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Richard Walter, *Anai'o: The Archaeology of a Fourteenth Century Polynesian Community in the Cook Islands*

ANAI'O: THE ARCHAEOLOGY OF A FOURTEENTH CENTURY POLYNESIAN COMMUNITY IN THE COOK ISLANDS

Richard Walter

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PREFACE

My interests in Cook Island archaeology started when I was a student in the Anthropology Department at the University of Auckland. In 1983 I was searching for a suitable topic for my post-graduate research when my professor, Roger Green, returned from a holiday in the Cook Islands. During his trip Roger visited the Museum on Rarotonga where he saw some archaic artefacts provenanced to a place called Anai'o on the island of Ma'uke. Because of my interests in East Polynesian archaeology and because I had connections to the island of Ma'uke, I was encouraged to initiate a research project on the island. I went to Ma'uke for the first time in the summer of 1984 hoping to locate a site suitable for defining the Cook Island aspect of the archaic tradition. I was able to locate the Anai'o site soon after arriving and carried out a small excavation there several weeks later. The site turned out to be large and well preserved and I returned to Ma'uke to carry out a more detailed investigation in 1985.

My intentions in 1985 were to excavate the site with a view towards addressing some current issues in the archaeology of East Polynesia. At that time a number of people were starting to question the conventional interpretations of East Polynesian settlement history, and the Cook Islands were beginning to be seen as crucial in understanding the timing and direction of East Polynesian settlement. Cook Island archaeology was still largely unknown in the 1980s although two previous projects by New Zealand teams had laid much of the groundwork. In my PhD thesis, which was completed in 1990, I discussed the excavations of the archaic horizons at Anai'o and used the Anai'o data to develop a particular model for East Polynesian colonisation and post-colonisation cultural change.

Since completing the Anai'o excavations I have continued to work on Ma'uke and elsewhere in Ngaputoru and the southern Cook Islands. The present monograph looks again at the Anai'o site with the benefit of insights gained from this subsequent fieldwork and from having extended the laboratory analysis of the excavated materials. In this volume I further develop the interaction model of East Polynesian colonisation and culture change raised in the thesis. The model hinges on the concept of an early voyaging network which linked islands of East Polynesia into an interaction sphere. It was initially based on the realisation that the Anai'o community were not isolated on the shores of Ma'uke, but were supported by the importation of raw materials from a range of different sources. The model was greatly strengthened by the results of subsequent sourcing and exchange studies both in the Cook Islands, and elsewhere in Polynesia. On the other hand, this volume presents a very different interpretation of the dating for Cook Island colonisation to that developed in the thesis. In my thesis I argued that the southern Cook Islands might have been settled early in the first millennium A.D. I felt that dated sites from this period were missing because of environmental effects such as sedimentation, as well as the lack of sufficient reconnaissance work. While this argument was tenable in the 1980s, enough thorough survey work, including systematic sub-surface testing, has been carried out in the interim to convince me that these sites probably do not exist.

As well as using the Anai'o data to explore wider problems in East Polynesian colonisation history, this work focuses more closely on the site itself than was attempted in my earlier analysis. The site was excavated as a wide areal exposure and this permits a detailed study of the spatial organisation of behaviour within the settlement. Considering technology, subsistence systems and the spatial organisation of activities, in this work I attempt an 'archaeological ethnography' of an early Ma'uke community.

During the course of my work in the Cook Islands I have been helped by many people and by many organisations. Funding for the Anai'o excavations was provided by the Wenner Gren Foundation for Anthropological Research, by the Mackenzie Trust and by the New Zealand Lotteries Board. Additional funding for aspects for the Cook Island research and the publication of this volume was provided by MOMBUSHO, Japan, the Otago University Research Grants Committee and the Otago University, Humanities Research Grants Committee.

In Rarotonga I received assistance and support from George Cowan, Ken Hallin, Margaret Karika, George Paniani, Ernest Taripo, Harry Taripo, Ina and Carmen Temata, Tereapi Temata, Bob Tongia, Makiuti Tongia, Puna Tongia, Tony Utanga, and the staff of the Prime Minister's Department and the Library and Museum Society.

On Ma'uke I was provided with assistance from many quarters and received support from many family members and friends. Amongst those whose efforts are gratefully acknowledged are: Tamuera Ariki, Archie and Kura Guinea, Tutu Mani and family, Mouauri Marsters, Rouru Noema, Timemi and Nane Oaariki, Aito and Tangi Oaariki, Mapu Taia, Papa Mana Tamuera. I am especially grateful to my mother-in-law Tiare Temata for so much support in my trips to Ma'uke over the last 15 years. Special thanks also to my wife Pat and to my daughter Inano who spent the first few years of her life in the field, and to my son Billy.

I am especially grateful for the support I received from the Member of Parliament for Ma'uke Mr Vaine Tairea, from the Government Representative Mr Tautara Purea and from the Ma'uke Island Council. The field crew Tau'u Nakuape, Maru Ngametua, Pokoparu and Timeni Oaariki, Achong Tamatoa, Henry and Piki Taripo, and Sam were excellent workers and provided a constant stream of ideas and speculations. The field visit by Sue Bulmer and Brenda Sewell was also greatly appreciated.

In New Zealand I received support and advice from many quarters during the course of my research and a number of people have kindly commented on drafts of this volume or on thesis chapters. These include: Dorothy Brown, Matthew Campbell, Jacquie Craig, Janet Davidson, Geoff Irwin, Pat Kirch, Foss Leach, Helen Leach, Reg Nichol, Robin Parker, Peter Sheppard, Yosihiko Sinoto, Ian Smith, Doug Sutton, Rod Wallace and Marshall Weisler. I am especially grateful to Barry Rolett who read a full draft of the volume and offered many worthwhile suggestions to improve the text. Technical support with illustrations and figures was kindly provided by Andre Brett, Martin Fisher, Les O'Neill and Caroline Phillips. Les O'Neill did the page layout with financial support provided by the Anthropology Department, University of Otago.

Doug Sutton's support in Auckland and in Rarotonga and the hours he spent discussing Cook Island archaeology with me are appreciated. Above all I would like to thank Roger Green who is the reason why I became involved in Pacific archaeology and without whose support I may not be fortunate enough to be doing it now.

CHAPTER 1. INTRODUCTION

The first European explorers in the Pacific frequently commented on the many cultural similarities they observed as they travelled between the scattered archipelagos and isolated islands of Polynesia. Cook in fact, went as far as to write of a Polynesian "Nation" (Beaglehole 1959:354). Common features of language, oral tradition, material culture and behaviour express patterns of cultural unity but Polynesia also contains some well defined internal cultural divisions.

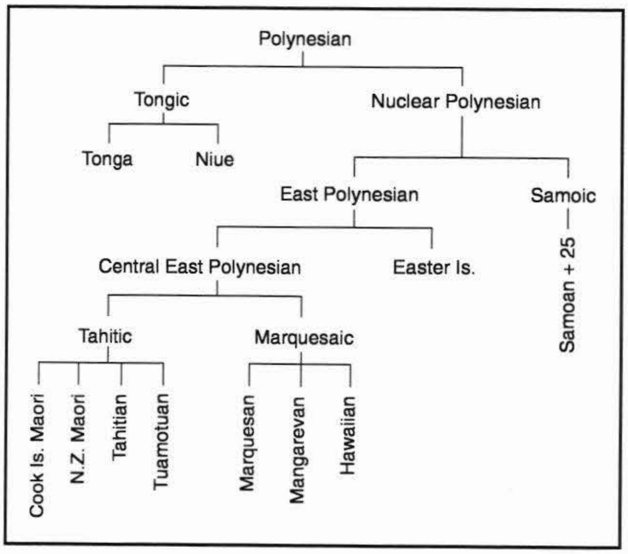

FIGURE 1.1. Polynesian language tree.

In a pioneering attempt to measure patterns of cultural similarity versus dissimilarity in Polynesia, Burrows (1938) compared features of material culture, kinship terminologies and certain formalised behaviours and used these observations to define three culture areas: Western, Central and Marginal Polynesia. Today, Central and Marginal Polynesia are usually grouped into a single culture unit, East Polynesia, and this fits the current linguistic models well. In the standard Polynesian language tree, those languages east of Samoa fall into a well supported Eastern subgroup of the Polynesian language family (Clark 1979). The languages of West Polynesia fall either into a first order subgroup, Tongic, (Niue, Tonga) or into Samoic which in turn, groups with the East Polynesian languages into the other first order Polynesian subgroup, Nuclear Polynesian (Fig. 1.1). Samoic and Tongic do not share any linguistic features exclusively and so there is no exact western counterpart to East Polynesian. This is an important point in terms of reconstructing settlement histories (see Clark 1979, Green 1966).

The current archaeological view is that West Polynesia and Fiji were settled late in the second millennium BC by a culture bearing the characteristic dentate stamped Lapita ceramics (Kirch 1997). The arrival of these Austronesian groups in West Polynesia marked the final phase of a maritime expansion which had begun about 3800 B.P. somewhere around the north coast and offshore islands of Papua New Guinea, and which led to the establishment of Lapita communities through the Solomon Island chain and into Vanuatu and New Caledonia (Kirch 1997). The Lapita colonists of the central Pacific subsequently became isolated from their western counterparts and a phase of cultural and linguistic development ensued which resulted in the emergence of a distinctive Polynesian or pre-Polynesian culture (Kirch 1997, 1984). In the more strict evolutionary versions of Polynesian culture history this process is spoken of as a period of adaptation in isolation resulting in the formation of a Proto-Polynesian language, an ancestral Polynesian society and a parental Polynesian population (Kirch and Green 1987). Following these developments, there was a pause of undetermined length before voyaging continued and the islands of East Polynesia were successfully settled.

Once the Polynesian ancestors ventured into East Polynesia they were faced with a whole new set of technological and environmental difficulties. After crossing the Andesite Line which runs south between Tonga and the Cook Islands, they found themselves on the Pacific plate which contains only recent volcanic islands and a relatively impoverished biota. Furthermore, sea distances between islands increase, complicating the processes of navigation and two-way voyaging. Nevertheless, the prehistoric societies of East Polynesia share a remarkable number of common traits including a material culture inventory which is highly distinctive and which contrasts markedly with that of the West Polynesian islands. Drawing on rich artefactual assemblages from a number of early sites in the Marquesas, New Zealand, Hawaii and the Society Islands, archaeologists have used comparative studies of material culture to construct a colonisation sequence for East Polynesia.

In 1978, Bellwood (1978b) listed the contents of what he termed an "Early East Polynesian" assemblage and in 1981 Sinoto described a similar "archaic" assemblage (Kirch 1986:16). Subsets of the archaic assemblage were found in the earliest horizons of sites across much of topical and temperate East Polynesia and included such diagnostic artefacts as one-piece and compound shank fishhooks, trolling lures, untanged adzes in a range of cross-sections, harpoon heads, tattooing chisels, octopus lures, whale tooth ornaments and reel pendants. Based on the distribution of archaic artefact types, Emory and Sinoto (1965) compiled one of the first stratigraphically based models of East Polynesian colonisation history. Although somewhat crude in its first manifestation, this model soon became the skeleton around which subsequent archaeological discoveries in East Polynesia were organised (see Bellwood 1978:318).

In 1979, Jennings published his landmark volume *The Prehistory of Polynesia* which presented the state of Polynesian archaeology at the time. In this work, a modified version of the Emory and Sinoto model was presented in the introduction, and became the principle around which the individual chapters were organised (Jennings 1979:3). This version of the settlement model had seven distinct phases:

1. *ca* 300 AD-Marquesas settled directly from West Polynesia;
2. *ca* 400 AD-Easter Island settled from the Marquesas;
3. *ca* 500 AD-Hawai'i settled from the Marquesas;
4. *ca* 600 AD-The Society Islands settled from the Marquesas;
5. *ca* 800 AD-New Zealand settled from the Society Islands, perhaps via the Cook Islands;
6. a later recolonisation of Hawai'i from the Society Islands;
7. a possible recolonisation of New Zealand from the Society Islands.

The most important element of this model was the idea of innovation and dispersal centres. These are regions in which linguistic, social and artefactual innovations developed in isolation, and from where they were later dispersed to newly discovered islands. The major innovation centre in East Polynesia was assumed to be the Marquesas (Sinoto 1970) which contained the archaic type site (Hane) and the earliest radiocarbon dates. From the Marquesas the archaic assemblages, along with a suite of unique linguistic features, were dispersed during a series of migrations (Phases 1 through 4). The Society Islands became a secondary innovation and dispersal centre with Society Island voyagers settling the Cook Islands and New Zealand, and resettling Hawaii. The concept of innovation and dispersal centres was useful because it gave a form to the settlement sequence which neatly mirrored the branching, nodal structure of the Polynesian language tree. It also provided a simple, plausible explanation for the homogeneity of East Polynesian society which was consistent with the radiocarbon dating of the time.

Despite its explanatory power, by the 1980s serious problems started to emerge with the innovation/dispersal centre model. Biggs (1972) had already cautioned prehistorians about the pitfalls of extending linguistic models of subgrouping to reconstructions of island settlement and pointed out that A to B to C scenarios were likely to prove poor approximations of actual colonising behaviour. Irwin reiterated this point in 1981 noting that the "authorised version", as he called it, was too inflexible to represent the dynamics of human movement and language change in the Pacific (Irwin 1981). He also argued against an hiatus between the settlement of West and East Polynesia. In Irwin's view, this was not only logically unsound given what was known of the colonising behaviour of Lapita and other Pacific peoples, but was based on a paucity of field work in those areas where evidence of early intrusion into East Polynesia would be most likely to be found (i.e. the Cook Islands). In 1986 Kirch published a reassessment of the authorised version (which he called the "orthodox model") in which he amplified the objections of Irwin and discussed a number of specific dating problems (Kirch 1986).

As a result of the criticisms offered by Irwin, Kirch and others many archaeologists are now suspicious of the geographically discontinuous pattern of colonisation implied by the authorised version, and expect the settlement of East Polynesia to have occurred in a more gradual west to east fashion. The pause in voyaging, which is uncomfortable to many archaeologists, has still not been entirely eliminated and there are vigorous debates about the exact dates of island settlement (see below). Nevertheless, few archaeologists still believe that the Marquesas were the first island group settled out of West Polynesia and this is consistent with recent reassessments of the early Marquesan dates (Anderson *et al.* 1993; Rolett and Conte 1995; Spriggs and Anderson 1993). There has also been a reevaluation of the innovation/dispersal centre model as an explanation for cultural homogeneity in East Polynesia, and for the development of the archaic assemblage.

The innovation centre hypothesis is powerful in explaining observed patterns of cultural and linguistic similarity, but it is weak in its ability to describe past human behaviour and cultural process. The idea that there were only a small number of centres of technological and cultural development is problematic in social and historical terms. What exactly were these centres, and why did they occur in some places and not others? What types of cultural processes were operating in them that led to phases of voyaging following periods of isolation and innovation? In short, the concept of pulses of migration out of a hypothetical innovation centre does not constitute a satisfactory theoretical model of colonising behaviour.

As an alternative to the innovation and dispersal centre explanation for East Polynesian cultural homogeneity, some archaeologists now see the answer lying in more complex models of inter-regional behaviour (Irwin 1990; Rolett 1994; Walter 1990; 1996b). In fact, for some East Polynesian archaeologists, 'interaction' has now replaced 'isolation' as the principal process directing cultural change. According to this view, understanding some of the qualitative and quantitative changes in the nature of long-distance interaction networks in East Polynesia provides a key to understanding settlement histories and post-colonisation socio-political and economic change. Within an interaction framework an alternative hypothesis for East Polynesian colonisation based on Cook Island archaeological data was outlined in Walter (1990, 1996b). This has been referred to as an "interaction and cultural continuity" model (Rolett 1994:30).

According to this model, East Polynesia was settled as part of a systematic eastward expansion which began with Lapita. Following a pause of a still unknown duration the Cook Islands were the first island group settled out of the West Polynesian homeland. Voyaging continued beyond the colonisation phase and resulted in the development of a long-distance interaction network linking islands *within* the main archipelagos of central East Polynesia and with less frequent interaction occurring *between* these archipelagos. As innovations in material culture and language appeared, they were spread throughout the network. Distance decay factors resulted in closer islands having more regular contact and this in turn resulted in the development of overlapping interaction spheres marked linguistically and technologically as dialect chains and style zones. Exchange of raw materials would also have taken place through the medium of the network. A wide area interaction network of this sort was not in place at the time of European arrival in the Pacific and is likely to have declined sometime after the 14th century when there is increasing evidence for isolation in the archaeological record of islands and archipelagos (see Chapter 11).

In view of current theories of East Polynesian colonisation, the southern Cook Islands stand out as occupying a position of particular significance. First, the southern islands of the Cook group lie between the core archipelagos of West and East Polynesia and thus they are likely to hold key information concerning the chronology of East Polynesian settlement (see also Kirch *et al.* 1995:47). Second, the Cook Islands offer an excellent opportunity to look at the history of inter-island voyaging and communication in the East Polynesian region. The southern Cook Islands lie on the western edge of a chain of islands making up central East Polynesia. They are an archipelago in which raw materials are unevenly distributed and as a result, Cook Island communities are likely to have engaged in the importation of raw materials as circumstances allowed. The stratigraphic record of these importations documents the changing pattern of inter-island communication and voyaging in Cook Island and East Polynesian prehistory. This bears on the wider question of interaction and its role in East Polynesian culture change.

COOK ISLANDS ARCHAEOLOGY

Although the Cook Islands were late in attracting large scale archaeological research they have played a significant role in the history of Polynesian scholarship because of the interests of early members of the Polynesian Society. Cook Island oral tradition, for example, played a very large role in the development of Percy Smith's interpretation of New Zealand's Polynesian settlement which has been so influential in New Zealand social history (Smith 1919; Sorrenson 1979). Smith's early interest in Cook Island oral tradition was followed by Buck's visit to the Cook Islands in the early decades of this century and his later publication of a number of groundbreaking monographs on the culture of islands in both the southern and northern Cook group (Buck 1927, 1934, 1944). Buck also produced the first overview of Cook Island prehistory which looked beyond oral tradition for its sources (Buck 1927).

Buck explicitly rejected a Melanesian origin for the Polynesian peoples and, basing his interpretation partly on oral tradition and partly on material culture, he argued that the Society Islands were settled early in the colonisation of Polynesia by groups moving south-east out of Micronesia. The Society Islands became a centre for the development of Polynesian culture and religious beliefs and later served as the dispersal point for colonists voyaging to the other groups in the region including the Cook Islands (Buck 1954). So in Buck's view, the Cook Islands were settled from the east, from the Society Islands. Buck's ideas on colonisation are expressed in one of the first, and by far the most imaginative, interpretive illustrations of Polynesian migration history. In Buck's illustration, a giant octopus straddles the Pacific with its head and body in the Society Islands (Havaii) and with each tentacle stretching out to the peripheries. All the major island groups are strung out along the arms. The southern Cook Islands lie halfway along a tentacle which leads ultimately to the Chatham Islands and New Zealand. The northern Cooks are on a different arm leading north-west to Kiribati (Fig. 1.2).

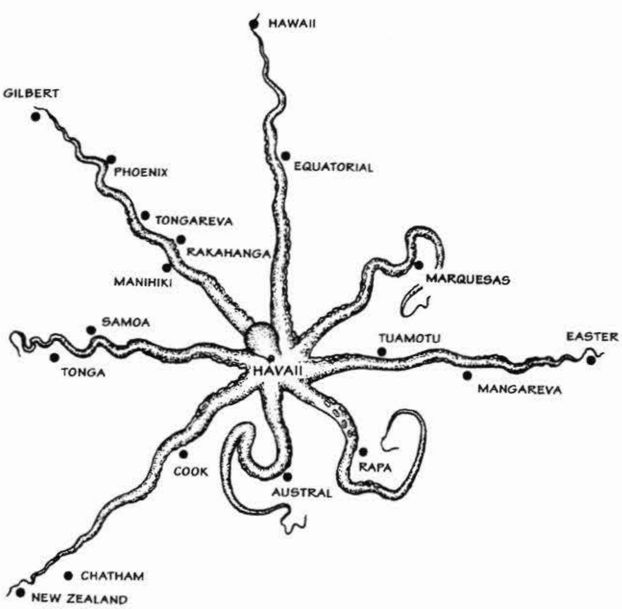

FIGURE 1.2. Buck's octopus model of Polynesian colonisation showing Havaii (the Polynesian homeland) situated in the Society Islands (after Buck 1954).

Following the work of Buck, which included detailed material culture surveys and the first descriptive typology of prehistoric stone tools, the next archaeological projects in the Cook Islands were two large survey programmes; one carried out by the Canterbury Museum in the 1960s and the other by the University of Auckland in the early 1970s (Bellwood 1978a; Trotter 1974). In addition to the site survey data which the Canterbury Museum archaeologists systematised and summarised in a variety of papers, Duff (1968) refined his adze typology work and used it to develop a Cook Island sequence, and Bellwood (1971) incorporated the survey data into a comparative discussion of settlement patterns and ecological adaptation. This early survey data has provided the basis for a number of subsequent settlement pattern studies which are summarised in a recent review article (Walter 1996a).

A period of fieldwork inactivity followed these two projects until the mid 1980s when I began work in Ngaputoru (Atiu, Mitiaro and Ma'uke), and other groups commenced new surveys in both the northern and southern islands (Allen 1992a, b, 1994, 1996; Allen and Steadman 1990; Chikamori 1990, 1995; Chikamori and Yoshida 1988; Chikamori *et al.* 1995; Kirch *et al.* 1991, 1995; Kirch and Ellison 1994; Sinoto *et al.* 1988; Walter 1988, 1989, 1990, 1994a, 1994b, 1996a, 1996b; Walter and Campbell 1996; Walter and Dickinson 1989; Walter and Sheppard 1996; Weisler *et al.* 1994). The recent field reconnaissance work has increased the coverage and quality of site survey data and a number of island sequences have now been proposed. There is also sufficient dated and provenanced material available to allow regional comparative studies to take place. This is especially important since before the 1980s, prehistoric Cook Island material culture was virtually unknown, and the islands were usually omitted from regional overviews of Polynesian prehistory (see for example Jennings 1979). Although the sample is extremely small compared to the other major archipelagos of East Polynesia, the Cook Islands now stand out as having one of the best dated and most comprehensively described archaeological assemblages of material culture in the region. As well as contributing to an understanding of material culture change, the excavations carried out on stratified sites have also supplied important information on subsistence economics, settlement patterns, prehistoric human ecology, monumental architecture, changing patterns of land tenure and on the development of Cook Island political and social systems.

Despite this diverse range of approaches and fairly good regional and temporal coverage, archaeologists do not seem to be as confident about developing provisional overviews of southern Cook Island prehistory as they have at similar stages in the investigation of other island groups. In particular, while most archaeologists have put forward their own views about when they believe the islands to have been colonised and from where, there is little agreement about how much of the cultural sequences are missing. The fact that as much as 60% is talked of in some cases (Kirch *et al.* 1991; Kirch and Ellison 1994) is very unusual in a group where so much work has now been done. Where explicit statements have been made about colonisation dates, these have aroused the most intense debate and this again reflects the crucial position which the Cook Islands occupies in the human geography of Polynesia. Upon the dating of the Cook's sequence the rest of East Polynesian prehistory hinges. In view of this point, a brief overview of the Cook Island dating debate seems appropriate.

Starting in the early 1980s archaeologists began to question the putative pause in voyaging between the settlement of West and East Polynesia which was required by the standard models of Polynesian prehistory (Irwin 1981; Kirch 1986). Because of its geographic position, the late settlement date for the southern Cooks implied in these standard models seemed particularly unsatisfactory. Much earlier dates for East Polynesian settlement were postulated and the earliest sites were anticipated in the Cook Islands. It was on the basis of the plausibility of these arguments that I first started working in the Cook Islands where I attempted, unsuccessfully as it turned out, to locate settlement horizons consistent with this emerging viewpoint. Elsewhere in East Polynesia some archaeologists suggested that there was already some radiocarbon dating evidence to support earlier colonisation dates (Kirch 1986; Sutton 1987).

