54	2	0.4	-	-	-	-
55	18	3.7	8	7.1	9	3.5
29	-	-	1	0.9	-	-
62	-	-	3	2.7	-	-
65	-	-	3	2.7	-	-
13	-	-	-	-	1	0.4
94	-	-	-	-	1	0.4
Incision and Relief						
43	50	10.4	6	5.4	8	3.1
44	137	28.4	17	15.2	53	20.6
79	2	0.4	-	-	-	-
83	1	0.2	-	-	-	-
41	-	-	-	-	5	2.0
43/25 (with cutouts)	-	-	-	-	1	0.4
incision and carving (M48)	-	-	-	-	2	0.8
Incision and Punctation						
19	1	0.2	2	1.8	1	0.4
32	5	1.0	-	-	2	0.8
33	1	0.2	1	0.9	-	-
37	3	0.6	1	0.9	1	0.4
59	3	0.6	-	-	-	-
60	1	0.2	-	-	-	-
64	1	0.2	-	-	-	-
77	2	0.4	2	1.8	5	2.0
57	-	-	1	0.9	1	0.4
76	-	-	2	1.8	2	0.8
75	-	-	-	-	1	0.4
Incision, Punctation, Relief						
45	36	7.5	5	4.5	7	2.7
81	1	0.2	-	-	-	-
44/50/77	1	0.2	-	-	-	-
67	-	-	1	0.9	-	-
Punctation						
35	42	8.7	13	11.6	53	20.6
6	-	-	1	0.9	15	5.8
26	-	-	1	0.9	-	-
78	-	-	1	0.9	-	-
punctation and carving (M34)	-	-	-	-	1	0.4
Punctation and Relief						
34	5	1.0	2	1.8	16	6.2
38	12	2.5	-	-	-	-
39	1	0.2	-	-	1	0.4
80	7	1.5	-	-	1	0.4
84	-	-	1	0.9	-	-
Applied Relief						
21	-	-	1	0.9	-	-
36	17	3.5	12	10.7	23	9.0
46	4	0.8	1	0.9	1	0.4
47	94	19.5	14	12.5	20	7.8
69	1	0.2	2	1.8	2	0.8
71	11	2.3	4	3.6	4	1.6
89	3	0.6	-	-	1	0.4
relief and cutouts (M25)	-	-	-	-	1	0.4
Total	483	100.0	112	100.0	257	100.0

Table 6.24 Motif frequencies for Hangan style pottery, Sites DJU (Pororan Island) and DJO (Kessa Plantation).

excavation level. The higher percentage of plain lip rims in the surface collection (14.2%) tends to support this evidence suggesting that plain rims increased in importance over time. As shown in Table 6.23 and Figure 6.5, applied relief is found on 63.2% of the sherds with external decoration both alone (24.4%) and in combination with linear incision (32.2%) or punctation (8.7%). Linear incision is almost as common (56.0%), followed by punctation (25.9%). Notched relief strips are fairly common (6.0%) and occur alone as well as combined with plain strips, incision or punctation. Of the 329 diagnostic Hangan style sherds collected from the site surface in the vicinity of the excavation trench, 261 have exterior decoration. The most common decorative technique on these sherds is incision (57.8%) followed by relief (35.2%) and punctation (15.5%). The percentage of plain rims (14.3%; n=28) is significantly higher than the excavated sample and along with the higher amount of incision, is more typical of later Hangan style pottery from DJO.

The percentage of rims with lip impressions (82.9%) and those which are plain except for lip impressions (14.3%) is significantly higher than at DJW. A couple of rims have deep notches cut into the lips in addition to impressions. Relief applied to lips to create a wavy margin occurs on 4.0% of the rims with lips and is associated with a variety of incised and incised and relief motifs (M11, M12, M44, M52, M54 and M55). Rim interior motifs are scarce and limited to incised crescent rows on five sherds and a single example with multiple rows of short slash incision. Most of these sherds are from the basal portion of the deposit. All rims with interior motifs have impressed lips and are decorated with punctate motif M35 or punctate and relief motifs M34 and M38. The single rim from the surface with interior decoration, two rows of slash incision, is associated with M35.

Of the 32 Hangan style motifs recognised in the excavated sample, only five represent more than 5% of the total (Table 6.24). The three most common are incised and relief motifs M44 and M43 along with relief motif M47. According to Specht (1969:203), these motifs are typical of the Hangan Incised and Relief substyle. Punctate motifs M35 and M45 which combine incision, punctation and relief are less common. Four previously unrecorded motifs are present (M64, M79, M81 and M83) along with five variants of M43 and M44, three of M45, two of M36 and single variants for a number of other motifs (M19, M32, M34, M47, M52, M55, M59, M80 and M89). Thirteen of the motifs (40.6%) are shared with the DJW assemblage, 18 with DJO-A and 22 with Hangan style pottery from DJO-D which is most similar in style and form. None of the motifs which Specht identified as typical of the Hangan Punctate and Relief substyle, such as M34, are significant at DJU which suggests that the Incised and Relief substyle had replaced the previous substyle by the time DJU was occupied. No significant change in the relative importance of individual motifs is evident stratigraphically. Of the 23 motifs recognised from the surface collection, those representing over 5% of the total include M44 (24.8%; n=63), M11 (15.0%; n=38), M47 (14.1%; n=36), M55 (9.0%; n=23) and M35 (5.9%; n=15). The range of motifs found and those which are dominant are quite similar to the excavated sample although some later Hangan style motifs such as M11 are also important.

Site DJO-A (Kessa Plantation)

The DJO-A deposit ranks fifth among the sites both in terms of the number of sherds recovered (n=922) and overall pottery density (1026 sherds/m^3). Sherd density is highest in the lower deposit with little variation between excavation levels, but increases again near the surface (Table 6.25). Only late Hangan Incised and Relief substyle pottery is present, including some sherds near the surface which resemble pottery described as transitional to the Malasang style in DJO-D. The few sherds collected from the surface were not included in the analysis. Although the deposit is undated, occupation appears to overlap that of the lower DJO-D deposit on the basis of ceramic attributes.

Plain body sherds account for 81% of the pottery sample and were separated into thin and thick categories in the same manner as the DJU assemblage (Table 6.25). The relative frequency of thick versus thin sherds is constant throughout the deposit with thick sherds (ranging from 5.5 to 7.5 mm), which include rounded base fragments, much less common. Vessel forms are like those at DJU with a similar ratio of decorated body to rim sherds and dominance of direct rims with straight courses, but inverted rims with outcurved courses are more frequent (Table 6.22). Lip forms are also similar, with parallel rounded lips most common and an increase in the percentage of pointed lips. The four estimated rim diameters range from 14 to 24 cm with a mean of 20 cm. Mean sherd thickness is nearly identical to DJU with a slightly higher value for rims but a lower one for

Layer	Level	Plain Thick	%	Plain Thin	%	Total Plain	%	Total Diagnostic	%	Sherd Total	n/m^3
I	1	10	10	90	90	100	79	27	21	127	1133
II	2	5	13	33	87	38	88	5	12	43	1132
II	3	6	11	50	89	56	82	12	18	68	920
II	4	5	14	32	86	37	93	3	8	40	533
II	5	4	12	29	88	33	67	16	33	49	640
II	6	8	18	36	82	44	66	23	34	67	1816
II	7	7	11	57	89	64	77	19	23	83	1400
II	8	9	10	78	90	87	81	20	19	107	1427
II	9	6	7	80	93	86	77	25	23	111	1480
II	10	8	8	91	92	99	89	12	11	111	1480
II	11-12	20	20	80	80	100	86	16	14	116	570
Total		88	12	656	88	744	81	178	19	922	1026

Table 6.25 Stratigraphic distribution of Hangan style pottery, Site DJO-A (Kessa Plantation).

body thickness (Table 6.4). Although both mean rim and body thickness increase slightly between the lower and upper deposit, the difference is not statistically significant. Manufacturing technology remains the same as at DJU with a high frequency of anvil impressions.

The frequency of decorated sherds (18.1%) is slightly higher than at DJU as is the percentage of plain rim sherds (7.2%; n=5). Unlike DJU, linear incision (53.7%) is slightly more common than applied relief (46.9%) but the percentage of punctate sherds is similar (28.5%) (Table 6.23). Incision unaccompanied by other techniques is most common, followed by applied relief strips. Incision with relief declines in importance from DJU and wavy incision occurs on two sherds. Notched relief strips are more common than at DJU (11.7%; n=19) and occur with plain strips, incision and punctation.

Lip decoration is present on 53.4% (n=47) of the rims with lips, which is the lowest percentage of any Hangan style assemblage found by either Specht or myself. As with the other Hangan style assemblages, plain impressions are by far the most important lip decoration technique and 5.7% of rims with lips are decorated with lip impressions alone. Applied relief 'notching', the only other form of lip decoration, is found on a similar percentage of rims as at DJU (4.5%; n=4) and associated exclusively with incised motifs M55 and M62. Rim interior decoration is limited to incised crescents found on four sherds from the base of the deposit which have lip impressions and the relief strip motif M36.

Of the 30 motifs identified at DJO-A, only five account for over 5% of the total. As indicated in Table 6.24, the most common of these is incised and relief motif M44 as is also the case at DJU and DJO-D. Punctate motif M35 and relief motifs M36 and M47 are nearly as common and are followed by incised motif M55. Single examples of two new motifs also occur, M66 and M67, along with four variants of M44, three of M43 and one each of M34, M35, M36 and M45. No significant variation in motif frequencies was evident within the deposit, due in part to the small number of examples for most motifs. Three of these motifs are also significant at DJU with two declining in importance (M44 and M47) and the third increasing (M35). The number of motifs shared with DJO-D (n=20) and DJU (n=18) is significantly higher than for the earlier DJW Punctate and Incised substyle assemblage (n=11).

Site DJO-D (Kessa Plantation)

The DJO-D deposit has the greatest quantity of pottery with 7294 sherds but an overall density not much greater than DJO-A (1658 sherds/m^3). The stratigraphic sequence in the DJO-D deposit was divided into nine zones based on natural layer boundaries combined with artefact distribution patterns (Table 6.26). Pottery density is greatest in the central portion of the deposit (Zones 3 to 5) with a gradual reduction in the upper two zones and a sharp drop in the basal zones where the cultural deposit grades into sterile sand.

The distribution of diagnostic pottery within the deposit reveals a clear shift from Hangan style to Malasang style vessels over time and a high frequency of transitional pottery with stylistic and formal attributes common to both styles in the middle stratigraphic zones. Table 6.27 shows the shift from predominantly Hangan style pottery in the basal Zones 6 to 9 to transitional pottery in Zone 5 and Malasang style ceramics in the upper three zones. A few sherds which appear to be transitional from the Malasang to Mararing style also occur in the uppermost zones. A similar pattern of change is evident in the distribution of plain body sherds based on sherd thickness (Table 6.26). The majority of thick sherds (those over 6 mm) most likely come from Malasang style vessels based on the high frequency of paste 6S represented while thin sherds are nearly all paste 6R which is diagnostic of the Hangan style. As with the diagnostic sample, thin Hangan style body sherds are dominant in the lower deposit but decline over time and are replaced by thicker sherds characteristic of the Malasang style. The following discussion is limited to the Hangan style assemblage at DJO-D as transitional, and Malasang style pottery is dealt with in the next section.

Zone - Layer	Level	Plain Thick	%	Plain Thin	%	Total Plain	%	Total Diagnostic	%	Sherd Total	n/m^3
1 - I	1	512	84	98	16	610	77	186	23	796	1447
2 - I/IIA	2	518	92	44	8	562	69	255	31	817	1796
3 - IIA	3	637	86	108	15	745	70	319	30	1064	2876
4 - IIA/B	4 (TP 1, 3) 4-5 (TP 2)	608	76	197	24	805	75	268	25	1073	2384
5 - IIA/B	4-7 (TP 4) 5 (TP 1) 6 (TP 2)	794	59	561	41	1355	81	317	19	1672	2787
6 - IIB/III	5 (TP 3) 6-10 (TP 1) 7-8 (TP 2) 8 (TP 4)	323	41	473	59	796	82	180	18	976	1084
7 to 9 - IIB/IV	6-8 (TP 3) 9-17 (TP 4)	145	19	609	81	754	84	142	16	896	833
Total		3537	63	2090	37	5627	77	1667	23	7294	1658

Table 6.26 Stratigraphic distribution of plain body sherds, Site DJO-D (Kessa Plantation).

Style Count Row Pct Col Pct	Hangan	Malasang	Hangan-Malasang	Malasang-Mararing	Row Total
Zone 1 Layer IA	11.0 5.9 2.9	150.0 80.6 17.8	16.0 8.6 3.7	9.0 4.8 69.2	186.0 11.2
Zone 2 Layer I/IIA	3.0 1.2 0.8	222.0 87.1 26.4	27.0 10.6 6.2	3.0 1.2 23.1	255.0 15.3
Zone 3 Layer IIA	10.0 3.1 2.7	275.0 86.2 32.7	33.0 10.3 7.6	1.0 0.3 7.7	319.0 19.1
Zone 4 Layer IIA/B	21.0 7.8 5.6	152.0 56.7 18.1	95.0 35.4 21.8		268.0 16.1
Zone 5 Layer IIA/B	73.0 23.0 19.4	39.0 12.3 4.6	205.0 64.7 47.0		317.0 19.0
Zone 6 Layer IIB/IIIB	118.0 65.6 31.4	3.0 1.7 0.4	59.0 32.8 13.5		180.0 10.8
Zones 7-9 Layer IIB/IV	140.0 98.6 37.2	1.0 0.7 0.1	1.0 0.7 0.2		142.0 8.5
Column	376.0	842.0	436.0	13.0	1667.0
Total	22.6	50.5	26.2	0.8	100.0

Table 6.27 Stratigraphic distribution of diagnostic pottery by style, Site DJO-D (Kessa Plantation). (Number of missing observations = 1)

Sherd types and vessel forms at DJO-D are very similar to both DJU and DJO-A (Table 6.22) with slightly more decorated body sherds than rims and a predominance of vertical sided Form 3 vessels (Fig. 6.4:f). Direct rims are more common than in the other two assemblages and straight rim courses remain dominant although incurved courses increase to 10.8%. All inverted rims have outcurved courses as do the majority of direct rims (67.1%) but straight courses are also relatively common (28.1%). Parallel rims increase somewhat while both reduced and expanded rims are less common. Almost all rims have simple rounded or flat lips although pointed lips represent 7.4% of the total.

Reconstructed rim diameters (Table 6.22) range from 16 to 34 cm with a mean of 22.3 cm which is very close to that of the other two later Hangan style assemblages and those reported for the late Hangan style by Specht (1969:114). As is the case at all of the excavated sites, a majority of the diameters are based on rim segments representing from 6 to 10% of the rim (71.4%) although segments of up to 25% of the rim are present. Mean rim thickness is identical to DJO-A while mean body thickness is slightly higher (Table 6.4). Both are within the mean thickness range for late Hangan style pottery documented by Specht (1969:117-18). There is a slight increase in mean rim and body thickness within the DJO-D deposit which may be significant in terms of a transition to the distinctly thicker Malasang style pottery. No change in manufacturing technology or composition is evident in either the DJU or DJO-A assemblages. Single drilled suspension holes are present below two rims with incised and relief decoration. Carbon residues most likely deposited as a result of food preparation were noted on the interior of a number of plain body sherds.

If it is assumed that all thin plain body sherds are from the Hangan style, then 14.8% (n=366) of the 2466 Hangan style sherds are decorated. This is quite similar to the figures for DJU and DJO-A as is the percentage of plain rim sherds (6.9%; n=9). The range of decorative techniques is more extensive than the other two assemblages and includes two examples each of carving (one with incision and one with punctation) and cutouts (one with relief and one with relief and incision). Cutouts are generally associated with the late Sohano style and carving with the early Hangan style at DJW and Specht's sites. The reappearance of these techniques in the late Hangan style is distinguished by new motifs and variants. The three principal decorative techniques are incision (45.5%), punctation (42.2%) and applied relief (46.1%) (Table 6.23). Each of these techniques occurs in combination with the others and linear incision with relief is the most common (18.9%) (Fig. 6.5). Notched relief strips occur less often than at DJO-A (6.8%; n=24) but are combined with the same techniques.

As at DJU, a high percentage of rims have lip decoration (85.7%) consisting of plain impressions both with (97.7% of rims with lips) and without (7.1% of rims with lips and lip fragments) other decoration. Applied relief 'notching' is found on four rims in association with incision (M52, M55), relief strips (M47) and punctation (M35). Rim interior motifs are more common than at any other site (n=21; 11.9%) and include incised crescents and short slash rows as well as unidirectional and opposed diagonal lines associated with motifs M34, M35 and M36.

The 35 motifs identified at DJO-D are dominated by the incised and relief motif M44 and punctate motif M35 which each account for 20.6% of the total number of sherds with identifiable motifs (Table 6.24). Other motifs representing from 5 to 9% of the total sample of identifiable motifs in order of importance include M36, M47, M34 and M6. No significant change in the relative importance of the major motifs is evident within the deposit. All of these motifs except for M6 and M34 are also important at DJU and DJO-A. The presence of M6, which is typical of the early Hangan style but executed somewhat differently at DJO-A and DJO-D, is interesting in light of the presence of carved (M34 and M48) and cutout (M25 with M43) motifs which are also characteristic of this early period. Although no new motifs were noted, variants of known motifs are quite common with six examples of M44, four of M43 and two each of M17, M34, M41 and M45. Based on the number of shared motifs, the DJO-D assemblage is fairly closely related to both DJU (23 motifs) and DJO-A (20 motifs) Hangan style pottery.

Discussion

When the Hangan style assemblages from DJU and DJO are considered together, the overriding impression is one of gradual change over time with basic underlying continuity. Based on Specht's descriptions, the assemblages fit the general characteristics of the Hangan Incised and Relief substyle. Radiocarbon dates confirm that this substyle developed between 1200 and 1300 years ago and continued for some 500 years until the transition to the Malasang style. This means that the two earlier Hangan substyles defined by Specht existed for only about 200 years.

There is little variation in either vessel form or manufacturing technology between the three Hangan Incised and Relief substyle assemblages. Vessel forms are dominated by vertical sided unrestricted pots with direct rim orientations and straight rim courses. The other common form has an inflected rather than simple contour with a slightly restricted inverted rim and outcurved rim course. Restricted vessels decline in frequency over time although outcurved rim courses appear to increase. These findings are generally in agreement with Specht's (1969:113-19, 202) observations that restricted vessels decline over time while vertical sided forms increase in frequency as do everted and raised (i.e. outcurved) courses. However, Specht's claim that restricted forms are the mode throughout the Hangan style is at odds with the present evidence. The mean orifice diameter recorded by Specht for late Hangan style pottery at DAI (20.5 cm) is close to those from DJU and DJO (20.0 to 23.5 cm). Mean thickness at DAI declines between the early and late Hangan style for both rim (6.5 mm and 5.0 to 5.5 mm) and body (5.5 to 6.0 mm and 4.6 to 4.9 mm) sherds. Similar means were recorded for both early and late Hangan style assemblages from the present study although mean body thickness is somewhat lower. Specht's exclusive use of rims for thickness measurements, which tend to have thicker walls than body sherds, may account for this discrepancy.

Variations in decorative technique and motif frequencies are the most important, and almost the only, means of distinguishing between the DJU and DJO assemblages (Fig. 6.5). The lack of radiocarbon dates for the upper DJU deposit and DJO-A make it difficult to establish the precise chronological relationship between the assemblages. A number of traits tend to indicate that the DJO-A ceramics are quite late although combining transitional sherds with Hangan style pottery during analysis may have influenced the results to some extent. Attributes found at DJO-A which are late include a percentage of plain lip rims which is much higher than for the other two assemblages and more similar to transitional pottery from DJO-D. Incised rim interior decoration is rare but occurs throughout the Hangan style in association with outcurved rim courses, impressed lips and a restricted range of exterior motifs. Although Specht records a decline in this form of decoration over time, the late DJO-D assemblage actually has the highest frequency of rim interior motifs.

The most common exterior decorative techniques in the combined DJU and DJO assemblages, in order of importance, are linear incision combined with applied relief (24.6%; n=295), applied relief (22.6%; n=271), linear incision (21.2%; 254) and punctation (17.8%; n=213). The first two techniques decrease over time and the other techniques represented increase. The occurrence of carving and cutouts on a few sherds at DJO-D is noteworthy as these techniques are typical of the late Sohano to early Hangan style. However, the designs are different and associated with incised and punctate motifs typical of the late Hangan style.

Of the 58 exterior motifs recorded for the Hangan style, 50 occur at both DJU and DJO, including six previously unrecorded motifs. The three latest Hangan style assemblages have similar dominant motifs, including M44 and M47 and lower frequencies of M35 and M36. M44 is consistently dominant while other motifs decrease (M43, M45 and M47) or increase (M35 and M36) over time.

MALASANG STYLE – SITE DJO-D

As previously noted, there is a transition from Hangan to Malasang style pottery over time within the DJO-D deposit. Transitional sherds with combinations of attributes present in both styles are of minor importance in the basal stratigraphic zones but become dominant in Zone 5 and decrease again in the upper three stratigraphic zones where over 80% of the diagnostic pottery is Malasang style (Table 6.27). Similar pottery with a paste typical of one style and stylistic elements of the other was also noted by Specht (1969:203) at Sites DAI and DAG. A number of sherds with stylistic traits which appear to be transitional between the Malasang and Mararing style are also present in the upper DJO-D deposit and will be discussed with the Malasang style assemblage.

Transitional Hangan to Malasang style pottery

Transitional vessel forms are generally similar to those of the late Hangan style with a predominance of restricted vessels having inflected contours and direct rims. A major point of contrast is the high percentage of vessels with outcurved raised rim courses (Fig. 6.4:g) that replace the straight courses of Hangan style pottery (Table 6.22). Nearly all (n=291; 96.7%) of the outcurved courses are associated with direct rims as are all straight and incurved courses. Although still the most common, there is a marked decline in parallel rims and increase in both expanded and reduced rims. A majority of rim lips are rounded but both gradually and abruptly pointed forms are also significant. Rim diameters are fairly small with a mean of 20.2 cm which is slightly lower than that of the Hangan style assemblage. Both rim and body thickness means are significantly greater than for the Hangan style but less than the Malasang style (Table 6.4). A small sample of transitional pottery collected from the surface of DJU also has similar mean thickness to that from Site DJO. Although pottery from DJO-D was not classified by paste, a majority of the transitional sherds have rough surfaces diagnostic of paste 6R. Two rim sherds occur with drilled suspension holes ca. 4 mm in diameter directly below the lips. One of the rims is undecorated except for lip impressions.

The range of decorative techniques and motifs associated with transitional pottery at DJO-D extends from the late Hangan to Malasang Early Comb Incised substyle according to Specht's typology. This is not surprising as transitional sherds were grouped with the Malasang Incised substyle 'with the proviso that their membership ... may be temporary' (Specht 1969:203). Based on the present evidence, pottery which I have designated transitional incorporates not only the Malasang Incised substyle but also overlaps to some extent with Specht's subsequent Early Comb Incised substyle. Thus much of Specht's transitional pottery should probably be placed within the late Hangan style in light of the close similarities it displays in vessel form and decoration. The Malasang Incised substyle would be more appropriately classified as pottery which is transitional from the Hangan to Malasang style. As discussed below, the distinctions between Specht's Early and Late Comb Incised Malasang substyles are also of questionable significance. This leaves the Malasang style without any clearly definable substyles.

As discussed in Chapter 3, the transition from the Hangan to Malasang style is estimated to have occurred at about 800 BP. This is based on secure dates for late Hangan style (calBP 1055 [966] 936) and Malasang style pottery (calBP 671 [660] 647) from DJO-D which bracket the transition. The present age estimate is 500 years later than the 1300 BP date proposed by Specht for the end of the Hangan style.

As shown in Table 6.23 and Figure 6.6, the most dramatic change in decoration between the Hangan and Malasang style is the appearance of comb incision which accounts for 67.4% of the transitional sherds with exterior motifs and is even more prevalent in the Malasang style.

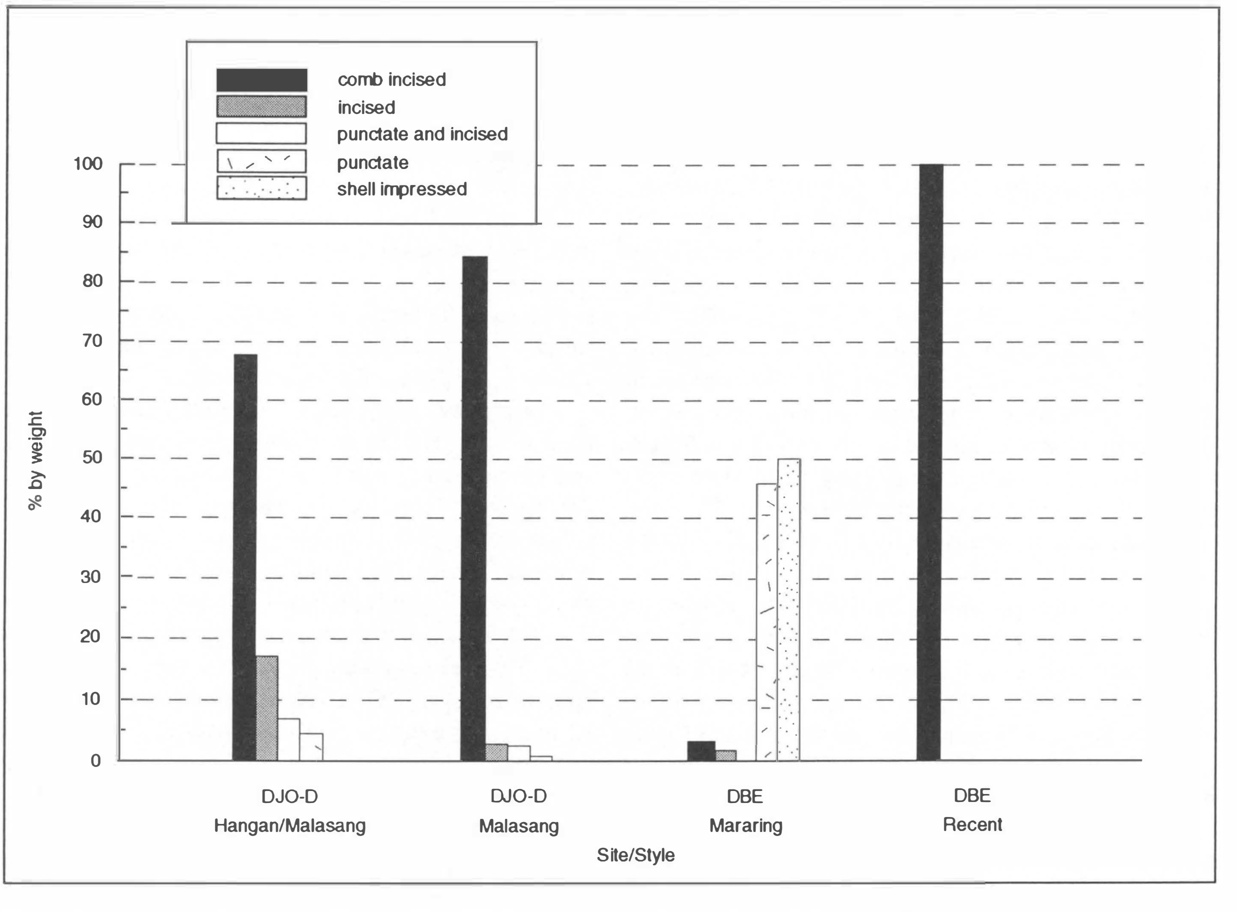


Figure 6.6 Malasang, Mararing and Recent styles: Relative frequencies of decoration techniques by site.

This stands in contrast to Specht's assertion that comb incision does not appear until the Malasang style and is not modal until the Early Comb Incised substyle. However, designs with parallel incision resembling combing and bordered by punctation are included in Specht's illustrations of transitional pottery (1969:Plate XI-31, w-z). The high frequency of comb incised rims from vessel forms like those of the late Hangan style at DJO strongly suggests that this technique was already important during the Hangan to Malasang style transition.

The second most common decorative technique is linear incision (24.7%) which occurs with punctation and/or applied relief strips on a number of sherds. Minor amounts of punctation and relief strips unaccompanied by other techniques are also present. Although Specht (1969:203) stated that motifs combining incision and relief strips were characteristic of transitional pottery, the evidence from DJO-D suggests that a majority of these motifs are more characteristic of the Hangan style proper.

Transitional pottery is dramatically different from the Hangan style in terms of lip decoration with a much higher percentage of plain rims with lips (n=87; 29.4%) and plain lip rims with exterior motifs (n=155; 42.6%). The frequency of rims with lip decoration is much lower (n=122; 33.5%), this consisting of shallow plain impressions with the exception of two cases of applied relief 'notching'. Motifs on rim interiors of transitional and later pottery styles are often located farther up onto the interior lip surface than those of the Hangan style. Comb incision occurs on the lip interiors of three transitional rims without additional lip decoration and includes wavy bands (Specht's IM6) associated with exterior comb incision and chevrons associated with exterior comb incision and punctation.

Frequencies for the 35 motifs on excavated transitional pottery are found in Table 6.28, including six which are new (M109, M189, M194, M195, M198 and M202). Eleven motifs were identified on transitional pottery collected from an eroding deposit near the DJO-D excavation trench and include three not found during excavation (M58, M82 and M202). Based on the frequency of shared motifs, the excavated assemblage is closer to the Malasang style with 20 motifs in common than the Hangan style with which 11 motifs are shared. A majority of the motifs are comb incised and M104, with a single band of tight horizontal wavy combing, is predominant. Other motifs representing over 5% of the total include simple vertical incised lines (M55), diagonal incision bounded by punctations above and below (M59) and loose horizontal comb incision (M105). Most motifs are located on rims directly below the lip although some extend farther down as indicated by their occurrence on body sherds. Nearly all of the incised motifs are represented in Specht's Malasang Incised and/or Early Comb Incision substyles and consist of simple vertical and diagonal lines, chevrons and cross-hatching. All but one of the comb incised designs are also found in the Malasang style although some are executed differently. The single comb incision and punctate motif (M115) is interesting in that it changes from wavy combing bounded by punctation on transitional pottery to straight comb incision which is often completely enclosed by punctation in the Malasang style.

Malasang style pottery

Just over half of the excavated diagnostic sherds at DJO-D are Malasang style (n=842; 50.5%) and an additional 13 have traits which are transitional to the Mararing style. Malasang style pottery is dominant in the upper four stratigraphic zones but drops sharply in Zone 5 and below (Table 6.27). Using Specht's classification system, a majority of the DJO-D pottery is characteristic of the Malasang Late Comb Incised substyle with a lesser amount more typical of the Early Comb Incised substyle. The difficulty in clearly distinguishing substyles within the Malasang style assemblage at DJO-D indicates that it may be more appropriate to eliminate the three substyles proposed by Specht and view the Malasang style as a single unit.

Unlike the earlier transitional pottery, Malasang style vessels have inflected contours with predominantly inverted (Form 4) rather than direct (Form 3) rim orientations and a high percentage of everted rounded to pointed lips typical of vessel Form 4B (Fig. 6.4:k, l; Table 6.28). Specht also recognised this trend which he describes as an increase in strongly everted rim courses between the Early and Late Comb Incised substyles. As with transitional forms, nearly all rim courses are outcurved. There is a decline in rounded lips and increase in both gradually and abruptly pointed lips making reduced rims dominant. The mean rim diameter increases slightly to 21.7 cm which is not as significant as the rise noted by Specht (1969:114) with the appearance of paste 6S. The trend towards increased thickness observed for transitional pottery continues within the Malasang style with significantly higher means for both rims (8.84 mm) and body sherds (7.44 mm) (Table 6.4). Pottery transitional to the Mararing style has a mean body thickness of 8.13 mm. A steady increase in mean body thickness was also noted within the deposit from 6.39 mm (n=39) in Zone 5 to 7.68 mm (n=203) in Zone 2. Small samples of Malasang style pottery collected from the surface at Site DJU and nearby Site DJZ have roughly similar means as the DJO material.

The presence of two additional vessel forms resembling those found in the Lapita assemblages (Lapita Forms 2C and 10) reflects a functional diversification of ceramics during the Malasang style beyond the globular to subglobular pots which were most likely utilised primarily for food preparation. The Form 2 vessel is a strongly unrestricted open bowl with a straight rim course (Fig. 6.4:m) which is also a minor form during the Hangan style. Three examples are present in the upper three stratigraphic zones at DJO-D with rim diameters ranging from 32 to 36 cm, exterior comb motif M105, lip notching and comb incision on the rim interior. Single rim sherds from open bowls were also found during shovel testing in Area 2 at DJO (with comb and punctate motif M201) and on the surface of DJU (with comb motif M102 and a shell impressed lip). Although the exterior motifs and use of shell impression are typical of the late Malasang

Motif	Transitional (Hangan-Malasang Style)		Malasang Style	
	n	%	n	%
Linear Incision				
11	2	1.0	1	0.2
13	2	1.0	-	-
17	3	1.5	-	-
50	1	0.5	-	-
52	5	2.5	1	0.2
55	16	8.0	1	0.2
57	6	3.0	-	-
58	1	0.5	-	-
62	2	1.0	-	-
82	1	0.5	-	-
195	2	1.0	-	-
Incision and Punctation				
33,53,198	3	1.5	-	-
59	10	5.0	2	0.5
76	2	1.0	-	-
190	-	-	4	0.9
191	-	-	5	1.1
incision, punctation, relief (M125)	-	-	6	1.4
Incision and Relief				
43	2	1.0	-	-
194	1	0.5	10	2.3
186	-	-	4	0.9
Comb Incision				
103	2	1.0	1	0.2
104	65	32.3	37	8.4
105	12	6.0	18	4.1
106	4	2.0	1	0.2
107	1	0.5	-	-
108	3	1.5	8	1.8
109	2	1.0	2	0.5
111	8	4.0	1	0.2
113	3	1.5	4	0.9
116	6	3.0	40	9.1
117	3	1.5	52	11.8
118	7	3.5	3	0.7
119	6	3.0	38	8.6
189	1	0.5	14	3.2
197	9	4.5	5	1.1
102	-	-	95	21.6
101,192,199	-	-	4	0.9
172	-	-	3	0.7
202	1	0.5	-	-
203	-	-	2	0.5
Comb Incision and Punctation				
115	6	3.0	44	10.0
128	-	-	6	1.4
166,196,200,201	-	-	4	0.9
comb incision and relief (M99)	-	-	1	0.2
shell edge impressions (M185)	-	-	1	0.2
Punctation				
35	1	0.5	-	-
95	-	-	1	0.2
Applied Relief				
21,71	2	1.0	-	-
70	-	-	2	0.5
88	-	-	15	3.4
punctation and relief (M188)	-	-	4	0.9
Total	201	100.0	440	100.0

Table 6.28 Motif frequencies for transitional and Malasang style pottery, Site DJO-D (Kessa Plantation).

style, Specht (1969:205, Fig. XI-34) noted the appearance of similar vessels during the Early Comb Incised substyle.

The second vessel form is a small mouthed jug or jar with constricted neck, strongly everted lip and orifices ranging from 4 to 10 cm which is classified as Form 5. Only two rims from this type of vessel were found during excavation, both in the upper DJO-D deposit. One lacks lip decoration and has an incomplete comb and punctate external motif and the other has an incised triangle motif (M190) with comb incised chevrons on the lip. Two similar rims were found on the surface at DJU with a comb incision and punctation variant of motif M102 and an exterior motif (M187) combining curvilinear and linear incision, shell notched relief strips bordered by short slash incision and punctation. One rim has comb incised chevrons and diagonal lines and the other has an incised motif on the interior lip surface. One rim from Site DJZ has exterior motif M115 associated with incised chevrons and a row of punctations on the interior lip. Although Specht does not mention small mouthed vessels in association with a particular pottery style, he does illustrate the upper portion of such a vessel with incised motif M98 collected from the surface at Ieta village on Buka which is either contemporary with or more recent than the examples found during the present investigations (Specht 1969:Plate IV-21, e). Based on both decorative techniques and motifs, the constricted jar form does not appear until the late Malasang style or transition to the Mararing style.

According to Specht (1969:204), the manufacturing technology employed during the Malasang style is similar to that of the Hangan style and is characterised by paste 6R, 'with the addition of careful smoothing on both interior and exterior surfaces' to produce paste 6S. Specht also claimed that red pigments or slips appear on one or both surfaces of vessels but no evidence of this was found during the present analysis. Despite the distinction between paste varieties made by Specht, petrographic analysis of temper in a sample of Specht's sherds by Key (1969:371) revealed no significant differences between pastes 6R and 6S in the type and percentage of mineral sand inclusions present. Summerhayes' (1987:332) microprobe analysis of Malasang style paste 6S sherds distinguished two clay sources, a previously unutilised source from which the majority of pottery was made, and more limited use (restricted to sherds with motif M108) of the same source as paste 3 from the Sohano and Hangan style as well as Buka style paste 1. Thus there is evidence for continuity in terms of temper but variability in clay sources between the paste 6 varieties.

Nearly all of the Malasang style sherds with exterior motifs are decorated with comb incision alone (83.9%) or combined with relief strips (7.2%) (Table 6.30). Linear incision occurs on only 5.3% of the decorated sherds including combinations with punctation and/or relief strips. The remaining decorative techniques include both curvilinear and straight relief strips and punctation found separately and combined, and single examples of relief nubbins and shell edge impressions. Nineteen sherds have notched relief strips (made with shell edges in three cases) including combinations with incision (n=4) and punctation (n=2).

Plain rims decrease in frequency from the transitional to Malasang style proper (n=55; 21.8%) as do plain lip rims with exterior motifs (n=61; 24.2%). Although plain impressions remain the dominant lip decoration and are found on 31.8% of the rims with lips and lip fragments, wavy comb incision (Specht's Lm 8) and shell edge impressions appear for the first time, in equal numbers. The shell impressions are deep notches in most cases (Specht's Lm 7/7A) although significant numbers of shallower 'flat' indentations also occur (Specht's Lm 6/6A).

Comb incised rim interior motifs are a hallmark of the Malasang style and occur on 24.7% (n=92) of the rims, most often located on the interior of highly everted lips. Nearly all of the interior motifs consist of single or double rows of wavy lines (Specht's IM 5 and 6) and the remainder are single rows of vertical or horizontal chevrons. Comb interior decoration is associated with comb exterior motifs except for four examples with relief strips, one with incision, another combining the two techniques and one with incision and punctation. Half of the 45 rims with comb interior motifs and lip decoration have comb incised lips and the remainder are evenly divided between shell and plain impressions. Shallow shell edge impression is the second most common interior decoration technique (Specht's IM 7) and occurs in single or double rows with comb and comb combined with punctation exterior motifs and shell edge lip impressions. A few rims have simple incised interior motifs including single rows of unidirectional or grouped opposed diagonal lines. Two rims from the surface of DJU and one from DJZ have incised diagonal lines on the interior lip with a row of punctations along the lower margin. The associated exterior motifs appear to be late and include combing bounded by punctations (M115), shell notched horizontal relief strips (M88) and wide incision (M58).

A total of 39 external motifs was recorded on Malasang style pottery from DJO-D of which 12 are new (M101, M102, M188 to M192, M196, M199 to M201 and M203) (Table 6.28). Twenty motifs are shared with the earlier transitional assemblage at DJO-D including four previously unrecorded by Specht (M109, M189, M194 and M197). The new motifs reflect a considerable expansion of the stylistic inventory recorded by Specht and shed additional light on the transition to Mararing style ceramics. The most common motifs are comb incised, led by M102 which employs straight vertical and diagonal combing. Other important motifs include M117 with bands of straight and wavy combing and M104 and M119 with wavy combing. Motif M115 with comb incision bounded by punctation is also important and changes from tight curvilinear combing during the transitional period to broader, linear and slightly wavy late Malasang style designs in the uppermost levels of DJO-D. The other comb and punctate motifs appear to be late as does comb incision combined with shell notched relief strips (M99). There is a general shift from narrow bands of tight wavy combing typical of the earlier transitional motifs to broad expansive designs extending farther down the vessel wall from the rim.

Motifs with simple incised lines in a band around the rim are much rarer than in the transition to the Malasang style. Several new motifs combining incised triangles filled with punctation (M190, M191), simple incised diagonals with notched or plain relief strips (M186, M194) and slash punctation bordering both incision and relief strips (M125, M187) do not appear until the Malasang style. The only example of a punctate motif (M95) has a simple curvilinear design which could be a precursor to motifs common during the Mararing style in the same manner as the shell edge motif M185. Applied relief motifs are restricted to M70 with multiple rows of nubbins, which may actually belong to the late Hangan style, and M88 with shell notched curvilinear and straight relief bands or strips characteristic of late Malasang to Mararing style transitional decoration. Motif M188 with curvilinear plain or notched relief strips bordered by slash punctation also seems to be late.

A variety of attributes from sherds in the uppermost zones of the DJO-D deposit support Specht's (1969:206) suggestion that certain decorative technique combinations are found on pottery which is transitional to the Mararing style. These include relief strips which are usually notched (including both plain and shell edge impressions) found alone or combined with incision, some of the incised designs, comb incision with punctations or short slash incision and shell edge impression. A single rim from the surface of DJU with comb motif M116 and a row of shell edge impressions below (designated motif M204) as well as comb lip decoration is of considerable significance in that it combines the techniques which are diagnostic of both Malasang and Mararing styles. A number of transitional sherds including a rim nearly identical to that from DJU were also described by Kaplan (1976:52-3, 58) in her analysis of Malasang to Recent style surface pottery collected on Nissan Island.

Lip decoration associated with transitional techniques at DJO-D is most often flat shell edge impressions (Specht's Lm 6) but shell edge notching (Specht's Lm 7A) and plain impressions also occur. Rim interior motifs consist of wavy and linear (chevrons) comb incision, one or two rows of shell edge impressions and one or two instances of incision. Vessel forms associated with probable transitional ceramics exhibit little variation from the Malasang style proper with a predominance of restricted pots and rounded to pointed everted lips. The introduction of small mouthed jars apparently takes place during the transition from the Malasang to Mararing style and open bowls are also present.

Discussion

The DJO-D pottery sequence not only provides convincing evidence for a gradual transition from the Hangan to Malasang style but also displays attributes transitional to the Mararing style in the uppermost excavation levels. However, no pottery typical of the Mararing style proper is present in the excavated deposits and only two such sherds were collected from the site surface. Based on the radiocarbon evidence from DJO-D, production of Malasang style pottery began sometime after 900 BP as indicated by a calibrated date of calBP 1055 (966) 936 (Beta-25828) for late Hangan style pottery at the base of the deposit. A calibrated date of calBP 671 (660) 647 (Beta-25827) from the upper deposit where Malasang style ceramics are overwhelmingly predominant indicates that the style was well established by 700 BP, if not earlier. Based on these two dates, pottery with attributes that are transition between the two styles would have been most common between 900 and 800 BP.

Specht's general sequence of ceramic change from the Hangan to Mararing style is strongly supported by the current evidence although his original classification scheme has been altered to some degree. Much of Specht's transitional pottery is placed within the Hangan style proper while the Malasang Incised and Early Comb Incised substyles are viewed as transitional and the Late Comb substyle as most typical of the Malasang style proper.

In the present analysis, vessel form is as important as stylistic variables in classification throughout the ceramic sequence. One important change is the gradual shift from vertical sided Form 3 vessels in the Hangan style to raised direct rims during the transitional period and finally restricted Form 4B vessels with strongly everted rim lips as well as Form 5 small mouthed jars and Form 2 open bowls in the Malasang style. Although the appearance of comb incision is a significant change in decorative technique associated with the Malasang style, its early presence on Hangan style vessel forms demonstrates the importance of this technique during the transition to Malasang style pottery. In a similar manner, the common occurrence of shell impressed lip decoration on Malasang style pottery at DJO-D shows that this technique was well established prior to the Mararing style where it is said to 'distinguish this style from its predecessors' (Specht 1969:208).

MARARING AND RECENT STYLES – SITE DBE

Palandraku Cave is the only excavated site deposit with substantial amounts of Mararing and Recent style pottery although low amounts of one or both styles occur in the uppermost levels of deposits at all sites except DJO. Both styles are also common on the surface of most recorded sites. Discussion of surface pottery will be limited here to unique or atypical specimens due to the more limited potential of this material for clarifying temporal relationships between styles. Mararing and Recent style pottery at DBE is found in the upper four layers, with the exception of three displaced sherds from the basal preceramic stratum, Layer VI (see Tables 6.8 and 6.9). Layers I and II are the principal Mararing to Recent style pottery-bearing strata. Layer III has much less pottery and other cultural remains and was deposited during a period of minimal use of the site following late Lapita phase occupation (Layer IV). Although no radiocarbon dates have been obtained from the post-Lapita phase strata at DBE a calibrated date of calBP 545 (506) 323 (ANU-6755) from the DAF excavation unit, which appears to be associated with Mararing and Recent pottery, suggests that production of Mararing style pottery may have begun about 500 BP.

Of the 893 Mararing and Recent style sherds recovered, 746 are plain body sherds which could not be separated by style. A majority of the diagnostic sherds are from the Mararing style with only three Recent style sherds found below Layer II. There is an increase in the relative importance of Recent style pottery over time and it is dominant in Layer I. A few modern sherds were also found in Layer I and on the surface.

Mararing style

As discussed in the previous section, pottery which is stylistically transitional between the Malasang and Mararing style was found in the DJO-D deposit and on the surface at DJU and DJZ. The limited amount of diagnostic pottery from the DBE deposit, which is evenly divided between rim and body sherds, is characteristic of the Mararing style proper in terms of vessel form and stylistic attributes.

There is little change in manufacturing technology from the Malasang style with evidence for use of the paddle and anvil technique and strip or coil construction. Vessels are predominantly Form 3 unrestricted to slightly restricted globular pots (Fig. 6.7:a, c) although some more highly restricted Form 4 vessels also occur (Fig. 6.7:b). While pots with rounded bases are still the most common, subconical or pointed bases appear for the first time in the ceramic sequence. A few examples of Form 2 unrestricted open bowls similar to those of the Malasang style were also identified (Fig. 6.7:d, e). No evidence was found of the lipped bowl form known today as *kepa* which according to Specht first appears during the Mararing style. Loop handle fragments similar to those found by Specht (1969:206-7) with rows of punctations in one case and shell edge impressions in the other were collected from the surface of DJY and DJU (Fig. 6.7:f).

Unlike Malasang style vessels, everted lips are rare and a majority of the rims are direct rather than inverted with a dramatic increase in incurved rim courses. Parallel rims are the mode with much fewer reduced and gradually expanded forms. The dominant lip form has shallow channelling on the interior (Form 8) and bevelled or rounded lips are also common. Eight of the ten estimated rim diameters are between 14 and 18 cm with a mean of 17.8 cm (Table 6.29). Mean rim and body thickness are both ca. 1 mm greater than Malasang style pottery at DJO-D (Table 6.4).

Analysis of temper from a sample of Specht's Mararing style sherds by Key (1969) revealed the presence of a distinctive feldspathic rock fragment temper in two samples, although other Mararing style samples have the same temper as Hangan, Malasang and Recent style sherds. Key (1969:371) suggested that new potters unfamiliar with the local clay and temper sources may account for the new temper type. Specht (1969:310) utilised Key's evidence to support the possibility that the Mararing style 'may imply the arrival of an intrusive culture'. Summerhayes' (1987:332) microprobe analysis of Mararing style pottery indicates that a single clay source was being used which is the same as that found in paste 4 and 5 Sohano style ceramics. Thus despite a change in clay sources from the Malasang to Mararing style, there is continuity in the sense that a formerly utilised clay source is brought back into production once again.

The same five decorative techniques found on Malasang style pottery also occur on Mararing style pottery at DBE although only two, shell edge impressions (50.0%) and punctation/short slash incision (45.7%), have more than two examples (Table 6.30). Both punctation and shell impressions usually occur in wide curving bands or arcs extending horizontally across the vessel body directly below the lip. The minor techniques suggest links with the preceding and succeeding styles including notched relief strips (M88) like those found in the Malasang style and comb incision (M141) similar to incised motif M12 from the late Recent style. The single incised design (M63) consists of simple diagonal lines.

Only seven motifs were recognised in the DBE deposit (M3, M63, M88, M141, M155, M157 and M158) and all were previously recorded by Specht. Shell impression motif M155 is the most common with 20 examples followed by punctate motif M158 with 15 examples and four variants. The remaining motifs have only one example each. A new motif (M205) with groups of vertical punctate rows extending downwards from the lip and a row of punctations on an everted lip is found on what appears to be a Mararing style rim from the surface of DJU. Another new motif (M209) from the surface of DJU which appears to be transitional between the Mararing and Recent style has multiple rows of slash punctation bounded by a wavy comb band with shell impressed lip decoration.

Only two rims are completely undecorated and over half have lip decoration which consists primarily of shell edge notching followed by shallow and deep plain impressions and a single instance of punctation. None of the rims have lip decoration alone. Lip decorations are associated with both punctate and shell impressed exterior motifs as well as a single plain impressed lip with an incised motif and punctate lip with punctate motif. Three rims with interior motifs are present including two with wavy comb incision associated with punctate exterior decoration (one of which has a shell notched lip) and one with shallow shell impression on the interior and exterior of the rim and a shell notched lip.

Recent style

Recent style pottery is present on the surface at all but three of the sites recorded during the present investigations (see Table 3.2) but the only significant sample of excavated sherds is from DBE. The 45 diagnostic sherds at DBE include nearly equal amounts of rims and decorated body sherds (Table 6.29). Construction techniques and vessel forms are similar to the Mararing style with a predominance of restricted Form 4 globular pots with round to pointed bases, incurved rim courses, and equal amounts of direct and inverted rims (Fig. 6.7:g). Two rims with straight rim courses from Form 3 vertical sided vessels are also present (Fig. 6.7:h). Neither the open bowl form nor lipped *kepa* noted by Specht for this style occurs at DBE. Parallel rims are the most common form with a wide variety of lips led by flat, narrow channelled and bevelled forms although

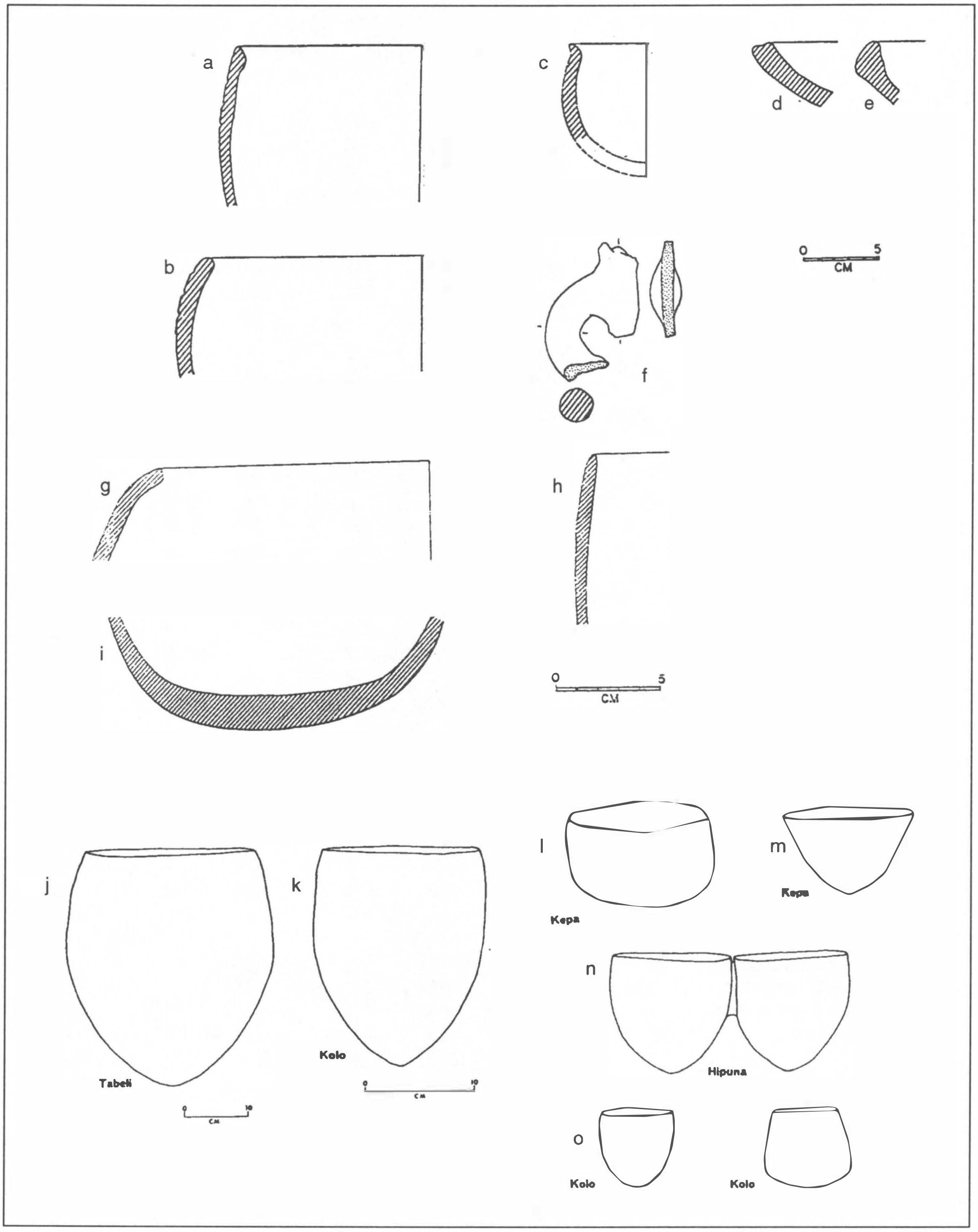


Figure 6.7 Mararing (a-f), Recent (g-i) and modem (j-p) styles: Vessel forms (from Specht 1969:Figs X-19 and XI-37, 41).

pointed lips are also important. The six estimated rim diameters range from 16 to 34 cm with a mean of 24.3 cm. Mean body thickness is nearly identical to the Mararing style sample while rims are slightly thinner (Table 6.4).

Pottery fabric composition is little changed from the Mararing style with the same clay source being utilised (Summerhayes 1987:332) and temper similar to the majority of paste 6 pottery (Key 1969). Vessels from the modern pottery industry on Buka are illustrated in Figure 6.7 (j-p) which is taken from Specht (1969:Fig. X-19). These include a majority of the main vessel forms recognised in earlier styles and several additional forms such as the lipped *kepa* (Fig. 6.7:l) and double *hipuna* (Fig. 6.7:n). The modern pottery industry has been discussed in detail by Specht (1969, 1972b) and is not included in the present study.

Only one plain rim is present and 60.0% of the rims have lip decoration including comb incision, shallow and deep shell edge impressions and a single example with plain impressions (Table 6.30). All decorated lips are

	Site DJO-D Malasang		Site DBE Mararing		Site DBE Recent	
	n	%	n	%	n	%
Sherd Type						
rim with lip	252	29.5	40	42.6	21	46.7
lip only	107	12.5	3	3.2	4	8.9
rim without lip	13	1.5	2	2.1	-	-
Rim Total	372	43.5	45	47.9	25	55.6
neck angle	56	6.5	1	1.1	-	-
neck and shoulder	17	2.0	-	-	-	-
decorated body	410	47.9	48	51.1	20	44.4
Total	855	100.0	94	100.0	45	100.0
Rim Orientation						
everted	10	2.8	2	4.5	-	-
direct	123	35.0	26	59.1	10	43.5
inverted	219	62.2	16	36.4	13	56.5
Total	352	100.0	44	100.0	23	100.0
Rim Course						
outcurved/concave	307	85.0	1	2.3	-	-
straight	42	11.6	8	18.2	2	9.1
incurved/convex	12	3.4	35	79.5	20	90.9
Total	361	100.0	44	100.0	22	100.0
Lip Form						
1 - flat-sharp margins	14	3.9	3	6.7	4	16.7
2 - rounded	95	26.2	7	15.6	1	4.2
4,5,6,7 - bevelled	6	1.7	7	15.6	3	12.5
3,9 - narrow or wide channel	-	-	3	6.7	1	4.2
8 - interior channel with narrow exterior lip	1	0.3	12	26.7	1	4.2
11 - exterior channel with interior pointed lip	-	-	-	-	4	16.7
10 - flat exterior with slight groove	7	1.9	-	-	-	-
12 - everted/flanged	1	0.3	1	2.2	-	-
Parallel Lip Subtotal	124	34.2	33	73.3	14	58.3
15 - pointed (gradual)	91	25.1	3	6.7	6	25.0
17 - pointed (abrupt)	88	24.2	3	6.7	2	8.3
19 - narrow everted point	-	-	1	2.2	1	4.2
Reduced Lip Subtotal	179	49.3	7	15.6	9	37.5
20,21,22 - rounded, gradual expansion	37	10.2	1	2.2	1	4.2
24,25 - rounded, braced	5	1.4	-	-	-	-
34,37 - flat, gradual expansion	-	-	2	4.4	-	-
38 - flat, bevelled expansion	2	0.6	1	2.2	-	-
31,35 - pointed, gradual expansion	16	4.4	1	2.2	-	-
Expanded Lip Subtotal	60	16.5	5	11.1	1	4.2
Total	363	100.0	45	100.0	24	100.0
Estimated Rim Diameter						
4-8 cm	4	4.1	-	-	-	-
10-18 cm	22	22.7	8	80.0	1	16.7
20-28 cm	60	61.9	2	20.0	3	50.0
30-38 cm	11	11.3	-	-	2	33.3
Total	97	100.0	10	100.0	6	100.0
Mean Rim Diameter (cm)	21.7	-	17.8	-	24.3	-

Table 6.29 Sherd type and rim attribute frequencies for Malasang, Mararing and Recent style pottery, Site DJO-D (Kessa Plantation) and Palandraku Cave (Site DBE).

associated with exterior comb incision, the only decorative technique represented. Four rims have comb incision on the interior associated with plain lips and comb incised exteriors. The dominant exterior motif is M113 (n=20) which consists of multiple horizontal rows of wavy combing and M105 with a single band of wavy combing is also common (n=6). The other three motifs identified (M103, M108 and M114) have two or less examples each. One of the motifs (M114), the only one with diagonal and wavy combing, is common on modern pottery which Specht (1969:211) considers a substyle of the Recent style.

Analysis of Recent style pottery from a single undated test unit on Teop Island off the coast of north Bougainville

	Site DJO-D Malasang		Site DBE Mararing		Site DBE Recent	
	n	%	n	%	n	%
External Decoration Technique						
linear incision	14	2.0	1	1.1	-	-
and punctation	12	1.7	-	-	-	-
and applied relief	12	1.7	-	-	-	-
with punctation and relief strips	1	0.1	-	-	-	-
Linear Incision Subtotal	39	5.5	1	1.1	-	-
comb incision	594	83.9	2	2.2	44	100.0
and relief strips	51	7.2	-	-	-	-
and punctation	3	0.4				
Comb Incision Subtotal	648	91.5	2	2.2	44	100.0
shell edge impressions	1	0.1	46	50.0	-	-
punctation	2	0.3	42	45.7	-	-
and relief strips	3	0.4	-	-	-	-
Punctation Subtotal	5	0.7	42	45.7	-	-
applied relief strips	14	2.0	1	1.1	-	-
applied relief nubbins	1	0.1	-	-	-	-
Applied Relief Subtotal	15	2.1	1	1.1	-	-
Total	708	100.0	92	100.0	44	100.0
Lip Decoration Technique						
comb incision	62	26.2	-	-	9	60.0
plain impressions with exterior motif	24	10.1	7	24.1	1	6.7
lip impressions only	90	38.0	-	-	-	-
Plain Impression Subtotal	114	48.1	7	24.1	1	6.7
flat shell edge impressions	17	7.2	-	-	2	13.3
shell edge notched impressions	45	19.0	21	72.4	3	20.0
Shell Impression Subtotal	62	26.2	21	72.4	5	33.3
punctation (single row)	-	-	1	3.4	-	-
Total Lip Decoration	237	100.0	29	100.0	15	100.0
Rim Interior Motif						
miscellaneous linear incision	3	2.9	-	-	-	-
Incised opposed oblique lines	2	1.9	-	-	-	-
Linear Incision Total	5	4.8	-	-	-	-
comb incised wavy lines	79	75.2	2	66.7	4	100.0
comb incised chevrons	13	12.4	-	-	-	-
Comb Incision Total	92	87.6	-	-	-	-
shell edge impressions	8	7.6	1	33.3	-	-
Total Interior Motifs	105	100.0	3	100.0	4	100.0

Table 6.30 Decoration technique frequencies for Malasang, Mararing and Recent style pottery, Site DJO-D (Kessa Plantation) and Site DBE (Palandraku Cave).

by Black (1977) revealed a stratified sequence with two (sub)styles. According to Black, the earlier pottery, designated Teop I, is characterised by horizontal wavy comb incision and is replaced by Teop II pottery which has more complex combinations of diagonal and vertical straight and/or wavy combing bounded by wavy horizontal combing below (Specht's M131 to M136). The evidence from DBE can be interpreted as supporting Black's temporal sequence in that a transition from Mararing to early Recent style pottery typical of Teop I is evident within the deposit. However, no pottery with Teop II motifs occurs which suggests that this substyle may have come into use during a period when the site was not being utilised.

The presence of several sherds with linear and curvilinear incision in the upper portion of Black's unit (1977: Figs 13, 14 and 23) is interesting as similar motifs occur on sherds collected from a number of sites on Buka in 1987 (e.g. DJU, DAF, DJW) and were noted by Specht (1969:Fig. XI-54) in surface collections. Based on vessel form attributes and the manner in which the designs are executed, it appears that these motifs are from the late Recent style or modern pottery industry. The designs include vertical zigzags (M12) which are sometimes enclosed within triangles, loose cross-hatching, curvilinear chevron groups (M207), 'Christmas tree' motifs with a central linear incision and projecting short diagonal incisions (M208), and a variety of more complex and roughly executed curvilinear patterns (M210). Lip decoration is common and includes plain and shell impressions as well as comb incision and a single example of diagonal incision. One rim from the surface at DJV has a combination of incised horizontal chevrons bounded by wavy comb incision with comb lip decoration. This motif (M206) may be transitional to modern pottery.

CONCLUDING DISCUSSION

It was possible to satisfactorily address the general objectives of pottery analysis due in large part to a sampling design which stressed limited excavation of deposits with relatively short occupation sequences and a high potential for revealing relationships between successive pottery styles. As anticipated, the pottery sequence established by Specht for southern Buka was documented in north Buka and undoubtedly covers the remainder of Buka, North Bougainville and nearby offshore islands as well. There is some evidence that particular substyles, such as the Hangan Punctate and Relief substyle which was not documented in the northern Buka sites, may have been more restricted geographically but alternative explanations such as a lack of deposits from particular time periods are also plausible.

Compositional analysis by Summerhayes (1987) demonstrated that a shifting configuration of clay sources were being utilised throughout the ceramic sequence. The implications of these results in terms of the distribution and number of potting centres on Buka are uncertain but there is a clear reduction in the number of pastes and clay sources being utilised following the Sohano style. Whereas three pastes and clay sources were in use during the latter part of the Sohano style, only one paste and clay source has been identified for the Hangan style, two clay sources during the Malasang style and a single clay source for Mararing and Recent style pottery. This trend is suggestive of a reduction in the number of potting centres over time and a potential development of specialised centres such as the contiguous villages of Malasang, Hangan and Lonahan where all pottery production took place traditionally on Buka.

Overall analytical results strongly suggest a high degree of continuity in the ceramic record extending from the late Lapita Buka style through to the modern pottery industry. There is also evidence for a temporal overlap between styles in several site assemblages including Buka and Sohano style pottery at DKC and Mararing and Recent style pottery at DBE. No convincing evidence for non-local introductions or replacement in the form of pots, or by extension, populations has been brought to light by the present study. Similar conclusions have been reached in earlier compositional (Summerhayes 1987) and stylistic analyses (Black 1977; Kaplan 1976) of Buka-made pottery, documenting continuous development between styles (i.e. classes) and assemblages (i.e. groups).

In contrast to Specht's (1969:220-59) concern with identifying extra-areal parallels and potential influences for the Buka sequence, I have adopted an approach which assumes that changes in pottery attributes are derived from local processes unless clear external links are demonstrated in the form of exotic clay, temper or other evidence. However, Specht's attempts to link post-Lapita pottery styles from Buka to various ceramic traditions from elsewhere in Melanesia (such as Mangaasi) cannot be dismissed. There do appear to be transitional sites within Island Melanesia in which a similar range of decorative techniques (i.e. incision and applied relief) come into prominence following the Lapita phase (Spriggs 1993a). Only when a fuller knowledge of local ceramic sequences in Melanesia, which are presently lacking in a number of areas, becomes available can the potential for widespread parallel stylistic change be fully assessed.

The Buka ceramic sequence: A review of the evidence

One of the central issues in discussions of ceramic change on Buka which remains partially unresolved is the nature of the relationship between the late Lapita phase Buka style and subsequent Sohano style pottery. Due to disturbed deposits and a lack of reliable dates, attempts to document the transition between the two styles by the present study were unsuccessful although a temporal overlap between them was established. Early Sohano style pottery from the DKC deposit includes sherds with calcareous sand temper similar to that of the Buka style (also noted by Specht as paste 1A) which appear to be transitional but the low amount of Buka style pottery and lack of stratigraphic integrity make this difficult to document. The only other deposit with significant amounts of pottery from both styles, the single test unit at DAF, is also disturbed and the Sohano style pottery appears to be limited to the later Incised substyle.

The most convincing argument for continuity between the Buka and Sohano style is provided by evidence that the same clay source was utilised in both styles (Summerhayes 1987). I would also argue that early Sohano style vessel forms and decoration represent a continuation of the process of simplification evident in late Lapita phase Buka style pottery. The number of vessel forms is significantly reduced and decoration is less frequent with fewer motifs and simple designs. Sohano style vessel forms are represented in the late Lapita assemblage at DAF and punctation, the primary Sohano style decorative technique, is also found on a few DAF Lapita vessels. Thus there are precedents for Sohano style pottery within the much broader range of Lapita vessels and decoration.

Apart from the undated pottery from DAF which is characteristic of the Sohano Incised substyle and early Sohano Plain Lip substyle ceramics at DKC, the only significant assemblage of excavated Sohano style pottery comes from the DJW site. The DJW material fits Specht's description of the late Sohano Incised and Relief substyle quite closely and a clear transition to the early Hangan Punctate and Incised substyle occurs within the deposit. A basal date of calBP 1496 (1397) 1330 (Beta-25825) from DJW for late Sohano style pottery suggests that this style ended slightly later than the estimate of 1500 BP proposed by Specht, at about 1400 BP. Transitional pottery at DJW has a mixture of attributes typical of both Sohano and Hangan styles and supports Specht's evidence for underlying continuity between the two styles.

Early Hangan style pottery from DJW is typical of the Punctate and Incised substyle which Specht described as seeming to 'bridge the gap between the Sohano Incised and Relief substyles and the main stage of the Hangan style' (1969:201). Attributes characteristic of the later Hangan style assemblages are already evident indicating a high degree of uniformity over a considerable period of time for this style. Pottery typical of the Hangan Punctate and Relief substyle was rare in the DJW assemblage and absent from the DJU excavations. This suggests either rapid replacement by the succeeding Incised and Relief substyle by about 1300 BP, based on a basal date for this substyle of calBP 1283 (1265) 1178 (Beta-25826) from DJU, or alternatively, that this substyle did not extend to the northern portion of Buka.