While some archaeologists were citing evidence to support the hypothesis of a longer chronology for East Polynesia others were moving in the opposite direction. As part of a move to improve and standardise radiocarbon reporting procedures, the published radiocarbon dates from sites in New Zealand and tropical Polynesia were reassessed using a conservative, but highly explicit set of protocols (Anderson 1991; Spriggs 1990; Spriggs and Anderson 1993). The results were generally to reject many of the earliest dates and to argue that the radiocarbon evidence supported a short rather than a long chronology for New Zealand and East Polynesia. Meanwhile, continued survey in tropical East Polynesia and New Zealand, including systematic sub-surface testing, failed to produce the expected earlier cultural horizons. Recognising the failure of these programmes, and the potential difficulty of identifying the 'earliest' cultural horizons, some archaeologists turned instead to the palaeo-environmental evidence in the hope of identifying and dating the first effects of colonisation as reflected in erosion events and deforestation. Palynology became a major tool in colonisation research, some say it became "archaeology by proxy" (Anderson 1995:116).

On Mangaia, in the southern Cook Islands, a multi-disciplinary project tackled the problem of settlement chronology through a combination of palaeo-environmental and archaeological techniques (Kirch *et al.* 1992; Kirch and Ellison 1994). A series of pollen cores taken from Lake Tiriara were first interpreted as indicating forest clearance at *ca* 1600 B.P. (Kirch *et al.* 1991). These cores were later reanalysed and a date of 2400 B.P. was assigned to a phase of fern spore increase, tree pollen decline and an increase in charcoal accumulation. This was taken to imply first human arrival, followed by rapid ecological impact from around 2500 B.P. (Kirch and Ellison 1994).

The archaeological component of the programme focussed on the excavation of the rockshelter site of Tangatatau (MAN-44) located in the same drainage as Lake Tiriara. This site produced a long stratigraphic sequence of which the earliest horizon looked very much like a settlement phase event, but dated at only around 1000 B.P. This included evidence for the rapid extinction of a number of land birds, a type of event which is known to follow very closely on the heels of human colonisation elsewhere in East Polynesia (Steadman 1995). The Mangaian study thus presented an apparent incompatibility between the palynological and archaeological evidence for colonisation. The resolution of this incompatibility required the assumption that slightly more than half the archaeological record (2400 B.P. to 1000 B.P.) was currently missing.

A number of objections have been raised concerning the dating and geophysical assumptions of the Mangaian work (see Anderson 1994). More general problems include the objection that if we accept that 50% or more of the sequences are missing in the Cook Islands do we not have to consider that the same may also be true in Oceanic islands to the west? In fact, palynological work in New Caledonia gives a very different picture to that of Mangaia. There, the archaeological evidence for first human arrival based on similar approaches undertaken in the Cooks and islands to the east agrees closely with the evidence from pollen cores (Stevenson and Dodson 1995).

Although many of the objections to the Mangaian sequence have been addressed (Kirch *et al.* 1995), the debate between long and short chronologies for Mangaia continues, with important implications for the archaeology of East Polynesia as a whole. If the early dates for Mangaia are upheld, this would provide the first solid evidence for continuous voyaging across the East-West Polynesia divide and would have, in addition, a dramatic impact on the theoretical and methodological implications of identifying colonisation events in Polynesia. If they are rejected, we are left with the problem of explaining the pause in voyaging which many archaeologists find theoretically difficult. In either case, Mangaia and the southern Cook Islands clearly stand in a pivotal position in Polynesian colonisation research.

RESEARCH DESIGN

Since the Anai'o excavations were completed, archaeological research in the Cook Islands has increased substantially. This volume looks at the Anai'o data in the light of some of these recent archaeology programmes and examines the results in reference to seven inter-connected research topics. Several of these topics draw on the Anai'o data to address current issues in East Polynesian culture history research. The others take a focussed look at the site itself and contribute towards what might be described as an ethnography of the Anai'o community. The major topics covered in the volume are summarised below.

The East Polynesian archaic

The concept of an archaic assemblage and of an archaic phase in East Polynesian prehistory has its origins in the similarity of material culture in the earliest East Polynesian assemblages (Walter 1996b:513). As discussed above, one of the big questions is whether this similarity can be explained in terms of inheritance from a shared ancestral tradition or whether a common culture developed through interaction in the post-settlement phases. In a recent discussion of the archaic Walter (1996b) suggested that the latter is more likely and that, "...the 'archaic' does not exist as a culture phase, but represents a period prior to regional isolation ...in which interaction was taking place at a relatively high frequency...homogeneity [resulted from] intermittent contact and the sharing of ideas, materials, innovations" (Walter 1996b:525). Regardless of what the archaic means in terms of regional culture history, there is little doubt that in the Cook Islands, New Zealand, the Society Islands and the Marquesas we have an 'early' period of cultures that look very similar to one another. So far, the Cook Island aspect of this early period is poorly known. Anai'o provides an excellent opportunity to compare an early Cook Island site with those from other East Polynesian contexts and to investigate regional variation in this formative period of East Polynesian prehistory.

Prehistoric interaction in East Polynesia

The history of voyaging will always be a central issue in the study of Polynesian prehistory but it is one area that is very difficult to address directly through the archaeological record. At least two basic forms of voyaging took place in Polynesia; first there were the exploratory and colonising voyages which established settlers on new islands and second, there were the inter-island voyages which took place between established colonies and which occurred for a number of social reasons including trade and exchange. Ma'uke was part of the Ngaputoru system, a loose alliance of the islands of Mitiaro, Ma'uke and Atiu whose communities share strong genealogical connections. Periodic voyaging took place between these three islands, but at the time of European arrival Ma'uke was not in regular contact with Rarotonga, Aitutaki, Mangaia or the northern Cook Islands (Murdoch n.d.). Whether there was regular contact beyond Ngaputoru during prehistory is another matter. The sourcing of basalts, ceramic tempers and other classes of industrial material from Anai'o and other sites in the Cook Islands provides an insight into the nature of early Cook Island voyaging and exchange systems.

The nature of early Polynesian voyaging networks is also central to understanding the history of Polynesian cultural development. In recent years interaction models have been increasingly cited in discussions of East Polynesian colonisation and post-colonisation culture change. These models assume, "...an early, relatively high degree of cultural continuity within the region linked by long distance voyaging, with later cultural differentiation developing after a breakdown in the network of intercommunication" (Rolett 1993:31). According to the models, long-distance voyaging networks developed soon after colonisation and these served to link the scattered communities of East Polynesia. Regular interaction allowed cultural and technological innovations to spread through the region, and facilitated the transfer of raw materials in an environment where natural resources were widely and unevenly separated. Patterns of homogeneity, previously explained by the existence of hypothetical innovation/dispersal centres, resulted instead from the regular exchange of ideas and things through a voyaging network. The maintenance of a regular network of communication is believed to have played a central role in early East Polynesian society. Cultural change, including economic and political change, was affected by the breakup of long distance voyaging networks in the last few centuries of prehistory (Walter 1990, 1996b).

Although the existence of interaction networks are consistent with contemporary archaeological data, so far there is little detailed knowledge of the nature of the contacts which existed between individual islands and outside communities during the early phases of East Polynesian prehistory (although see Weisler 1993b). Anai'o provides an excellent case study of the interaction theory since it is an early archaic site and is located on an island with poor natural resources. Yet it contains a rich variety of imported manufacturing materials. A number of these items can be sourced to their island of origin thus providing a detailed picture of a node in an early East Polynesian voyaging network.

Cook Island culture history

The definition of a culture historical sequence is an essential first tool in archaeological research. Although Anai'o is a single phase site and the analysis of material culture and faunal remains is primarily directed toward describing this specific community, these analyses are also intended to contribute towards the longer term goal of sequence construction. Today, the periodisation of an archaeological landscape is rarely seen as an end in itself, but as Kirch has pointed out, archaeologists need to understand how the, "...variability of material archaeological phenomena is highlighted in time and space" (Kirch 1988:14). This sequence provides the basic framework from which we work towards a description, then an explanation of the processes of culture change which are the real topics of archaeological interest. Culture historical sequences lie at the core of archaeological interpretation and useful ones provide more than the standard artefactual inventories. It is usual nowadays that the sequence encompasses a series of trajectories incorporating a diversity of archaeological information. The following discussions of the Anai'o data include an analysis of material culture, subsistence economics, settlement pattern, ecological adaptation, socio-political organisation, trade and exchange, ideology and symbolism. Situating these topics in a well defined temporal framework contributes toward the construction of a culture history sequence for the Cook Islands.

Subsistence economics

The calcareous sand matrix of the Anai'o ridge was particularly well suited to the preservation of faunal remains and good assemblages of bone and shell were recovered from both cultural horizons. As Anai'o was the living zone for a small sedentary community, the faunal assemblage provides a representative sample of the full range of faunal items used by that community and of their subsistence practices. A wide subset of Pacific economic strategies are represented including, terrestrial and marine hunting, fishing, marine gathering and animal husbandry. Given the lack of post-Anai'o faunal materials from Ma'uke it is not possible to provide overviews of within-island change in economic strategies, but comparisons with other island assemblages do provide such information on a inter-island level. Placed as it is near, but not necessarily at the beginning of the Ma'uke sequence, the faunal assemblage also provides some insight into the extent to which Ma'uke society has impacted on natural faunal reserves over the course of island occupation.

Material culture

The Anai'o site produced the most diverse range of artefacts yet recovered from any site in the Cook Islands. Until the excavation of Anai'o, the prehistoric material culture of the Cook Islands was very poorly represented in comparison with the other main groups in East Polynesia. Of the artefacts that were situated in museum or private collections, few were well provenanced, less than a handful were dated and some of the most characteristic items of East Polynesian culture were not represented at all. The Anai'o artefacts make an important contribution toward defining the full range of variation in Cook Island material culture. Besides this general culture historical interest, the Anai'o material affords the opportunity to address a number of other specific goals. These include a typological and functional discussion of shell fishhooks and a technological analysis of flake tools.

Spatial archaeology

Spatial archaeology is used here as a general covering term for both inter-site and intra-site studies. Intra-site spatial analysis is concerned with identifying patterns in the distribution of archaeological materials in a single-site setting as a means of gaining an insight into the social rules and practices which governed inter-personal behaviour within that living community. This type of micro-scale or intra-site analysis assumes a hierarchical organisation in which the smallest archaeological units (artefact or feature etc.) are grouped with their nearest neighbours to form structural and behavioural aggregates. In this manner we can identify houses or other functional categories of structure as well as individual activity areas. These aggregated units become the next element in the hierarchy of analysis. In this way information is gained about the organisation of tasks at the level of the individual, the household and so on through a range of larger social units. Being a well preserved site representing the nucleated residential zone of a small sedentary community, Anai'o contains data extremely well suited to this type of analysis.

Inter-site spatial archaeology is concerned with the question of settlement patterns. This is a wide and diverse field united by a common interest in the spatial patterning of archaeological sites in relation to geographic, social and economic variables (Kirch 1989). Settlement pattern archaeology in the Pacific has taken a number of different approaches falling into the general areas of ecological, social, economic and semiotic analysis (Weisler and Kirch 1985). In practice few, if any, archaeologists would consider these approaches to represent genuinely separate fields of inquiry (Bellwood 1979; Kirch 1982; Walter 1996a). In adopting a settlement pattern approach at Anai'o, the primary focus is on the place of Anai'o within the wider social and physical landscape of Ma'uke. Site survey data and ethnohistoric observations also allow the reconstruction of a late prehistoric settlement pattern for Ma'uke and comparing this with the Anai'o phase highlights some important changes in the social parameters of landscape use through time.

Adaptation in Ngaputoru

The raised coral-reef or makatea island has a peculiar environment and resource zonation which offers a specific set of opportunities and constraints to human culture. The contrast between makatea island environments and those of atolls and high islands is striking and from the archaeological perspective they require a very specific set of methodological approaches. These land forms are quite common in the Pacific and they are the dominant island type in the southern Cook Islands. Ngaputoru is a cluster of three makatea islands (Ma'uke, Atiu, Mitiaro) plus one presently uninhabited sand cay (Takutea). The three inhabited islands are different to one another in many ways but they also share common features of ecology and human history. Comparing the archaeology of Ma'uke with that of Mitiaro and Aitu it is possible to recognise some unique elements of adaptation within Ngaputoru.

In addressing the topics summarised above a central objective in the Anai'o study is to work towards the description of a single Polynesian community situated in a particular time and place. The methodological approaches employed are traditional archaeological ones, yet the goal is to use these methods to provide what might be described as an 'historical anthropology' of Ma'uke. I have not drawn heavily on oral traditions in this work because I believe that to use tradition in anything other than a trivial manner requires much more specialist study that I can offer at the present time. It would be inappropriate simply to cite traditions in order to substantiate some archaeological statement without fully considering their literary history and context.

The site was excavated by Ma'ukeans and many of the directions taken are as a result of their comments and insights. I hope that this volume will be of interest to the Ma'uke community and help stimulate a more general awareness of Cook Island cultural heritage.

CHAPTER 2. ENVIRONMENTAL AND CULTURAL SETTING

GEOLOGICAL ORIGINS

Ma'uke lies 190 km north-east of Rarotonga at latitude 20° 08' S and 157° 21' W (Fig. 2.1). It is the southernmost of a chain of islands and submarine sea mounts united at the 4500 m isobath stretching from Aitutaki in the north-west to Ma'uke in the south-east (Summerhayes 1967) (Fig. 2.2). A parallel chain to the south-west contains the other two islands of the southern Cooks, Rarotonga, and Mangaia. Within the southern Cooks can be found the full complement of oceanic island forms. Rarotonga is a high volcanic island, Aitutaki is an almost-atoll with a volcanic core surrounded by a wide, deep lagoon with a fringe of sand cays as well as two small islets of volcanic origin. Manuae is an atoll, Takutea is a sand cay on a coral foundation and the remaining islands of Atiu, Mitiaro, Ma'uke and Mangaia are raised reef or makatea islands. Between Rimatara and Ma'uke lie a number of recently described submarine seamounts which link the Aitutaki-Ma'uke chain to the main Austral group (Lambeck and Coleman 1982). The islands of the southern Cooks and Australs are ultimately of common origin although the exact nature of

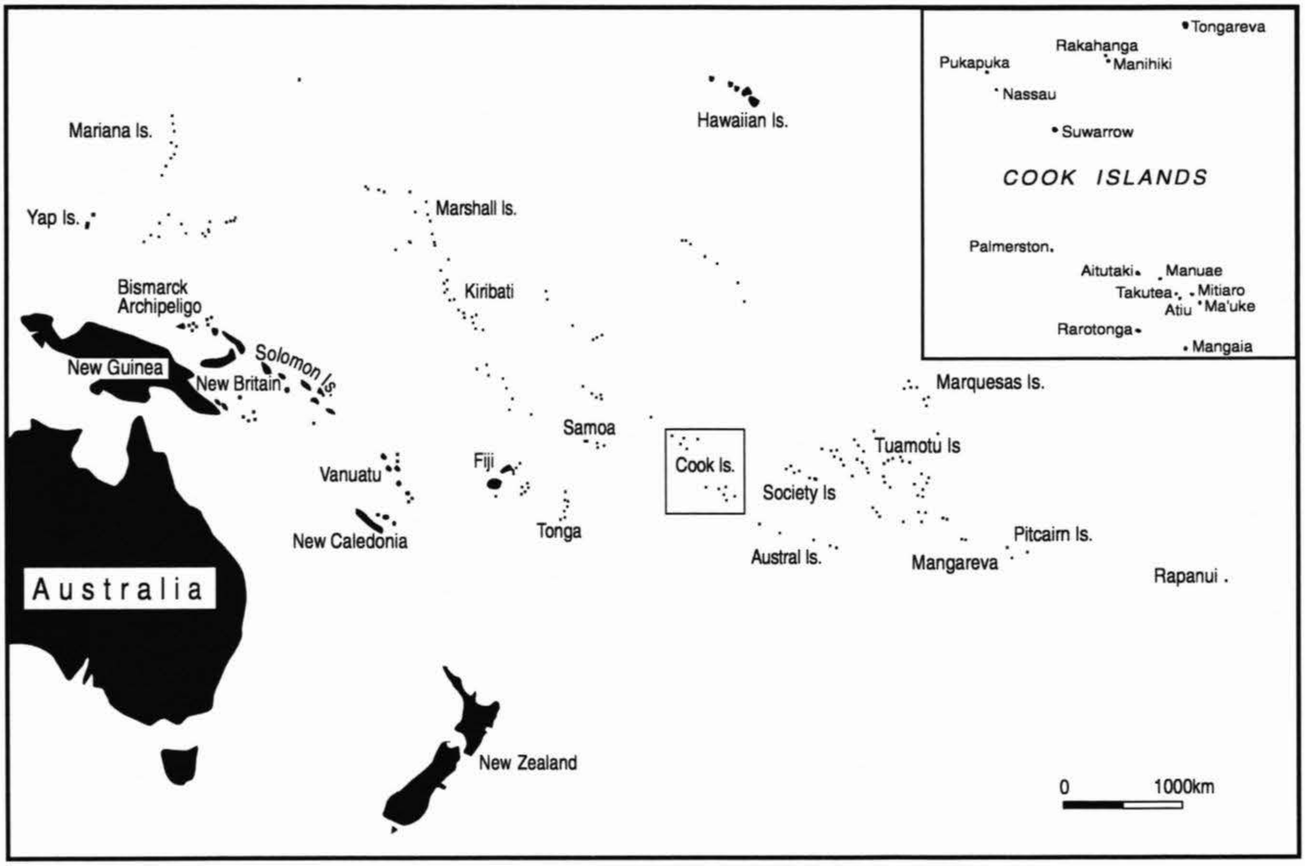

FIGURE 2.1. Map of the Pacific showing the Cook Islands as inset.

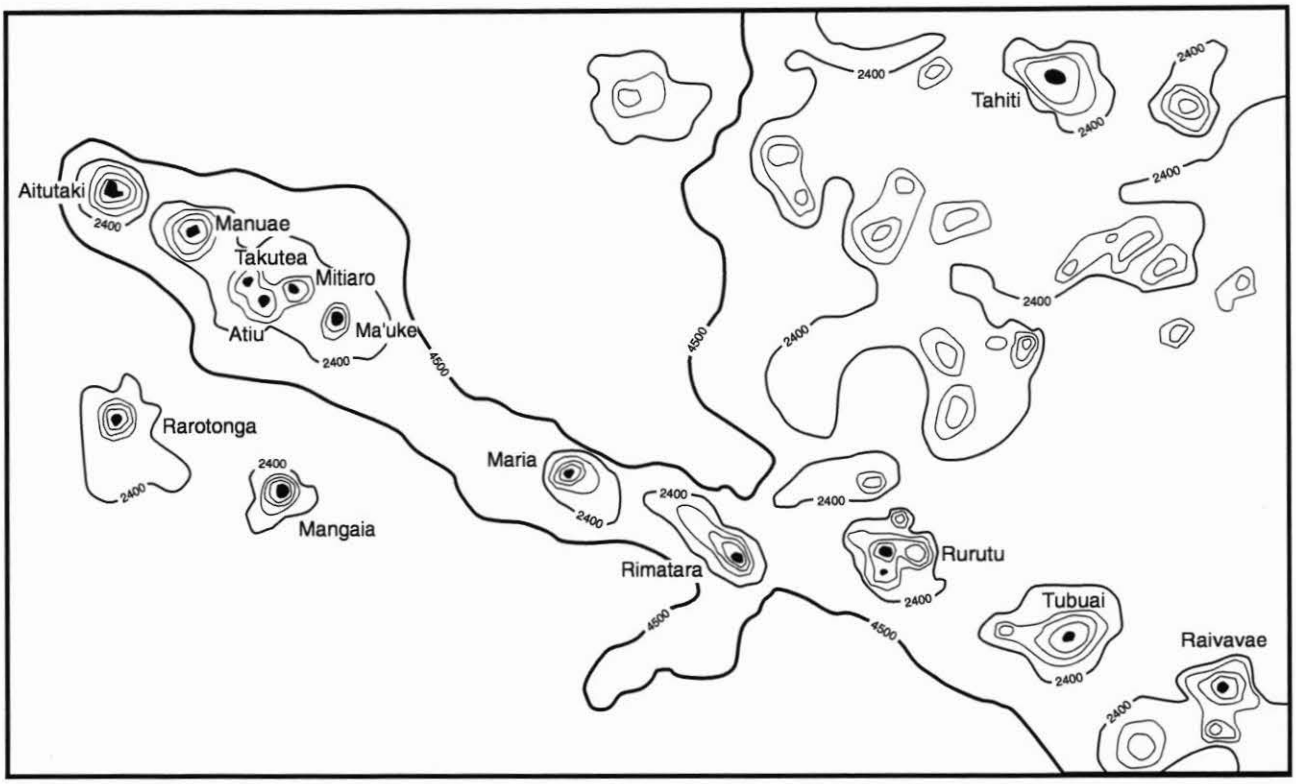

FIGURE 2.2. Bathymetry of the southern Cook, western Austral and Society Island groups showing their union at the 4500 m isobath (after Summerhayes 1967).

their historical relationship is complex and still partly undetermined.

The Cook-Austral chain is one of a number of linear chains of Oceanic islands, most of which are oriented north-west to south-east. A number of explanations for their genesis have been proposed of which the most successful is the hot-spot hypothesis which proposes that a source of magma below the lithosphere generates volcanoes which are slowly carried off by the drifting plate (Turner and Jarrard 1982:207). The hot-spot thesis carries a number of testable predictions of which the most important is that there should be a linear increase in island age with distance from the hot-spot. This prediction fits the Hawaiian age data almost perfectly, but the Cook-Austral data provides the least convincing correlation of the hot-spot hypothesis in the Pacific (Okal and Batiza 1987:4).

The Cook-Austral hot-spot, known as the McDonald Seamount, currently lies south-west of Rapa implying an increasing age from Aitutaki through the Australs with Ma'uke situated near the older end of the Cook Island portion of the sequence. In fact, these age-distance predictions, as determined by K-Ar dating of volcanics, are not realised except in the case of Mangaia (Turner and Jarrard 1982). Thus a straightforward developmental model involving linear plate movement over a single stationary hot-spot is not supported for the southern Cook Islands (Okal and Batiza 1987; Turner and Jarrard 1982). To reconcile the Cook-Austral age data Turner and Jarrard (1982:211) suggest either three hot-spots (McDonald plus one near Rurutu and another near Rarotonga) or an alternative and slightly more complex hypothesis. This involves a proposed 'hot-line'; a line joining the Tongan trench to the Peru-Chile trench which incorporates 12 of the 19 known Quaternary volcanoes associated with linear chains (see also Diament and Baudry 1987:429). Deviations from strict age-distance predictions from McDonald are accounted for by small convection rolls along this line.

Whatever the underlying cause, volcanism in the southern Cooks is thought to have begun during the Palaeocene with the formation of volcanic islands to sea level occurring during the Eocene and Oligocene (Lambeck 1981:484) (Fig. 2.3a). The oldest of these volcanic peaks is Mangaia where alkali basalts are well dated to about 19 million years ago (mya) (Dalrymple *et al.* 1975; Turner and Jarrard 1982). The youngest basalts are from Ma'uke where a minimum K-Ar date of about 6.0 mya was returned on loose basalt cobbles from the central plateau, other ages are summarised in Table 2.1.

Following the initial formation of a volcanic core, the volcanics on Ma'uke were capped with a coral reef of late Miocene age (Fig. 2.3b). Yonekura (1988) provides a date of

Island	K-Ar dates (mya)	Renewed volcanism
Mangaia	19.3	
Mitiaro	> 12.3	
Atiu	8 -10	
Aitutaki	8.1	0.7-1.9
Ma'uke	> 6.0	
Rarotonga	2.0	1.0

TABLE 2.1. K-Ar ages of southern Cook Island volcanics (after Turner and Jarrard 1982).

17 mya for initial reef formation on Mangaia which is very close to the date for the volcanic core, and if Ma'uke followed a broadly similar pattern we might expect initial reef growth by at least 5 mya. Bevelling of the central plateau might attest to wave planation at sea level (Grange and Fox 1953; Marshall 1927), but Ma'uke is too low to display very well developed Pleistocene benches or terraces below the summit (Stoddart *et al.* 1990:58).

Along with the other makatea islands of the southern group Ma'uke has undergone a period of emergence resulting in the exposure of the makatea beds. Contrary to earlier views which associated this process with extreme high Pleistocene sea levels (Schofield 1967), this is now believed to have happened as a result of lithospheric flexing following plate loading associated with the formation of more recent volcanics. According to McNutt and Menard (1978) the makatea islands, including Ma'uke, were raised with the formation of the islands of Rarotonga, Aitutaki and Manuae. However, since only Rarotonga is known to post-date the formation of the makatea islands, it is very likely that Rarotonga alone is responsible for their uplift. Revisions of the McNutt and Menard (1978) scheme in which lithospheric flexure is modelled on the basis of loading by Rarotonga alone are offered by Lambeck (1981) and Stoddart *et al.* (1990).

The timing for the uplift on Ma'uke is generally believed to be in the region of 2-3 mya (Lambeck 1981:484). A second Pleistocene reef built seaward following and during island uplift, and this represents the contemporary limestone platform between the makatea proper and the shore (Fig. 2.3c). Subsequent Holocene emergence, as represented by such features as emergent corals in growth position and raised tidal notches are associated with mid to late Holocene fluctuations in sea levels (Stoddart *et al.* 1990, see also Pirazzoli and

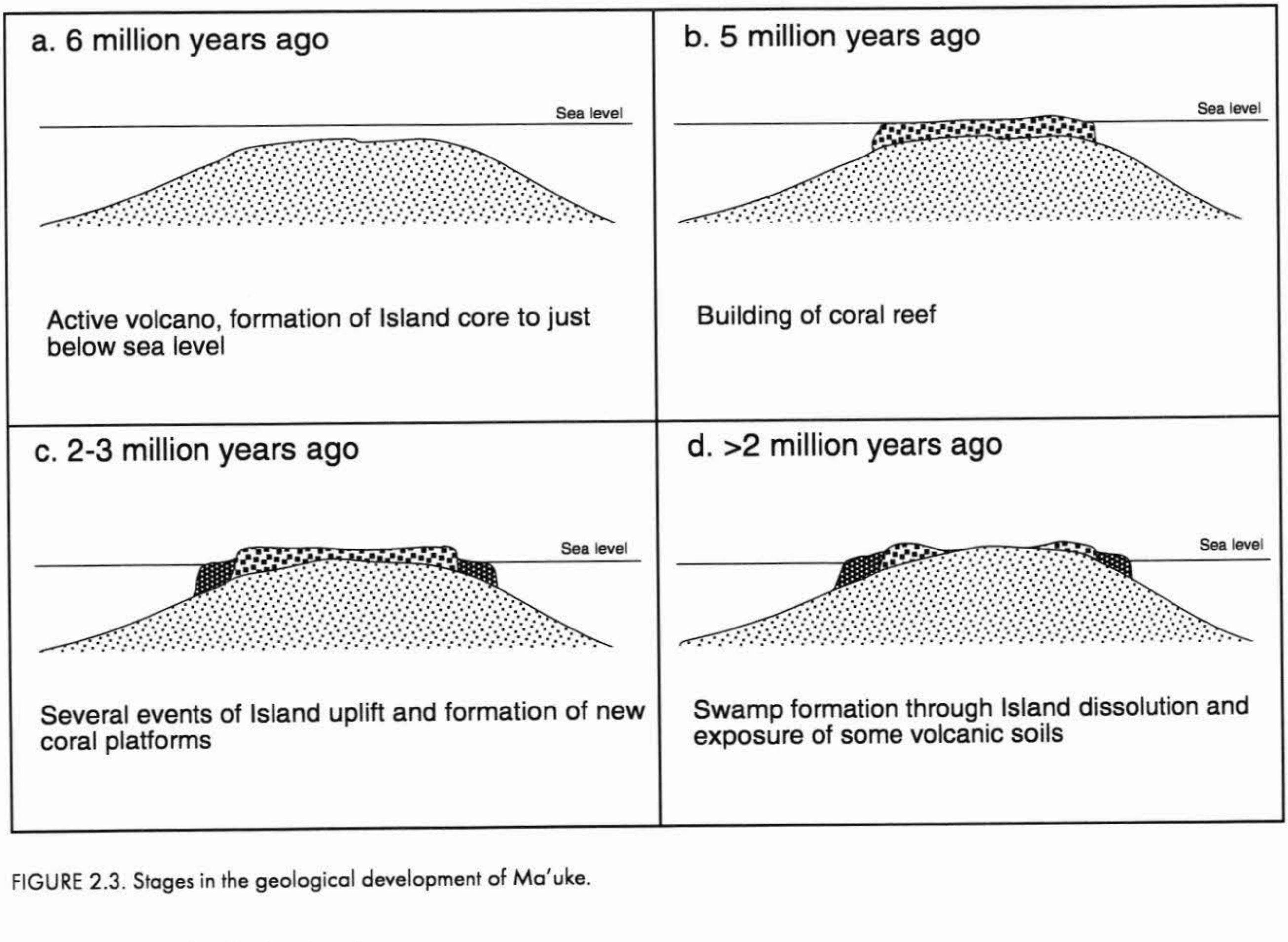

FIGURE 2.3. Stages in the geological development of Ma'uke.

Montaggioni 1988a, b, c). Sea level changes in this period are clearly of enormous importance archaeologically since they coincide with the early colonisation of Polynesia and Micronesia and bear on such fundamental issues as whether islands were above the sea, and thus available for human settlement, or not.

Unfortunately, it is now obvious that sea level changes did not follow Pacific wide trends but followed highly localised paths, although some general trends such as a tendency for greater emergence to the south, have been proposed (Pirazzoli and Montaggioni 1988c). In French Polynesia Pirazzoli and Montaggioni (1988c) report a mean sea level 0.8-1.0 m above present between 5000 and 1250 B.P. with a peak between 2000 and 1500 B.P. In the southern Cooks a more comprehensive analysis of Holocene emergence has been provided for Mangaia where Yonekura *et al.* (1986, 1988) report features indicating a sea level stand of between 1.0 and 1.7 m higher than present during the period 3150 to 5000 B.P. Mitiaro displays evidence of emergence between 1-1.2 m and the figure from Ma'uke is likely to be similar although the exact heights are not yet determined but are certainly lower than those calculated for Mangaia (Stoddart *et al.* 1990, Woodroffe *et al.* 1990:38).

GEOGRAPHY

Ma'uke is 6.4 km long (north-south) and 4 km wide. Working from the New Zealand Department of Lands and Survey (1975) 1:12,500 topographic map Stoddart *et al.* (1990) estimate the land area at approximately 20.3 km2 which is probably a more accurate estimate than the 18.4 km2 provided by Grange and Fox (1955; see also Walter 1990; Wilson 1982). The raised coral beds (makatea) account for nearly 15 km2 or 75% of Ma'uke's surface area.

Ma'uke has a central volcanic core rising to 24.4 m with prominent horizontal bevelling at 20-24 m attributable to marine erosion (Stoddart *et al.* 1990:57). The central plateau is covered by poorly drained, red-brown soils and is cut by a number of gullies which drain into the central swamps along the inner margin of the makatea. These swamp lands probably formed through a similar process of limestone retreat as suggested for Mangaia (Stoddart *et al.* 1985, 1990:58) (Fig. 2.3d). There is no bedrock exposure on Ma'uke but localised scatters of highly weathered olivine basalt cobbles can be found in several places along the central plateau and on the inner edges of the makatea (Sheppard *et al.* n.d.; Turner and Jarrard 1982; see also Chapter 5). Standing water on the island is restricted to deep pools in the underground caves scattered throughout the makatea and to the taro swamps and feeder channels of the interior.

A series of limestone terraces lie between the central plateau and the sea, these include the makatea as well as more recent uplifted corals. The makatea itself consists of Tertiary limestones between 0.8 and 1.6 km wide and with a maximum elevation of about 15 m. The makatea contacts the underlying volcanics at just below 10 m elevation (Turner and Jarrard 1982). A raised Pleistocene reef abuts the edges of these limestones, but the actual point of contact is generally masked by overlying perched beach detritus. These storm beach ridges encircle the island but are deeper and wider on the western, leeward coast. There they consist of marine sands and storm washed coral boulders and cobbles up to several metres in depth. The beach ridge averages 90 m in width with an inner edge lying at a mean distance of 175 m from the coastal cliff edge (Stoddart *et al.* 1990:9).

The maximum elevation of the Pleistocene limestones is about 12.7 m which is likely to represent the maximum height for late Pleistocene coral deposition. This Pleistocene terrace is distinguished from the Cenozoic limestone by the presence of well preserved corals, especially *Porites*. It also contains numerous "subhorizontal stratigraphic discontinuities" many of which Stoddart *et al.* (1990) attribute to marine processes. These include large flat, horizontal notches indicative of former sea levels and fossil beaches. Several late Pleistocene dates (*ca* 31,600 and 39,000 B.P.) have been reported for corals within 35 cm of the current upper limit for coral growth at Tukume. Cliff notches at 0.6-1.5 m, and a 2.7 m bench at Anaraura attest to Holocene sea level fluctuations (Stoddart *et al.* 1990:60). In addition, a corrected Holocene age of 2900 B.P. is reported for emergent coral on the reef crest north of the landing at Taunganui (Woodroffe *et al.* 1991).

There is no lagoon on Ma'uke. Instead, a continuous reef flat encircles the island with an average width of 155 m. It is cut by narrow surge channels, some of which are wide enough to allow canoes to be beached. Most are no more than a metre or two in width where they extend through the algal ridge and offer minimal protection from the waves. Most of the Ma'uke reef flat is barren of live coral and there are extensive areas of emerged coral on the reef platform. On the inland edge the reef flat abuts a low cliff face which is 4-5 m in height around most of the island but rises occasionally to as high as 10 m. This cliff is cut at the base by an inter-tidal notch, or in places by a terrace or bench. At various points around the island, including Anai'o, the cliff is notched by narrow pocket beaches of carbonate sands.

The most suitable areas for human settlement on the island are either along the deep, sheltered beach ridges of the north and west coasts or on the dry soils inland of the makatea beds. The leeward coast is unsuitable for habitation because it is dry and contains very little sand deposit over the exposed reef surface. The inland areas have the advantage of access to water, flat open land and agricultural soils. The interior of the island is also easy to traverse while the coast is rocky and the makatea beds virtually impenetrable. Early visitors such as Williams (1838) report the Ma'ukean villages as lying inland, around the present settlement of Oiretumu. The single modern coastal settlement of Kimiangatau is less than a century old and represents a recent change in traditional settlement patterns (see below).

SOILS

Ma'uke soils have been described by Wilson (1982) in relation to three major landforms of roughly concentric orientation (Fig. 2.4).

Makatea

Makatea soils consist of wind-blown and water-laid coral-soils and gravels on the coastal margin, and weakly weathered limestone derived soils on the raised reef beds. On the inland edges of the makatea patches of pre-weathered basaltic alluvium overlie coral limestone in pockets about 1-1.5 m in depth. These are known as Taiki soils and are well drained and are the most agriculturally productive of all Ma'uke soils. They are used for mixed dry root-crop and arboreal production. Although these soils do have a slight potassium deficiency, their major limitation for agricultural production is their scarcity.

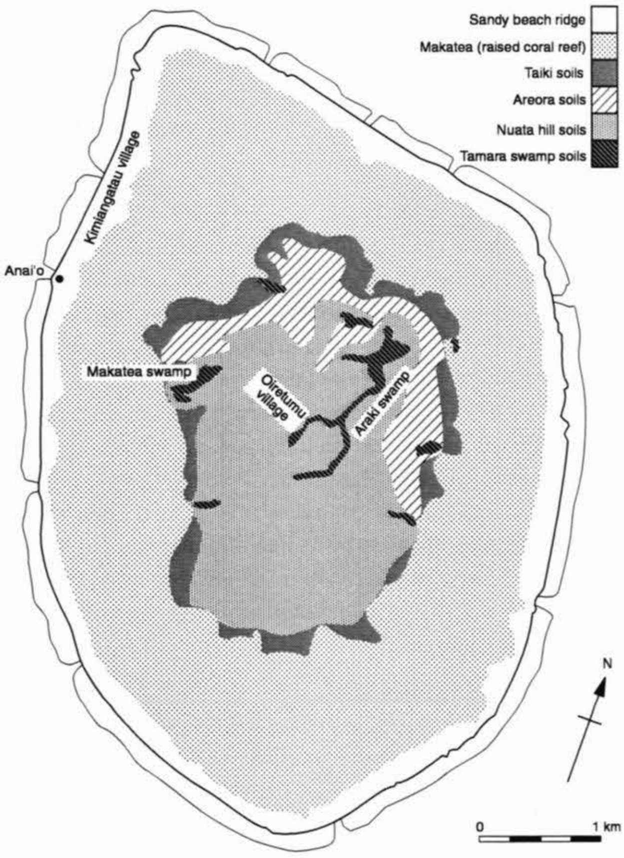

FIGURE 2.4. Distribution of Ma'uke soils showing concentric zonation.

Interior lowlands

The most important soils of the interior lowlands are the Tamarua swamp soils. These are poorly drained soils derived from basaltic alluvium which have been washed into the lowest lying areas of the island interior. These are the taro soils and are of reasonable productivity.

Interior uplands

The interior uplands include the hilly land between the lower valley floors and the adjacent plateau fringe, the sloping to moderately steep land of the plateau fringe and the central plateau.

On the plateau footslopes the most important soil is Areora clay loam. This is a well drained red soil derived from strongly weathered basalts. Although they have a fairly low nutrient status, Areora soils produce well if they are given adequate nutrients, such as the organic refuse and burn-off materials collected during weeding, clearing and planting activities. These soils lie adjacent to Taiki soils in many places and are used today for a variety of dry crops but they are especially suitable for cassava production. In general the soils of the interior uplands are extremely low in nutrients and on the slopes they are highly susceptible to erosion.

CLIMATE AND HYDROLOGY

The Cook Islands has two climatic seasons; a hot, humid 'summer' from October to April with highest temperatures in January-February, and a warm, dry 'winter' from May to September. The long-term average rainfall in the southern Cook Islands is 1900-2050 mm per year although Ma'uke lies on the western fringe of a drier zone extending eastward towards French Polynesia and the subtropical high pressure belt (Hessell 1981; Thompson 1988:28). As a consequence, rainfall levels on Ma'uke tend to be lower than the archipelago average with a recorded mean over the period 1958-1970 of 1626 mm (Wilson 1982:8). The mean annual temperature on Ma'uke is 25° C with a humidity of 82%. There are few permanent streams on Ma'uke but small springs in the volcanic uplands feed a number of swamps which are mainly wet throughout the year although the upper zones of some are subject to drying out during periods of drought. Permanent standing water can also be found in numerous caves located on both the volcanic zone and within the makatea limestone.

VEGETATION

There are two main vegetation communities on Ma'uke corresponding to the makatea and volcanic soils. Indigenous vegetation predominates on the makatea. On the inland volcanic zone there are patches of secondary forest and scrub as well and the main suite of introduced plants, including both weeds and crop plants (Sykes 1976). The makatea vegetation zone consists of a strandline fringe dominated by low-growth *Pemphis acidula* and several other low subshrubs and sedges. A few metres inland the *Pemphis* gives way to a band dominated by the common Pacific strand species *Scaevola taccada*, with a number of other low shrub and understorey species including *Euphorbia filiformis* and several trailing plants and grasses. Behind the *Scaevola* belt, a range of small trees dominate, many of which are of economic value. These include *Cocos nucifera, Hernandia peltata, Casurina equisetifolia, Pandanus tectorius* and *Hibiscus tiliaceus*.

The inland makatea consists of a low forest cover dominated by *Hibiscus tiliaceus, Pisonia grandis, Guettarda speciosa*, and *Hernandia* spp. The larger forest species *Barringtonia asiatica, Calophyllum inophyllum* and *Aleurites moluccana* are also present and provide a canopy for climbing plants such as *Jasmin didymyum* and *Morinda umbellata*, as well as a variety of herbs, succulents and ferns. The inland makatea is also home to the maire (*Phymatosorus scolopendria*) for which Ma'uke is well known. Wild maire is gathered on Ma'uke by the local women and air freighted weekly to Hawaii where it is used to make 'leis' for both traditional Hawaiian ceremonies and for use in the tourist industry.

In the inland volcanic zone there are small patches of modified secondary forest but most of the land is under open scrub or grass having been cleared for cultivation or more recently, grazing. The scrub includes *Psidium guajava* as well as stands of *Hibiscus tiliaceus, Aleurites moluccana* and *Inocarpus fagiferus*. Other than these species, the crop plants and pasture land grasses and sedges, the rest of the vegetation is dominated by herbaceous weeds.

TERRESTRIAL FAUNA

The Ma'uke terrestrial fauna is relatively impoverished, even by Polynesian island standards. Extant populations of land bird species include *Egretta sacra* (Reef Heron), *Ducula pacifica* (Pacific Pigeon), *Pluvialis fulva* (Golden Plover), *Heteroscelus incanus* (Wandering Tattler) and *Halcyon tuta mauke* (the Ma'uke subspecies of the Chattering Kingfisher) (Taylor 1984). Various terns and noddies also visit the island and there are also populations of introduced duck and fowl. In addition, there are historic records of another pigeon species, plus a rail, a duck, a parrot and a passerine all of which are now locally extinct (Franklin and Steadman 1991:511). The fruit bat *Pteropus tonganus* is now extinct on Ma'uke (see Chapter 6) and there are no other native terrestrial mammals on the island. The only other non-human mammals on Ma'uke in prehistory were the Polynesian commensals, pig, dog and rat (*Rattus exulans*). In addition, the domestic fowl was also brought to the island and, with the other domesticates, is represented in the Anai'o faunal assemblage (Chapter 6).

AGRICULTURE

The agriculture system of Ma'uke has both a cash and subsistence component both of which have undergone significant changes over the last century and a half. Ma'uke does not have the rich dryland or swamp soils of some of the other islands in the region and has occupied a particularly fragile position within the primary production economy of the southern Cook Islands. Earlier this century and into the last, cash crops such as copra and later citrus have been successful on the island but there has been a tendency for cash cropping to be a very volatile industry with various experimental and semi-experimental crops going through short boom and bust cycles. The subsistence economy has also changed recently, the most important changes being the adoption of *Xanthosoma sagittifolium* as the primary wet field taro species and the widespread use of cassava (*Manihot esculenta*) on the dry soils.

The spatial patterning of agricultural practices is tied to soil zonation. The soils of the coastal margin are used for low intensity production of coconut and supported some of the large copra plantations of the 19th and early 20th centuries. It is here too that wild stands of the Polynesian arrowroot (*Tacca leontopetaloides*) can be found and, although it is no longer an economic food plant, it is probable that it was formerly grown commercially on this coastal zone (see Gilson 1980). In Kimiangatau, the coastal village, the Muri soils also support a range of household tree species such as breadfruit, citrus and banana.

Along the inner edge of the makatea the Taiki soils are the highest nutrient soils of the island and support all the dry tree and root crop plants in the Ma'uke subsistence cultivation regime including dry crop taro, kumara, green leaf vegetables, banana and breadfruit. The Taiki soils also support the short term cash crops which require high nutrient soils.

The Tamarua soils of the low swamps are excellent for taro production where *Colocasia esculenta* and *Xanthosoma sagittifolium* are currently produced solely for domestic use. The remains of extensive field systems can be seen in the Ma'uke swamp land but today, little more than about 20% of these systems are currently under cultivation. The taro production system used on Ma'uke is based on the construction of raised beds surrounded by free-flowing drains. Following a fallow period, a bed is cleared and the swamp-mud turned completely over. The bed is then covered with coconut leaves and the taro shoots planted in holes driven through the coconut bedding into the mud. *Alocasia* is not grown on Ma'uke but stands of wild plants in damp soils along the edge of the inland makatea attest to its former status as a crop plant. Wild yam (*Dioscoria* sp.) can also be found in the makatea and is considered a famine food but is not grown today in the plantations.

Subsistence tree cropping is a very low intensity activity on Ma'uke, and elsewhere in the southern Cook Islands and, apart from coconut, is mainly restricted to household stands of breadfruit, banana, citrus, mango and a variety of other fruits and nuts. The inland villages are located on the Areora clay loams and here these tree crops grow well. The Areora soils of the inland village and surrounding areas also support kumara and cassava, which thrives on these limited nutrient soils. Cassava is grown both as an everyday tuber substitute for taro as well as for the production of starch which is used in the local exchange economy and in that of the New Zealand-Cook Island community.

FISHING AND MARINE FORAGING

Fishing is an important subsistence activity on Ma'uke today and for most households fish is a major component of the diet. There are no sheltered inshore waters on Ma'uke and the reef platform provides a very effective barrier to the open sea. As a result, contemporary subsistence fishing practices are mainly directed towards the exploitation of the inshore zones, with a particular emphasis on the resources of the outer reef face. Nets and hand rods (matira) are used to target the fish of the surge channels. A variety of other techniques are used on the reef flat. Reef edge fishing with rods is mainly carried out by men but women are commonly seen on the reef working with nets or participating in a variety of other fishing activities. Outside the reef, free divers using spears target a range of coral reef fish. They usually enter the water from the reef face and shoot fish on the reef floor at depths of 6-15 m. In the same zone and depth they take *Tridacna* clam. People with access to canoes fish the reef edge zone during the day or at night. Using lures and bait hooks they target small and mid-size benthic predators feeding on the reef floor as well as a range of pelagic fish. Flying fish are taken in the inshore zone at night using boats equipped with outboard motors and powerful lights, although traditional water craft are also occasionally used for flying fishing. Canoes and more modern craft are also taken into the offshore zones to fish for tuna, and a range of other large pelagic species. The ecological context of Ma'uke fishing is discussed in greater detail in Chapter 6.

The reef flat itself provides a wide variety of molluscs, echinoderma and crustacea and is a reliable source of marine food. However, there are few items which can be regularly taken in bulk, as is the case in the lagoonal environments, and so marine foraging is only a supplemental activity on the island. Nevertheless, shellfish from the algal ridge and crabs gathered by torchlight at night are a common supplement to the diet of most Ma'uke households. Reef edge foraging is carried out by men, women and children.

ECOLOGICAL ZONATION

As is apparent from the above discussion of geography, Ma'uke, like many Oceanic islands, has a strongly marked concentric pattern of resource distribution (Fig. 2.5). The outer ring of resources are those of the marine environment and these can be divided up into inshore and offshore zones as discussed more fully in Chapter 6. The reef gives way to the encircling strandline and then the narrow storm ridges which have sandy tree cropping soils and land suitable for housing. It is very likely too that at the time of island colonisation the strandline and coastal strip were a source for ground nesting birds and perhaps some other seabird populations although there is not yet any archaeological evidence for the existence and exploitation of these resources. Inland of the coastal strip are the wide makatea beds which provide few resource although they do provide a habitat for the coconut crab (*Pagrus latro*) and several economically useful plant species including pandanus and maire. Some of the land birds which were presumably of economic importance in prehistory would also have been hunted in the makatea zone. Inland of the makatea are the dry soils and the swamp land. These resource zones are concentrically arranged but within this general patterning they are somewhat patchy in their distribution. The premium agricultural zones are located just inland of the makatea and particularly in areas where the high quality Taiki soils lie adjacent to the taro swamp-land.

The interior upland is somewhat unproductive from the point of view of soil status, but has a number of short streams, at least one of which, Vaitaruke, is known from historical accounts and from oral tradition to have been an important and reliable source of fresh water during periods of drought. It is also likely that the open scrubland which would once have covered the island interior was a good hunting zone for land birds.

TRADITIONAL POLITICAL AND SOCIAL SYSTEM

The traditional social organisation of Ma'uke society conforms closely to the ranked chiefdom system described for Rarotonga (see Beaglehole 1957; Goldman 1970 for example). A lineage, or ngati, is comprised of a number of household groups tracing descent to a shared ancestor. Each ngati usually recognises a titular head who holds a named mataiapo title. In practice, ngati is a term used to refer to social units of varying scale roughly

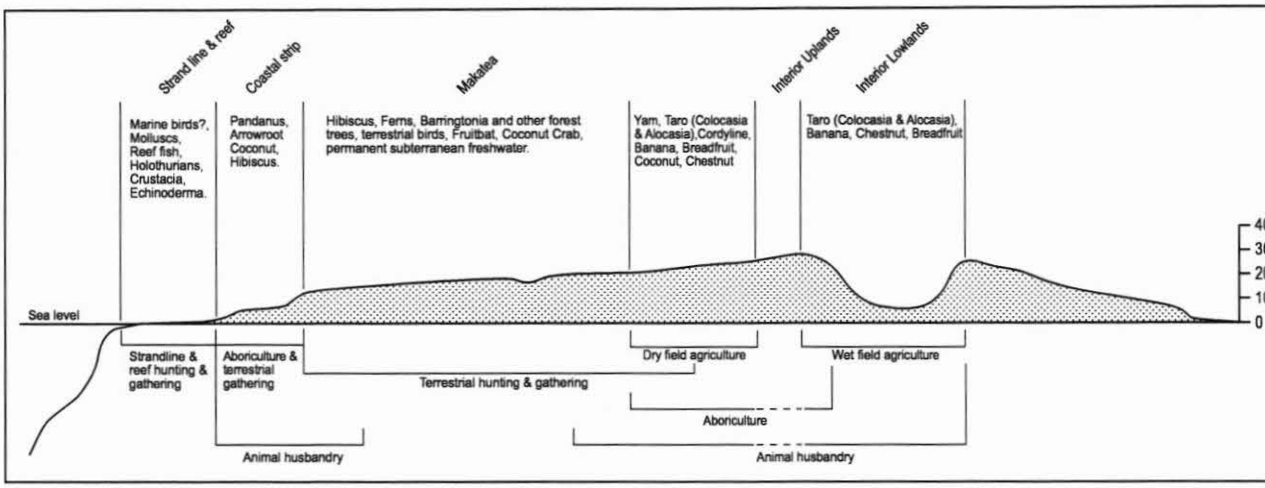

FIGURE 2.5. Ecological zonation of Ma'uke with reference to major resources of the traditional subsistence system.

corresponding to tribes and sub-tribes. On Ma'uke the term can be used at the highest scale to refer to all lineages identifying with one of the three Ariki: Tamuera, Tararo and Te Ao. Ngati Tamuera for example, refers to all individuals tracing decent through the major lineage of Tamuera to the founding ancestor 'Uke and recognising the contemporary Tamuera Ariki title. There are also many minor lineage groups within Ngati Tamuera which identify as ngati and many of these have a mataiapo as a titular head.