Hangan style pottery from both DJU and the two excavation locations at DJO is characteristic of Specht's Incised and Relief substyle and dates to between calBP 1283 (1265) 1178 (Beta-25826) based on the basal date at DJU and sometime after calBP 1055 (966) 936 (Beta-25828), a date obtained from the base of the DJO-D deposit with late Hangan style ceramics. Although documenting changes within the Hangan style with considerable precision, Specht's interpretation of the radiocarbon evidence led him to claim that this style lasted only about 200 years, from 1500 to 1300 BP. As he stated:

> these dates imply a very rapid development and diversification within the Hangan Style, and this may be reflected among the sherds by the considerable overlap between its three constituent substyles [Specht 1969:215].

Evidence from the present study supports the overlap between substyles but demonstrates that the style was in existence for a much longer period of time, approximately 600 years.

In the same manner as at DJW, there is a gradual transition from Hangan to Malasang style pottery within the DJO-D deposit. Transitional sherds tend to share the same vessel forms as late Hangan style pottery but have stylistic attributes, such as the use of comb incision, which become the mode in the Malasang style. According to Specht, comb incision on Malasang style pottery has antecedents in late Hangan style parallel incised line motifs but is not similar in content. Specht also recognised transitional sherds but on the basis of the DJO-D evidence it appears that these would be better placed within the Hangan style proper and the early Malasang Incised substyle be reclassified as transitional. Specht's division of the Malasang style into Early and Late Comb Incised substyles was also difficult to substantiate at DJO-D and it is questionable whether substyles are justified for this style.

A limited number of sherds from the upper deposit at DJO-D have stylistic attributes which were seen as transitional from the Malasang to Mararing styles but pottery typical of the Mararing style is absent. A date of calBP 671 (660) 647 (Beta-25827) for the Malasang style was obtained from the upper DJO-D deposit. Although Mararing style sherds were not found at DJO-D, some sherds appear to be transitional to this style. A date of calBP 545 (506) 323 (ANU-6755) from DAF and additional dates from the Nissan Island sites excavated by Spriggs (1991a) indicate that the Mararing style was in existence by 500 BP and overlaps temporally with the following Recent style for which no secure dates are available. The only site deposits excavated during the present investigations with significant amounts of pottery of these two styles is the upper portion of the Site DBE deposits. There is a clear shift from a predominance of Mararing style to Recent style pottery over time at this site. Specht estimated that the Recent style began at about 300 BP, which he admits 'may bear little relationship to its real date' (Specht 1969:215). Due to the lack of absolute dates for this style, Specht's original age estimate has not been revised but it must be treated as only a rough approximation of the date at which manufacture of Recent style pottery began.

Although Specht utilised ceramic evidence such as the introduction of a new temper type and the lipped *kepa* bowl form to suggest a possible break in the Buka sequence with the advent of the Mararing style, he also stressed the overall continuity in ceramic development from the Sohano to Recent styles and this conclusion is strongly supported by the present analysis.

7

NON-CERAMIC PORTABLE ARTEFACTS

Non-ceramic artefacts collected during survey and excavations include a wide range of stone, shell and bone tools, and ornaments extending from the preceramic to late prehistoric and historic periods. Following a brief discussion of overall artefact distribution by phase, a more detailed examination of general artefact classes grouped by raw material is presented beginning with stone and followed by shell and bone. This chapter focuses on long-term artefactual variability in functional and stylistic terms as it relates to patterns of human subsistence and economy. Although the following discussion addresses inter- and intra-site variability and chronological change, a more detailed treatment of artefact distribution patterns within individual site deposits has been provided in Chapter 3 and will therefore receive only minor attention here.

Presence/absence data for non-ceramic artefact categories are presented in Tables 7.1 and 7.2 for each phase of the Buka cultural sequence. Artefacts whose chronological association with a particular phase is uncertain are noted as are those found in site deposits which are transitional between phases, based primarily on ceramic evidence. Artefact types from Buka collected by Specht (1969) are also included in these tables and distinguished from those found during the present study. Extra-areal comparisons within Island Melanesia and Western Polynesia are discussed by artefact type in the concluding section of this chapter. The reader is referred to a summary of non-ceramic artefact type distribution in southwest Pacific sites by Spriggs (1984:Table 1) for additional presence/absence data.

STONE ARTEFACTS

The following section deals with the various categories of stone tools obtained from local residents, surface collections and excavated deposits. Flaked stone artefacts (including obsidian) are discussed first, followed by adzes, axes and various other pecked and/or ground tools including hammerstones and anvils, grindstones and abraders. Worked pumice and coral are discussed next followed by miscellaneous material including ochre, polished pebbles and possible pieces of fired clay. Worked pottery sherds are also included in this section.

Flaked stone

Preceramic phase

Nearly all of the flaked stone artefacts recovered, excluding obsidian, were obtained from the preceramic deposits at Kilu Cave (Site DJA) and Palandraku Cave (Site DBE). The distribution of flakes classified by raw material is presented in Table 7.3 for DJA and Table 7.4 for DBE.

Site DJA

Of the 204 excavated flakes from DJA, the majority are of coarse-grained volcanic rock (74%), followed by chert and other fine-grained siliceous rock (11%), fine-grained volcanics (7%), quartz and coarse quartzite (4%), and calcite (4%). A total of ten pieces of flaked limestone was also found in the Kilu deposit and all but one originate in the Pleistocene deposit.

A majority of the flaked stone occurs in the Layer II Pleistocene deposit (82.8%; n=169) and 41.4% of these flakes are from the basal excavation level. There is a shift in importance from coarse-grained volcanic rock to fine-grained raw material between the two principal occupation components. Although dominant throughout the site deposit, coarse-grained volcanics decline from 80% of all flakes in Layer II to 43% in Layer I while fine-grained volcanics are absent in the lower portion of the Pleistocene deposit and increase from 5 to 14% of the assemblage over time. The frequency of chert increases from 9 to 20% of the flake total between layers and quartz and calcite also increase from 6 to 17%. The highest flake density in Layer I occurs at the base with a gradual decline evident over time although the small

Artefact Type	Cultural Phase Pre-Ceramic	P/L	Lapita	L/S	Sohano	S/H	Hangan	H/M	Malasang	Mararing/ Recent
ground pottery sherds	-	-	-	-	-	-	W	W	W/S?	W
block coral abrader	-	-	-	-	-	W	-	W	-	W
branch coral abrader	-	-	-	-	-	-	W	W	-	W
pumice abrader	-	-	-	W	S	-	S	-	W/S	W/S
stone abrader	W?	-	W/S	W/S	S	W	-	-	-	S?
grindstone	-	-	W	W	-	-	-	-	-	W/S
polished pebble	W	W	-	W	-	-	-	-	-	W
hammerstone/anvil	-	W	W?	W	-	-	-	-	S?	W/S
ground stone axe	-	-	-	-	-	-	-	-	-	W/S
ground stone adze	-	-	W/S?	-	S?	-	-	-	-	-
ground flake tool	-	-	W	-	-	-	-	-	-	-
triangular-sectioned volcanic flake	-	-	W	W	-	-	-	-	-	-
coarse volcanic flake	W	-	-	-	-	-	-	-	-	-
fine volcanic flake	W	-	W?	-	-	-	-	-	-	-
chert/siliceous flake	W	W	W	W	-	-	-	W	W	W
obsidian	-	-	W/S?	W	S	W	W	W	W	-
haematite/pigment	W	-	W	W	-	W	-	-	-	-
heat-altered clay	W	W	-	-	-	-	-	-	-	W

Table 7.1 Distribution of stone and coral artefacts by phase. (Code: W - Wickler; S - Specht; ? - uncertain; P/L - Preceramic or Lapita; L/S - Lapita or Sohano; S/H - Sohano or Hangan; H/M - Hangan or Malasang)

sample size represented must be taken into account when interpreting this trend.

Site DBE

The range of raw materials being flaked at DBE resembles the flaked stone assemblage from the Holocene deposit at DJA although coarse-grained volcanic rock is absent and chert is dominant (71%) followed by nearly equal amounts of fine-grained volcanics and quartz (Table 7.4). Flake density is halved between the lower (Layer VI) and upper (Layer V) preceramic deposit at DBE which is consistent with a decline in shell and bone midden density and may suggest more limited use of the site over time.

Of the 56 flakes recovered from DBE, 38% are from the ceramic-bearing strata. The relative abundance of flakes in the Layer IV late Lapita phase deposit (21%; n=12) indicates continued use of a similar range of flaked stone as during the preceramic phase. The low number of flakes in Layer III (n=2) is not surprising as this stratum formed during a period of limited site use between the late Lapita phase and Mararing phase. As was also the case in late Hangan to Malasang phase deposits at Site DJO-D, small flakes of siliceous rock (n=6) were found in the Mararing to Recent phase occupation component at DBE (Layer I). However, no flakes were recovered from Layer II, which also dates to this period. Some of the flakes in the ceramic-bearing strata may have been displaced from the preceramic deposits in view of the similarities in raw material and scarcity of flaked stone in the other ceramic site deposits.

Flake characteristics and raw material

Very few formal tools are present in the flaked stone assemblages from either of the cave sites which are dominated by small, unretouched waste flakes from raw materials that are likely to have been readily available locally. Much of the coarse-grained volcanic material was obtained in the form of waterworn river cobbles as indicated by the presence of cobble cortex on many of the larger flakes. The overall average weight of coarse-grained volcanic flakes at DJA is 3.4 g and decreases somewhat between the two occupation components although no definite chronological trend is evident. Fine-grained volcanic flakes were probably also struck from cobbles although few flakes are large enough to confirm this with an average weight of only 1.2 g at DBE and 2.3 g at DJA.

The hard siliceous flakes are primarily cherts which range in colour from white or translucent to very dark brown, grey, tan and various shades of green and red. Flakes are small with an average weight of 1.7 g at DJA which declines slightly over time and 1.2 g at DBE where no temporal trend is evident. A number of flakes have remnants of cortex (15% at DBE) and appear to have been struck from small nodules. In addition to primary flakes, several cores, retouched flakes and a probable burin of chert were found. In contrast to the cherts, calcite and vein quartz flakes are often large and angular. The single piece of calcite from DBE weighs 43.3 g and the average weight of calcite flakes at DJA is 7.5 g while mean quartz weights range from 1.5 g at DBE to 3.0 g at DJA. The low mean weight for quartz is due in part to the inclusion of small flakes of coarse quartzite, which are similar in appearance, in this category.

Residue analysis

Starch grains and crystalline raphides characteristic of the taro genus *Colocasia* have been identified on a number of flakes from both Pleistocene and Holocene strata at DJA and the preceramic deposit at DBE (Loy et al. 1992). This represents the earliest direct evidence for the use of root vegetables in the world and is discussed more fully in Chapter 8. Of the 47 flakes and fragments

Artefact Type	Cultural Phase									
	Preceramic	P/L	Lapita	L/S	Sohano	S/H	Hangan	H/M	Malasang	Mararing/ Recent
Shell Artefacts										
Tridacna adze	W?	-	-	-	S	W	W/S	W	S	W/S
Terebra adze	-	-	-	-	-	-	-	-	-	S
Cassis chisel	-	-	S?	-	-	-	-	-	-	-
ground gastropod	W	-	-	W	-	-	-	-	-	-
urchin spine file	-	-	-	-	S	-	-	S	-	-
bivalve scraper/peeler	-	-	W?	-	-	-	-	W	-	W
trolling shank (*Pinctada*/*Tridacna*)	-	-	-	-	S	-	W	W	-	W
pearl shell waste	W	-	W	W	-	-	W	-	-	W
T. marmoratus waste	W	-	W	-	-	-	-	-	-	-
Tridacna ring	-	-	-	-	-	W	S	-	S	W/S
Trochus ring	-	W	W	W	S	W	W/S	W	W/S	W/S
Conus ring	-	-	-	-	S	W	W/S	-	S?	W/S
Conus disc	-	-	W	W?	S	-	S	-	W/S	W
Oliva/Conus ornament	-	W	-	-	-	W	W	W	W	-
Nassarius ornament	-	-	-	-	-	W	W	W	W	-
Polinices ornament	-	-	-	-	-	-	-	W	-	-
red bead (*Spondylus*)	-	W	-	-	-	-	W	W	W	-
white bead (*Conus*?)	-	W	-	-	-	W	W	W	W	W
Bone Artefacts										
perforated shark vertebrae	W	-	-	-	-	-	-	-	W	-
perforated shark tooth	W	-	-	-	-	-	-	-	-	-
perforated human tooth	-	-	-	-	-	W	-	S	-	-
perforated porpoise tooth	-	-	-	-	-	-	-	-	S	-
perforated bone	-	-	-	-	-	-	-	-	W	S
bone point or awl	-	-	-	-	S	W	S	W	W	S
cut bone	-	-	-	-	-	-	W	-	-	-
ground turtle bone	-	-	-	-	-	-	-	-	W	-

Table 7.2 Distribution of shell artefacts by phase. (Code: W - Wickler; S - Specht; ? - uncertain; P/L - Preceramic or Lapita; L/S - Lapita or Sohano; S/H - Sohano or Hangan; H/M - Hangan or Malasang)

analysed, the majority of which are unretouched, 27 had residue deposits or showed use-wear. A single flake with extensive silica polish on both lateral edges and unidentified starch grains unlike yam or taro was found in Layer II at DJA.

Extra-areal comparisons

Comparison of the Buka preceramic lithic assemblages with sites of similar age from New Ireland in the Bismarcks reveals a number of notable parallels and contrasts. Stone tools from the Matenkupkum and Matenbek sites, where occupation dates to between 33,000 and 6000 BP, are characterised by an emphasis on the use of volcanic river cobbles which increases over time in relation to siliceous material (Allen et al. 1989). In contrast, the Panakiwuk and Balof 2 sites, occupied from 14,000 to 7000 BP, have a higher frequency of chert and few volcanics with an average flake weight (1.4 g) which is much lower than the other two sites.

Although the general range of raw material and predominance of unretouched flakes at the New Ireland sites is similar to the Buka sites, the increase in volcanic rock over time at Matenkupkum and Matenbek is the reverse of the Kilu pattern. The argument made by Allen et al. (1989:554) that the increase in volcanic rock is due to dwindling supplies of more desirable siliceous rock does not appear to hold true for the Kilu site where siliceous flakes are increasingly common over time. The lower amount of volcanic rock and emphasis on small chert flakes at Panakiwuk and Balof 2 are more similar to the Holocene-age lithic assemblages from both DJA and DBE. The geographic location of the New Ireland sites may explain the contrast between them as Balof and Panakiwuk are smaller rockshelters from the northern end of the island and Matenkupkum and Matenbek are larger caves located in southern New Ireland.

Ceramic-age sites

Flaked stone artefacts from ceramic-bearing sites fall into two general categories: small unretouched flakes of chert and fine-grained volcanics and larger unretouched flakes with triangular cross-sections. The collective evidence indicates that the use of flaked stone unmodified by grinding was minimal following the Lapita phase although this may be an artefact of inadequate sampling. Although no attempt has been made to source any of this material, it appears likely that most, if not all, was obtained locally.

A majority of the flakes were found in association with Lapita pottery from intertidal reef flats at Sites DAF and DAA. Small, fine-grained volcanic flakes were found at Site DAF in Area 2 (n=1) and Area 8 (n=3), as well as Area 1 at DAA (n=1). Angular chunks and small flakes of greenstone (sard) were found at Area 4 on the reef at DAF (n=1), Areas 1 (n=6) and 3 (n=1) at DAA, and the reef at Site DAG (n=1) to the north of DAA. Single greenstone flakes were also collected from the surface in the vicinity of TP 1 at DAF as well as level 3 of the

Unit	Layer	Level	Quartz/Calcite			Chert/Siliceous				Fine Volcanic			Coarse Volcanic			Total Flakes
			n	g	%	n	g	%	type	n	g	%	n	g	%	n
1	IA	6,8	1/0	9.9	50	1	1.7	50	red-core?	0	0	0	0	0	0	2
3	IA/B	6	0	0	0	0	0	0		1	1.8	50	1	3.1	50	2
	Subtotal (IA)		1/0	9.9	25	1	1.7	25		1	1.8	25	1	3.1	25	4
3	IB/C	7,8	0/2	1.4	25	1	1.0	13	grey	2	0.9	25	3	2.1	38	8
3	IC/B	9	0/3	8.9	43	0	0	0		0	0	0	4	1.2	57	7
	Subtotal (IB/C)		0/5	5.7	33	1	1.0	7		2	0.9	13	7	1.6	47	15
2	IC	11,12	0/2	9.5	100	0	0	0		0	0	0	0	0	0	2
2	IC/IIA	14	0	0	0	0	0	0		1	1.9	50	1	6.0	50	2
3	IC/IIA	10,11	0	0	0	4	1.2	44	brown, red	1	0.3	11	4	2.7	44	9
3	IIA/B/IC	12	0	0	0	1	0.6	33	green	0	0	0	2	1.2	67	3
	Subtotal (IC)		0/2	9.5	13	5	1.1	31		2	1.1	13	7	2.8	44	16
Total (Layer I)			1/7	9.9/6.8	3/20	7	1.2	20		5	1.2	14	15	2.2	43	35
2	IIA/B/D	15	0	0	0	4	1.1	57	gray, red	2	0.7	29	1	5.8	14	7
3	IIA/B/D	13	1/0	0.3	20	1	0.5	20	dark red	1	0.4	20	2	7.8	40	5
	Subtotal (IIA)		1/0	0.3	8	5	1.0	42		3	0.9	33	3	5.3	17	12
1	IIB/D	16	0	0	0	1	2.4	100	green	0	0	0	0	0	0	1
2	IIB/D/A	16,17	3/0	1.3	15	2	0.5	10	grey, light red	2	1.7	10	13	5.4	65	20
3	IIB/D	14,15	2/0	2.2	10	3	2.0	14	tan, red	3	6.9	14	13	5.8	62	21
	Subtotal (IIB)		5/0	1.6	12	6	1.2	14		5	8.6	12	26	5.6	62	42
3	IIC/D/B mixed	16	0	0	0	1	2.9	13	white/red	1	1.1	13	6	2.2	75	8
1	IID	18	0	0	0	1	0.2	50	dark brown	0	0	0	1	0.4	50	2
2	IID	18	0/1	12.7	25	0	0	0		0	0	0	3	5.5	75	4
3	IID	17	0	0	0	0	0	0		0	0	0	6	6.4	100	6
	Subtotal (IID-1)		0/1	12.7	8	1	0.2	8		0	0	0	10	5.6	83	12

Table 7.3 Flaked stone from Kilu Cave (Site DJA). (Code: g = mean weight)

Unit	Layer	Level	Quartz/Calcite			Chert/Siliceous				Fine Volcanic			Coarse Volcanic			Total Flakes
			n	g	%	n	g	%	type	n	g	%	n	g	%	n
1	IID	19	0	0	0	0	0	0		0	0	0	9	12.6	100	9
2	IID	19	0	0	0	0	0	0		0	0	0	4	0.9	100	4
3	IID	18	0	0	0	0	0	0		0	0	0	1	2.2	100	1
	Subtotal (IID-2)		0	0	0	0	0	0		0	0	0	14	8.5	100	14
1	IID	20	0	0	0	1	5.4	17	grey chunk	0	0	0	5	5.0	83	6
2	IID	20	0	0	0	0	0	0		0	0	0	1	2.6	100	1
3	IID	19	1/0	2.6	25	0	0	0	very fine	0	0	0	3	10.2	75	4
	Subtotal (11D-3)		1/0	2.6	9	1	5.4	9		0	0	0	9	2.0	82	11
1	IID/E	21	1/0	6.3	2	1	13.9	2	very dark brown 'burin'	0	0	0	51	1.6	96	53
2	IID/E	21	0	0	0	0	0	0		0	0	0	6	5.3	100	6
3	IID/E	20	0	0	0	0	0	0		0	0	0	11	1.9	100	11
	Subtotal (11D/E)		1/0	6.3	1	1	13.9	1		0	0	0	68	1.6	97	70
Total (Layer II)			8/1	2.1/12.7	5/1	15	1.9	9		9	3.0	5	136	3.5	80	169
Grand Total			9/8	3.0/7.5	4/4	22	1.7	11		14	2.3	7	151	3.4	74	204

Table 7.3 cont.

TP 1 deposit. Three small round nodular cores of red siltstone/chert with multiple flake scars were collected from Area 1 at DAA. Flaked siliceous material from the post-Lapita phases is limited to Area D at Site DJO where 3 small red chert (jasper) flakes were found in the upper Malasang phase deposit (TP 3, levels 3 and 4) and a larger nodular core of reddish grey (5YR 5/2) chert with cortex in the lower late Hangan phase deposit (TP 4, level 9).

As indicated in Plate 7.1, a variety of unretouched flakes with triangular to subtriangular (trapezoidal) cross-sections were recovered, and most are midsection fragments of long, narrow flakes. Flakes of dark green lithified (metamorphosed) mudstone (n=10) as well as andesite (n=9) were collected from the southern reef at DAF in Area 1 (n=5), Area 2 (n=10), Area 3 (n=1) and at the DAA (n=1) and DJQ (n=2) reef sites. Two volcanic flakes were also found at the DES reef site on Nissan Island. Five of the reef site flakes have ground or polished margins suggesting use as cutting implements. The only flake recovered during excavation is of coarse-grained andesite from the base of Layer I at DKC dating to the late Lapita to early Sohano phase.

Obsidian

The primary emphasis of obsidian analysis was on sourcing rather than flaking technology or function, with no formal analysis of flake morphology, reduction sequences or use-wear. A more detailed analysis of the material was beyond the scope of the present study and would be restricted by the predominance of small unretouched flakes and debitage, as well as the minimal amount of obsidian from excavated deposits. The only formal tools identified are several blades with retouch and a triangular point fragment from the DAF reef site. Although separate counts of cores, formal flakes and general debitage were not made, few cores or cortical flakes were noted during inspection of the material.

Sourcing

Analysis of obsidian from archaeological contexts in Oceania has focused primarily on sourcing as a means of investigating prehistoric exchange, particularly during the Lapita period. The establishment of specific density values to distinguish obsidian sources in Melanesia (Ambrose n.d.; Green 1987) has enabled obsidian samples to be sorted to source using the non-toxic heavy liquid sodium metatungstate.

Unit	Layer	Level	Quartz/Calcite n	g	%	Chert/Siliceous n	g	%	Type	Cortex quartz/chert	Fine Volcanic n	g	%	FlakeTotal n
1/2	IA	1	0	0	0	3	1.2	100	pink, red-orange	0/1	0	0	0	3
2	IA/B/II	3	1	2.0	25	3	0.8	75	red nodule, dark red, orange	1/0	0	0	0	4
	Subtotal (Layer I)		1	2.0	14	6	1.1	86		1/1	0	0	0	7
3	IIIA/B	3	0	0	0	1	<1.0	100	light red		0	0	0	1
3	IIIB/IV	4	0	0	0	1	0.8	100	red mottled		0	0	0	1
	Subtotal (Layer III)		0	0	0	2	0.9	100			0	0	0	2
1/3	IV/IV-V(M)	6,7/5	4	1.3	33	6	0.9	50	red, orange, gray	3/2	2	0.3	17	12
Total (Layer I-IV)			5	1.4	24	14	0.9	67		4/3	2	0.3	10	21
1/2	V/IV	8	1	1.0	25	2	2.5	50	red nodule, pink	1/1	1	4.3	25	4
1	V	9	0	0	0	2	1.0	100	gray, green		0	0	0	2
1/2	V/VI	10/9	0	0	0	2	0.8	67	red nodule, tan		1	0.1	33	3
	Subtotal (Layer V)		1	1.0	11	6	1.5	67		1/1	2	2.2	22	9
2	VI/V	10	0	0	0	2	-	50	red nodules		2	0.4	50	4
1-3	VI	11/9	1/1	2.2/43.3	33/33	0	0	0	calcite? chunk		1	0.6	33	3
1	VI/VII	13	0	0	0	18	1.3	95	red frags.(17), green(1)		1	-	5	19
	Subtotal (Layer VI)		1/1	2.2/43.3	6/6	20	1.3	77		0/0	4	0.5	15	26
Total (Layer V-VI)			2/1	1.6/43.3	6/3	26	1.4	74		1/1	6	1.2	17	35
Grand Total			7/1	1.5/43.3	13/2	40	1.2	71		5/6	8	1.2	14	56

Table 7.4 Flaked stone from Palandraku Cave (Site DBE). (Code: g = mean weight)

The use of specific density as an initial step in sourcing obsidian followed by more precise chemical characterisation of a smaller sample using PIXE-PIGME has been successfully employed on Lapita obsidian assemblages from Mussau (Kirch et al. 1991), Watom (Green and Anson 1991), Nissan (Spriggs 1991a) and the Reef-Santa Cruz islands (Green 1987).

All obsidian collected from the three reef sites on Sohano and Buka islands (n=370) and 15 of the 20 obsidian flakes from the other sites were sorted by specific density at the Research School of Pacific and Asian Studies, The Australian National University (ANU), under the supervision of Wal Ambrose. Density values indicate that obsidian was being imported from two sources in the Bismarck Archipelago, the Willaumez Peninsula (Talasea) on New Britain and the Admiralty Islands (Lou). Obsidian was sorted using density ranges established by Ambrose (n.d.) of 2.3445-2.3631 for West New Britain (Talasea) and 2.3786-2.4032 for Lou. As shown in Table 7.5, 87.1% (n=304) of the sourced obsidian from the reef sites was identified as coming from Lou and only 1.4% (n=5) from Talasea. The amount of Lou obsidian is slightly higher in the excavated deposits representing 91.3% (n=21) of the securely sourced pieces (see Table 7.6). A number of obsidian samples have density values which are either slightly above or below the density range for each source and the uncertainty of these source attributions is indicated in the tables by question marks. A few samples produced anomalous values which were either very low or very high and therefore unclassifiable.

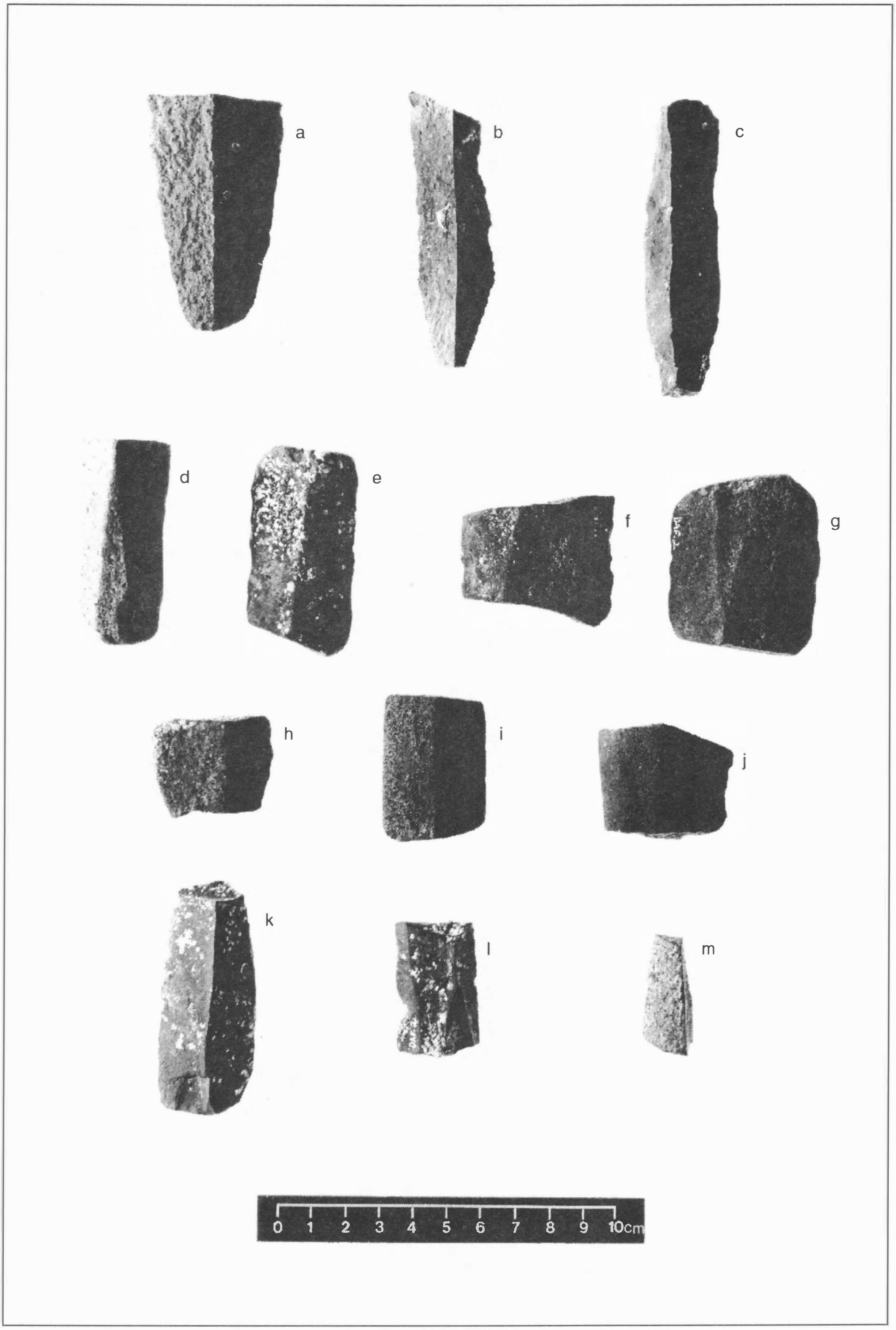


Plate 7.1 Stone flakes with triangular to subtriangular cross-sections from the Buka ceramic sites. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DAF.2: surface; b: DKC: 1: I/5; c: DAF.2: surface; d: DAF.1: surface; e: DAF.1: surface; f: DAF.1: surface; g: DAF.2: surface; h: DJQ.Tr. 53-64: surface; i: DAF.1: surface; j: DAA.1: surface; k: DAF.2: surface; l: DAF.2: surface; m: DBE: 1: IV/7.

Site	Area	ANU Catalogue Number	Anom. (low)	Talasea? low/high	Talasea	Lou? low/high	Lou	Anom. (high)	Total Flakes	Total Wt. (g)	Mean Wt. (g)
DJQ	Tr.19	3876	-	-	-	1/0	-	-	1	1.10	-
	Tr.30, 31	3877, 75	1	-	-	-	1	-	2	7.04	3.52
	Tr.40	3880, 81	-	-	-	-	2	-	2	2.98	1.49
	Tr.49, 50	3879, 78	-	0/1	-	-	1	-	2	2.04	1.02
	Tr.53-56, L. conc.	3874, 73, 72, 71	-	0/1	-	-	3	-	4	5.53	1.38
Subtotal			1	0/2	0	1/0	7	0	11	18.69	1.70
DAA-1	s. of hospital, beach/reef	4067-70	-	-	-	0/2	2	-	4	4.99	1.25
2	beach, clinic	3838-45	-	-	-	1/0	7	-	8	14.60	1.83
Subtotal			0	0	0	2/2	9	0	12	19.59	1.63
DAF-1	south end	4761-64	-	-	-	-	3	-	3	6.65	2.22
3	outer L. conc.	4765-67	-	-	-	-	4	-	4	14.96	3.74
4	s. of wharf, inner reef	3996-4025, 4077, 4106-7, 4666	-	0/1	1 L?	1/0	32	-	35	86.16	2.53
7	s. of jetty, inner reef	4026-37, 4677-4716	-	0/1	-	1/1	58	1	62	136.03	2.19
8	n. of jetty, reef	3891-3995, 4622-4664	4	3/3	2 (1L?)	7/5	117	2	143	351.59	2.39
9	s. of jetty, reef/beach	4075, 4665, 4667-76, 4741-4760	-	0/4	-	3/0	32	-	39	109.65	2.81
10	s. of wharf, reef/beach	4076, 4589-4621	-	0/1	1 L?	1/1	30	-	34	90.00	2.65
12	s. of jetty, beach	4717-4730	-	0/1	1 L?	-	12	-	14	35.65	2.55
DAF Subtotal			4	3/11	5	13/7	288	3	334	830.69	2.49
Total Reef Obsidian			5	3/13	5	15/9	304	3	357	868.97	2.43
% of total sourced material			-	0.9/3.7	1.4	4.6/2.6	87.1	-			

Table 7.5 Reef site obsidian frequencies and source attributions.

Analysis of a large obsidian sample from Mussau by Kirch et al. (1991:156) resulted in the sourcing of all artefacts with densities equal to or greater than 2.356 to Lou as well as 35% of the samples with densities less than 2.356 on the basis of subsequent PIXE-PIGME analysis. Based on these results, only five (1.4%) of the 362 sourced Buka reef site obsidian samples are likely to be from Talasea as opposed to Lou. All but one of the 13 sourced pieces from the other sites are from Lou.

The scarcity of Talasea obsidian in the Buka sites contrasts with its dominance in the Reef-Santa Cruz Lapita assemblages dating to between 1200 and 600 BC, where New Britain material is predominant throughout the sequence and Admiralty and Vanuatu sources account for only ca. 1% of the assemblages (Green 1987). In the Mussau sites, there is a trend over time towards decreased use of Talasea obsidian relative to the Admiralty sources with exclusive use of Admiralties material by the late prehistoric period (Kirch et al. 1991). On Nissan, New Britain is the exclusive source of obsidian during the preceramic period but Admiralties material is dominant in Lapita assemblages and increases in importance over time (Spriggs 1991a). The situation at the Watom Lapita sites contrasts with that for Nissan and Mussau in that Talasea obsidian increases significantly over time relative to the Admiralties material (Green and Anson 1991). Regional differences between Lapita sites in terms of the obsidian sources being utilised demonstrates that geographic proximity was not necessarily the most important criterion in the movement of this valuable commodity.

Despite the lack of absolute dates from the Buka and Nissan reef sites, a relative chronology has been established through pottery seriation. On the basis of this evidence, DJQ is clearly the earliest site and may date to before 800 BC followed by DES and the outer and central reef areas at DAF which were probably occupied prior to 500 BC. The inner reef and beach areas at DAF date to the late Lapita phase (i.e. post-500 BC). Although Lou obsidian is clearly predominant during the entire Lapita phase, there appears to be an increase in the amount of obsidian being transported to Buka during the late Lapita phase followed by a return to lower amounts by the early Sohano phase. Given the almost exclusive use of Talasea obsidian in the Reef-Santa Cruz assemblages prior to 600 BC and the scarcity of obsidian in general and this source in particular from sites of similar age on Buka, there appears to be significant differences in patterns of exchange between the two regions. These interpretations are based on the assumption that the distribution of obsidian from the present sample of sites is representative of obsidian use during the Lapita period, which has yet to be conclusively demonstrated.

Temporal change

With the exception of the DAF reef site, the quantity of obsidian recovered was insufficient to permit the investigation of intra-site variability. The most significant distribution pattern at DAF is the lack of obsidian on the outer reef and minimal quantities on the central reef Areas 1 and 3 (n=7) which

Site/Area	Unit	Layer	Level	ANU Catalogue No.	Anom. (low)	Talasea	Lou	No. Density	Total Flakes	Total Wt.(g)	Density (g/m³)	Mean Wt.(g)
DBE	1	II	5(south)	-	-	-	-	1	1	-	-	-
	1	IV/V	8	-	-	-	-	1	1	-	-	-
DBE Subtotal					-	-	-	2	2	-	-	-
DAF	1	surface		3846,47	-	-	1/1?	-	2	4.88	-	2.44
	1	IB	2,4-6,9	3848-54	-	1	10	-	11	10.18	24.29	-
DAF Subtotal					-	1	11/1?	-	13	15.06	-	-
DJW	1/2	I	1	4073,74	-	0/1?	-	1	2	4.40	-	2.20
	1	IIB	5	4072	-	-	1	-	1	0.09	-	-
	1	IIB/C	7	4071	-	0/1?	-	-	1	0.21	-	-
	2	III/IID	9	-	-	-	-	1	1	0.10	-	-
DJW Subtotal					-	0/2?	1	2	5	4.80	2.78	0.96
DJU-2		surface		3836	-	1	-	-	1	6.26	-	-
DJU-3		surface		3837	1	-	-	-	1	10.19	-	-
DJU Subtotal					1	1	-	-	2	16.45	7.99	8.23
DJO-A	1	I/II	1,5	3863,64	-	-	2	-	2	0.57	0.63	0.29
DJO-D	2	IA	Zone 2	3868	-	-	1	-	1	0.17	-	-
	2	IIB/III	Zone 5	3865	-	-	1	-	1	3.42	-	-
	1/2	IIB/III	Zone 6	3859,66	-	-	1	1	2	1.56	-	-
	4	IV/III	Zone 8	3862	1	-	-	-	1	0.05	-	-
	3	III	Zone 9	3860-61,3867	-	-	3	-	3	-	-	-
	1/3	III	Zone 9	3869	-	-	1	-	1	0.14	-	-
DJO Subtotal					1	-	9	1	11	5.91	1.21	1.07
Total					2	2/2?	21/1?	5	33	42.22	-	1.56

Table 7.6 Obsidian frequencies and source attributions from Site DAF excavations and non-reef sites.

were occupied earliest, in comparison to the later beach (Areas 9-12) and inner reef (Areas 4, 7 and the inner portion of Area 8) locations (n=327). The active erosion of obsidian from the beach deposit onto the inner reef at the northern end of the site accounts for the high number of flakes from Area 8 (n=143). The relatively high density of obsidian from the test unit excavated at the north end of the beach deposit (21 pieces/m^3) supports this evidence. By comparison, the maximum density of obsidian at Lapita sites on Nissan is 10.4/m^3 (Spriggs 1991a:229) and 12/m^3 for the Reef-Santa Cruz sites (Green 1991a:206).

Given the relative abundance of obsidian collected from the inner reef and beach at DAF, it is somewhat surprising that no flakes were found by Specht at this site. Five of the eight pieces of obsidian collected by Specht (1969:264) were found during excavation of the DAA shelter site from layers associated with late Lapita Buka style and Sohano style ceramics. The other three pieces were surface finds. The use of 1/4 inch (6.4 mm) mesh screen by Specht may be at least partially responsible for the minimal amount of obsidian recovered during his excavations as a majority of the excavated pieces from the present study are quite small.

The 13 pieces of obsidian from TU 1 at DAF and the two flakes found in the Palandraku Cave (DBE) deposit presumably date to the late Lapita phase and represent the only obsidian from Lapita deposits apart from the five flakes collected by Specht from DAA. Importation of obsidian appears to drop off dramatically after the Lapita period based on the limited quantity and small size of pieces recovered from post-Lapita sites on Buka (Table 7.6). Of the 18 pieces of obsidian found at these sites, nine weigh less than 1 g and 12 have maximum diameters of under 2 cm. A total of five flakes was recovered from the late Sohano to early Hangan phase deposit at DJW. Two flakes were collected from the surface of DJU, one from the vicinity of the excavation trench in Area 3 most likely dating to the Hangan phase, and the second from Area 2 which appears to be associated with post Hangan phase ceramics. A couple of flakes of obsidian were also found in the late Hangan phase deposit at DJO-A and both the late Hangan and Malasang phase components at DJO-D (n=9). No obsidian sourced to Talasea was found in the post-Lapita sites except for the single surface flake from DJU.

The absence of obsidian from excavated deposits and surface collections dating to the Mararing and Recent phases and lack of references to the material in the ethnographic record strongly suggests that importation had ceased by about 500 years ago. This was not the case on Nissan where importation of both Talasea and Lou obsidian continued into the historic period during which time significant quantities of pottery were being imported from Buka. Thus the cessation of obsidian use on Buka was most likely due to cultural factors rather than a lack of access to this resource.

Technology

Nearly all of the obsidian collected consisted of small unretouched waste flakes and shatter. Although a formal technological analysis of the material was not carried out, very few cores or retouched flakes were noted. Formal tools include four non-cortical blades and an incomplete triangular point collected from the DAF reef site (Plate 7.2). The blades, two of which are incomplete, range from 4.4 to 5.1 cm in length and 1.5 to 1.7 cm in width with triangular to lenticular cross-sections similar in general appearance to blades from Umleang on Lou Island illustrated by Fullagar and Torrence (1991:Plate 3). One of the blades has unifacial retouch on a restricted portion of the ventral surface (Plate 7.2:b) and another has extensive irregular retouch along both margins of the dorsal surface. A third blade has extensive carefully executed retouch along both margins of the ventral and dorsal surfaces significantly reducing bladethe width to form a blunt point (Plate 7.2:c).

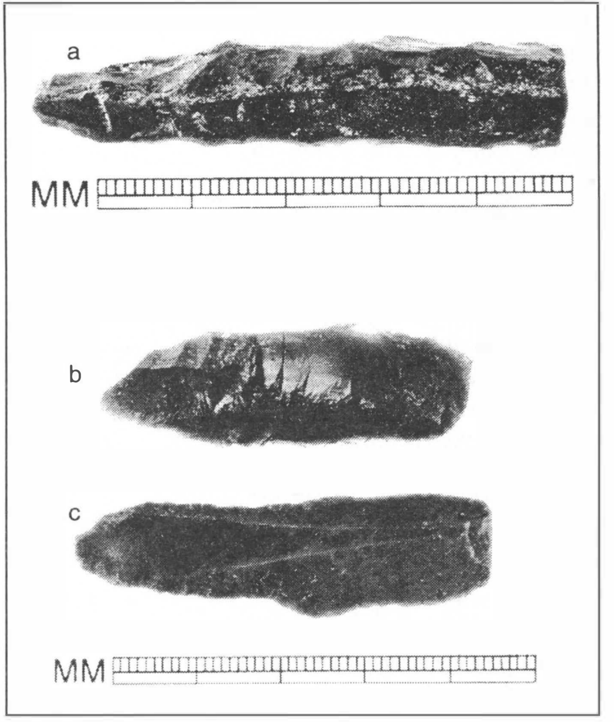


Plate 7.2 Obsidian point (a) and blades (b, c) from Area 4 (surface), Site DAF.

The most interesting obsidian tool collected from DAF is a triangular (spear) point fragment 5.5 cm long with a maximum (proximal) width of 1.4 cm and extensive retouch on the two dorsal surfaces (Plate 7.2:a). Nearly identical points have been recovered from the Sasi site dated to 100 BC and the somewhat later Emsin site on Lou Island in the Admiralties (Ambrose 1991). According to Ambrose, the only published record of such points outside of the Admiralties is from the Lossu site on New Ireland where two point fragments from Lou dating to around AD 300 were found (White and Downie 1980:Plate 7). The point fragment from DAF, which is sourced to Lou, expands the distribution range for triangular-section points to include the northern Solomons and is also the first to be found in association with Lapita ceramics. It is highly probable that the point, and blades as well, were imported to Buka as finished products as there is no evidence of a local blade or point industry.

Dates from Lou indicate that production of blades and points like those at DAF had begun by the late Lapita period. This agrees well with the predominance of late Lapita Buka style ceramics at the locations where the blades and point were collected. The point and two of the retouched blades were found in Area 4 on the inner reef and the other two blades were found on the beach fronting Area 4 (Area 10) and slightly farther north along the beach in Area 9.

One aspect of technology addressed in previous studies of Lapita obsidian utilisation is the intensity of flake use as indicated by such variables as the presence of cortex and changes in flake size (Allen and Bell 1988). A drop off in the size and weight of obsidian flakes has been observed between Lapita sites as distance from the sources increases and the resource increases in value. In a preliminary study of obsidian assemblages from the Reef-Santa Cruz Lapita sites, Lawlor (1978) concluded that more intensive utilisation of obsidian took place over time as indicated by a reduction in the frequency of cortical flakes from 7% to none between the early SZ-8 and late RF-6 sites accompanied by a drop in the average weight of flakes from 7.5 to 1.35 g. The attributes of the obsidian assemblages from the Buka reef sites are most similar to the late Reef-Santa Cruz Lapita site RF-6 dating to around 600 BC with average flake weights ranging from 1.6 g at DAA and 1.7 g at DJQ to 2.5 g at DAF. Although not formally recorded, the percentage of flakes with cortex is minimal at each sites.

The low number of cores and abundance of small flakes in the Buka assemblages could be interpreted as supporting a resource maximisation model which stresses the role of obsidian as a scarce raw material that would have been reduced as much as possible. However, a fuller analysis of obsidian assemblages from the Reef-Santa Cruz Lapita sites by Sheppard (1993) suggests that obsidian was not viewed as a scarce utilitarian resource given the expedient style of flaking practised at these sites. This is somewhat at odds with the conclusions reached by Lawlor based on his initial analysis of the assemblages which may have been skewed by major differences in sample size and the proportion of the sites sampled.

Stone adzes and axes

Stone adzes were found only on the surface of the reef sites where the majority are associated with Lapita ceramics. A variety of stone axes were obtained from villagers and surface collections on Buka and do not appear to pre-date the Mararing phase based on associated ceramics from the surface collections. No axes were recovered from any post-Lapita deposit that could be securely dated to before the Mararing phase. The four small stone axe/adze fragments excavated by Specht (1969:271) are either early (Buka to early Sohano phases) or late (Mararing to Recent phases) in the prehistoric sequence. The present lack of secure evidence for either stone axes or adzes between the late Sohano and Malasang phases is suggestive but may reflect inadequate sampling of sites from this period rather than the absence of this tool type.

Stone adzes

As indicated in Table 7.7, a total of 18 adzes was collected from reef sites DJQ (n=4), DAF (n=12) and DAA (n=1), as well as a single adze from the reef fronting site DAG located to the north of DAA. This sample includes four complete adzes, two adze blanks with initial flaking, a single polished flake and 11 butt or bevel fragments. Detailed descriptions of each specimen are presented in Table 7.8 and selected examples are illustrated in Plate 7.3. Although not included in the present analysis, 12 finished adzes were recovered from the reef site DES on Nissan which closely resemble adzes in the Buka assemblages. The DES sample includes five complete or nearly complete adzes, four butts and two bevel and one midsection fragment.

Previous classifications of adzes from the southwest Pacific have focused on cross-section as the primary attribute for establishing types. These include adze typologies from Samoa (Green 1974; Green and Davidson 1969), Tonga (Poulsen 1987) and Fiji (Best 1984) that provide the taxonomic framework for the present study. As indicated in Table 7.8, a range of discrete and continuous attributes were recorded for the reef adzes. Buka adze cross-sections range from semi-quadrangular to curvilinear and are evenly distributed (six examples each) between:

1. oval (ranging from flat oval to lenticular);
2. plano-lateral (lenticular with flat sides); and
3. plano-convex forms.

The ten adzes with identifiable cross-sections from DES on Nissan are oval. Oval adzes (Poulsen Type 2a; Best Type 2) are widespread in Lapita sites extending from Watom in the Bismarcks to Fiji and Tonga but are absent in Samoa (cf. Green 1974) and plano-convex adzes (Poulsen Type 2 b/c; Best Type 3; Green and Davidson Type V a/b) are also a widespread Lapita type known to be common in early sites (Best 1984:397). Plano-lateral adzes (Poulsen Type 1a; Best Type 11) occur in Lapita sites from Tonga and Fiji but not Samoa (see Poulsen 1987:174) and Green (1979:Plate 2.4) illustrates an example from the RF-2 Reef-Santa Cruz Lapita site.

Of the 16 finished adzes from the Buka reef sites, at least nine are fully ground, two have extensive grinding and one has moderate grinding. The majority of these adzes (n=8) have pronounced side angles from the distal to proximal end giving them a triangular appearance with blunt butt profiles (n=7). The adzes are generally small and the four complete specimens range in length from 46.7 to 107.4 mm with a mean of 70.5 mm (the mean for DES is 54.0 mm; n=4).

Buka adze rock types were identified by Dr John Sinton of the University of Hawai'i based on visual inspection of hand specimens. Igneous rocks include grey to black fine-grained basalts (n=7), aphyric andesite (n=4), porphyritic andesite (n=1) and possibly diorite (n=3). The single non-igneous rock type is a distinctive olive to olive grey lithified (metamorphosed) mudstone with banding in one example (n=3). It is probable that all of the rock types are from Buka or Bougainville. Spriggs (1991a:235) states that some of the lithic artefacts (including adzes) from DES on Nissan are made of a similar material to Lapita adzes from the Reef-Santa Cruz Lapita sites

Village	Locality	Provenience	Complete Axe	Axe Fragment	Adze
Pororan	Pororan		1	0	0
Hetau	Hetau		1	0	0
Poposoko	Suhin		1	0	0
Munakobu	Iltopan		1	0	0
Munakobu	Iltopan		1	0	0
Kakalis	Malasang		2	0	0
Kubese	Malasang		1	0	0
Tokoruna	Tohatsi		1	0	0
Subtotal			9	0	0
Site	Area				
DJC		surface	1	0	0
DJF		surface	0	1	0
DJL	1	surface	1	0	0
DJX		surface	0	1	0
DKF		surface	0	1	0
Subtotal			2	3	0
DJQ	Tr.43-50	reef flat	0	0	1
DJQ	Tr.51-54(S)	reef flat	0	0	2
DJQ	Tr.61-64	reef flat	0	0	1
Subtotal			0	0	4
DAG		reef flat	0	0	1
DAA	1	reef flat	0	0	1
DAF	1	reef flat	0	0	2
DAF	2	reef flat	0	0	6
DAF	3	reef flat	0	0	2
DAF	6	reef flat	1	0	0
DAF	9	reef flat	0	0	1
DAF	12	surface	0	0	1
Subtotal			1	0	12
DJU	General	surface	1	0	0
DJU	1	surface	0	1	0
DJU	3	surface	0	1	0
Subtotal			1	2	0
Total			13	5	18

Table 7.7 Distribution of stone axes and adzes.

although descriptions of this material have not been published.

Reef site adzes were found in close association with Lapita ceramics. All but one of the adzes from DJQ were located within the dense concentration of Lapita ceramics at the western end of the site. At DAF, all but two adzes (from the northern inner reef and War Memorial Park) were collected from the central reef in the southern portion of the site. The majority are from Area 2 where the densest concentration of Lapita ceramics was collected, although very few dentate-stamped sherds occurred in this part of the site. A variety of other lithic artefacts, primarily grindstones and abraders, were also associated with the adzes. As discussed in Chapter 4, the high proportion of utilitarian ceramic vessels from this portion of the site, coupled with the lithic artefacts, suggest that domestic and industrial activities may have been focused here.

Stone axes

Specht (1969:272-86) developed a preliminary typological classification of stone axes from Buka and north Bougainville based on personal, museum and private collections. This typology provides the framework for the classification of axes in the present study. According to Specht, these tools were formed by a uniform technology in which a blank was pecked into its rough form, finished by grinding and hafted with the cutting edge parallel to the haft.

A total of 13 complete axes and five fragments were received as gifts, purchased from villagers or collected from the surface during site survey (Table 7.7). The nine axes obtained from local residents are identified by village and general locality in Table 7.7 although their original provenience is unknown. One axe was collected from Area 6 at the DAF reef site and three axe fragments, two of which appear to be waisted, from the DES reef site on Nissan. The most common type of axe in the Buka area is a lugged form in use at the time of European contact which was often completely ground only on the blade and is designated Type 2 in Specht's classification system. Twelve of the axes are of this type characterised

Site	Area	Status	Material	Grind	Cross-Section	Side Angle	Butt Form	Munsell Colour	Length (mm)	Butt Width (mm)	Butt Thickness (mm)	Bevel Width (mm)	Bevel Thickness (mm)	Midpoint Width (mm)	Midpoint Thickness (mm)
DJQ	Tr.43-50	6	3	1	3	-	-	7.5YR N3/ very dark grey	64.5	36.4	15.9	44.5	12.0	42.2	15.0
DJQ	Tr.51-54	6	2	1	1	-	-	5G 4/1 dark green grey	59.4	35.4	21.2	44.3	16.0	42.6	21.0
DJQ	Tr. 54	3	4	6	1	3	-	5G 4/1	46.8	-	-	42.0	14.3	37.2	16.2
DJQ	Tr.61-64	5	1	4	2	1	1	2.5Y 4/4 olive brown.	107.4	30.0	10.6	-	-	50.6	11.1
DAG	1	1	3	6	2	3	1	2.5Y 3/0 very dark grey	61.0	25.3	14.0	40.1	18.0	37.7	19.2
DAA	1	2	3	3	1	3	3	7.5YR N3	55.0	16.7	16.7	-	-	32.9	18.4
DAF	1	2	3	2	2	2	2	7.5YR N3	42.0	33.8	17.0	-	-	42.4	18.6
DAF	1	3	3	6	3	1	-	7.5YR N3	50.0	-	-	-	-	44.5	>16.7
DAF	2	3	1(bands)	5	1	1?	-	5Y 4/2 olive grey	29.5	30.0	-	46.7	7.8	-	-
DAF	2	2	1?	5	1	2	2	5Y 5/3 olive	34.5	30.0	-	-	-	40.3	22.4
DAF	2	4	3	6	2	3	1?	7.5YR N3	60.0	34.9	-	-	-	-	-
DAF	2	2	4	6	3	3	1	5G 4/1	44.3	31.8	17.8	-	-	37.5	19.3
DAF	2	1	2	6	3	2	1	black w/ white incl.	66.9	23.7	17.0	33.0	11.0	32.8	16.0
DAF	2	3	2	6?	3	-	-	black w/ white bands	36.6	-	-	27.9	-	-	-
DAF	3	1	4	6	2	3	1	7.5YR N3	46.7	21.6	15.1	27.3	12.2	25.1	14.8
DAF	3	2	3	6	2	3	1	7.5YR N3	26.2	30.7	14.5	-	-	>35.4	>21.7
DAF	7	2	4	3	3	3	2	7.5YR N3	46.8	38.2	19.0	-	-	-	-
DAF	12	3	5	6	1	1	-	5Y 5/1 grey	43.5	-	-	36.0	19.1	38.1	22.5

Table 7.8 Descriptive data for reef site stone adzes.

Status

1. complete
2. butt fragment
3. bevel fragment
4. polished flake or fragment
5. complete with portion of bevel missing
6. preform with initial flaking

Material

1. lithified (metamorphosed) mudstone
2. possible diorite
3. fine-grained basalt
4. aphyric andesite
5. porphyritic andesite

Degree of Grinding

1. none
2. moderate
3. extensive
4. sides fully ground
5. sides and back or front fully ground
6. fully ground

Cross-section

1. oval (ranging from flattened to lenticular)
2. plano-lateral
3. plano-convex

Side Angle

1. parallel sides (no angle)
2. slight angle from distal to proximal end (sub-triangular)
3. pronounced angle from distal to proximal end (triangular)

Bevel Edge

1. straight
2. curved
3. slightly pointed

Butt Morphology

1. blunt/flat
2. rounded (arc covers at least half of total length)

Key to discrete attribute codes for stone adze analysis (Table 7.8).

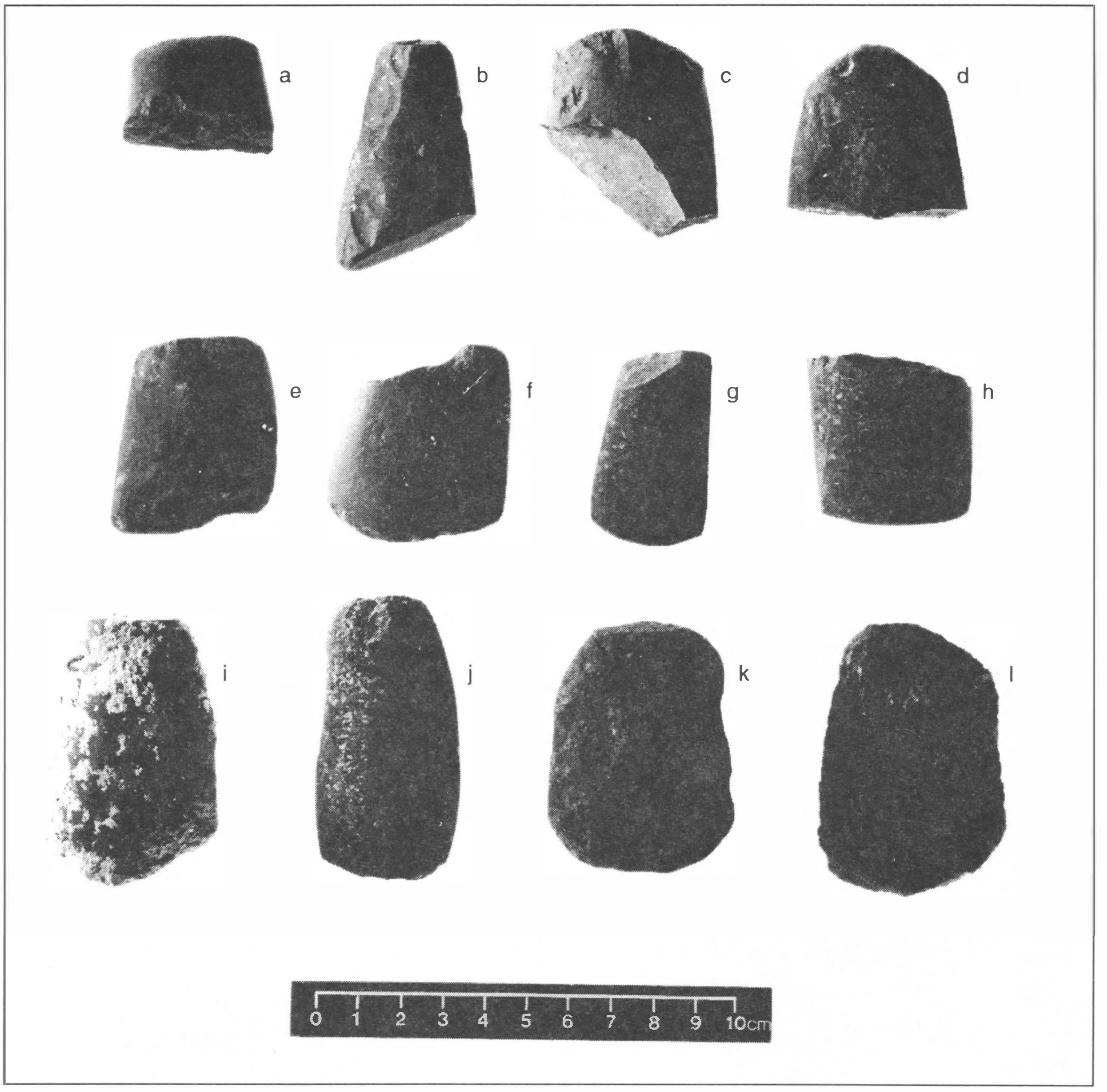


Plate 7.3 Stone adze preforms (k, l), complete finished adzes (g, i, j) and butt (a-e) and bevel (f, h) fragments from Buka reef. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DAF.3: surface; b: DAA.1: surface; c: DAF.7: surface; d: DAF.1: surface; e: DAF.2: surface; f: DJQ. Tr. 54: surface; g: DAF.3: surface; h: DAF.12: surface; i: DAG: surface; j: DAF.2: surface; k: DJQ.Tr. 51-54 (south): surface; l: DJQ.Tr. 43-50: surface.

by a single side lug with a groove or notch on the opposite lateral margin to aid in hafting as illustrated in Plate 7.4. Two specimens have grooves above and below the lug (Plate 7.4:a, b). One fragmentary example of Specht's Type 2A lugged axe variant distinguished by its greater length to width ratio (often 3:1 or more) was collected in Malasang village (Plate 7.5:b). One example of a fully-ground Type 1 axe, described by Specht as rare on Buka and north Bougainville, was obtained at the village of Suhin along the central eastern coast of Buka (Plate 7.5:e). This is a true axe with a medial straight cutting edge and lenticular cross-section which is 105 mm in length and 20.6 mm thick at the midpoint.

Based on Specht's data, the remaining axe types collected in 1987 have not been recorded on Buka previously although several are nearly identical to axes from the Buka-north Bougainville area illustrated by Blackwood (1935:Plate 63). One of these is an incomplete (poll missing) long, narrow axe resembling Specht's Type 4 that was collected at Tohatsi along the northeast coast of Buka (Plate 7.5:c). It is almost totally ground with an oval cross-section and is 187 mm long and 73 by 48 mm at the midpoint. Axes of this type are characteristic of the north coast of Bougainville and were hafted medially. Two unique axes were purchased from a man at Iltopan village near the northern tip of Buka. The first is triangular in plan with a slight restriction at the shoulder for hafting similar to Specht's Type 8 (represented by a single museum specimen attributed to Teop). It is well ground with a lenticular cross-section measuring 140 mm in length with a width and thickness of 64 by 31.6 mm at the midpoint (Plate 7.5:d). The second axe is long and narrow with a pointed poll and does not resemble any of Specht's types but is similar to an axe illustrated by Blackwood (1935:Plate 63). It has a highly polished fully ground surface with a plano-convex cross-section and

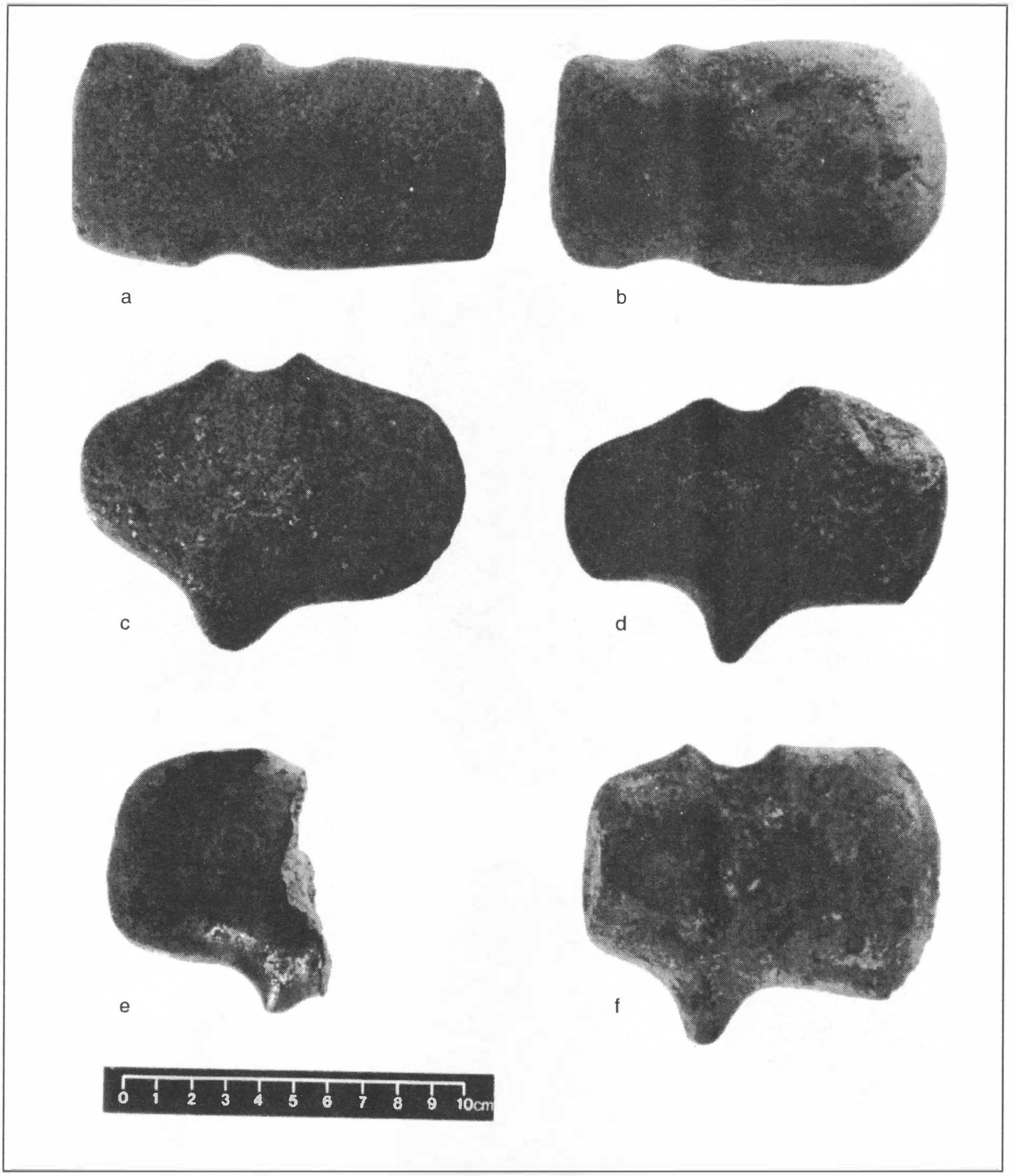


Plate 7.4 Lugged stone axes. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/ Level. **Data** – a: DJC: surface; b: Malsang; c: Pororan; d: Hetau; e: DJL.1: surface; f: DJU.1: surface.

may have been mounted as an adze although there is no well defined bevel. This is the largest specimen collected with a length of 234 mm and midpoint dimensions of 49.6 by 36.8 mm (Plate 7.5:a).

Hammerstones and anvils

This category of tool includes a range of implements made from volcanic rock and utilised in food processing and/or artefact manufacture. With the exception of a head fragment from a large pestle found on the surface at DBE, these artefacts are cobbles which range from rounded or oval to rectangular in both plan and cross-section and were hand-held. The rock types utilised are primarily basalt and andesite (dacite) although one granite hammerstone was collected from Area 6 on the reef at DAF. The distribution of the 14 specimens collected is shown in Table 7.9 and selected examples are illustrated in Plate 7.6.

Nine of the tools are rounded river cobbles up to 13 cm in diameter with oval cross-sections which had been used as both hammerstones and anvils as indicated by the presence of pecking or bruising on both lateral and terminal margins. Three of the cobbles have a minor amount of bruising on one or both lateral surfaces and two also have polished surfaces with clay adhering to the margins suggesting use as anvil stones for pottery

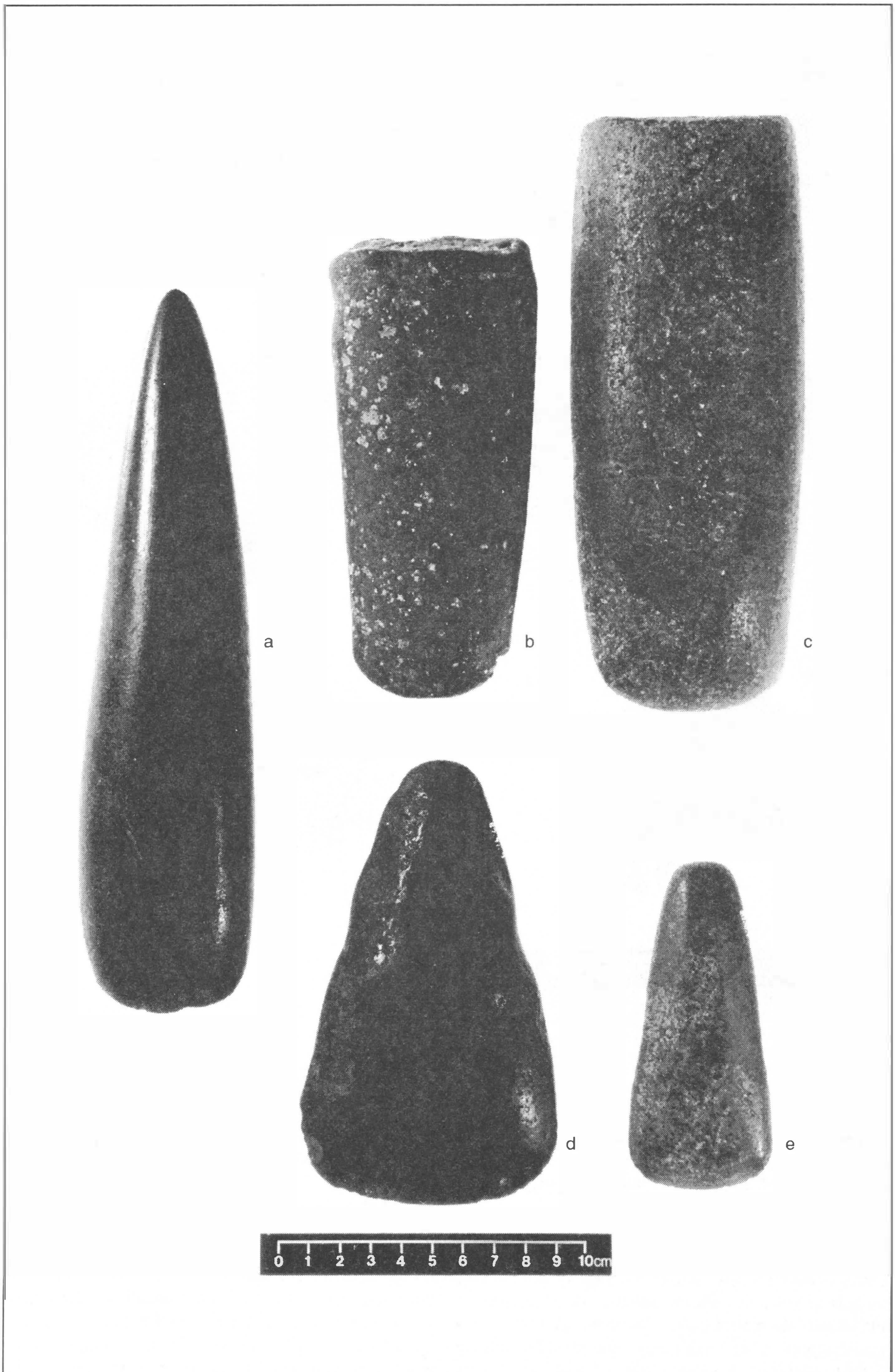


Plate 7.5 Stone axes. **Code** – Letter Designation: Site. **Data** – a: Iltopan; b: Malasang; c: Tohatsi; d: Iltopan; e: Suhin.