Both historic and oral sources indicate quite clearly that Ma'uke has been subject for some time, along with Mitiaro, to varying levels of subjugation by the chiefs of Atiu. For example, in a particularly brutal and unsympathetic account by Large (1913) a series of battles are described which probably took place in the fifty years or so prior to European arrival. These incidents involved expansionary military exercises by Atiu which included massacres on both Ma'uke and Mitiaro. At the conclusion of hostilities, Atiu installed a caretaker Ariki (Tararo) on Ma'uke. The last of these battles is probably the same one referred to as occurring in 1819 in an account gathered on Ma'uke by Gill (1894). Large's (1913:69) statement that the Arikis of Ma'uke and Mitiaro, "...from that time onward held their positions as feudatories at the pleasure of the Arikis of Atiu" probably has a great deal of truth but undoubtedly overlies a far more complex set of relationships between the three islands.

Ma'uke oral traditions indicate the presence of a set of complex symbolic links between the three islands which have been historically reflected in matters of social and political interaction. These include both bouts of warfare but also inter-island marriages, mutual participation in ceremonial and ritual activities and secular economic exchange and social interaction. Nevertheless, William's (1838) account of his first visit to Ma'uke in 1823 clearly shows that the Atiuan chief Rongomatane Ariki who accompanied his group, wielded direct political control over at least some of the Ma'uke Ariki and was able to effect virtually instant adherence to his will. In this case his will was that the people of Ma'uke abandon their heathen practices and accept the mission teachings (Rere n.d.; Williams 1838). The structure and development of Ngaputoru as a social and political entity has not yet been fully examined but it appears that at about the time of European arrival there were major changes occurring in Ngaputoru politics involving the use of military force for the centralisation and consolidation of power in Atiu. From about 1888 when the British Protectorate came to Atiu the authority of Atiu over the neighboring islands of Ma'uke and Mitiaro was officially recognised by law and the chief Ngamaru of Atiu was recognised as controlling all three islands. In fact, it was Ngamaru who made out the deed of cession of Atiu, Mitiaro, Ma'uke and Takutea to the crown in 1900 (Crocombe 1967:106).

Traditionally, the Ariki of Ma'uke had direct control over the lands of their lineage group and the use of these lands was granted in return for labour and kind (Bourke 1888). Vestiges of this system still exist in that ngati members in conjunction with the relevant mataiapo and perhaps the Ariki discuss the allotment of land rights although on Ma'uke the final statement on land matters now lies with the Land Court.

Land tenure on Ma'uke is closely tied to the tapere system which has been described by Crocombe (1964) for Rarotonga. A tapere is a basic land holding unit under the authority of a ngati and associated title holders and on which the individual householders reside and enjoy certain rights to plant and utilise natural resources. On Rarotonga, the tapere approaches the idealised form as a wedge shaped unit roughly synonymous with the ahupua'a units of Hawaii (Kirch 1985). These wedges run inland from the coast with side boundaries corresponding to the lateral ridges, and cut through each of the major ecological zones. In this way each tapere has access to portions of each of the major resource zones. Because Ma'uke is a makatea island displaying a far more patchy distribution of ecological zones than Rarotonga, the tapere units are highly variable in size, and content. Furthermore, the complexity of kinship relations and residential practices among the various ngati and the historical patterns of land right allocations which have followed, have had the effect of scattering individual land rights such that any householder may exercise rights to land in a number of different parts of the island. Nevertheless, the tapere system is currently recognised and accords very closely in spirit and reasonably closely in practice to the classic tapere system outlined in Crocombe (1964).

LATE PREHISTORIC SETTLEMENT PATTERNS

During the excavation seasons on Ma'uke in the early 1980s, and during subsequent visits to the island, a series of field surveys were carried out with the aim of recording surface archaeological features. A combination of poor preservation conditions and a relatively undeveloped use of stonework construction meant that on the whole, sites were sparsely distributed and poorly preserved. Nevertheless, seven major site types were recorded. These are: settlement areas; house sites; marae; paved tracks; cave burials; miscellaneous stone structures (including garden walls and pig enclosures) and traditional sites (Walter 1993). Three of these site types, marae, settlement areas and paved tracks, assist in the reconstruction of late period settlement patterns.

Marae

There are no well preserved examples of prehistoric marae on Ma'uke but it seems apparent from the remaining surface features that the typical Ma'uke marae included a raised rectangular platform of earth *ca* 4 x 4 m in size, enclosed by a coral facing wall *ca.* 600 mm high. All marae recorded on Ma'uke are named and are associated with historical events or people, suggesting that they were still in use late in prehistory.

Settlement areas

These sites consist of sparse distributions of water rolled coral pebbles (kirikiri) from prehistoric house floors, ash, broken oven rock and other cultural material covering areas of several hectares. Within each settlement area features such as hearths or umu can sometimes be seen and these mark the site of individual household clusters. Many of the recorded settlement areas are named and associated in oral tradition with particular individuals and ngati suggesting that they too were in use late in prehistory. This interpretation is consistent with the material culture recovered from these sites. I have inspected at least 80 adzes or adze pieces which were surface collected from these sites and no typologically early forms have yet been identified, nor have any fishhooks or pearlshell artefacts been reported. These latter items are common in the early stratified sites in the archipelago but are rare or absent from late phase contexts (see Chapters 4 and 11).

Paved tracks

These are one of the more characteristic site types of Ngaputoru and consist of flat coral slabs laid through the makatea beds to form pathways between and over the sharp coral outcrops. By way of these paths, people are able to move between the coastal zone and the inland agricultural soils. The paved tracks are about a kilometre long and between 500 mm to 1500 mm in width. In some places they consist solely of flat slabs placed on the ground while in others they form high causeways over the sharpest coral outcrops. Many paved tracks are still in use on Ma'uke and elsewhere in Ngaputoru. The distribution of the three site types in relation to soil zonation is shown in Figure 2.6. Several patterns of association are apparent.

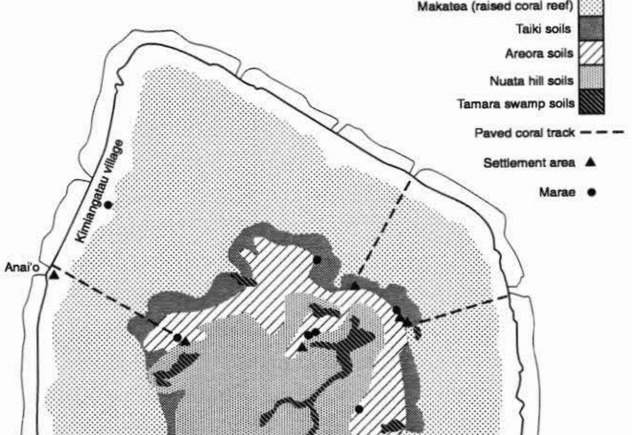

FIGURE 2.6. Distribution of paved tracks, prehistoric settlements and marae in relation to major soil zones.

Discussion

Each of the settlement areas is interpreted as coinciding roughly with the main residential and dryland agricultural zone of a specific community. Each household within this community occupied a household cluster located somewhere within this general settlement zone and close to the crop land under cultivation by that social unit at any given time. As the focus of agricultural activities shifted over the years, so too would the household cluster. The cumulative effect of this shifting pattern of low density residence and cropping activity was the scattered, ill-defined pattern of archaeological remains found along the inner edges of the makatea belt. Each community maintained at least one marae within their land unit and it was probably located very close to the main residential areas. The marae served as a unifying focus. It was the place where tribal ceremonial activities took place and was probably also a centre for political decision making. More than anything it served as symbolic link between the community and its land.

Each settlement area was linked by a paved track through the makatea to the coast. Like the marae there are strong traditional grounds for defining these tracks as communal sites and they may also be said to have some symbolic significance within the settlement pattern of the makatea islands. In oral tradition the tracks are described as being deliberately constructed so as to provide warning to the resident community if enemies were approaching (see also Gill 1894:56 in reference to Mangaia). This was achieved by placing flat coral boulders along the track in strategic locations so that when they were stepped on they rocked, sending a loud hollow ring to warn the local residents of an approaching war party. All the makatea tracks contain such stones but whether they were deliberately placed to achieve this end or whether the tradition is *post hoc* is unclear. The important point however, is that there is a clear traditional association between the tracks and a local residential kin group. They are seen as serving and in some sense protecting a specific community. In a symbolic sense they also serve as a link between the sea and the inland. The sea-inland (tai-'uta) distinction is a fundamental conceptual division in Polynesian society and on Ma'uke with the raised coral beds it has a more immediate significance. By crossing between these two zones the paved tracks not only allow the community to maintain access to the two major resource zones, the reef edge and the agricultural soils, but they symbolically traverse and mediate between tai and 'uta. There are hints of this process in some of the Ma'uke oral traditions. Finally, the tracks serve to protect the community not only from war parties but also from the very real dangers of the makatea beds.

Ecologically, each community was situated in the most strategic position for exploiting the three major resource zones on the island. The households were located directly on the dryland planting soils (the Taiki soils and deep phase Areora clay loams), and at a minimum distance from an area of swamp land (the Tamarua soils) where taro could be planted. Marae sites are also associated with the higher quality planting soils and were located in close proximity to the settlement areas. The paved tracks show a strong spatial correlation with marae and settlement areas and in many cases the tracks run directly from one of the settlement sites through the makatea to the closest reef passage. This gives each community direct access to the coast and via the passages to the important fishing zones along the outer edges of the reef.

CHAPTER 3. EXCAVATIONS

Anai'o is the name of a tapere or traditional land unit located on the west coast of Ma'uke approximately 1 km south of the main village of Kimiangatau (Fig. 2.4). The name Anai'o consists of two morphemes *ana* (cave) and *i'o* (mirror) and according to most local traditions this is a reference to a deep embayment undercutting the beach cliff at Anai'o which fills with water at high tide. The sandy beach ridge is particularly well developed from the south end of Kimiangatau through Anai'o where it reaches its highest elevation, continuing south nearly to the southern tip of the island. From there the sandy coastal deposits become shallower and are frequently interrupted by sections of exposed reef. One of the most sheltered natural passages through the reef is located at Anai'o.

The prehistoric settlement of Anai'o was situated in a choice location on the sheltered leeward coast adjacent to a good natural passage and high on a well developed sandy ridge. The Anai'o passage gives good access to the reef edge which provides the richest inshore fishing grounds in the makatea islands of the southern Cooks. Here benthic fishing from stationary canoes was probably the most favoured practice in prehistory (see Chapter 6). One of the largest taro swamps, known today as Makatea, is located approximately 1 km inland from Anai'o and is linked to the site by a narrow partly paved track which winds its way through the makatea beds (Fig. 2.6). According to tradition, the track is prehistoric and it is conceivable that it was in use when Anai'o was first occupied.

Early this century, or late in the last, a large pit was excavated on the site to burn coral to make lime for building (Fig. 3.1). This is the earliest record of historic activity at Anai'o. Since then, whenever copra prices have been high, the landowners have taken advantage of the deep, sandy soils to plant coconut and in 1986 when the first excavations at Anai'o took place, approximately 2,000 m2 of land was cleared and under coconut trees. During the 1960s, the Ma'uke Island Council began to quarry the deeper portion of the Anai'o beach ridge to supply sand for road surfacing and it was during these activities that the Anai'o shell artefacts in the Cook Island Museum were recovered. The quarrying stopped in the 1970s and between then and the present the quarry has been gradually infilled as a rubbish dump. A deep cutting still exists along the north-east margin of the site where the sandy ridge meets the makatea and the two cultural layers are well exposed in a long profile.

The main excavations took place under a coconut plantation lying between the coastal road and the makatea beds with additional test excavations between the road and the beach cliff. In 1987 a permanent datum was established in the north-west corner of the site (Fig. 3.1). This datum lay 142 m north and 3° west of the Anai'o/Taeke land boundary peg, a surveyed marker which lies about 8 m west (seaward) of the coastal road to the south of the Anai'o block. An arbitrary north-south baseline was laid over the site with an orientation 20° west of magnetic north and marked out in intervals to establish 2 m wide, numbered columns over the site. An east-west baseline was marked out in 2 m intervals at right angles to the first, and lettered from A to S. This grid divided the site into a series of 2 x 2 m squares each square being labelled with a letter and number corresponding to the peg at its north-west corner. These formed the basic excavation units.

STRATIGRAPHY

The excavations which had been carried out in the northern parts of the site in 1985 had established a general profile for the Anai'o soils (Walter 1990). Some minor modifications were later made to the 1985 interpretation of the stratigraphy (Walter 1987:239). Five distinct layers were recognised at Anai'o confirming a high level of stratigraphic conformity across the whole site. Given this relatively uniform stratigraphy all the excavation areas at Anai'o are discussed in relation to a general profile described below (Fig. 3.2).

Layer 1. A light grey surface deposit of coral sand containing a quantity of shell fragments and small lumps of coral (diameter less than 30 mm).

Layer 2. A mid to dark grey coral sand containing small sized beach detritus such as shell, echinoderm spines and lumps of coral. The darker colour of the Layer 2 soil results from the inclusion of fine grained charcoals. Much of the faunal detritus

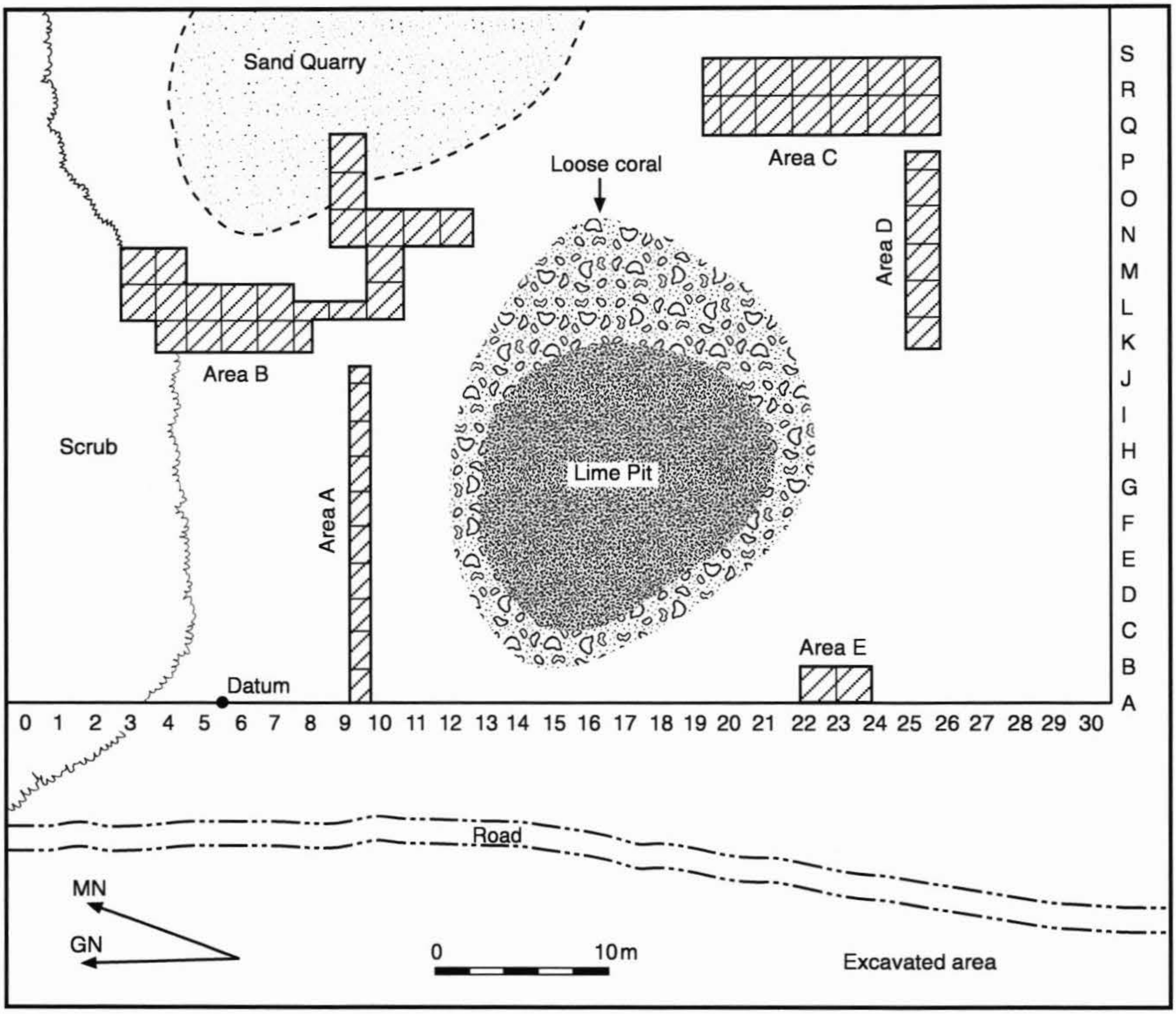

FIGURE 3.1. Map of Anai'o site showing excavation areas.

in Layer 2 is cultural in origin, although some is naturally deposited. Layer 2 represents the second of two cultural horizons at Anai'o.

Layer 3. A white coral sand of similar grain size to Layers 1 and 2. In some areas no inclusions were present, in others there were large quantities of shell, rough coral beach pebbles and other beach debris. In Area A Layer 3 consisted of a number of sublayers.

Layer 4. A dark grey to black, charcoal stained coral sand containing a high proportion of broken shell, charcoal, burnt pebbles and other cultural refuse. The non-culturally derived component of this layer consisted mainly of sands derived from Layer 5 on which it was built. Layer 4 represented the earlier of the two cultural horizons at Anai'o.

Layer 5 formed the sterile base layer for the Anai'o excavations. It consisted of a white, loosely packed coral sand containing many small lumps of coral, fossil and sub-fossil shells (including *Tridacna*) and large coral boulders.

RADIOCARBON DATING

Radiocarbon samples were collected from both occupation layers during the 1984 excavation and submitted to the D.S.I.R., Institute for Nuclear Sciences in Wellington for analysis. The samples were of marine shell *(Turbo setosus)* which appeared from context to have been used as a food source and thus gathered live from the reef flat. The sample sites were spaced about 10 m apart but do not correspond exactly with the later site grid. The radiocarbon ages were calibrated using the Marine Calibration dataset in Calib Rev 3.0 (Stuiver and Braziunas

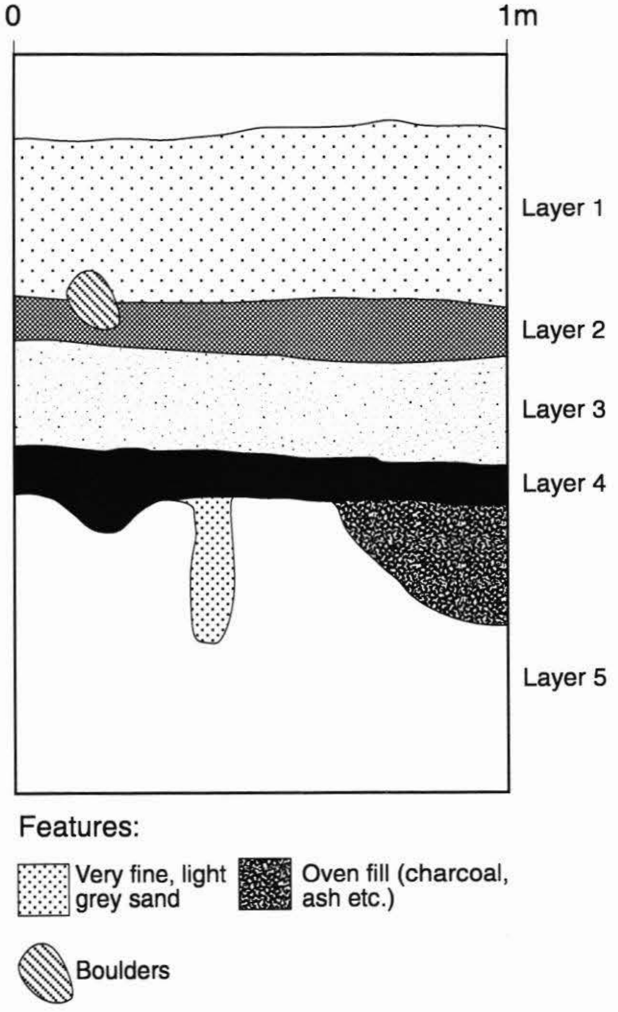

FIGURE 3.2. Typical profile of Anai'o soil horizons.

1993). This marine calibration curve takes the reservoir effect as a world average of 362 years for the southern hemisphere. There are local deviations from this average which are expressed as a Delta R value. This value can then be used to provide a calibrated date which takes local reservoir conditions into account. Delta R values are highly variable across the Pacific and so far, no value has been calculated for the southern Cook Islands. The geographically closest Delta R value which has been published is from the Society Islands although there is no guarantee that this lies close to the true southern Cook Island value (Stuiver, Pearson and Braziunas 1986). In Table 3.1 the radiocarbon ages have been calibrated with the Delta R set to 45 ± 30 (Society Islands) and to 0 ± 0, which is what Stuiver and Braziunas (1993) recommend in the absence of a local calculation. The difference between the results is slight, but meaningful and highlights the importance of obtaining a fuller set of Pacific Delta R figures.

SITE GEOMORPHOLOGY

A line of 500 x 500 mm test pits was excavated along the north-south base line and another line was excavated at right angles to this starting from the grid datum and extending west to the beach cliff (Figs 3.1 and 3.3). Together with the Area A transect (Fig. 3.4) these provide a view of the general sequence of soil deposition and site geomorphology.

The process of beach ridge development began prior to the establishment of the first settlement at Anai'o and the initial occupation occurred on a ridge then about 600-700 mm lower than present. The beach ridge continued to develop in the last 5-600 years since human occupation although the rate of development has been variable. Layer 4 represents the settlement of a previously unoccupied beach ridge with first clearance activities represented by burning and the deposition of ash lenses directly over Layer 5 in Areas C and D. Clearance was followed by the construction of a hamlet or small village consisting of structures and related activity areas. The duration of the first occupation was long enough to witness several periods of rebuilding as illustrated by an intercutting succession of features and activity areas within Layer 4. These restructuring activities demonstrate both continuity and change in the spatial organisation of the site during this first occupation phase. The final stage of this occupation is represented by a contiguous series of features on the surface of the layer which provide a static view of the range, distribution and relationship between features and activity areas in an early Ma'uke village.

Lab. no	Sample	Layer	Conventional age	Δ13C	Age range ΔR = 45 ± 30	Age range ΔR = 0 ± 0
N.Z. 6939	Shell	Layer 4	1075 ± 48 B.P.	2.6 ± 0.1	1337-1435 A.D.	1290-1346 A.D.
N.Z. 6960	Shell	Layer 4	1015 ± 35 B.P.	3.9 ± 0.1	1360-1434 A.D.	1325-1405 A.D.
N.Z. 6984	Shell	Layer 4	1026 ± 24 B.P.	2.9 ± 0.1	1348-1424 A.D.	1324-1392 A.D.
N.Z. 6943	Shell	Layer 4	1055 ±58 B.P.	2.5 ± 0.1	1307-1422 A.D.	1295-1394 A.D.
N.Z. 6958	Shell	Layer 2	947 ± 47 B.P.	3.2 ± 0.1	1415-1475 A.D.	1395-1446 A.D.

TABLE 3.1. Radiocarbon dates from Anai'o calibrated at 1-sigma.

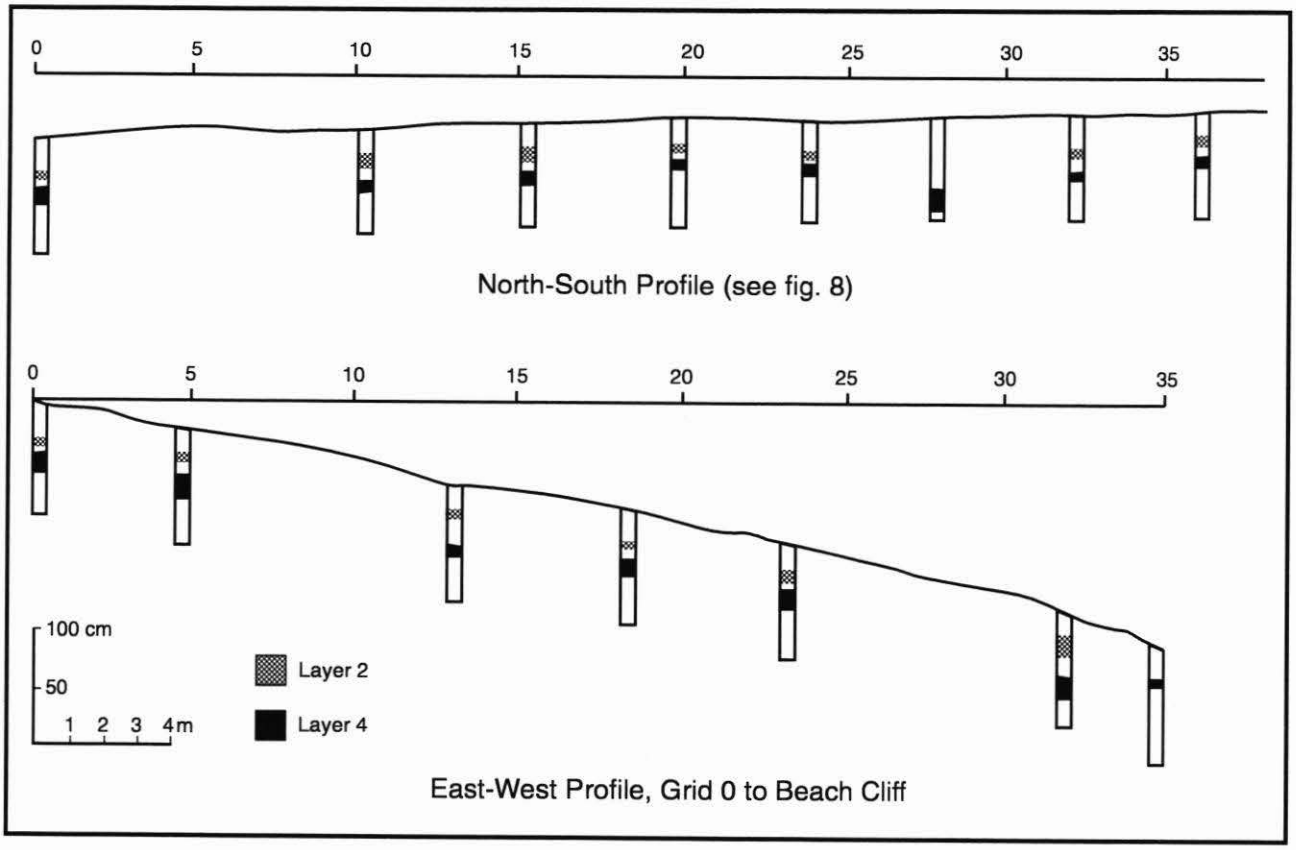

FIGURE 3.3. Sub-surface profiles cutting north-south and east-west across the Anai'o site (see Figure 3.1 for location).

Based on the radiocarbon determinations, the occupation of Layer 4 is likely to have lasted up to a century. It was abandoned with the deposition of wave and wind borne sands and gravels, probably following from a single hurricane event. Whether this event precipitated site abandonment is uncertain but this interpretation seems indicated by the degree of preservation at the site. The Layer 3 sands, representing this period of site abandonment, were deposited over a short space of time but display some variation in the nature of the deposition process. The lower portions of the site were infilled first and rapidly and included the deposition of large grained beach detritus by wave action. Elsewhere wind blown deposition also occurred.

Reoccupation of Anai'o occurred between a few decades and a century after the abandonment of the first village, as indicated by the radiocarbon chronology, but the second occupation was either focussed outside the boundaries of the 1987 excavation area or represented significant change in the nature of land use at the site. Layer 2 contained only a sparse record of human presence, few features and no clearly defined living surface.

Following the abandonment of the second occupation the sand ridge continued to develop to an additional height of *ca* 300 mm. No subsequent human modification of the site is evident prior to the construction of the lime burning pit in the late 19th or early 20th century and then the quarry and landfill.

EXCAVATION AND RECORDING STRATEGY

Excavation proceeded according to natural stratigraphy but individual layers were usually removed in unit spits of approximately 20-30 mm depth. In Layer 4, this procedure was particularly useful in dealing with complex sets of inter-cutting features representing activities spanning the duration of occupation. Excavation was carried out in 2 x 2 m units and all portable artefacts, apart from those recovered in the sieves, were recorded directly onto plan drawings. All others materials were recorded to 1 x 1 m quadrant. Soils were screened through 5 mm or 3 mm mesh sieves. Bone was recorded in the field to 1 x 1 m quadrant and spit level but since the Anai'o sands contained a high proportion of natural shell only a 25% sample was collected from the field. Shell from each 2 x 2 m excavation unit was saved until the completion of a spit level at which time the shell was laid evenly across the quadrangular screen surface and a single quadrant randomly selected. Three shell taxa found in the site, *Asaphis* sp., *Codakia* sp. and *Pinctada margaritifera,* were considered likely to be exotic and were collected in total and recorded on the plans.

Five excavation areas (Areas A-E) were opened during the 1987 season and each of these are discussed below. The excavation was primarily directed towards wide horizontal exposure in order to identify activity areas and related spatial patterns. This approach was best suited to Layer 4 where the surface of the layer preserved a variety of features representing the final construction events of occupation one and depicting the state of the site at the point of abandonment. These surface features overlay a mass of intercutting features representing the sum total of events leading up to the final state of the site. Thus Layer 4 contains both a diachronic and a synchronic view of spatial use within an early Cook Island settlement. Although the earlier features of Layer 4 display a confused pattern, it is possible to identify areas of continuity and change in the nature of spatial use during the period of occupation. In the following discussion the earlier features of Layer 4 are not illustrated since the contemporaneity of individual elements is uncertain although composite illustrations appear in Walter (1990).

AREA A

Area A was a 19 x 1 m transect excavated on an east-west orientation at 19 m grid south and was the only area not excavated primarily as a horizontal exposure. Instead, the purpose of Area A was to obtain stratigraphic information pertaining to the deposition of materials in a coastal-inland section across the flat central portion of the site (Fig. 3.1). It was also used to extend the profile already gained through the excavation of test pits west from the base line to the beach cliff (Fig. 3.3).

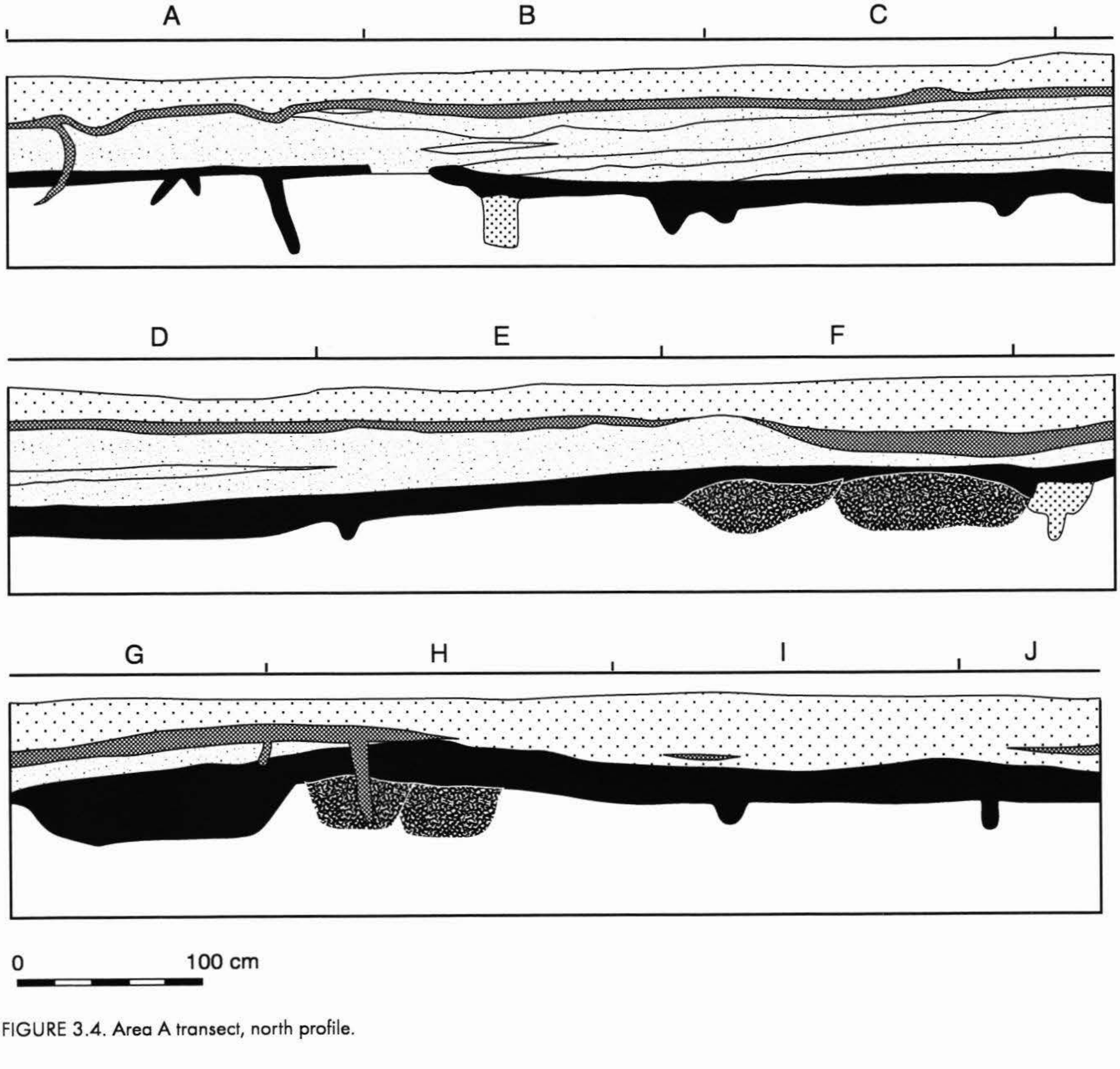

FIGURE 3.4. Area A transect, north profile.

In Area A, Layer 4 dipped slightly towards the west indicating that the initial occupation was situated on a land surface that was slightly more sloped than the present one (Fig. 3.4). Some of the Layer 3 sand was deposited onto the site in the form of distinct lenses tapering off to the east (inland). Finer grained wind borne materials were deposited towards the makatea while larger grained sands had been washed onto the site by waves and deposited slightly further to the west.

AREA B

Area B was selected for excavation because it lay high on the beach ridge adjacent to the quarry face where both cultural layers were exposed and well defined. A 16 m2 area was marked out in grids 9N to 12N following a north-south orientation parallel to the sand quarry face and this was eventually enlarged to expose a total of 90 m2 (Fig. 3.1). The final shape of Area B was determined by the distribution of coconut trees.

The stratigraphy of Area B conformed closely to the general profile with the only major variation being a number of discontinuities in the Layer 4 horizon and the presence of a recently redeposited overburden to the north-west.

Layer 2

Where present, this layer contained a sparse distribution of bone, shell fragments and other organic material and while a small number of features were recorded on the surface (Walter 1990:Table 2.2), no distinct living surface could be identified.

Layer 4 - surface

The surface of Layer 4 displayed a great deal of diversity in texture and composition. The eastern and southern areas were darker and contained a greater quantity of debris associated with cooking activities including fragments of burnt shell and heat fractured coral and volcanic rock. To the north of unit 10L the soil was lighter in colour and contained fewer signs of burning activities.

A number of cooking features were found including umu, oven scoops, and circular stone-lined hearths. These were infilled with a similar mixture of ash, charcoal, burnt stone and shell. The distribution of oven scoops and pits plus hearths showed marked clustering and regular associations with other feature classes. The most dense concentration of cooking features was located in the south-east of the site, within the 9N and 10M units. These features included intercutting umu, oven rake-out and groups of discarded oven rocks. The fact that these features were intercutting suggests that this portion of the site had been used continuously as a cooking area. A number of postholes were found adjacent to these cooking facilities and although other alignments were not found, it is probable that the umu were located within structures at the time of use. A band of small water washed coral pebbles (kirikiri) running through the 10M to 9P units further suggests that some flooring had been laid around these, and a likely interpretation is that a sequence of cooking shelters had been built in this part of the site (Fig. 3.5). This concentrated cooking area lay adjacent to two structures (Structures 1 and 2) which appear also to have been primarily associated with cooking or food preparation activities (see below).

Charcoal and ash from a large shallow oven scoop in 9P had been scattered, perhaps by trampling, over the surface of Layer 4 for a distance of *ca* 1.5 m. This feature was not directly associated with kirikiri flooring and may not have been located within a structure at the time of use.

Hearths in Area B were found in regular association with structures and were frequently accompanied by clusters of artefacts. One hearth was located on the verandah area of Structure 1 and another within the interior of Structure 2.

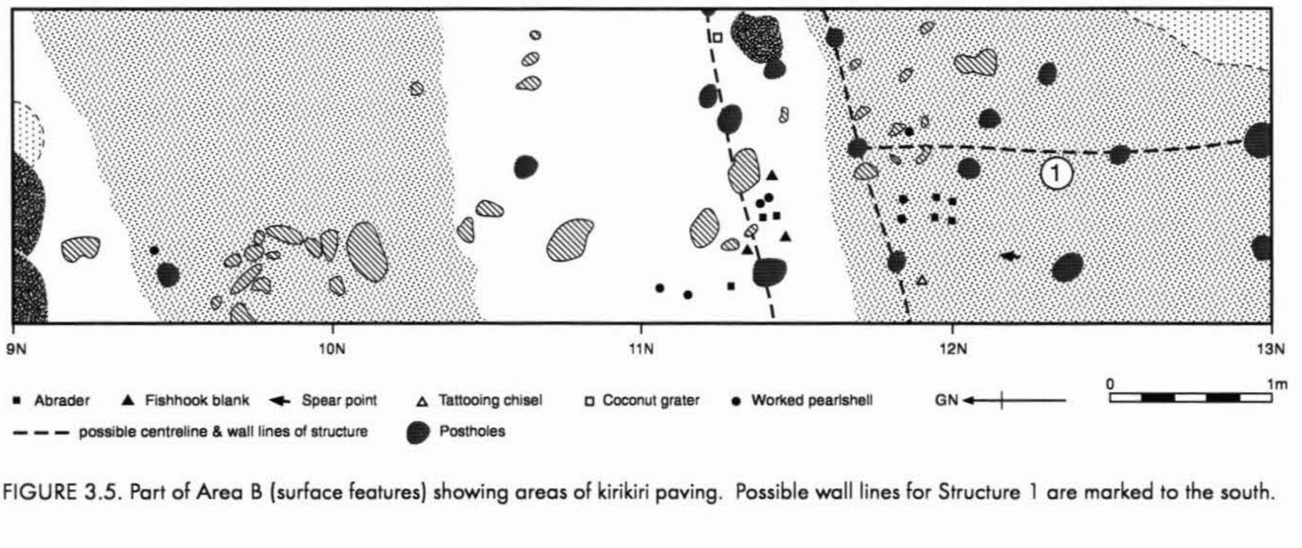

FIGURE 3.5. Part of Area B (surface features) showing areas of kirikiri paving. Possible wall lines for Structure 1 are marked to the south.

Although the hearths both contained a small quantity of fishbone they were probably not used primarily as cooking facilities.

Tight patches of kirikiri were found in four parts of Area B. In the Cook Islands this material is routinely brought up from the coast to be laid as flooring in cooking shelters, fishing or agricultural shelters and in dwellings. Three of these patches relate directly to structures but the fourth is more ambiguous and seems to relate to the concentration of cooking facilities in the 9N-9P and 1ON-10M units (see above).

Structure 1. In 12N and the south half of 11N a layer of kirikiri was associated with several posthole alignments (Fig. 3.5). The outer line of postholes running east-west across 11N about 800 mm north of the kirikiri layer is interpreted as a support line for a section of roof overhanging an external verandah. A second line of postholes parallel to the first and lying within 150 mm of the edge of the kirikiri is interpreted as an outside wall line. At right angles to these two rows, alignments run through the centre of 12N and these define the position of centerline posts for the structure (Fig. 3.5). The posthole alignments suggest that the structure was northward facing.

A small stone-lined hearth was located in the eastern half of the verandah area very close to one of the outer house walls but was too small to have contained large open fires. A variety of artefacts were found within and adjacent to Structure 1, including a pearlshell coconut scraper and a concentration of worked and unworked pearlshell fragments. The pearlshell was found in association with a number of echinoderm spine abraders and some fishhook blanks and taken together these constitute the major components of a small scale shell-working area. Lying within the house interior were a number of waste fragments of pearlshell, several abraders, a tattooing chisel and a pearlshell spear or harpoon point. It was not possible to determine the floor area of Structure 1 because of constraints on the enlargement of areas adjacent to 12N but a total of 6 m2 of internal flooring was exposed and the verandah area accounts for *ca* 1.5 m2 in addition. An estimate based on a comparison with Structure 2 is that this was a small shelter enclosing an area of *ca* 16 m2 and it probably functioned as a cooking shelter. The flooring contained less midden than Structure 2 although it did contain a number of burnt oven rocks, small lenses of ashy oven rake-out and small lumps of charcoal. The close proximity of Structure 1 to a number of umu features in 10M and 9O-9P strengthens the interpretation of its generalised kitchen and domestic activity function.

Structure 2. In units 8K, 8L and 9L was another tight scatter of kirikiri about 80 mm deep. Within the perimeter of this flooring material were a number of postholes as well as a small hearth (Fig. 3.6). An umu was located 1.5 m to the south, in 9L. The postholes found within the kirikiri did not follow clearly defined alignments allowing the reconstruction of definite wall lines. Still, it may be argued that the structure faced north on the basis of the artefact distribution outside the northern limit of the kirikiri flooring. Artefacts recovered from here included a small number of basalt flakes, a polished quadrangular adze, a fishhook, two fishhook blanks some fragments of worked pearlshell and a single abrader. These artefacts were all found within 1 m of the edge of the kirikiri and, although the assemblage was small, it was clustered enough to allow it to be interpreted as representing the locus of an activity area. This artefact distribution is comparable with that found on the verandah area to the north of Structure 1. Several postholes located within a metre of the flooring to the north may represent supports for a verandah overhang as was found outside Structure 1. One of these postholes was particularly curious in that it contained a large piece of fine-grained basalt at the base. This was first exposed in section view during the excavation of 5L-7L and prompted the excavation of row K which contained this structure. The burial of a similar fine grained basalt block in a pit within Structure 3 is also noted.

Like Structure 1, Structure 2 was closely associated with cooking activities although it contained a much higher concentration of faunal remains than either of the other structures in Area B. In addition to its association with cooking, Structure 2 was also the focus for shell manufacturing and stone tool maintenance. These activities were carried out on what was possibly a verandah to the north as well as around the internal hearth. The floor area of Structure 2 is estimated to have been about 16 m2 or less.

Structure 3. Only a portion of this structure could be exposed because it lay on the edge of the modern landfill (Figs 3.1 and 3.7). Nevertheless, enough floor area was excavated to provide an interesting comparison with the other structures on the site. The first point of contrast was that Structure 3 was lined around the perimeter with coral boulders and instead of a kirikiri interior, this material had been laid in a 1-1.5 m wide band outside the southern wall. The internal flooring was composed of coarse light grey/brown sand and pebbles. In the south-west corner of Structure 3 were two small pits, roughly circular in shape and infilled with a similar grey/brown sand to that which made up the flooring. One was lined at the top with coral rocks and the other contained a large piece of fine grained basalt at the base, probably as a deliberate cache. A coral lined hearth was located within the kirikiri zone to the south. This area also contained heavy concentrations of basalt flakes, and several adzes and had clearly been the focus of some intensive stone working activities.

Another point of contrast between Structure 3 and Structures 1 and 2 is that while the interiors of these latter two structures were heavily stained with charcoal and contained varying amounts of ashy oven refuse, the floor of Structure 3

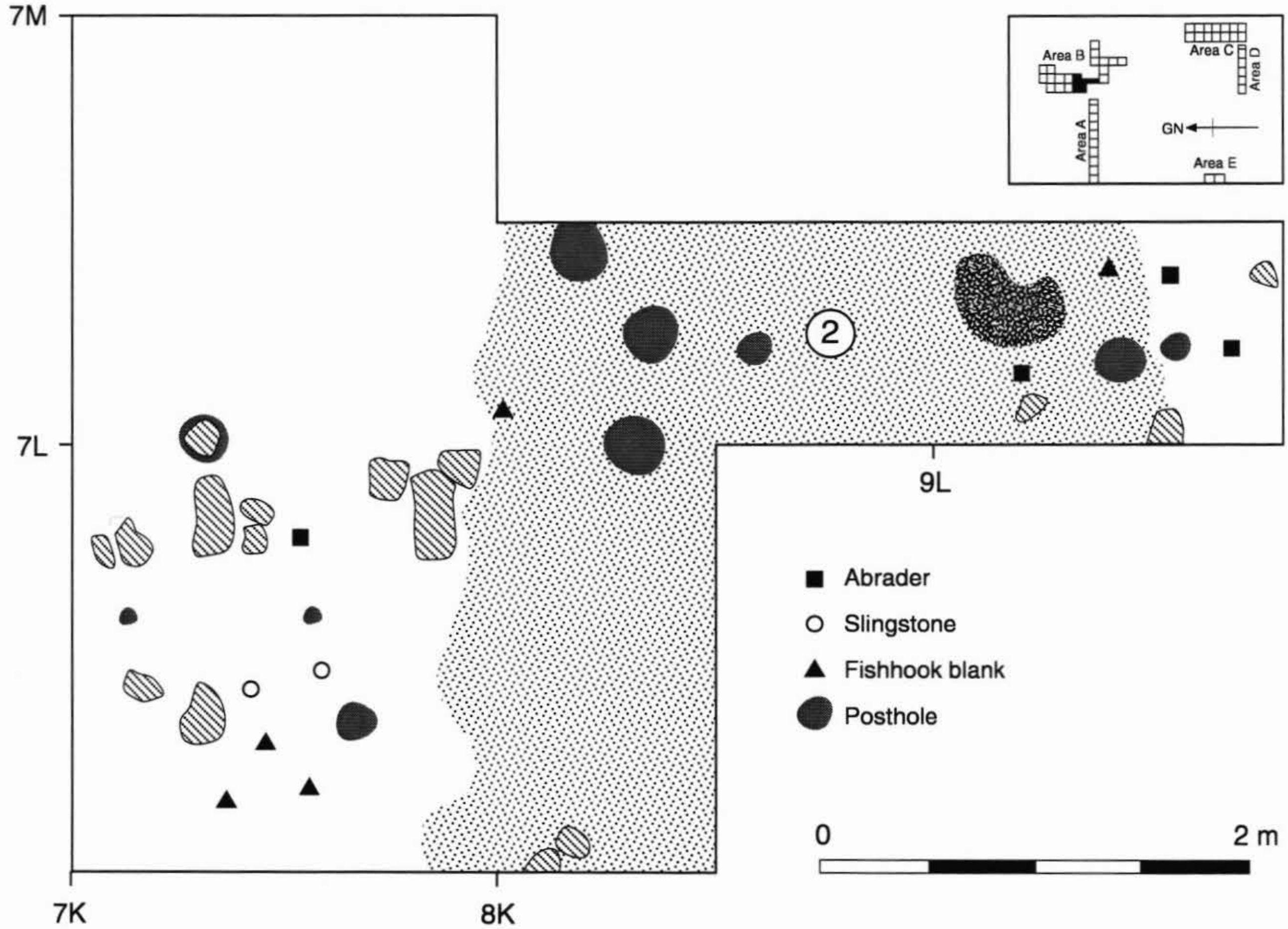

FIGURE 3.6. Part of Area B (surface features) showing kirikiri paving and postholes. These features are interpreted as defining the location of Structure 2.

was relatively clean. This, and the lack of evidence for intensive cooking or food preparation suggests that Structure 3 was functionally different from the other structures, probably being used as a dwelling.