Site	Area	Unit	Layer	Level	Polished Pebble	Hammerstone/ Anvil
DAI	B		surface		0	1
DBZ			surface		0	1
DCU			surface		1	0
DJC			surface		0	1
DJE			surface		1	0
DAF	3		reef flat		0	1
DAF	6		reef flat		1	2
DAF	13	1	IB	3	0	1
DAF Subtotal					1	4
DKC		1	IIA	6	1	0
DJA		1	IA	4	0	1
DJA		3	IA	4	1	0
DJA		1	IA	7	1	0
DJA		1	IC/IIB/D	15	1	0
DJA		1	IIB/D	16	1	0
DJA Subtotal					4	1
DBE			surface		0	3 (1 pestle)
DBE		1	IA	1	0	1
DBE		2	II	5	1	0
DBE		3	V	7	2	0
DBE		1	V/IV	8	1	0
DBE		2	VI	12	2	0
DBE Subtotal					6	4
DJW			surface		0	1
DJU	1		surface		0	1
Total					14	14

Table 7.9 Distribution of hammerstones, anvils and polished pebbles.

manufacture (Plate 7.6:f, h). The remaining cobbles have deeper pecked depressions on the lateral surfaces which are either circular (Plate 7.6:d, g) or linear (Plate 7.6:a) and were most likely used as anvil stones for opening *Canarium* nuts, a practice which continues today. Another probable nut anvil from the upper Kilu Cave (DJA) deposit (Plate 7.6:b) has a shallow linear pecked depression on one surface and two deep (8 mm) lenticular-shaped pecked depressions on the opposite surface, which is well ground. Although the deeper depressions could have been used to hold *Canarium* nuts to be opened, the lack of bruising on the surrounding ground surface does not support this interpretation. Single examples of rectangular hammerstones with bruising on both terminal margins were collected from the surface of DJU and the reef and TP 1 at DAF (Plate 7.6:c, e).

A majority of the artefacts were collected from the surface of sites in association with Mararing and Recent style pottery. The three excavated specimens are from the Mararing to Recent phase deposit at DBE, the late Lapita to Sohano phase deposit at DAF and the upper deposit at DJA dated to the late preceramic period (although Buka style pottery is present in the uppermost levels). Similar hammerstones and anvils found by Specht (1969:269-70) are mainly associated with the Mararing to Recent phases but possibly the Malasang phase as well.

Grindstones and miscellaneous ground stone

The term 'grindstone' refers to rocks on which objects were ground that are differentiated from abraders on the basis of their shape and larger size (i.e. not hand-held). Two main types of grindstones are represented; those with multiple grooves formed by grinding narrow or sharply angled objects and those with more extensive, often slightly concave, surfaces from grinding larger flat objects. A further distinction was made between rough and smooth ground surfaces on ungrooved grindstones. As shown in Table 7.10, all but two of the 92 grindstone fragments (no definite complete examples were found) are from the reef sites, including two from the TP 1 deposit at DAF.

Five grindstone fragments up to 11 cm in diameter with shallow grooves up to 1 cm wide and several millimetres deep on a single surface were collected from reef sites DJQ (n=1) and DAF (n=4). In each case, both lateral surfaces have also been ground to a variable extent. A majority of the grindstones without grooves are small fragments that have been ground on both surfaces and the margins as well in some cases. Although some ground surfaces are flat, most are concave to some extent and the thickest example, from TP 1 at DAF, is 3 cm while most average 2 cm. Two grindstones, from Sites DJX and DAF, have a single well ground concave surface and a convex unmodified surface giving them a curved

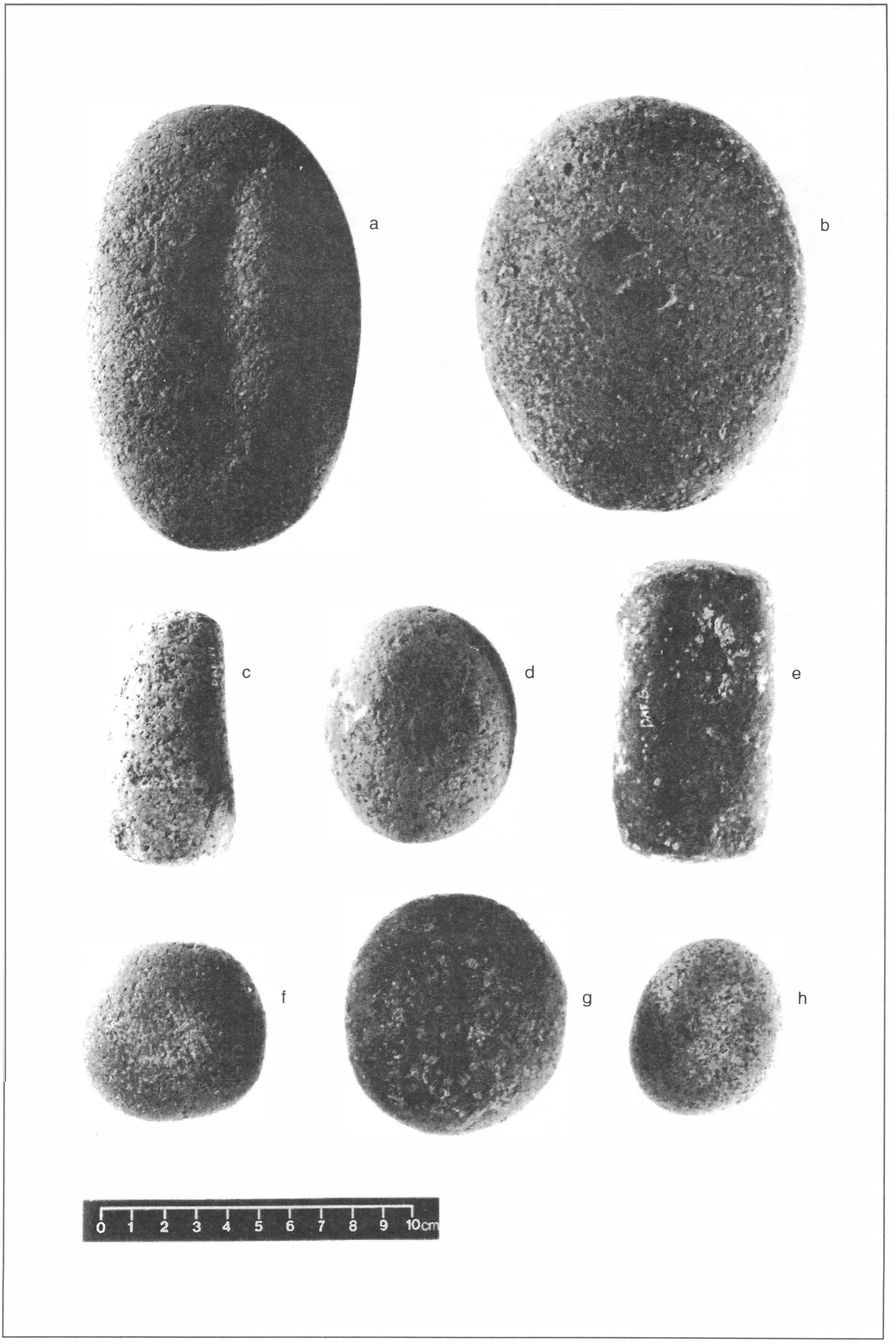


Plate 7.6 Hammerstones and anvils. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DBZ: surface; b: DJA: 1: IA/4; c: DAF: 1: IB/3; d: DBE: surface; e: DAF.6: surface; f: DJC: surface; g: DBE: 1: I/1; h: DBE: surface.

Site	Area	Unit	Layer	Level	Rough Surface	Smooth Surface	Grooved Surface	Misc. Ground Stone
DJH			surface		0	1	0	0
DJX			surface		1	0	0	0
DJQ	Lapita conc.		reef flat		0	0	0	2
DJQ	Tr.39-44(N)		reef flat		1	0	0	0
DJQ	Tr.43-50		reef flat		0	1	0	0
DJQ	Tr.51-54(S)		reef flat		0	0	1	0
DJQ Subtotal					1	1	1	2
DAA	1		reef flat		7	0	0	0
DAF	1		reef flat		16	9	1	0
DAF	2		reef flat		7	17	2	1
DAF	3		reef flat		10	11	0	0
DAF	4		reef flat		0	1	0	0
DAF	5		reef flat		0	1	0	0
DAF	6		reef flat		0	0	1	1
DAF	7		reef flat		0	2	0	0
DAF	TP 1	1	IB	2	0	1	0	0
DAF	TP 1	1	IB	5	0	1	0	0
DAF Subtotal					33	43	4	2
DBE		1	IIIA/B/II	4	0	0	0	1
DBE		1	IV/IV-V(M)	6	0	0	0	1
DBE Subtotal					0	0	0	2
Total					42	45	5	6

Table 7.10 Distribution of grindstones and miscellaneous ground stone artefacts.

profile. The frequency of specimens with rough versus smooth ground surfaces is nearly equal and relates to the type of rock utilised and the object being ground. Identification of a sample of grindstones by J. Sinton indicates that porphyritic andesite is the most common rock type although the specimen from DJX may be diorite and examples of siltstone also occur.

The distribution of grindstones at the reef sites is clearly similar to that of the other lithic artefacts, primarily adzes and abraders, associated with Lapita ceramics. At least six grindstone fragments collected from the DES reef site on Nissan closely resemble those from the Buka reef sites. There is a distinct clustering of grindstones and other lithic artefacts within the reef sites suggestive of activity areas related to artefact production. At DJQ, grindstones were found at the western end of the site where Lapita ceramics were concentrated and at DAA and DAF they are concentrated on the south central portion of the reef together with adzes, abraders and other lithic artefacts. Nearly all of the grindstones come from DAF (87.0%; n=80) and 91.5% of these are from Areas 1 to 3 on the south central portion of the reef. Grindstones do not reappear in the archaeological record until the Mararing to Recent phase as documented by two surface finds from Sites DJH and DJX and examples recovered by Specht (1969:269). As with the stone axes and adzes, the apparent chronological gap in the distribution of this artefact type may reflect inadequate sampling of post-Lapita sites.

Miscellaneous ground stone artefacts were found at reef sites DJQ and DAF in addition to Palandraku Cave (DBE) as indicated in Table 7.10. A disc-shaped piece of breccia 5.5 cm in diameter and 2 cm thick with smooth surfaces and a probable grindstone fragment with a maximum diameter of 5.5 cm were collected from DJQ. One of the DAF items is trapezoidal in plan with highly polished surfaces and slightly bevelled ground margins and the other is 4.5 cm long and oval in plan with all surfaces completely ground. Both are ca. 6 mm thick and may be ornaments of some kind although neither is complete. The DBE artefacts are small (less than 3 cm) fragments of volcanic rock with well ground surfaces from the upper preceramic deposit whose function is unknown.

Stone abraders

Hand-held abraders or files used in artefact manufacture were collected primarily from the surface of the reef sites although a few examples were found at DJW and DJA. As shown in Table 7.11, nearly all of the 152 abraders collected are from the reef at DAA (n=93; 61.2%) and DAF (n=52; 34.2%) where they were concentrated in the same areas as the stone adzes and grindstones discussed above. A distinction was made between artefacts manufactured of rough textured rock (tuffaceous sandstone and lapilli tuffs) and smoother textured rock (olivine and pyroxene phyric andesites and possibly volcanic breccia). Smooth textured abraders are nearly twice as common as rough specimens suggesting a greater emphasis on the final stage of artefact manufacture where finer grinding would have been required. A majority of the abraders are long (up to 8 cm) and narrow (usually less than 3 cm) and a substantial number (n=63; 42%) are tapered from the proximal to distal end from use-wear as indicated in Table 7.12. Most of the tools are incomplete and dominated

Site	Area	Unit	Layer	Level	Rough Abrader	Smooth Abrader
DJQ	Tr. 53-64 (Lapita conc.)		reef flat		0	1
DAA	1		reef flat		31	47
DAA	2		reef flat		7	8
DAA Subtotal					38	55
DAF	1		reef flat		1	16
DAF	2		reef flat		2	14
DAF	3		reef flat		2	3
DAF	4		reef flat		3	1
DAF	5		reef flat		0	1
DAF	6		reef flat		0	1
DAF	7		reef flat		1	2
DAF	8		reef flat		3	2
DAF	13	1	IB	3	1	0
DAF Subtotal					13	40
DJA		2	IC	10	1	0
DJW			surface		0	1
DJW		1	I/IIA/B	2	0	2
DJW		1	IIB/A	4	0	1
DJW Subtotal					0	4
Total					52	100

Table 7.11 Distribution of stone abraders.

by midsections (81%) with lesser amounts of proximal (16%) and distal (3%) fragments.

A classification system based on abrader cross-section was devised as a means of differentiating tools which may have been utilised for different tasks (e.g. different stages of manufacture or types of raw material). Seven cross-section types and one sub-type were defined and their distribution frequencies are found in Table 7.13. Cross-sections range from square (Type I) and rectangular (Type II) to subtriangular/ trapezoidal (Type III), triangular (Type IV) and curvilinear. Curvilinear forms include lenticular (Type V), oval (Type VI), plano-lateral (Type VIa) and round (Type VII) cross-sections. Nearly equal amounts of triangular to trapezoidal (37%), square to rectangular (35%) and curvilinear (28%) cross-sections are represented.

There is a temporally significant distinction between abraders from the reef sites and other sites. The reef examples almost certainly date to the Lapita phase and are part of lithic assemblages which include the adzes and grindstones previously discussed. The single abrader from DJQ was found in the Lapita pottery concentration area (Tr. 53-64), the majority of those from DAA were found in a lithic concentration on the outer reef in Area 1 and nearly all of the DAF sample is from Areas 1 and 2 on the central reef associated with grindstones and adzes. Four probable abrader fragments with curvilinear Type VI cross-sections were also collected from the reef at DES on Nissan. Of the four abrader forms from Buka recognised by Specht (1969:267-8), Form 1 is the only one typical of those found at the reef sites and the two dated examples are associated with Buka style and early Sohano style ceramics from Site DAA. The presence of an abrader in the TP 1 deposit at DAF supports this association. Abrader fragments found in the DJA (n=1) and DJW (n=3) deposits are small pieces of andesite with lenticular to oval cross-sections which date to the preceramic at DJA and late Sohano to early Hangan phase at DJW. A larger abrader fragment of uncertain age with an oval cross-section was collected from the surface of DJW.

The available evidence suggests that changes may have occurred in the type of abraders being utilised following the Lapita phase reflecting the type of artefacts being manufactured by these tools. It is uncertain what sort of function was served by the abraders from the reef sites but the variety of forms represented suggests some differentiation of activities. No pattern was evident in the distribution of cross-section forms on the reef sites with similar amounts of the three major formal classes represented. The differences between these forms may simply be the result of the different types of artefacts being produced, which probably included a variety of shell tools and ornaments. Unfortunately, no shell artefacts were preserved on the reef flats at these sites.

Pumice abraders

Five pieces of pumice with ground surfaces were recovered from four sites as shown in Table 7.14. Three of the pieces are small (4.5 cm or less in diameter) with single flat grinding facets and come from late Lapita deposits at DAF and DBE and the Mararing to Recent phase deposit at DBE. The other two pieces of pumice are larger (6-9 cm) and have a series of abraded U-shaped grooves. One specimen was found in the upper Malasang phase deposit at DJO-D and has two shallow and one deep (up to 15 mm) groove. The other example is from the surface of

Site	Area	Unit	Provenience (Layer/Level)	Rough	%	Smooth	%	Taper	%	Proximal	%	Mid-section	%	Distal	%	Total
DJQ	Tr. 53-64 (Lapita conc.)		reef flat	0	0	1	100	1	100	1	100	0	0	0	0	1
DAA	1		reef flat	31	40	47	60	36	46	10	13	65	83	3	4	78
DAA	2		reef flat	7	47	8	53	4	27	2	13	12	80	1	7	15
DAA Subtotal				38	41	55	59	40	43	12	13	77	83	4	4	93
DAF	1		reef flat	1	6	16	94	4	24	2	12	15	88	0	0	17
DAF	2		reef flat	2	13	14	88	6	38	3	19	13	81	0	0	16
DAF	3		reef flat	2	40	3	60	4	80	2	40	3	60	0	0	5
DAF	4		reef flat	3	75	1	25	2	50	0	0	4	100	0	0	4
DAF	5		reef flat	0	0	1	100	1	100	1	100	0	0	0	0	1
DAF	6		reef flat	0	0	1	100	1	100	1	100	0	0	0	0	1
DAF	7		reef flat	1	33	2	67	1	33	1	33	2	67	0	0	3
DAF	8		reef flat	3	60	2	40	1	20	1	20	4	80	0	0	5
DAF	13	1	IB/3	1	100	0	0	0	0	0	0	1	100	0	0	1
DAF Subtotal				13	25	40	75	20	38	11	21	42	79	0	0	53
DJA		2	IC/10	1	100	0	0	1	100	0	0	1	100	0	0	1
DJW			surface	0	0	1	100	1	100	1	100	0	0	0	0	1
DJW		1	1/2	0	0	2	100	-	0	0	0	2	100	0	0	2
DJW		1	IIB/A/4	0	0	1	100	-	0	0	0	1	100	0	0	1
DJW Subtotal				0	0	4	100	3	75	1	25	3	25	0	0	4
Total				52	35	100	65	63	42	25	16	123	81	4	3	152

Table 7.12 Descriptive data for stone abraders including material, tapering and region.

Area 1A at DJU where Mararing and Recent style pottery was collected and has a flat ground surface with three shallow grooves up to 8 mm in width. Specht (1969:265-6) recovered worked pieces of pumice with both grooved and flat ground surfaces from early Sohano phase to Mararing and Recent phase contexts on Buka. Pumice was used in the manufacture of artefacts in much the same manner as the grindstones discussed above. The flat ground surfaces would have been produced by working artefacts with flat surfaces such as shell beads while the grooves are associated with the finishing stages in the manufacture of artefacts with circular cross-sections. Grooved stones from sites elsewhere in the Southwest Pacific have been interpreted as being associated with arrow shaft production (Best 1984:444-5; Garanger 1972:80).

Coral artefacts

The distribution of branch and block coral artefacts with ground surfaces is found in Table 7.14. The *Acropora* sp. branch coral specimens are fragments of abraders or files in which the naturally rough surface has been ground smooth from use. Three examples have one end abraded producing a smooth tapered appearance (Plate 7.7:a,d,e) while grinding is restricted to one side of a fourth tool (Plate 7.7:c). The final example is the proximal 'handle' portion of an abrader for which the surface has been ground smooth to provide a grip (Plate 7.7:b). Three of the branch coral abraders are from the late Hangan to Malasang phase deposits at DJO-A (n=1) and DJO-D (n=2) and the fourth was found on the surface at DJW.

Three pieces of block coral (possibly *Porites* spp.) which had been used as abraders were recovered. These include a triangular block with two flat ground surfaces from the Mararing to Recent phase deposit

Site	Area	Unit	Provenience/ Layer/Level	I	II	III	IV	V	VI	VIa	VII	Total
DJQ	Tr. 53-64 (Lapita conc.)		reef flat	0	0	0	1	0	0	0	0	1
DAA	1		reef flat	14	18	14	14	6	2	7	2	77
DAA	2		reef flat	1	4	1	5	0	1	3	0	15
DAA Subtotal				15	22	15	19	6	3	10	2	92
%				15	24	16	21	7	3	11	2	100
DAF	1		reef flat	1	3	2	4	3	0	0	1	14
DAF	2		reef flat	2	2	1	6	1	1	3	1	16
DAF	3		reef flat	1	1	1	2	0	0	0	0	5
DAF	4		reef flat	1	0	1	1	1	0	0	0	4
DAF	5		reef flat	0	0	0	0	0	0	1	0	1
DAF	6		reef flat	0	0	1	0	0	0	0	0	1
DAF	7		reef flat	0	1	0	0	1	0	0	1	3
DAF	8		reef flat	1	2	0	0	1	0	0	0	5
DAF	12	1	IB/3	1	0	0	0	0	0	0	0	1
DAF Subtotal				7	9	6	13	7	1	4	3	50
%				14	18	12	26	14	2	8	6	100
DJA		2	IC/10	0	0	0	0	1	0	0	0	1
DBE		2	VI/11	0	0	0	0	1	0	0	0	1
DJW			surface	0	0	0	0	0	1	0	0	1
Total				22	31	21	33	14	5	14	5	145
%				14	21	14	23	10	3	10	3	100

Table 7.13 Distribution of stone abraders by cross-section type.

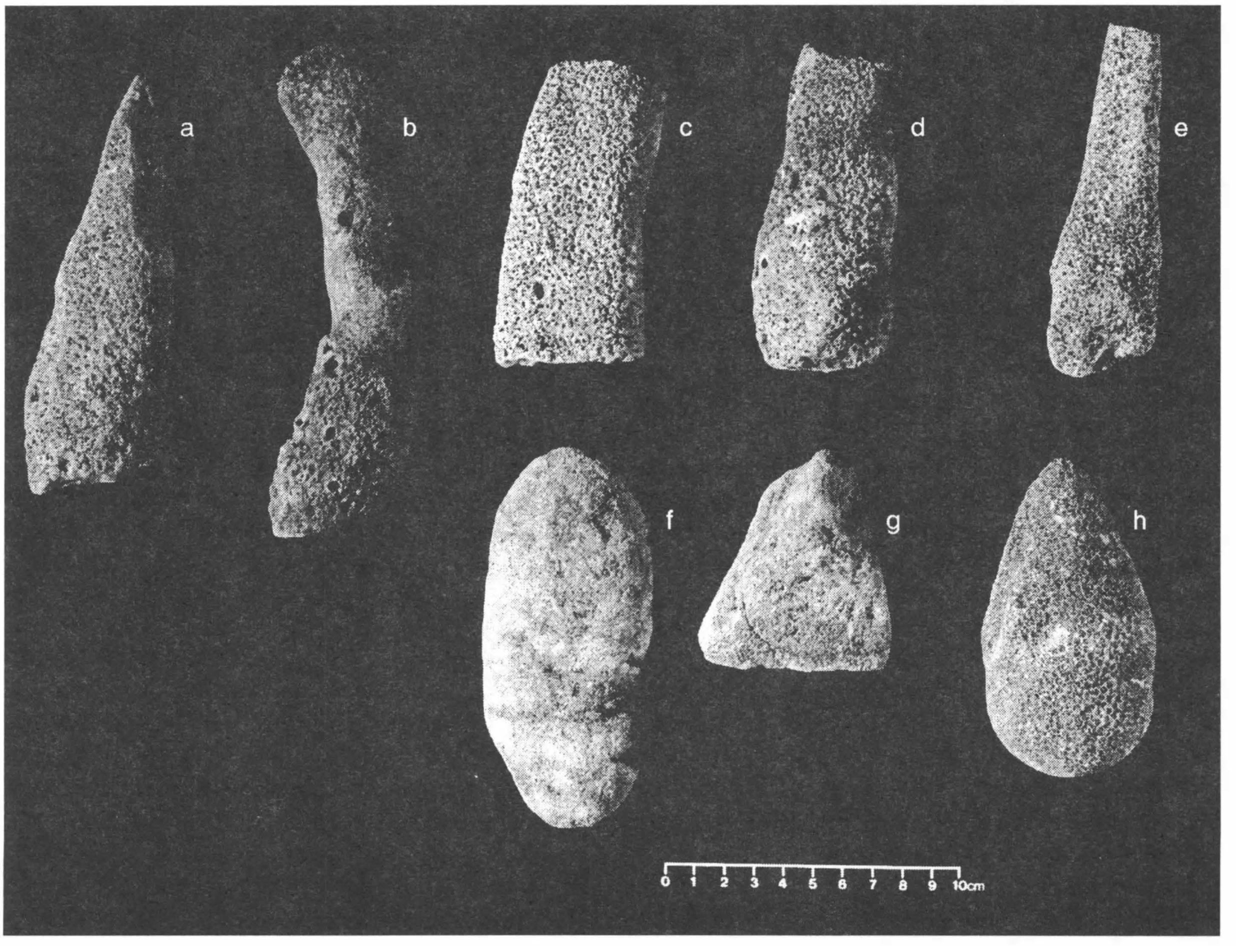


Plate 7.7 Coral abraders (a-g) and pounder (h). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJW: surface; b: DJO-D: 1: IIA/5; c: DJV: surface; d: DJO-D: 4: IIA-B/5; e: DJO-A: 1: I/1; f: DJO-D: 1: IIA/4; g: DBE: 2: II/4; h: DJW: surface.

Site	Area	Unit	Layer	Level	Block Coral	Branch Coral	Pumice
DJV			surface		0	1	0
DAF	13	1	IB	6	0	0	1
DBE		3	IIIA/B	3	0	0	1
DBE		2	II	4	1	0	0
DBE		2	IV/II	6	1	0	1
DBE Subtotal					2	0	2
DJW			surface		1	1	0
DJW		1	IIB/A/I	3	1	0	0
DJW Subtotal					2	1	0
DJU	1A		surface		0	0	1
DJO	A	1	I/II	1	0	1	0
DJO	D	1	IIA/feature 1	Zone 3	0	0	1
DJO	D	1	IIA/feature 1	Zone 4	1	0	0
DJO	D	1/4	IIA/B	Zone 5	0	2	0
DJO Subtotal					1	2	1
Total					5	5	5

Table 7.14 Distribution of coral and pumice artefacts.

at DBE (Plate 7.7:g), an oval shaped piece of coral from the Malasang phase deposit at DJO-D with most of the surface ground smooth (Plate 7.7:f) and a small (3 by 2 cm) piece of coral with two parallel sharply angled grooves ground into one surface found in the upper DJW deposit dating to the transition from the Sohano to Hangan phase. A conical block coral pounder or pestle possibly used for grinding ochre was collected from the surface of DJW. The distal portion had been ground down giving a slightly waisted appearance to the midsection (Plate 7.7:h). A piece of coral found in the late Lapita deposit at DBE which had been shaped into a semi-crescent form 2.1 cm long and up to 1 cm wide may be an ornament fragment.

Although no coral artefacts were found by Specht on Buka in 1967, sea urchin spine files were identified in Sohano and late Hangan phase deposits. Abraders and files similar to those described above are a common artefact type in sites dating back to the Lapita period in both Melanesia and Polynesia (e.g. Best 1984:437; Kirch 1988c:212; Kirch and Yen 1982:253-5; Kirch et al. 1991; Poulsen 1987).

Miscellaneous stone artefacts and manuports

Three types of material are discussed in this section: highly polished pebbles, haematite and pigments used as colouring agents, and pieces of probable heat-altered clay.

Pebble manuports

As indicated in Table 7.9, a total of 14 polished pebbles was recovered from the excavations and surface collections. The majority are rounded volcanic (andesite) river cobbles with no evidence of human modification although those from the surface of several sites (DJE, DCU and DAF) may have been used as anvil stones in pottery manufacture. All of the excavated examples are from the shelter sites DKC (n=1), DJA (n=4) and DBE (n=6) and were distinguished from volcanic oven stones by their highly polished surfaces. At DJA pebbles are found in both Pleistocene and Holocene deposits and five of the six examples at DBE are from the preceramic levels. Specht (1969:270-1) stated that small rounded pebbles (including coral and volcanic rock) were the most common lithic artefact found during his Buka excavations.

Colouring agents

This category includes two types of rock: hard, heavy pieces of red siltstone or haematite and softer angular pieces of light red to reddish yellow clay or mudstone pigment. Four pieces of siltstone up to 3.8 cm in diameter were recovered from DAF (Areas 1, 2, 4 and TP 1) and those from the reef have multiple grinding facets. Most of the clay-like material comes from DBE where eight larger pieces (up to 3.3 cm) and numerous smaller 'crumbs' were located in the preceramic deposit. Three pieces from TP 2 (level 10) and TP 1 (level 13) have single shallow grooves ground into the surface. Single pieces of unmodified mudstone were found on the surface at DAF (Area 12), in the Pleistocene deposit at DJA (TP 2, level 17) and near the base of the DJW deposit (TP 1, level 9).

Heat-altered clay?

Irregular shaped small (less than 2.5 cm) pieces of reddish brown material found in the DJA (n=17) and DBE (n=8) deposits have the appearance of clay which has been exposed to heat from hearths or other sources. Several pieces have slight impressions which may have been made by fingers. A majority of the pieces at DJA (n=13) are from the uppermost levels where Buka style and Mararing to Recent style pottery was present and the remainder are from the preceramic Holocene deposit. At DBE all pieces occur in the Mararing to Recent phase deposit. The most plausible explanation for this material is the alteration of clay through exposure to heat from hearths. This interpretation is supported by the presence of blackened surfaces or smudging on some pieces.

Ground pottery sherds

Two types of modified pottery sherds were found during the present study: ground discs and sherds with bevelled to rounded ground margins. All of the discs are made from undecorated Lapita pottery collected from the reef at DAF and are discussed in Chapter 4. The other ceramics with ground margins include 18 plain and two decorated body sherds from four site locations (see Table 7.15 for distribution). In each case at least one margin has been:

1. ground to form either a rounded (n=3) or flat (n=2) edge; or
2. bevelled on one (n=8) or both surfaces (n=7) to form a pointed edge.

Most sherds are less than 8 cm in diameter although the largest has a maximum diameter of 24 cm.

A majority of the ground sherds were found in late Hangan and Malasang phase deposits at DJO in Area A (n=3), Area B (n=2) and Area D (n=7) and include two decorated Malasang style sherds. Five sherds were found in the Hangan phase deposit at DJU and single Recent style sherds were collected from the surface at DBB and DCQ, sites originally recorded by Specht. Specht (1969:264) found two sherds with rounded and bevelled ground margins from the DAA deposit probably dating to the Malasang phase. Whether the sherds functioned as tools or ornaments is unknown and no references to ground sherds, other than discs from Lapita sites, were found in archaeological reports from Island Melanesia or Western Polynesia. However, ceramics with ground margins have been reported from Latte period (post AD 1000) sites on Guam in the Mariana Islands (Davis et al. 1992:180; Reinman 1977) and elsewhere in Micronesia.

Site	Area	Unit	Layer	Level	Total
DBB	A		surface		1
DCQ			surface		1
DJU	4		surface		1
DJU	3	1	I	1	1
DJU	3	2	IIB	5	1
DJU	3	2	IIB	6	1
DJU	3	1	IIC/B	7	1
DJU Subtotal					5
DJO	B	S.T.1	I		1
DJO	B		surface		2
DJO	A	1	II	5	1
DJO	A	1	II	6	1
DJO	A	1	II	8	1
DJO	D	4	IA	Zone 1	1
DJO	D	4	IIA/feature 1	Zone 3	1
DJO	D	2	IA/IIA/B	Zone 3	2
DJO	D	2	IIA/B/IIIB	Zone 4	1
DJO	D	4	IIB	Zone 5	1
DJO	D	3	IIIB	Zone 6	1
DJO Subtotal					13
Total					20

Table 7.15 Distribution of ground pottery sherds.

SHELL TOOLS

Although adzes are the primary shell tool type, ground gastropods, trolling hook shanks and bivalve scrapers and peelers were also recovered during the field investigations. The distribution of the principal artefact categories is found in Table 7.16. Pieces of pearl shell (*Pinctada*) and *Turbo marmoratus* manufacturing waste from ornament or tool production are also discussed in this section.

Tridacna adzes

Analysis of shell adzes in Oceania has been directed nearly exclusively at establishing typologies for culture historical purposes although more recent studies have begun to shift the focus towards a wider range of problems including technology, function and ecological variables (Kirch and Yen 1982; Moir 1986). The shell adze assemblage from Buka, comprised exclusively of *Tridacna* (Giant Clam) species, was sufficiently large to permit a more detailed analysis with 20 complete or fragmentary finished examples, 13 preforms and seven blanks. Unfortunately, only four of the finished adzes, a single preform and five blanks were obtained from controlled excavations. However, many of the surface finds can be dated by phase based on the styles of ceramics with which they were associated.

Apart from a single specimen in the preceramic deposit at DJA, all adzes date to the late Sohano to Recent phases. The adze analysis utilised discrete and continuous (metric) attributes patterned on those employed by Kirch and Yen (1982:206-32) for adzes from Tikopia. This attribute-based approach enabled individual traits to be assessed independently without *a priori* definition of types. Descriptive information is presented for each of the finished adzes in Table 7.17 and preforms in Table 7.18. Finished adzes are illustrated in Plates 7.8 and 7.9.

All of the adzes which could be identified taxonomically are *Tridacna maxima*, with the exception of four preforms of *Tridacna crocea* from Sites DJU, DJV and DJW. Only adzes from the dorsal valve region with the longitudinal axis oriented in a posterior-anterior direction across the fold interstices are represented in the assemblage. The production sequence for adze manufacture was reconstructed through examination of manufacturing debitage found during excavation in addition to blanks and preforms. Following reduction of the valve into rough blanks, preforms were produced by flaking from the exterior surface through direct percussion. The relatively high frequency of complete preforms (n=6; 46.1%) suggests that they were produced and set aside for later grinding. A few of the finished adzes have minimal grinding (n=3) and the rest are either moderately (n=9) or extensively (n=7) ground. None are totally ground, a trait most often associated with hinge region adzes.

Adze morphology was recorded by means of discrete and continuous attributes and although only four of the finished adzes are complete, most of the attributes could be recorded on a majority of the specimens. No clear chronological change was evident in any of the attribute frequencies although the small sample size makes it difficult to insure that the results are representative. The only

Site	Area	Unit	Layer	Level	Adze	Adze Preform/Blank	Bivalve Scraper	Trolling Hook Shank
DCQ			surface		1	0	0	0
DJC			surface		0	0	2	0
DJK			surface		0	0	1	0
DJV			surface		3	5	1	0
DJX			surface		1	0	0	0
DJY			surface		1	1	0	0
Subtotal					6	6	4	0
DJA		1	IA	2	0	0	1	0
DJA		1	IC	10	1	0	0	0
DJA Subtotal					1	0	1	0
DBE			surface		1	0	0	1
DJW			surface		4	4	1	0
DJW		1	I	1	0	1	0	0
DJW		2	I/IIB/A	2	0	1	0	0
DJW		1	IIB/A/I	3	1	0	0	0
DJW		2	IIB	4	0	2	0	0
DJW		2	IIB/IID	7	0	2	0	0
DJW Subtotal					5	10	1	0
DJU	General		surface		0	1	0	0
DJU	1/1A		surface		2	3	0	1
DJU	3		surface		3	0	0	0
DJU	3	1	IIB	4	0	0	0	1
DJU	3	1	IIC	8	1	0	0	0
DJU Subtotal					6	4	0	2
DJO	D	1	IIA/feature 1	Zone 4	0	0	1	0
DJO	D	4	IIB	Zone 5	1	0	0	0
DJO	D	4	IIB/IIIA/B	Zone 7	0	0	0	1
DJO Subtotal					1	0	1	1
Total					20	20	7	7

Table 7.16 Distribution of shell tools.

attribute exhibiting some variability over time is adze cross-section, with the four quadrangular examples restricted to the Mararing and Recent phases. The remaining adzes have elliptical to oval cross-sections except for two plano-convex specimens. A distinction was made between adzes with parallel sides (six finished adzes and seven preforms) and those angled from the bevel to the butt forming either isosceles (ten finished and two preforms) or right-angled (one preform) triangles in plan. All but two of the bevel edges are curved rather than straight and butt form is either pointed (four finished adzes and five preforms) or rounded (four finished adzes and one preform) with the exception of a single blunt specimen which is extensively ground (Plate 7.8:l).

Metrical attributes fall within the range of those recorded on a much larger sample of dorsal region adzes from Tikopia by Kirch and Yen (1982:Plate 85) although the Buka adzes are thinner and have wider bevels than the Tikopia average. Three of the Kirch and Yen (1982: Plate 88) adze types are represented in the Buka assemblage: Type 2 (n=3) which has minimal grinding, Type 3 (n=4) which is a rounded butt form and Type 4 (n=4) which is distinguished by a pointed butt.

The lack of fully ground adzes and plano-convex cross-sections on Buka is consistent with the absence of hinge region adzes which display these attributes. Hinge region adzes are also clearly associated with Lapita assemblages from a wide geographic area (Kirch and Yen 1982:230-1). Unfortunately, no adzes were recovered from Lapita sites on Buka. The absence of adzes and other shell artefacts from the reef sites is most likely due to a lack of preservation.

Only one adze fragment was found in deposits earlier than the late Sohano phase. The presence of what appears to be a midsection fragment of a finished adze with minimal grinding in the lower Holocene deposit at DJA (TP 1, level 10) dating to ca. 8000 BP indicates that shell adzes were in use during the preceramic period. *Tridacna* adzes have also been recorded at the Pamwak rockshelter site on Manus between 7000 and 10,000 years ago (Fredericksen et al. 1993). *Tridacna* adzes were common by the late Sohano phase as demonstrated by the presence of finished adzes, preforms and blanks from the DJW deposit. A number of adzes were also found during excavations and on the surface of Area 3 at DJU dating to the middle Hangan phase. A single adze was recovered from the DJO-D deposit dating to the transition from the Hangan to Malasang phase. A majority of the surface adzes are from the Mararing to Recent phase.

Specht (1969:287-8) found nine *Tridacna* adzes, including three complete specimens, in datable contexts from the Sohano to Recent phases. Two adze forms were

Site/Area	Unit	Layer/Level	Status	Species	Grinding	Cross-Section	Side Angle	Bevel	Butt	Length (mm)	Thickness (mm)	Midpt. Width (mm)	Butt Width (mm)	Bevel Width (mm)	Bevel Angle	Weight (g)
DCQ		surface	2	1	3	2	2	0	1	40	4	38	22	0	0	10
DJV		surface	2	1	2	3	2	0	3	73	6	46	10	0	0	37
DJV		surface	3	1	2	2	1	2	0	58	6	46	0	47	0	37
DJV		surface	1	1	2	1	2	2	3	62	9	40	10	47	30	39
DJX		surface	3	1	2	3	1	2	0	75	11	74	0	77	0	153
DJY		surface	3	1	2	2	0	2	0	48	5	0	0	56	0	30
DJA	1	IC/10	4	1	1	2	0	0	0	40	8	0	0	0	0	24
DJW		surface	2	1	2	2	2	0	2	80	9	57	20	0	0	84
DJW		surface	3	1	3	2	1	1	0	85	7	0	0	67	0	102
DJW		surface	3	1	3	2	2	1	0	55	6	45	0	51	50	41
DJW		surface	3	1	3	2	1	2	0	63	5	48	0	47	35	41
DJW	1	IIB/3	3	1	3	2	1	2	0	50	7	0	0	0	30	13
DJU-1		surface	5	1	2	2	3	2	3	100	8	43	18	52	0	68
DJU-1A		surface	3	1	1	3	2	2	0	65	5	45	0	0	0	30
DJU-3		surface	1	1	2	3	2	2	2	56	6	32	20	37	30	28
DJU-3		surface	2	1	3	2	1	2	0	50	8	0	0	45	0	40
DJU-3		surface	2	1	2	2	2	0	2	60	5	48	20	0	0	31
DJU-3	1	IIC/8	2	1	1	2	2	0	2	60	6	45	18	0	0	29
DJO-D	4	IIB/5	5	1	3	2	2	0	3	70	7	37	13	0	0	50

Table 7.17 Descriptive data for finished *Tridacna* shell adzes.

Status		**Species**	**Degree of Grinding**	**Cross-section**	**Side Angle**	**Bevel Edge**	**Butt Morphology**
Finished Adze 1 complete 2 butt 3 bevel 4 midsection 5 complete with portion of bevel missing	Preform 1 complete 2 proximal (butt) 3 distal (bevel) 4 midsection 5 complete except for bevel portion 6 proximal or distal (indefinite)	1 *Tridacna maxima* 2 *Tridacna crocea*	1 minimal (flutes unground, sides/bevel ground) 2 medium (recessed and some protruding flutes visible) 3 extensive (only recessed flutes visible) 4 total	1 plano-convex 2 elliptical/oval 3 quadrangular (rectilinear)	1 parallel sides (no angle) 2 angled from bevel to butt (triangular) 3 one side straight, one angled (triangular)	1 straight 2 curved 3 pointed (arc covers less than half of length)	1 blunt 2 rounded (arc covers at least half of total length) 3 pointed (arc covers less than half of length)

Key to attribute codes for *Tridacna* shell adze analysis.

Site/Area	Unit	Layer/Level	Status	Species	Cross-section	Side Angle	Butt	Length (mm)	Thickness (mm)	Midpt. Width (mm)	Butt Width (mm)	Bevel Width (mm)	Weight (g)
DJV		surface	2	1	0	1	0	90	7	63	0	0	90
DJV		surface	2	1	2	0	1	65	10	54	43	0	66
DJV		surface	1	1	0	0	0	70	10	0	0	0	56
DJV		surface	1	1	0	2	3	90	6	49	13	47	59
DJV		surface	6	2	0	1	0	65	4	43	0	0	27
DJY		surface	2	1	0	2	2	90	7	0	0	0	90
DBE		surface	2	1	2	1	1	60	7	56	0	0	45
DJW		surface	6	1	0	1	0	100	10	70	0	0	154
DJW		surface	1	1	0	0	3	120	7	64	20	55	120
DJW	2	I/2	1	2	1	1	0	68	4	35	0	0	22
DJU		surface	5	1	0	3	3	83	8	65	10	0	67
DJU-1		surface	2	1	2	0	3	65	7	0	12	0	44
DJU-1		surface	4	2	2	1	0	59	8	55	0	0	35
DJU-1A		surface	1	2	2	1	3	92	4	44	12	37	36

Table 7.18 Descriptive data for *Tridacna* shell adze preforms.

identified by Specht, those with a sub-triangular (Kirch and Yen's Type 3) to triangular (Kirch and Yen's Type 4) outline and those with parallel sides and a probable blunt butt (Kirch and Yen's Type 3) of which no complete examples were found. Both adze forms come from the dorsal valve region and are generally well ground with rounded to flattened margins (oval to quadrangular cross-sections). A single *Cassis* lip chisel was found by Specht at the DAI site in a layer dating to the end of the Lapita phase (calBP 2344-1988, ANU-234) although the style of pottery with which it was associated is uncertain (1969:288). On Nissan, Spriggs (1991a:Table 7) recorded hinge region *Tridacna* adzes from the aceramic Halika phase and Lapita phase and dorsal region adzes from the late Hangan to Recent phases.

Ground gastropods

Several species of gastropods with one surface or opposing surfaces ground on the bevel in the apex region were found in the Holocene preceramic deposit at DJA and deposits with Buka and Sohano style ceramics at DAF and DKC. The distribution of these artefacts is presented in Table 7.19 and examples are illustrated in Plate 7.10. Shells from DJA are restricted to a single species, *Terebralia palustris* (Linn. 1758), commonly found on intertidal mud flats and also present in the midden at DJA and other sites. Worked examples are restricted to 11 apex fragments, three of which are ground on one surface (Plate 7.10:g, h) and the remainder on two opposing surfaces (Plate 7.10: a-d, f). The presence of grinding on opposing surfaces and lack of wear on specimens representing food remains strongly indicates that these shells were purposefully modified though their function remains unknown.

As the natural surface of this species of gastropod is fairly smooth it seems unlikely that they would have been utilised as abraders, and grinding to produce a pointed apex suggests use as chisels in a similar fashion as those made from *Terebra* shell. *Terebra* adzes or chisels are widely distributed in Oceania and a single specimen was found by Specht (1969:296) in association with Mararing and Recent style pottery on Buka. A majority of the examples from DJA (n=7) were found in the basal levels of the Layer IC Holocene deposit dating from 10,000 to 9000 BP although four specimens come from the upper levels of Layer IA which date to between 8000 and 5500 BP.

Gastropods with ground surfaces from Sites DAF and DKC on Sohano Island differ from those at DJA in terms of the taxa represented and type of grinding. Classification of these shells as artefacts is less certain than for the type found at DJA as all examples are ground on only one surface which may be due to natural abrasion by sand particles when the mollusc was alive. However, shells of the same species found in the midden at other sites did not have worn surfaces. The single DAF specimen and most of those from DKC are from the basal portion of the deposits where naturally occurring shell was mixed with food species. All but three examples, which are apex fragments, are nearly complete shells and the majority are from the species *Rhinoclavis vertagus* (Linn. 1758). A single *R. aluco* (Linn. 1758)

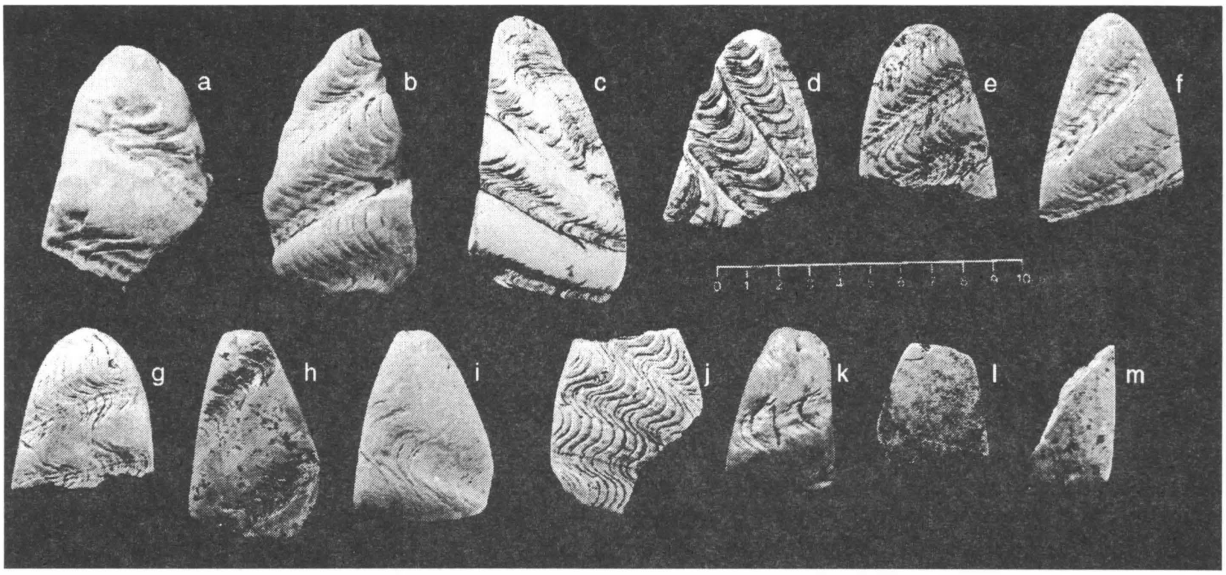


Plate 7.8 *Tridacna* shell adze preforms (a, b), complete finished adzes (c, h, i, k), butt fragments (d-g, l) and other incomplete adze fragments (j, m). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJW: surface; b: DJV: surface; c: DJU.1: surface; d: DJU.1: surface; e: DJU.3: 1: IIC/8; f: DJV: surface; g: DJU.3: surface; h: DJO-D: 4: IIB/5; i: DJV: surface; j: DJU.1A: surface; k: DJU.3: surface; l: DCQ: surface; m: DJW: 1: IIB/3.

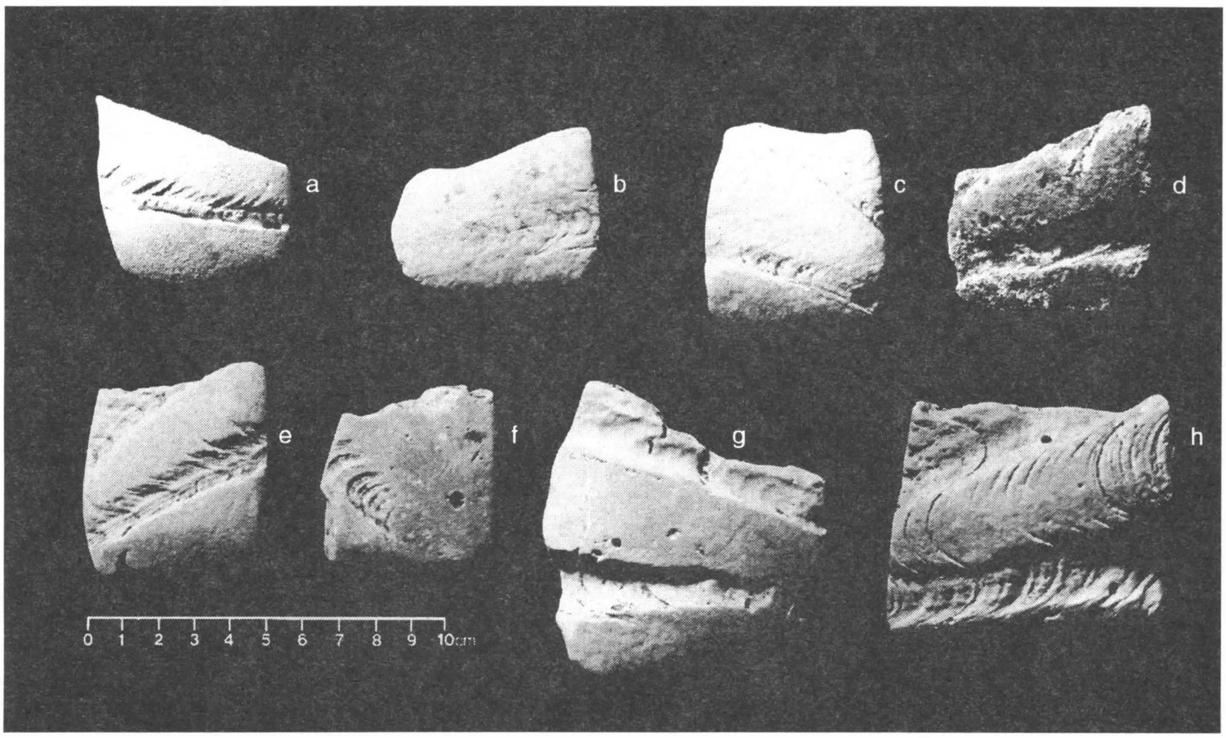


Plate 7.9 Bevel fragments of *Tridacna* shell adzes. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJU.3: surface; b: DJY: surface; c: DJV: surface; d: DBE: surface; e: DJW: surface; f: DJW: surface; g: DJW: surface; h: DJX: surface.

specimen (Plate 7.10:i) and apex fragment of an *Epitonium* sp. shell (Plate 7.10:e) were also recovered.

Compound fishhooks

Trolling hook shanks were received as gifts from local residents on Buka and recovered from both excavated deposits and surface collections. The distribution of shanks by site is found in Table 7.16 and all examples are illustrated in Plate 7.11. A complete trolling hook with a *Tridacna* shank and turtle shell point (Plate 7.11:a), turtle shell point blank and shank of *Conus* shell (Plate 7.11:c) were received from an elderly man at Malasang village. A shank formed from a piece of plastic was found on the surface at DBE (Plate 7.11:b) and an incomplete *Tridacna* shank was collected from Area 1 at DJU (Plate 7.11:d). Each of these examples are typical of trolling hooks still used for bonito fishing and have oval to plano-convex cross-sections, a knobbed shank head (snood) and shank tails with one to two side-lugs and a squared terminus. Analyses of trolling hook types from the late

19th and 20th centuries and their geographic distribution within the Solomons by Cummings (1973) and Bell et al. (1986) have demonstrated that hook forms in the Buka-north Bougainville area are distinct from those elsewhere in the archipelago. The validity of this distinction prior to European contact remains unknown.

The two excavated trolling hook shank fragments are quite different from the recent examples in raw material and form. Both are made of pearl shell from the hinge region of *Pinctada margaritifera* (Linn. 1758). The shank from the lower late Hangan deposit at DJO-D (TP 4, level 10) was cut along the central hinge portion of the valve and is missing the tail section but has an intact pointed head with two small knobs separated by a shallow groove (Plate 7.11:f). A shank tail fragment from the Hangan phase deposit at DJU (level 4) had been cut from the valve diagonally along the hinge and appears to be unfinished as the tail has not been modified for attachment of a point (Plate 7.11:e).

Site	Unit	Layer	Level	*Rhinoclavis vertagus*	*Terebralia palustris*
DAF	1	IB	9	2	0
DKC	1	IA/B	2	1	0
DKC	1	IB/C	3	2	0
DKC	1	IIA	6	4	0
DKC	1	IIB	7, 8, 10	4	0
DKC Subtotal				11	0
DJA	3	IA	3	0	3
DJA	3	IA	5	0	1
DJA	2	IC	12	0	2
DJA	2	IC	13	0	1
DJA	3	IC/IIA	11	0	4
DJA Subtotal				0	11
Total				11	11

Table 7.19 Distribution of ground gastropod tools.

Three incomplete pearl shell trolling hook shanks were found by Specht (1969:289) during excavations at DAI in association with late Sohano style pottery. These

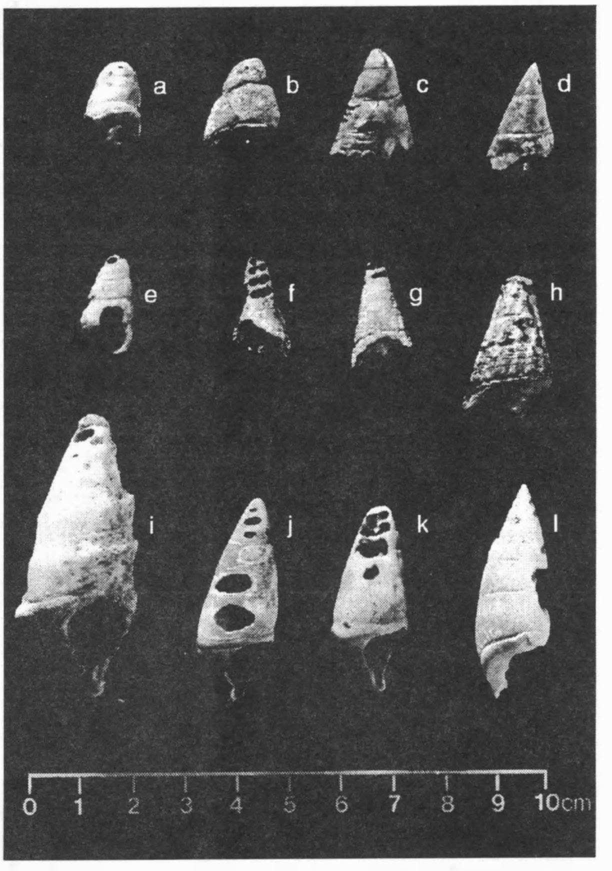


Plate 7.10 Gastropods with ground surfaces. **Code** – Letter Designation: Provenience Code (Site, Collection Area/ Transect): Excavation Unit: Layer/Level. **Data** – a: DJA: 2: IC/13; b: DJA: 3: IA/3; c: DJA: 2: IC/12; d: DJA: 3: IC/11; e: DKC: 1: IB/3; f: DJA: 2: IC/12; g: DJA: 3: IC/11; h: DJA: 3: IC/11; i: DKC: 1: IIB/8; j: DAF: 1: IB/9; k: DKC: 1: IIB/8; l: DKC: 1: IIB/10.

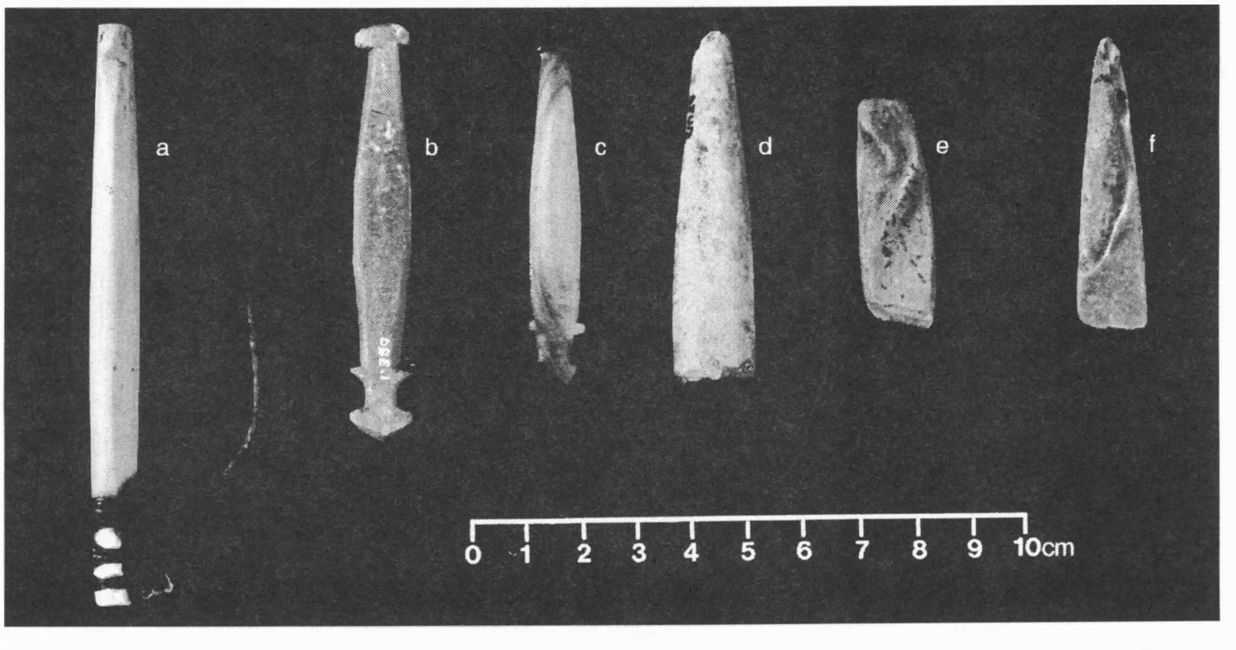


Plate 7.11 Complete compound trolling hook (a) and shanks (b-f). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: Malasang; b: DBE: surface; c: Malasang; d: DJU.1: surface; e: DJU: 1: IIB/4; f: DJO-D: 4: IIB/10.

examples differ from the shanks obtained during the present study in both head and tail form but exhibit the same general form. Thus pearl shell shanks were in use from the Sohano phase through the Hangan phase with the addition of *Tridacna* and *Conus* shanks by the Mararing to Recent phase. Blackwood (1935:328) states that *Turbo* and *Cassis* were also used for shanks ethnographically. Pieces of pearl shell manufacturing debris from site deposits which may be associated with trolling hook production are discussed in a separate section below.

Bivalve scrapers and peelers

Several types of modified bivalves assumed to have been utilised in food preparation were found and their distribution is indicated in Table 7.16. Valves with chipped perforations below the umbo and worn dorsal margins interpreted as coconut graters were found at three sites and include single *Spondylus* sp. specimens from the surface of DJV and DJW on Pororan Island (Plate 7.12:b, c) and a valve from the Cardiidae family (cf. *Trachycardium unicolor*) in the upper DJA deposit (Plate 7.12:d). Two of the valves have perforations with irregular margins but the DJV example is uniformly circular with smooth margins. These perforations appear to have been made in order to fasten the valves to a piece of wood or other object for use as coconut graters as has been recorded ethnographically in the Solomons and elsewhere in Oceania. The smooth margins on the DJV example could have been caused by abrasion of the shell surface against the lashings during use.

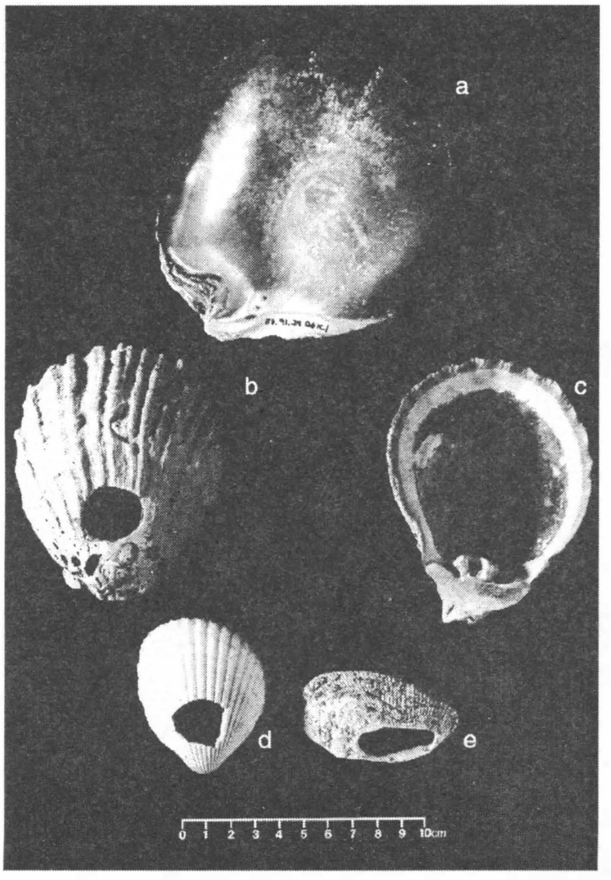


Plate 7.12 Bivalve scrapers and peelers. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJK: surface; b: DJV: surface; c: DJW: surface; d: DJA: 1: IA/2; e: DJO-D: 1: IIA/4.

Although this type of artefact was not collected by Specht, Blackwood (1935:274) records the use of Cardiidae valves attached to boards as coconut scrapers on Buka and possible examples have been recorded archaeologically from a wide geographic area including Vanuatu (Garanger 1972:51), Fiji (Best 1984:Plate 7.30, j) and Tonga (Poulsen 1987:184). Both of the *Spondylus* graters appear to be from the Mararing to Recent phase on the basis of associated pottery styles. The DJA example is from a level with a calibrated date of calBP 5587 (5447, 5404, 5328) 5285 (ANU-6757) although both Buka and Mararing style pottery was present in levels of comparable depth.

A single valve of *Barbatia* sp. from the upper DJO-D deposit (TP 1, level 4) dating to the late Hangan to early Malasang phase with a large perforation in the umbo region is interpreted as a scraper or peeler used in food preparation such as the processing of tubers (Plate 7.12:e). The smooth and slightly bevelled margin of the perforation is characteristic of use-wear in contrast to valves of similar species of bivalves with roughly chipped holes often identified as net sinkers by archaeologists in Oceania. Specht (1969:296) notes the presence of *Arca* valves with perforated umbos throughout the Buka sequence and suggests that some may be net sinkers. Similar perforations were found on *Anadara antiquata* valves from several sites in the present study but sufficient evidence to justify their classification as artefacts was lacking. As Spennemann (1993) has pointed out, breakage patterns on shells interpreted as 'tools' from archaeological deposits may be due to biogenic rather than anthropogenic factors and use-wear studies are necessary to distinguish artefacts from shells with a 'tool-like' appearance.

The final artefact type is represented by a single complete valve of pearl shell (*Pinctada margaritifera*) from the surface of the DJK rockshelter site at Hanahan found in association with Mararing and Recent style pottery (Plate 7.12:a) and two valve fragments from the cave site DJC at Malasang where Mararing style sherds were collected (Plate 7.13:e, f). The dorsal margins of the valves appear to have been worn smooth through use-wear and the exterior surfaces of the two fragments have been ground away to expose the pearly interior. Blackwood (1935:273 and Plate 38) recorded the use of pearl shell knives similar to these surface finds by women on Buka to peel uncooked taro corms.

Manufacturing waste

This category consists of pieces of worked shell that were discarded during the manufacture of tools and/or ornaments (Table 7.20). Two principal taxa are represented, *Turbo marmoratus* (green snail) and *Pinctada* cf. *margaritifera* (pearl shell), as well as miscellaneous species (primarily bivalves).

Pieces of broken *Turbo marmoratus* shell with probable chipped or ground margins were found in the late Lapita and preceramic phase deposits at DBE (n=11) and both Pleistocene and Holocene preceramic occupation

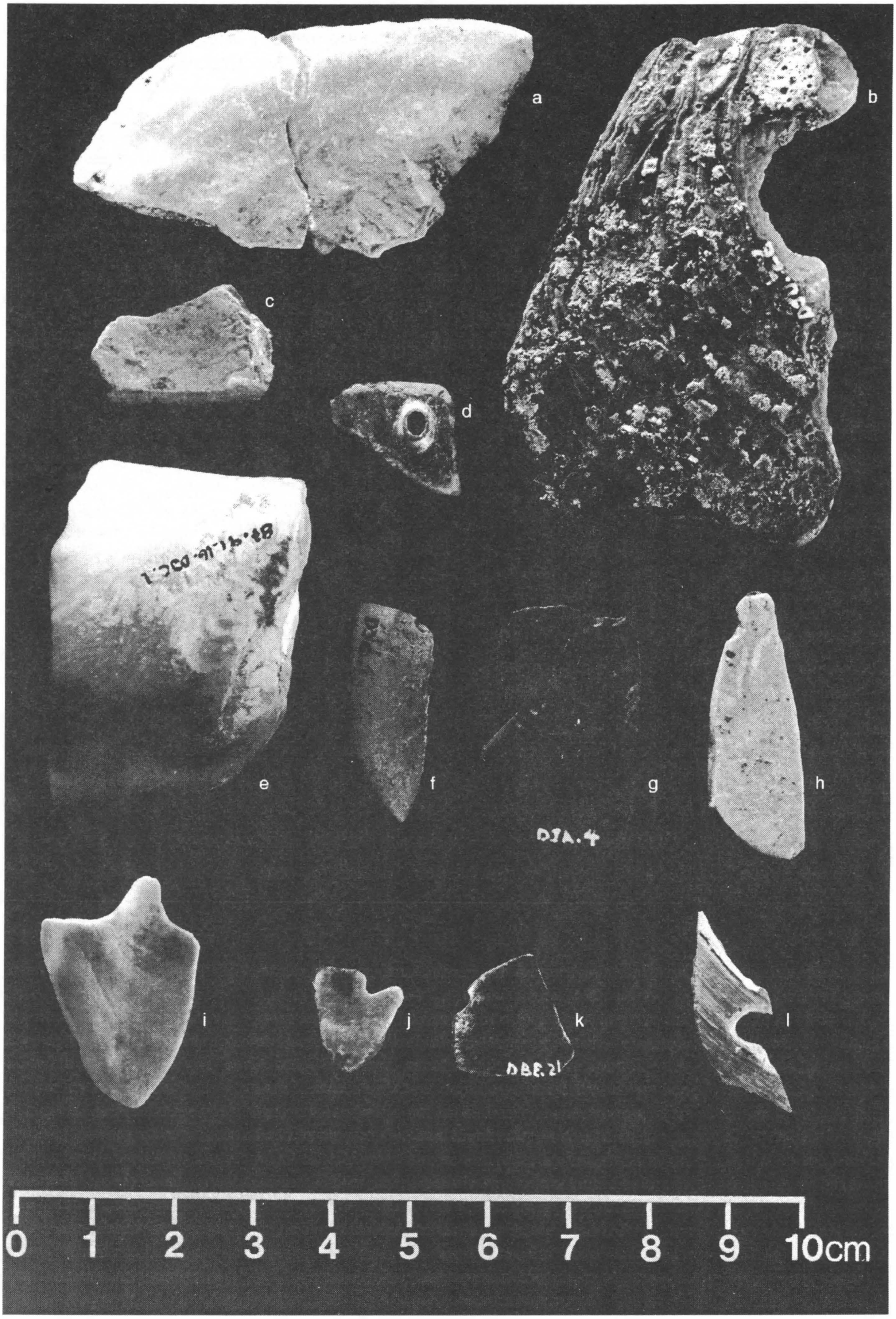


Plate 7.13 Shell artefact fragments and manufacturing waste. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJU: 2: IIB/8; b: DJU: 2: IIB/8; c: DJU: 2: IIB/8; d: DJA: 2: IA/1; e: DJC: surface; f: DJC: surface; g: DJA: 1: IA/2; h: DJU: 2: IIB/4; i: DBE: 2: IA/2; j: DBE: 2: II/4; k: DBE: 2: IV/6; l: DJA: 2: IA/1.

components at DJA (n=7), although the majority of pieces are from the upper DJA deposit where Buka and Mararing style ceramics were present. Most of the pieces are from the knobby ridged region of the shell which is less suitable for artefact production, although some of the larger pieces (up to 6 cm) may be blanks for the manufacture of fishhooks or ornaments. It is uncertain what was being manufactured as no finished artefacts from this species of shell were found.