Distribution of artefacts and midden. Artefacts were found in clear patterns of association reflecting the presence of activity specific kits. Furthermore, these were differentially located in reference to specific features within the site. Shell tool maintenance activities were represented by clusters of echinoderm and coral abraders, worked pearlshell and fishhook blanks. Stone tool manufacture and maintenance activities were represented by clusters of stone flakes and adze roughouts. These activities have two main foci within the site: along the outer perimeter of the structures, and adjacent to hearths. The midden bone recovered from Area B also showed some signs of clustering with the highest concentration occurring around the cooking areas, as might be expected, and declining from there with distance.

Layer 4 - sub-surface

The lower levels of Layer 4 contained a great many more features than were found on the surface, but they intercut one another in a complex manner, and problems of contemporaneity were impossible to resolve. Although no clearly defined floors were located, kirikiri was well spread throughout the layer suggesting that a number of structures had been erected and rebuilt during the course of this occupation phase. One particular point which stands out was the number and variety of pits recorded in the lower levels of Layer 4 (Fig. 3.8). Pits were an enigmatic feature of the Anai'o site coming in a variety of forms and with differing fill contents. Most had square cut sides and displayed no evidence of cooking or burning and it is assumed that they were associated in some way with food storage although their specific function is unknown. With one exception, they contained no deep organic staining which may indicate their use for the anaerobic preservation of breadfruit and the single exception has a more likely explanation (see below). Figure 3.9 shows a cross-section through some typical pit features from Area B.

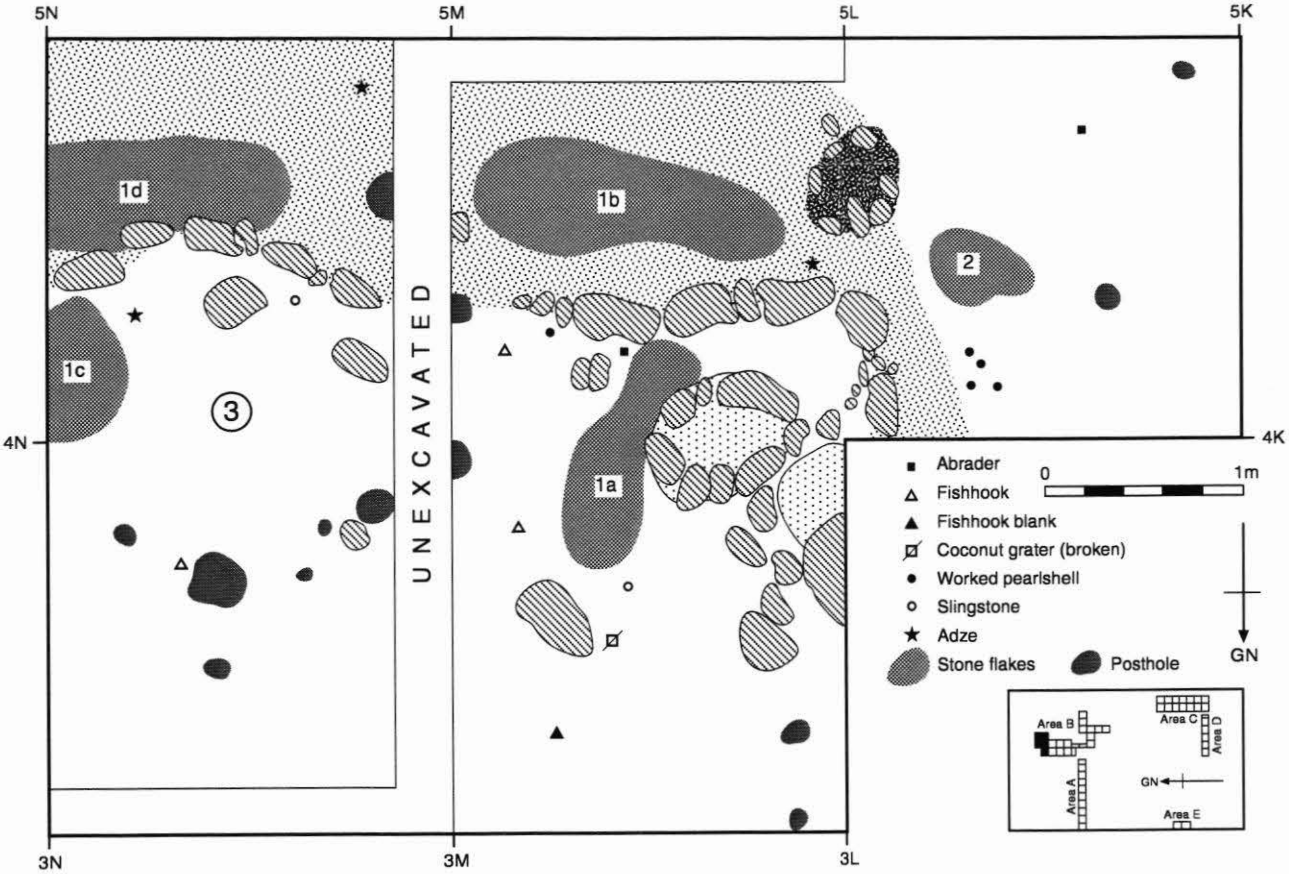

FIGURE 3.7. Part of Area B (surface features) showing kirikiri paving, postholes and flaking floors. These features are interpreted as defining the location of Structure 3.

Two parts of the site with particularly heavy concentrations of umu and shallow fire scoops outline an area which was used repeatedly for cooking activities. The first of these concentrations occurred in the south-east underlying and adjacent to Structures 1 and 2. This suggests a pattern of functional continuity, with this part of the site remaining as a focus for food preparation throughout the full span of the occupation. The second concentration was in the northern units, beneath Structure 3 and here the opposite interpretation is indicated. There was an early use of this part of the site for cooking and perhaps storage followed by the construction of a dwelling and the abandonment of these earlier types of activity.

The range of artefacts recovered in the lower levels of Layer 4 was similar to that recovered at the surface. There was some concentration of artefacts associated with shell manufacturing activities (waste flakes of pearlshell and abraders) in the vicinity of the cooking areas to the south-east, elsewhere their occurrence was sparse and showed no distinct clustering. It should be noted that some post-depositional movement of artefacts must be entertained in relation to both levels of the Layer 4 horizon. In particular it is almost certain, given the artefact distribution at the surface of the layer, that a slingstone and quantities of stone flakes recorded deep in 3M-4M were intrusive from above.

AREA C

Area C was 13 x 4 m and was located approximately 20 m to the south of Area B and at a similar distance inland (Figs 3.1 and 3.10). The northern end of Area C lay on the edge of the old quarry and there the ground level dipped toward the quarry face so that Layer 2 in some places lay under only 20-30 mm of overburden. Before excavation commenced the western face of the quarry between Areas B and C was cleaned down in order to ascertain the level of stratigraphic continuity between the two areas. Both occupation layers were found to be continuously present along this face and on this basis the features found at the surface level of Layer 4 are assumed to be contemporary with those found at the same level in Area B.

Stratigraphically, Area C exhibited only minor variations from Areas A and B. These variations relate mainly to the process by which the Layer 3 sands were deposited. In contrast to Areas A and B, the surface of Layer 4 in Area C contained a number of depressions so that during the deposition of Layer

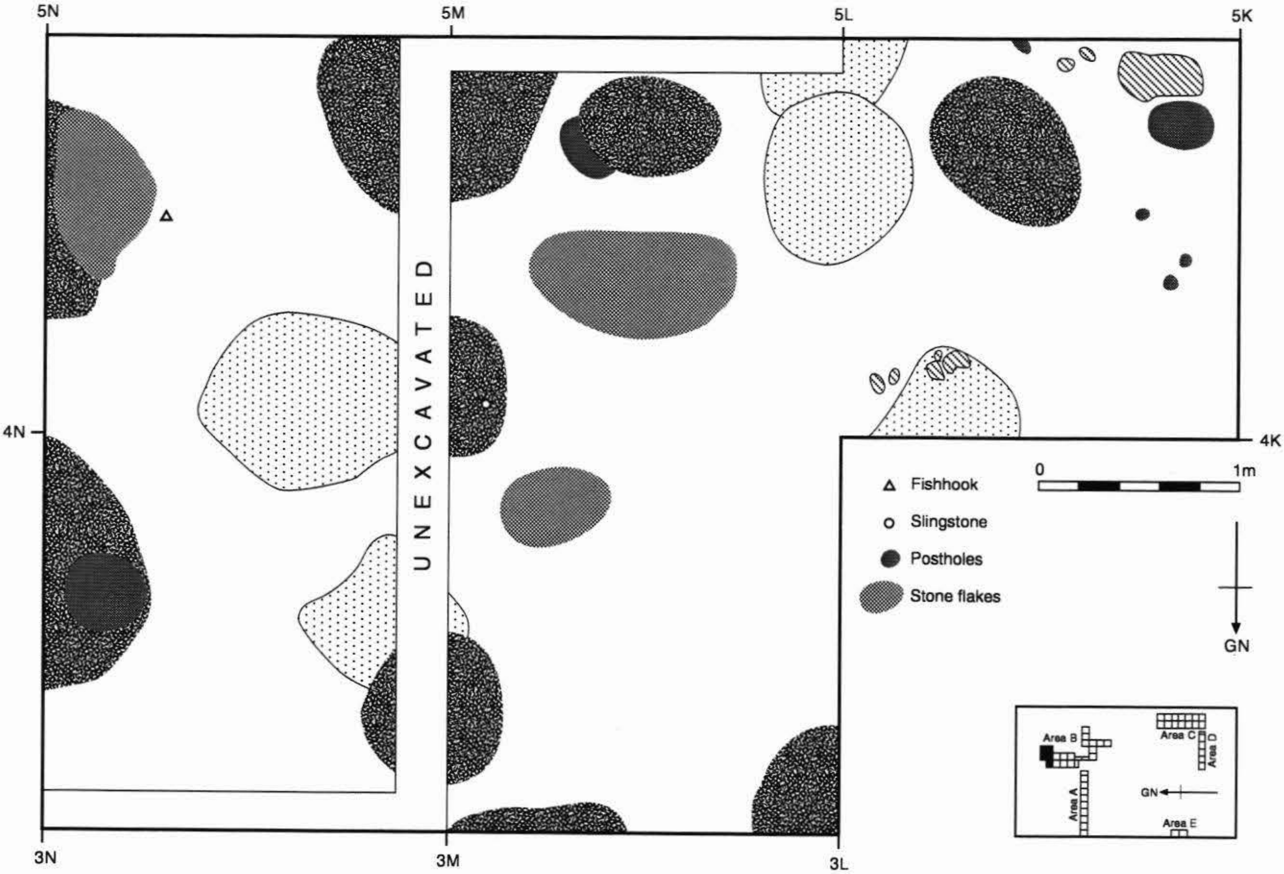

FIGURE 3.8. Part of Area B (lower features) showing pits and oven features located below (and predating) Structure 3 (Fig. 3.7).

3, beach detritus accumulated in the low lying areas. As the deposition process continued, thin bands of dark Layer 4 sands washed off the higher portions of Area C and then in turn were covered by a further deposition of Layer 3 material. This resulted in thin bands of Layer 4 material becoming sandwiched between deposits of the Layer 3 sand (Fig. 3.11). In much of Area C, Layer 4 was slightly lighter in colour than in the areas to the north.

Layer 2

As in Areas A and B, Layer 2 in this part of the site contained few features and no definite living surface (see Walter 1990:Table 2.5 for a description of these features). Faunal material from this level of the site was also sparse, only a small number of fishbones were recovered and no mammal or bird bone. However, a greater proportion of artefacts was recovered from this area than from the same layer in any other part of the site (Table 3.2).

Layer 4 - surface

Layer 4 in Area C was sloped slightly downward from the north so that the southern parts of Area C were approximately 400-500 mm lower (Figs 3.10 and 3.11). On the higher levels to the north, Layer 4 was covered with clean densely packed kirikiri with a depth of 120-180 mm making up the floor of a small structure (Structure 4). The kirikiri stopped at the edge of the slope and gave way to dark sand similar, although slightly lighter in colour, to the Layer 4 sands found elsewhere on the site. A wide, shallow umu was located *ca* 500 mm to the west

Find no	Grid unit	Description
372	25Q	3 x *Echinoderm* spine abraders
373	25Q	1 x Pearlshell tattooing chisel
375	23Q	4 x Fragments worked pearlshell
376	23Q	2 x One-piece pearlshell fishhooks
399	20Q	1 x One-piece pearlshell fishhook
401	20R	4 x Fragments worked pearlshell
413	21R	2 x Fragments worked pearlshell
414	21R	1 x One-piece pearlshell fishhook
424	20Q	1 x Butt end triangular adze
429	22R	1 x Pearlshell awl

TABLE 3.2. Artefacts from Layer 2, Area C.

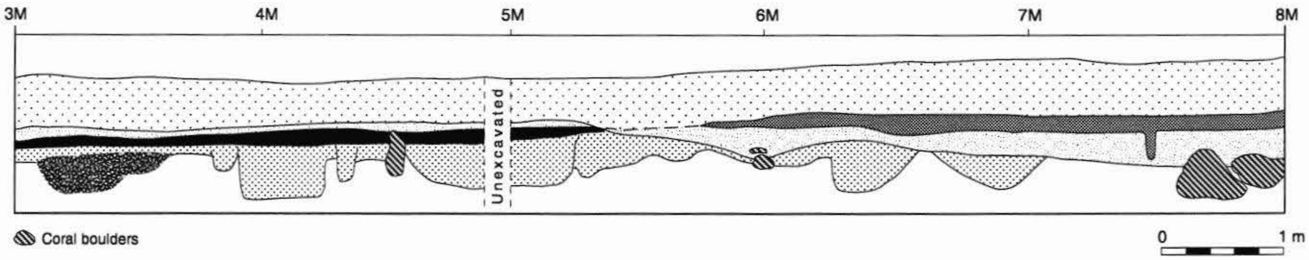

FIGURE 3.9. North-South section through Area B, east Profile. Note the variety of pits from Layer 4 (see Figure 3.1 for location).

of the kirikiri in the north of Area C and a charcoal stain had spread from this feature for a distance of about 1 m. Another much deeper umu filled with ash and humus in alternate lenses was found within a cluster of coral rocks that made up part of the flooring of Structure 5.

Structure 4 was defined by the tight deep layer of kirikiri enclosing a number of postholes in the north of Area C (Fig. 3.10). The structure was located on the highest part of the excavation with one wall roughly coinciding with the edge of the slope. Structure 4 probably enclosed a total of 16-20 m2 of floor space although it was not possible to excavate further to the north to check the total size as it was located on the edge of the old quarry face and coconut trees located to the east prevented expansion there too. The kirikiri within Structure 4 was less stained than that found within Structures 1 and 2 and contained little midden. A large shallow umu lay adjacent to Structure 4 to the west and was probably a contemporary feature. Although it contained burnt oven rock, this feature was too wide and shallow to have been used for underground cooking in the manner suggested for the other umu on the site and instead, it was probably used for heating or small scale ember cooking. Structure 4 is most similar to Structure 3 in terms of the degree to which the internal flooring has been kept clear of organic refuse. On this basis it is assumed to have had a similar function, as a dwelling or sleeping house rather than as a food preparation area.

Structure 5. This second structure is interpreted as a permanent cooking shelter. It was represented by coral rock paving surrounding a deep umu pit (Fig. 3.10). No postholes were found in association with this paving.

Distribution of artefacts and midden. As had been noted in respect of Area B the portable artefacts from this level of the site showed distinct signs of clustering. Structure 4 was virtually devoid of any artefacts with the exception of several pieces of worked and unworked pearlshell found within the general flooring layer. This contrasted with the tight cluster of artefacts found amongst the coral rocks forming the floor and surrounds of Structure 5. These latter artefacts included shell working by-products (worked shell and a fishhook blank), several

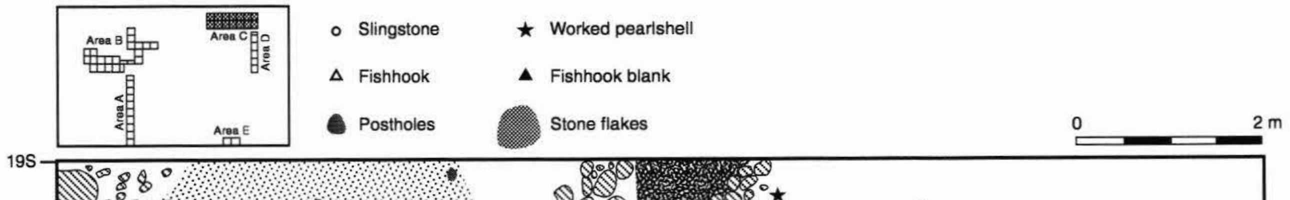

FIGURE 3.10. Area C showing kirikiri paving and postholes to the north which define the location of Structure 4. The cooking shelter, Structure 5, is represented by coral paving surrounding a deep umu along the east wall. Note location of activity areas around Structure 5.

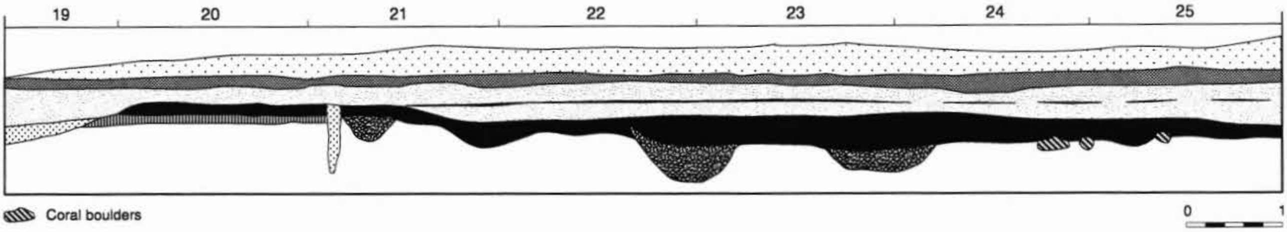

FIGURE 3.11. North-South section through Area C, east profile. Note the thin band of Layer 4 sand sandwiched within Layer 3. This shows that waves washed across the site during deposition of Layer 3 material.

finished hooks, a slingstone, a pearlshell ornament and the proximal end of a polished-stone chisel (Fig. 3.10). In addition, a scatter of stone flakes adjacent to an alignment of rocks running out from the stone paving marked an area where stone flaking had been carried out.

Faunal remains also showed signs of clustering and three areas of greatest concentration could be identified. The first of these was around Structure 5. The second was around the shallow umu and here the faunal material was distributed in a band along the west half of the 19Q-21Q units with very little found within the kirikiri of Structure 4. This distribution suggests that when the feature was in use a wall line separated it from the interior flooring of the structure. The third cluster of midden was found in the 24Q and 25Q units and was not associated with any specific feature. This last cluster of bone probably related to activities carried out around the pit features in Area D which are discussed below.

Layer 4 - sub-surface

Only a few features were found in the lower levels of Layer 4. This includes two small pits containing heat shattered stones and charcoal, a lens of oven rake-out and a single posthole (Fig. 3.11). The rake-out material was not associated with any oven and it is possible that it was related to some activity outside the Area C exposure. The only portable artefacts were a number of worked fragments of pearlshell. They were not associated with any other features or manufacturing tools.

In contrast to the paucity of features and artefacts, a relatively large quantity of bone was recovered from the lower parts of Layer 4 in Area C. Most of this bone was found in the 23R unit and it is possible that much of it had intruded from the top of the layer. During the time when the surface oven feature was in use in this area food consumption was also taking place and bone was discarded and tramped into the surrounding soils.

AREA D

Area D was 12 m x 2 m and oriented at right angles to Area C (Figs 3.1 and 3.12). This area was completed prior to the Area C excavations and a 1 m baulk was left standing but was later removed (the baulk is still shown in Fig. 3.1). The stratigraphy in Area D was similar in most important respects to elsewhere on the site. The only major difference was that Area D contained large coral boulders ranging up to 1.5 m in diameter in Layer 5. This is because Area D is directly aligned with the reef passage and so is more liable to receive large size reef debris during hurricanes.

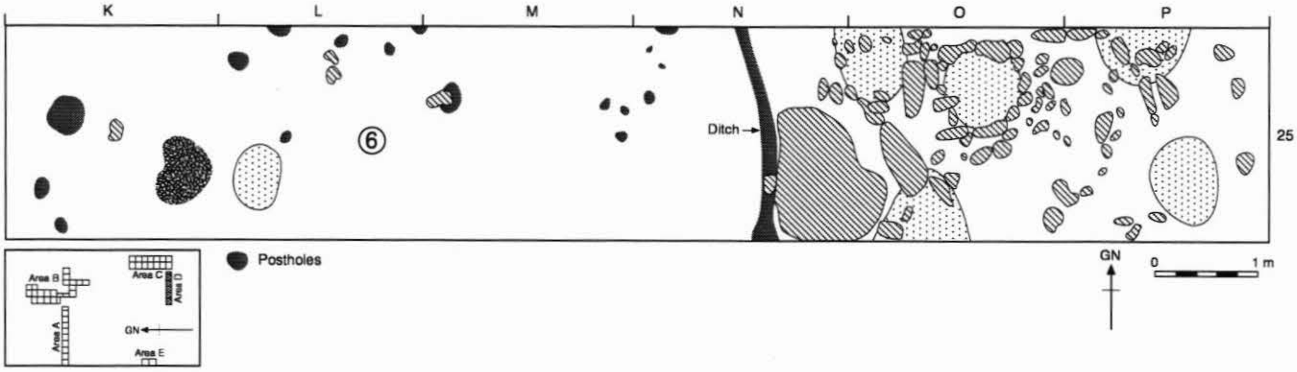

FIGURE 3.12. Area D. Postholes located in the western half indicate the location of Structure 6 with the east wall marked by a narrow drip line or bedding trench running north-south across the excavation.

Layer 2

In common with the other excavated areas, Layer 2 contained few features and no clear living surface. The three recorded features were all postholes and were roughly aligned, although no additional evidence was present to suggest that they formed part of a structure. No portable artefacts and only a few fishbones were recovered.

Layer 4 - surface

The surface of Layer 4 in Area D varied considerably in colour and inclusions from unit to unit. A range of features were recorded including what appears to have been a large sized structure (Structure 6).

Structure 6. Structure 6 is represented by a number of postholes and by a *ca* 90 mm deep ditch or dripline which ran approximately north-south across 25N (Fig. 3.12). Although the postholes did not form any coherent alignments, they were probably all part of this one structure which was rebuilt several times so that the resulting pattern of holes represents a sequence of reconstruction phases. The two largest postholes near the centre of the excavation may represent the location of consecutively erected centre posts and the ditch might mark the location of an outside wall. This latter feature may have been a wall bedding trench or a drip line from a roof overhang. No estimates of size are offered here other than that it must have been larger than any of the other structures judging by the size of the centre posts. The western most of these postholes was 720 mm deep and was lined to the base with coral rocks. The other posthole was 830 mm deep and filled with a heavily compacted grey sand.

Unlike some of the other structures in Layer 4, Structure 6 did not contain any kirikiri or other distinctive flooring material. However the narrow ditch does mark a division in the excavation area between two types of surface cover. To the west (in what is assumed to be the interior of a structure) the surface is clear of boulders and of midden or cooking debris. To the east a scatter of midden was found around a number of coral rocks. On neither of the surfaces was there any evidence for cooking activities. To the east of Structure 6 three pits were found with steep sided pits and rounded bases. They were filled with fine light grey sand and their proximity to one another suggests that this area may have been intensively used for some type of storage purpose. The function of Structure 6 is unclear but since was larger and it was different to those interpreted as cooking shelters and dwellings, it may have been a community structure of some sort.

Distribution of artefacts and midden. A wide variety of portable artefacts were recovered from amongst the pit features in the eastern third of Area D. These included several complete fishhooks and one hook blank, some coral grinders (probably used for the maintenance of shell fishing gear) a pearlshell neck ornament and some slingstones. No waste flakes of shell or stone were found and this part of the site does not appear to have been used for manufacturing. In the interior of Structure 6 however, four complete hooks were recovered. The presence of complete artefacts in Area D as opposed to half complete tools, manufacturing equipment and associated waste flakes contrasted with the type of products found in Areas B and C.

The recovery of portable artefacts in the rocky area of Area D outside the east wall of Structure 6 is unusual. These items are of good quality and were probably not deliberately

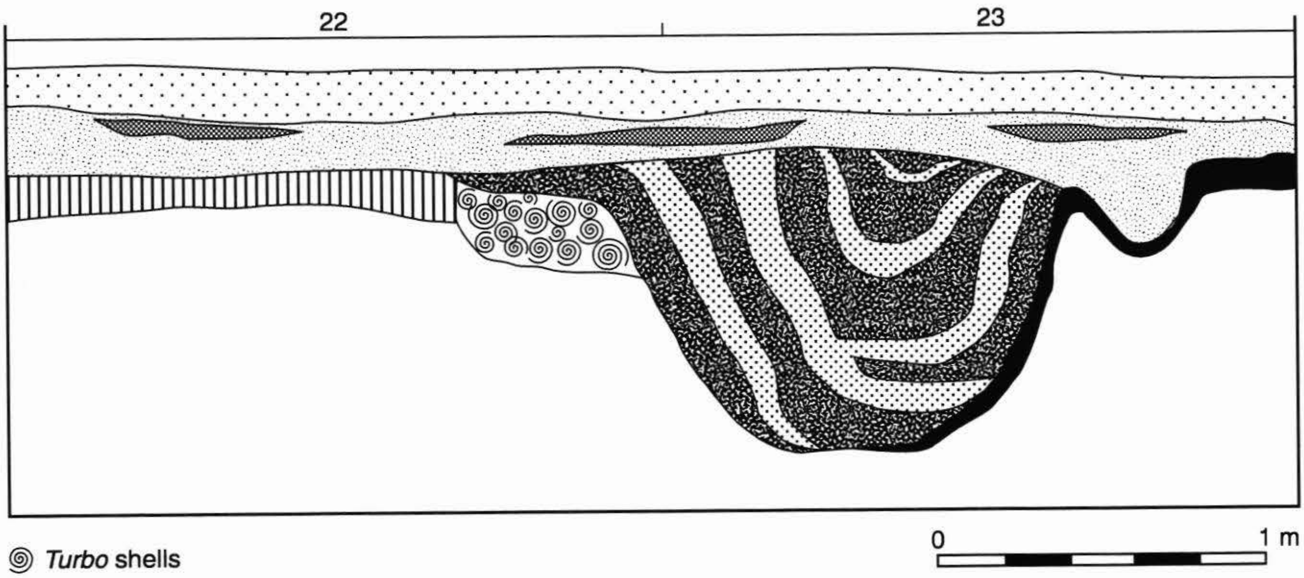

FIGURE 3.13. South-north section through Area E, east profile.

discarded, yet they do not represent a specific assemblage type. It may be that this area, close to the outer wall of a large structure, was used for general storage. Roofing of the area, while possible was not indicated by postholes.

Faunal remains in Area D were concentrated in the east half of 25N through 25O and 25P. This material was not associated with any cooking facilities but was spread amongst the rocks around the pit features. An articulated pig foot was part of the collection of bone recovered in the 25N unit. The units that were within the interior of Structure 6 were relatively free of faunal remains. In fact, west of the ditch only 4.0 g of fishbone and 18.7 g of mammal bone was found.

There were few features recorded below the surface of Layer 4 in this area. Some thin layers of compact charcoal and light grey ash were found in the west half of Area D lying directly over the Layer 5 sand and these appear to relate to burning activities during the period of first clearance at the site. The artefacts recovered from the lower portions of Area D include a single pearlshell fishhook from the 25P unit and several fragments of worked shell from 25K and 25L.

AREA E

Area E was a smaller exposure measuring 2 x 4 m (Fig. 3.1). It was excavated as an extension of a test pit in 23A that had been dug as part of the north-south transect (Fig. 3.3). During the excavation of the initial test pit, a tightly packed mass of *Turbo* shell was found in Layer 4 that was thought to have been part of a larger midden. As no specific midden areas had been located at Anai'o the area was enlarged. Following excavation it became clear that this was not an extensive midden area but a small and localised dump of a single faunal species. However a full 8 m2 was excavated in order to determine whether any gross differences could be discerned in the pattern of occupation in this part of the site which lay about 20 m seaward of all other areal excavations at Anai'o. Area 5 lay on the western limits of the Layer 2 occupation area and no features, midden nor portable artefacts were recovered from this horizon.

Layer 4 - surface

In contrast to the situation elsewhere on the site, the surface of Layer 4 contained few features and no well defined living surface. The only feature recorded is shown in section view in Fig. 3.13. This large umu had been cut through the edge of an earlier feature and had later been infilled with alternating lenses of ash, charcoal and dark grey sand. No artefacts, and only a small quantity of faunal material, was recovered from the surface of Layer 4.

Layer 4 - sub-surface

The lower levels of Layer 4 contained more features than the upper level although it was probably never a major focus of human activity within the Anai'o settlement. The largest feature was an oven scoop beside which lay a pile of foetal pig bones. This cooking feature was probably not contained within a structure at the time of use. Two small dumps of *Turbo* shell were found within shallow scoops excavated into Layer 5. A total of 15 shells were found in the feature in 23A and 17 in 22A. The only artefacts found were several small fragments of worked pearlshell.

CHAPTER 4. MATERIAL CULTURE

The Anai'o area of the western coast has long been recognised by Ma'ukeans as a source for unique items of material culture such as adzes and unusual shell tools. In fact, despite there being no habitations and little activity occurring along this area of the coast, Anai'o is generally regarded as having some special significance in the history of Ma'uke culture. A number of oral traditions refer to a settlement at Anai'o and some of these mention a village in reference to important political events in Ma'uke's history. Although it is clear from their context that these traditions refer not to the archaeological settlement of Layer 4 but to a later hamlet or camp site, these stories have become entangled in the discussions of artefact finds to create a strong feeling for the cultural importance of Anai'o.

The collecting of artefacts from Anai'o probably began 80 to 100 years ago when people started to prepare lime on the site, since the lime-pit cuts through the centre of one of the densest occupation zones. However, most of the artefacts recovered from the site by local collectors were taken from an area close to the makatea edge where a sand quarry was dug in the early 1960s. The holder of the Tamuera Ariki title during that period had a deep interest in Ma'uke history and material culture and had built up a sizable collection of Ma'ukean adzes of which many are said to have come from Anai'o. This collection was acquired by the Cook Island Museum on Rarotonga in the mid 1970s together with a small collection of shell tools which were recovered from Anai'o by quarry workers several years earlier. It was this small museum collection of shell tools which alerted archaeologists to the possibility that there could be a site on Ma'uke which would answer questions about the Cook Island aspect of the archaic tradition.

In the absence of pottery, culture history research in East Polynesia has concentrated on plotting the temporal and spatial distribution of non-ceramic tool classes such as shell and bone fishhooks, ornaments and adzes. Large assemblages of these tools had been recovered from archaic sites in New Zealand, the Society Islands, the Marquesas and from similar sites in Hawaii, but until the excavation at Anai'o, very little was known of the prehistoric material culture of the Cook Islands. Anai'o provides the first well dated assemblage of early artefact forms from the southern Cooks, expanding our knowledge of regional variation in the early phases of East Polynesian prehistory. Since the Anai'o excavations, archaeological investigations on a number of other islands in the Cook group, but particularly on Aitutaki and Mangaia, have provided additional detail on artefact type and style (Allen 1992a, 1996; Allen and Schubel 1990; Allen and Steadman 1990; Kirch and Ellison 1994; Kirch *et al.* 1992; Walter and Campbell 1996; Weisler *et al.* 1994). The following sections provide descriptive, comparative and interpretative statements on some of the important classes of material culture recovered from the Anai'o site with a full listing of artefacts shown in Table 4.1.

FISHHOOKS

Although Anai'o is a large, well-preserved site the density of hooks was much lower than in the rockshelter sites of Moturakau on Aitutaki (Allen 1992a, 1996) or Tangatatau on Mangaia (Kirch *et al.* 1992). This is partly because of the difference in site formation processes between rockshelters and open settlements in Polynesia. Rockshelters tend to accumulate deep deposits of material in small areas and were often occupied (or reoccupied) over long periods of time. In open settlements such as Anai'o, material culture is distributed at a low density over the entire occupation surface with few areas of higher concentration. These factors affect patterns of recovery and taphonomy.

Pearlshell

All the Anai'o fishhooks were manufactured of pearlshell but two drilled fishhook tabs were made of *Turbo setosus*, a gastropod shellfish found on the nearby reef. Pearlshell has a number of advantages for fishhook manufacture. It is easy to work, its lamination and molecular structure provide great strength and its surface lustre attracts fish. For this reason pearlshell was the favoured material for fishhook manufacture throughout prehistoric East Polynesia (Sinoto 1967:347, 1995:152). One-piece hooks are especially suited to pearlshell

Artefact	Layer 2	Layer 4
Fishing gear (*Pinctada margaritifera*)		
One-piece fishhooks and fragments	5	40
Two piece fishhook point		1
Undrilled fishhook tab		15
Core from fishhook tab		8
Fishing gear (*Turbo*)		
Drilled fishhook tabs		2
Fishing sinkers		
Coral[1]		11
Stone		1
Ornaments		
Lanceolate pearlshell pendant		2
Drilled shell ornament		1
Drilled tooth ornament		2
Scrapers and graters		
Turtle carapace scraper		1
Mammal bone scraper		2
Asaphis Vegetable scraper	2	14
Codakia Vegetable scraper	2	3
Pearlshell Coconut grater		4
Pearlshell Coconut scraper		1
Abraders, chisels and grinders		
Echinoderm spine abrader	3	39
Branch coral abrader		12
Terebra shell chisels		3
Coral sharpening stone		3
Coral grinding stone		3
Spearpoint		
Mammal bone		1
Pearlshell[2]		2
Miscellaneous		
Awl (pearlshell)	1	
Tattooing chisel (mammal bone)		2
Tattooing chisel (pearlshell)	1	
Stone tools		
Adze (lenticular)		2
Adze (quadrangular)		1
Adze roughout (quadrangular)		2
Adze roughout (reverse trapezoid)		2
Adze/chisel roughout		1
Adze section (triangular)	1	
Adze section		4
Chisel		1
Basalt scraper with retouched edges	1	
Basalt grinding stone		2
Pottery		
Plainware sherd		2

[1] These may be slingstones, see text
[2] These are similar to New Zealand harpoon heads

TABLE 4.1. Artefacts from Layers 2 and 4, Anai'o.

and the specialised one-piece technology of East Polynesia is clearly a pearlshell based adaptation.

Unfortunately, the distribution of pearlshell in Polynesia is discontinuous, being mainly restricted to the protected lagoons of the atolls such as, for example, those of the northern Cooks and Tuamotus. Where pearlshell was not available, alternative manufacturing techniques were developed. This included a switch to other manufacturing materials as well as changes in basic hook form. In fact, it is probable that many of the variations in East Polynesian hook morphology, particularly those found in the peripheries of East Polynesia, reflect attempts to adapt a shell one-piece technology to a non-pearlshell environment. For example, in Hawaii, New Zealand, Pitcairn and Easter Island one-piece hooks were rendered in materials such as bone and stone. These materials are technologically inferior to pearlshell and were rarely used in islands where pearlshell was available. In Hawaii, Easter Island and New Zealand the two-piece hook was also developed, probably as an adaptation to the inadequacies of bone for manufacturing one-piece hooks. Two-piece hooks eliminate the weak area of the bend by binding separate shank and point sections.

Pearlshell was used as the standard material for one-piece hook manufacture throughout the early phases of southern Cook Island prehistory. However, while pearlshell is ubiquitous in early sites, it declines in the archaeological record of the southern Cook Islands from about the 15th century A.D. when it was replaced by *Turbo* as the favoured manufacturing material (Walter 1990, 1996b; Walter and Campbell 1996). The steady increase in the relative importance of *Turbo* for hook manufacture is consistent across the southern Cook Islands as is shown in the seriation diagram in Figure 11.2. *Turbo* shells are smaller, more brittle and are not as easily worked as pearlshell and they will not produce the large flat tabs which give manufacturers great versatility in the matter of hook size and form. This suggests that the replacement of pearlshell was not driven by intentional factors but by a decrease in the availability of source material.

Pearlshell thrives naturally in the lagoons of the northern atolls of the Cook group. In the southern group it may be found in small quantities in the Aitutaki lagoon but it is absent altogether from the makatea islands where there are no suitable lagoons. The lagoons of Rarotonga are also too shallow to support pearlshell beds. All the pearlshell found at Anai'o must have been imported to Ma'uke, as it was to Rarotonga and the other raised reef islands such as Mangaia, Atiu and Mitiaro. On this basis, the decline in pearlshell in the archaeological record of the southern Cook Islands is interpreted as reflecting general changes in the exchange system or voyaging networks of the time. Other imports also decline in the archaeological record from about the 15th century which suggests that the Cook Islands witnessed a systematic decline in inter-island exchange systems from this time (see Chapter 11).

Interestingly, the decline in the use of pearlshell coincides roughly with a general decline in the use of the one-piece fishhook which might suggest that *Turbo* proved unsatisfactory in the long term. Hooks are not found in surface collections anywhere in the southern archipelago (Walter 1990) and ethnographic reports suggest that they were rarely if ever, manufactured during the late prehistoric era. Gill reports their occasional manufacture out of *Turbo* shell on Mangaia in the early historic era, but they are unknown from any late archaeological context (Buck 1944; Gill 1880:65). In the northern Cook Islands where pearlshell is plentiful, shell hook manufacture continued well into the historic era.

Hook form

The excavated hook assemblage consists of 45 specimens made up of a single point of a two-piece hook, nine complete or near complete one-piece hooks and a quantity of one-piece hook fragments. A number of hook tabs and waste flakes of pearlshell used for hook manufacture were also recovered (Figs 4.1-4.6). In addition, several fragments of one-piece pearlshell hook and a trolling lure shank were taken from Anai'o during the 1970s and are now housed in the museum on Rarotonga.

In their taxonomic classification of one-piece hooks, Emory *et al.* (1959; see also Sinoto 1991) first distinguish

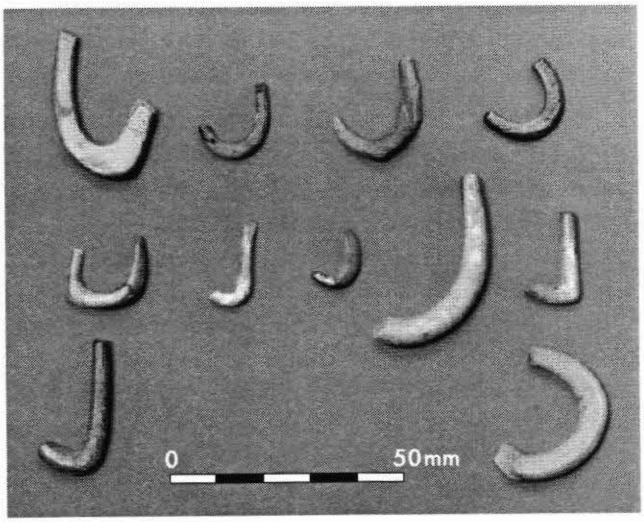

FIGURE 4.1. Pearlshell one-piece fishhooks.

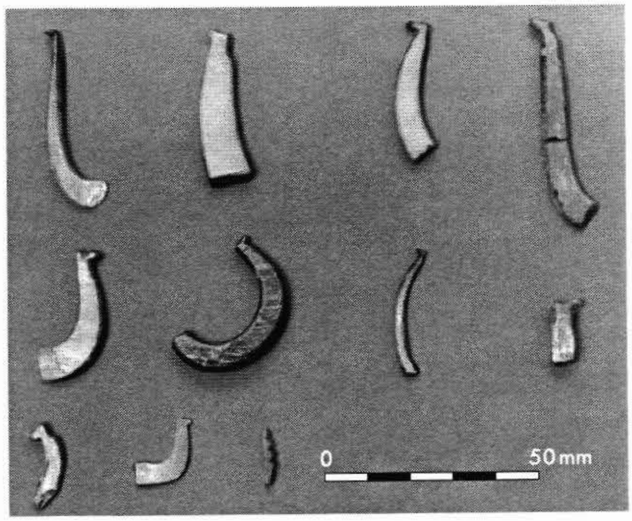

FIGURE 4.2. Pearlshell one-piece fishhooks.

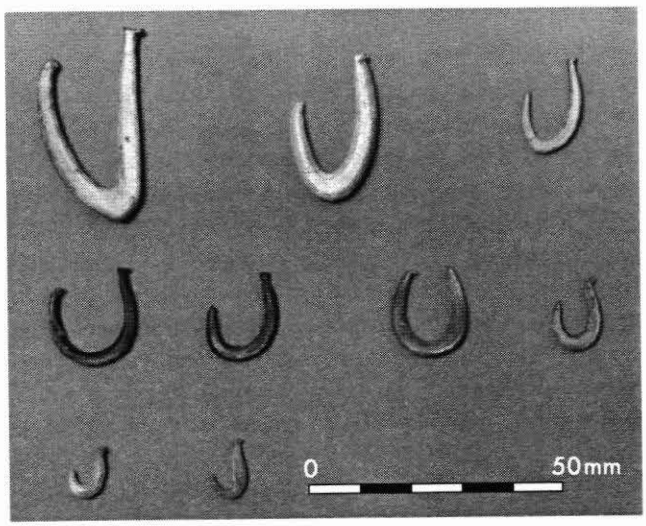

FIGURE 4.3. Pearlshell one-piece fishhooks.

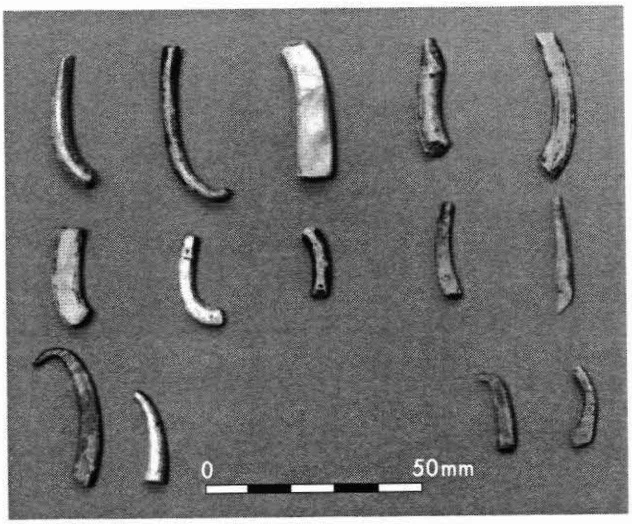

FIGURE 4.4. Pearlshell one-piece fishhooks.

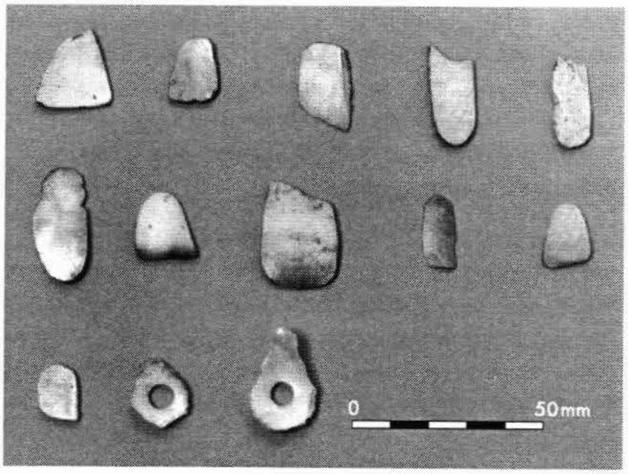

FIGURE 4.5. Fishhook blanks. All specimens are pearlshell except two on bottom right which are *Turbo setosus*.

FIGURE 4.6. Waste pieces of pearlshell from hook manufacturing industry. Note evidence for drilling and sawing actions.

between jabbing and rotating hook classes. Sinoto (1991) defines a rotating hook as any hook in which the shank and point are converging, while in jabbing hooks the shank and point are either parallel or diverging. On the basis of these criteria, 12 of the excavated hooks and two of the Museum specimens can be separated into seven jabbing specimens and seven rotating (Walter 1989:70). Most of the hooks fall into the small to medium range for East Polynesian assemblages. One of the museum specimens has a shank length of 118 mm but the remainder of the hooks have a shank length ranging between 10 mm and 39 mm (Table 4.2).

There are a number of ways in which the Anai'o hooks can be described and compared with other Cook Island assemblages. Most hooks could be accommodated within the Emory *et al.* (1959) taxonomic classification system but, for the purposes of simple comparisons of hook morphology, I consider the Suggs (1961) classification as adapted by Rolett (1998) to be more useful, because it can account for broken fragments and thus allows a maximum number of specimens

Type	Shank	Point	Width	Shank/point ratio
Jabbing	10	5	7	2.0
Jabbing	14	10	9	1.4
Jabbing	20	13	12	1.5
Jabbing	12	5	7	2.4
Jabbing	29	20	17	1.5
Jabbing	17	11	13	1.5
Rotating	19	16	16	1.2
Rotating	18	17	14	1.1
Rotating	39	35	19	1.1

TABLE 4.2. Dimensions of complete fishhooks in mm.

to be included in the comparison. In this discussion I retain the use of the Emory *et al.* (1959) categories of 'jabbing' and 'rotating'. However, in this section on fishhook form I use these terms in inverted commas to distinguish them from the rotating and jabbing types used in the Suggs/Rolett typology (see Rolett 1998; Suggs 1961). Elsewhere in the text the terms 'jabbing' and 'rotating' refer to the Emory *et al.* (1959) classification.

In the Suggs/Rolett system the Anai'o assemblage contains definite examples of the following types: acute recurved point, obtuse recurved point, circular, curved shank, jabbing and rotating. Since many of the hooks are broken and could fall into one of several categories, I have not quantified these types but all hook specimens are shown in Figs 4.1-4.4 (see also Walter 1989). A number of classification systems have been used to describe variation in the Polynesian one-piece fishhook head or lashing device (Green 1962; Sinoto 1962). Nineteen of the Anai'o hooks had intact heads and 18 of these were found to be variations of the Sinoto (1962) projecting knob head form (Walter 1989:71). The remaining device was similar to Sinoto's HT2a variety. Variation in the Anai'o head forms occurred in two main areas. The inner proximal surface of the shank was either unmodified, reduced or notched and the upper surface of the head was either flat or saddled. In an earlier discussion of head form the angle between the upper surface of the head and the shank was also mentioned in relation to typology (Walter 1989:72). This mode of variation is extraneous to the model and is not considered here (see also Allen 1996:104). Variation in these two modes results in six potential types of which five were realised in the excavated assemblage (Fig. 4.7).

Several other fishhook assemblages have now been reported from elsewhere in the Cook Islands. On Pukapuka in the northern Cook Islands a sequence of fishhooks has been

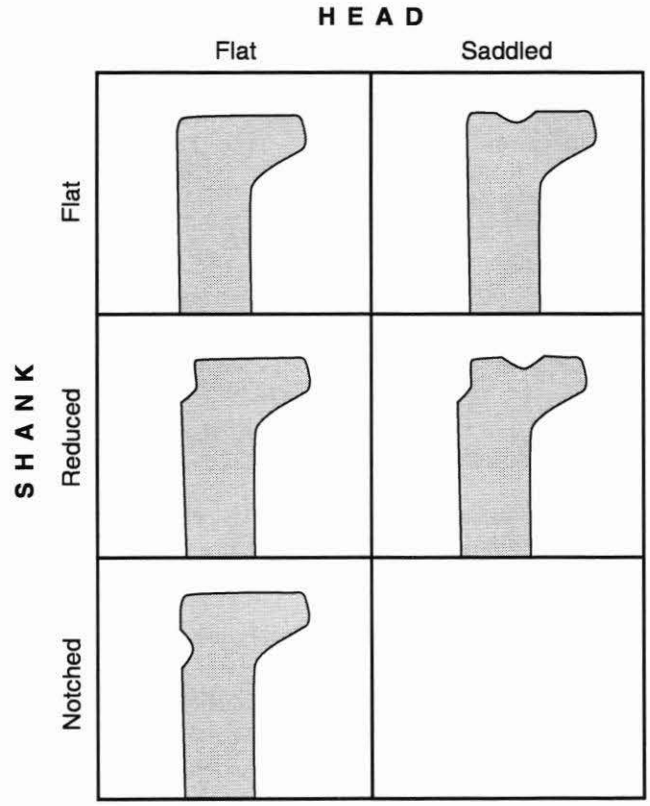

FIGURE 4.7. Classification of one-piece fishhook heads based on variation in head upper surface and outer face of the shank.

recovered which is claimed to span a period from the first few centuries B.C. until early historic times, with a thousand year gap from *ca* 500 A.D. (Chikamori and Yoshida 1988). Spriggs and Anderson (1993) suggest on a number of grounds that these dates are too early but the assemblage is likely to span most of the Pukapukan sequence even if the basal dates have to be upwardly adjusted. A total of 39 one-piece hooks were recovered from Pukapuka all of which were 'rotating' hooks in the Emory *et al.* (1959) system. In terms of the Suggs/Rolett classification, 21 fell into the acute recurved point category, seven were circular with an inner barb, three had a curved shank and eight were unclassifiable in this scheme.