Nine of the 15 pieces of probable worked pearl shell were found in the lower DJU Hangan phase deposit and the remainder are from the late Hangan deposit at DJO-A (n=2), both Mararing to Recent and preceramic phase deposits at DBE (n=2), late Lapita to Sohano phase deposits at DAF (n=1) and excavation level 2 of the DJA deposit (n=1). The margins of the shell fragments appear to have been modified through a combination of chipping (Plate 7.13:b), grinding (Plate 7.13:g) and cutting (Plate 7.13:a, c, h). Pieces with chipped margins are often fairly large and may represent the initial stages of artefact manufacture while pieces of cut shell, which often have bevelled margins, are either waste from more advanced stages of manufacture or discarded blanks. Several of the pieces with ground margins may be fragments of knives or scrapers similar to those discussed in the previous section. The types of artefacts being manufactured are unknown but may include trolling hook shanks and one-piece fishhooks, as well as ornaments.

Other types of worked shell include a triangular piece of *Nautilus* sp. septum with the siphuncle hole enlarged and two of the margins cut to form a right angle from TP 1, level 1 at DJA (Plate 7.13:d). This may be a discarded fragment of an ornament blank and is similar to an artefact found by Best (1984:481) at a site on Lakeba, Fiji. Pieces of worked shell from other species which were probably associated with ornament manufacture include three cut and notched bivalve fragments with pearly interiors (cf. *Modiolus* spp.) from both ceramic and preceramic levels at DBE (Plate 7.13:i-k) and a deeply notched fragment of a probable Tellinidae valve from level 1 of TP 2 at DJA (Plate 7.13:l).

SHELL ORNAMENTS

A majority of the shell artefacts recovered during excavation are ornament types widely distributed in Oceania. These include *Trochus* and *Tridacna* rings and associated waste material from different stages of manufacture, *Conus* rings and discs, an assortment of small perforated gastropods and various types of beads.

Site	Area	Unit	Layer	Level	*Turbo marmoratus*	*Pinctada*	Other Shell
DAF	12	1	IB	7	0	1	0
DJA		2	IA	1	0	0	2
DJA		2	IA	2	3	0	0
DJA		1	IA	2	0	1	0
DJA		1	IA	4	1	0	0
DJA		2	IIB/D	17	3	0	0
DJA Subtotal					7	1	2
DBE		2	IA	2	0	0	1
DBE		2	II	4	0	0	1
DBE		1	IIIA/B/II	4	0	1	0
DBE		1	IIIB/IV	5	3	0	0
DBE		2	IV/II	6	0	0	1
DBE		2	IV	7	1	0	0
DBE		1	IV/IV-V (mixed)	6	1	0	0
DBE		3	IV-V (mixed)/V	6	2	0	0
DBE		2	V/VI	9	1	0	0
DBE		2	VI/V	10	1	0	0
DBE		2	VI	12	0	1	1
DBE		1	VI/VII	13	2	0	0
DBE Subtotal					11	2	4
DJU	3	2	IIB	4	0	1	0
DJU	3	2	IIB	6	0	2	0
DJU	3	2	IIB/C	8	0	5	0
DJU	3	1	IIC	8	0	1	0
DJU Subtotal					0	9	0
DJO	A	1	I/II	1	0	1	0
DJO	A	1	II	7	0	1	0
DJO Subtotal					0	2	0
Total					18	15	6

Table 7.20 Distribution of shell artefact manufacturing waste.

Trochus rings

Fragments of rings made from *Trochus niloticus* (Linn. 1758) were the most common type of shell ornament recovered and occur in all ceramic phases on Buka up to the ethnographic present. It is uncertain whether this artefact type was present during the preceramic period. The two rings from the base of the preceramic deposit at DBE (level 13) may have been displaced from the overlying ceramic-bearing deposits through crab burrowing activity as indicated by the presence of a Recent style sherd in the same excavation level. The single ring from DJA was found in an excavation level with both Mararing and Buka style pottery.

Although *Trochus* rings were worn as armbands or armlets ethnographically on Buka, those with smaller diameters must have been used in another manner. The quantity of specimens from different stages of production, including 115 unfinished and 29 finished ring fragments, was sufficient to document the manufacturing sequence which was broken down into four stages as indicated in Table 7.21. Stage 1 involved removal of a ring preform from the basal portion of a shell through chipping/pecking with a rock or other object (Plate 7.14:a, b, d, f) followed by Stage 2 in which the preform was reduced by additional pecking with blows always struck along the exterior margins (Plate 7.14:c, e, g). The third stage involved grinding of surfaces to a variable degree (Plate 7.15:a, d, e, f) to reach Stage 4, the finished ring (Plate 7.15: b, c, g-m). Initial grinding was probably carried out using a grindstone followed by finishing of the outer and inner surfaces with a coral abrader in a similar fashion to that recorded ethnographically on Tikopia (Kirch and Yen 1982:250).

Unfinished rings were found at six of the seven sites where this artefact type is represented indicating local manufacture. The high quantity of waste material from

Site	Area	Unit	Layer	Level	Stage 1	Stage 2	Stage 3	Stage 4
DJV			surface		0	0	1	0
DKC		1	IA	1	1	1	1	0
DKC		1	IA/B	2	5	3	0	0
DKC		1	IB/C	3	1	1	0	0
DKC		1	IIA	6	2	0	1	1
DKC		1	IIB	8, 9	4	0	0	0
DKC Subtotal					13	5	2	1
DJA		3	IA	2	0	0	0	1
DBE		2	II	5	1	0	0	0
DBE		1/3	IV/IV-V (mixed)	7/5	0	0	1	1
DBE		2	VI/VIII	13	0	0	0	2
DBE Subtotal					1	0	1	3
DJW		1/2	I/IIB/A	2	3	1	0	0
DJW		1/2	IIB/A	3	6	2	0	0
DJW		2	IIB	4	3	0	0	0
DJW		2	IIB	5	1	1	0	0
DJW		1/2	IIB	6	6	0	0	0
DJW Subtotal					19	4	0	0
DJU	1/1A		surface		0	2	0	1
DJU	3		surface		1	0	0	0
DJU	3	1/2	IIA/B	3	4	2	1	0
DJU	3	1/2	IIB	4	6	0	0	2
DJU	3	2	IIB	5	0	0	0	1
DJU	3	2	IIB	6	2	1	0	1
DJU	3	1	IIC/B	7	2	1	0	0
DJU Subtotal					15	6	1	5
DJO	B		surface		2	0	0	0
DJO	A	1	II	4, 7, 9	0	1	1	3
DJO	D		surface		3	0	0	0
DJO	D	1/2	IIA	Zone 3	1	1	1	1
DJO	D	1/2	IIA/B	Zone 4	0	8	0	0
DJO	D	1/2/4	IIA/B	Zone 5	1	13	1	5
DJO	D	1-4	IIB/III	Zone 6	2	3	3	4
DJO	D	3/4	III	Zone 7	0	0	0	2
DJO Subtotal					9	26	6	15
Total					57	41	11	25

Table 7.21 Distribution of *Trochus* rings.

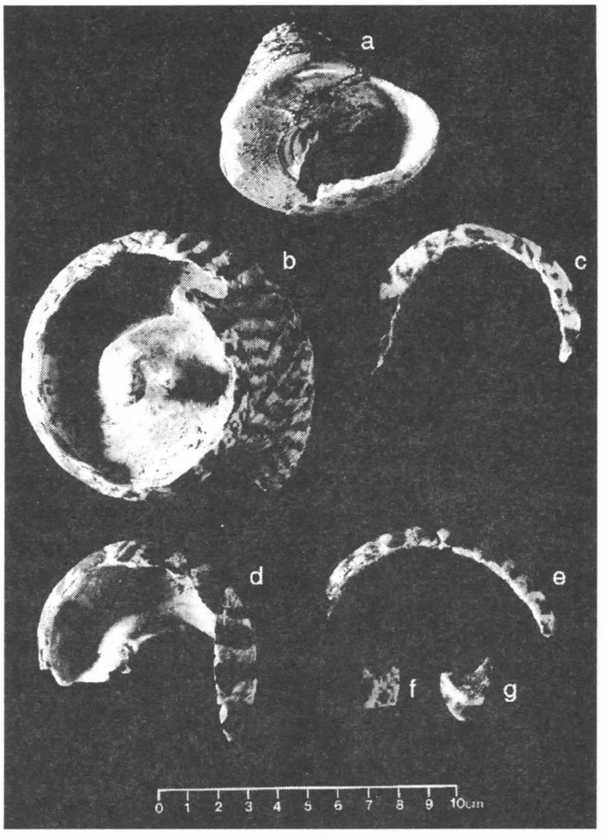


Plate 7.14 Examples of unfinished *Trochus* rings from stages 1 (a, b, d, f) and 2 (c, e, g) in the manufacturing process. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJU: 2: IIA/3; b: DJO-D: surface; c: DJO-D: 4: IIA-B/6; d: DJW: 2: IIB/3; e: DJO-D: 2: IIA-B/6; f: DKC: 1: IIA/6; g: DJU.1: surface.

Sites DKC, DJW, DJU and DJO also indicates fairly large scale production of rings at these sites. In contrast, Blackwood (1935:422) states that *Trochus* armbands were rare and imported from outside the Buka area in the 1930s. Specht (1969:294) also claimed that rings must have been imported during the prehistoric period as well due to the lack of unfinished examples from his sites.

The distribution of the two ring forms found in the Buka assemblages appears to be chronologically significant. The first type is restricted to deposits at DJA, DBE and DKC and appears to be associated with late Lapita phase occupation. It includes examples from the smaller Trochidae species *Tectus pyramis* (Born 1778) as well as *Trochus niloticus*. The distinguishing features of this early ring type are its probable smaller diameter, narrowness and minimal amount of grinding on the inner and outer surfaces (Plate 7.15:a,b). Although no early ring type fragments of sufficient size for reliable estimates of diameter were recovered, the four finished specimens (from Sites DJA, DBE and DKC) have widths from 1.6 to 3.3 mm and thicknesses ranging from 4.4 to 9.8 mm. The second ring form is much more common and found in all of the post-Lapita phase site deposits. It is generally well ground on all surfaces with square to plano-convex and oval cross-sections and inner diameters of 5 to 8 cm. This ring type has an average width between 6 and 7 mm and thickness between 5 and 6 mm.

The ethnographic form of *Trochus* ring on Buka is cut in such a way that it has a sharply angled corner (Blackwood 1935:8 and Plate 67). Examples of both unfinished (Plate 7.16:a, b) and finished (Plate 7.16:c, e, f) angled ring fragments were found in the DJU (n=1) and DJO-D (n=5) deposits dating from the middle Hangan to Malasang phase. An angled ring fragment was also found by Specht (1969:294) in association with Hangan style pottery at DAI. One of the specimens from DJO-D has an incised geometric pattern consisting of a zigzag line bounded by a series of four parallel lines at the point where the ring is angled (Plate 7.17:b). A ring fragment with a similar incised design was found at approximately the same depth at DJO-D and may be part of the same artefact (Plate 7.17:a). A unique *Trochus* artefact found near the base of the late Hangan phase DJO-A deposit has the appearance of an angled ring fragment except that the angled end has been ground flat (Plate 7.16:d). This object may be a nose ornament similar to those recorded ethnographically on Buka which were usually made of *Tridacna* (Blackwood 1935:7 and Plate 67).

Tridacna rings

Finished rings of *Tridacna* (cf. *T. maxima*) shell are limited to four fragments from two sites and waste material from ring production was collected from the surface of two sites as indicated in Table 7.22. Two of the finished examples (Plate 7.18:a, b) are broad rings with rectangular cross-sections from the surface of DJW (43.7 mm wide and 8.2 mm thick) and DAI (30.0 mm wide and 6.7 mm thick). The DJW specimen has a shallow drilled depression 2.5 mm in diameter on the exterior surface at one end and fine striations on both exterior and interior surfaces where the ring was cut from the valve, unlike the DAI ring which is highly polished. The other two rings are narrow and come from the surface and excavations at DJW (Plate 7.18:c, d). The surface example is 12.2 mm wide and 5.8 mm thick with an oval cross-section and estimated outer diameter of 8 cm. A drilled perforation 3 mm in diameter is located at one end of the ring fragment. A small ring fragment 8.4 mm wide and 6.2 mm thick with a quadrangular cross-section was found in the lower DJW deposit dating to the transition from the Sohano to Hangan phase. A majority of the pottery associated with the rings found on the surface is from the Mararing and Recent styles.

Specht (1969:295) found several types of *Tridacna* rings during excavation although only one example, with a unique triangular cross-section, definitely dates earlier than the middle Hangan phase. Specht's most common ring form had a vertically rectangular cross-section and occurs from the middle Hangan phase onward. Other ring types were rare and include square and horizontally rectangular cross-sections and a single thick sub-square example possibly made from *Hippopus* which Specht claims resembles ethnographically recorded ring money from Nissan and the central Solomons.

Four thick discs of *Tridacna maxima* waste material from ring manufacture were collected from the surface of Site DAI and apparently date to the Mararing to Recent phase (Plate 7.19:a-c, e). The discs range from 65 to 75 mm

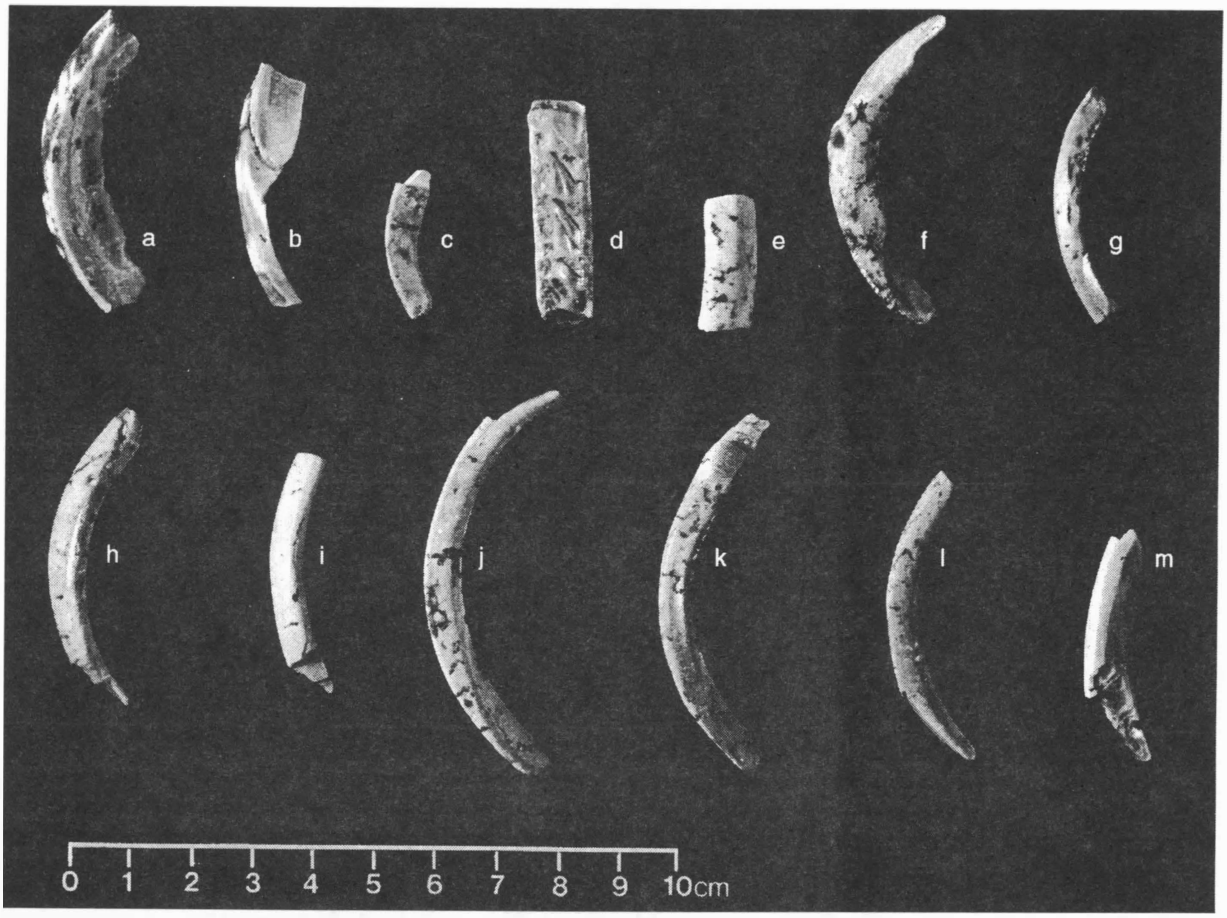


Plate 7.15 Examples of nearly finished and finished *Trochus* ring segments: stages 3 (a, d-f) and 4 (b, c, g-m). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DKC: 1: IIA/6; b: DBE: 2: VI/13; c: DJO-D: 1: IIA/5; d: DJO-D: 1: IIB/6; e: DJO-D: 1: IIB/7; f: DJU: 1: IIA/3; g: DJO-D: 4: IIB/6; h: DJO-A: 1: II/7; i: DJO-A: 1: II/7; j: DJO-D: 4: III/13; k: DJU: 1: IIB/4; l: DJU: 2: IIB/6; m: DBE: 2: VI/13.

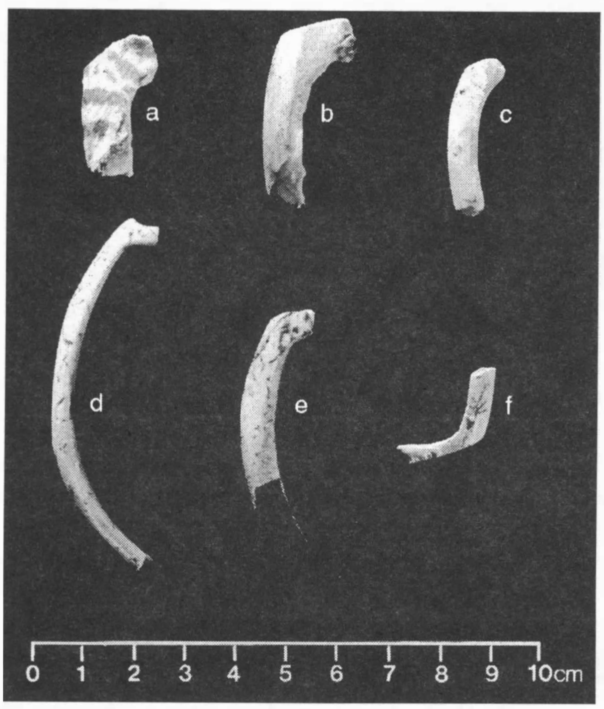


Plate 7.16 Unfinished and finished angled *Trochus* ring (a-c, e, f) and nose ornament (d) segments. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJO-D: 3: IIA/4; b: DJO-D: 4: IIB/8; c: DJO-D: 1: IIB/6; d: DJO-A: 1: II/7; e: DJU: 2: IIB/5; f: DJO-D: 1: IIA/5.

in diameter and have single conical perforations with maximum diameters of 11 to 19 mm drilled along the margin from the interior surface. Both valve surfaces are intact on three of the discs which range from 26 to 67 mm in thickness with concave sides and diameters up to 45 mm (Plate 7.19:a-c). *Tridacna* rings were cut from the outer margins of these discs and would have had similar diameters, which is the case with the finished wide ring from DJW (Plate 7.18:a). Specht (1969:287) found five discs of this type in the upper deposit at DAI dating to the Mararing to Recent phase which he identified as the central portions of arm or currency rings. Russell (1972:26) illustrates a *Tridacna* disc found on Rendova Island in the western Solomons which is nearly identical to those from DAI and Hocart (cited in Russell 1972:24) observed that such discs were removed from the centre of rings called *poata* by first drilling a hole and then cutting out the ring using a creeper wetted with sand.

One thick ring disc with the exterior valve surface removed (Plate 7.19:e) and a thin disc from the external portion of a valve with a plano-convex profile and cut marks on the interior surface (Plate 7.19:d) were also collected from the surface at DAI. These objects may be associated with the production of flat disc ornaments from thick ring discs and most likely date to the Mararing to Recent phase. *Tridacna* discs called *pirir* with attached pieces of turtle shell filigree work worn as pendants are described by Blackwood (1935:422) as the most highly prized ornament on Buka. Other waste material includes a valve fragment with a cut or ground margin from DAI and an irregular piece of shell with two holes from 6 to 9 mm in diameter drilled from opposing surfaces found in Area 1A at DJU (Plate 7.19:f, g).

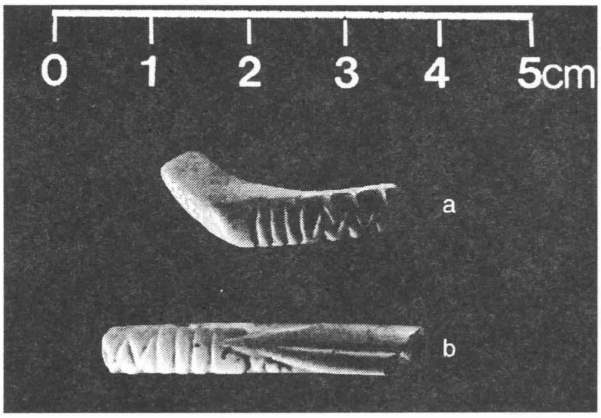


Plate 7.17 *Trochus* ring segments with incised designs. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJO-D: 1: IIA/5; b: DJO-D: 3: III/5.

Conus rings and discs

Single examples of three types of *Conus* rings were found at three sites as shown in Table 7.22. A highly polished broad ring fragment 38 mm wide and ca. 50 mm in diameter which appears to be from *Conus leopardus* was found on the surface at DJA (Plate 7.18:e). A narrow ring fragment 12 mm wide and 3 mm thick with an estimated diameter of 50 mm and oval cross-section was found in the late Sohano phase DJW deposit (Plate 7.20:d). The third ring, located at the base of the late Hangan phase DJO-D deposit, is small and highly polished with an outer diameter of 23 mm and round cross-section up to 5 mm thick (Plate 7.20:g). Specht (1969:294) reported two forms of *Conus* rings on Buka: broad rings dating from the Hangan to Mararing phases and two small rings with round cross-sections from the Sohano phase. Use of rings in composite ornaments is likely as their small diameters preclude utilisation as armbands or bracelets.

Five fragments of finished discs and two unfinished examples made from grinding down the spires of cone shells were recovered (Table 7.22). The finished specimens have diameters up to 38 mm with central perforations ranging from 3.4 to 7.4 mm and are badly eroded except for two highly polished and heat-altered examples from

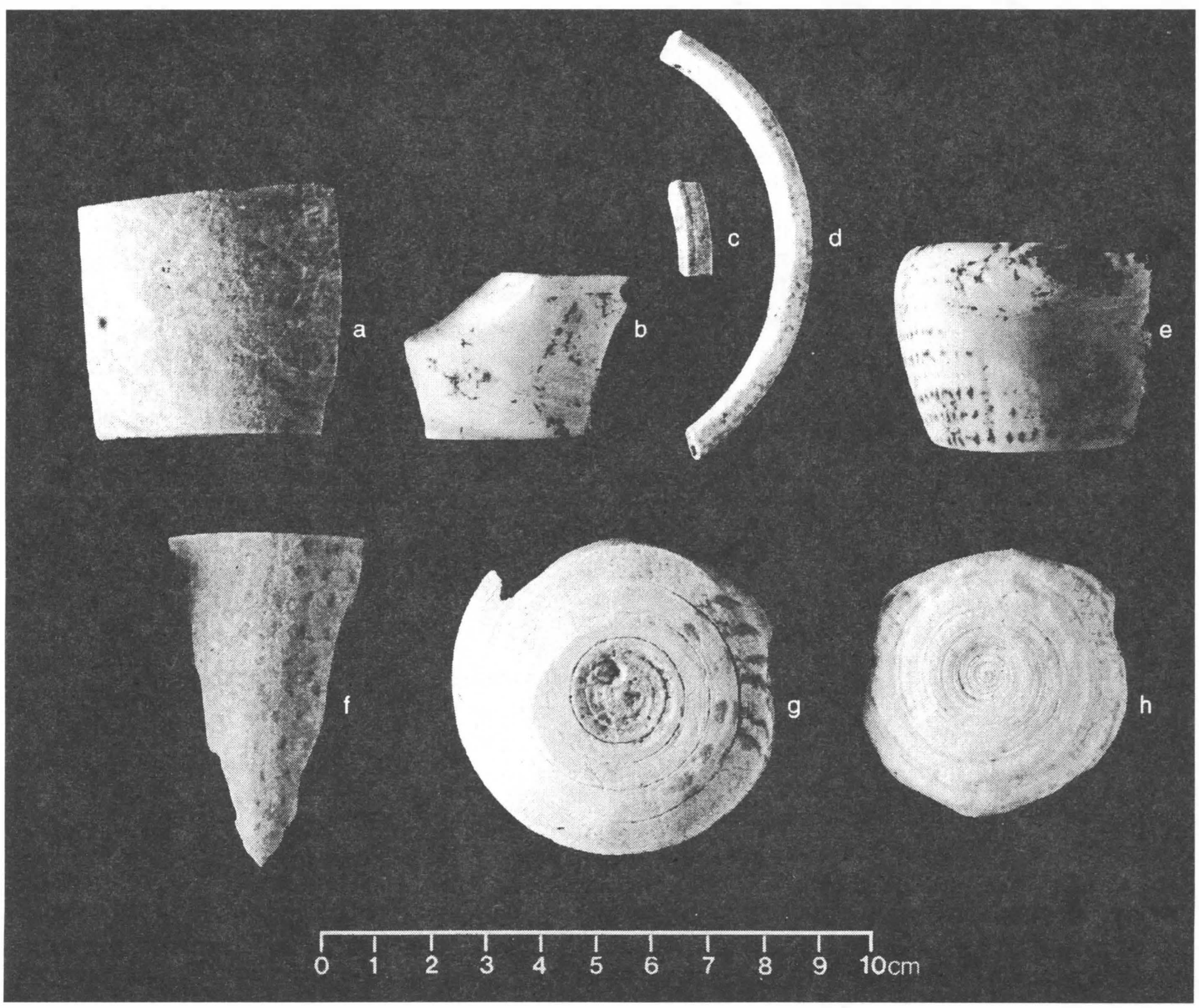


Plate 7.18 *Tridacna* (a-d) and *Conus* (e) ring segments and *Conus* disc blanks (g, h) and manufacturing waste (f). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJW: surface; b: DAI.A: surface; c: DJW: 2: IIB/6; d: DJW: surface; e: DJA: surface; f: DJU.3: surface; g: DJU.1A: surface; h: DJY: surface.

Site	Area	Unit	Layer	Level	*Tridacna* Ring	*Tridacna* Waste	*Conus* Ring	*Conus* Disc
DAI	A		surface		1	1	0	0
DAI	B		surface		0	5	0	0
DJY			surface		0	0	0	1
DJZ			surface		0	0	0	1
DKC		1	feature 1/2	6	0	0	0	1
DJA			surface		0	0	1	0
DJA		1	IA	4	0	0	0	1
DJA		1	IA	5	0	0	0	1
DJA Subtotal					0	0	1	2
DJW			surface		2	0	0	0
DJW		1	IIB/A	4	0	0	1	0
DJW		2	IIB	6	1	0	0	0
DJW Subtotal					3	0	1	0
DJU	1/1A		surface		0	1	0	1
DJU	3		surface		0	0	0	1
DJU Subtotal					0	1	0	2
DJO	D	2	IIB/A/IIIB	Zone 4	0	0	0	1
DJO	D	4	IIIA	Zone 8	0	0	1	0
DJO Subtotal					0	0	1	1
Total					4	7	3	8

Table 7.22 Distribution of *Tridacna* and *Conus* rings and discs.

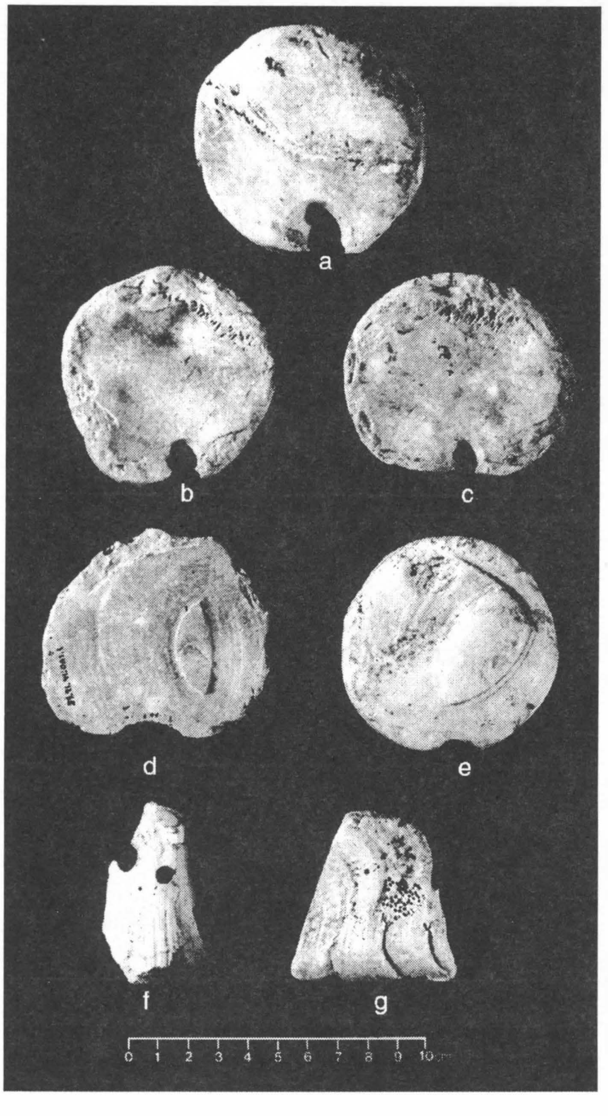


Plate 7.19 Waste material from manufacture of *Tridacna* rings. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DAI.B: surface; b: DAI.B: surface; c: DAI.B: surface; d: DAI.A: surface; e: DAI.B: surface; f: DJU.1: surface; g: DAI.B: surface.

DJA (Plate 7.20:a-c,f). A ground spire fragment from the DJO-D deposit (Plate 7.20:e) has a central perforation 20 mm in diameter and resembles a ring. Manufacturing waste includes partially ground spires from the surface of DJY and DJU representing the initial stage of disc manufacture (Plate 7.18:g, h) and a shell fragment (cf. *Conus leopardus*) with a cut edge parallel to the spire found on the surface of DJU (Plate 7.18:f).

With the exception of the single example from the late Hangan phase deposit at DJO-D, dating the discs is problematic as the DKC example is from a disturbed context and although the two disc fragments from DJA are found in the upper preceramic deposit, they may be associated with late Lapita or Mararing to Recent phase use of the site based on the ceramic evidence. Specht (1969:295) found *Conus* discs in deposits dating from the early Sohano to Malasang phases.

Perforated gastropods

Artefacts in this category include a number of small shell taxa with perforated spires and/or dorsal surfaces which could be necklace units or components of composite ornaments and have not been previously documented archaeologically on Buka (Table 7.23). *Nassarius* spp. shells with perforations formed by grinding the dorsal surface are the most common ornament class and predominantly *N. dorsatus* (Plate 7.21:g-i) although three other

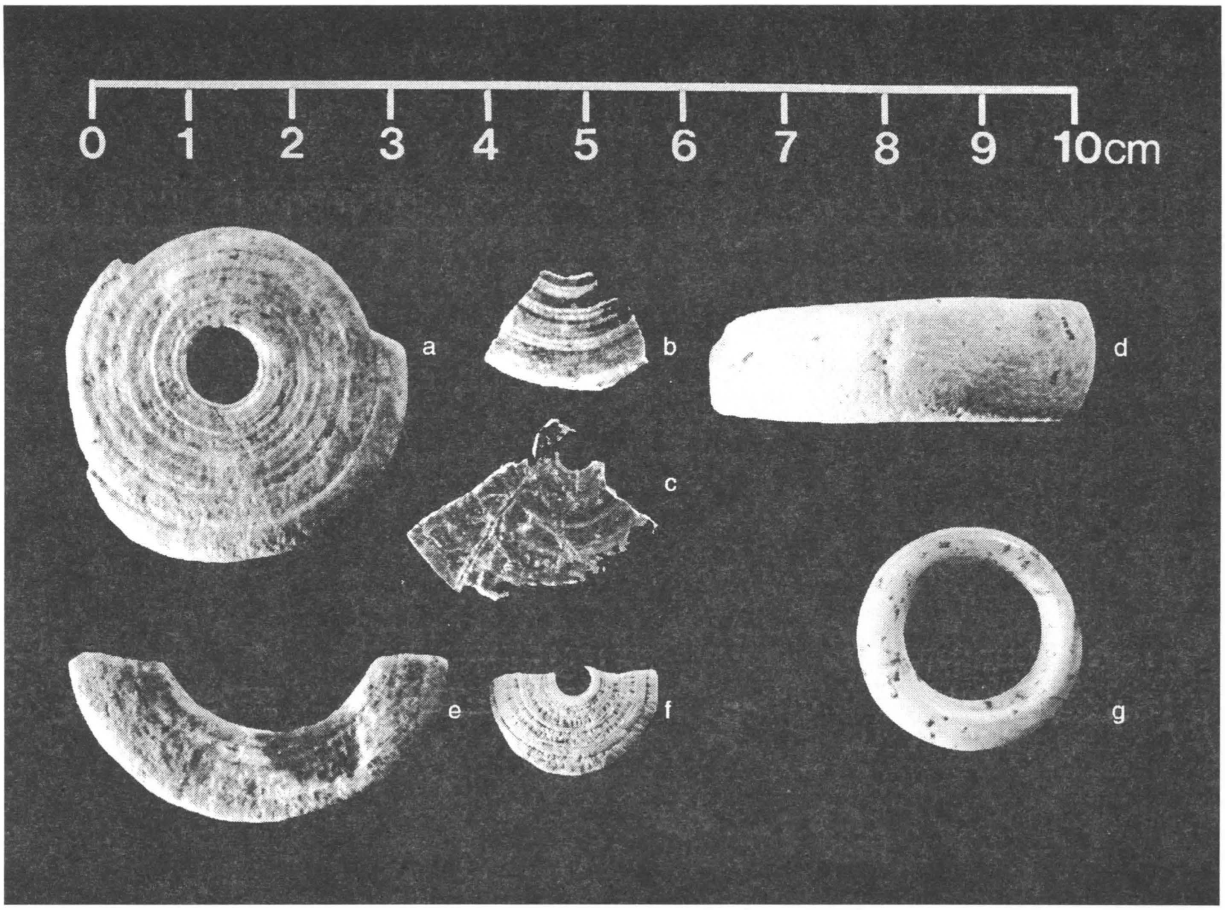


Plate 7.20 *Conus* rings (d, e, g) and discs (a-c, f). **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJZ: surface; b: DJA: 1: IA/5; c: DJA: 1: IA/4; d: DJW: 1: IIB/4; e: DJO-D: 2: IIB/5; f: DKC: 1: Feat. 1-2/6 (disturbed); g: DJO-D: 4: IIIA/12.

species were also utilised, *N. margaritiferus* (Plate 7.21:d, e), *N.* cf. *arcularius* (Plate 7.21:f) and *N.* cf. *nodiferus* (Plate 7.21:c). No unmodified shells of these taxa were found in the site deposits indicating collection for artefact manufacture rather than human consumption. Two of the 73 examples come from the DJW deposit and the remainder are evenly distributed between the DJU and DJO deposits documenting use from the late Sohano through the Malasang phase. Similar artefacts have also been recorded on Nissan (M. Spriggs pers. comm.).

Other ornaments include three *Polinices* (cf. *malanostomus*) shells with roughly chipped perforations from the DJO-D deposit (Plate 7.21:a, b) similar to those identified as nose ornaments on Tikopia by Kirch and Yen (1982:251). Four *Oliva* shells with the spires removed, from the late Hangan deposits at DJO and late prehistoric and preceramic components at DBE (referred to as Type 1 ornaments in Table 7.23), are probable necklace units or long beads (Plate 7.22:f-i). Similar ornaments were recorded by Best (1984:481) on Lakeba in Fiji. A small *Melampus* sp. shell with a hole in the spire and ground lip margin found in the preceramic deposit at DBE is also classified as a bead (Plate 7.22:e). The second type of 'long bead' ornament includes three *Oliva* shells and a single *Conus* shell from the DJO-D and DJW deposits from which the spires have been removed and perforations ground through the central wall of the body whorl (Plate 7.22:a-d).

Beads

Included in this artefact category are miscellaneous bead types and the more common flat circular beads resembling ceremonial shell money (*beroan*) recorded ethnographically on Buka which was obtained from New Ireland, New Britain and especially Manus (Blackwood 1935:447). The circular beads include 25 examples of *Conus* and 13 of *Spondylus* shell (Plate 7.23:g-l). Bead diameters range from 3.0 to 8.3 mm with a mean of 4.5 mm, thickness ranges from 1.1 to 2.7 mm with a mean of 1.55 mm and perforation diameters range from 1 to 3.5 mm with a mean of 1.6 mm. Both bead types are found in the late Lapita phase deposit at DBE and each of the post-Lapita site deposits as shown in Table 7.24. Although *Spondylus* beads were found in the preceramic deposits at DJA (n=1) and DBE (n=2), these may actually be associated with ceramic period occupation. The fact that Specht (1969:293) found only three circular beads during his excavations may be due to the use of 1/4" (6.4 mm) mesh as indicated by the larger diameters of the beads he recovered (8 to 10.5 mm).

Most of the miscellaneous small beads come from the DBE deposit and include two probable unfinished beads of *Spondylus* and *Conus* (Plate 7.23:b, c) from the late Lapita phase deposit and a circular *Spondylus* disc with three knobbed projections (Plate 7.23:d) from the preceramic deposit. The basal portion of a shell from

Site	Area	Unit	Layer	Level	*Nassarius* spp.	*Oliva* Type 1	*Oliva/Conus* Type 2	*Polinices* sp.
DBE		3	IIIB/IV	4	0	1	0	0
DBE		3	VI	9	0	1	0	0
DBE Subtotal					0	2	0	0
DJW		2	IIB/A	3	1	0	0	0
DJW		1	IIB/C	7	0	0	1	0
DJW		1	IIC/B	8	1	0	0	0
DJW Subtotal					2	0	1	0
DJU	3	1	I	1	1	0	0	0
DJU	3	2	IIA/B	2	1	0	0	0
DJU	3	1/2	IIA/B	3	2	0	0	0
DJU	3	1/2	IIB	4	7	0	0	0
DJU	3	2	IIB	5	1	0	0	0
DJU	3	1/2	IIB	6	5	0	0	0
DJU	3	1/2	IIB/C	7	6	0	0	0
DJU	3	1/2	IIB/C	8	5	0	0	0
DJU	3	1	IIC	9	2	0	0	0
DJU Subtotal					30	0	0	0
DJO	A	1	II	5, 7, 8	3	1	0	0
DJO	D	4	IIA	Zone 2	3	0	0	0
DJO	D	1/2	IIA	Zone 3	1	0	1	0
DJO	D	1/2	IIA/B	Zone 4	14	0	0	3
DJO	D	1/2/4	IIA/B	Zone 5	11	0	1	0
DJO	D	1/2/4	IIB/III	Zone 6	3	0	1	0
DJO	D	4	IIB/III	Zone 7	1	1	0	0
DJO	D	4	III/IV	Zone 8	1	0	0	0
DJO	D	3	IV/III	Zone 9	1	0	0	0
DJO Subtotal					38	2	3	3
Total					70	4	4	3

Table 7.23 Distribution of perforated gastropod ornaments.

the Buccinidae family (cf. *Pisania truncata*) with two small drilled perforations and the base of a *Nassarius* sp. shell were recovered from the Mararing to Recent phase deposit. A similar *Nassarius* base ground flat with a single drilled perforation was found in the lower Hangan phase deposit at DJU (Plate 7.23:a). A unique long bead from a ribbed dentalium shell (cf. *Dentalium octangulatum*) which had been cut and ground at both ends to enable suspension was found in the lower DJW deposit dating to the late Sohano to early Hangan phase (Plate 7.23:e).

BONE ARTEFACTS

The number of worked bone items recovered is limited and all were found during excavation, consisting primarily of ornaments along with a few tool fragments and manufacturing waste (Table 7.25). The earliest bone artefacts are from the preceramic Holocene deposit at DJA and include 12 shark teeth with centrally positioned drilled perforations (Plate 7.24:f-k) and three elasmobranch vertebrae with holes drilled through the centre. Although a number of other perforated vertebrae were found, these may be the result of biogenic processes. A single elasmobranch vertebra with a large drilled perforation was also found in the Malasang phase upper DJO-D deposit (Plate 7.24:l). A vertebra with a possible drilled perforation was found in the upper DJU deposit (Plate 7.24:m). Both artefact types from DJA are probably necklace units although drilled shark teeth lashed to wooden handles served as cutting tools and weapons elsewhere in Oceania (e.g. Kirch 1993:164). The only other definite ornament is a human incisor from the early Hangan phase upper DJW deposit with a drilled suspension hole through the root which has traces of red pigment on the margins (Plate 7.24:e). Two human teeth and a porpoise tooth with drilled suspension holes were found in association with Malasang style ceramics by Specht (1969:262).

The remaining bone artefacts are probable tools from DJO-D (n=7), DJO-A (n=1) and DJW (n=1). Bone point fragments made from half-sections of medium to large mammal long bones (probably pig) were found in the early Hangan phase deposit at DJW (n=1) and late Hangan to Malasang phase deposit at DJO-D (n=2) (Plate 7.25:a-c). A small fragment from the enamel portion of a tooth ground to a point was located in the upper Malasang phase deposit at DJO-D (Plate 7.24:a). Several point fragments with oval cross-sections were also found by Specht (1969:262-3) in Sohano and Hangan phase deposits.

In addition to bone points, miscellaneous artefact fragments were also recovered from the late Hangan to Malasang phase deposits at DJO. A long narrow piece

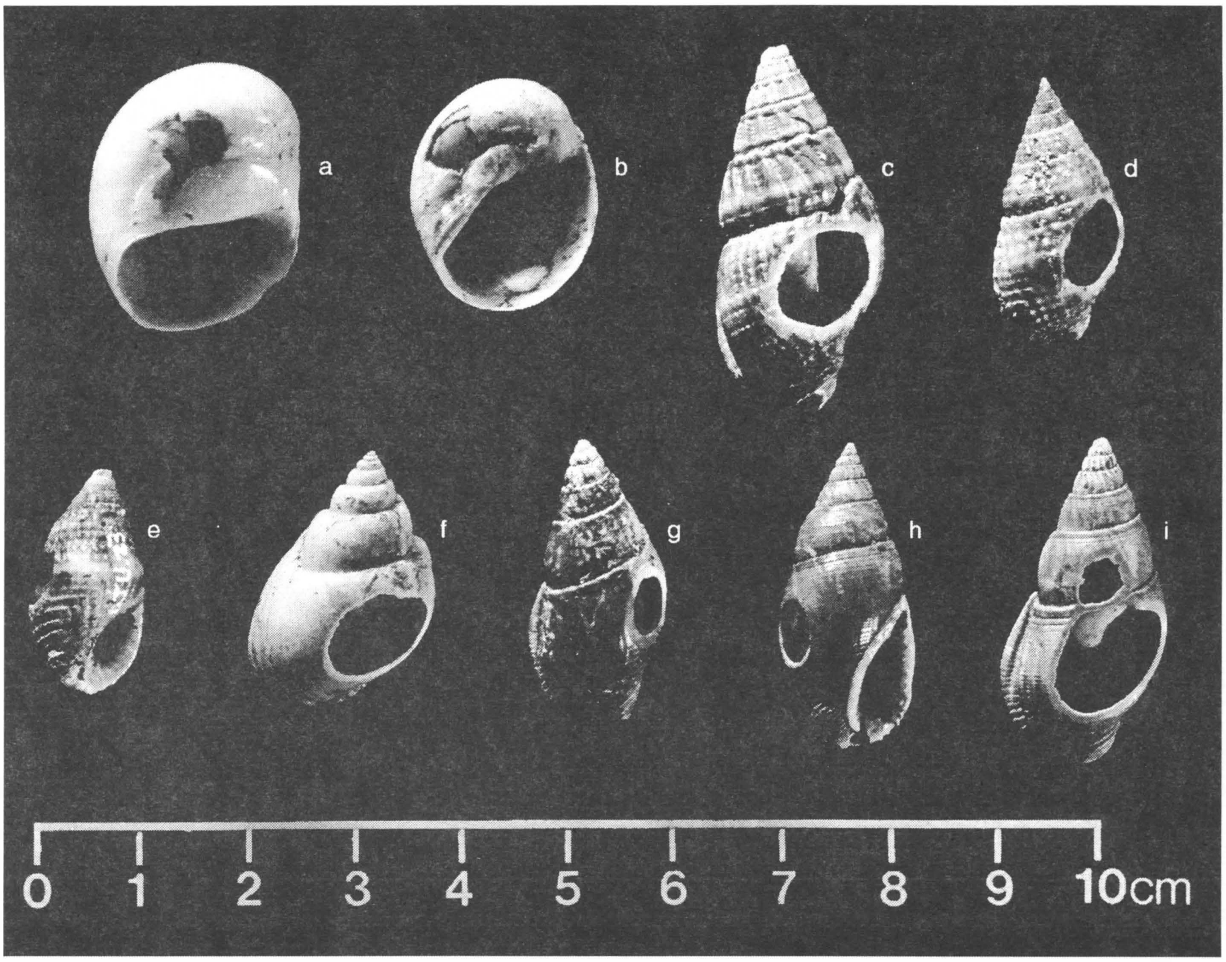


Plate 7.21 Small perforated gastropod shell ornaments. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJO-D: 1: IIA/4; b: DJO-D: 1: IIA/4; c: DJO-D: 4: IIB/5; d: DJU: 1: IIB/7; e: DJU: 2: IIB/5; f: DJU: 1: IIA/3; g: DJU: 1: IIB/6; h: DJO-D: 1: IIA/3; i: DJO-D: 2: IIA/3.

of ground mammal bone (45 by 5 mm) from DJO-D with a circular cross-section at one end and a slightly bevelled oval cross-section at the other may have been used as a lime spatula (Plate 7.25:d). Another incomplete artefact from DJO-D is a costal plate from a turtle which has been ground to form a curved flat margin and may be a spatula or disc-shaped ornament fragment (Plate 7.25:e). Of considerable interest is the presence of what may be a curved shank fragment of a one-piece fishhook with a slightly knobbed head from the upper DJO-D deposit (Plate 7.24:b). A rectangular piece of cut bone with striations on the exterior surface found in the DJO-A deposit may be a fishhook blank (Plate 7.25:d). Two nearly identical small circular pieces of cut bone ca. 7 mm in diameter with drilled perforations 2 mm in diameter and fragments of curved extensions were found at DJO-D. These may be ornaments or parts of composite artefacts (Plate 7.24:c, d).

Possible explanations for the lack of bone artefacts in the ceramic-bearing sites apart from DJO include differential preservation or deposition of worked bone related to the types of activities reflected in the site deposits or other variables such as the age of the deposit and degree to which high densities of shell midden aided bone preservation. Alternatively, there may have been an increase in the use of bone artefacts beginning in the late Hangan phase although a much larger site sample would be necessary to evaluate this possibility.

SUMMARY AND CONCLUSION

Chronological trends

Several interesting trends are evident in the chronological distribution of artefact types. Of the 15 categories of stone artefacts identified, the widest range occurs during the Lapita phase and Mararing to Recent phase with nine categories in each. Flaked stone other than obsidian is the primary lithic artefact type in the preceramic site deposits and relatively common during the Lapita phase but rare in later deposits. There is also evidence for a change in raw materials during the preceramic period with a shift in emphasis from coarse-grained volcanic rock to fine-grained volcanic and siliceous rock types between the Pleistocene and Holocene preceramic deposits at DJA. This trend is supported by the evidence from the preceramic deposits at DBE, which post-date those at DJA, where coarse-grained volcanic rock is absent and chert is dominant. Flaked siliceous rock is also present in the late Lapita and Mararing to Recent phase

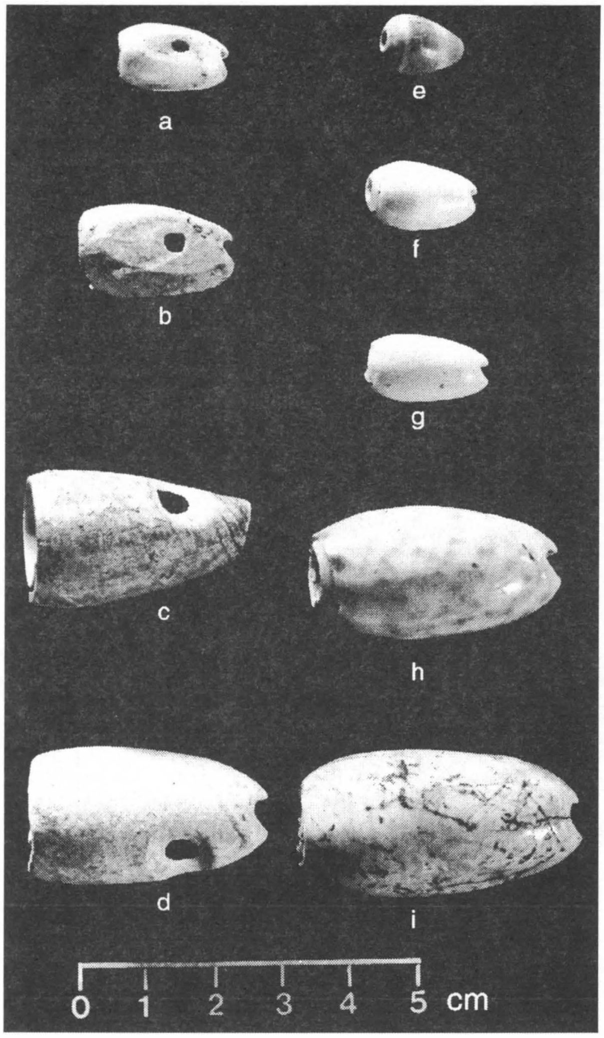


Plate 7.22 *Oliva* (f-i), *Conus* (a-d) and *Melampus* (e) shell ornaments. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJO-D: 4: IIB/7: b: DJO-D: 4: IIB/8; c: DJO-D: 1: IIA/3; d: DJW: 1: IIB/7; e: DBE: 1: V/8; f: DBE: 3: IIIB-IV/4; g: DBE: 3: VI/9; h: DJO-D: 4: IIB-IIIB/10; i: DJO-A: 1: II/5.

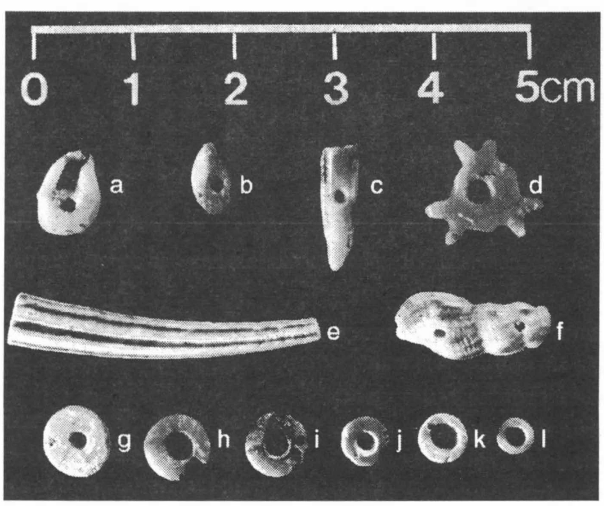


Plate 7.23 Small shell beads. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJU: 1: IIC/8; b: DBE: 3: IV/5; c: DBE: 3: IV-V/6; d: DBE: 2: V/9; e: DJW: 1: IIB/6; f: DBE: 1: III/4; g: DBE: 1: V/9; h: DJU: 2: IIB/6; i: DJU: 2: IIB/4; j: DJO-D: 1: IIB/7; k: DJO-D: 4: IA/1; l: DJA: 3: IA/3.

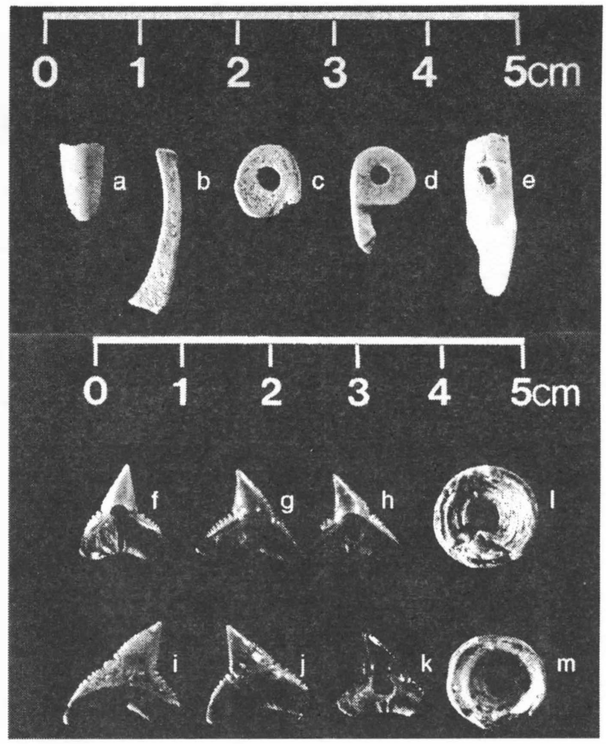


Plate 7.24 Small bone artefacts. **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJO-D: 3: IIA/3; b: DJO-D: 1: IIA/4; c: DJO-D: 1: IIA/4; d: DJO-D: 3: IIA/3; e: DJW: 2: I/2; f: DJA: 3: IB-C/7; g: DJA: 2: IA/3; h: DJA: 2: IA-B/9; i: DJA: 2: IA-B/9; j: DJA: 2: IC/11; k: DJA: 3: IB-C/7; l: DJO-D: 1: IA/1; m: DJU: 2: I/1.

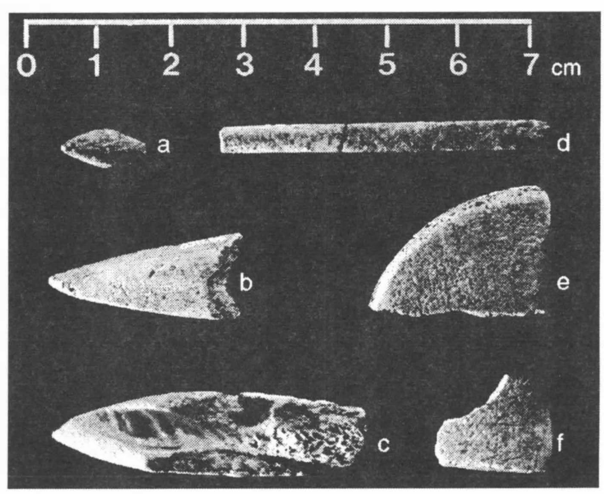


Plate 7.25 Bone points (a-c) and miscellaneous worked bone (d-f) **Code** – Letter Designation: Provenience Code (Site, Collection Area/Transect): Excavation Unit: Layer/Level. **Data** – a: DJO-D: 3: IA-B/2; b: DJO-D: 1: IIA/2; c: DJW: 1: I/2; d: DJO-D: 2: IIA/4; e: DJO-D: 3: IIB/3; f: DJO-A: 1: II/4.

occupation components at DBE although some of this material may have been displaced from the preceramic deposits. Obsidian from the Bismarcks was first imported to Buka during the Lapita phase and very low amounts are found in post-Lapita site deposits up until the termination of the Malasang phase. Obsidian was not recorded ethnographically on Buka and importation appears to have ceased by the Mararing or Recent phase.

Site	Area	Unit	Layer	Level	Miscellaneous Bead	*Spondylus* (red)	*Conus* (white)
DJA		3	IA	3	0	1	0
DBE		1	IIIA/B/II	4	2	0	1
DBE		3	IV/IV-V(M)	5	0	0	1
DBE		3	IV-V(M)/V	6	0	1	0
DBE		1	V	9	0	1	0
DBE		2	V/VI	9	0	1	0
DBE Subtotal					2	3	2
DJW		1	IIB/A	4	0	0	1
DJW		1	IIB/C	6	1	0	1
DJW		2	IIB/IID	7	0	0	1
DJW		2	III/IID	8	0	0	1
DJW Subtotal					1	0	4
DJU	3	1/2	IIA/B	3	0	0	2
DJU	3	1/2	IIB	4	0	3	1
DJU	3	1	IIB	5	0	0	2
DJU	3	2	IIB	6	0	1	1
DJU	3	1/2	IIC/B	7	0	0	2
DJU	3	1/2	IIC/B	8	1	0	1
DJU Subtotal					1	4	9
DJO	A	1	II	2, 7	0	0	2
DJO	D	4	IA	Zone 1	0	1	2
DJO	D	3/4	I/IIA	Zone 2	0	1	1
DJO	D	3	IIIB/IIB	Zone 3	0	1	1
DJO	D	3	IIIB	Zone 4	0	0	1
DJO	D	1/2	IIA/B	Zone 5	0	0	2
DJO	D	1-3	IIB/IIIB	Zone 6	0	2	1
DJO Subtotal					1	5	10
Total					4	13	25

Table 7.24 Distribution of shell beads.

Site	Area	Unit	Layer	Level	Perforated Shark Vertebrae	Perforated Shark Tooth	Miscellaneous Bone
DJA		2	IA	3	0	1	0
DJA		3	IA	5	1	0	0
DJA		2	IA/B	9	0	2	0
DJA		3	IB/C	7	0	3	0
DJA		3	IB/C	8	2	1	0
DJA		2	IC	11	0	1	0
DJA		2	IC	12	0	1	0
DJA		2	IC	12	0	1	0
DJA		3	IC/IIA	10	0	1	0
DJA		3	IIA/B/IC	12	0	1	0
DJA Subtotal					3	12	0
DJW		1/2	I/IIA/B	2	0	0	2
DJO	A	1	II	4	0	0	1
DJO	D	1	IA	Zone 1	1	0	0
DJO	D	1/3	I/IIA/B	Zone 2	0	0	2
DJO	D	3	IIIB/IIB/I	Zone 3	0	0	3
DJO	D	1/2	IIA/B	Zone 4	0	0	3
DJO Subtotal					1	0	9
Total					4	12	11

Table 7.25 Distribution of bone artefacts.

Small stone adzes appear to be restricted to the Lapita phase reef site assemblages with larger adzes and distinctive lugged axes coming into use by the Mararing to Recent phase and continuing up until European contact. Although sampling inadequacies must be taken into account, these changes may represent significant shifts in lithic technology over time. Manufacturing tools of stone, primarily grindstones and abraders, occur during the Lapita to Recent phases. A remarkably high concentration of grindstones and abraders were found in association with Lapita ceramics at the reef sites and they were also recovered from excavated deposits dating to the late Lapita phase. There is less evidence for these artefact types in later deposits up until the Mararing to Recent phase although this may be a result of inadequate sampling. Some changes in the type of abraders being utilised following the Lapita phase may also have taken place. Pumice and coral abraders are present in most of the ceramic-age phases. Pottery sherds with ground margins, whose function is unknown, are present from the Hangan phase onward in all excavated deposits as well as surface collections.

Shell artefacts cover a wide range of categories including seven tool types, eight classes of ornaments and a variety of waste material from artefact manufacture. A significant increase in the range and frequency of shell artefacts, especially ornaments, occurs after the end of the Sohano phase and is maintained through the remainder of the cultural sequence. As indicated in Table 7.2, the number of shell artefact types increases from six during the Sohano phase to 11 during the Hangan phase and at least nine types are represented in later phases. The full range of shell artefacts is probably underrepresented for the preceramic through Sohano phases due to fewer site deposits and the lack of shell on the reef sites. However, there does appear to be an increased emphasis on the manufacture of certain shell artefact types by the Hangan phase as reflected in the abundance of manufacturing debris from *Trochus* rings and the initial appearance of a variety of small ornament types.

The most common shell tool type is *Tridacna* adzes which may have come into use during the preceramic period as indicated by a probable adze fragment from the Holocene deposit at DJA. Adzes are common from the Sohano phase onward and their absence in Lapita phase deposits is most likely due to limited excavation and the lack of shell preservation on the reef sites. An unusual possible shell tool type found in preceramic and late Lapita phase deposits is gastropods with ground apices possibly used as chisels - although some examples may be the result of biogenic rather than anthropogenic factors. A variety of bivalve scrapers and peelers used in food preparation are found in both early and late phases.

Fishing gear made of shell is limited to trolling lure shanks present in Sohano and subsequent phases. Shanks from excavations are manufactured exclusively of pearl shell while those from Mararing to Recent phase surface collections and recorded ethnographically include a much wider range of materials such as *Tridacna, Conus, Turbo* and *Cassis.* The significance of this potential diversification in raw materials is uncertain and may be an artefact of inadequate sampling. Although no other fishing related shell artefacts were recovered, pieces of worked pearl shell and *Turbo marmoratus* manufacturing waste potentially related to fishhook production occur from the preceramic to Recent phases. A single piece of worked bone which may be a fishhook shank fragment was found in the Malasang phase deposit at DJO-D.

At least eight categories of shell ornaments have been documented from excavations and surface collections on Buka and they are a major artefact type in all ceramic-age sites, particularly following the Sohano phase. These include rings of *Tridacna*, *Trochus* and *Conus*, *Conus* discs and small beads. Small perforated gastropods including *Conus*, *Oliva*, *Nassarius* and *Polinices* species are common in deposits from the Hangan and Malasang phases. No temporal trends were evident for any of the ornament types with the exception of *Trochus* rings for which early and late types were recognised. The earlier type, which is restricted to sites with Lapita deposits, is narrow with a rectangular cross-section and minimal grinding. The second type is similar to that described ethnographically and is common by the Sohano phase. It is cut in a way that produces a sharply angled corner, is wider than the early type with a circular to oval cross-section, and usually well ground. Several examples with finely executed incised designs were found.

Bone artefacts are rare in all phases and include perforated shark, human and porpoise teeth, perforated shark vertebrae, points, a possible fishhook shank and miscellaneous cut and ground fragments. The perforated shark teeth are restricted to the preceramic DJA deposit but other bone artefacts are found primarily in ceramic-age deposits beginning with the Hangan phase.

Comparison of pre-Lapita and Lapita assemblages

One of the research problems to be investigated was the impact of Lapita settlement on resident populations and an assessment of the evidence for continuity and discontinuity between the preceramic and Lapita phases on Buka. As ceramics are absent prior to the Lapita phase, non-ceramic artefacts are one of the principal means of addressing these issues.

The most obvious contrast between the preceramic and Lapita phase artefact assemblages from site deposits on Buka is the much wider range of types found in Lapita assemblages. The evidence from both of the sites with preceramic occupation (DJA and DBE) reveals a pronounced emphasis on flaked stone technology with a wide range of raw material including coarse- and fine-grained volcanics, chert and other siliceous rock, quartz, calcite and limestone. Obsidian is added to the inventory of flaked stone during the Lapita phase but is scarce at all sites except for the late Lapita phase occupation areas at Site DAF. Although flaked stone apart from obsidian continues to be represented in the Lapita and post-Lapita phases, the quantity of flakes and range of raw materials are more limited (primarily siliceous rock).

In an earlier paper (Wickler 1990), I stressed the evidence for discontinuity between the preceramic and Lapita phases on the basis of shell and bone artefacts from DJA and DBE where limited late Lapita utilisation of the sites occurred following preceramic occupation. It was argued that a range of shell artefact types, primarily ornaments, make an initial appearance only in the upper portion of the DJA deposit where Buka style ceramics are found and the late Lapita phase deposit at DBE. Unfortunately, the original provenience of a number of artefacts at these sites is uncertain due to potential disturbances by crab burrowing activity and some mixing of strata. At DJA, the Buka style ceramics do not occur in a distinct stratum but extend into the upper preceramic deposit which makes it difficult to determine if artefacts from the same levels as the ceramics are contemporaneous with them.

While there is no question that non-lithic artefacts within the Pleistocene deposit at DJA are limited to three pieces of *Turbo marmoratus* manufacturing waste, the range of artefacts in the preceramic Holocene deposit is less certain. Perforated shark teeth and ground *Terebralia* shells are definitely associated with the preceramic rather than ceramic phase occupation. Pieces of worked *Turbo marmoratus* occur in the preceramic deposit at both DJA and DBE and extend into the late Lapita phase deposit at DBE. Single pieces of worked pearl shell (*Pinctada)* and another small bivalve are found in the preceramic deposit at DBE and also occur in the upper two levels at DJA suggesting use during the later preceramic period. The presence of a probable *Tridacna* adze midsection fragment from the lower Holocene deposit at DJA suggests that shell adzes were being manufactured by about 9000 BP on Buka. This is supported by the presence of *Tridacna* adzes at the Pamwak site on Manus which are at least 7000 years old (Fredericksen et al. 1993). The only other shell tool found at DJA is a perforated Cardiidae valve which may have been used as a coconut grater. The shell was located in an excavation level with Buka style pottery from which a preceramic date of calBC 3637 (3498, 3455, 3379) 3335 was obtained. This presents obvious difficulties in determining if the artefact is pre-Lapita or not.

One of the non-ceramic elements supposedly associated with the Lapita cultural complex is a distinctive range of shell ornaments (Green 1992; Spriggs 1993a), although there is increasing evidence for a number of shell ornament types such as *Trochus* and *Tridacna* rings, *Conus* discs and shell beads from pre-Lapita contexts in the Bismarcks and Solomons (Gosden et al. 1994; Spriggs 1991b). Shell ornaments from Lapita and/or pre-Lapita deposits at DBE and DJA include *Trochus* rings (n=5) and small shell beads (n=5) from both sites, *Conus* discs (n=2) from DJA and *Oliva* shells with the spires removed (n=2) from DBE. All of the ornaments from DJA are within the zone in which Buka style pottery occurs but preceramic dates were obtained. At DBE, two of the *Trochus* rings and small beads and one of the *Oliva* ornaments were found in the preceramic deposit but the *Trochus* rings occur in a level in which an intrusive Recent style sherd was also present. Each of these ornament types also occur in the late Lapita deposit. Perhaps the only definite conclusion which can be reached in reviewing this evidence is that shell ornaments do not appear to come into use until the mid-Holocene and some types may not have been introduced prior to the Lapita phase.

Spatial variability at the reef sites

Spatial variation in the distribution of Lapita ceramics at the reef sites, especially DAF, has been discussed. The available evidence suggests that differences in stylistic and formal attributes of pottery from different portions of the DAF site are chronological. Based on frequency seriations, the earliest ceramics occur on the outer reef at the north end of the site followed by the south central reef and finally the beach and inner reef. The ceramics at DJQ have traits which are earlier than any of the DAF areas and DES falls somewhere between DJQ and the outer reef at DAF chronologically.

The ceramic evidence has a number of implications for interpreting the distribution of lithic artefact assemblages from these sites. There is an overall unity in the range of stone artefacts found at each of the reef sites despite the differences in age. As with the ceramics, there was no obvious clustering of lithic artefacts at DJQ or DES except for higher densities in the same areas where Lapita ceramics were most concentrated. At DAF and DAA, stone artefacts other than obsidian were clearly clustered on the central reef and include similar types of tools although the proportion of abraders at DAA is much higher.

At DAF almost all of the stone tools were found in Areas 1 to 3 on the south central reef although lithic artefacts were collected from all areas of the reef and beach. The highly concentrated distribution of the stone tools at DAF indicates that occupation of the reef during the latter part of the Lapita phase was focused on a specific set of activities related to artefact manufacture as indicated by the predominance of manufacturing tools such as grindstones and abraders. The high quantity and concentrated clustering of the tools are suggestive of large scale production of certain artefact types such as shell armbands and other ornaments which could have been important items of exchange (cf. Kirch 1988b). The high proportion of pottery vessels used for cooking and storage on the south central reef at DAF indicates that food preparation was also an important activity here. Spatial analysis of artefact distribution patterns from the SE-RF-2 Lapita site in the Reef Islands has shown that food preparation and stone tool use (obsidian and chert) were focused in different areas of the site (Sheppard and Green 1991). However, the basis for comparison between DAF and this site is limited by the fact that one represents probable stilt house occupation on the reef and the other is an open beach habitation site.

Evidence for exchange

The principal evidence for exchange on Buka is the presence of obsidian from West New Britain and the Admiralties in the Bismarcks which appears to have been imported from the Lapita phase to the Malasang phase. Only a few pieces of obsidian were collected from the DJQ and DES reef sites but the distribution of obsidian at DAF is more complex and also spatially distinct from the other lithic artefacts represented. Only six flakes were found on the south central reef and very few collected from the outer reef but a much higher concentration was present on the inner reef and eroding beach deposit which is dated to the late Lapita phase on the basis of ceramic evidence.

The low amounts of obsidian at DJQ, DES, and the outer and central portions of the DAF reef suggest that the amount of obsidian being imported to Buka was quite low until the late Lapita period when there was a significant increase as indicated by the high density of obsidian from the beach and test unit at DAF. It is possible that greater amounts of obsidian were being imported to Buka during the early Lapita phase but this is not reflected in the site sample presently available. Following the Lapita phase, the amount of obsidian found in site deposits is minuscule and limited to very small flakes.

Sourcing by the specific density method has confirmed that almost all of the obsidian from Buka is from the Admiralty Islands (Lou) rather than West New Britain (Talasea). This is interesting as Talasea is the dominant source for obsidian in the Reef-Santa Cruz Lapita sites and also common during the early Lapita period on Nissan. In contrast to the Reef-Santa Cruz sites, the ratio of Talasea to Lou obsidian on Nissan decreases significantly over time. The contrasts between Buka, Nissan and the Reef-Santa Cruz sites in terms of obsidian sources being utilised suggest that exchange networks during the Lapita phase may have been complex with multiple networks operating simultaneously.

Kirch (1988b) has argued that a range of shell ornaments functioned as Lapita exchange valuables. His argument is based largely on ethnographic analogy with reference to well known exchange networks such as the *kula* where shells were among the most prestigious objects being exchanged. The categories of ornaments which may have functioned as exchange valuables include rings, discs, beads, pendants, rectangular units and elongate bars made from *Tridacna, Spondylus, Conus* and *Trochus* shell. Six of the ten classes of exchange items recognised by Kirch are present in the Buka site assemblages although only four definitely occur in Lapita deposits. There is also evidence for the local manufacture of at least four classes of 'valuables' on Buka based on the presence of waste material and unfinished examples. It is notable that *Trochus* rings, which are the class of ornament most commonly found on Buka in both Lapita and post-Lapita phases and for which there is ample evidence of local manufacture, are absent from the Mussau and Reef-Santa Cruz site assemblages according to Kirch's data. It is also interesting that evidence for the manufacture of *Trochus* rings is only recorded in one of the ten Lapita assemblages examined by Kirch (Lakeba, Fiji).

8

PREHISTORIC SUBSISTENCE STRATEGIES ON BUKA: THE FAUNAL AND FLORAL EVIDENCE

Animal and plant remains from the Buka site deposits represent a valuable source of information reflecting changes in subsistence patterns over an immense period of time which covers the transition from Pleistocene hunting and gathering to fully-developed agriculture by the Lapita period. In this chapter, the analyses of faunal and floral remains are presented and the results examined in terms of changing subsistence patterns and their relationship to environmental variables and cultural practices. The following discussions bring together data gathered by a diverse group of specialists which make it possible to formulate a model of prehistoric subsistence change on Buka. These include analyses of vertebrate remains by J. Peter White and his students (mammals and reptiles), Tim Flannery (rodents), Sarah Colley (fish) and Corrie Williams (birds). Botanical remains from the Kilu Cave site were analysed by Douglas Yen (charcoal) and Thomas Loy (plant residues on stone tools).

Results of vertebrate faunal analysis are presented by major taxonomic classes (i.e. mammal and reptile, bird and fish) chronologically beginning with the preceramic period, followed by a general discussion of evidence from the ceramic-age sites. Both intra- and inter-site distribution patterns for molluscan remains are examined in terms of spatial and temporal variability in the abundance and relative importance of taxa. Specific issues addressed by the Buka faunal data include human transport of animals, faunal extinctions, potential overexploitation of marine shell resources and insights into environmental change offered by faunal and floral remains from the preceramic deposits. The final portion of the chapter reviews the botanical evidence from the Pleistocene and early to mid-Holocene deposits at Kilu Cave which include charred plant remains and residues on stone tools.

SAMPLING AND ANALYTICAL METHODS

The sampling strategy employed in the collection of faunal remains from the Buka sites was designed to provide representative and comparable data from each site to address questions regarding the nature of subsistence both temporally and spatially for the entire prehistoric sequence. The amount of data on prehistoric subsistence for the northern Solomons prior to the present study was limited despite the growing body of archaeological evidence from the region. No quantitative analysis of faunal remains from Buka was undertaken by Specht although identifications of mammal bone from his Buka sites and those excavated by Spriggs on Nissan have been published (Flannery et al. 1988). A detailed report of Spriggs' Nissan research has yet to be published although the preliminary report (Spriggs 1991a) briefly discusses the results of faunal analysis for fish and mammal remains. Terrell's (1976) survey work on Bougainville involved little excavation and the only assessment of faunal remains is a limited analysis by Kriszcziokaitis (1976).

Excavations during the present investigations were carried out in arbitrary levels of 10 cm or less within natural stratigraphic units. All excavated matrix was first dry-screened and subsequently wet-screened through 1/8" (3.2 mm) wire mesh. Material remaining in the screen was bulk bagged and transported to a field laboratory for further analysis. The bulk residue was first dried and then sieved through nested 1/4" and 1/8" mesh screens at the field laboratory. All bone was picked from each screen fraction and shell was collected only from the 1/4" (6.4 mm) screens due to time constraints and the low amount of identifiable shell in the 1/8" fraction.

Samples of non-marine molluscs were also retained from the 1/8" screen fraction.

Bone weights were recorded by excavation level for all excavation units in the field and a total of 19.1 kg of bone was recovered, 70.3% (13.4 kg) of which comes from the Kilu Cave site (DJA). Fish bone from all excavated sites was later separated and sent to Dr Sarah Colley who analysed all of the fish bone from the Kilu Cave excavations (Colley n.d.a). Mammal and reptile bone from a single excavation unit at Kilu Cave (TP 3) and all units from the other sites was analysed by Dr J. Peter White and his students at the University of Sydney (White n.d.a, n.d.b). Rodent jaws from Kilu Cave were identified by Dr Tim Flannery at the Australian Museum (Flannery and Wickler 1990) and identifications of bird bone from Kilu Cave were done by Corrie Williams, an honours student at Monash University at the time (Williams n.d.).

The methodology employed in the analysis of vertebrate remains varied to some degree between analysts as did the taxonomic level at which the identifications were made. The degree to which the analytical results could be synthesised was dependent on the manner and degree to which the individual analysts interpreted the data.

Shell from the 1/4" screen fraction for all excavation units was weighed by excavation level and a single 1 m² excavation unit was selected from each site for sorting into taxonomic categories, in most cases to the species level. Units with the highest density of shell within individual sites were selected for identification to increase the sample size. Weights for each taxonomic category were recorded on standardised forms by excavation level. Taxonomic identifications were made with the aid of a reference collection in the field and voucher specimens of all taxa were collected and examined by Dr Alison Kay at the University of Hawai'i. The reference collection was donated to the Department of Anthropology, University of Hawai'i where it is permanently housed.

ANALYTICAL RESULTS – VERTEBRATE REMAINS

The results of bone analysis are presented by major classes beginning with mammals and reptiles and followed by birds and fish. A portion of the tables presenting the bone data are found in Appendix C. Due to the exceptional abundance and diversity of faunal remains at the Kilu site, discussion is focused on this material. The bone from Palandraku Cave and the ceramic sites is disappointingly meagre and often highly fragmented. Preservation is good to excellent at most of the sites although much of the material from DJW and DJU is whitish and chalky due to decalcification. The bone from Kilu Cave is well-preserved although drip-stone concretions (calcium carbonate) hindered the identification of some remains. Much of the bone is a dark brown colour which may be due to chemical staining as noted for bone from at least one of the Pleistocene age sites from New Ireland (Marshall and Allen 1991:72). Although not quantified, approximately 10 to 20% of the bone at Kilu is obviously burnt and includes all excavation levels and taxa represented. Similar frequencies of charred bone occur at the other Buka sites.

Mammal and reptile remains – Kilu Cave (Site DJA)

Due to the abundance of bone at Kilu, time constraints restricted analysis of mammal and reptile remains to a single excavation unit, TP 3. However, bone from the other two excavation units was inspected to determine if taxa not found in TP 3 were present. The 13.42 kg of bone recovered from Kilu is evenly distributed between the three excavation units. Nearly three-quarters of the 4.0 kg of bone from TP 3 is mammal or reptile (2.93 kg). The following discussion is based on an interim report of analytical results by White (n.d.a). Despite the considerable amount of time spent by White and his students analysing the TP 3 material, many of the identifications were only made to the family level due to a lack of comparative specimens, particularly for the reptiles, and general bone fragmentation (e.g. lack of epiphyses). Identification of post-cranial remains was limited to general size categories (large, medium and small) and only identifications of jaws and innominates are considered reliable for the reptiles. Percentages of unidentified bone range from 28.8 to 73.6% between excavation levels but are below 50% for all but the upper six levels where the least amount of bone occurs.

Since there are no endemic bone-accumulating scavengers on Buka and the bone remains show little sign of rodent gnawing, White (n.d.a) maintains that nearly all of the bone can be attributed to human consumption. There is minimal evidence for crushing of bone or breakage of articular ends for the extraction of marrow. Skeletal element frequencies demonstrate that both rodents and reptiles were being brought to the site whole for consumption as might be expected from the sizes of the animals involved. Although a majority of the bone is undoubtedly human related, frogs and some of the small lizards and rats may have been residents of the cave and represent natural bone input. Bats did not roost in the cave at the time the site was excavated but some species may have done so in the past and entered the deposit naturally. No attempt was made to distinguish bone which may not have a cultural origin during analysis as most taxa which may occur naturally could also have been consumed by humans.

Distribution patterns

Bone counts (Table 8.1) and weights (Table 8.2) are highest in the lower portion of the Holocene deposit (Layer IC) between levels 8 and 12 which accounts for 64.1% of all mammal and reptile bone by weight. As discussed in Chapter 3, both an increase in sediment accumulation rates and higher midden densities suggest that the intensity of site use increased significantly from the Pleistocene (Layer II) to Holocene (Layer I) components. Peak densities of both bone and shell occur in the basal levels of Layer I for all units. Bone densities are twice as high in excavation unit TP 2 as the other two units for

Layer	Level	Rodent	Bat	Snake	Varanid	Skink	Agamid	Unid. Reptile	Total
IA	1	2	-	-	-	-	-	2	4
IA	2	41	15	3	18	15	-	-	92
IA	3	72	10	1	37	44	-	39	203
IA	4	18	9	-	14	16	-	-	57
IA	5	18	10	-	11	12	-	-	51
IA	6	7	2	2	5	7	-	-	23
IB/C	7	114	37	8	26	47	3	11	246
IB/C	8	116	58	32	49	53	1	23	332
IB/C	9	261	16	182	153	15	4	76	707
IC	10	338	51	190	66	141	-	309	1095
IC	11	277	82	218	253	130	7	182	1149
IC	12	324	67	285	42	159	3	165	1423
Subtotal (Layer I)		1588	357	921	1052	639	18	807	5382
IIA	13	83	16	84	86	25	-	26	320
IIB	14	26	2	27	22	17	-	3	97
IIB	15	24	4	21	39	10	-	8	106
IIC	16	36	6	10	46	3	-	7	108
IID	17	42	24	6	30	17	-	46	165
IID	18	18	12	4	22	2	-	-	58
IID	19	60	2	18	35	6	-	-	121
IID	20	67	8	19	50	4	-	25	173
Subtotal (Layer II)		356	74	189	330	84	-	115	1148
Total		1944	431	1110	1382	723	18	922	6530

Table 8.1 Number of Identified Specimens (NISP) for mammal and reptile bone from TP 3, Kilu Cave (Site DJA).

Layer	Level	Rodent	Bat	Snake	Other Reptile	Total
IA	1	0.34	-	-	0.05	0.39
IA	2	12.59	0.70	0.30	9.70	23.29
IA	3	21.30	1.80	0.20	24.94	48.24
IA	4	4.24	3.03	-	5.03	12.30
IA	5	4.21	1.60	-	2.21	8.02
IA	6	0.85	0.22	0.11	1.53	2.71
IB/C	7	25.44	8.50	2.30	14.11	50.35
IB/C	8	24.15	8.50	3.86	12.87	49.38
IB/C	9	71.20	3.73	43.98	64.35	183.26
IC	10	88.94	8.55	48.94	115.77	262.20
IC	11	86.36	22.12	47.78	102.32	258.58
IC	12	144.90	24.06	73.37	155.21	397.54
Subtotal (Layer I)		484.52	82.81	220.84	508.09	1296.26
IIA	13	36.46	3.68	23.10	30.09	93.33
IIB	14	9.54	0.18	5.18	15.73	30.63
IIB	15	7.31	1.28	5.06	25.38	39.03
IIC	16	18.35	3.35	2.96	16.30	40.96
IID	17	21.50	18.84	2.00	33.97	76.31
IID	18	10.61	2.95	0.37	10.90	24.83
IID	19	32.90	0.63	6.64	11.23	51.40
IID	20	28.68	1.44	4.72	32.11	66.95
Subtotal (Layer II)		165.35	32.35	50.03	175.71	423.44
Total		649.87	115.16	270.87	683.80	1719.70

Table 8.2 Total weight (g) of mammal and reptile bone from TP 3, Kilu Cave (Site DJA).

these levels. The proportion of identified reptile bone for these levels is somewhat higher than those above or below although whether this difference is real or a reflection of analytic methodology is uncertain.

Amounts of bone drop dramatically above excavation level 7 which is at the contact between Layer IA and IB, as shown in Tables 8.1 and 8.2. The percentage of bone identified for the combined sample of mammal and reptile bone also decreases to between 26.4% and 43.9%. According to White (n.d.a), the lower proportion of identified bone seems to be due to a greater degree of breakage. There is a similar decrease in the amount of bone in both of the other excavation units which is most pronounced in the upper three excavation levels (see

Table 3.10). A decrease in the intensity of site use may partially explain the decline in bone but the increase in breakage also suggests a change in the focus of site activity.

Another factor contributing to the lower quantities of bone in levels 6 to 8 is the presence of a series of superimposed hearth features (Layer IB) found in units TP 3 and TP 2 towards the mouth of the cave. Both bone and shell densities are substantially lower within the hearth zone, particularly in TP 2, which suggests that refuse was removed from this area and disposed of elsewhere. A similar pattern has been observed at the Pleistocene cave site Matenkupkum on New Ireland where shell and stone densities are low in hearth areas (Gosden and Robertson 1991:36). Although spatial patterns of discard at Kilu remain poorly understood due to the limited area excavated, there does not appear to be a consistent increase in the amount of bone or other midden towards the rear of the cave like that observed for bone at least one of the sites with Pleistocene occupation (Panakiwuk) on New Ireland (Marshall and Allen 1991:79).

Taxonomic representation

As shown in Tables 8.1 and 8.2, taxonomic identification did not proceed beyond the family level except in the case of rodent jaws identified by Flannery (Table 8.3). In general terms, the fauna at Kilu is similar to the assemblages from cave sites of comparable age on New Ireland although species richness appears to be greater at Kilu and there is no definite evidence of introduced species as on New Ireland (Allen et al. 1989; Marshall and Allen 1991; White et al. 1991). There is little change in the rank order of individual taxa over time within TP 3. Mammals are dominated by rodents with much lower numbers of large to small bats. No definite pig remains have been identified in TP 3 or in levels 1 to 7 of the other two excavation units. There is a possible pig long bone fragment in TP 1, level 1 and another, along with a vertebra fragment, from TP 2, level 4, but none of these bones could be positively identified and may be human or sea mammal. A single *Phalanger* bone has also been identified from the base of Layer I (level 12). Terrestrial reptiles are comprised of snakes and lizards, including at least two sizes of varanids and skinks and a low number of agamids. Marine reptiles are represented by a group of small turtles from the base of the Holocene deposit (levels 10 to 13). The turtle bone is included under the category 'unidentified reptile' in the tables as bone counts were not provided. A low number of frog bones were also scattered through the site deposits.

Rodents

The remains of six rodent species from the Kilu deposit have been identified by Flannery from jaw bones (Table 8.3). Three of these species (*Solomys ponceleti*, *S. salebrosus* and *Melomys bougainville*) are still extant and endemic to the islands of Buka, Bougainville and Choiseul (*S. salebrosus* only). An additional two species (*S. sprigg-sarum* and *M. spechti*) have not been previously described and are now apparently extinct. Both of these species have been named in honour of individuals who have played an important role in archaeological research within the northern Solomons. *S. spriggsarum* is named for Matthew Spriggs and his wife Ruth Saovana-Spriggs and *M. spechti* for Jim Specht. As detailed taxonomic

Layer	Level	*Rattus exulans*	*Solomys spriggsarum*	*Solomys salebrosus*	*Solomys ponceleti*	*Melomys spechti*
IA	1	-	-	-	-	-
IA	2	-	1?	1	-	1
IA	3	2	-	2	1	1?
IA	4	-	-	-	-	-
IA	5	-	(TP1:1)	-	-	(TP1:1)
IA	6	-	-	-	-	-
IB/C	7	-	3	7	-	1
IB/C	8	-	2	2	-	-
IB/C	9	-	2	5	1	-
IC	10	-	4	9	2	-
IC	11	-	11	8	-	2
IC	12	-	10	7	9	4
Subtotal (Layer I)		2	33	41	13	9
IIA	13	-	4	3	2	-
IIB	14	-	-	-	-	1
IIB	15	-	-	-	-	1
IIC	16	-	1	1	-	-
IID	17	-	1	1	-	-
IID	18	-	1	2	1	-
IID	19	-	2	1	1	-
IID	20	-	-	1	1	1
Subtotal (Layer II)		-	9	9	5	3
Total		2	42	50	18	12

Table 8.3 Rodent jaws (NISP) from TP 3, Kilu Cave (Site DJA). (* Bone counts for *Melomys bougainville* not included. *Solomys salebrosus* and *S. ponceleti* also occur up to level 2 in TP 1 or TP 2)

descriptions of these rodent species have been published elsewhere (Flannery and Wickler 1990), additional details are not provided here. The sixth rodent species, *Rattus exulans*, is found only in level 3 of TP 3, which has evidence from late prehistoric and historic use of the cave (i.e. Mararing style pottery and a piece of metal).

The extinction of *S. spriggsarum* and *M. spechti* occurred sometime after 5000 BP (the terminal date for preceramic occupation from Kilu) and most likely before 2000 BP based on the lack of remains from either species in Buka ceramic-bearing sites (Flannery et al. 1988). It remains uncertain why these species became extinct while the other endemic species survived. Both are in the middle of the size range for endemic murids of the region and at least *S. spriggsarum* is relatively common in the Holocene deposit (Table 8.3). Recent research in the Solomons has shown that terrestrial murids are much more vulnerable to the impact of pigs, dogs and other introduced animals than arboreal species and the extinction of *S. spriggsarum*, which may have been terrestrial, could have been due to such competition (Flannery and Wickler 1990).

In the case of *M. spechti*, competition with the introduced species *Rattus praetor*, which is similar in body size, may have led to its extinction. On New Ireland, *R. praetor* has caused the extinction of a similar-sized rat, *R. mordax* (Flannery and White 1991:104). Although there is evidence for the introduction of *R. praetor* by 8000 BP at the Panakiwuk site on New Ireland (Allen et al. 1989:556) and Tikopia sometime after 3000 BP, the first appearance of this species in the Buka archaeological record dates to the Sohano phase after 2000 BP (Flannery et al. 1988:90, 93). Based on present evidence, *R. exulans* is a relatively late introduction in Island Melanesia with no secure dates prior to the Lapita period (ca. 3000 BP). According to Flannery et al. (1988:91), the lack of *R. exulans* bone and rarity of other small murids from Specht's Buka excavations may be attributed to use of a 5 mm mesh screen. However, Specht (1969:35) states that he used an even larger 1/4" (6.4 mm) mesh to screen his excavated soil in order 'to recover as much small faunal and artefactual material as possible'.

Bats

Although not identified to family, the bat taxa represented range from large fruit bats (Megachiroptera), including *Pteropus neohibernicus* and *Dobsonia* cf. *moluccensis*, to small fruit bats and insectivorous species. Bats are of minor importance in the TP 3 deposit representing 6.6% of the total identified bone by Number of Identified Specimens (NISP) and 6.7% by weight.

Phalanger

A single *Phalanger orientalis* zygomatic bone has been identified by White and Flannery from level 12 at the base of the Holocene deposit (Layer IC) in TP 3. No other *Phalanger* bone is present in corresponding levels from the other two excavation units or elsewhere in TP 3. There is also no *Phalanger* in the upper excavation levels at Kilu which have evidence of ceramic period occupation (levels 1 to 7 in both TP 1 and TP 2 were scanned for *Phalanger* bone). *P. orientalis* was introduced to southern New Ireland by 19,000 BP based on remains from the Matenbek site (Allen et al. 1989:556). On Nissan, the diminutive form of *P. orientalis* found on the island today is present in the earliest site deposit which has a calibrated date of calBP 5268 (4864) 4554 (Flannery et al. 1988:92; Spriggs 1991a:227, 237).

Although the single *Phalanger* bone at Kilu could be viewed as evidence for human transport of *P. orientalis* to Buka by 9000 BP, the lack of additional *Phalanger* bone from Kilu and its absence in the preceramic deposits at Palandraku Cave argue against this interpretation. In my opinion, a single bone is not sufficient evidence for the introduction of a new species and it must be considered intrusive until additional evidence is available which can contradict this interpretation. Flannery and White (1991:110) claim that *P. orientalis* was a highly successful coloniser and that 'no clear evidence indicates that *P. orientalis* ever reached an island and then failed to colonise'. If this is the case, then one would certainly expect to find more than one bone from the preceramic deposits on Buka if *Phalanger* had been introduced during this period.

Reptiles

A wide range of terrestrial reptiles occur in the Kilu deposits representing 63.8% of the identified bone by NISP and 55.6% by weight in TP 3. Lizards are the most abundant category represented with relatively high amounts of varanids and large skinks and a much lower number of agamids. However, White (n.d.a) states that only the identifications of lizard jaws and innominates can be wholly relied on as demonstrated by disproportionate amounts of cranial and post-cranial bone attributed to the same taxa in some levels. Thus the NISP frequencies in Table 8.1 indicate a higher percentage of varanid than skink remains while weights for reptile jaws reveal a predominance of skink. Snake remains account for 17.0% of the identified bone by NISP and 15.8% by weight.

The identification of a concentration of young marine turtles in levels 10 to 13 at the base of the Holocene deposit (Layer IC) in TP 3 is of considerable interest. Dr Jerry van Tets, who identified the material, provided a size estimate for the turtles of ca. 20 cm or less and suggested that they may have been confined and reared since hatching, as has been recorded in more recent times (J. van Tets, pers. comm. cited in White n.d.a). Although not all of the bone has been identified, about 20 individuals may be represented.

Mammal and reptile remains – ceramic sites

The total weight of all bone recovered from the six other sites excavated in 1987 (5.67 kg) is less than half of that from Kilu Cave alone. In addition to the low quantity of bone from these sites, the material is highly fragmented and preservation is poor in several deposits. Analysis of non-fish vertebrate remains from the ceramic sites, including Palandraku Cave which also has a preceramic component, was carried out by White in conjunction with the Kilu bone (White n.d.b). Rat and bat dentition samples held by Flannery were excluded from the analysis.

Identifications were made to the same taxonomic level as for the Kilu bone and include the following categories:

human, pig, *Phalanger*, rat, bat, reptile and bird. Bats and rats were divided into large, medium and small size groups. For rats these sizes are comparable to *Melomys rothschildii*, *Rattus praetor* and *R. exulans* respectively. Large bats are similar in size to the fruit bats *Dobsonia moluccensis* and *Pteropus neohibernicus*. Bone frequencies were recorded by NISP for individual skeletal elements using abbreviations following Klein and Cruz-Uribe's (1984) BONECODE. Only a small percentage of the bone was identified (never more than 10%) and although additional identifications could be made, it is unlikely that these would exceed 20% of the sample.

A majority of the site assemblages are dominated by pig bone. Site DJU has a number of bones which are from a large sea mammal which has been tentatively identified as dolphin. Palandraku Cave (DBE) has the most diverse faunal remains with a marked contrast between the preceramic assemblage, which contains only endemic species, and the ceramic-bearing levels where pig and *Phalanger*, both introduced species, first appear.

Palandraku Cave (Site DBE)

Despite the highly fragmentary state of the Palandraku bone and decalcification of material in the uppermost stratum (Layer I), identification of a relatively wide range of taxa was possible. As shown in Tables 8.4 and C.1, a number of interesting changes occur in the taxonomic composition of the faunal assemblage between the initial preceramic component (Layers V and VI) dated to around 5000 BP and later ceramic-age occupation. The preceramic phase fauna is dominated by endemic rodents, bats and reptiles similar to those found at nearby Kilu Cave. The only other vertebrate remains identified from these levels are human, including bone fragments (some of which are burnt) and a few teeth and other small bones which may be intrusive from the overlying late Lapita phase deposit (Layer IV).

Ceramic period occupation at Palandraku includes a late Lapita phase component (Layer IV) and Mararing to Recent phase deposit (Layer I and II) separated by a non-cultural stratum (Layer III) which formed during the hiatus in occupation between the two components. A majority of the bone in Layer III is probably intrusive. Although the rodents, bats and reptiles which are dominant in the preceramic faunal assemblage continue to occur in the ceramic-bearing layers, their rank order importance decreases over time. Two species also appear for the first time during the late Lapita phase, *Phalanger orientalis* and pig (*Sus scrofa*). The presence of pig agrees well with current evidence which links the introduction of domesticated animals into Island Melanesia with the advent of Lapita. The absence of *Phalanger* (except for a single incisor) in the preceramic deposit at Palandraku in contrast to its relative abundance in the ceramic-bearing levels of the site supports the claim that *Phalanger* was not introduced to Buka until the Lapita period. The most parsimonious explanation for the single *Phalanger* incisor found in the uppermost level of preceramic Layer V (TP 3, level 7) is that it is intrusive from the overlying late Lapita phase deposit.

A concentration of human teeth (n=56) and phalanges (n=23+) was found within the late Lapita phase Layer IV stratum (Table C.1). The limited range of skeletal elements represented and absence of evidence for burning suggest that the remains were deliberately deposited rather than the result of regular burials or disturbance of such features. Based on the wear and condition of the teeth, two or more individuals including at least one subadult (as indicated by the presence of seven unerupted teeth) are represented. The presence of a few human teeth in Layers III and V is probably the result of displacement of material from the Layer IV bone concentration.

Other ceramic sites

Tables 8.5 and C.2 reveal the limited nature of the vertebrate faunal remains from the five ceramic-bearing site deposits, which are presented in chronological order in the tables. Sites DJW, DJU and DJO-D have the most bone by weight (1.3-2 kg) while the remaining site deposits (DKC, DAF and DJO-A) have less than 100 g each. *Sus scrofa* is by far the most abundant species at each site and has also been reported throughout the Buka ceramic sequence by Specht (1969:299). Although no dog remains were found in sites from the present study,

Taxon	Layer					
	I	II	III	IV	V	VI
Homo sapiens	-	1	5	82	5	2
Sus scrofa	11	11	4	10	-	-
Large mammal	3	2	-	2+	2+	2+
Phalanger orientalis	4	4	-	4	1	-
Rat						
large	13	5	1	10	25	16
medium	3	6	11	24	6	10
small	3	-	14	12	5	3
Bat						
large	2+	-	-	4	-	2+
medium	-	-	1	7	11+	5
small	-	-	-	1	1	2
insectivorous	3	-	-	1	1	2
Reptile (unidentified)	5	2	4	35	15	18
Skink	1	-	-	1	-	-
Snake	-	2	-	-	-	-

Table 8.4 Non-fish bone (NISP) from Palandraku Cave (Site DBE).

Site/ Provenience	*Homo sapiens*	*Sus scrofa*	Large Mammal	Dolphin?	*Phalanger orientalis*	Large Rat	Medium Rat	Small Rat	Large Bat	Medium Bat	Reptile	Bird
DKC (level 1-4, 6)	7	-	2	-	-	-	-	-	-	-	5	-
DAF	-	10	1	-	-	-	-	-	-	-	-	-
DJW	-	80+	-	-	-	-	-	-	5	2	-	-
DJU	-	27+	-	24	1	-	-	-	-	3+	1	-
DJO-A	-	6	9	-	-	-	1	-	-	-	-	-
DJO-D												
Zone 1	1	?	4+	-	-	1	1	-	1	-	-	-
Zone 2	-	3	2	-	1	-	-	1	-	-	-	-
Zone 3	1	7	-	-	-	-	9	1	2	-	1	-
Zone 4	1	3	1	-	1	-	-	-	-	1	1	1?
Zone 5	2	6	1	-	-	-	-	1	-	-	1	1
Zone 6	3	9	2+	-	-	-	-	-	-	1	-	-
Zones 7-9	1?	3	6+	-	-	-	1	2	-	-	-	-

Table 8.5 Non-fish faunal remains (NISP) from Buka ceramic sites.

Specht (1969:299) recovered dog bones in association with Sohano style pottery at the DAI site. Other large mammal remains include low amounts of human bone from Sites DKC and DJO-D and fragments of pig or human bone in most site deposits. A few *Phalanger* bones have been identified at DJU and DJO and also occur throughout the DAI deposit excavated by Specht (Flannery et al. 1988:89). A single metatarsal from another introduced species, the wallaby *Thylogale brunii*, has also been identified from the Sohano phase deposit at DAI and is thought to represent a trade item as the nearest extant population of this species is found on New Ireland (Flannery et al. 1988:90). Low amounts of bone from large to small rats occur at DJO and large to medium bats occur at DJW, DJU and DJO (including the large fruit bat *Pteropus neohibernicus*). Evidence for the exploitation of marine mammals is present at DJU where a concentration of vertebrae, ribs and long bones tentatively identified as dolphin occur. Reptile remains include varanids and other lizards, and bird bone is limited to two fragments from DJO-D.

Avifaunal remains – Kilu Cave

Bird bone from all units at Kilu has been identified by Corrie Williams and the following discussion of this material is based on a preliminary report of this analysis (Williams n.d.). All recognisable bird bone was first removed from the general Kilu bone sample and classified by skeletal element. Identifications to the family level were possible in most cases using the avian reference collections at the Earth Sciences Department, Monash University and the National Museum of Victoria. Bone measurements followed procedures recommended by von den Driesh (1976) and were used to estimate approximate size ranges for each of the specimens.

The number of bones identified by skeletal element for each of the species identified is presented in Table 8.6. A total of 13 taxa representing five families and one more

Taxon	Body Size (mm)	Layer I	Layer II
Ardeidae	650-700	1 TM	
Accipitridae	890-1006	1 TM	
	520		1 U
	480-550	1 TT	
Megapodiidae	< 580-700	1 TM	
Rallidae	460		1 TT
Charadriiformes	380-455	1 H	
	350-380	1 U	
	250-280	1 U	
Columbidae	710-780	2 TM	
	610-710	1 TT	
	ca. 320		1 TM
	ca. 120	1 C	
Unidentified	400-430	1 TM	
		3 (1 PM)	
Total (NISP)		15	3

Table 8.6 Avifaunal remains (NISP) from Kilu Cave (Site DJA) by skeletal element. (Code: PM - premaxilla; TT - tibiotarsus; TM - tarsometatarsus; H - humerus; U - ulna; C - coracoid)

general class of avifauna was identified from 14 elements. Four elements could not be identified, including two radii or ulnii and a premaxillary. Although the amount of avian remains is inadequate to address chronological trends within the Kilu deposit, some impression of the diversity of taxa exploited is possible.

A majority of the taxa identified are land birds, including a megapode (Megapodiidae), rail (Rallidae) and several species of hawks (Accipitridae) and pigeons (Columbidae). A single heron species (Ardeidae) and three Charadriiformes are also represented. Most taxa have size ranges which match those of avifauna from the same families found in the North Solomons at the present time (Mayr 1945). The identification of taxa which are larger than those presently found on Buka is of considerable interest. These include a rail from the upper Pleistocene deposit (level 13, TP 3) which appears to be much larger than any extant species and three pigeon specimens from the Holocene deposit (TP 1 and TP 3, level 11 and TP 3, level 2) which are significantly bigger (610-780 mm) than the largest extant pigeon in the Buka region (410 mm). Two smaller pigeons are also represented in the deposits.

There is a rapidly growing body of evidence from Polynesia relating to the extirpation (loss of individual island populations of extant species) and to a lesser extent, extinction, of bird taxa which can be directly attributed to human influences (Steadman 1989, 1995). The fossil record of birds from Island Melanesia is presently limited to New Caledonia and the Polynesian outliers of the southeast Solomons. Although there is some evidence for the possible extinction or extirpation of bird taxa from Near Oceania (Williams n.d.), the situation is much more complex than for Remote Oceania where initial human settlement did not occur before 3500 BP. Whereas the impact on bird populations is related to initial human settlement in Remote Oceania, the evidence from Buka suggests that the potential extirpation of some species did not occur until the mid- to late Holocene, many millennia after initial settlement during the late Pleistocene.

Bird remains from Pleistocene sites in the Bismarcks are quite limited and have only been discussed for the Panakiwuk site (Marshall and Allen 1991:78-9). As with the Kilu remains, a variety of land birds occur at this site including species from the rail, parrot, pigeon and fowl families. There is no apparent evidence for the potential extirpation or extinction of species although the level of taxonomic identification is probably insufficient to preclude this possibility. Although the Kilu evidence is intriguing, additional analysis will be required to confirm the possibility of extinctions and determine what role, if any, humans played.

Fish remains – Kilu Cave

All fish bone from the Kilu Cave excavations was analysed by Sarah Colley and the resulting raw data tabulated by Lisa Nagaoka. However, no summary of the analytical results was provided by Colley and the following discussion is based on my own interpretation of the data. Taxonomic identifications were made using the comparative fish reference collection at the then Department of Prehistory, RSPacS, The Australian National University (now part of the Department of Archaeology and Natural History, Research School of Pacific and Asian Studies [RSPAS]). Of the 11,279 pieces of bone examined, only 15.4% were identifiable and the amount of material which might be identified with additional analysis is quite low (1.1%). Although the remains are well-preserved, the presence of concreted calcium carbonate made identification of some of the material difficult.

The NISP from each taxonomic category in the assemblage for the two principal occupation components at Kilu (Layers I and II) is presented in Table 8.7 and more detailed bone counts by stratigraphic unit for each excavation unit are found in Appendix C (Tables C.3 to C.5). Identifications were made using a wide array of elements consisting primarily of cranial material (dentary, articular, quadrate, premaxilla, maxilla, upper and lower pharyngeal, jaw bone, teeth) but also including vertebrae (precaudal, caudal, tail caudal), fin rays (dorsal and modified dorsal), spines (dorsal, dermal, locking) and other skin elements (scute, dermal plate). Utilisation of a wide range of elements for identification and screening with relatively small mesh (1/8" = 3.2 mm) increased the reliability of taxonomic abundance estimates for the assemblage (see Butler 1988, Gordon 1993 and Nagaoka 1994 for discussions of screen size and differential recovery of fish remains).

The distribution of fish remains within the Kilu deposits is quite similar to other types of bone and shell midden. The highest concentration of bone occurs at the base of the Holocene deposit (Layer IC). There is a significantly lower frequency of fish bone in the hearth zone (Layer IB) from TP 2 and TP 3 as is the case with other classes of vertebrate remains and shell. Spatial distribution of fish remains is fairly even within Layer I but there is a marked increase in the number of specimens as between TP 1 at the rear of the cave and TP 3 towards the cave mouth in Layer II (Tables C.3 to C.5). Interpreting the significance of this pattern is difficult due to the great amount of time represented by this stratum, although it does suggest that a greater number of bones were being discarded away from the rear of the cave. Despite nearly equal amounts of bone from both occupation periods, the number of identifiable elements from the Layer II Pleistocene deposit (n=323) is significantly lower than that from the Holocene Layer I deposit (n=1411).

Taxonomic representation

Although the 1734 specimens positively identified include 20 types of fish from 17 families, five families and one class account for 86.7% of the total identified sample (Table 8.7). The taxa represented in both occupation components are nearly identical apart from a few minor families not found in Layer II which is most likely due to the smaller sample size from this stratum.

Elasmobranchii dominate the assemblage (56.5%) and include 597 vertebrae (most likely shark) accounting for 34.4% of the elements identified. Teeth (along with three articulars and a maxilla) from species of the Charcharinidae family, which includes grey, blacktip and tiger sharks, are nearly as common (22.1%) although identification to species was not possible due to a lack of reference material. Despite their overall importance,

Taxon	Common Name	L. I	%	L.II	%	Total	%
Charcharinidae	requiem sharks	373	26.44	10	3.10	383	22.09
Elasmobranchii (Class)	sharks and rays	564	39.97	33	10.22	597	34.43
Acanthuridae	surgeonfishes	9	0.64	4	1.24	13	0.75
Balistidae	triggerfishes	127	9.00	36	11.15	163	9.40
Carangidae	trevallies						
Elagatis bipinnulatus	rainbow runner	-	-	1	0.31	1	0.06
Coryphaenidae	dolphinfishes	5	0.35	24	7.43	29	1.67
Diodontidae	porcupinefishes	2	0.14	-	-	2	0.12
Kyphosidae	drummer, sea chubs	3	0.21	6	1.86	9	0.52
Labridae	wrasses	54	3.83	116	35.91	170	9.80
Lethrinidae	emperors, sea bream	7	0.50	3	0.93	10	0.58
Lutjanidae	snappers	17	1.20	14	4.33	31	1.79
Monacanthidae	leatherjackets, filefish	23	1.63	6	1.86	29	1.67
Muraenidae	moray eels	55	3.90	1	0.31	56	3.23
Nemipteridae	coral breams	8	0.57	-	-	8	0.46
Pomadasyidae (Haemulidae)	grunts	1	0.07	-	-	1	0.06
Scaridae	parrotfishes	73	5.17	17	5.26	90	5.19
Scombridae	mackerals and tunas	73	5.17	28	8.67	101	5.82
Serranidae	groupers and cods	10	0.71	11	3.41	21	1.21
Epinephelus sp.	rockcod	7	0.50	12	3.72	19	1.10
Variola louti	coronation trout	-	-	1	0.31	1	0.06
Total Identified		1411	100.00	323	100.00	1734	100.00
Potentially Identifiable (UN)		68	1.12	52	1.00	120	1.06
Unidentifiable (X)		4589	75.63	4836	92.80	9425	83.56
Total		6068	100.00	5211	100.00	11,279	-

Table 8.7 Fish remains (NISP) from Kilu Cave (Site DJA).

shark elements are much less common in the Pleistocene deposit (Layer II) where they rank a distant second behind wrasses. It is also interesting that nearly all of the shark remains from Layer II are found in the uppermost levels. Sharks can be found in a wide range of habitats from shallow lagoons to the open-sea and it is impossible to say anything about the Kilu sample without knowing what species of shark were being exploited. Shark remains have been noted in Pleistocene to early Holocene deposits on New Ireland at both Matenkupkum (Colley n.d.b) and Balof 2 (White et al. 1991:54) where three species of small charcharinids were identified. The importance of sharks relative to other taxa at these sites has not been discussed but analysis of fish remains from Lapita sites indicates that elasmobranchii are of minor significance (Butler 1994; Green 1986:126). Shark remains have been noted by Specht (1969:301) from Sohano phase deposits on Buka and elasmobranchii are a minor faunal component in the Nissan ceramic deposits (Spriggs 1991a:235).

Inshore fishes commonly inhabiting reefs and shallow water lagoons account for nearly all of the families represented and are dominant (over 5%) throughout the Kilu deposits. These include, in order of importance, labrids (wrasses), balistids (triggerfish), scarids (parrotfish) and serranids (groupers and cods). Labrids are by far the most common taxonomic group during the Pleistocene (35.9%) but much less important in the Holocene deposit (3.8%). Serranids also decline in frequency from 7.1% to 1.2% between the two layers. Three families of fish which are generally classified as pelagic also occur at Kilu. Scombrids (mackerels and tunas) are the most common and rank fifth in both Pleistocene and Holocene strata. Coryphaeinids (dolphinfishes) also rank fifth in Layer II but are of little importance in the Holocene deposit and carangids are restricted to a single element identified as *Elegatis bipinnulatus*, which is an open ocean fish. The assignment of fish to particular habitats such as pelagic versus inshore is not without problems as species often move between habitats. For example, corypheaninids are primarily pelagic but the young are often taken inshore (Springer 1982). This fact has sometimes been overlooked by archaeologists seeking to determine which habitats were emphasised in the exploitation of marine resources by prehistoric populations (Sweeney et al. 1993:232).

Exploitation strategies

In discussing fish remains from Oceanic archaeological sites, the importance of pelagic versus inshore species has been of particular interest in relation to the type of fishing strategies employed and, at least for the pre-Lapita period, the degree of fishing sophistication. Green (1986:129) argues that scombrids from the RF-2 Lapita site were captured inshore as these species sometimes enter lagoons and no trolling lures like those used traditionally for offshore tuna fishing are present. Spriggs (1991a:235) equates the appearance of scombrids for the first time in the Nissan sequence during the late Hangan phase (ca. 750 BP) with the development of ethnographically recorded trolling techniques for the capture of this taxon. According to Allen (1993:144), the evidence for Pleistocene marine exploitation at the Matenkupkum site on New Ireland indicates 'neither specialised technology (nets, lines, poisons, fish spears) nor deliberate pursuit'.

Butler's (1994) examination of relationships between fish feeding behaviour and human predation strategies based on the analysis of fish remains from Lapita sites has revealed significant geographical contrasts between assemblages. While western Melanesian assemblages are comprised of similar frequencies of carnivores and herbivores/omnivores, eastern Lapita sites have a predominance of herbivores/omnivores. Based on evidence that carnivorous fish are predominantly captured by hook-and-line while omnivores and herbivores are more likely to be caught by netting and spearing, Butler argues that both angling and netting were common at western Lapita sites while netting was more common at eastern Lapita sites. The fish bone assemblage from Kilu Cave has twice as many taxa of carnivorous fish (ten families) as herbivorous/omnivorous fish, including three of the four highest ranked families (Charcharinidae, Labridae and Scombridae). This suggests that angling was an important fishing technique during the preceramic period on Buka and may actually have been less significant during the Lapita phase. The testing of this hypothesis must await analysis of fish bone from Lapita sites and additional preceramic assemblages. Although no fishhooks were found in the preceramic site deposits, pieces of worked *Turbo marmoratus* are present in the Pleistocene and early to mid-Holocene site deposits which may be waste material from fishhook manufacture. Probable shell fishhook blanks have also been recovered from preceramic contexts at the Pamwak site on Manus (M. Spriggs, pers. comm.) and Guadalcanal (Roe 1993).

In addition to the evidence from fish feeding behaviour, the wide range of fish taxa in the Kilu assemblage and significant numbers of both inshore and pelagic species indicate that fishing during the Pleistocene was not only deliberate but most likely involved a variety of capture techniques. The fact that pelagic species are the fourth and fifth most abundant in the Pleistocene deposit demonstrates that fishing skills extended to the offshore zone. Based on the number and kinds of fish taxa represented, it is likely that both angling and netting techniques were in use during the Pleistocene and early to mid-Holocene. Seventeen traditional fishing techniques from Buka were discussed by Blackwood (1935:341-58). These include four methods for offshore and lagoon fishing used exclusively by men (net on frame, troll line, rod and line, fishing kite) and seven for reef fishing (bow and arrow, spear, hook and line, hand plunging trap, thorn-lined trap, stunning and poisoning, drives), four methods of reef fishing employed exclusively by women (barricade of leaves, women's hand-net, basket, hand capture) and two methods of freshwater fishing used by both sexes (hand-net, dam made with leaves).

INVERTEBRATE MARINE FAUNA

Invertebrate faunal remains recovered from the Buka sites consist of molluscs and a limited amount of landsnail, crustacea (primarily crab claws) and echinoderm (sea urchin) remains. A total of 871.4 kg of shell was recovered from the 1/4" (6.4 mm) screen fraction during excavation and 354.4 kg (40.7%) of this is from units sorted by taxonomic category.

Shell density

Shell weights, recorded in grams, were corrected for volume (g/m^3) to enable comparison of shell midden densities between units of variable volume. Shell density frequencies for the excavation units from each site by species are presented in Appendix C (Tables C.6 to C.15) and total shell density values (kg/m^3) for each site are graphically represented in Figure 8.1. There is no discernible temporal trend in shell density between sites and the most plausible explanation for variations in density relates to differences in site location and shellfish utilisation patterns. The fact that the three cave/rockshelter sites (DJA, DBE and DKC) have the lowest density figures is most likely due to less intensive use of these locations relative to the other sites, which are open coastal middens. Intra-site variability is difficult to assess due to the limited areal extent of excavation at all sites and lack of spatially separated excavation units, except at Site DJO. Shell preservation is good to excellent and it is interesting to note that the only site where some leaching of shell had occurred, DJW, has by far the highest shell density.

It is necessary to keep in mind that the inter-site comparability of shell density figures is dependent on the number of occupation components and amount of time represented at individual sites. This is not a problem for the majority of sites which were occupied continuously for a relatively short period of time. The two sites with preceramic occupation are more complex with three temporally distinct occupation components at Palandraku Cave (DBE) and an occupation sequence spanning more than 28,000 years at Kilu Cave (DJA).

At Kilu Cave (DJA), shell density drops significantly between the Pleistocene (Layer II) and Holocene (Layer I) components suggesting at first glance either a reduction in intensity of occupation or a possible reduction in the availability of molluscan resources (Fig. 8.2). However, when the increase in sedimentation accumulation rate from Layer II to Layer I is taken into account, it is evident that greater amounts of shell were deposited over a much more limited amount of time in Layer I than Layer II. The significantly lower density of shell in the Layer IB hearth zone is similar to that discussed earlier for bone and suggests that this area was kept clear of refuse.

As shown in Figure 8.3, the much lower density of shell at Palandraku Cave (DBE) than Kilu Cave (DJA) may be explained by the less hospitable environment of Palandraku with more limited natural light and greater dampness. There is little change in shell density between the preceramic component (Layers V to VIII) and late Lapita phase stratum (Layer IV) at Palandraku but the Mararing to Recent phase strata are more variable (Layers I and II). Layer III, which was deposited during a period of minimal use between the late Lapita and Mararing to Recent phase occupation of the site, has the lowest density of shell.

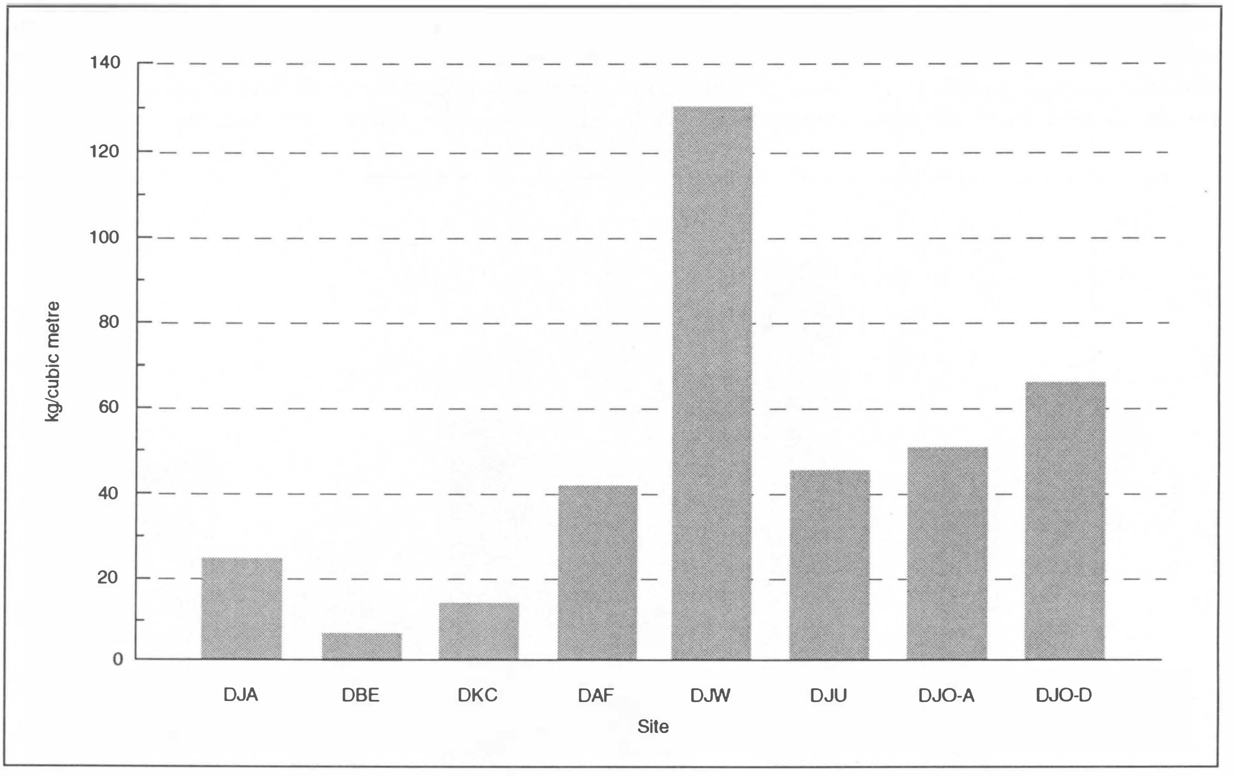


Figure 8.1 Comparison of shell densities between sites.

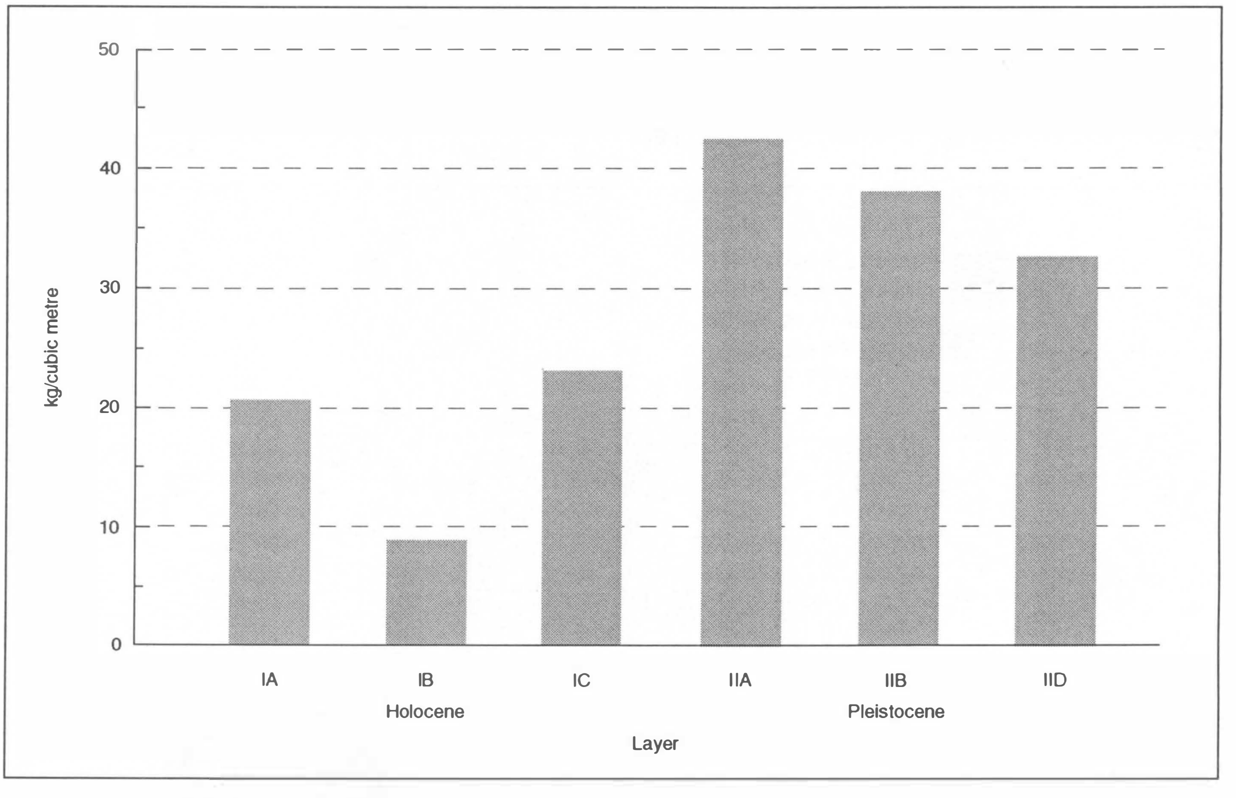


Figure 8.2 Shell density by layer at Kilu Cave (Site DJA).

Taxonomic frequencies

As demonstrated by the list of species represented (Table 8.8), the diversity of molluscan taxa found in the Buka sites is extremely rich with more than 87 species from 30 gastropod families and 25 species from 15 families of bivalves. A variety of marine habitats are represented as well as brackish and fresh water. The predominant molluscan taxa in the five ceramic site deposits are remarkably similar given the considerable amount of temporal and spatial variability between them (Table 8.9 and Fig. 8.4). Six species sorted into five taxonomic categories comprise from 80% to 91% of the total identified shell by weight at four of these sites but only 47% for the DKC site on Sohano Island. The relative frequencies of taxa at DKC are more uniform than the other sites suggesting less selective shell collection practices or, alternatively, the presence of natural shell in the deposit. The latter explanation seems more plausible in light of the low shell density and presence of 49 species within the deposit, the highest species richness figure of any Buka site. Small non-food species, which are rare or absent at other sites, account for much of this diversity.

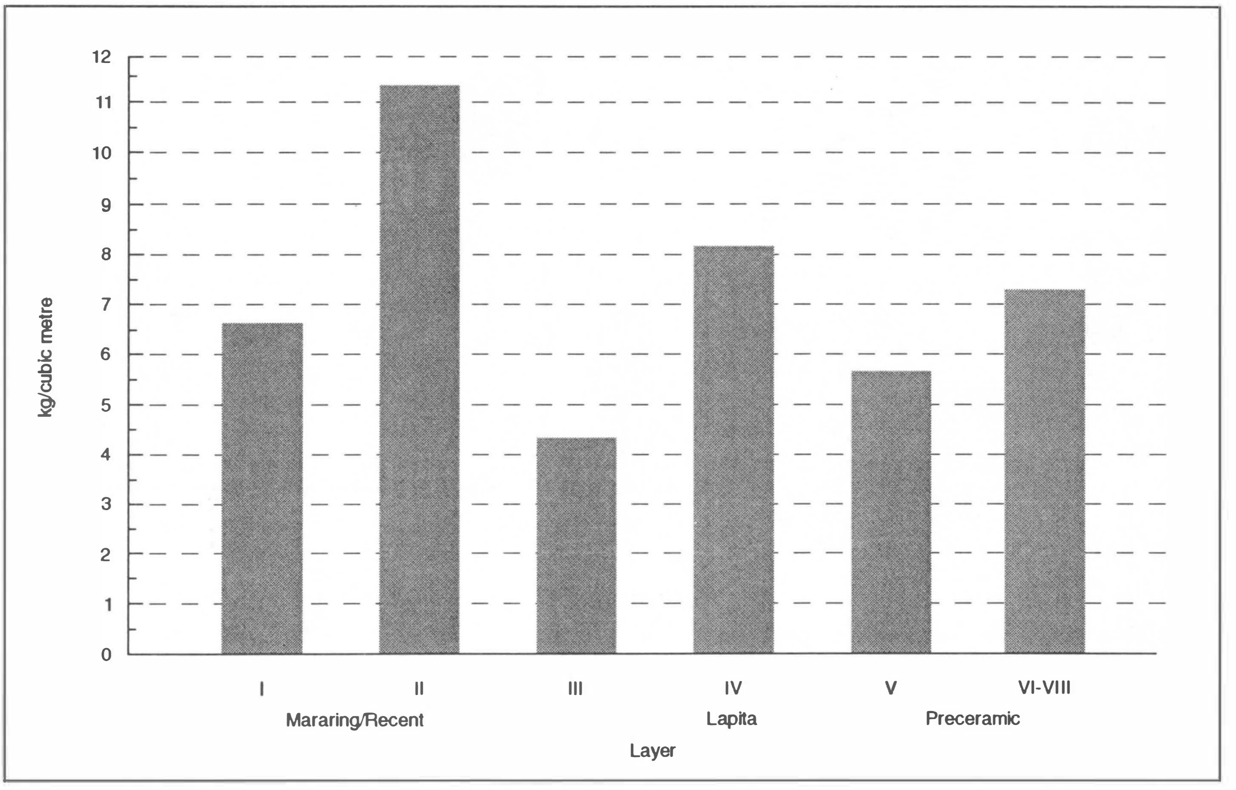


Figure 8.3 Shell density by layer at Palandraku Cave (Site DBE).

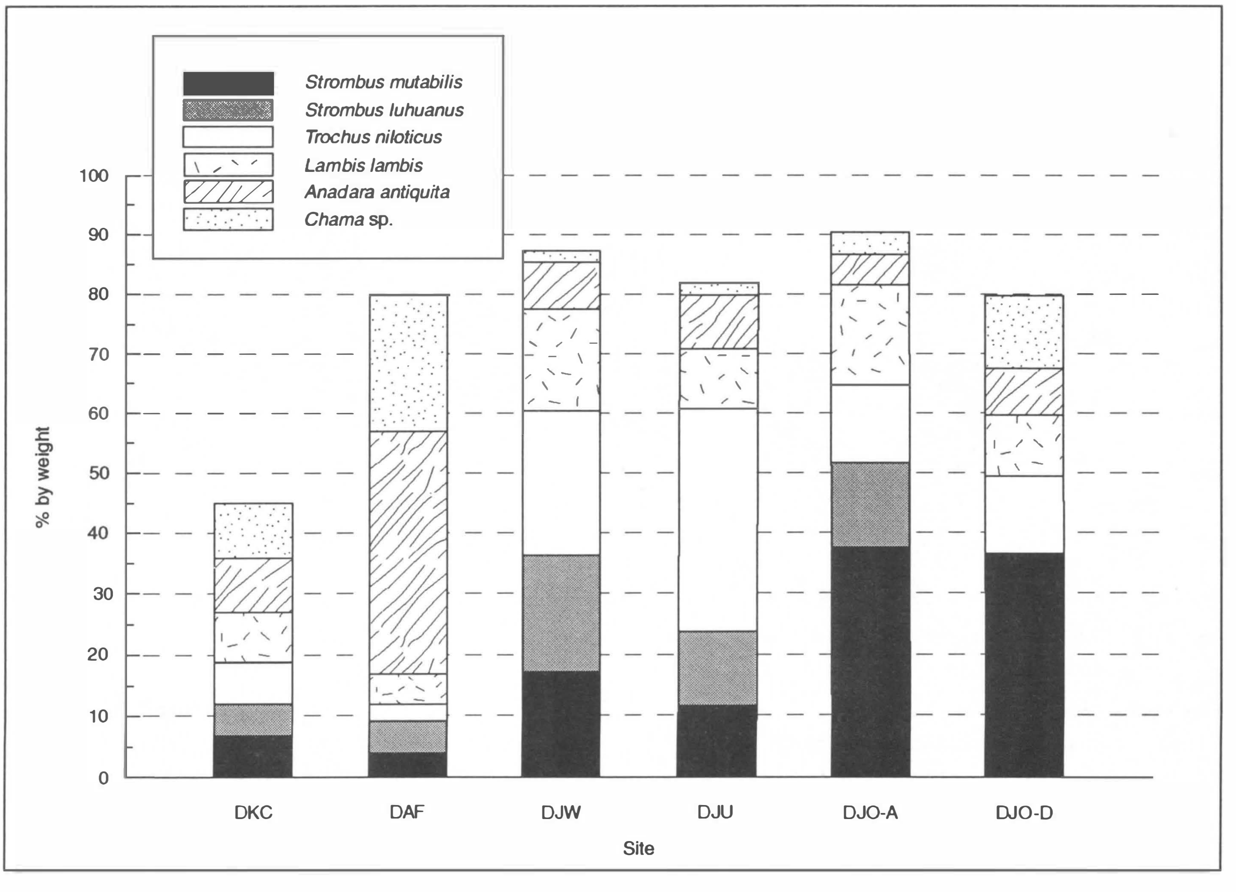


Figure 8.4 Relative frequencies of major shell species at Buka ceramic sites.

Family	Genus	Species	Author/Date	Habitat
GASTROPODA				
Haliotidae	*Haliotis*	cf. *varia*	Linn.,1758	4
Patellidae	*Patella*	*flexuosa*	Quoy and Gaimard,1834	5
	Patella	*radiata*		5
	Patella	*tucopiana*		5
	Patella	spp.		5
	Patelloida	*saccharina*	Linn.,1758	5
Trochidae	*Angaria*	*delphinus*	Linn.,1758	1
	Trochus	*niloticus*	Linn.,1767	2
	Trochus	*maculatus*	Linn.,1758	2
	Tectus	*pyramis*	Born,1778	2
Turbinidae	*Turbo*	*setosus*	Gmel.,1791	1, 2
	Turbo	*crassus*	Wood,1828	1, 2
	Turbo	*chrysostoma*	Linn.,1758	2
	Turbo	*petholatus*	Linn.,1758	2
	Turbo	*marmoratus*	Linn.,1758	1
Astraeidae	*Astraea*	sp.		6
Neritidae	*Nerita*	*grossa*	Linn.,1758	5
	Nerita	*plicata*	Linn.,1758	5
	Nerita	*squamulata*	Le Guillou,1841	5
	Nerita	*undata*	Linn.,1758	5
	Neritina	cf. *communas*	Quoy and Gaimard,1832	8
	Neritina	cf. *pulligera*	Linn.,1767	8
	Neritodryas	cf. *dubia*	Gmel.,1791	9
	Theodoxus	sp.		
Neritopsidae	*Neritopsis*	*radula*	Linn.,1758	6
Littorinidae	*Tectarius*	*pagodus*	Linn.,1758	5
	Tectarius	*tectumpersicum*	Linn.,1758	5
	Littorina	cf. *coccinea*	Gmel.,1791	5
Planaxidae	*Planaxis*	cf. *sulcatus*	Born,1778	4
Potamididae	*Terebralia*	*palustris*	Linn.,1758	8
Thiaridae	*Melanoides*	spp.		10
Cerithiidae	*Cerithium*	*columna*	Sowerby,1834	3
	Cerithium	*echinatum*	Lamarck,1822	3
	Cerithium	*nodulosum*	Bruguiere,1792	6
	Clypeomorus	sp.		6
	Rhinoclavis	*aluco*	Linn.,1758	3
	Rhinoclavis	*vertagus*	Linn.,1758	3
Epitoniidae	*Epitonium*	sp.		6
Strombidae	*Lambis*	*lambis*	Linn.,1758	6
	Lambis	*chiragra*	Linn.,1758	6
	Strombus	*canarium*	Linn.,1758	6
	Strombus	*lentiginosus*	Linn.,1758	3
	Strombus	*luhuanus*	Linn.,1758	3
	Strombus	*gibberulus gibbosus*	Roeding,1798	3
	Strombus	*mutabilis*	Swainson,1821	3
	Strombus	*erythrinus*	Dillwyn,1817	3
Cypraeidae	*Cypraea*	*annulus*	Linn.,1758	6
	Cypraea	*arabica*	Linn.,1758	6
	Cypraea	*mauritiana*	Linn.,1758	5
	Cypraea	*tigris*	Linn.,1758	4
Naticidae	*Polinices*	*melanostomus*	Gmel.,1791	6
Cymatiidae	*Cymatium*	*pileare*	Linn.,1758	6
Muricidae	*Chicoreus*	*laciniatus*	Sowerby,1841	1
	Chicoreus	*ramosus*	Linn.,1758	6
Thaididae	*Drupella*	cf. *cornus*	Roeding,1798	5
	Mancinella	*bufo*	Lamarck,1822	5
	Purpura	*persica*	Linn.,1758	5

Table 8.8 Species list of molluscs from the excavations. **Habitat Key:** 1 - sub-littoral (outside reef/offshore). 2 - algal crest/outer reef edge. 3 - subtidal rocks and coral. 4 - intertidal to subtidal sand. 5 - intertidal rocky surge zone. 6 - intertidal reef platform. 7 - intertidal, mangrove mud flats. 8 - intertidal, brackish water. 9 - freshwater/estuary. 10- supra-littoral (strand).

Family	Genus	Species	Author/Date	Habitat
Thaididae	*Drupa*	*grossularia*	Roeding,1798	6
	Drupa	*morum*	Roeding,1798	6
	Drupa	*ricinus*	Linn.,1758	5
	Drupa	cf. *rubusidaea*	Roeding,1798	6
	Thais	*armigera*	Link,1807	5
	Thais	cf. *luteostoma*	Holten	5
Buccinidae	*Cantharus*	*undosus*	Linn.,1758	5
	Pisania	cf.*truncata*	Hinds,1844	5
Columbellidae	*Euplica*	sp.		6
Nassariidae	*Nassarius*	*dorsatus*	Roeding,1798	6
	Nassarius	*margaritiferus*	Dunker,1847	6
	Nassarius	*globosus*	Quoy and Gaimard,1833	6
	Nassarius	cf. *nodiferus*	Powys,1835	6
	Nassarius	cf. *arcularius*	Linn.,1758	3
Fasciolariidae	*Pleuroploca*	*filamentosa*	Roeding,1798	6
	Fusinus	*colus*	Linn.,1758	3
	Latirus	cf. *amplustris*	Dillwyn,1817	6
Vasidae	*Vasum*	*turbinellus*	Linn.,1758	6
	Vasum	*ceramicum*	Linn.,1758	6
Harpidae	*Harpa*	sp.		3
Tonnidae	*Tonna*	sp.		3
Olividae	*Oliva*	sp.		3
Mitridae	*Mitra*	cf. *stictica*	Link,1807	6
Vexillidae	*Vexillum*	*ziervogelii*	Gmel.,1791	6
Conidae	*Conus*	*distans*	Hwass,1792	6
	Conus	*leopardus*	Roeding,1798	6
	Conus	*litteratus*	Linn.,1758	6
	Conus	*marmoreus*	Linn.,1758	3
	Conus	*pulicarius*	Hwass,1792	3
	Conus	cf. *virgo*	Linn.,1758	6
Terebridae	*Terebra*	cf. *maculata*	Linn.,1758	3
	Terebra	cf. *crenulata*	Linn.,1758	3
Bullidae	*Bulla*	cf. *vernicosa*	Gould,1859	6
Ellobiidae	*Melampus*	*flavus*	Gmel.,1791	5
	Pythia	*scarabaeus*	Linn.,1758	5
BIVALVIA				
Nuculidae	cf. *Nucula*	sp.		3
Arcidae	*Anadara*	*granosa*	Linn.,1758	7
	Anadara	*antiquata*	Linn.,1758	3
	Barbatia	cf. *velata*	Sowerby,1843	4
	Barbatia	cf. *fusca*	Bruguiere,1792	4
Mytilidae	*Modiolus*	sp.		6
	Septifer	cf. *bilocularis*	Linn.,1758	5
Pteriidae	*Pinctada*	*margaritifera*	Linn.,1758	1
Isognomonidae	*Isognomon*	cf. *ephippium*	Linn.,1758	5
Pectinidae	*Pecten*	sp.		6
Spondylidae	*Spondylus*	sp.		6
Fimbriidae	*Fimbria*	*fimbriata*	Linn.,1758	6
Ostreidae	*Ostrea*	spp.		5, 4
Chamidae	*Chama*	cf. *iostoma*	Conrad,1837	5
Cardiidae	*Trachycardium*	cf. *flavum*	Linn.,1758	6
Tridacnidae	*Tridacna*	*maxima*	Roeding,1798	6
	Tridacna	*crocea*	Lamarck,1819	6
	Hippopus	*hippopus*	Linn.,1758	6
Tellinidae	*Tellina*	*palatam*	Iredale,1929	6
	Tellina	spp.		6
Corbiculidae	*Polymesoda*	cf. *coaxans*		7

Table 8.8 cont.

Family	Genus	Species	Author/Date	Habitat
Psammobiidae	*Asaphis*	*violascens*	Forskal,1775	7
Veneridae	*Periglypta*	*reticulata*	Linn.,1758	3
	Gafrarium	*pectinatum*	Linn.,1758	3
	Lioconcha	*fastigiata*	Sowerby,1852	3
	Costacallista	*lilacina*	Lamarck,1819	3
POLYPLACOPHORA				
Chitonidae				5
ECHINODERMATA, ECHINOIDEA				
Echinometridae	*Hetero-centrotus*	sp.		2, 6
ARTHROPODA, CRUSTACEA (class)				
CIRRIPEDIA (subclass)				
Balanidae	*Balanus*	sp.	(barnacle)	5
DECAPODA (order)			(crab claws)	

Table 8.8 cont.

Taxon	DKC	DAF	DJW	DJU	DJO-A	DJO-D
Gastropoda						
Trochus niloticus	6	7	1	1	4	3
Strombus mutabilis	5	5	4	3	1	1
Strombus luhuanus	9	3	2	2	3	2
Lambis lambis	4	4	3	4	2	5
Bivalvia						
Anadara antiquata	3	1	5	5	5	6
Chama cf. *iostoma*	2	2	6	6	6	4

Table 8.9 Rank order of major shell species from Buka ceramic sites.

Sites DJW, DJU and DJO have a similar range of taxa dominated by the gastropods *Strombus mutabilis*, *Strombus luhuanus*, *Trochus niloticus* and *Lambis lambis*. An environmental explanation for this pattern is most likely as the three sites are located in fairly close proximity to one another with access to similar shellfish habitats on broad, sandy intertidal reef flats. The DAF site on Sohano Island, which has access to a different set of molluscan microenvironments including extensive mangrove mud flats, is dominated by two species of bivalve, *Chama* cf. *iostoma* and *Anadara antiquata*.

The principal shell taxa at the two cave sites with preceramic occupation contrast markedly with those from the ceramic sites (Table 8.10 and Figs 8.5, 8.6). At Kilu (DJA), the nerite species *Nerita undata* and *N. plicata* are dominant in all strata. Limpets, including *Patella flexuosa* and two minor species, and two species of *Tectarius* occur in relatively constant frequencies throughout the sequence. Chitons are common until about 8000 BP when they decline to about 1% of the identified shell. An interesting temporal trend is the decline in *Turbo* cf. *crassus* from 27% in the lower Pleistocene deposit (Layer IID) to 7.5% in Layer IIB, and only 3 to 4% in the Holocene component (Layer I). In contrast, a large bivalve from the Corbiculidae family tentatively identified as *Polymesoda* cf. *coaxans*, first appears in Layer I where it represents 10 to 13% of the identified molluscs. This bivalve is also found throughout the Palandraku sequence (Fig. 8.6), where it represents a major species in the Mararing to Recent phase component, as well as several of the ceramic period sites. Brackish water nerites (*Neritina* spp.) occur in low numbers throughout the sequences at both cave sites and can still be found at the mouth of the nearby Malasang River. Of considerable interest is the fact that nine of the 41 species which occur in Layer IA are found only in the uppermost levels which also contain Buka and Mararing style ceramics. This may indicate a change in shellfish collection patterns or the type of molluscs available in the vicinity of the site between the preceramic and ceramic period occupation of the site.

Despite Palandraku's close proximity to Kilu, the main shell taxa are somewhat dissimilar. The major species are nearly identical in the preceramic and late Lapita phase components with *Turbo* shell dominating and lower amounts of *Nerita*, *Polymesoda*, Thaididae spp. (drupes) and *Cypraea*. Taxonomic frequencies change in the Mararing to Recent phase component where two previously minor species, *Chama* cf. *iostoma* and *Anadara antiquata*, become dominant along with *Polymesoda* cf. *coaxans*. All of the dominant species at Palandraku also occur at Kilu Cave although only three are of major importance. Of these, *Chama* and *Strombus* species are found only in the upper levels at Kilu where ceramics are also present.

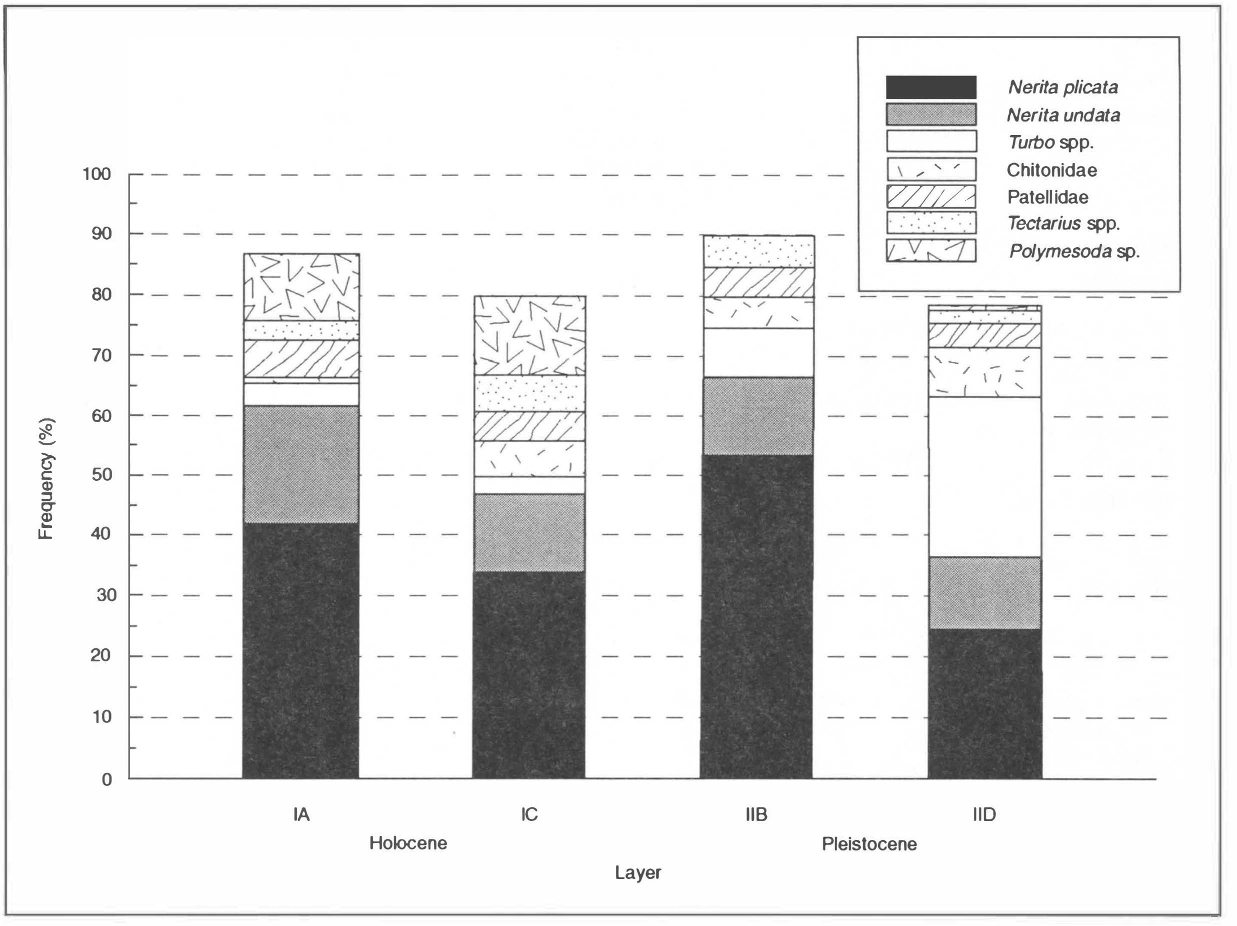


Figure 8.5 Relative frequencies of major shell species by layer in TP 1 at Kilu Cave (Site DJA).

Taxon	Kilu Cave (DJA) Pleistocene (L. II)	Lower Holocene (L. IC)	Upper Holocene (L.IA)	Palandraku Cave (DBE) Preceramic (L. V-VI)	Late Lapita (L. IV)	Mararing/ Recent (L. I-II)
Gastropoda						
Nerita plicata	1	1	1	5	3	13
Nerita undata	3	3	2	-	-	-
Turbo spp.	2	9	5	1	1	4
Tectarius spp.	6	5	6	19	16	-
Thaididae spp.	4	11	9	2	9	12
Cypraea spp.	8	6	14	6	2	5
Strombus mutabilis	-	-	-	14	14	8
Patellidae spp.	5	7	4	15	14	15
Bivalvia						
Polymesoda cf. *coaxans*	11	2	3	4	5	2
Chama cf. *iostoma*	-	-	-	-	17	1
Anadara antiquata	-	14	8	11	10	3
Chitonidae	4	4	10	19	15	18

Table 8.10 Rank order of major shell species from Kilu Cave (Site DJA) and Palandraku Cave (Site DBE). (Note: *Nerita* species were combined at DBE but the majority are *N. plicata*)

Environmental and cultural variables in shellfish exploitation

Disentangling environmental from human factors when interpreting variability in the density and taxonomic frequencies of molluscs is an almost hopeless task without adequate data regarding past environments, shellfish habitats and behaviour, and human collection strategies. In the past, environmental factors have commonly been cited to explain changes in species exploited within sites although there has been a growing trend in Oceania and elsewhere to view such patterns as the result of human predation on molluscan resources. Claims for the overexploitation of molluscs following initial human settlement can be viewed as one component of this general trend.

Reduction in average shell size over time has been the principal form of evidence employed as an indicator

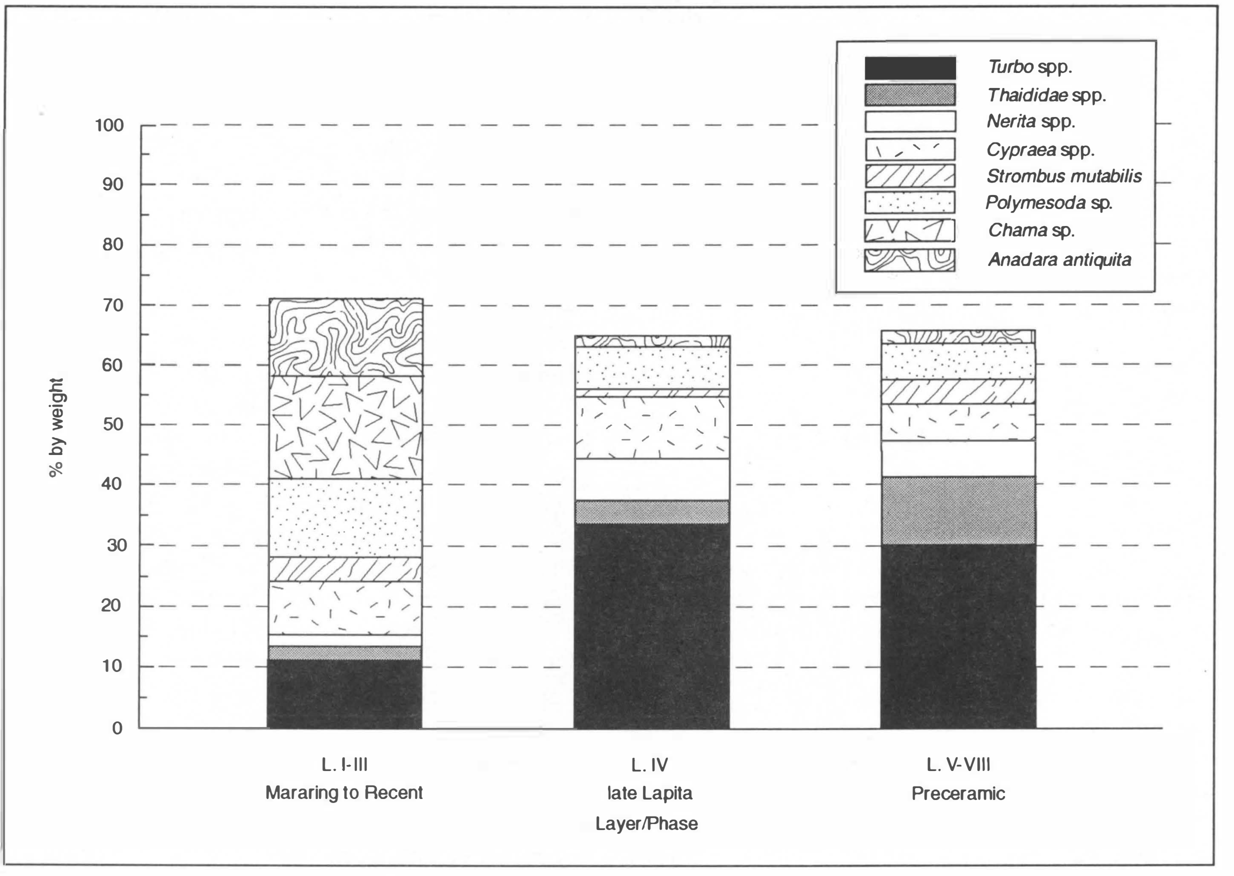


Figure 8.6 Relative frequencies of major shell species by layer in TP 1 at Palandraku Cave (Site DBE).

of shellfish overexploitation. Examples from Oceania most often relate to the impact of Lapita settlement on 'pristine' island environments. Qualitative observations of shell size reduction have been used as evidence of overexploitation in Lapita sites on Tikopia and Tongatapu (Kirch and Yen 1982; Poulsen 1987). Kirch and Yen (1982) also cite decreases in shell density over time on Tikopia as additional evidence for overexploitation. For example, a density figure of 38.4 kg/m^3 from an early site is claimed to be 'an extremely high value for any Oceanic site' (1982:293). A similar claim is made by Kirch for sites on Niuatoputapu where a decline in shell density from 19.74 kg/m^3 to 4.76 kg/m^3 over time is attributed to 'the heavy exploitation of a pristine reef ecosystem with high standing-crop biomass by the island's first human occupants' (1988c:228). Interestingly, the Tikopia density figures are cited as supporting evidence for this argument. The validity of these claims can be questioned in light of shell densities as high as 129.6 kg/m^3 from post-Lapita Buka sites. There is also no indication of a decrease in shell density over time on Buka with much lower figures for the preceramic and Lapita phase deposits than those with later ceramic phase occupation (Fig. 8.1).

In sum, there is no evidence for human overexploitation of molluscs from the Buka sites. The overriding impression is one of stability in exploitation patterns over time. The preceramic shell assemblage at Kilu Cave, which permits an examination of mollusc predation over an extensive period of time, exhibits continuity in the dominant species exploited and no indication of reduced shell size. One factor which may have been at least partially responsible for this pattern is the rapid increase in ocean depth beyond the reef at Malasang which would have minimised the impact of fluctuating sea level on access to molluscan resources.

The most dramatic change in species composition at Kilu is the appearance of the bivalve *Polymesoda coaxans* in the Holocene component. Exploitation of a previously unused or unavailable molluscan microenvironment appears to be a reasonable explanation for this change. *Polymesoda* species are found in the muddy bottoms of mangrove swamps, which do not presently exist in the vicinity of Kilu. However, the occurrence of this species in significant numbers throughout the Palandraku Cave deposit, which includes occupation during the Mararing to Recent phase, argues against this interpretation. The dominance of *Chama*, commonly found on mangrove trunks, provides additional evidence for the exploitation of mangrove areas up until the late prehistoric period. All of the other major species at Kilu are found in rocky intertidal areas easily accessible to human collection. The present shoreline in the immediate site vicinity is not rocky but consists of a narrow sand beach with a relatively narrow sandy intertidal reef flat and fringing reef.

Comparisons of shellfish from Kilu Cave with sites of similar age on New Ireland reveals some suggestive similarities. The dominant species at the Pleistocene site of Matenkupkum are identical to those at Kilu and display the same continuity over time (Gosden and Robertson 1991). At the Balof 2 shelter, which was utilised intermittently over the past 14,000 years, nerites (*Nerita plicata* and *N. polita*) and limpets (*Cellana* sp. and *Patella flexuosa*) are dominant throughout the sequence as at Kilu (White et al. 1991:54). The site of Panakiwuk, occupied between 14,000 and 7000 BP, has a range of taxa more similar to Palandraku and is dominated by *Polymesoda coaxans* (Marshall and Allen 1991:86). The possibility that these similarities reflect shared exploitation strategies during the late Pleistocene to mid-Holocene is intriguing and needs to be tested by the excavation of additional sites in a variety of environments.

PLANT REMAINS

Charcoal

As is usually the case in Oceanic sites, carbonised botanical remains provide the principal evidence for past exploitation of plant resources on Buka. Charcoal identifications were made by Dr Douglas Yen (then of the Department of Prehistory, Research School of Pacific Studies, The Australian National University) and limited to a single excavation unit (TP 1) at Kilu Cave. As shown in Tables 3.10 to 3.12, charcoal at Kilu is only present in the Layer I Holocene deposit and the uppermost level of the Pleistocene deposit (Layer II). There is a marked decrease in charcoal density within the lower Layer I deposit and only a few grams in the basal levels. The trace of charcoal in Layer II may be intrusive from Layer I. Table 8.11 lists the identified plant species from Kilu, including carbonised fragments of *Canarium* almond endocarp, coconut (*Cocos nucifera*) and palm bark which may be sago. Uncarbonised seeds of *Celtis*, a native elm indigenous to Melanesia, also occur in both Pleistocene and Holocene levels and have been noted in deposits of similar age from Matenkupkum (Gosden and Robertsen 1991:42) and Panakiwuk (Marshall and Allen 1991:88) on New Ireland and Pamwak on Manus (Fredericksen et al. 1993).

The positive identification of *Canarium* at Kilu, including *C. indicum* and *C. solomonense*, is of considerable importance as it is likely that edible *Canarium* species were introduced to both the Bismarcks and Solomons from New Guinea (Yen 1990:268). *Canarium* has also been documented at the Pamwak rockshelter site on Manus by the terminal Pleistocene (Fredericksen et al. 1993). The fact that *Canarium*, which is an important tree crop in the North Solomons today, was probably purposefully introduced to Buka suggests that it was being managed to some extent as a food resource by 10,000 years ago. Spriggs (1993b:139) argues that the early presence of *Canarium* at Kilu and Pamwak together with ethnographic evidence for the harvesting and storage of these nuts may indicate that arboriculture was an early step on the pathway to agriculture in the region.

Plant residues

Residue analysis of stone tools from Kilu Cave has provided the earliest direct evidence for the prehistoric use of root vegetables, in the form of starch grains and crystalline raphides. The results of this analysis have been published (Loy et al. 1992) and will not be discussed in detail here. Starch residues of both *Colocasia* (*C. esculenta*) and *Alocasia* taros have been positively identified on stone tools from the Pleistocene levels of the site dating back to ca. 28,000 BP but only *Colocasia* residues were observed in the Holocene deposits. In addition to the size and shape of the starch grains, the presence of raphides seemingly distinctive to species increases the confidence of the identifications. Replication experiments demonstrated that scraping cooked taro with stone tools produced an entirely different type of starch deposit than that observed for scraping and cutting uncooked corms. Based on the residue characteristics from the prehistoric tools, the processing of fresh rather than cooked taro can be inferred.

Of the 47 flakes and fragments examined, 27 have residue deposits or display use-wear. One tool has starch grains unlike either yam or taro, as well as extensive silica polish build-up on both lateral edges. Another tool had starch grains which could not be matched with any in the reference collection. Twenty of the 47 flakes have no evidence of use. Of the remaining 25 flakes, eight come from the Holocene deposits and 17 from the Pleistocene component. Of the 17 flakes from the Pleistocene deposits, 14 have residues identified as *Colocasia* and three as *Alocasia* taro. Only *Colocasia* residues were observed on the eight tools from the Holocene component.

The results of residue analysis have significant implications for the natural distribution of *Colocasia* and other aroids by confirming their presence at least as far east as the northern Solomons. An alternative, though less likely, interpretation is that root crops were deliberately transported and cultivated by human populations at a very early date. Attempts to recreate the natural habitats

Layer/Level	*Canarium indicum*	*Canarium solomonense*	*Canarium* sp.	*Canarium* Comments	*Cocos nucifera*	Miscellaneous Taxa
IA/4	A			side walls	A	
IA/6	C			basal with corners		
IA/8			D		D	palm bark (sago?)
IC/10	B	A	B		C	
IC/14			E	poss. wild?	D	
IC/15			D	poss. wild?	E	
IIB/16			D		D	

Table 8.11 Carbonised plant remains from TP 1, Kilu Cave (Site DJA). (Identification Confidence Key: A - confident; B - some doubt; C - questionable; D - questionable/not confident; E -not confident)

of taro may also have played a role in the development of agriculture in the region (Spriggs 1993b:138). Three additional studies have reported evidence for the processing of aroids from stone tools in terminal Pleistocene and Holocene contexts in the Bismarcks (Barton and White 1993; Brown 1988; Fullagar 1993). The identification of intact starch grains and other plant residues on artefacts opens an important avenue for the investigation of plant resources utilised by prehistoric populations and will undoubtedly become increasingly common in the future.

SUBSISTENCE STRATEGIES: A REVIEW OF THE EVIDENCE

Despite the still fragmentary nature of the faunal and floral record for Buka, discussion of some basic issues related to subsistence change and continuity over time within a regional context are now possible.

Faunal introductions and extinctions

The introduction of animal species as a result of both accidental and purposeful transport by humans has been documented in Pleistocene sites from the Bismarcks (Allen et al. 1989) and Holocene sites in the northern Solomons (Flannery et al. 1988). *Phalanger orientalis* appears on New Ireland by 19,000 BP and is found in the earliest site deposits on Nissan dating to about 5000 BP. There is no secure evidence for *Phalanger* on Buka prior to the late Lapita period although a single bone was found at the base of the Holocene deposit at the Kilu Cave site dating to ca. 9000 BP. A single wallaby (*Thylogale brunii*) bone from the Sohano phase deposit at Site DAI excavated by Specht has been interpreted as a possible trade item as the nearest extant population is found on New Ireland.

Two species of rats, *Rattus praetor* and *R. exulans,* were also introduced to Buka. The earliest evidence for *R. praetor* is from the early Sohano phase deposit at Site DAI excavated by Specht (Flannery et al. 1988). Although *R. praetor* is presently found on Buka and was introduced to New Ireland by 8000 BP (Allen et al. 1989), it is not known from the modern fauna on Nissan. A single bone fragment of this species has been found on Nissan in association with Malasang style pottery and may represent an accidentally introduced animal rather than an established population (Flannery et al. 1988). *R. exulans* is a common faunal element in Lapita sites throughout Island Melanesia and western Polynesia but has not been securely dated in pre-Lapita contexts. Its appearance in the upper portion of the Kilu Cave deposit is most likely associated with late Lapita or more recent occupation of the site.

Domesticated animals do not appear in the archaeological record prior to the Lapita phase with pig bone found in late Lapita deposits excavated by Specht and at Sites DAF and DBE. The earliest evidence for dog is from the Sohano phase.

Faunal extinctions on Buka include two endemic rat species which are present throughout the Kilu Cave sequence but not found in any of the ceramic-bearing site deposits. Although the causes of these extinctions are unknown, possible explanations include competition with an introduced rat species (*R. praetor*) or domesticated animals. There is also tentative evidence for the extirpation of several bird species as indicated by the presence of rail and pigeon species at Kilu Cave which are much larger than any found in the northern Solomons at the present time.

On Buka there is a marked contrast between the pre-Lapita and Lapita faunal assemblages which indicates that Lapita represents a major discontinuity in the faunal record. In contrast, the preceramic faunal assemblages from Kilu and Palandraku caves are characterised by relative stability and continuity in the fauna which are dominated by bats, lizards, snakes and fish with only minor changes in the relative importance or range of species represented over time. The abundant fish remains at Kilu document deliberate exploitation of both inshore and pelagic species using a range of techniques from the earliest levels.

A significant problem in addressing issues related to faunal change between the pre-Lapita and Lapita phases on Buka is the lack of site deposits between the mid-Holocene from about 5000 BP and the late Lapita phase at around 2500 BP. This gap leaves us with a 'before' and 'after' perspective of the faunal record which lacks the critical evidence for what happened immediately prior to Lapita and during the first centuries of the Lapita phase. Based on the available evidence, there are a number of faunal introductions which can be dated to the Lapita phase with reasonable confidence. As is the case elsewhere in Oceania, the introduction of domestic animals (of which pig and dog are represented in the Buka sites) is associated with Lapita along with the probable accidental introduction of *Rattus exulans*. There is secure evidence for the introduction of *Phalanger* by the Lapita phase and its earlier presence on Nissan suggests that it may have arrived on Buka sometime before Lapita. The single *Phalanger* bone from Kilu at ca. 10,000 BP is not considered sufficient evidence to argue for its presence by the early Holocene.

The timing and explanations for the extinction of the two endemic rat species *Solomys spriggsarum* and *Melomys spechti* and possible extirpation of several bird species on Buka remain uncertain although they may also be linked to Lapita settlement. Although the rat species are clearly absent from the faunal record by the Lapita phase, the avifaunal evidence is too meagre to speculate on what taxa may have been extirpated or when this occurred.

Environmental and human factors in shellfish exploitation

Although there are significant differences between the shell assemblages of the two cave sites with preceramic occupation (Kilu and Palandraku) and the five ceramic-age sites, molluscan assemblages within each of these two subsets exhibit a great deal of continuity over time both in terms of the range of species represented and those which are most common. For all but one of the ceramic sites, six species account for at least 80% of the identified shell and are led by the gastropods *Strombus mutabilis*, *S. luhuanus* and *Trochus niloticus*. The taxonomic variation between these sites can best be explained in terms of contrasts in the molluscan habitats being exploited and the presence of non-food species at the DKC site.

Preceramic shellfish remains at Kilu and Palandraku caves display marked differences from the ceramic sites. At Kilu the nerite species *Nerita undata* and *N. plicata* are dominant while *Turbo* is most common at Palandraku. Several changes in the ranking of taxa do occur between the Pleistocene and Holocene deposits at Kilu including a decline in the frequency of both *Turbo* and chitons and the appearance for the first time of the large mangrove bivalve *Polymesoda*. Considering the great amount of change which may have taken place in local shellfish habitats between the abandonment of the site at 20,000 BP and reoccupation at 10,000 BP, the appearance of new taxa is not surprising. There are also some changes in the species represented in the uppermost levels of Kilu where ceramics are found.

Analysis of shell from the Matenkupkum site on New Ireland indicates a decrease in both large species and large shells between the Pleistocene and Holocene occupation strata (Gosden and Robertson 1991:40). Although they suggest that heavy predation may account for these changes, Gosden and Robertson (1991:41) admit that disentangling human from environmental causes is difficult for the earliest layers which span almost 20,000 years. Allen (1993:144-5) has been somewhat less cautious in his interpretation of the Matenkupkum data and uses the decrease in shell size to support a 'strandlooper strategy' model for early Pleistocene occupation on New Ireland. This model emphasises low-level exploitation of shellfish and a secondary role for fishing with a change to more intensive exploitation by the terminal Pleistocene. The faunal remains from Kilu call into question the validity of the strandlooper model by providing definite evidence for exploitation of both inshore and pelagic fish species from the earliest levels and no significant change in the size of shells or number of species represented over time.

Plant remains and agriculture

The evidence for agriculture from Kuk in the New Guinea Highlands (Golson 1989) by 9000 BP is among the earliest in the world. Although the emergence of agriculturists from hunter-gatherers has been established for mainland New Guinea, the validity and extent of this sequence in Island Melanesia has yet to be demonstrated. The situation is further complicated by the fact that Oceanic systems of subsistence were not derived from New Guinea alone. Assuming that the appearance of Lapita ceramics represents a secondary colonisation of Near Oceania by agricultural populations out of Southeast Asia, the colonists would have brought with them a variety of cultigens. These would probably have included domesticates of the same genera, and even species, as the New Guinea cultigens in addition to previously unknown cultigens (Yen 1993:90-1). Botanical evidence for arboriculture from the Mussau Lapita sites (Kirch 1989) indicates that tree crop domesticates unique to New Guinea were being utilised by Lapita colonists in the Bismarcks.

The question of when agriculture emerged in Island Melanesia and the degree to which it represent internal processes as opposed to outside introductions cannot be resolved on the basis of available evidence. However, there is a sufficient amount of data, which is rapidly increasing, to develop models of potential pathways for agricultural development.

Given the early dates for agriculture from mainland New Guinea, the potential for similar developments by the terminal Pleistocene in Island Melanesia cannot be dismissed. Spriggs (1993b) has recently addressed this possibility and raised two issues which are of direct relevance to the present study:

1. the role of *Canarium* almonds in arboriculture; and
2. early evidence for the use of taro and its later importance as a staple crop.

Carbonised plant remains from the Kilu Cave site document the presence of edible *Canarium* species back to the terminal Pleistocene at 10,000 BP. These nut trees were an important economic resource in the northern Solomons ethnographically and it is likely that the species represented were transported by humans from New Guinea to the Bismarcks and Solomons (Yen 1990). Although it is possible that *Canarium* was an important food resource by the terminal Pleistocene to early Holocene on Buka, its presence at a single site is not sufficient evidence to argue for an incipient form of arboriculture at this early date.

The second form of botanical evidence from preceramic contexts on Buka is starch residues and crystalline raphides found on stone tools from both Pleistocene and Holocene deposits at the Kilu Cave site. This evidence suggests that both *Colocasia* and *Alocasia* taro were being utilised by the time Kilu was initially occupied at around 28,000 BP (Loy et al. 1992). Although the size and shape of starch grains is consistent with the identification of taro species and is supported by the raphide evidence, there is a possibility that the starches are from an as yet unknown prehistoric plant resource. While the starch residues from Kilu provide the earliest direct evidence for the prehistoric use of root vegetables, there is no indication that this was related to the development or adoption of agriculture.

There is still no secure evidence for agriculture in Island Melanesia prior to the Lapita period when macrobotanical remains of a variety of domesticated plants appear for the first time (Gosden et al. 1989; Kirch 1989). The absence of domesticated animals (pig, dog and chicken) pre-Lapita also supports this evidence. Despite the evidence for utilisation and possible management of plant resources during the pre-Lapita period on Buka, the first convincing (indirect) evidence for agriculture is the presence of pig in Lapita deposits.

Subsistence change on Buka: General conclusions

As is usually the case when archaeological research is undertaken in areas where significant gaps exist in our knowledge of the prehistoric sequence, the evidence relating to past subsistence on Buka raised far more questions than it answered. The discovery that initial settlement of Buka took place at least 26,000 years earlier than the late Lapita phase occupation dated to ca. 2500 BP by Specht, necessitated a radical redefinition of the scope of subsistence change to be addressed. A host of new issues such as long-term changes in the environment and the nature of the transition from hunting and gathering to agriculture were raised. Despite the obvious limitations of a sample size restricted to two cave sites in attempting to address changes which took place over a period of 26,000 years, a wealth of data relating to long-term subsistence change was obtained. The chief value of this data is not necessarily what it has told us but the extent to which it provides a basis for constructing models of subsistence change which can guide future research in the region.

The insights into prehistoric subsistence offered by the existing evidence are varied. We now have evidence for the utilisation of root vegetables and tree crops which are important agricultural components ethnographically extending back to the terminal Pleistocene. There is also ample evidence for the exploitation of marine resources, including shellfish and fish, by 28,000 years ago. The number and kinds of fish taxa from this period indicate that fishing was deliberate and involved a variety of techniques for the capture of both inshore and pelagic species. Active manipulation of faunal resources has been documented in the form of human introduction of animals such as *Phalanger* and several species of rats. The extinction of two endemic rat species and possible extirpation of bird taxa are also potentially related to human activity either directly or indirectly through competition with introduced species or habitat loss. The timing of faunal introductions and extinctions remains uncertain due to gaps in the archaeological record but the available evidence suggests that Lapita settlement played a significant role in altering the faunal and floral resources of Buka. There is presently no evidence for agriculture or animal husbandry prior to the Lapita period on Buka and the introduction of cultigens and domesticates at this time may have had a significant impact on the existing fauna and flora.

9

SYNTHESIS AND CONCLUSIONS

This chapter assesses the degree to which the research objectives were achieved by synthesising the detailed information presented in the previous chapters. The initial step in the synthesis is a presentation of the local phase sequence for Buka as it is inferred on the basis of past research and the present study. The degree to which the initial set of three research problems was addressed is incorporated into the discussion of the phase sequence. Evidence from Buka which addresses the final two research objectives, to examine the role of exchange and nature of long-term subsistence change, is presented following the cultural sequence. The final section examines the Buka sequence from a regional perspective.

THE BUKA SEQUENCE

Despite criticisms of periodisation frameworks as artificially compartmentalising and distorting the continuous nature of culture change, the construction of phase sequences remains one of the basic building blocks in understanding prehistoric change at the local and regional level in Oceania (Kirch 1988a:339-40; Sharp 1991:326). This is certainly the case for Buka and the northern Solomons where a significant portion of the prehistoric record remains undocumented or poorly understood.

The chronological framework of the Buka and Nissan cultural sequences is found in Table 1.1. The phase designations used for the Buka sequence were selected on the basis of their appropriateness for the temporal extent and nature of the periods of time represented. For the preceramic period, settlement is divided into coarse-grained units of geologic time (Pleistocene and early to mid-Holocene) that are most appropriate for a period representing many thousands of years for which archaeological evidence is extremely limited. Lapita settlement is divided into early and late phases and the post-Lapita phases adopt the names of pottery styles in Specht's Buka ceramic sequence. Spriggs (1991a) also utilised Buka ceramic styles to designate phases in the Nissan sequence during which Buka ceramics were being imported to the island. Although the degree to which ceramic change reflects changes in other aspects of culture is uncertain, pottery was adopted as the most visible marker of change in the archaeological record.

The Preceramic period (Pleistocene and early to mid-Holocene phases)

As the earliest evidence for human settlement on Buka prior to the present study came from the late Lapita phase, documentation of pre-Lapita occupation was a major objective of the field investigations. The preceramic deposits at the Kilu Cave site (DJA) dating from 28,000 to 5000 BP and occupation of nearby Palandraku Cave (DBE) by about 5000 BP firmly establish that initial settlement of Buka took place during the Pleistocene and document subsequent occupation in the early and mid-Holocene. These sites provide some initial insights into the many millennia of preceramic settlement based on evidence from subsurface features, artefact assemblages, and faunal and floral remains. A much larger site sample from a wider range of environments will be required before we can begin to accurately model long-term change during this period. There are also substantial gaps in the existing preceramic site chronology with a hiatus in occupation at Kilu between 20,000 and 10,000 BP and abandonment of the site by about 5000 BP. Apart from the limited evidence at Palandraku dating to about the same time as Kilu was abandoned, there are no site deposits between the mid-Holocene and late Lapita phase.

At the time Kilu was first occupied during the late Pleistocene, sea level was -46 m and beginning its rapid fall to a low stand of -130 m at 17,000 BP. Tectonic uplift of the east coast of Buka coupled with the drop in sea level would have placed Kilu many tens of metres higher than it is today at the glacial maximum and may partially explain why the site was abandoned during this period. Due to subsidence along the west coast of Buka and the rise in sea level by the mid-Holocene, it is unlikely that preceramic sites have been preserved along this portion of the coastline, which is presently low-lying with extensive mangrove growth. The location of preceramic sites in the Parkinson Range and interior raised limestone areas of Buka will also be difficult due to the lack of cave or rockshelter sites and poor preservation conditions for open sites. Potential explanations for the abandonment of both Kilu and Palandraku during the mid-Holocene are difficult to evaluate given the limited site sample but may represent a shift in settlement focus away from the use of cave and shelter sites.

Some indication of site use is provided by subsurface features within the two cave deposits. At Kilu, a concentration of superimposed, overlapping hearths occurs in the early Holocene deposits towards the mouth of the cave. This area appears to have been purposefully kept free of refuse as indicated by lower frequencies of bone and shell food remains than in contemporaneous deposits outside of the hearth zone. At Palandraku, an earth oven feature with a high density of heat-altered volcanic rock extends into the face of the excavation trench within the preceramic deposit.

Artefactual evidence

The artefact assemblages from both Kilu and Palandraku are dominated by flaked stone which is typical of preceramic sites from elsewhere in Island Melanesia. There is a predominance of coarse-grained volcanic rock in the Pleistocene levels at Kilu and lesser amounts of fine-grained volcanics, chert, quartz and quartzite. The quantity of flaked stone decreases between the Pleistocene and Holocene deposits at Kilu and there is a shift in emphasis from coarse-grained volcanic rock to siliceous rock over time with cherts accounting for nearly two-thirds of the assemblage at Palandraku. The excavation of additional sites will be necessary to evaluate the degree to which this trend reflects general patterns of raw material use over time on Buka. Flaked stone assemblages at both sites are dominated by small, unretouched flakes with a restricted range of formal tool types. Reduction of river cobbles is evident and raw materials would probably have been readily available locally.

Non-lithic artefacts from the preceramic period are limited to pieces of worked *T. marmoratus* representing waste material from artefact manufacture in the Pleistocene deposits at Kilu. The range of artefacts expands to include worked *Terebralia* shells that may have been used as chisels, a possible *Tridacna* shell adze fragment and perforated shark teeth and vertebrae during the Holocene period. A variety of shell ornaments were found in the upper levels at Kilu and the preceramic deposits at Palandraku (i.e. *Trochus* rings, *Conus* discs, perforated *Oliva* shells and small shell beads) but some of these are likely to be intrusive from overlying ceramic-age deposits.

Faunal and floral evidence

A wealth of data on pre-Lapita subsistence was obtained from the abundant bone and marine shell food remains found at Kilu. The faunal remains at both preceramic sites include small to large rats and bats, lizards (skinks, varanids, agamids), snakes, frogs, birds, marine turtle and fish. The amount of non-food remains in the faunal assemblages is limited to smaller lizards, bats and frogs which may have been cave residents. Although a single bone of the introduced species *Phalanger orientalis* occurs at the base of the Holocene deposit at Kilu, its presence is most parsimoniously explained as intrusive from ceramic-age occupation of the site in view of the lack of additional *Phalanger* bone at either Kilu or in the preceramic deposits at Palandraku. Of the five species of endemic rats which occur throughout the Kilu deposits, two are now extinct (*Solomys spriggsarum* and *Melomys spechti*).

Analysis of the abundant fish remains throughout the Kilu deposits indicates that a variety of capture techniques, included angling and netting, were in use as early as the Pleistocene. Twenty types of fish from 17 families were identified and are dominated by inshore taxa (labrids, balistids, scarids and serranids) although three families of fish generally classified as pelagic are represented (scombrids, coryphaeinids and caranginids). Sharks (Elasmobranchii) are the most common taxon in the assemblage and increase in importance between the Pleistocene and Holocene deposits. Although shifts in the relative importance of particular taxa are evident, the general range of fish represented and quantity of bone do not change significantly over time.

Molluscan remains at Kilu are dominated by small gastropods (*Nerita* and *Turbo* spp.), chitons and a large bivalve (*Polymesoda* cf. *coaxans*). There are few significant changes in the dominant species of molluscs over time apart from a decline in *Turbo* and chitons and appearance of *Polymesoda* between the Pleistocene and Holocene deposits. The mid-Holocene deposits at Palandraku have a somewhat different range of molluscs but the assemblage is also dominated by small gastropods (*Turbo* spp. and Thaididae spp.) and the bivalve *Polymesoda*. The degree of continuity in shellfish taxa over time suggests that habitats in the vicinity of the sites did not undergo radical changes despite fluctuations in sea level and tectonic uplift. There is also no evidence for significant reductions in shell size or decreasing amounts of shellfish over time which would suggest human overexploitation.

Plant remains from the preceramic period consist of carbonised particles and residues found on stone tools. Charcoal is present in the terminal Pleistocene deposits at Kilu and includes *Canarium* almond endocarp, coconut (*Cocos nucifera*) and palm bark which may be sago. The positive identification of *Canarium*, including *C. indicum* and *C. solomonense*, by 10,000 BP is of considerable importance in that edible *Canarium* species were probably introduced from mainland New Guinea via the Bismarcks. Plant residues on stone tools from both Pleistocene and Holocene deposits at Kilu, in the form of starch grains and crystalline raphides, constitute the earliest direct evidence for use of root vegetables. Starch residues of both *Colocasia* and *Alocasia* taros have been identified from the basal levels of the site dating to ca. 28,000 BP (Loy et al. 1992).

The Lapita period (early and late Lapita phases)

One of the research objectives was to expand the existing evidence for Lapita settlement on Buka beyond the two late Lapita deposits excavated by Specht in 1967 to include a wider range of sites from both early and late Lapita phases. By providing a more complete and detailed perspective on Lapita, continuities and discontinuities with pre- and post-Lapita settlement could be evaluated more effectively. The analysis of ceramics played a key role in investigating changes within the Lapita period and between the late Lapita phase and subsequent Sohano phase.

The division of Lapita settlement into early and late phases is based primarily on evidence for significant changes in ceramics over time which are widely recognised in both western and eastern Lapita pottery sequences (Green 1979; Spriggs 1984). Early assemblages have complex vessel forms and a high percentage of dentate-stamped decoration, while late assemblages are often predominantly plainwares and dentate-stamping is replaced by incision and lower frequencies of applied relief and impressed decoration in some areas. The decision to place the division between early and late Lapita phases at 500 BC was based on dates obtained by Specht associated with late Lapita pottery (the Buka style) extending back to 500 BC.

Settlement patterns

A majority of the archaeological evidence from the Lapita period was obtained from surface collections of ceramics and lithic artefacts from intertidal reef flats at three locations on Buka, Sohano and Nissan islands. Evidence from the early phase of Lapita settlement is restricted to the reef sites which were dated on the basis of ceramic seriation. The location of concentrations of pottery and lithic artefacts on the central and outer portions of tidal reef flats at Sites DJQ and DAF suggests that the cultural material represents refuse from stilt house occupation on the reef rather than eroded beach deposits. This is supported by the lack of evidence for storm damage or active geologic subsidence and the presence of advancing mangroves which suggest that the shorelines have not been extensively eroded. The presence of stilt villages on reef flats during this period and lack of evidence for beach or inland deposits are noteworthy and it is tempting to speculate that it may reflect a settlement pattern in which manufacturers/users of Lapita ceramics were spatially segregated from non-pottery using (i.e. indigenous) populations. There are obviously other factors which could account for the patterns observed such as inadequate sampling or a lack of evidence due to geomorphological change which may have buried or drowned sites.

During the late Lapita phase, the range of site types expands considerably. There are beach deposits at the DAF site on Sohano Island which include material eroding onto the inner reef flat and the DAI site on the east coast of Buka excavated by Specht, small rockshelter sites such as DKC and Specht's DAA excavations on Sohano Island, and limited utilisation of the larger cave sites DJA and DBE. If the argument for an early emphasis on reef occupation is accepted, then the late Lapita evidence can be interpreted as suggesting that the producers of Lapita ceramics (and their wares) became more fully integrated into the existing pre-Lapita social structure or that their populations expanded as reflected by the wider range of sites with Lapita ceramics. However, a critical factor which needs to be addressed before this interpretation can be evaluated is whether the current distribution of Lapita sites accurately reflects the full range of settlement during this period.

Ceramic variability

A seriation of the reef site ceramic assemblages using frequency and type of decoration indicates that the Kessa Plantation site (DJQ) on Buka is earliest with the highest percentage of decorated pottery, dentate-stamping and bounded incision but lowest percentage of unbounded incision. The Tarmon reef site (DES) assemblage on Nissan seriates between DJQ and the outer reef area of Site DAF on Sohano Island. The Lapita ceramic assemblages on the central reef and beach areas of Site DAF have the lowest percentage of decoration and are classified as late Lapita. On the basis of stylistic attributes, the following age ranges for the reef sites appear to be most probable:

1. DJQ - 1000 to 800 BC;
2. DES and the outer reef at DAF - 800 to 500 BC;
3. the central reef at DAF - 500 to 300 BC; and
4. the beach and inner reef area at DAF - 300 to 100 BC.

In addition to dentate-stamping and incision, decorative techniques represented in the reef site assemblages include various forms of applied relief, carving, impression, punctation and perforation.

Analysis of Lapita designs has enabled assemblages to be grouped geographically and ordered relative to one another chronologically within design regions that include Eastern, Western and Early Western Lapita provinces. The Buka/Nissan reef assemblages are most similar to the Western Lapita design province and share the highest percentage of motifs with the Reef-Santa Cruz Lapita sites. Despite extra-areal motif similarities, 11 of the 56 motifs identified in the Buka/Nissan assemblages appear to be unique to the northern Solomons. This suggests that the northern Solomons represents a regional style within the Western Lapita province.

A total of ten vessel forms with nine subforms was identified in the Lapita pottery assemblages from the reef sites ranging from flat and round bottomed serving dishes and bowls to large subglobular and globular pots and jars for cooking and storage. There is a decline in the frequency of unrestricted shallow bowls, some of which have flat bases, between the early and late Lapita phases which is correlated with a decrease in dentate stamping. These vessels are most common at the DJQ site where they are often decorated with stamped motifs. At Site

DAF, the representation of particular vessel forms varies between collection areas on the reef. Higher frequencies of large globular jars and pots used for cooking and storage occur on the central portion of the reef in contrast to outer reef areas where shallow serving vessels are more common. Although functional differences may partially account for spatial variability at DAF, chronological change is also evident from the seriation of ceramics which indicates that occupation shifted from the outer reef to central reef and finally the beach over time. Unfortunately, the sampling strategy employed at DAF was not fine-grained enough to document ceramic variability within the collection areas. Disentangling chronological and functional factors is also difficult in the absence of an absolute chronology for the reef sites.

Compositional analysis of Lapita pottery from the reef sites included visual inspection of temper inclusions and elemental microanalysis of the clay matrix. The results of temper analysis demonstrates that calcareous sand was employed almost exclusively at each of the sites although low numbers of sherds with mineral sand temper (primarily ferromagnesian) were also noted. A potential correlation between non-calcareous temper and dentate-stamping decoration for ceramics from DAF is supported by chi-square values. There is also evidence that the use of mineral sand temper declined over time with nearly exclusive use of calcareous temper during the late Lapita phase. Microanalysis of late Lapita Buka style pottery by Summerhayes (1987) indicates that three local clay sources were being utilised during this period. Analysis of clay from a sample of 44 Lapita style sherds from reef sites DAF, DJQ and DES using a scanning electron microscope in conjunction with an X-ray analyser was carried out as a means of characterising potential clay sources. A total of 14 clay groups was produced by clustering procedures and the presence of clusters with sherds from each of the three sites demonstrates that the assemblages are closely related. The lack of shared clay sources between the outer reef, central reef and inner reef/beach collection areas at DAF suggests that clay sources changed over time as these areas are chronologically distinct on the basis of stylistic evidence.

Non-ceramic artefactual evidence

Although flakes of volcanic and siliceous rock were recovered from the reef sites and late Lapita deposits at Palandraku Cave (Site DBE), a majority of the flaked stone associated with Lapita ceramics at the reef sites is obsidian. The long-distance transport of obsidian from New Britain and the Admiralty Islands in the Bismarcks throughout Island Melanesia is a hallmark of the Lapita period. Although West New Britain obsidian was imported to New Ireland by 19,000 BP and appears on Nissan in the earliest site deposits at about 4900 BP, obsidian does not occur in pre-Lapita deposits on Buka. Of the 309 obsidian samples from the surface of the reef sites DJQ, DAA and DAF positively sourced by specific density, 98.4% (n=304) are from the Admiralties (Lou) and only 1.6% (n=5) are from West New Britain (Talasea) with no trends evident in the relative frequencies of the two sources over time. Nearly all of the obsidian was collected from the inner reef and beach at DAF where occupation dates to the late Lapita phase. The low amount of obsidian from the outer and central reef areas at DAF and the other two reef sites suggests that importation of obsidian increased over time although this pattern may be site specific. Obsidian assemblages from the reef sites are characterised by a predominance of small unretouched flakes and debitage with few cores or cortical flakes noted. The only formal tools identified are four blades and a triangular point from the inner reef and beach at DAF. The latter closely resembles points from Lou Island in the Admiralties dating to 100 BC (Ambrose 1991).

Small stone adzes with cross-sections ranging from semi-quadrangular to curvilinear but predominantly oval were found in association with Lapita ceramics on the reef sites. Grindstones and abraders used in artefact manufacture were also collected from the same locations as the adzes at the reef sites. Concentrations of these artefact types occur on the central reef at Site DAF and Site DAA on Sohano Island. This evidence may reflect large-scale production of artefacts such as shell ornaments or 'valuables' involved in exchange at these locations (cf. Kirch 1988b).

Shell artefacts were not preserved on the reef flats but were present in the late Lapita deposits at DAF and DBE. Apart from manufacturing waste of *Turbo marmoratus*, *Pinctada* and small bivalves, ornaments are the main type of shell artefact recovered. These include *Trochus* rings, *Conus* discs, perforated *Oliva* shells and small beads of *Spondylus* and *Conus* shell. There is some uncertainty as to the original provenience of some shell ornaments from the upper DJA deposit where late Lapita ceramics occur but preceramic dates have been obtained, and the preceramic deposit at DBE where artefacts may have been displaced from the overlying Lapita deposit.

Faunal evidence

Faunal remains from the Lapita period are restricted to bone and shell from the excavated deposits at Sites DKC and DAF on Sohano Island and Palandraku Cave (DBE). The faunal evidence from these sites is limited but provides some insights into subsistence change. Faunal introductions documented in the Lapita phase deposits include *Phalanger orientalis* and pig. Based on the evidence for animal husbandry and a range of direct and indirect evidence from Lapita sites over a wide area, there is little doubt that Lapita pottery users were agriculturists. The Pacific rat (*Rattus exulans*) is another (accidental) Lapita introduction and a second rat species (*R. praetor*) may also have been transported to Buka during this period although it has not been identified in site deposits until the Sohano phase. The timing and cause of the extinction of two endemic rat species, *Solomys spriggsarum* and *Melomys spechti*, and possible extirpation of several bird species present in the preceramic deposits at Kilu remain uncertain although they may be linked to Lapita settlement. Molluscan remains from Palandraku (DBE) exhibit a similar range of taxa and dominant species as the preceramic deposit while the shellfish from the DAF and DKC sites more closely resemble those found in the post-Lapita sites.

The Sohano phase

The post-Lapita phases of the Buka sequence have been documented to a variable degree by Specht (1969) and the names adopted for each phase are based on the styles from his pottery sequence. Specht's evidence from the Sohano phase is more extensive than that obtained by the present study which concentrated on the early and late portions of the phase in order to define its chronology more precisely. The divisions between each of the post-Lapita phases are defined primarily on the basis of changes in the ceramic styles.

Excavations with significant Sohano phase components include the DKC shelter site on Sohano Island which has late Lapita and early Sohano phase occupation, the DAF excavations where late Lapita deposits are mixed with those from the middle Sohano phase and the coastal midden site of DJW on Pororan Island where a transition from Sohano to Hangan style ceramics is documented. A few probable early Sohano style sherds were found in the Palandraku (DBE) deposits indicating limited use of the site at this time. Sohano style pottery which is similar stylistically to the ceramics from the DAF excavations was also present on the reef, especially the inner portion. A majority of this pottery appears to have eroded from the beach deposit.

Ceramic evidence

One of the research problems to be addressed by the present study was the relationship between late Lapita and Sohano style pottery. Despite problems related to disturbed deposits and a lack of reliable radiocarbon dates, a temporal overlap between the two styles was documented within the DKC site deposit. The temporal extent of the overlap is unknown but most likely occurred at the end of the first millennium BC. There is evidence for continuity between late Lapita and Sohano pottery compositionally at DKC as some of the early Sohano style sherds have calcareous sand temper like that of the late Lapita Buka style rather than volcanic sand temper which is characteristic of Sohano and later styles on Buka. Summerhayes (1987) has provided evidence that the same clay source was used for the manufacture of both styles on the basis of elemental microanalysis. Continuity is also evident in early Sohano style vessel forms and decoration which represent a continuation of the process of simplification seen in Buka style pottery. The number of vessel forms is even more restricted and decoration less frequent with fewer motifs and simple designs. Punctation, which is a minor technique on late Lapita pottery, becomes the principal form of decoration during the early Sohano style. The rate of ceramic change during the Sohano style is gradual and continuous with minimal change in vessel form, which is limited to large bowls with restricted orifices and direct or incurving rim courses.

Termination of the Sohano style is dated to about AD 600 on the basis of evidence from the DJW site where a gradual shift from Sohano to Hangan style ceramics occurs. This date is a century later than the one proposed by Specht but the evidence for continuity and gradual change between the styles which he recorded is supported by the present study.

Non-ceramic artefacts

The range of artefacts which are definitely associated with the Sohano phase is rather limited although a number of additional types occur in contexts in which pottery from the earlier Buka style or subsequent Hangan style is found with Sohano ceramics. Due in part to limited excavation of Sohano phase deposits during the present investigations, nearly all of the artefacts from this phase were recorded by Specht. Lithic artefacts include pumice and stone abraders, a possible ground stone adze and small flakes of obsidian. Two flakes which may date to the Sohano phase were found by Specht and an additional five were recovered from the Sohano to Hangan phase deposit at Site DJW. The apparent decline in obsidian between the late Lapita phase and subsequent phases suggests that a contraction in the exchange networks by which this material was moved took place by the end of the Lapita phase.

Apart from a single possible *Tridacna* shell adze fragment from the early Holocene deposit at Kilu, the first definite evidence of this artefact type is from the Sohano phase. *Tridacna* adzes are also found in all subsequent phases. Other tool types include sea urchin spine files, trolling lure shanks made from pearl shell and bone points. Shell ornaments include *Trochus* rings and *Conus* discs which also occur in the Lapita phase and, for the first time, *Conus* rings. Additional ornament types appear by the late Sohano phase, including *Tridacna* rings and small gastropods with perforations (*Nassarius* and *Oliva* spp.). The only evidence for change in a particular artefact type is an apparent shift from an early form of *Trochus* ring which appears to be restricted to Lapita deposits and a second form which first appears during the Sohano phase and resembles armrings described ethnographically on Buka.

Faunal remains

The amount of faunal remains from Sohano phase sites was disappointingly meagre and almost exclusively comprised of pig bone, especially at the DJW site. The earliest evidence for dog comes from Sohano phase deposits at the DAI site excavated by Specht. A single bone from another introduced species, the wallaby *Thylogale brunii,* was also found by Specht in the same deposits and is thought to be a trade item as the nearest extant population of this species is found on New Ireland (Flannery et al. 1988:90). Low amounts of fish bone are present in each of the Sohano phase faunal assemblages examined by Specht and those of the later phases as well but these remains were not identified or quantified.

Shellfish associated with Sohano style pottery from the DKC and DAF sites are similar in terms of density and taxonomic representation to the underlying Lapita phase levels. The late Sohano to Hangan phase deposits at Site DJW had the highest shell density of any site excavated during the present study (129.6 kg/m^3). A restricted number of species dominate the assemblage at this site and include the following species in order of importance; the gastropods *Trochus niloticus*, *Strombus luhuanus*, *Lambis lambis* and *Strombus mutabilis,* and the bivalves *Anadara antiquata* and *Chama* cf. *iostoma*.

The same species are also dominant in each of the later site deposits which are located in coastal environments with access to a similar range of molluscan habitats on broad, sandy intertidal reef flats. Considering the significant amount of chronological and spatial separation between the sites, the most likely explanation for the marked similarities between the molluscan assemblages is the exploitation of similar environments.

The Hangan phase

The number of sites investigated during this study with substantial Hangan phase deposits is significantly greater than for the Sohano phase although the range of site types is limited to beach middens from northern Buka. Early Hangan phase occupation is documented in the upper portion of the DJW site deposits on Pororan Island and a sequence of later Hangan phase occupation was obtained from the DJU site on Pororan and two excavation locations from the DJO site at Kessa Plantation. This set of sites provides a nearly continuous sequence for the Hangan phase which extends from AD 600 to 1200 on the basis of ceramic evidence. The excavation of sites on north Buka and Pororan Island was done in order to expand the geographical range of sites from post-Lapita phases excavated by Specht.

Ceramic evidence

As with the Sohano style, three substyles of the Hangan style were identified by Specht. The collective evidence documents a process of continuous gradual change throughout the Hangan style and continuity with the earlier Sohano style and subsequent Malasang style. The ceramic sequence from the present investigations parallels that documented by Specht in the Buka Passage area although one of the substyles which he identified is not as well represented in the northern Buka sites. Specht's interpretation of his radiocarbon dates led him to claim that the Hangan style lasted only about 200 years from AD 500 to 700. Radiocarbon evidence from the present study demonstrates that the Hangan style was in existence for a much longer time, approximately 600 years.

Based on compositional analysis by Summerhayes (1987), there is a decline in the number of clay sources being utilised from three sources during the Sohano style to only one of these sources during the Hangan style. Pottery construction techniques are the same as for the Sohano style with evidence of coil and strip methods but wall thickness is significantly reduced. Vessel forms are generally vertical sided to slightly restricted without angles and have rounded bases. The reduction in wall thickness may be related to a change in the manner in which pottery was utilised (e.g. the adoption of new cooking methods which required vessels with different heat conducting properties).

The range of major decorative techniques expands from punctation and incision during the late Sohano style to include applied relief during the Hangan style and motifs combining these techniques become common. Decoration of rim interiors also begins during the Hangan style. Distinctions in decoration between the substyles are based on variations in the complexity and organisation of the three dominant techniques. A shift from Hangan to Malasang style pottery occurs within the DJO-D deposit at Kessa Plantation and transitional ceramics with elements common to both styles were also recognised.

Non-ceramic evidence

Stone and coral artefacts from Hangan phase deposits are limited to manufacturing tools (stone, coral and pumice abraders) and a few small flakes of obsidian from Sites DJW and DJO. The low amounts of obsidian are comparable to the Sohano phase and all sourced flakes are from Lou. Pottery sherds with ground margins which may have been used as tools appear for the first time during the Hangan phase and continue to occur in subsequent phases. Shell artefacts include *Tridacna* adzes, pearl shell trolling hook shanks and discarded material from artefact manufacture and a wide range of ornaments including *Tridacna* and *Trochus* rings, *Conus* rings and discs and small perforated gastropods (*Nassarius, Polinices, Oliva* and *Conus* spp.). In addition to an expansion in the quantity and range of ornament types compared with the Sohano phase, there is evidence for large-scale production of *Trochus* armrings in the form of unfinished rings and waste material from each of the Hangan phase deposits. The presence of stone and coral abraders which were probably used in the manufacture of shell ornaments provides supporting evidence for an emphasis on shell ornament production.

Vertebrate faunal remains from the Hangan phase sites are limited in quantity and dominated by pig. Other large mammal remains include a few human teeth and vertebrae from the DJO-D deposit and a concentration of marine mammal bones at DJU which have been tentatively identified as dolphin. A limited amount of *Phalanger,* rat, bat and lizard bone is also scattered through the Hangan phase deposits and fish are present but have not been quantified. The range of dominant molluscs represented in Hangan phase deposits is nearly identical to the Sohano phase assemblage at DJW.

The Malasang phase

Evidence from the Malasang phase is limited to the upper portion of the DJO-D site deposits at Kessa Plantation and surface collections of Malasang style pottery at several sites. On the basis of radiocarbon dates and ceramic evidence from DJO-D, the Malasang phase appears to extend from AD 1200 to 1500 although precise dates for the termination of this phase have not been established.

Ceramic evidence

As previously noted, there is a transition from Hangan to Malasang style pottery over time within the DJO-D deposit which indicates that the changes between the two styles were continuous and gradual. Although Specht tentatively identified three Malasang substyles, the evidence from DJO-D suggests that the degree of change within the style is not sufficient to permit substyles to be defined. Malasang style pottery is technologically identical to the Hangan style except for the smoothing of interior and exterior surfaces which contrasts with the rougher surfaces found on Hangan style pottery. Microanalysis by Summerhayes (1987) distinguished two clay sources in pottery from this phase; a previously unutilised source that is predominant and restricted use of the same source utilised for Hangan style pottery.

Malasang style vessels are predominantly globular with restricted orifices and thicker walls than the Hangan style. Pottery which is transitional between the two styles has vessel forms that are generally similar to the Hangan style with inflected contours and direct rims. In contrast, Malasang style vessels have inflected contours with predominantly inverted rather than direct rim orientations and a high percentage of everted lips. Two new minor vessel forms are introduced during the Malasang style which resemble open bowls (Form 2C) and small mouthed jugs or jars (Form 10) found in the Lapita assemblages.

A significant change in decoration occurs with the initial appearance of comb incising in transitional pottery and its dominance during the Malasang style. Motifs with non-comb incision, some of which are curvilinear, are most common during the transitional period and early Malasang style while punctation combined with comb incision appears during the late Malasang style. Comb-incised rim interior decoration increases over time.

Non-ceramic evidence

There is little change in the artefact assemblages from the Hangan phase with the continued presence of a majority of both stone and shell artefact types. Tools include abraders of pumice and coral, *Tridacna* shell adzes and a few small flakes of chert and obsidian. Although not extensive, the range of bone artefacts exceeds that of the earlier phases and includes ground turtle bone, points, perforated shark vertebrae and perforated human and porpoise teeth. The range of shell ornaments is similar to the Hangan phase and includes waste material from the manufacture of *Trochus* rings.

There is no change in bone or shell density or the taxa represented between the Hangan and Malasang phase deposits at the DJO-D site but evidence from a single site deposit is not sufficient to permit an accurate assessment of subsistence trends during the Malasang phase.

The Mararing and Recent phases

Palandraku Cave (DBE) is the only site excavated with substantial evidence from the final two phases of the Buka sequence. The phases are discussed as a single unit as there is a significant temporal overlap between the pottery styles which are the primary means of distinguishing between the phases. The chronology of these phases remains imprecise as there are no secure radiocarbon dates from excavated deposits and a majority of the evidence is derived from surface collections. It seems likely that the Mararing phase began at about AD 1500 based on the single date for the Malasang phase from DJO-D and a date which appears to be associated with Mararing and Recent style pottery from the DAF excavations. The Recent phase extends from the late prehistoric or protohistoric period through to the ethnographic present.

Ceramic evidence

Some of the pottery from the uppermost levels of the DJO-D deposit has stylistic attributes which are transitional between the Malasang and Mararing styles. These include combinations of decorative techniques such as relief bands with incision and comb incision with punctations which are found in both styles. Specht (1969:310) also recognised the presence of pottery with transitional traits but claimed that the introduction of a new temper type and the lipped *kepa* bowl form during the Mararing style might indicate the arrival of an intrusive culture. Evidence from the present investigations argues against this interpretation as does compositional analysis which indicates that the clay source used during the Mararing and Recent styles was also in use during the Sohano phase (Summerhayes 1987). The Recent style includes the modern pottery industry which was restricted to the three contiguous villages of Malasang, Hangan and Lonahan on the east coast of Buka and almost completely abandoned by the late 1960s. Recent style pottery was present on the surface at all but three of the sites recorded during the present investigations.

Both Mararing and Recent style pottery is made of the same smooth surfaced paste as the Malasang style and constructed in the same manner by coil or strip building. A majority of the Mararing style vessels are globular with slightly restricted orifices and rounded to pointed bases although direct and unrestricted vessels are also common. In addition to the introduction of vessels with pointed bases, loop handles from an unknown vessel type and the spouted *kepa* bowl used ethnographically for cooking coconut oil also appear for the first time during the Mararing style. Recent style vessels range from unrestricted bowls to vertical sided and restricted pots and the *kepa*.

The introduction of new vessel forms during the Mararing style, particularly pots with pointed bases, may be due to the influence of pottery produced in the Kieta area of south Bougainville, which includes vessels with pointed bases. Kieta pottery is known to have been transported as far north as Teop Island off the coast of north Bougainville by the Malasang phase, where Buka-made ceramics are also found (Black 1977).

Although the same five decorative techniques found during the Malasang style also occur on Mararing pottery from the DBE deposit, only two of these techniques, shell edge impression and punctation, are represented by more than two examples. The only decorative technique found on Recent style pottery from Site DBE is comb incision although a few sherds from surface collections have comb incision combined with regular incision. Many of the motifs from this style continued into the modern pottery industry.

Non-ceramic evidence

The quantity of artefacts from the Mararing to Recent phase deposit at DBE is quite limited but a much larger sample was obtained from surface collections in association with Mararing and Recent style pottery. This combined sample includes many of the artefact types described ethnographically on Buka and exhibits a number of contrasts with the Malasang phase assemblage. These differences may be partially due to the effects of sample size as the combination of surface artefacts with excavated material from the Mararing to Recent phase represents a much larger sample than the limited Malasang phase deposits.

One of the changes in artefactual evidence which cannot be explained by sample size differences is the lack of obsidian from excavations and surface collections which date to the Mararing and Recent phases. This evidence and the lack of references to obsidian in the ethnographic record strongly suggest that importation of obsidian ceased by the end of the Malasang phase or soon after. Another apparent change which occurred after the Malasang phase was the introduction of a variety of ground stone axes which are documented ethnographically. Many of these axe types are unique to the Buka-north Bougainville area but the factors responsible for their initial development or introduction remain unknown. The only other artefact type which is not represented in earlier phases is a *Terebra maculata* shell adze collected by Specht. Apart from stone axes and the *Terebra* adze, none of the artefact types present during the Mararing and Recent phases are absent from the Hangan or Malasang phases which underscores the basic continuity in the archaeological record extending back to the Sohano phase.

The amount of vertebrate faunal remains from the Mararing to Recent phase deposit at DBE is comparable or slightly greater than the Malasang phase assemblage at DJO-D. As with the other ceramic-age assemblages, there is a predominance of pig bone and some *Phalanger*. A variety of endemic fauna is also represented including large to small rats, large fruit bats and insectivorous bats, skink and medium to small lizards, and snake. Although not as abundant as in the preceramic deposits at DBE, the presence of significant numbers of large rat bones indicates that endemic rodents continued to be exploited as a food source during the late prehistoric period. Fish bone was present but has not been analysed. Molluscan remains are dominated by the bivalves *Chama* cf. *iostoma*, *Polymesoda* cf. *coaxans* and *Anadara antiquata*. This represents a change from the preceramic and late Lapita deposits at DBE where *C. iostoma* and *A. antiquata* are minor species although *Polymesoda* is also important in these earlier deposits.

EXCHANGE AND INTERACTION

Research questions relating to exchange were concerned with long-term trends in the movement of the most visible items of exchange, obsidian and ceramics, and the shifting configurations of exchange networks for specific periods of the prehistoric sequence. The degree to which these questions were addressed by the present investigations is summarised below for the three principal periods of settlement on Buka:

1. Preceramic;
2. Lapita; and
3. post-Lapita.

As the evidence for exchange from each of these periods has been dealt with extensively in an earlier paper (Wickler 1990), the following discussion is brief. The use of Lapita as a reference point for the evaluation of prehistoric exchange is due to its broad geographical extent and the significant amount of evidence for long-distance transport of goods from this period. Although Lapita exchange is of obvious importance, it must be viewed from the perspective of interactions between populations in the northern Solomons extending back to the Pleistocene as well as evidence for extensive post-Lapita exchange networks.

The Preceramic period

The limited evidence for interaction or exchange prior to the Lapita period needs to be evaluated with the awareness that the present sample of two sites with preceramic occupation is not sufficient to reflect accurately patterns of settlement over a period of at least 25,000 years. The collective evidence from this period indicates an emphasis on local resources by groups of hunter-gatherers. There is no sign of sustained contacts with the 'homeland' to the west in the Bismarcks in the form of exchange. The single *Phalanger* bone from the early Holocene deposit at Kilu Cave could be interpreted as evidence for contacts with the Bismarcks in the form of animal translocation but is considered intrusive given the lack of additional remains. The presence of carbonised remains of the *Canarium* almond by the terminal Pleistocene at Kilu Cave indicates some form of contact with the Bismarcks, from where this tree crop was most likely introduced.

Artefactual evidence from Buka for preceramic exchange is limited to what Green (1982:15) has called direct access or local reciprocity, with no suggestion of long-distance transport of material. This situation contrasts with sites of similar age on New Ireland where Talasea obsidian was being imported by 19,000 BP (Allen et al. 1989). Obsidian from this source is also present on Nissan from the earliest phase of settlement dating to 4900 BP (Spriggs 1991a). The lack of obsidian in the preceramic site deposits on Buka suggests that Nissan was the eastern terminus of the exchange network(s) for this resource.

Lapita exchange

Long-distance exchange is one of the most distinctive features of the Lapita cultural complex, and transport of obsidian, chert, metavolcanic rock, pottery and other materials has been documented from Lapita sites over a wide area. The geographical extent of Lapita exchange far exceeds any of the ethnographic networks with movement of obsidian from the Bismarcks over 3000 km to Fiji.

The principal evidence for Lapita exchange from Buka is obsidian from New Britain and the Admiralties collected from the reef sites. The low quantity of flakes at DJQ, the outer reef at DAF and DES on Nissan, in contrast to the relative abundance of obsidian on the inner reef and beach at DAF, suggests that importation increased during the late Lapita phase. There is no apparent change in the relative importance of sources represented over time with Admiralties (Lou) obsidian dominant throughout the sequence. Formal tools are rare and include four blades and a triangular point from DAF which is identical to points from sites on Lou Island dating to 100 BC that have also been found at the Lossu site on New Ireland at about AD 300. Given the lack of evidence for blade or point manufacture on Buka, it is assumed that these tools were imported as finished products.

Comparisons between the Buka obsidian assemblages and those in the Bismarcks and Solomons reveals some interesting contrasts. New Britain obsidian is dominant throughout the Reef-Santa Cruz Lapita sequence and also common on Nissan where it is the exclusive pre-Lapita source. There is a general trend towards increasing percentages of Admiralties obsidian in assemblages on Nissan and parts of the Bismarcks such as Mussau although New Britain obsidian continues to be represented. This evidence demonstrates the complexity of exchange networks in the region with variable distribution of material from different sources over time and space.

Analysis of Lapita ceramics from the reef sites indicates that pots were also a probable item of exchange. Elemental microanalysis has demonstrated that identical clay sources were utilised in the manufacture of pottery from both Buka and Nissan reef sites which strongly suggests that Buka-made pots were being transported to Nissan. Half of the 14 potential clay sources recognised are restricted to pottery from DES and DAF, revealing a particularly strong link between these assemblages which are later than the ceramics at DJQ on the basis of stylistic seriation. Design analysis places the Buka and Nissan reef assemblages within the Western Lapita design province. The percentage of shared motifs is highest between the reef site assemblages themselves, followed by the Reef-Santa Cruz sites in the southeast Solomons. Fewer motifs are shared with Western Lapita sites in the Bismarcks than sites in eastern Melanesia suggesting that assemblages in the Solomons represent a stylistic unit. Stylistic evidence cannot be directly equated with exchange but it does provide a means of examining the degree of interaction between communities using Lapita style ceramics.

In addition to the artefactual evidence, Lapita settlement patterns also provide potential insights into interactions between Lapita and pre-Lapita populations in the northern Solomons. There is a growing body of evidence for Lapita stilt villages in intertidal locations from Mussau (Kirch 1988a), New Britain (Specht 1991) and the Arawe Islands (Gosden and Webb 1994) in the Bismarcks. Similar evidence from the reef sites on Buka suggests that this was a widespread settlement pattern which may have been significant in terms of relations between Lapita colonists and resident populations. The absence of early Lapita phase sites on Buka may be due in part to geomorphological and geological processes which have hidden or destroyed site deposits. However, the possibility that early settlement by Lapita pottery users focused on reef locations must also be considered. Reef site occupation on Buka can be viewed as the extension of an established pattern of stilt village settlement in the Bismarcks.

Post-Lapita exchange

As with the Lapita period, obsidian and pottery are the primary means of identifying patterns of exchange during the post-Lapita phases. With the exception of a single piece of Talasea obsidian of unknown age from the surface of the DJU site, all of the sourced post-Lapita obsidian is from the Admiralty Islands. There is a significant decline in the quantity of obsidian following the late Lapita period with only a few small flakes in the later site deposits. It is likely that importation of obsidian to Buka ceased by the Mararing phase as there is no definite evidence of obsidian from excavations or surface collections dating to the Mararing and Recent phases and obsidian is not recorded ethnographically. On Nissan, obsidian from both New Britain and the Admiralties continued to be imported into the historic period. However, the contrasts in obsidian exchange patterns between Buka and Nissan cannot be attributed to a lack of interaction as there is ample evidence for the importation of pottery to Nissan from Buka.

Buka-made ceramics were transported over an increasingly wide area within the northern Solomons over time. Sohano phase pottery was found in surface collections along the northeast coast of Bougainville and as far south as Teop Island by Terrell (1976) and several Sohano style sherds occur at the DES reef site on Nissan. Transport of pottery to Nissan apparently ceased by the early Sohano phase and did not recommence until the late Hangan phase. The abundance of Malasang to Recent style pottery on Nissan indicates that ceramics from Buka were an important exchange item after about AD 800. Buka ceramics are increasing common along the coastal portion of northern Bougainville following the Hangan phase and extend as far south to Numa Numa by the Mararing phase. An expansion of pottery exchange to the Bismarcks is documented by the presence of Malasang and Mararing style pottery on Ambitle in the Feni Islands and the southern coast of New Ireland (Kaplan 1976). A Mararing style sherd has also been found on the atoll of Ontong Java east of Bougainville (M. Spriggs, pers. comm.). At the time of European contact, pottery production was restricted to three contiguous villages on Buka. The trend towards specialised production centres may have been a response to increased ceramic exchange which required larger scale production for export. The expansion of exchange during the late prehistoric period anticipates the ethnographic trade network between the Bismarcks and northern Solomons in which Nissan played an important role as middleman.

Additional evidence for exchange is more limited and conjectural. The faunal record includes a single wallaby (*Thylogale brunii*) bone from a Sohano phase deposit excavated by Specht which has been interpreted as a possible trade item. Evidence for the manufacture of *Trochus* shell armrings in the form of unfinished rings and waste material from Hangan and Malasang phase deposits may be related to the exchange of shell 'valuables'. Kirch (1988b) has argued that a range of shell ornaments functioned as valuables in Lapita exchange and particular sites served as production centres. Adapting this model to the post-Lapita evidence from Buka, the sites on Pororan Island and Kessa Plantation may have served as manufacturing centres for the large scale production of armrings which were items of exchange. In the ethnographic exchange network between New Ireland and Buka, *Trochus* armrings were items of exchange traditionally produced on Nissan (Spriggs 1991a: Table 1).

SUBSISTENCE CHANGE

As with exchange, the evidence for subsistence change on Buka is examined for the preceramic, Lapita and post-Lapita periods which encompass major shifts in subsistence and the nature of archaeological evidence for these changes.

Plant remains from preceramic contexts on Buka provide insights into the early utilisation of botanical resources consistent with a hunting and gathering subsistence base. Starch residues identified as taro on stone tools from Kilu dating to ca. 28,000 BP provide the earliest direct evidence for the use of root vegetables. The presence of *Canarium* by the terminal Pleistocene at the Kilu Cave site demonstrates early use of this ethnographically important tree crop which is likely to have been introduced from New Guinea. Although the introduction of *Canarium* cannot be directly equated with arboriculture, it does suggest some degree of resource management.

In contrast to the limited botanical evidence, there is an abundance of faunal remains from the preceramic deposits on Buka which include rats, bats, snakes, lizards, fish and molluscs. Unlike the preceramic sites from New Ireland and elsewhere in the Bismarcks, there is no evidence for human introduction of animals on Buka prior to the Lapita phase. The fish remains from Kilu Cave indicate that fishing included both inshore and offshore zones and involved angling and netting techniques during the Pleistocene. Shellfish from the two preceramic sites on Buka exhibit a significant degree of continuity over time in terms of taxonomic diversity and dominant taxa although some changes attributable to environmental variables are evident. The lack of evidence for human overexploitation of molluscs and importance of fish remains throughout the Kilu deposits argue against the 'strandlooper' model proposed by Allen (1993:144-5) on the basis of evidence from the Matenkupkum site on New Ireland which suggests that exploitation of marine resources intensified significantly by the terminal Pleistocene.

As is the case elsewhere in Island Melanesia, the earliest evidence for agriculture on Buka is from the Lapita phase. Although no macrobotanical remains of cultigens were recovered, domesticated animals appear in the form of pig bones which dominate the faunal assemblages of ceramic-age sites. Additional faunal introductions which appear to coincide with Lapita include *Phalanger orientalis, Rattus exulans* and possibly *R. praetor*. Competition with introduced fauna may have been an important factor in the extinction of two endemic rat species which occur throughout the preceramic site deposits but are absent in Lapita sites. On the basis of preliminary analysis, there is also evidence for the extirpation of several bird taxa by the Lapita phase.

The major faunal component in post-Lapita sites is marine shell, for which density figures of up to 129.6 kg/m^3 are recorded from coastal middens. The dominant taxa are nearly identical at most sites and inter-site taxonomic variability is attributed to differences in the shellfish habitats which were readily accessible. Vertebrate faunal remains are limited and dominated by pig. Dog is added to the list of domesticates by the Sohano phase. *Phalanger*, rats, bats and lizards are also represented in the assemblages indicating a continued reliance on non-domesticated fauna. Fish remains are also common in all of the post-Lapita sites.

BUKA FROM A REGIONAL PERSPECTIVE

The task of integrating the Buka sequence within a regional framework has been addressed for specific components of the archaeological record in the previous chapters. In this section these divergent strands of evidence are brought together to provide a broader perspective on the role which Buka played within the northern Solomons and Bismarcks-Solomons region as a whole.

The Preceramic period

The growing number of preceramic sites in the Bismarcks and Solomons has made it possible to begin to make meaningful comparisons on a regional level. This increase in data has also revealed the degree to which sites vary within subregions and individual islands and cautions against overly broad generalisations based on the small size of the current sample.

To date, most of the published data from preceramic sites has come from a series of cave sites on New Ireland. Comparisons of stone tool assemblages and faunal remains reveal some interesting similarities and contrasts between these sites and the two preceramic cave sites on Buka. Although similar types of fauna are represented on both islands, there is no secure evidence for the introduction of animals on Buka as in the New Ireland sites. Similarities in dominant shellfish taxa with several of the New Ireland sites are most likely due to environmental factors but shared exploitation strategies are also a possibility.

In terms of artefact assemblages, one of the most obvious differences is the presence of obsidian by 19,000 BP on New Ireland (and from the earliest phase of settlement on Nissan at 4900 BP) in contrast to its total absence in preceramic deposits on Buka. This suggests that the open-water gap between the Bismarcks and Solomons represented a significant barrier to interaction during the Pleistocene and early to mid-Holocene. Non-obsidian flaked stone assemblages on Buka are comparable to the New Ireland assemblages in terms of raw material and flaking technology and the shift in emphasis from volcanic to siliceous rock over time on Buka is similar to that documented for sites from northern New Ireland.

An increasing range of shell artefact types has been documented in preceramic sites from the Bismarcks and Solomons, including ornaments commonly associated with the Lapita cultural complex. Pre-Lapita shell artefacts from Buka include a possible *Tridacna* adze fragment from the terminal Pleistocene deposit at Kilu Cave and ornaments such as *Trochus* rings, small shell beads, *Conus* discs and perforated *Oliva* shells from mid-Holocene deposits. Although some of the ornaments may be intrusive from ceramic-age deposits, the presence of similar artefacts in preceramic sites elsewhere in the region suggests that they are in situ.

The combined evidence from the preceramic period on Buka reveals broad similarities with other sites of comparable age within the region but also displays a number of distinctive traits. The lack of faunal introductions and obsidian from the Bismarcks argues for more limited contacts to the west prior to the Lapita phase although *Canarium* was introduced by the terminal Pleistocene. Parallels from outside Buka in terms of changes in artefact and faunal assemblages over time can be attributed largely to the utilisation of similar resources from comparable environments.

Lapita in the northern Solomons

Models of the Lapita cultural complex in Near Oceania where pre-Lapita settlement extends back to the Pleistocene must take into account the greater complexity of settlement in a region where Lapita populations were not the initial colonists as in Remote Oceania. The impact of Lapita colonisation in Remote Oceania with its 'pristine' island ecosystems cannot be viewed in the same manner as in areas such as Buka where long-term human interactions with the environment prior to Lapita must be taken into account.

The evidence from Buka suggests that discontinuities between pre-Lapita and Lapita settlement outweigh the continuities. These include:

1. settlement in stilt villages on intertidal reef flats;
2. the introduction of ceramics;
3. the importation of obsidian;
4. the initial appearance of domesticated animals in the form of pig remains, and by inference, agriculture; and
5. the introduction of additional fauna including *Phalanger orientalis*, *Rattus exulans* and possibly *R. praetor*.

The extinction of two endemic rat species and possible extirpation of bird taxa may be indirectly attributed to the impact of Lapita settlement through competition with introduced taxa and other possible factors such as habitat destruction. Lapita continuities include the use of flaked stone and shell artefacts represented in the preceramic sites and continued exploitation of the wild fauna hunted during the preceramic period.

Based on the available evidence, Lapita settlement on Buka appears to have focused on intertidal stilt villages during the early Lapita phase with an expansion to open coastal sites and caves/rockshelters by 500 BC. This pattern may reflect initial segregation of Lapita populations from existing pre-Lapita settlements with later integration of settlements and expanded distribution of Lapita ceramics. Evidence for Lapita stilt village settlement is widespread in the Bismarcks (i.e. the Arawes, southwest New Britain and Mussau) and may also extend to the western Solomons during the post-Lapita period (Reeve 1989). If Lapita settlement in the main Solomons focused on reef areas, this may partially explain the present lack of land-based Lapita sites here. However, the absence of ceramics on Guadalcanal and elsewhere in the central Solomons (Roe 1993) indicates that some portions of the archipelago may have been bypassed by Lapita pottery producers.

The distribution of obsidian on Buka and elsewhere in the Solomons indicates that networks of Lapita exchange and interaction were complex and regionally variable. Obsidian from New Britain is dominant throughout the Lapita sequence in the Reef-Santa Cruz sites and during the early Lapita phase on Nissan. There is a trend towards increasing amounts of Admiralties obsidian on Nissan and Mussau but on Watom New Britain obsidian becomes more common in the late Lapita period. The exclusive presence of Admiralties obsidian at the early Lapita site of DJQ on Buka and its dominance in the later Lapita assemblages at DAF and DAA contrasts with the Reef-Santa Cruz sites and is most similar to the Nissan sites where Admiralties obsidian is dominant after the early Lapita period.

Lapita ceramics from the reef sites on Buka and Nissan are most similar to the Western Lapita Reef-Santa Cruz sites stylistically and share many fewer motifs with Early Western Lapita ceramic assemblages in the Bismarcks. This contrasts with the other Lapita ceramic assemblages on Nissan which are Early Western and may have been imported from Ambitle (Spriggs 1991a:239). Microanalysis of the clay fraction in pottery from the Nissan and Buka reef sites indicates that vessels from each of the sites were made from the same clay sources, which are likely to be located on Buka. The contrast between the reef and excavated Lapita assemblages on Nissan may indicate that pottery was being imported from both Buka and the Bismarcks simultaneously. Temper analysis of pottery from the reef sites revealed that non-calcareous inclusions (primarily ferromagnesian sands) are most common during the early Lapita phase and drop out completely during the late Lapita phase when calcareous temper was used exclusively. There is also a correlation between mineral sand temper and dentate-stamping.

Post-Lapita

The pottery assemblages excavated during the present study and by Specht in 1967 provide the framework for the definition of phases in the post-Lapita cultural sequence on Buka and are of central importance in examining prehistoric change from a regional perspective. The question of 'What happens to Lapita?' was one of the research problems to be addressed by the present study and has also been a focus of research elsewhere in Island Melanesia.

The ceramic evidence from Buka indicates that there is a temporal overlap between the late Lapita phase Buka style and subsequent Sohano style pottery and a gradual transition from one style to the next. The Sohano style represents a continuation of a process of simplification evident in late Lapita ceramics in which the amount of decoration, range of techniques, and motif complexity are reduced significantly and vessel forms are restricted to simple bowls and jars. In contrast to early Lapita assemblages where serving vessels such as unrestricted bowls with extensive dentate-stamping are common, late Lapita and Sohano style vessels are utilitarian wares designed for cooking and storage. Continuity between the later ceramic styles is also evident in terms of composition, form and stylistic attributes indicating a process of gradual, internal change rather than the rapid replacement of styles as a result of external influences.

Post-Lapita ceramic sequences remain poorly understood in much of the Bismarcks and Solomons although recent research has established more complete sequences for areas such as the Arawe Islands and Mussau. Ceramics from Lossu and Lasigi on New Ireland offer insights into post-Lapita developments but their relationship to Lapita ceramics is still unclear. Buka-made ceramics are exported over an increasingly large area over time extending from the north and east coasts of Bougainville in the south to Nissan, Ambitle and New Ireland in the north by the Mararing to Recent phase. A reduction in the number of pottery manufacturing centres also appears to have occurred over time which may have been linked to the increasing volume of pottery production for export.

Interestingly, there is a hiatus in the transport of Buka pottery to Nissan for a period of nearly 1500 years between the early Sohano style and late Hangan style. However, contact between the two islands was most likely maintained during this period as obsidian continued to be transported to Buka from the Bismarcks. Differential transport of obsidian and pottery is also evident during the Mararing to Recent phase when obsidian is no longer present on Buka but substantial amounts of Buka-made pottery were transported to Nissan. The roots of the ethnographic exchange network between New Ireland and the northern Solomons can be traced back to the prehistoric exchange of pottery and obsidian in which Nissan played a central role in directing the flow of goods.

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APPENDIX A

LAPITA POTTERY MOTIF FREQUENCY TABLES FOR REEF SITES DAF (SOHANO ISLAND), DJQ (KESSA PLANTATION) AND DES (NISSAN)

Design Description			Decoration Location											
			Top of Lip (O)uter lip		Below Rim-Zone 1/2 (I)nterior		Neck		Shoulder		Carination Angle/ Above or Below		Body	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
unidirectional - isolated	92	6.6	-	-	-	-	-	-	-	-	-	-	92	100.0
unidirectional - group	603	43.1	1	0.2	1	0.2	1	0.2	1	0.2	-	-	599	99.3
vertical - isolated	6	0.4	-	-	3	50.0	-	-	2	33.3	1/0	16.7	-	-
vertical - group	12	0.9	1	8.3	1	8.3	-	-	8	66.7	2/0	16.7	-	-
horizontal - isolated	10	0.7	2(O)	20.0	2/2(I)	40.0	-	-	1	10.0	1/1	20.0	1	10.0
diagonal - isolated	28	2.0	4	14.3	7	25.0	3	10.7	7	25.0	2/1	10.7	4	14.3
diagonal - group	224	16.0	69	30.8	5	2.2	3	1.3	90	40.2	2/3	2.2	52	23.2
opposed diagonals - isolated	22	1.6	2	9.1	2	9.1	1	4.5	7	31.8	0/4	18.2	6	27.3
opposed diagonals - group	328	23.4	14	4.3	2	0.6	2	0.6	44	13.4	3/8	3.3	255	77.7
diagonal with vertical and/or horizontal	17	1.2	2	11.8	1	5.9	1	5.9	4	23.5	0/5	29.4	4	23.5
incision associated with applied strips	53	3.8	2	3.8	-	-	1	1.9	-	-	-	-	50	94.3
infilled triangles	2	0.2	2	100.0	-	-	-	-	-	-	-	-	-	-
perpendicular lines	2	0.1	-	-	-	-	-	-	1	50.0	-	-	1	50.0
Total	1399	100.0	99	7.1	26	1.8	12	0.8	165	11.8	11/22	0.8/1.6	1064	76.1

Table A.1 Non-intersecting rectilinear incision design frequencies by decoration location, Site DAF.

Design Description			Decoration Location											
			Top of Wide Lip		Below Rim-Zone 1/2		Neck		Shoulder		Carination Angle (A)bove carination		Body	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
loosely intersecting diagonals	52	8.3	-	-	1	1.9	2	3.8	11	21.2	2	3.8	36	69.2
cross-hatched diagonals	477	76.4	1	0.2	-	-	1	0.2	90	18.9	15	3.1	370	77.6
chevrons														
row(s) of single chevrons	5	0.8	-	-	1	20.0	-	-	2	40.0	-	-	2	40.0
row(s) of herringbone chevrons	54	8.7	4	7.4	-	-	1	1.9	1	1.9	1(A)	1.9	47	87.0
opposed chevron groups	6	1.0	5	83.3	-	-	-	-	-	-	-	-	1	16.7
connected groups of opposed diagonals	8	1.3	-	-	-	-	-	-	3	37.5	-	-	5	62.5
chevron row between diagonal or vertical lines	7	1.1	-	-	1	14.3	2	28.6	1	14.3	1(A)	14.3	2	28.6
multiple zigzag lines	15	2.4	-	-	-	-	-	-	4	26.7	1(A)	6.7	10	66.7
Total	624	100.0	10	1.6	3	0.5	6	1.0	112	17.9	20	3.2	473	75.8

Table A.2 Chevron and intersecting incision design frequencies by decoration location, Site DAF.

Design Description			Decoration Location									
			Transverse Bar		Below Rim-Zone 1/2 (I)Interior		Shoulder		Above and/or Below Carination (C)On Angle		Body	
Short Slash Incision	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
vertical and/or diagonal lines - single row	10	20.4	1	10.0	1/1(I)	20.0	4	40.0	1/1(C)	20.0	1	10.0
single or multiple direction lines - multiple rows	15	30.6	-	-	1/1(I)	13.3	2	13.3	-	-	11	73.3
loosely organised multidirectional lines	6	12.2	-	-	1	16.7	1	16.7	1	16.7	3	20.0
chevron row(s)	10	20.4	-	-	2	20.0	2	20.0	-	-	6	60.0
chevrons and diagonal lines - single row	1	2.1	-	-	1	100.0	-	--	-	-	-	-
zigzag rows	5	10.2	-	-	-	-	1	20.0	1	20.0	3	60.0
'leaf' motif	2	4.1	-	-	-	-	-	-	-	-	2	100.0
Total	49	100.0	1	2.0	8	16.3	10	20.4	4	8.2	26	53.1
Curvilinear Incision												
enclosed 'leaf' motif	1	16.6	-	-	-	-	-	-	-	-	1	100.0
curved lines intersecting straight line(s)	1	16.6	-	-	-	-	-	-	-	-	1	100.0
parallel crescents	2	33.3	-	-	-	-	-	-	-	-	2	100.0
intersecting crescents above and below horizontal line	1	16.6	-	-	-	-	-	-	-	-	1	100.0
'face' motif on applied disc	1	16.6	-	-	-	-	-	-	-	-	1	100.0
Total	6	100.0	-	-	-	-	-	-	-	-	6	100.0

Table A.3 Slash and curvilinear incision design frequencies by decoration location, Site DAF.

Design Description			Decoration Location							
			Top of Lip		Below Rim-Zone 1		Neck		Body	
Non-intersecting Rectilinear Incision	Total	%	Total	%	Total	%	Total	%	Total	%
unidirectional - isolated	3	30.0	-	-	-	-	-	-	3	100.0
unidirectional - group	1	10.0	-	-	-	-	-	-	1	100.0
horizontal - isolated	2	20.0	1	50.0	1	50.0	-	-	-	-
horizontal - group	1	10.0	-	-	-	-	1	100.0	-	-
diagonal - group	1	10.0	-	-	1	100.0	-	-	-	-
Chevrons and Curvilinear Incision										
connected multiple line chevrons	1	10.0	-	-	-	-	-	-	1	100.0
single curved line fragment of larger motif	1	10.0	-	-	1	100.0	-	-	-	-
Total	10	100.0	1	10.0	3	30.0	1	10.0	5	50.0

Table A.4 Unbounded incision design frequencies by decoration location, Site DJQ.

Design Description			Decoration Location							
			Shoulder/Above and/or Below Carination		Below Rim Zone 1/Zone 2		Below Lower Double Rim		Body/Top of Lip	
Simple Rectilinear Incision	Total	%	Total	%	Total	%	Total	%	Total	%
unidirectional - isolated	3	14.3	-	-	0/2	66.7	-	-	1/0	33.3
vertical - isolated/group	2	9.5	0/1	50.0	-	-	1	50.0	-	-
diagonal - group	4	19.1	-	-	1/0	25.0	1	25.0	1/1	50.0
opposed diagonals - group	4	19.1	-	-	2/0	50.0	-	-	2/0	50.0
long line with intersecting short lines	1	4.8	-	-	1/0	100.0	-	-	-	-
Diagonal and Curvilinear Incision										
cross-hatched diagonals	4	19.1	2/0	50.0	-	-	-	-	2/0	50.0
single line chevrons	2	9.5	0/1	50.0	1/0	50.0	-	-	-	-
intersecting crescents above and below horizontal line	1	4.8	-	-	-	-	-	-	1/0	100.0
Total	21	100.0	2/2	19.1	5/2	33.3	2	9.5	7/1	38.1

Table A.5 Unbounded incision design frequencies by decoration location, Site DES.

Design Description			Decoration Location											
			Lip Interior/ Top or Exterior		Below Rim - Zone 1/2 (I)Interior		Neck		Shoulder		Above Carination		Body	
Linear Applied Relief Strips	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
vertical strip(s)	25	12.9	0/1	4.0	7	28.0	4	16.0	10	40.0	1	4.0	2	8.0
vertical raised strips	3	1.5	-	-	3	100.0	-	-	-	-	-	-	-	-
horizontal strip(s)	30	15.5	14/11	83.3	2	6.7	1	3.3	-	-	-	-	2	6.7
diagonal strip(s)	18	9.3	-	-	66/1(I)	38.9	1	5.5	4	22.2	3	16.7	3	16.7
unknown orientation strip(s)	95	49.0	1/2	3.1	-	-	1	1.1	-	-	-	-	91	95.8
multidirectional strips	23	11.8	7/0	30.4	2/2(I)	17.4	-	-	3	13.0	-	-	9	39.1
Total (55.8% notched)	194	100.0	36	18.5	23	11.8	7	3.6	17	8.8	4	2.1	107	55.2
Curvilinear Relief Strips														
vertical strip(s)	2	11.8	0/1	50.0	1	50.0	-	-	-	-	-	-	-	-
horizontal strip(s)	5	29.4	0/4	80.0	-	-	-	-	-	-	-	-	1	20.0
diagonal strip(s)	1	5.9	0/1	100.0	-	-	-	-	-	-	-	-	-	-
unknown orientation strip(s)	9	52.9	-	-	-	-	-	-	-	-	-	-	9	100.0
Total	17	100.0	6	35.3	1	5.9	-	-	-	-	-	-	10	58.9

Table A.6 Linear and curvilinear applied relief strip design frequencies by decoration location, Site DAF.

Design Description			Decoration Location											
			(I) Inner Lip (O) Outer Lip (T) Transverse Bar (H) Handle		Below Rim - Zone 1/2 (I)Interior		Neck		Neck/Shoulder Angle		Above Carination/ Carination Angle		Body	
Nubbins	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
isolated single	16	36.4	(O)2 (H)1	18.7	1	6.3	1	6.3	6	37.5	0/1	6.3	4	25.0
single - part of row?	11	25.0	(I)3	27.3	1/(I)1	18.2	1	9.1	-	-	-	-	5	45.4
horizontal row	10	22.7	(I)1 (H)1	20.0	4	40.0	1	10.0	2	20.0	1	10.0	-	-
'nubbin' row formed by deep notching	4	9.1	(T)1	25.0	-	-	-	-	-	-	-	-	3	75.0
nubbins connected by vertical relief bar (VB 2.1 Mead) - horizontal row	1	2.3	-	-	-	-	-	-	-	-	1	100.0	-	-
applied disc (1 detached)	2	4.6	-	-	1	50.0	-	-	-	-	-	-	-	-
Total	44	100.0	9	20.5	8	18.2	3	6.8	8	18.2	3	6.8	12	27.3
Transverse Bar														
applied relief bar	17	89.5	-	-	3	17.6	-	-	-	-	1	5.9	12	70.6
structural bar	2	10.5	-	-	2	100.0	-	-	-	-	-	-	-	-
Total	19	100.0	-	-	5	26.3	-	-	-	-	1	5.3	12	63.2

Table A.7 Nubbin and other applied relief frequencies by decoration location, Site DAF.

Design Description			Decoration Location									
			Top of Everted Lip - Zone F		Below Rim - Zone 1/ Zone 1 and 2		Neck		Neck/Shoulder Angle		Body	
Nubbins	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
single - part of row?	6	24.0	4	66.7	-	-	2	33.3	-	-	-	-
vertical row(s)	2	8.0	-	-	1/0	50.0	-	-	-	-	1	50.0
horizontal row	15	60.0	6	40.0	4/0	26.7	-	-	4	26.7	1	6.7
nubbins connected by vertical bar (VB 2.1 in Mead) - horizontal row	2	8.0	2	100.0	-	-	-	-	-	-	-	-
Total	25	100.0	12	48.0	5/0	20.0	2	8.0	4	16.0	2	8.0
Transverse Bar												
applied relief bar on carination angle	1	100.0	-	-	-	-	-	-	-	-	1	100.0
Linear Relief Strips												
vertical strip(s)	2	100.0	-	-	1/1	100.0	-	-	-	-	-	-
Curvilinear Relief Strips												
diagonal strip(s)	2	100.0	-	-	-	-	-	-	-	-	2	100.0

Table A.8 Frequencies of applied relief nubbins, strips and transverse bars by decoration location, Site DJQ.

Design Description			Decoration Location							
			Below Rim - Zone 1/Zone 2		Carination Angle		Neck/Shoulder Angle		Body	
Nubbins	Total	%	Total	%	Total	%	Total	%	Total	%
single	1	11.1	(I)1/0	100.0	-	-	-	-	-	-
single - part of row?	5	55.6	-	-	-	-	4	80.0	1	20.0
horizontal row	3	33.3	1/0	33.3	-	-	2	66.7	-	-
Total	9	100.0	2/0	22.2	-	-	6	66.7	1	11.1
Transverse Bar										
applied relief bar	5	100.0	0/1	20.0	4	80.0	-	-	-	-
Linear Relief Strips										
vertical strip(s)	1	10.0	1/0	100.0	-	-	-	-	-	-
horizontal strip(s) (1 notched)	3	30.0	2/0	66.7	-	-	-	-	1	33.3
strip(s) - unknown orientation (1 notched)	6	60.0	-	-	-	-	-	-	6	100.0

Table A.9 Frequencies of applied relief nubbins, strips and transverse bars by decoration location, Site DES.

Design Description			Decoration Location									
			Lip Edge (Outer and/or Inner)		Top of Lip		Edge(s) and Top of Lip		Lip and Transverse-Bar/Lower Double Rim		Transverse Bar or Lower Double Rim	
Row(s) of Impressions	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
wide impressions	240	14.3	118	49.2	109	45.4	2	0.8	1	0.4	10	4.2
wide impressions with lipping along margins	8	0.5	-	-	-	-	-	-	-	-	8	100.0
wide paddle impressions on wide lip rim	175	10.5	27	15.4	148	84.6	-	-	-	-	-	-
scalloping produced with paddle-like object	705	42.1	642	91.1	63	8.9	-	-	-	-	-	-
narrow impressions	380	22.7	266	70.0	105	27.6	2	0.5	2	0.5	5	1.3
very narrow incision-like fingernail impressions	13	0.8	8	61.5	5	38.5	-	-	-	-	-	-
pairs of opposing fingernail impressions	18	1.1	13	72.2	2	11.1	-	-	1	5.6	2	11.1
'Scalloped' Rims												
discrete impressions	59	3.5	59	100.0	-	-	-	-	-	-	-	-
continuous impressions	67	4.0	66	98.5	1	1.5	-	-	-	-	-	-
continuous impression displacing opposite surface - wavy appearance	9	0.5	9	100.0	-	-	-	-	-	-	-	-
Total	1674	100.0	1208	72.2	433	25.9	4	0.2	4	0.2	25	1.5

Table A.10 Lip impression frequencies by decoration location, Site DAF.

Design Description			Decoration Location							
			Below Rim - Zone 1/ Zone 1 and Lip		Neck (N) Shoulder (S)		Carination Angle/ Carination and Lip		Body/Handle	
Horizontal Row(s) of Impressions	Total	%	Total	%	Total	%	Total	%	Total	%
vertical narrow fingernail crescents	15	16.1	7/0	46.7	1(N)	6.6	7/0	46.7	--	--
narrow impressions	4	4.3	2/0	50.0	--	--	2/0	50.0	--	--
wide impressions	52	55.9	14/2	30.8	3 (N+S)	5.8	20/7	51.9	5/1	11.5
wide impressions with lipping along margins	19	20.4	1/0	5.3	--	--	18/0	94.7	--	--
multiple rows of single or paired impressions	3	3.2	--	--	2(S)	66.7	--	--	1/0	33.3
Total	93	100.0	24/2	27.9	6	6.5	47/7	58.1	6/1	7.5

Table A.11 Frequencies of impressions below rim by decoration location, Site DAF.

Design Description			Decoration Location							
			Lip Edge (Outer or Inner)		Top of Lip		Lower Double Rim		(Z) Zone 1 (C) Above Carination (B) Body	
Row(s) of Impressions	Total	%	Total	%	Total	%	Total	%	Total	%
wide impressions	7	9.3	1	14.3	5	71.4	-	-	(C) 1	14.3
wide impressions with lipping along margins-horizontal row	1	1.3	-	-	-	-	-	-	(B) 1	100.0
scalloping produced with paddle-like object	7	9.3	3	42.8	4	57.2	-	-	-	-
narrow impressions	41	54.7	19	46.3	21	51.2	1	2.4	-	-
narrow fingernail crescents - single or paired	1	1.3	-	-	-	-	-	-	(Z) 1	100.0
'Scalloped' Rims										
discrete impressions	2	2.7	2	100.0	-	-	-	-	-	-
continuous impressions	2	2.7	2	100.0	-	-	-	-	-	-
continuous impressions displacing opposite surface - wavy appearance	14	18.7	12	85.7	2	14.3	-	-	-	-
Total	75	100.0	39	52.0	32	42.7	1	1.3	3	4.0

Table A.12 Impression frequencies by decoration location, Site DJQ.

Design Description			Decoration Location											
			Lip Edge (Outer and/or Inner)		Top of Lip/ Top and Edge of Lip		Transverse bar or Lower Double Rim Lip		Carination Angle/ Above Carination		Exterior Zone 2/ Body		Handle	
Row(s) of Impressions	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
wide impressions	12	7.0	3	25.0	2/0	16.7	3	25.0	3/1	33.3	-	-	-	-
wide impressions with lipping along margins	4	2.3	-	-	-	-	1	25.0	3/0	75.0	-	-	-	-
scalloping produced with paddle-like object	14	8.1	11	78.6	3/0	21.4	-	-	-	-	-	-	-	-
narrow impressions (1 incision-like)	116	67.4	60	51.7	27/2	25.0	22	18.9	-	-	1/0	1.0	4	3.4
single or multiple isolated impressions	1	0.6	-	-	-	-	-	-	-	-	1/0	100.0	-	-
pairs of opposing fingernail impressions	3	1.7	3	100.0	-	-	-	-	-	-	-	-	-	-
multiple rows of single or paired impressions	2	1.2	-	-	-	-	-	-	0/1	50.0	0/1	50.0	-	-
'Scalloped' Rims														
discrete impressions	7	4.1	7	100.0	-	-	-	-	-	-	-	-	-	-
continuous impressions	6	3.5	5	83.3	1/0	16.7	-	-	-	-	-	-	-	-
continuous impressions displacing opposite surface - wavy appearance	7	4.1	7	100.0	-	-	-	-	-	-	-	-	-	-
Total	172	100.0	96	55.8	33/2	20.3	26	15.1	6/2	4.7	2/1	1.8	4	2.3

Table A.13 Impression frequencies by decoration location, Site DES.

Decoration Description			Decoration Location											
			Top of Lip		Inner Lip/Outer Lip		Below Lip Zone 1/2		Transverse Bar/ Handle		Carination Angle		Body	
Punctation	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
single shallow drilled depression	2	22.2	-	-	-	-	-	-	-	-	-	-	2 (disc)	100.0
shallow irregular band	2	11.1	1	100.0	-	-	1	100.0	-	-	-	-	-	-
single row	2	22.2	1	50.0	-	-	-	-	1/0	50.0	-	-	-	-
deep row alternating with perforations	1	11.1	1	100.0	-	-	-	-	-	-	-	-	-	-
deep double row	2	22.2	2	100.0	-	-	-	-	-	-	-	-	-	-
Total	9	100.0	5	55.6	-	-	1	11.1	1/0	11.1	-	-	2	22.2
Perforation														
single drilled suspension hole	2	9.5	-	-	1	50.0	1	50.0	-	-	-	-	-	-
single (part of row)	5	23.8	4	80.0	1	20.0	-	-	-	-	-	-	-	-
horizontal row - closely spaced	5	23.8	-	-	4	80.0	1	20.0	-	-	-	-	-	-
horizontal row - widely spaced	5	23.8	3	60.0	1	20.0	1	20.0	-	-	-	-	-	-
parallel rows on handle	3	14.3	-	-	-	-	-	-	0/3	100.0	-	-	-	-
dispersed/random holes on restricted jar	1	4.8	-	-	-	-	1	100.0	-	-	-	-	-	-
Total	21	100.0	7	33.3	7/0	33.3	4	19.1	0/3	14.3	-	-	-	-
Carving/Notching-Single Row														
deep carved triangles (DE 8.1 in Mead)	2	10.5	2	100.0	-	-	-	-	-	-	-	-	-	-
V-shaped cut notch	15	79.0	6	40.0	1/6	47.0	-	-	1/0	6.7	1	6.7	-	-
U-shaped deep impressed notch	2	10.5	-	-	1	50.0	-	-	-	-	1	50.0	-	-
Total	19	100.0	8	42.1	2/6	42.1	-	-	1/0	5.3	2	10.5	-	-

Table A.14 Punctation, carving and perforation design frequencies by decoration location, Site DAF.

Decoration Description			Decoration Location							
			Top of Everted Lip (Zone F)		Top of Lip/Outer Lip		Below Rim Zone 1		Body	
Punctation	Total	%	Total	%	Total	%	Total	%	Total	%
shallow depressions - single row	1	100.0	-	-	1	100.0	-	-	-	-
Perforation										
single drilled suspension hole	1	5.6	-	-	-	-	1	100.0	-	-
single (part of row)	7	38.9	6	85.7	-	-	1	14.3	-	-
horizontal row - closely spaced	3	16.7	3	100.0	-	-	-	-	-	-
horizontal row - widely spaced	1	5.6	1	100.0	-	-	-	-	-	-
single pair	6	33.3	5	83.3	-	-	1	16.7	-	-
Total	18	100.0	15	83.3	-	-	3	16.7	-	-
Carving/Notching-Single Row										
shallow carved triangles	1	5.3	1	100.0	-	-	-	-	-	-
shallow V-shaped notch	6	31.6	-	-	4/2 (1+lower double rim)	100.0	-	-	-	-
deep V-shaped notch	12	63.2	-	-	11/1 (2+lower double rim)	100.0	-	-	-	-
Total	19	100.0	1	5.3	15/3	94.7	-	-	-	-

Table A.15 Punctation, carving and perforation frequencies by decoration location, Site DJQ.

Design Description			Decoration Location							
			Top of Lip/ Lower Double Rim		Below Rim - Zone 1		Neck/Neck - Shoulder Angle		Body/Handle	
Punctation	Total	%	Total	%	Total	%	Total	%	Total	%
deep impression forming 'boss' on interior surface	2	100.0	-	-	1	50.0	-	-	1/0	50.0
Perforation										
single drilled suspension hole	1	3.6	-	-	1	100.0	-	-	-	-
single (part of row)	6	21.4	3/0	50.0	1	16.7	0/1	16.7	1/0	16.7
horizontal row - closely spaced	11	39.3	7/0	63.6	4	36.4	-	-	-	-
2 parallel rows	5	17.9	-	-	-	-	-	-	0/5	100.0
single pair	4	14.3	-	-	-	-	1/0	25.0	0/3	75.0
3 perforations in the form of a triangle	1	3.6	-	-	-	-	-	-	0/1	100.0
Total	28	100.0	10/0	35.7	6	21.4	1/1	7.1	1/9	35.7
Carving/Notching - Single Row										
deep excised triangles above base angle (DE 8.3 in Mead)	1	7.7	-	-	-	-	-	-	1/0	100.0
shallow V-shaped notch	2	15.4	2/0	100.0	-	-	-	-	-	-
deep V-shaped notch	10	76.9	4/5 +1 top & double	100.0	-	-	-	-	-	-
Total	13	100.0	6/5 +1 top & double	92.3	-	-	-	-	1/0	7.7

Table A.16 Punctation, carving and perforation frequencies by decoration location, Site DES.

	Motif No.				Decoration Location									
					Below Rim - Zone 1/Zone 2		Neck		Shoulder/ Neck and Shoulder		Above Carination		Body	
Fine Line Bounded Incision	Donovan	Anson	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
diagonals with no boundary line	76.1	435	26	47.3	9/0	34.6	5	19.2	1/0	3.8	1	3.8	10	38.5
diagonals with horizontal boundary line	76.1	435	13	23.6	2/1	23.1	1	7.7	1/0	7.7	-	-	8	61.5
opposed groups of diagonals	16.8	161	1	1.8	1/0	100.0	-	-	-	-	-	-	-	-
intersecting diagonals forming triangles	80.1	463	1	1.8	-	-	-	-	-	-	-	-	1	100.0
multidirectional connecting groups of diagonals	18.3/ 18.4	187/188	7 (D)1	14.6	3/0	37.5	1	12.5	1/0	12.5	-	-	3	37.5
unidirectional diagonals with diagonal boundary line	18 frag.?	-	3	5.5	-	-	1	33.3	-	-	-	-	2	66.7
multidirectional and unidirectional diagonals	76.1 +18.3/4	435 +187/8	2	3.6	-	-	-	-	0/2	100.0	-	-	-	-
multidirectional connecting diagonals with vertical and horizontal boundary lines	57.3? frag.	370?	1	1.8	1/0	100.0	-	-	-	-	-	-	-	-
Total			55	100.0	16/1	30.9	8	14.6	3/2	9.1	1	1.8	24	43.6

Table A.17 Bounded incision motif frequencies by decoration location, Site DAF. (Code: (D) - dentate stamped)

	Motif No.				Decoration Location: Below Rim - Zone 1/ Zone 1 and 2		Neck		Neck and Shoulder Angle		Shoulder/Above and Below Carination		Body	
Fine Line Bounded Incision or Dentate Stamping (D)	Donovan	Anson	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
diagonals with no boundary line	76.1	435	5	9.4	--	--	--	--	--	--	--	--	5	100.0
diagonals with horizontal boundary line	76.1	435	18 (D)1	35.8	3/0 1E&I	15.8	6	33.3	2	11.1	1/1	11.1	6	33.3
opposed groups of diagonals	16.8	161	1	1.9	--	--	1	100.0	--	--	--	--	--	--
intersecting diagonals forming triangles	80.1	463	1	1.9	--	--	--	--	1	100.0	--	--	--	--
multidirectional connecting groups of diagonals	18.3/4	187/8	14 (D)1	30.2	4/1	31.3	8	50.0	--	--	1/0	6.2	2	12.5
unidirectional diagonals with diagonal boundary line	18 frag.?	--	4 (D)1	9.4	--	--	3	60.0	1	20.0	--	--	1	20.0
multidirectional and unidirectional diagonals	76.1 + 18.3/4	435 + 187/8	2	3.8	0/1	50.0	--	--	1	50.0	--	--	--	--
multidirectional connecting pairs of diagonals	18(2).9	192	(D)2	1.9	0/1	100.0	--	--	--	--	--	--	--	--
opposed unidirectional diagonals with vertical boundary lines	75.1 frag.?	433	1	1.9	--	--	--	--	--	--	--	--	1	100.0
multidirectional connecting diagonals with horizontal and vertical boundary lines	57.3	370	2	3.8	0/1	50.0	1	50.0	--	--	--	--	--	--
Total			48 (D)5	90.6 9.4	7/4	20.8	19	35.8	5	9.4	2/1	5.7	15	28.3

Table A.18 Bounded incision or dentate-stamped motif frequencies by decoration location, Site DJQ.

	Motif No.				Decoration Location: Below Rim - Zone 1/ Zone 1 and 2		Neck		Body	
Bounded Incision	Donovan	Anson	Total	%	Total	%	Total	%	Total	%
diagonals with no boundary line - motif fragments	motif fragments	motif fragments	6	75.0	2/1	50.0	2	33.3	1	16.7
opposed unidirectional diagonals with vertical boundary line	75.1 frag.?	433?	1	12.5	-	-	1	100.0	-	-
multidirectional connecting diagonals with horizontal and vertical boundary lines	75.1 frag.?	433?	1	12.5	0/1	100.0	-	-	-	-
Total			8	100.0	2/2	50.0	3	37.5	1	12.5

Table A.19 Bounded incision motif frequencies by decoration location, Site DES.

Zone Marker Type	GZ # ( ) Total	Total Dentate/ Incised	%	Decoration Location: Exterior Zone 1/ Zone 2 Total	%	Interior Zone 1/ Zone 2 Total	%	Exterior + Interior Zone 1/ Zone 1 and 2 Total	%	Neck/Above Carination Total	%	Body Total	%
RZ 1 - multiple, transverse	#2 (2)	3/0	6.3	-	-	0/1	33.3	-	-	1/1	66.7	-	-
RZ 3 - multiple, diamond	#2 (8/2) #3 (1)	11/1	25.0	0/2	16.7	1/1	16.7	1/2	33.3	0/1	8.3	4	33.3
RZ 4 - loosely superimposed single crescents (includes M3.1/35(Anson))	#2 (3/1)	6/0	12.5	1/2	50.0	-	-	0/1	16.7	1/0	16.7	1	16.7
RZ 4 - tightly superimposed single crescents	#1 (1) #2 (3) #3 (1)	6/2	16.6	1/0	12.5	0/1	12.5	0/3	15.0	-	-	3	37.5
multiple rows of RZ 4	#2 (1)	1/0	2.1	-	-	-	-	-	-	1/0	100.0	-	-
RZ 3 or RZ 4 ?	#2 (8/1)	10/0	20.8	2/1	30.0	0/1	10.0	1/1	20.0	1/1	20.0	2	20.0
RZ 3 and RZ 4	#2 (1/1) #3 (1)	3/0	6.3	0/1	33.3	-	-	0/2	66.7	-	-	-	-
RZ 5 - single row, oblique	#2 (1)	4/1	10.4	2/0	40.0	1/2	60.0	-	-	-	-	-	-
Total		44/4	100.0	6/6	25.0	2/6	16.7	2/9	22.9	4/3	14.6	10	20.8

Table A.20 Restricted zone marker frequencies by decoration location, Site DAF.

				Decoration Location									
				Exterior Zone 1/ Zone 2		Interior Zone 1/ Zone 2		Exterior + Interior Zone 1/Zone 2		Neck/Above or Above and Below Carination		Body/Top of Lip (only 1)	
Zone Marker Type	GZ #	Total Dentate	%	Total	%	Total	%	Total	%	Total	%	Total	%
RZ 1 - multiple, transverse long lines		1	1.3	-	-	-	-	-	-	-	-	1 lip	100.0
RZ 3 - multiple, diamond	#1 (1) #2 (13/1)	17	22.7	2/4	35.3	1/1	11.8	0/3	17.6	1/1	11.8	4	23.5
RZ 4 - loosely superimposed single crescents (includes M3.1/35(Anson))	#2 (4)	4	5.3	2/0	50.0	-	-	-	-	1/1	50.0	-	-
RZ 4 - tightly superimposed single crescents	#2 (7)	9	12.0	2/2	44.5	1/1	22.2	-	-	1/0	11.1	2	22.2
RZ 3 or RZ 4 ?	#2 (14/1)	28	37.3	6/3	32.1	0/4	14.3	1/3	14.3	2/3	17.9	6	21.4
RZ 3 and RZ 4	#2 (1)	1	1.3	-	-	-	-	0/1	100.0	-	-	-	-
RZ 5 - single row, oblique	#2 (2/2)	9	12.0	1/1	22.2	1/1	22.2	0/2	22.2	1/1	22.2	1	11.1
RZ 5 variant-oblique S-shaped lines		2	2.7	-	-	-	-	-	-	-	-	2	100.0
RZ 5 and RZ 3 or 4	#2 (3)	4	5.3	-	-	-	-	0/4	100.0	-	-	-	-
Total	#1 (1) #2 (44/4)	75	100.0	13/10	30.7	3/7	13.3	1/13	18.7	6/6	16.0	16	21.3

Table A.21 Restricted zone marker frequencies by decoration location, Site DJQ.

				Decoration Location							
				Exterior Zone 1/ Zone 2		Interior Zone 1/ Zone 2		Neck/Above Carination		Body	
Restricted Zone Marker Type	GZ #	Total Dentate	%	Total	%	Total	%	Total	%	Total	%
RZ 3 - multiple, diamond	#2 (1/1)	3	27.3	-	-	0/1	33.3	1/0	33.3	1 above base	33.3
RZ 4 - loosely superimposed single crescents (includes M3.1/35 (Anson))	#2 (1)	3	27.3	2/1	100.0	-	-	-	-	-	-
RZ 5 - single row, oblique	#2 (0/1)	4	36.4	1 Z1&2	25.0	2/0	50.0	0/1	25.0	-	-
RZ 5 variant- single row, intersecting s-shaped oblique lines		1	9.1	-	-	-	-	-	-	1	100.0
Total	#2 (2/2)	11	100.0	2/2	36.4	2/1	27.3	1/1	18.2	2	18.2
Horizontal and Vertical Crescents (DE1)											
joined paired crescents M1(2).1/2 (Anson)	#2 (3/1)	5	71.4	0/1	20.0	3/0	60.0	-	-	1	20.0
joined paired vertical crescents with DE3 in centre M64(2).3/394 (Anson)		1	14.3	-	-	-	-	-	-	1	100.0
row of grouped single crescents connected at alternating ends M28.5/260 (Anson)		1	14.3	1 Z1&2	100.0	-	-	-	-	-	-
Total	#2(3/1)	7	100.0	0/2	28.6	3/0	42.8	-	-	2	28.6

Table A.22 Restricted zone marker and crescent motif frequencies by decoration location, Site DES.

Motif/Design Element Description					Decoration Location					
					Exterior Zone 1/Zone 2		Interior Zone 1/Zone 2		Body/Neck (only 1)	
	GZ No. ( ) Total	Motif No. Donovan/ Anson	Total Dentate/ Incised	%	Total	%	Total	%	Total	%
Circular Stamp (DE 3.1)										
single horizontal row - DE3-Mead	#1 (3) #2 (0/1)	69/421	4	100.0	0/1	25.0	-	-	3	75.0
Horizontal Crescents (DE1)										
discrete single crescents	#2 (1)	1.6/6	2/1	14.3	-	-	1/0	33.3	2	66.7
discrete paired crescents	#2 (0/1)	1(2).6 Alloform New B1	1/0	4.8	-	-	1/0	100.0	-	-
joined paired crescents/1 incised wavy pair - B2	#1 (1) #2 (8)	1(2).1/2 New B2	11/1	52.4	1/0	9.1	6/2	72.7	2	18.2
multiple rows of joined paired crescents	#2 (1/1)	1.4 or .5/5 horizontal?	3/0	14.3	-	-	1/1	66.7	1	33.3
joined paired crescents with internal DE3 or perforation	#2 (1)	62(2).6/ 390	1/0	4.8	1/0	100.0	-	-	-	-
joined paired crescents with DE3 between crescent	#2 (1)	62(2).2/ 387	1/0	4.8	-	-	-	-	1	100.0
joined triple crescents with DE3 between and offset crescent row below		2(2).4 Alloform New B3	1/0	4.8	-	-	-	-	1	100.0
Total	#1 (1) #2 (13/2)	-	19/2	100.0	2/0	9.5	9/3	57.2	7	33.3
Opposed Crescents (DE4)										
joined single crescents with DE3 in centre		5.6/44	2/0	40.0	1/0	50.0	-	-	1 (neck)	50.0
joined paired crescents with DE3 in centre	#2 (1)	5(2).6/45	1/0	20.0	-	-	-	-	1	100.0
row of vertical single crescents with DE3 in centre		64.3/399?	1/0	20.0	-	-	-	-	1	100.0
Total	#2 (1)	-	4/0	100.0	1/0	25.0	-	-	2/1	75.0

Table A.23 Circular stamp and horizontal crescent motif frequencies by decoration location, Site DAF.

Motif/Design Element Description					Decoration Location							
					Exterior Zone 1/2		Interior Zone 1/2		(N) Neck (S) Shoulder (A) Above Carination		Body/Top of Everted Rim	
	Motif No. Donovan/ Anson	GZ No. ( ) Total	Total Dentate/ Incised	%								
Circular Stamp DE 3.1					Total	%	Total	%	Total	%	Total	%
single or multiple stamps	DE3	#2 (1/1)	6	31.6	1/0	16.7	2/0	33.3	(A)1	16.7	2	33.3
single horizontal row	69.2/421	#1 (5) #2 (0/3)	13	68.4	1/4	38.5	-	-	(N)2	15.4	5/1	46.1
Horizontal Crescents (DE1)												
discrete paired crescents	1(2).6 Alloform-B1	#2 (1)	1	2.5	0/1	100.0	-	-	-	-	-	-
joined paired crescents/1 incised pair - B1	1(2).1/2 New B1	#1 (1) #2 (18/4)	26/1	67.5	3/1	14.8	16/4	74.1	(S)1	3.7	2/0	7.4
multiple (up to 6) rows of joined paired crescents	1.4 or 5/5 horiz.?	#1 (1) #2 (1)	7	17.5	-	-	1/0	14.3	(N)2	28.6	3/1	57.1
joined paired crescents with internal DE3 or perforation	62(2).6/ 390	#2 (3)	3	7.5	1/0	33.3	2/0	66.7	-	-	-	-
joined paired crescents with DE3 between crescent and offset crescent row below	2(2).4/ 25	#2 (1)	1	2.5	-	-	-	-	(A)1	100.0	-	-
joined paired crescents with M19.1 triangle between	19.5/196	#2 (0/1)	1	2.5	-	-	-	-	-	-	1/0	100.0
Total		#1 (2) #2 (23/5)	39/1	100.0	4/2	15.0	19/4	57.5	4	10.0	6/1	17.5
Opposed Crescents (DE4)												
joined single crescents	5.1/37		1	25.0	-	-	1/0	100.0	-	-	-	-
joined single crescents with DE3 in centre	5.6/44	#2 (1)	1	25.0	-	-	1/0	100.0	-	-	-	-
joined paired crescents with DE3 in centre	5(2).6/45	#2 (1)	1	25.0	1/0	100.0	-	-	-	-	-	-
vertical paired crescents with DE3 in centre	64(2).3/394		1	25.0	-	-	-	-	-	-	1/0	100.0
Total		#2 (2)	4	100.0	1/0	25.0	2/0	50.0	-	-	1/0	25.0

Table A.24 Circular stamp and horizontal crescent motif frequencies by decoration location, Site DJQ.

Motif Descriptions					Decoration Location					
					Exterior Zone 1/Zone 2		Zone F/Interior Zone 1		Body/Above Carination	
Vertical Crescents (DE1)	Motif No. Donovan/ Anson	GZ No. ( ) Total	Total Dentate/ Incised	%	Total	%	Total	%	Total	%
row of single crescents-DE 1.1 in Mead	99.1/497	#1 (1) #2 (1)	3/0	75.0	0/2	66.7	1/0	33.3	-	-
row of paired crescents (DE14) with DE3 at end	76(2).2/ 437 Alloform New B6	#2 (1)	1/0 untoothed	25.0	-	-	-	-	1/0	100.0
Total		#1 (1) #2 (2)	4/0	100.0	0/2	50.0	1/0	25.0	1/0	25.0
Vertical Crescents with Vertical Lines - New Motifs										
group of single lines next to group of single crescents (DE1.1 and DE5)	77.1+99.1 New B7	#2 (1)	2/0	50.0	0/1	50.0	1/0	50.0	-	-
group of paired lines next to group of paired crescents (DE1.2 and DE5)	77(2).1 + 99(2).1 New B8		1/0	25.0	-	-	1/0	100.0	-	-
pair of vertical lines with crescent group on each side	142 (Anson) Alloform New B9		1/0	25.0	-	-	1/0	100.0	-	-
Total		#2 (1)	4/0	100.0	0/1	25.0	3/0	75.0	-	-
Vertical Lines (DE5)										
row of single lines	77.1/448		4/0	40.0	1/0	25.0	2/1	75.0	-	-
widely spaced groups of single lines	77.4/444	#5 (1)	3/0	30.0	1/0	33.3	1/0	33.3	0/1	33.3
row of paired lines	77(2).1/441	#1 (2)	2/0	20.0	-	-	-	-	2/0	100.0
row of grouped single lines associated with perforations	77.4/444?		1/0	10.0	1/0	100.0	-	-	-	-
Total		#1 (2) #5 (1)	10/0	100.0	3/0	30.0	3/1	40.0	2/1	30.0

Table A.25 Vertical crescent and/or vertical line motif frequencies by decoration location, Site DAF.

Motif Description					Decoration Location							
					Zone F		Exterior Zone 1/Zone 2		Above and/or Below Carination		Body/Neck (only 1)	
Vertical Crescents (DE1)	Motif No. Donovan/Anson	GZ No. ( ) Total	Total Dentate/ Incised	%	Total	%	Total	%	Total	%	Total	%
row of single crescents - DE 1.1 in Mead	99.1/497	#1 (1)	3/1	50.0	2	50.0	-	-	-	-	2	50.0
intersecting crescents	99.2/499	#2 (1)	0/1	12.5	-	-	1/0	100.0	-	-	-	-
2 joined paired crescents - DE 2.2 in Mead	65.1/16	#3 (1)	1/1	25.0	-	-	1/0	50.0	1	50.0	-	-
row of connected single crescents (DE 2.3)	none/15	#2 (1)	1/0	12.5	-	-	0/1	100.0	-	-	-	-
Total			5/3	100.0	2	25.0	2/1	37.5	1	12.5	2	25.0
Vertical Crescents with Vertical Lines												
group of single lines next to group of single crescents (DE1.1 and DE5)	77.1+99.1 Donovan New B7	#2 (1)	1/0	50.0	-	-	-	-	1	100.0	-	-
group of paired lines next to group of paired crescents (DE1.2 and DE5)	77(2).1 + 99(2).1 New B8		1/0	50.0	1	100.0	-	-	-	-	-	-
Total			2/0	100.0	1	50.0	-	-	1	50.0	-	-
Vertical Lines (DE5)												
row of single lines	77.1(I)/448	#2 (1)	4/0	30.8	1	25.0	3/0 1E+I	75.0	-	-	-	-
groups of single lines at regular intervals	77.4/444		3/0	23.1	-	-	3/0	100.0	-	-	-	-
row of paired lines	77(2).1/441	#1 (1) #2 (2)	6/0	46.1	2	33.3	1/0	16.7	1	16.7	1/1	33.3
Total		#1 (1) #2 (3)	13/0	100.0	3	23.1	7/0	53.8	1	7.6	1/1	15.4

Table A.26 Vertical crescent and/or vertical line motif frequencies by decoration location, Site DJQ.

Motif Description					Decoration Location							
					Exterior Zone 1/Zone 2		Zone F/Interior Zone 1-2		Above Carination/ Carination Angle		Body	
Oblique Lines (DE6)	Motif No. Donovan/Anson	GZ No. ( ) Total	Total Dentate/ Incised	%	Total	%	Total	%	Total	%	Total	%
row of single lines	76.1(I)/435		1/0	11.1	-	-	-	-	1/0	-	-	-
row of paired lines	76(2).1/436	#2 (2)	2/0	22.2	-	-	0/1	50.0	-	-	1	50.0
single or paired lines (fragments of larger motifs)		#2 (2)	5/0/1 D+I	66.7	1/1	33.3	1/1	33.3	1/0	16.7	1	16.7
Total		#2 (4)	8/0/1 D+I	100.0	1/1	22.2	1/2	33.3	2/0	22.2	2	22.2
Intersecting Oblique Lines (DE16)												
oblique lines joined to form apex of a triangle	19.1/206 & 207	#2 (1)	1/0		-	-	1/0	100.0	-	-	-	-
row of paired opposing lines forming triangular pattern	16.6/160	#3 (1)	0/1		1/0	100.0	0/1	100.0	-	-	-	-
single line equilateral triangle(s)	16.9/162	#1 (1) #2 (1)	2/0		1 Z1+2	50.0	-	-	-	-	1	50.0
single line Xs separated by vertical line	45.1(I)/323	#2 (0/1)	1/0		-	-	-	-	-	-	1	100.0
row of intersecting paired Xs	30.6/279	#5 (0/1)	0/1		-	-	-	-	0/1	100.0	-	-
loosely intersecting paired lines forming rough triangle	Alloform New B5 80(2).2(I)/464 ?	#2 (1)	1/1 D+I		0/1	50.0	0/1	50.0	-	-	-	-
Total		#1 (1) #2 (3/1) #3 (1) #5 (0/1)	5/2 1 D+I	100.0	1/1/1	37.5	1/2	37.5	0/1	12.5	2	25.0

Table A.27 Oblique and intersecting oblique line motif frequencies by decoration location, Site DAF.

Motif Description	Motif No. Donovan/Anson	GZ No. ( ) Total	Total Dentate/ Incised	%	Exterior Zone 1/Zone 2 Total	%	Zone F/ Interior Zone 1 or 2 Total	%	(N) Neck (S) Shoulder/ Above Carination Total	%	Body Total	%
Oblique Lines (DE6)												
row of single lines	76.1(I)/435	#2 (1/2)	5/0	14.3	4/1	100.0	-	-	-	-	-	-
row of paired lines	76(2).1/436	#1 (1) #2 (6/2)	14/0	40.0	2/2	28.6	3/3 (2-Z2)	42.8	(S)1/1	14.3	2	14.3
row of single lines and row of paired lines	76.1 + 76(2).1	#2 (1)	1/0	2.8	1 E+I	100.0	-	-	-	-	-	-
single or paired lines (fragments of larger motifs)		#2 (2)	11/4	42.9	2/2 (1E+I)	33.3	1/0	6.7	(S)1/0	6.7	8	53.3
Total		#1 (1) #2 (10/4)	31/4	100.0	8/5 +2 E+I	42.8	4/3	20.0	2/1	8.6	10	28.6
Intersecting Oblique Lines (DE 16)												
oblique lines joined to form apex of a triangle	19.1/206		1/0	16.7	-	-	1/0	100.0	-	-	-	-
vertical oblique paired lines forming zig-zag pattern	29(2).2 or 3/271 or274		1/0	16.7	-	-	-	-	-	-	1	100.0
loosely intersecting single lines forming rough triangle	80.2/464	#3 (1)	0/1	16.7	-	-	-	-	(N)1/0	100.0	-	-
single oblique line intersecting paired oblique lines	18.8(I)/191?	#3 (1)	0/1	16.7	-	-	-	-	(N)1/0	100.0	-	-
single line Xs separated by single vertical lines with crescents above and below	83.6/470		1/0	16.7	-	-	-	-	-	-	1	100.0
paired oblique lines forming diamond pattern	24/-Allo.? New B4	#2 (0/1)	1/0	16.7	-	-	-	-	-	-	1	100.0
Total		#2 (0/1) #3 (2)	4/2	100.0	-	-	1/0	16.7	(N)2/0	33.3	3	50.0

Table A.28 Simple and intersecting oblique line motif frequencies by decoration location, Site DJQ.

Motif Description					Decoration Location							
					Exterior Zone 2/ Interior Zone 1		Neck		Above Carination		Body	
Vertical Lines (DE5)	Motif No. Donovan/Anson	GZ No. ( ) Total	Total Dentate/ Incised	%	Total	%	Total	%	Total	%	Total	%
row of triple line groups	77.4/442?	#2 (1)	1/0	10.0	-	-	-	-	1	100.0	-	-
row of paired lines	77(2).1/441	#2 (1)	1/1	20.0	-	-	-	-	2	100.0	-	-
Oblique Lines (DE6)												
row of single oblique lines	76.1/435	#2 (1)	3/1	40.0	-	-	1/1	50.0	2	50.0	-	-
row of opposed paired oblique lines with excised triangles between	16.6/159? DE6+DE8.3		0/1	10.0	-	-	-	-	-	-	1/0 Above base	100.0
Intersecting Oblique Lines (DE16)												
row of single line intersecting Xs	24.1/231	#2 (0/1)	1/0	10.0	-	-	-	-	-	-	0/1	100.0
loosely connecting single and paired opposed lines forming rough triangles	18.8/191?	#2 (1)	1/0	10.0	1	100.0	-	-	-	-	-	-
Total		#2 (4/1)	7/3	100.0	1	10.0	1/1	20.0	5	50.0	1/1	20.0

Table A.29 Vertical, oblique and intersecting oblique line motif frequencies by decoration location, Site DES.

Motif Description					Decoration Location					
					Zone 1		Zone 2		Body/Above Carination	
New Curvilinear Motifs (B10-B11)	Motif No. Donovan/Anson	GZ No. ( ) Total	Total Dentate	%	Total	%	Total	%	Total	%
concentric curvilinear paired lines	B10 fragment	#1 (1)	1	9.1	-	-	-	-	1/0	100.0
intersecting curvilinear paired lines	B10 fragment		1	9.1	-	-	1	100.0	-	-
single curved line with single lines to interior	B10 fragment	#2 (1)	1	9.1	-	-	-	-	0/1	100.0
single curved line with paired lines to interior	B10 fragment	#2 (1)	2	18.2	-	-	1	50.0	1/0	50.0
pair of curved lines with paired lines to interior and/or exterior	B10 fragment	#1 (2) #2 (1)	5	45.4	-	-	2	40.0	3/0	60.0
concentric curvilinear paired lines connected by paired lines	B10 fragment		1	9.1	-	-	-	-	1/0	100.0
Total		#1 (3) #2 (3)	11	100.0	-	-	4	36.4	6/1	70.0
Miscellaneous Complex Motifs										
joined crescent pairs with paired vertical lines at ends and centre of crescents	8(2).8/73	#2 (1)	1 D/1 D+I	50.0	-	-	2	100.0	-	-
oval formed of opposed single crescents (DE 4) with DE 3 in centre and connected oblique lines	fragment of M83 variant?	#2 (1)	1	25.0	1 (Int.)	100.0	-	-	-	-
single crescent with DE 3, single vertical lines at ends and single line X between	83.2/469?	#2 (1)	1	25.0	-	-	-	-	1/0	100.0
Total		#2 (3)	3/1 D+I	100.0	1	25.0	2	50.0	1/0	25.0

Table A.30 Curvilinear and complex motif frequencies by decoration location, Site DAF.

Motif Description					Decoration Location							
					Exterior Zone 2/ Interior Zone 1		Neck		Above Carination		Body	
New Curvilinear Motifs	Motif No. Donovan/Anson	GZ No. ( ) Total	Total Dentate	%	Total	%	Total	%	Total	%	Total	%
concentric curvilinear paired lines	New B10 fragment	#2 (1)	3	17.7	1/0	33.3	-	-	-	-	2	66.7
single curved line with paired lines to exterior	New B10 fragment	#2 (1)	2	11.8	-	-	-	-	1	50.0	1	50.0
pair of curved lines with paired lines to interior and/or exterior	New B10 fragment	#2 (2)	6	35.3	1/0	16.7	2	33.3	-	-	3	50.0
combination of previous two motifs	New B10 fragment	#2 (1)	2	11.8	-	-	1	50.0	-	-	1	50.0
concentric curvilinear paired lines connected by paired lines	New B10 fragment	#2 (1)	2	11.8	2/0	100.0	-	-	-	-	-	-
circle with or without DE3 inside and paired lines radiating outward	New B11 fragment		2	11.8	2/0	100.0	-	-	-	-	-	-
Total		#2 (6)	17	100.0	6/0	35.3	3	17.6	1	5.9	7	41.2
Miscellaneous Complex Motifs												
joined crescent pairs with paired vertical lines at ends and centre of crescents	8(2).8/73	#1 (1) #2 (1)	2	33.3	0/1	50.0	-	-	-	-	1	50.0
M8(2).8 with oblique lines replacing crescents - multiple rows	39(2).7/316		2	33.3	2/0	100.0	-	-	-	-	-	-
single crescent with DE 3 below and connected oblique lines	fragment of M83 variant?		1	16.7	-	-	-	-	-	-	1	100.0
single crescent with DE 3, single vertical lines at ends and single line X	83.2/469?		1	16.7	-	-	-	-	-	-	1	100.0
Total			6	100.0	2/1	50.0	-	-	-	-	3	50.0

Table A.31 Curvilinear and complex motif frequencies by decoration location, Site DJQ.

APPENDIX B

DESCRIPTIONS AND ILLUSTRATIONS OF NEW POST-LAPITA POTTERY MOTIFS

Motif Number	Pottery Style	Motif Description
5	Sohano Plain Lip	row of punctations below rim lip with filled triangle formed of punctations extending below
64	Hangan Incision/Relief	four rows of punctation with cross-hatched incision below
66	Hangan Incision/Relief	thin horizontal applied relief band with series of triangles below outlined by single or double incised lines and filled with punctation (similar to M19)
67	Hangan Incision/Relief	single row of vertical incised chevrons bounded below by a single horizontal applied relief band with notching
79	Hangan Incision/Relief	row of thin applied relief bands arranged in groups of opposing diagonals with unidirectional diagonal incision below
81	Hangan Incision/Relief	single horizontal applied relief band with curvilinear incised line below bounded on both sides by short 'slash' incision
83	Hangan Incision/Relief	series of regularly spaced single and paired vertical incised lines connected by loosely organised diagonal incision
101	Malasang	joined opposing horizontal arcs of broad comb incision filled with rows of wavy comb incision
102	Malasang	series of connecting broad comb incised diagonals similar to but shorter than in M116 with or without single rows of punctations along the margins
109	Malasang	single row of tightly spaced broad wavy comb incision similar to M105
187	Malasang	groups of vertical applied relief bands with shell edge notching and bounded by punctation combined with designs of linear and curvilinear incision between the bands (similar to M125)
188	Malasang	curvilinear applied relief bands (with and without shell notching) bounded by punctation
189	Malasang	vertical or diagonal broad comb incision arranged at regular intervals with a continuous band of wavy wide comb incision below
190	Malasang	triangular incised designs filled with multidirectional groups of incised lines
191	Malasang	two rows of opposing diagonal incision bounded by a single row of punctation below
192	Malasang	intersecting opposing diagonal wide comb incision bands forming a cross-hatched design
193	Hangan - Malasang Transition	multiple rows of jab and drag 'slash' punctation bounded by single rows of regular punctation above and below
194	Malasang	combination of vertical and horizontal applied bands with incised diagonals and chevrons between (like M171)
195	Malasang	row of diagonal incision with a horizontal band of comb incision below
196	Malasang	single horizontal band of wavy comb incision with wide opposing diagonal bands of comb incision below bounded by punctation
197	Hangan – Malasang Transition	single band of comb incision forming connecting horizontal arcs
198	Hangan - Malasang Transition	single row of jab and drag 'slash' chevrons with a row of vertical incised chevrons below (like M61)
199	Malasang	horizontal and wavy comb incised bands with mirror image of design below (combination of M117 and M119)
200	Malasang	series of adjoining open diamonds formed of joined diagonal bands of comb incision bounded by punctation
201	Malasang	series of joined arcs of wide comb incision connected to a single opposed arc of wide comb incision which is bounded by punctation
202	Malasang - Mararing Transition	continuous band of vertical wavy comb incision
203	Malasang	wide curvilinear band of comb incision
204	Malasang - Mararing Transition?	comb incised vertical chevrons (M116) combined with one or more rows of shell edge impressions below
205	Mararing	regularly spaced vertical bands of punctation
206	Recent	row of incised chevrons with a narrow band of wavy comb incision below
207	Recent	roughly executed chevron designs combining linear and curvilinear incision
208	Recent	series of incised chevrons with single line through center forming a 'Christmas tree' pattern
209	Mararing to Recent	multiple rows of punctation bounded by a narrow band of comb incision below
210	Recent	roughly executed curvilinear incised arcs bounded by a single horizontal incised line below

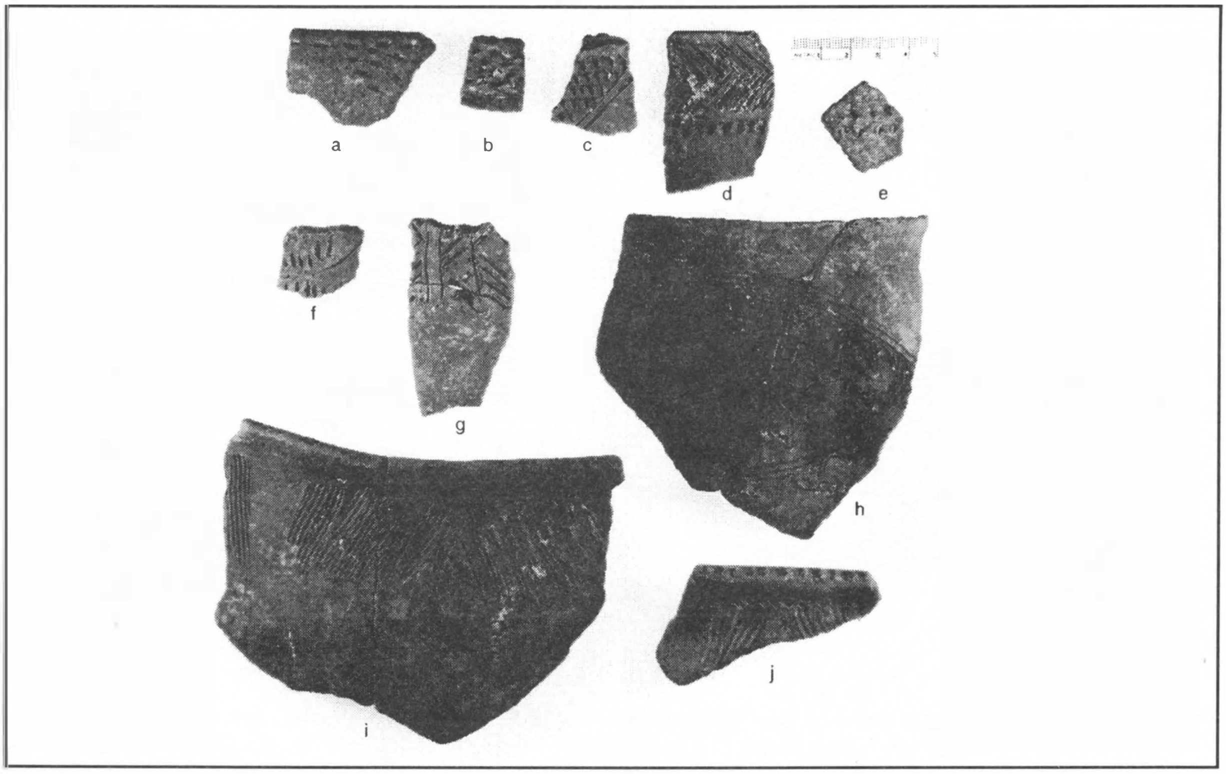


Plate B.1 New post-Lapita pottery motifs 5 (a), 64 (b), 66 (c), 67 (d), 79 (e), 81 (f), 83 (g), 101 (h), 102 (i) and 102A (j). **Code** – Letter Designation: Provenience Code (Site-Area.Unit.Layer/Level). **Data** – a: DKC.1.IIB/8; b: DJU-3.2.IIA/3; c: DJO-A.1.II/9; d: DJO-A.1.II/6; e: DJU-3.2.IIB/4; f: DJU-3.1.IIA/3; g: DJU-3.2.IIB/9; h: DJO-D.4.IIA/3; i: DJO-D.4.I/1; j: DJO-D.1.I/1.

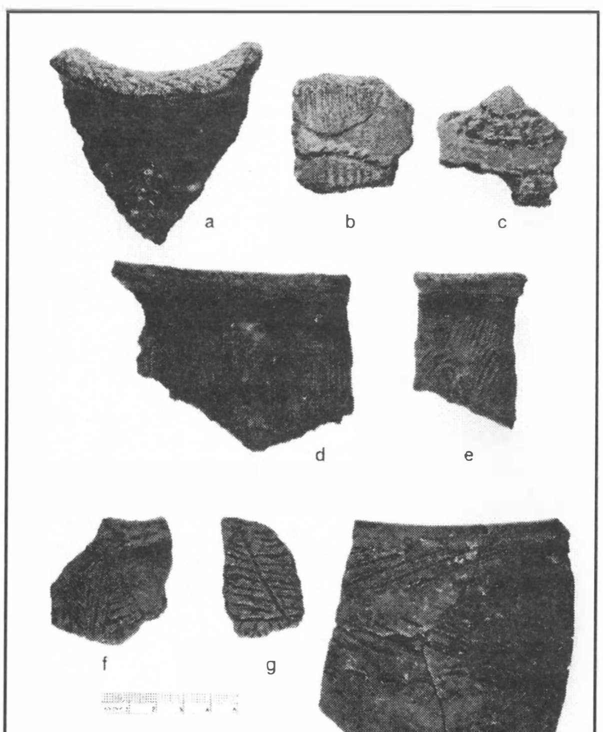


Plate B.2 New post-Lapita pottery motifs 187 (a), 187A (b), 188 (c), 189 (d), 189A (e), 190 (f), 190A (g) and 191 (h). **Code** – Letter Designation: Provenience Code (Site-Area.Unit.Layer/Level). **Data** – a: DJU-3.surface; b: DJU-3.surface; c: DJO-D.3.I/2; d: DJO-D.4.I/1; e: DJO-D.1.I/1; f: DJO-D.4.I/1; g: DJO-D.3.I/2; h: DJO-D.1.IIA/3,4.

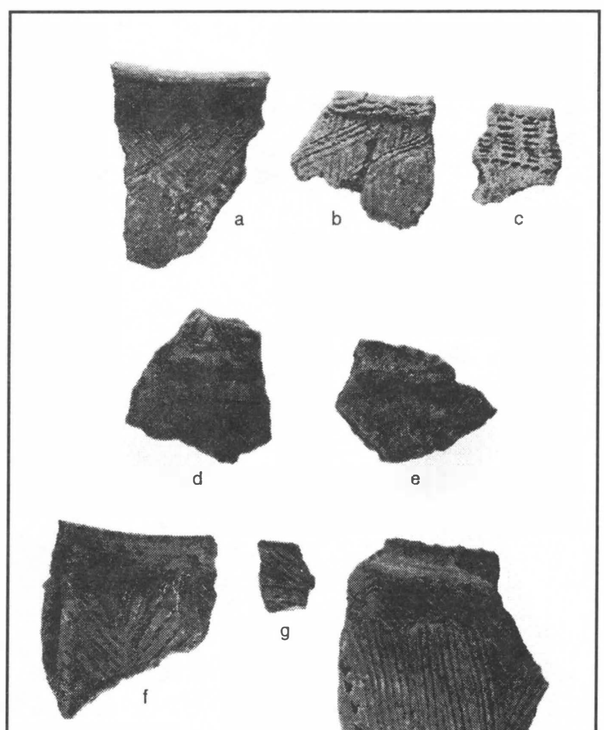


Plate B.3 New post-Lapita pottery motifs 192 (a, b), 193 (c), 194 (d), 194A (e), 194B (f), 195 (g) and 196 (h). **Code** – Letter Designation: Provenience Code (Site-Area.Unit.Layer/Level). **Data** – a: DJO-D.1.I/2; b: DJO-D.1.I/2; c: DJU-3.surface; d: DJO-D.1.I/2; e: DJO-D.1.I/2; f: DJO-D.1.IIA/3; g: DJO-D.1.IIA/4; h: DJO-C.surface.

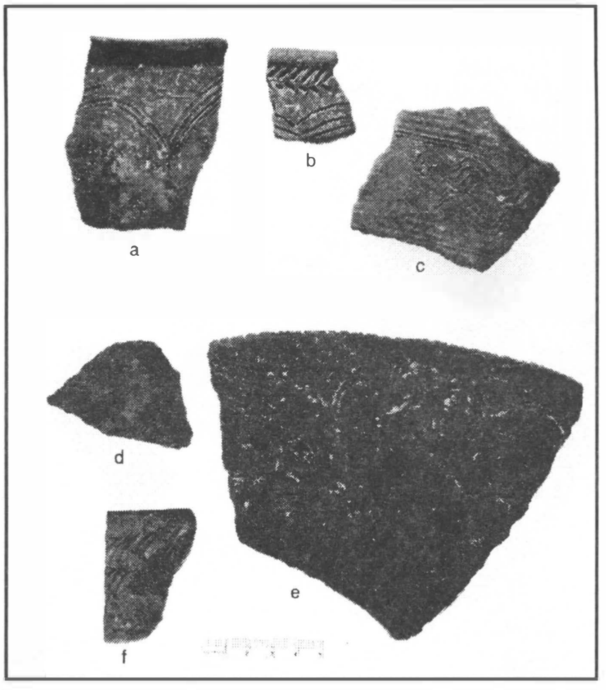


Plate B.4 New post-Lapita pottery motifs 197 (a), 198 (b), 199 (c), 200 (d), 201 (e) and 202 (f). **Code** – Letter Designation: Provenience Code (Site-Area.Unit.Layer/Level). **Data** – a: DJO-D.2.IIA/3; b: DJO-D.2.IIA/6; c: DJO-D.3.IIA/3; d: DJO-D.3.I/2; e: DJO-B.feature 1; f: DJO-E.surface.

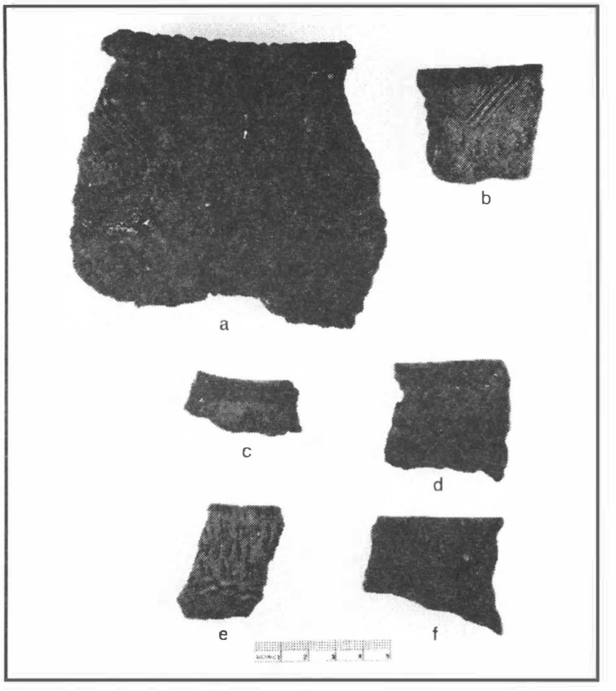


Plate B.5 New post-Lapita pottery motifs 203 (a), 204 (b), 205 (c), 207 (d), 209 (e) and 210 (f). **Code** – Letter Designation: Provenience Code (Site-Area.Unit). **Data** – a: DJO-E.surface; b: DJU-3.surface; c: DJU-3.surface; d: DJV.surface; e: DJU-3.surface; f: DJU-2.surface.

APPENDIX C

FAUNAL TABLES FOR VERTEBRATE AND MOLLUSCAN REMAINS

Taxon	Layer					
	I	II	III	IV	V	VI
Homo sapiens	-	I(fr)	4T,M	56T(7unerupted), 23PHAL, (terminal)+other PHAL,MET,fr.	3T,PHAL,MET	T,T(fr)
Sus scrofa	3T,I,M,2MAN(fr), 4fr.	2T,I,3MAN,TI, 2MET,rib,wrist	2T,2fr.	7T,MAN(fr), ?patella,frags.	-	-
large mammal fragment	3	2 (pig?)	-	fragments	frags.,(human?)	blackened (human?)
Phalanger orientalis	?I,P3 ?FE,?HU (3 bumt)	IN,3(fr)	-	M,3(fr)	I	-
Rat						
large	I,M,2MET,2IN, 4VT,HU,FE,TI	I,IN,UL,FE,TI	TI	3I,M,3VT,TI, PHAL,calcaneum	3I,M,2MAN,MAX, 7VT,IN,UL,FE, 5MET,calc.,ast.	long bones 9I,M,MAX(fr), 2VT,HU,FE,TI
medium	I,2VT	I,5VT	6VT,2FE,RA, MET,calcan.	4I,M,MAX,9VT, HU,UL,FE,2TI, 4MET	M,VT,RA,2MET, astragalus	3I,M,IN,VT,HU, 2TI,MET
small	3HU	-	2I,4VT,2SC,2HU, FE,2TI,MET	I,2MAN,3VT,2IN, HU,FE,TI,?foot	I,M,2VT,HU	I,M,VT
Bat		? 2 long bones				long bone shafts (>4)
large	long bone shafts	-	-	T,M,2long bones	-	long bone shafts
medium	-	-	MAX(fr)	I,MAN,2RA,HU, long bone shafts	I,MAN,TI,2HU, >5 l.b.shafts	HU,RA,long bone shafts(>2)
small	-	-	-	2MAN,3HU,fr	-	FE
insectivorous	MAN,HU,RA	-	-	MAN	MAN	2MAN(1fr)
Reptile	5VT(2 medium)	VT(sm),HU	4VT	10VT,25VT(sm)	10VT,4VT(sm), HU	SK,6VT(sm)11VT(sm /med)
skink	(small)HU	-	-	IN	-	-
snake	-	2VT	-	-	-	-

Table C.1 Skeletal elements (NISP) of non-fish vertebrate faunal remains, Palandraku Cave (Site DBE). (Code: T - teeth; MAN - mandible; IN - innominate; TI - tibia; I - incisor; MAX - maxillary; HU - humerus; FI - fibula; C - canine; SK - skull; RA - radius; MET- metapodials; P - premolar; VT - vertebrae; UL - ulna; PHAL- phalanges; M - molar; SC - scapula; FE - femur; fr. - fragment)

Site/ Provenience	*Homo sapiens*	*Sus scrofa*	Large Mammal	Dolphin?	*Phalanger*	Large Rat	Medium Rat	Small Rat	Large Bat	Medium Bat	Reptile	Bird
DKC (levels1-4,6)	5T,I,M	-	2 frags.	-	-	-	-	-	-	-	3 l.bone shafts,?FE FE(varanid)	-
DAF	-	4fr.,2T,P,3M (2 unerupted)	1 frag.	-	-	-	-	-	-	-	-	-
DJW	-	55T,2MAN,>4SK, 6VT,4HU,2RA, 2FE,TI,MET,astr., calc.,many frags.	-	-	-	-	-	-	3T, 2 l.b. shafts (?*P.neohib.*)	2 long bone shafts	? frags.	-
DJU	-	5T,2I,3P,6M, 2MAN(fr),SK(fr), 3VT,ribs,RA,UL, TI,many frags.	-	11 VT, 10 ribfrags. 3 longbone(fr)	MAN(fr)	-	-	-	-	3+ long bone shafts	VT	-
DJO-A	-	I,P,2M(1decid) SK(fr),PHAL	9 frags.	-	-	-	I	-	-	-	-	-
DJO-D				-								
Zone 1	I	? frags.	4+ frags.	-	-	I	TI	-	C	-	-	-
Zone 2	-	T,PH,fr.	2 frags.	-	MAN	-	-	IN	-	-	-	-
Zone 3	T	2TI,FE,I,fr., 2M (1unerupted)	-	-	-	-	IN,VT, fr 3FE, 3TI	I	2M	-	VT	-
Zone 4	I	M,SK, long bone fr.	1 frag.	-	P	-	-	-	-	long bone shaft	VT	?1
Zone 5	2T	2M(1unerupted) Sc,HU,2 frags.	1 frag.	-	-	-	-	HU	-	-	IN	shaft (sm)
Zone 6	2VT,fr.	P,VT,Sc,TI,HU, rib,calcaneum, 2 frags.	2+ frags.	-	-	-	-	-	-	long bone shaft	-	-
Zones 7-9	?VT	SK,2 fr. (1 heavily burnt)	6+ frags.	-	-	-	VT	VT,FE	-	-	-	-

Table C.2 Skeletal elements (NISP) of non-fish faunal remains, Buka ceramic sites. (see Table C.1 for key)

	IA	IC (upper)	IC (lower)	Total IC	Total I	IIB(1)	IIB(2)	Total IIB	IID(1)	IID(2)	IID(3)	IID(4)	Total IID	Total II	TOTAL
Carcharinidae	63	3	25	28	91	1	1	2						2	93
Elasmobranchii	142	32	29	61	203	7	14	21						21	224
Acanthuridae	3				3										3
Balistidae	16	20	4	24	40	1	1	2	1				1	3	43
Coryphaenidae							2	2	2	4	1		7	9	9
Diodontidae	2				2										2
Labridae	10	11	1	12	22	1	4	5	4		1		5	10	32
Lethrinidae	1				1				1				1	1	2
Lutjanidae	2	4	1	5	7	1		1				1	1	2	9
Monacanthidae	1	5	2	7	8										8
Muraenidae	2	11	3	14	16										16
Nemipteridae	4	3		3	7										7
Pomadasyidae	1				1										1
Scaridae	28	9	1	10	38	1		1	2				2	3	41
Scombridae	60	2	1	3	63		1	1		5		8	13	14	77
Serranidae	4				4				2			2	4	4	8
IDENTIFIED	339	100	67	167	506	12	23	35	12	9	2	11	34	69	575
Potentially Identifiable	35	7	3	10	45	4		4		1	1		2	6	51
Unidentifiable	964	481	149	630	1594	56	110	166	135	95	50	130	410	576	2170
TOTAL	1338	588	219	807	2145	72	133	205	147	105	53	141	446	651	2796

Table C.3 Fish remains (NISP) from TP 1, Kilu Cave (Site DJA).

	IA	IA/B	IC (upper)	IC (lower)	Total IC	Total I	IIA	IIB(1)	IIB(2)	Total IIB	IID(1)	IID(2)	IID(3)	IID(4)	Total IID	Total II	TOTAL
Carcharinidae	50	15	61	6	67	132	4									4	136
Elasmobranchii	75	59	59	11	70	204	5	1		1				1	1	7	211
Acanthuridae	4					4											4
Balistidae			3	45	48	48	20	1		1	2				2	23	71
Coryphaenidae							1	1	4	5	4				4	10	10
Kyphosidae	1					1											1
Labridae	4	1	1	6	7	12	8	11		11	13		3		16	35	47
Lethrinidae	1		1	1	2	4											3
Lutjanidae	2			3	3	5	2	2	2	4	1				1	7	12
Monacanthidae				5	5	5	2	1		1						3	8
Muraenidae	10			7	7	17											17
Nemipteridae				1	1	1											1
Scaridae	8			5	5	13	8									8	21
Scombridae	8					8	2				2		1		3	5	13
Serranidae	1			1	1	2		2	3	5	1				1	6	8
IDENTIFIED	164	75	125	91	216	455	52	19	9	28	23	0	4	1	28	108	563
Potentially Identifiable	4	2		6	6	12	2		2	2	3		2		5	9	21
Unidentifiable	382	51	123	836	959	1392	337	256	345	601	271	31	160	59	521	1459	2851
TOTAL	550	128	248	933	1181	1859	391	257	356	631	297	31	166	60	554	1576	3435

Table C.4 Fish remains (NISP) from TP 2, Kilu Cave (Site DJA).

	IA	IB/C	IC	Total I	IIA	IIB(1)	IIB(2)	Total IIB	IIC	IID(1)	IID(2)	IID(3)	IID(4)	Total IID	Total II	TOTAL
Carcharinidae	35	97	18	150	3	1		1							4	154
Elasmobranchii	114	39	4	157	5										5	162
Acanthuridae	1		1	2	1				1	1		1		2	4	6
Balistidae	7	3	29	39	6	1	2	3	1						10	49
E. bipinnulatus						1		1							1	1
Coryphaenidae			5	5		1	1	2		1	2			3	5	10
Kyphosidae			2	2	1	1		1		4				4	6	8
Labridae	3		17	20	13	8	13	21	11	14	6	5	1	26	71	91
Lethrinidae	1		2	3	1		1	1				1		1	3	6
Lutjanidae			5	5	1				2	2				2	5	10
Monacanthidae			10	10	1	1	1	2							3	13
Muraenidae	6	2	14	22	1										1	23
Scaridae	2		20	22	3	1	1	2			1			1	6	28
Scombridae			2	2	1					3		5		8	9	11
Serranidae			4	4	1										1	5
Epinephelus sp.	2		5	7	6	1	2	3	2		1			1	12	19
V. louti										1				1	1	1
IDENTIFIED	114	141	138	393	44	16	21	37	17	26	10	12	1	49	147	540
Potentially Identifiable	1	3	7	11	7	1	1	2	11	10	4	3		17	37	0
Unidentifiable	179	166	1258	1603	430	342	511	853	372	362	460	209	115	1146	2801	48
TOTAL	294	310	1403	2007	481	359	533	892	400	398	474	224	116	1212	2985	4404

Table C.5 Fish remains (NISP) from TP 3, Kilu Cave (Site DJA).

	Level								%(Wt.)
	1	2	3	4	5	6	7	8	
Gastropoda									
Haliotis cf. *varia*	0	0	0	20	0	50	0	0	0.04
Patellidae spp.	773	1010	1030	1360	2000	1900	1038	808	5.73
Trochus niloticus	0	1000	0	0	0	0	0	0	0.56
Trochus maculatus	0	10	0	0	0	0	100	17	0.06
Turbo spp.	1427	2630	1390	700	310	120	62	150	4.20
Turbo marmoratus	0	370	0	0	0	0	0	0	0.21
Turbo petholatus	80	0	0	0	0	0	0	0	0.07
Astraea sp.	0	10	0	0	0	0	0	0	0.00
Nerita undata	507	1830	4670	7550	8990	5950	3200	2483	19.70
Nerita plicata	1060	3160	9530	13140	16270	14130	11375	8692	42.11
Neritina/Theodoxus spp.	0	0	0	10	0	10	0	0	0.01
Tectarius spp.	0	810	950	1070	1570	720	500	550	3.45
Littorina cf. *coccinea*	0	10	10	10	60	20	62	17	0.09
Terebralia palustris	0	0	10	0	0	20	125	242	0.23
Melanoides spp.	0	10	0	0	0	0	0	0	0.00
Strombus luhuanus	160	10	0	10	0	0	0	0	0.14
Strombus mutabilis	80	0	10	0	10	0	0	0	0.07
Cypraea spp.	60	100	50	200	0	90	112	0	0.35
Cymatium pileare	100	10	270	10	10	0	0	0	0.24
Drupa spp.	93	640	0	730	520	420	138	75	1.48
Drupella cf. *comus*	0	0	750	0	0	0	0	0	0.42
Thais spp.	153	0	0	0	0	0	0	0	0.13
Conus spp.	33	0	40	0	0	0	0	0	0.05
Pythia scarabaeus	80	20	100	100	120	100	62	42	0.91
							Gastropod %		81.25
Bivalvia									
Anadara granosa	33	0	180	430	710	450	0	142	1.11
Anadara antiquata	127	90	200	1520	1610	260	25	42	2.20
Mytilidae spp.	33	0	10	10	0	0	0	0	0.04
Isognomon cf. *ephippium*	0	0	10	0	0	20	12	25	0.03
Ostrea spp.	33	410	470	1590	810	450	262	367	2.47
Chama cf. *iostoma*	20	0	0	0	0	0	0	0	0.02
Trachycardium cf. *flavum*	13	0	0	0	540	60	0	0	0.35
Hippopus hippopus	0	0	480	0	0	0	0	0	0.27
Polymesoda cf. *coaxans*	367	710	1110	3410	3300	3790	3425	2942	10.69
Periglypta reticulata	20	0	0	0	0	0	0	0	0.02
Gafrarium pectinatum	0	10	0	180	0	140	138	92	0.31
							Bivalve %		17.51
Polyplacophora									
Chitonidae	47	170	140	180	100	510	388	625	1.24
Unidentified Shell	2380	3920	5130	10000	7660	7670	7812	8108	
TOTAL SHELL	8207	16840	26460	42250	44670	36840	28875	25458	27414
Echinoidea									
Heterocentrotus sp.	33	20	270	650	1580	1630	950	92	
CRUSTACEA (crab claws)	X	X		X			X		

Table C.6 Shell density (g/m³), TP 1, Layer IA, Kilu Cave (Site DJA). (Code: X = present)

	Level							% (Wt.)
	9	10	11	12	13	14	15	
Gastropoda								
Haliotis cf. *varia*	0	0	11	12	62	0	0	0.09
Patellidae spp.	350	630	6000	950	625	525	1025	5.18
Trochus maculatus	0	0	33	0	0	0	0	0.04
Tectus pyramis	0	0	0	0	0	300	775	1.13
Turbo spp.	62	80	467	188	362	262	1600	3.25
Nerita undata	1388	870	2356	1762	2038	1338	2312	13.20
Nerita plicata	4075	3050	3267	3562	3738	3725	9462	33.94
Neritina/Theodoxus spp.	25	0	0	0	0	0	12	0.03
Tectarius spp.	275	240	578	438	1675	938	1462	6.02
Littorina cf. *coccinea*	12	0	0	12	12	0	38	0.05
Terebralia palustris	188	240	1578	212	750	662	50	4.13
Melanoides spp.	0	0	11	0	0	0	0	0.01
Cypraea spp.	150	0	400	450	1050	1150	1950	5.46
Drupa spp.	50	0	78	25	275	288	162	0.90
Drupella cf. *cornus*	0	0	67	0	0	112	125	0.33
Purpura persica	0	0	100	25	125	0	0	0.25
Melampus flavus	0	10	0	0	0	0	0	0.01
Pythia scarabaeus	88	10	33	12	25	12	125	0.27
							Gastropod %	75.29
Bivalvia								
Anadara granosa	38	290	256	1388	350	538	0	3.11
Anadara antiquata	0	0	0	0	0	175	338	0.54
Mytilidae spp.	0	0	0	12	0	0	0	0.01
Isognomon cf. *ephippium*	0	0	11	12	12	0	0	0.04
Ostrea spp.	100	80	122	450	412	62	0	1.32
Polymesoda cf. *coaxans*	1900	1040	1122	888	4088	2862	312	13.24
Gafrarium pectinatum	0	0	0	0	238	25	0	0.27
							Bivalve %	18.53
Polyplacophora								
Chitonidae	212	300	1178	625	638	488	2225	6.18
Unidentified Shell	4200	1630	3478	2050	3462	5525	8325	
TOTAL SHELL	13138	8430	15778	13000	20162	19312	30875	16919
Echinoidea								
Heterocentrotus sp.	62	30	11	12	25	50	75	
CRUSTACEA (crab claws)	X	X	X	X	X		X	

Table C.7 Shell density (g/m³), TP 1, Layer IC, Kilu Cave (Site DJA). (Code: X = present)

	Level						% (Wt.)
	16	17	18	19	20	21	
Gastropoda							
Haliotis cf. *varia*	50	36	267	482	700	236	1.09
Patellidae spp.	1425	1600	2347	953	878	236	4.51
Tectus pyramis	425	200	0	0	11	0	0.39
Turbo spp.	1775	1291	5587	8494	6944	509	14.57
Turbo marmoratus	0	564	0	0	0	0	0.43
Nerita undata	3438	6091	4467	2247	1156	2664	12.93
Nerita plicata	12350	16300	29133	7188	3544	3418	43.19
Neritina/Theodoxus spp.	0	0	0	0	11	0	0.01
Tectarius spp.	2000	2155	560	82	567	418	3.76
Littorina cf. *coccinea*	75	36	147	94	33	18	0.23
Terebralia palustris	0	0	0	118	0	0	0.07
Cypraea spp.	1425	245	120	82	378	82	1.38
Cymatium pileare	0	36	0	24	22	0	0.05
Thaididae spp.	288	2145	0	0	0	0	1.79
Drupa spp.	0	0	787	1294	844	73	1.75
Drupella cf. *cornus*	0	0	760	0	0	0	0.39
Purpura persica	512	264	1360	1929	1711	1645	4.64
Thais spp.	0	0	213	318	700	0	0.73
Cantharus undosus	0	0	0	0	0	55	0.04
Pythia scarabaeus	25	82	133	35	44	0	0.18
						Gastropod %	93.13
Bivalvia							
Ostrea spp.	0	82	360	94	0	27	0.32
Polymesoda cf. *coaxans*	0	82	0	0	0	418	0.38
cf. *Nucula* sp.	0	0	0	0	0	36	0.03
						Bivalve %	0.73
Polyplacophora							
Chitonidae	2225	1882	1053	129	1000	2927	6.14
Unidentified Shell	10038	6364	987	2788	4033	4309	
TOTAL SHELL	36350	39636	48240	26718	23000	17045	30539
Echinodermata, Echinoidea							
Heterocentrotus sp.	75	127	27	0	0	0	
Crustacea, Cirripedia (barnacle)							
Balanidae sp. (in TP 2)	318	56	1550	242	48	19	

Table C.8 Shell density (g/m^3), TP 1, Layer II, Kilu Cave (Site DJA).

Layer	I	I	I	II	II	III	I-III % (wt)	IV	IV % (wt)	V	V	V	VI	VI	VI	V-VI % (wt)
Level	1	2	3	4	5 (South)	5 (North)		6/7		8	9	10	11	12	13	
Gastropoda																
Patellidae spp.	0	22	90	10	0	0	0.94	25	0.64	17	30	32	42	68	50	1.11
Trochus niloticus	50	0	0	0	0	41	0.39	10	0.25	78	0	0	105	23	17	1.07
Trochus maculatus	0	22	0	0	148	55	0.78	20	0.51	96	0	11	116	68	50	1.62
Tectus pyramis	0	56	0	20	0	0	0.55	40	1.02	0	50	0	0	0	0	0.23
Angaria delphinus	25	0	0	0	0	0	0.08	0	0.00	0	0	0	0	0	0	0.00
Turbo spp.	250	100	30	310	2296	329	10.73	1345	34.35	852	470	832	821	1648	1792	30.56
Turbo marmoratus	0	0	0	0	0	233	1.33	0	0.00	1296	90	0	105	625	0	10.35
Nerita spp.	50	56	110	10	0	27	1.64	270	6.90	217	110	211	137	284	308	6.08
Neritina/Theodoxus spp.	0	0	0	0	0	0	0.00	5	0.13	26	30	53	0	0	0	0.51
Tectarius spp.	0	0	0	0	0	0	0.00	15	0.38	17	0	11	21	23	75	0.74
Terebralia palustris	0	0	0	80	0	0	0.62	10	0.25	26	0	63	0	34	67	0.93
Melanoides spp.	0	0	0	0	0	0	0.00	5	0.13	0	0	0	0	0	0	0.00
Cerithium spp.	100	89	230	140	259	14	4.46	45	1.15	35	10	42	21	114	0	0.83
Strombus luhuanus	0	0	0	0	0	0	0.00	0	0.00	209	0	0	242	0	0	2.18
Strombus mutabilis	100	133	190	40	185	14	3.52	25	0.64	122	0	116	32	68	8	1.35
Cypraea spp.	75	322	450	210	370	96	8.99	395	10.09	339	230	316	168	114	67	5.85
Polinices melanostomus	0	0	0	0	0	0	0.00	0	0.00	0	0	0	0	159	17	0.74
Cymatium pileare	50	11	30	20	148	68	1.33	210	5.36	78	60	42	63	91	0	1.53
Thaididae spp.	225	44	50	30	0	82	2.11	160	4.09	217	540	463	253	761	200	11.05
Cantharus undosus	0	0	0	0	0	0	0.00	20	0.25	0	0	0	0	0	0	0.00
Tonna sp.	0	0	0	0	0	0	0.00	200	2.55	0	0	0	0	0	0	0.00
Conus spp.	0	78	90	50	593	27	3.05	185	4.72	200	220	179	158	170	67	4.64
Pythia scarabaeus	325	78	0	50	37	68	2.42	260	6.64	217	50	147	63	136	117	3.53
Gastropod %							42.94		80.09							85.90
Bivalvia																
Arcidae spp.	0	0	0	0	0	0	0.00	90	2.30	0	0	32	53	0	0	0.37
Anadara granosa	0	0	300	0	0	0	2.34	0	0.00	0	0	0	0	0	0	0.00
Anadara antiquata	250	333	230	630	1222	27	12.59	85	2.17	296	0	0	0	11	25	1.76
Barbatia spp.	0	0	10	10	222	0	0.62	10	0.25	0	10	0	0	0	0	0.05
Modiolus spp.	25	0	30	0	37	0	0.31	5	0.13	0	0	21	0	11	0	0.37

Table C.9 Shell density (g/m^3), TP 1, Palandraku Cave (Site DBE).

Layer	I	I	I	II	II	III	I-III % (wt)	IV	IV % (wt)	V	V	V	VI	VI	VI	V-VI % (wt)
Level	1	2	3	4	5 (South)	5 (North)		6/7		8	9	10	11	12	13	
Bivalvia cont.																
Isognomon sp.	0	11	10	10	37	0	0.23	5	0.13	0	0	0	0	0	0	0.00
Ostrea spp.	0	0	0	0	0	0	0.00	0	0.00	61	0	0	0	0	0	0.32
Chama cf.*iostoma*	400	667	1000	80	481	315	17.20	10	0.25	0	0	0	0	0	0	0.00
Trachycardium cf. *flavum*	0	0	30	0	0	0	0.23	15	0.38	130	10	0	0	0	0	0.74
Tridacna maxima/crocea	0	0	30	50	37	14	0.78	235	6.00	270	30	126	263	0	0	3.30
Hippopus hippopus	125	0	0	0	0	0	0.39	0	0.00	0	0	0	0	0	0	0.00
Tellina sp.	50	144	800	0	0	0	7.43	30	0.77	0	0	0	0	0	0	0.00
Polymesoda cf. *coaxans*	400	344	250	530	1370	68	13.06	255	6.51	78	50	105	179	136	675	6.22
Gafrarium pectinatum	0	89	90	0	0	0	1.33	20	0.51	43	0	0	0	0	0	0.23
Bivalve %							56.51		19.40							13.36
Chitonidae	0	11	10	10	37	41	0.55	20	0.51	17	0	21	21	23	83	0.74
Unidentified Shell	875	2044	1550	1630	2296	945	Total Shell	4215		4635	2110	2463	2863	2852	2908	Total Shell
Total shell	3300	4733	5640	3920	9630	2370	4528	8130		9557	4260	5305	5663	7420	6533	6356
Echinoderamta, Echinoidea																
Heterocentrotus sp.	25	22	10	40	74	192		240		9	10	11	11	11	8	
CRUSTACEA (crab claws)	25	22	0	0	74	27		25		26	30	11	53	23	33	

Table C.9 cont.

Layer	IA	IA	IB/C	ID	ID	IIA	IIA	IIB	IIB	IIB	IIB	% (wt)
Level	1	2	3	4	5	5	6	7	8	9	10	
Gastropoda												
Trochus niloticus	442	2070	1520	110	0	640	293	740	118	100	1640	6.52
Trochus maculatus	0	70	0	0	0	0	0	0	0	0	0	0.07
Tectus pyramis	0	100	460	110	0	0	0	0	0	0	0	0.67
Angaria delphinus	0	20	0	200	0	140	67	240	153	290	0	1.00
Turbo spp.	0	20	0	100	20	160	0	90	0	0	0	0.30
Turbo cf. *chrysostoma*	0	0	0	0	0	0	213	90	82	60	140	0.45
Turbo petholatus	0	0	0	0	0	0	93	0	0	60	0	0.13
Nerita spp.	17	40	60	200	140	200	480	140	212	10	560	1.45
Tectarius spp.	0	0	30	0	0	0	0	0	0	0	0	0.03
Planaxis cf. *sulcatus*	0	10	0	0	0	0	0	0	0	0	0	0.00
Terebralia palustris	42	90	10	50	0	0	0	0	0	0	0	0.20
Cerithium nodulosum	83	10	40	0	0	180	320	1020	118	180	480	2.02
Rhinoclavis spp.	100	110	130	150	100	380	933	420	412	320	600	2.71
Lambis lambis	908	640	390	1160	1980	900	280	1530	306	140	1300	7.50
Strombus lentiginosus	0	0	1270	0	0	0	0	0	0	0	0	1.27
Strombus luhuanus	742	1630	0	590	140	180	653	130	329	160	1360	5.00
Strombus mutabilis	483	870	200	700	220	1860	1747	720	682	400	1220	7.00
Cypraea spp.	192	110	70	240	140	220	133	280	12	10	800	1.62
Polinices melanostomus	83	0	0	50	0	780	1347	0	847	0	2020	3.27
Cymatium pileare	50	0	10	70	0	200	213	220	176	260	320	1.18
Purpura persica	0	0	0	0	0	0	0	0	0	60	0	0.06
Nassarius spp.	0	0	0	0	0	0	0	0	0	0	60	0.03
Fasciolariidae spp.	0	410	0	0	0	0	0	0	0	0	0	0.41
Harpa sp.	0	0	0	0	0	0	0	10	0	0	0	0.00
Conus spp.	17	100	0	80	60	100	53	150	106	30	0	0.59
Terebra spp.	0	0	0	0	0	0	0	0	0	210	0	0.21
Bulla cf. *vernicosa*	0	0	0	0	0	0	40	30	24	0	0	0.23
Pythia scarabaeus	0	90	0	50	0	520	320	70	0	50	300	0.91
											Gastropod %	45.83

Table C.10 Shell density (g/m^3), TP 1, Site DKC (Sohano Island).

Layer	IA	IA	IB/C	ID	ID	IIA	IIA	IIB	IIB	IIB	IIB	% (wt)
Level	1	2	3	4	5	5	6	7	8	9	10	
Bivalvia												
Anadara antiquata	500	760	750	2380	1360	240	1267	760	376	530	1000	8.34
Barbatia spp.	0	0	0	0	0	0	0	0	35	0	0	0.03
Mytilidae spp.	8	0	0	0	0	0	0	0	0	0	0	0.00
Pecten sp.	0	0	60	0	0	20	0	0	0	0	0	0.07
Spondylus sp.	725	20	460	360	0	340	587	400	1200	1070	2740	6.17
Ostrea spp.	133	20	110	2640	0	0	0	2120	0	80	1160	5.70
Chama cf. *iostoma*	0	590	130	0	540	3560	3027	1180	1200	700	980	8.42
Trachycardium cf. *flavum*	0	100	50	0	160	160	187	190	259	240	520	1.36
Tridacna maxima/crocea	650	460	220	30	0	400	0	390	529	0	0	2.53
Hippopus hippopus	1667	560	50	0	0	440	1067	150	0	0	660	4.10
Tellinidae spp. (small)	250	170	200	570	360	0	2840	2360	2376	1600	3300	13.46
Tellina spp.	0	70	40	30	160	200	360	60	94	100	60	0.86
Polymesoda cf. *coaxans*	0	0	0	0	0	2500	0	0	0	0	0	1.25
Periglypta reticulata	0	0	60	80	0	0	0	0	753	860	80	0.72
Gafrarium pectinatum	17	440	0	170	140	620	107	0	59	0	40	1.16
Unidentified Shell	3500	2130	1690	3080	1560	3600	5000	4040	2224	1650	5740	
Total Shell	10700	11690	7850	13170	7040	18480	21573	18530	12624	10760	27020	13766

Table C.10 cont.

	Layer/Level									% (wt)
	IA/1	IB/2	IB/3	IB/4	IB/5	IB/6	IB/7	IB/8	IB/9	
Gastropoda										
Patellidae spp.	0	0	0	0	20	0	0	0	0	0.00
Trochus niloticus	210	790	4790	0	600	2400	180	0	0	3.08
Trochus maculatus	0	0	70	30	80	225	0	0	280	0.13
Tectus pyramis	0	0	0	0	0	200	0	0	80	0.04
Angaria delphinus	0	80	170	20	0	575	340	480	0	0.39
Turbo spp. (cf. *crassus, setosus)*	0	0	0	0	120	0	20	0	320	0.06
Turbo marmoratus	0	0	0	0	0	0	0	0	200	0.02
Turbo petholatus	60	20	60	0	60	125	60	540	80	0.23
Nerita spp.	110	80	50	40	100	175	160	80	2040	0.44
Planaxis cf. *sulcatus*	0	0	0	0	40	0	0	0	0	0.00
Terebralia palustris	0	1020	1270	230	380	25	140	80	3000	1.54
Cerithium nodulosum	0	600	110	190	140	0	600	340	0	0.62
Cerithium spp.	0	0	0	0	60	0	0	0	0	0.00
Rhinoclavis spp.	110	350	340	140	580	200	460	520	1720	0.96
Lambis lambis	970	3590	3780	800	0	3875	0	0	1560	4.78
Strombus lentiginosus	0	940	430	0	0	0	0	0	920	0.69
Strombus luhuanus	1050	6030	1870	420	1260	2125	780	760	3240	5.36
Strombus mutabilis	330	2510	1420	730	2900	2050	1040	960	3640	3.96
Cypraeidae spp.	830	440	390	200	40	225	300	120	600	1.00
Polinices melanostomus	0	50	0	110	60	50	0	80	0	0.11
Cymatium pileare	0	160	30	20	40	525	120	360	240	0.32
Chicoreus laciniatus	0	320	0	0	0	0	0	0	0	0.14
Nassarius dorsatus	0	0	0	0	0	75	0	0	0	0.01
Vasum sp.	0	0	330	0	0	0	0	0	400	0.18
Conus spp.	70	730	530	590	680	0	0	100	1560	1.16
Pythia scarabaeus	0	0	0	0	0	0	0	0	320	0.03
									Gastropod %	26.25
Bivalvia										
Anadara antiquata	4350	30310	31520	9260	17240	0	7060	3420	18360	39.71
Barbatia cf. *velata*	0	0	0	30	200	9775	0	80	0	1.76
Modiolus sp.	0	0	10	0	0	0	0	0	0	0.00
Spondylus sp.	350	990	470	320	160	4050	0	140	1000	1.79
Ostrea spp.	30	220	30	0	900	50	60	0	0	0.33
Chama cf. *iostoma*	2570	16380	14170	5980	9600	7475	3340	3760	14280	23.30
Trachycardium cf. *flavum*	0	0	580	150	0	0	0	0	1000	0.42
Tridacna spp.	230	0	3380	3270	1560	25	680	0	240	3.48
Hippopus hippopus	170	0	1260	0	120	0	100	0	280	0.69
Tellina spp. (small)	20	70	0	0	120	0	0	0	0	0.06
Tellina sp.	0	0	0	80	0	0	0	80	0	0.05
Polymesoda cf. *coaxans*	0	1150	480	60	440	525	120	160	200	1.00
Periglypta reticulata	0	90	1440	70	260	0	80	0	280	0.79
Gafrarium pectinatum	150	360	160	0	100	0	0	180	200	0.37
									Bivalve %	73.75
Unidentified Shell	4240	8170	4410	1380	3180	1800	2620	2480	8400	
TOTAL SHELL (1/4" Screen)	15810	75410	73530	23800	42600	36600	18180	14660	64120	41779

Table C.11 Shell density (g/m^3), TP 1, Site DAF (Sohano Island).

	Layer/Level									% (wt)
	I/1	I/2	IIB/3	IIB/4	IIB/5	IIB/6	IIB/7	IIC/8	IID/9	
Gastropdoda										
Trochus niloticus	5830	3530	8000	36000	43000	30500	66000	33000	22000	23.98
Trochus maculatus	590	50	1000	970	0	0	2640	100	50	0.51
Tectus pyramis	0	0	0	0	0	0	0	400	710	0.11
Turbo spp.	290	260	80	70	250	210	10	130	80	0.13
Turbo marmoratus	0	0	0	3330	4070	0	0	0	0	0.72
Nerita spp.	0	0	0	0	10	0	10	20	20	0.00
Terebralia palustris	0	0	90	0	0	120	120	0	0	0.03
Cerithium spp.	510	500	0	200	210	290	450	780	820	0.34
Cerithium nodulosum	0	0	0	160	50	170	100	190	280	0.09
Rhinoclavis spp.	0	0	340	800	0	0	0	0	0	0.11
Lambis lambis	14000	11500	16500	19500	24000	30500	40000	14000	20000	17.40
Strombus lentiginosus	330	1680	1120	740	1000	2880	1510	850	730	1.05
Strombus luhuanus	10750	26000	25000	26000	18000	21000	23000	15000	14000	19.21
Strombus mutabilis	31000	11500	20500	26000	18500	24000	35000	18000	14000	17.30
Strombus spp.	340	0	0	0	0	0	0	0	0	0.03
Cypraea spp.	390	430	1110	1170	310	540	350	400	200	0.47
Polinices melanostomus	0	0	0	10	0	0	30	0	50	0.00
Cymatium pileare	10	10	120	70	250	10	80	120	50	0.07
Chicoreus ramosus	0	0	0	0	3100	0	0	0	0	0.30
Vasum spp.	0	0	0	2650	0	1510	1430	6000	100	1.13
Conus spp.	990	1810	690	2020	480	1820	3340	880	620	1.22
Terebra spp.	0	0	0	0	50	0	370	0	100	0.15
Pythia scarabaeus	30	40	30	90	120	130	240	170	290	0.10
								Gastropod %		85.45
Bivalvia										
Anadara antiquata	21000	10000	12000	14000	7000	8000	6000	4500	2130	8.19
Barbatia sp.	0	0	0	0	0	10	40	10	10	0.00
Pinctada margaritifera	0	0	0	0	170	80	10	10	0	0.02
Spondylus sp.	0	10	10	0	0	0	230	0	0	0.02
Ostrea spp.	0	250	0	0	0	200	0	0	0	0.04
Chama cf. *iostoma*	4650	3940	2750	1830	1260	960	1490	930	1100	1.83
Trachycardium cf. *flavum*	50	0	330	50	0	160	200	50	50	0.07
Tridacna maxima/crocea	3550	490	700	2890	730	1580	6480	200	1410	1.74
Hippopus hippopus	920	0	0	0	0	0	1880	0	1520	0.42
Tellinidae spp. (small)	130	70	130	180	220	270	260	220	220	0.16
Polymesoda cf. *coaxans*	340	750	1220	930	870	1000	3820	2300	2250	1.30
Periglypta reticulata	1810	480	250	240	130	1000	1030	320	510	0.56
Gafrarium pectinatum	0	240	180	260	110	190	370	510	180	0.20
								Bivalve %		14.55
Unidentified Shell	81000	55000	58000	62000	52500	50000	70500	50000	41500	
TOTAL SHELL	177740	129480	150090	201880	176470	177190	266930	149400	124830	172668

Table C.12 Shell density (g/m^3), TP 1, Site DJW (Pororan Island).

	Layer/Level										% (wt)
	I/1	IIA/2	IIA/3	IIB/4	IIB/5	IIB/6	IIC/7	IIC/8	IIC/9	III/10	
Gastropoda											
Patellidae spp.	0	0	10	0	0	0	0	10	0	0	0.00
Trochus niloticus	360	3170	32500	15000	3310	8500	80000	21250	2030	33	36.60
Trochus maculatus	60	10	0	260	870	610	3480	1740	0	7	1.52
Tectus pyramis	130	0	1190	0	0	0	0	0	10	0	0.28
Angaria delphinus	0	0	0	100	0	90	300	150	70	240	0.23
Turbo spp.	250	580	480	670	0	490	290	640	310	0	0.80
Astraea sp.	0	0	0	0	150	0	0	0	0	0	0.03
Nerita spp.	70	140	160	110	70	50	150	170	70	127	0.25
Terebralia palustris	180	0	90	0	250	870	3350	2170	190	0	1.53
Cerithium nodulosum	80	230	200	230	0	0	0	370	0	0	0.24
Cerithium spp. (small)	0	0	10	0	0	50	10	140	60	80	0.08
Lambis lambis	780	2050	0	8000	1000	4500	16500	11000	510	13	9.57
Strombus lentiginosus	0	370	690	230	800	0	550	0	600	0	0.70
Strombus luhuanus	3420	2970	7000	6000	6000	8000	8250	14250	1750	0	12.44
Strombus mutabilis	2800	2120	7000	9000	6250	4010	12000	11000	760	60	11.88
Cypraea spp.	0	10	40	200	0	1910	3980	1180	0	0	1.58
Polinices melanostomus	60	20	40	160	200	200	130	20	60	0	0.19
Cymatium pileare	130	0	0	0	10	0	380	40	80	33	0.15
Vasum spp.	0	0	110	0	0	0	0	0	0	0	0.02
Conus spp.	120	50	890	380	190	210	2830	980	630	0	1.36
Pythia scarabaeus	340	200	350	560	440	490	820	1000	630	180	1.10
Bivalvia									Gastropod %		81.55
Anadara antiquata	1980	1020	3750	5000	2740	4000	8000	11750	3600	420	9.17
Pinctada margaritifera	0	130	0	370	750	100	300	1270	1040	0	0.85
Spondylus sp.	0	0	0	0	0	0	0	620	0	27	0.14
Ostrea spp.	0	0	270	0	500	0	0	0	0	0	0.17
Chama cf. *iostoma*	1010	1440	1590	1030	310	180	340	750	0	0	2.04
Trachycardium cf. *flavum*	0	0	0	0	130	10	110	30	10	100	0.09
Tridacna maxima/crocea	490	820	380	1320	110	1370	0	270	0	40	1.04
Hippopus hippopus	0	0	0	0	0	0	2550	0	0	0	0.55
Tellinidae spp. (small)	390	440	400	240	1210	120	100	220	1700	107	1.07
Polymesoda cf. *coaxans*	190	260	530	1310	310	1320	1540	3700	220	47	2.04
Periglypta reticulata	0	0	10	50	740	510	50	1050	200	0	0.56
Gafrarium pectinatum	140	170	510	930	310	630	290	280	90	20	0.73
									Bivalve %		18.45
Unidentified Shell	16000	10500	15000	15500	11000	13000	20000	31000	2450	353	
TOTAL SHELL	28910	26650	86120	66640	37600	51170	166230	116950	15320	1767	56975

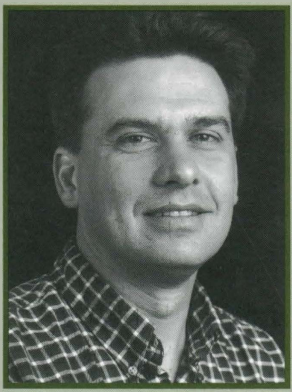
Table C.13 Shell density (g/m^3), TP 1, Site DJU (Pororan Island).

	Layer/Level											% (wt)
	I/1	II/2	II/3	II/4	II/5	II/6	II/7	II/8	II/9	II/10	II/11	
Gastropoda												
Trochus niloticus	327	1342	13	880	347	2658	533	5693	6240	6533	17699	12.62
Trochus maculatus	0	26	587	813	147	342	517	400	693	1107	2416	2.01
Turbo spp.	0	0	0	13	0	0	17	0	640	27	0	0.17
Nerita spp.	88	500	107	67	93	26	0	13	13	0	9	0.26
Terebralia palustris	0	0	453	13	0	0	0	0	13	0	0	0.11
Cerithium nodulosum	0	0	0	0	0	0	633	200	0	13	0	0.18
Cerithium spp. (small)	0	0	0	13	13	0	17	0	0	13	9	0.02
Lambis lambis	416	605	2520	453	1067	3289	5567	8053	13333	19333	11504	17.41
Strombus lentiginosus	0	0	0	0	0	1079	0	653	1200	373	0	0.70
Strombus luhuanus	1929	1079	2200	667	0	5237	9450	10667	14667	9333	4080	14.44
Strombus mutabilis	1292	2026	2560	1653	4467	5605	8983	24000	50000	24000	19912	37.68
Cypraea spp.	0	0	0	0	0	0	0	653	707	0	0	0.34
Polinices melanostomus	168	237	67	267	107	500	533	227	333	293	97	0.63
Cymatium pileare	9	26	13	0	0	0	17	13	0	13	133	0.05
Chicoreus cf. *laciniatus*	0	0	0	0	0	0	17	0	0	0	327	0.12
Vasum spp.	0	0	0	0	0	0	0	0	0	13	336	0.13
Conus spp.	0	0	520	0	0	789	17	1467	1147	813	593	1.32
Pythia scarabaeus	177	158	67	27	67	184	183	213	440	347	372	0.54
											Gastropoda %	87.73
Bivalvia												
Anadara antiquata	991	1921	2027	733	573	4289	2583	2427	3413	2640	2159	5.48
Mytilidae spp.	0	26	13	13	0	0	0	0	0	0	0	0.01
Pinctada margaritifera	0	0	0	67	0	0	517	0	0	0	44	0.10
Chama cf. *iostoma*	2363	1211	1747	187	2027	1684	2717	2147	2600	333	44	4.09
Tridacna maxima/crocea	44	0	0	0	0	0	0	0	0	680	91	0.17
Hippopus hippopus	0	0	0	0	573	0	0	0	333	1853	0	0.69
Polymesoda cf. *coaxans*	0	0	0	0	0	1289	550	0	907	640	0	0.66
Gafrarium pectinatum	9	0	0	0	267	0	0	0	13	13	0	0.07
Tellinidae spp. (small) common in all levels	-	-	-	-	-	-	-	-	-			
											Bivalve %	11.27
Unidentified Shell	11504	21053	12000	8667	10667	18421	19167	18667	20000	21333	15044	
TOTAL SHELL	19342	30533	24787	14387	20333	45973	51933	76787	116640	89613	75004	50345

Table C.14 Shell density (g/m^3), TP 1, Site DJO-A (Kessa Plantation).

	Layer/Level										% (wt)
	IA/1	IIA/2	IIA/3	IIA/4	IIA/5	IIB/6	IIB/7	IIB/8	III/9	III/10	
Gastropoda											
Patellidae spp.	0	0	0	0	0	0	0	10	0	170	0.03
Trochus niloticus	4876	13139	7027	1750	900	5730	12000	14500	120	10	13.24
Trochus maculatus	124	496	0	0	100	10	1720	750	0	190	0.71
Tectus pyramis	429	1348	0	0	40	1290	0	0	0	0	0.72
Turbo spp.	6	522	0	0	0	10	140	130	0	0	0.18
Turbo marmoratus	0	0	0	0	330	0	0	0	0	0	0.06
Nerita spp.	41	9	9	80	10	0	40	40	0	10	0.05
Terebralia palustris	229	600	0	3460	1250	140	950	150	0	10	1.40
Cerithium nodulosum	0	304	0	190	0	190	400	140	0	0	0.18
Lambis lambis	2012	1435	1418	2370	3200	7290	11000	16000	1530	200	9.65
Strombus lentiginosus/canarium	235	0	0	0	0	1470	800	890	0	0	0.71
Strombus luhuanus/mutabilis	9306	18261	29727	37500	28000	15500	16000	16000	1420	3200	37.46
Cypraea spp.	0	9	9	10	350	10	0	10	1080	0	0.29
Polinices melanostomus	0	174	245	200	70	40	60	110	90	0	0.21
Cymatium pileare	59	9	255	120	0	100	0	0	40	0	0.13
Vasum spp.	0	0	0	0	180	0	0	0	0	0	0.04
Conus spp.	0	0	791	0	300	10	340	0	0	0	0.30
Terebra spp.	0	0	0	0	0	0	0	0	0	310	0.06
Pythia scarabaeus	429	704	127	290	180	110	90	140	30	60	0.52
									Gastropod %		64.94
Bivalvia											
Anadara antiquata	1376	2078	3227	6430	10000	3910	5340	3370	60	850	7.65
Mytilidae spp.	6	9	118	20	10	10	20	20	0	10	0.03
Pinctada margaritifera	0	0	0	0	160	250	0	0	0	0	0.08
Spondylus sp.	0	0	0	0	0	0	0	0	140	0	0.03
Chama cf. *iostoma*	2718	7174	11818	15500	9500	2960	1970	1730	120	610	11.66
Trachycardium sp.	0	0	0	10	0	0	0	0	120	0	0.02
Tridacna maxima/crocea	0	0	0	1020	4430	0	9000	570	0	0	3.01
Hippopus hippopus	1635	739	0	380	550	2700	0	3000	270	350	2.18
Tellinidae spp. (small)	3559	13487	X	X	X	X	X	X	X	X	-
Polymesoda cf. *coaxans*	376	922	1845	2360	820	910	700	300	630	10	1.89
Periglypta reticulata	0	348	0	0	0	0	0	0	0	0	0.08
Gafrarium pectinatum	1476	3104	782	2020	1840	880	370	290	120	290	2.55
									Bivalve %		35.06
Unidentified Shell	8235	26087	21818	36000	31000	26000	18000	19500	10000	10500	
TOTAL SHELL	37118	90913	81182	109670	93190	69470	78920	77610	15980	16730	65320

Table C.15 Shell density (g/m^3), TP 1, Site DJO-D (Kessa Plantation). (Code: X = common, but not sorted)



THE AUTHOR

Stephen Wickler is a Researcher in the Department of Archaeology at the Tromsø University Museum in Tromsø, Norway. He has worked as an archaeologist in Oceania for two decades and has field experience in Melanesia, Polynesia and Micronesia. He conducted fieldwork on Buka and nearby islands over a period of ten months in 1987 for his PhD dissertation at the University of Hawai'i, which provides the basis for the present monograph.

Wickler's research in Oceania since 1995 has focused on the Palau Islands in western Micronesia where he has directed survey and excavation on the island of Babeldaob for the ongoing Compact Road Project. Project results include archaeological evidence for settlement by 3400 BP, more than a millennium earlier than previously documented. Palaeoenvironmental coring results from the project provide indirect evidence for human colonisation of Palau by 4500 BP. He is presently involved in a joint research project with Atholl Anderson, head of the Centre for Archaeological Research, Research School of Pacific and Asian Studies, The Australian National University which focuses on the initial colonisation and early settlement of Babeldaob.

The Prehistory of Buka: A Stepping Stone Island in the Northern Solomons publishes for the first time the detailed results of archaeological field research carried out by the author on the island of Buka and smaller offshore islands in what was then North Solomons Province, Papua New Guinea. These results include documentation of Pleistocene human settlement for the first time in the main Solomon Islands, information on the nature of Lapita settlement from reef flat sites, a detailed assessment of the post-Lapita ceramic sequence for Buka originally constructed by Jim Specht (1969), the elucidation of long-term trends in subsistence, and the examination of changing patterns of exchange and interaction throughout the prehistoric sequence. Excavations at four open beach sites and three cave/rockshelter sites document settlement from the late Pleistocene to late prehistoric period.

The earliest occupational evidence dates to 29,000 BP at the Kilu cave site. The rich faunal assemblage at this site includes endemic rats which are now extinct. Starch residues and raphides from aroids found on stone tools from the basal site deposit provide the earliest direct evidence for the use of root crops in the World.

Prior to the late Lapita period when beach and cave/rockshelter sites are documented, evidence for Lapita settlement is restricted to artefacts on intertidal reef flats interpreted as stilt village settlements. Analysis of ceramics from reef flat sites on Buka, Sohano and Nissan Island reveals similarities in clay and temper composition, vessel form and decoration. Evidence for exchange during the Lapita period includes obsidian from the Bismarcks (almost exclusively from the Admiralties rather than New Britain) and the probable transport of Buka-made ceramics to Nissan Island.

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