There are a number of major differences between the Pukapukan and Anai'o fishhook assemblages. Anai'o has a much higher proportion of 'jabbing' hooks than Pukapuka (in fact, none were reported from Pukapuka). Only one definite example of the acute recurved point hook which dominates the Pukapukan assemblage was present at Anai'o, although several other specimens with broken points might be included in that group (Fig. 4.3). The curved shank hooks from Pukapuka were much more massive and severely angled than the two excavated Anai'o examples, although one from the museum collection (not figured) was more similar to the Pukapukan specimens. The Anai'o collection did not include any barbed hooks, and indeed none are known from the southern Cook Islands. Thirty-four of the Pukapukan hooks had recognisable lashing devices and on the basis of illustrations given in Chikamori and Yoshida's (1988) Figure 16 they all appear close to the HT4a variety (Sinoto 1991:96, Fig. 13). This device was absent from the Anai'o assemblage.

Chikamori and Yoshida (1988) also report 17 lure shanks and two lure points from Pukapuka. This type of hook was not excavated at Anai'o, although there is a broken fragment of a lure shank in the Cook Island Museum collection listed as having come from Anai'o. Lures are usually used to catch surface swimming species such as tuna (Scombridae spp.) and since Scombrids are represented in the midden, it is likely that the Anai'o community practiced some form of lure fishing.

The differences between the Pukapukan and Anai'o assemblages reflect different fishing adaptations. At Anai'o, the fishers were targeting small to medium specimens of inshore species which inhabit the edges of the fringing reef (see below). The larger rotating hooks found in the Pukapukan assemblage were designed for the exploitation of larger, deeper water benthic feeders. Pukapukan angling would have been carried out mainly from canoes, since these hook types can not be easily used when positioned on the reef, and it is likely that the fishing was taking place over deep coral shelves in the lagoon or more likely, in the deep passages between the atoll and open sea. Neither fishing zone is available to the Ma'uke fishers and so the variation in fishing kits can be interpreted as having a strong environmental and ecological component. Pukapukans were also more involved in offshore lure fishing activities than the Anai'o community.

A comparison is also useful with the hooks from the Moturakau site on the Aitutaki lagoon which produced about 140 whole and partial one-piece hooks of both pearlshell and *Turbo* spanning an 800 year sequence (Allen 1992a:238). Allen established a classification involving variation in the dimensions of shank and point. This paradigmatic scheme produced four possible classes of which three were represented in the collection. All three of these hook classes would fall within the general 'rotating' category of Emory *et al.* (1959). The Moturakau hooks were similar in the range of forms to those from Anai'o suggesting a similar exploitation strategy based on selection for the inshore fishing zones. The Aitutaki hooks varied in size from 9.7 mm to 71.6 mm with some evidence for a slight decline in average size through time, and with a mean shank/point ratio of 1.14 (Allen 1992a:246).

Other large and varied assemblages of one-piece pearlshell hooks derive from two coastal sites on Mangaia excavated as part of a multi-disciplinary Japanese anthropology project. At least one of these sites appears to be similar to Anai'o, a nucleated hamlet on the sheltered leeward coast adjacent to a reef passage, but published details of the hooks are so far unavailable. The Tangatatau site on Mangaia which spans an 8-900 year period from about 1000 A.D. has produced a total of 232 whole and partial fishhooks, including both jabbing and rotating varieties but again, full typological details are presently unavailable (Kirch *et al.* 1992, 1995). Several isolated hooks have been reported from excavations on Aitutaki and Rarotonga (Allen 1992a; Bellwood 1978a) but the only other excavated assemblage is from the 1600 A.D. Paraoa site on Mitiaro (Walter and Campbell 1996). This small assemblage of 19 one-piece hooks and fragments consists of 15 *Turbo* hooks, three pearlshell hooks and the only mammal bone hook so far reported from the southern Cook Islands. The size range of these hooks falls well within the Anai'o range and the only outstanding difference, other than the predominant use of *Turbo*, is in the head forms. Most of the intact Paraoa hooks have a simple projecting head lashing but two *Turbo* specimens have a pointed shank tip above an inner-shank projection (Walter and Campbell 1996:Figs 3, 17 and 18). The only other examples of this lashing form that I am aware of are also in *Turbo* and are from the To'aga site in the Manu'a Islands and date at least 1000 years earlier than the Mitiaro specimens (Kirch and Hunt 1993). This appears to be a good example of a lashing device type specifically adapted to the structural properties of *Turbo*.

Fishhook function

It is possible to make a number of simple observations about the function of the Anai'o hooks based on hook form, supplemented by observations of current fishing practices and the evidence of the midden data.

In the absence of detailed experimental data the relationship between typology and function is not well understood in Polynesia. Nevertheless, the distinction made by Emory *et al.* (1959) and Sinoto (1991) between 'jabbing' and 'rotating' hook classes is recognised as having a definite functional component (Reinman 1970). Jabbing hooks have no in-built mechanism for keeping the fish on the line. Instead the operator must first jerk the line to set the hook and then keep a constant and steady upward pressure on the line to prevent the fish from wriggling free. For this reason, jabbing hooks must be used in conditions where the fisher can either see or feel the feeding activities of the target fish which means that they are particularly well suited for use in shallow, calm waters. The rotating hook, on the other hand, hangs free and sets itself by rotating and passing the point into the mouth as the fish strikes. It is ideally designed for catching deeper feeding, benthic or epipelagic predators which strike hard and fast. Rotating hooks are best used on dropped lines from canoes where they are allowed to hang free, often over a submerged reef. They are not as well suited for shore based fishing.

This size range of the jabbing hooks from Anai'o reflects shallow water exploitation with a selection for the resources of the reef edge and the inner margins of the inshore zone. A common angling practice on Ma'uke today is to tie a small baited hook to a short line which is attached to the end of a bamboo pole. The rod is known as a matira and it is used to dangle the bait into crevices and surge channels along the edge of the reef. When the fish strike, they are jerked high out of the water and landed on the reef flat. Fish caught using this technique are mainly small members of the family Serranidae. This type of fishing practice is likely to account for most of the Anai'o jabbing hooks, an interpretation which is reinforced by the midden data which is dominated by small Serranids (Chapter 6). Local informants suggested that the very smallest specimens of jabbing hook from Anai'o may have been used for titomo fishing. This is a specialised fishing practice which targets small schooling pelagic species such as *Decapterus* or *Selar* spp. The fishers paddle out to where a school of fish has been spotted, usually about 50 to 100 m offshore. They then jump into the water with a very short line attached to a rod about 1 m or less in length. Fish are attracted by the use of grated or chewed coconut which is spread into the water and as the fish congregate and feed , they are jerked out of the water using the rod and thrown up into the waiting canoe. On the suggestion of my Ma'uke field crew, I manufactured replica hooks out of pearlshell and tested them in titomo fishing off the Anai'o coast. They were difficult to use, but ideally suited to this practice (Walter 1988).

The rotating hooks from Anai'o were also in the small size range and suggest the targeting of small to medium specimens of benthic predators. The only place around Ma'uke where hooks of this size could be used are within 100 m or so of the reef face. Here the base of the sloping coral shelf could be fished for species such as Carangids, Lethrinids or Lutjanids. These fish patrol the reef face and could have been caught using baited rotating hooks from stationary canoes positioned 50 m or so offshore.

Style versus function

A number of attributes of one-piece hooks have been identified as stylistic, rather than purely functional. The fishhook lashing device or head form was identified as a stylistic trait by Green (1962), and subsequently Allen examined this issue at some length. Allen (1996:98) used a theoretical approach in which, "...the identification of a particular trait as stylistic or functional begins as a hypothesis, which is then empirically evaluated by comparing the spatio-temporal patterns of particular traits with those of the model". According to Allen, the distribution of variation in head form across time and space compares most closely with the model for stylistic traits-a gradualistic as opposed to stochastic pattern of change. Sinoto (1967) has also suggested that the shank/point ratio may be most usefully viewed as a stylistic trait. Allen (1992a:242) agrees, and suggests that in evolutionary terms, the trait is "selectively neutral". The importance of detecting style is that the distribution of stylistic attributes provides a good estimate of historical interaction (Allen 1996:106; Green 1961).

I take a more conservative approach than Allen, Green or Sinoto to distinguishing between functional and stylistic attributes, and believe that any final judgement will require more empirical data on the way in which Polynesian fishhooks operate in practice. My own observations of fishing in the Pacific suggest that there is probably a functional component to both the form of the head and to shank/point ratios. The lashing device has the specific function of attaching the hook to the line. But it is possible to alter the manner in which a hook hangs in the water and thus its functionality as a fish catching device, by altering the form of lashing, even to the point where a jabbing hook can be lashed to act in a similar manner to a rotating hook. The selection of head form is also directly relevant to the type of line being used and to the manner in which the line is rigged. All these issues are well known and widely discussed in the New Zealand recreational fishing community. In fact, this is why modern hook manufacturers like Mustad produce a range of hooks which are identical except for lashing type (Mustad n.d.). Furthermore, certain lashing devices seem to co-vary strongly with material as Walter and Campbell (1996) demonstrate with respect of the "pointed shank tip above an inner-shank projection" form of device found so far only in *Turbo* (see above).

The shank/point ratio also affects the functionality of the hook in a number of ways. First, and most obviously, the facial structure of the fish and its feeding and flight behaviour are relevant (Johannes 1981). The most extreme example of this are the hooks sold commercially for eel fishing which have shanks sometimes more than three times the length of the point. But the shank/point ratio also affects the manner in which the hook is baited and the way in which the bait is presented to the fish.

Despite the fact that fishhooks have been the subject of considerable archaeological research in Polynesia, we still do not have a very detailed understanding of how they work. In my view, it is very likely that a great deal of the variation we observe has some functional basis. While theoretical models of "spatio-temporal distribution" (Allen 1996) might produce a testable hypothesis concerning the distinction between stylistic and functional attributes, a more urgent priority is to undertake experiments with replica hooks, and to observe and consult with experienced fishers.

ABRADERS

Abraders manufactured in echinoid spine were probably used in the manufacture and maintenance of shell artefacts such as fishing gear (Fig. 4.8). This interpretation is reinforced by the observed distribution patterns where these artefacts were consistently found amongst scatters of pearlshell waste flakes (see Chapter 10). The abraders all had a single working surface located on the distal end and carried a use surface at an angle of between 40° and 50° to the shaft. Tools of the same class reported from the Moturakau site on Aitutaki were remarkably similar. Like the Anai'o specimens they also carried a use surface on the distal end and their working angle was reported at around 45° (Allen 1992a:215). The use wear surfaces on some of the Anai'o tools displayed striation lines running parallel to the length of the tool. Three abraders showed a wear surface extending along the full length of the spine.

A number of coral abraders in both *Acropora* and *Porites* were also recovered (Fig. 4.9). Most of these were 'casual' tools; small lumps of coral with no formal modification and evidence of a single abrading event in the form of a small, narrow use surface. Two cylindrical tools, one in *Acropora* and one in *Porites*, displayed use wear around their entire length of *ca* 50 mm. The narrower (maximum width = 14 mm) *Acropora* example may have been used to work the interior edges of shell hooks. Two larger, flat *Porites* abraders with converging planar use surfaces were also recovered and their shape suggests their use with a filing or perhaps a cutting action (Fig. 4.9, top right, lower left).

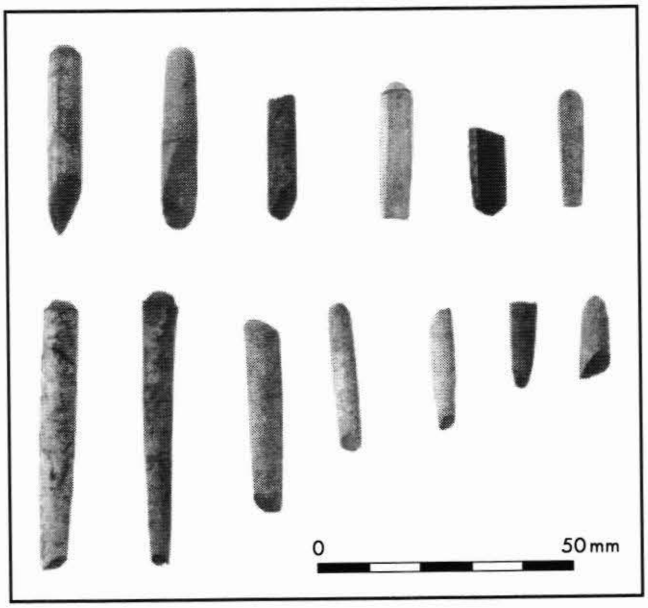

FIGURE 4.8. Echinoderm spine tools from Anai'o. All classified as abraders except specimen on top left which is a boring tool.

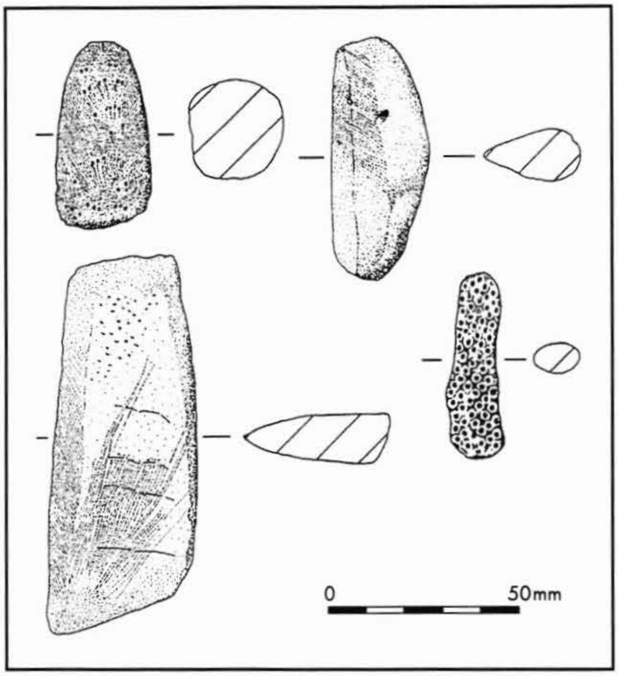

FIGURE 4.9. *Porites* and *acropora* (bottom left) coral abraders.

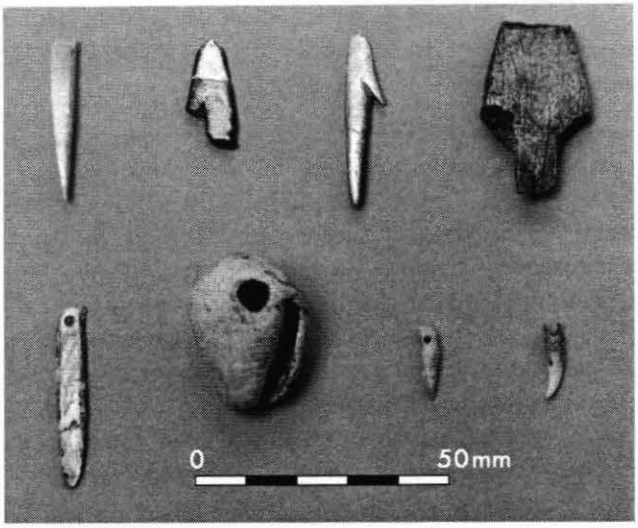

FIGURE 4.10. Miscellaneous small tools and ornaments from Layer 4. Top row from left: pearlshell awl, two pearlshell spearpoints or harpoon heads, shaped section of turtle bone. Bottom row from left: part-drilled pearlshell ornament, pierced shell ornament, two drilled fish teeth.

ORNAMENTS

None of the characteristic East Polynesian archaic ornament classes such as whale tooth pendants or reel necklace units were found at Anai'o but these high status items are often recovered with burials, and so their absence at Anai'o is not necessarily significant in a culture historical sense. Two drilled tooth necklace units were somewhat reminiscent of the tooth ornaments found at Wairau Bar (Duff 1977:Plate 8b) but the Anai'o specimens were manufactured out of fish teeth, either of the family Lethrinidae or Labridae (Fig. 4.10, lower right). The other ornaments included a single drilled shell ornament of very general form which would not be out of place in virtually any Oceanic assemblage, and two narrow shafts of pearlshell, one of which had a part-drilled hole at one end. The most unusual ornament recovered from Anai'o was one which was picked up on the site by Mr Mose Samuela of Kimiangatau village in the 1970s and which is now housed in the museum on Rarotonga. This neck ornament is in the form of a curved calcite shaft with holes drilled at each end (Fig. 4.11).

ADZES AND OTHER CORE TOOLS

Eleven adzes and adze fragments were recovered from Anai'o during the 1987 excavation and an unknown quantity of adzes have been collected from the site at odd times this century. The excavated adzes were all untanged and were manufactured using a flaking and grinding technique with no evidence for the use of hammer dressing. Those adzes with a recognisable cross-section consisted of two with quadrangular sections, two with lenticular sections, two with reversed trapezoid sections and one with a triangular (apex on face) section. The Anai'o adzes which are housed in the museum on Rarotonga are amongst a collection gifted by the late Samuela Ariki. This collection also includes many adzes which are not from Anai'o and unfortunately it is not possible to be certain which are which. However, the museum collection does contain a number of large quadrangular, trapezoid and triangular adzes similar to those commonly found in early East Polynesian assemblages and it is probable that these were found at Anai'o. In addition to the adzes a steep sided scraper with retouched edges was also recovered and this was probably used for dressing wood

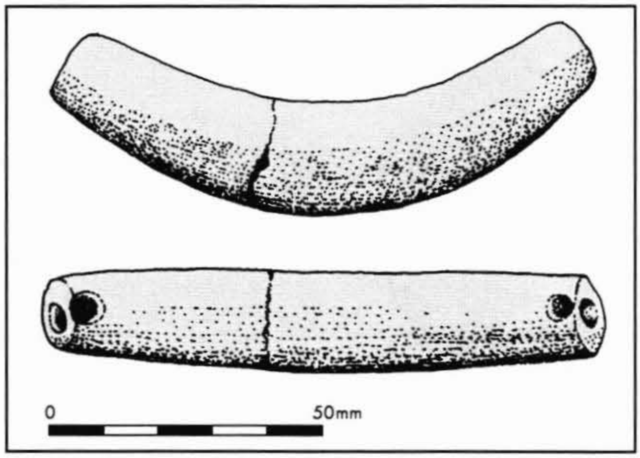

FIGURE 4.11. Drilled calcite neck ornament recovered from Anai'o sand quarry in the 1970s (courtesy of Mr Ken Mills).

(Fig. 4.12). The steep manner of retouch suggests a similar function to the New Zealand artefacts described in Leach (1993) as plane-rasps.

Flaking and grinding are characteristic techniques of the earlier adze assemblages in the southern Cook Islands as reported, for example, in the adzes from the Tangatatau rockshelter on Mangaia (Kirch *et al.* 1995). In late phase assemblages, including most surface collected adzes the flake scars are usually removed through the more extensive use of hammer dressing and grinding. This change, occurring concurrent with changes in cross-section, is also found in other parts of Polynesia, including New Zealand. The adze working industry revolves around the intersection of four variables: adze function, the physical properties of available stone types, manufacturing technology, and adze form (with special reference to cross-section). When selection processes effect change in any one of these variables, changes occur in the other three. Such selections may represent choices made by the adze makers based on some functional or cultural criteria, others may be related to environmental factors such as, for example, the working out of a limited, high quality basalt source. In discussions of adze change in Polynesia archaeologists have identified various of these variables as prime causes. Best (1977) for example cites functional change as underlying alterations in the New Zealand stone tool industry, while Leach (1990) stresses the material properties and form of occurrence of available stone types. In the Cook Islands high quality flaking rock is of limited availability, particularly in Aitutaki and Ngaputoru. In those islands the availability of stone also involved the costs and reliability of inter-island transport which, as I have argued, changed through prehistory.

In the Cook Islands many of the changes which took place in the adze industry were related to a decline in access to high quality flakable basalts although there may also be a functional component to the equation. The decreasing availability of high quality rock resulted from the working out of the high silica basalt sources as well as from a decrease in inter-island exchange in the archipelago. Throughout the southern Cook Islands the rounded, reverse triangular cross-section (apex on back) tanged adze became dominant late in prehistory and this was accompanied by the abandonment of the quadrangular, trapezoid and triangular (apex on face) adzes which require a fine, high silica basalt where the adze makers can exercise a more precise control over the flaking process. On Mangaia, where high quality basalt was available in quantity, a specialised ceremonial adze tradition developed late in prehistory. The high quality basalts of Mangaia fell out of an inter-island exchange system and passed into a locally based exchange economy where the emphasis was placed on the finished product, which acquired ceremonial status.

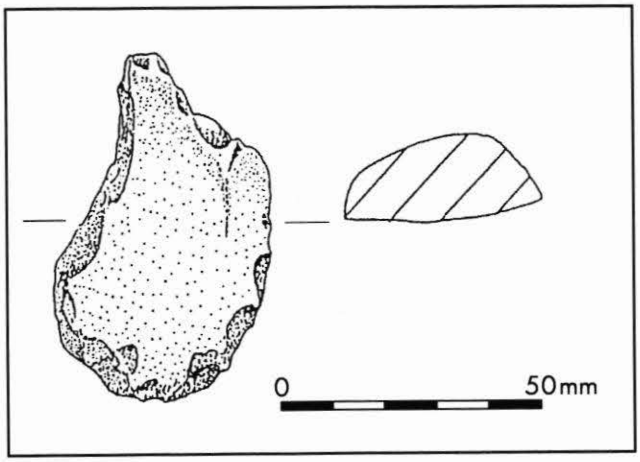

FIGURE 4.12. Steep sided basalt scraper or plane rasp from Layer 4 (see Leach 1993).

STONE FLAKES

A total of 592 stone flakes were recovered from Layer 4 of which 545 (92%) were found within distinct clusters where densities of stone flakes fell between 100-150 flakes per m2 as opposed to densities of 0.25 per m2 elsewhere on the site (these activity areas are discussed in Chapter 10). None of the Anai'o flakes show evidence of edge modification or use and they clearly comprise a secondary or by-product assemblage as opposed to a primary tool assemblage. Since many of the flakes were found associated with adzes in different stages of finish, it is reasonable to hypothesise that the primary activity was part of the adze working industry.

Core tool manufacture is often conceived as falling into a number of distinct stages, each requiring different tools and techniques and each resulting in different types of by-product or waste material. Following from this, various attempts have been made to assign flake assemblages to different stages of adze manufacture by quantifying flake attributes. The assumption that stone reduction follows distinct stages has been criticised on a number of grounds, and some archaeologists argue that the manufacturing process is better understood as tracing a continuum. The corollary of this is that the technological origins of flakes cannot be easily or reliably identified (Sullivan and Rozen 1985:758). Yet in a place like Ma'uke where the stone is mainly imported (see Chapter 5), the 'continuum' of adze reduction, will be forced by the economics of transport into discrete packets of activity. The primary reduction of cores and preform production will take place on the same island as the source, if not directly adjacent to the source. The tasks carried out at Anai'o are likely to be those associated with later stages in the manufacturing and use life of an adze such as roughout reduction, bevel preparation and polishing, and resharpening and repair activities. To test the hypothesis that the activities represented by the Anai'o flake assemblage were those involving the final phases of adze manufacture, and the repair and maintenance of finished adzes, a number of attributes of the stone flakes were measured. These attributes were chosen on the basis of the following model of adze working.

The reduction sequence involves changes in the force applied to the stone following a general pattern of increasing precision and focus, accompanied by a decrease in the average force of each blow as the reduction sequence proceeds. As the requirement of each percussion event changes through the adze making process, so too does the nature of the waste flakes or debitage which are produced. As the reduction process continues, the number of flakes with cortex decreases and the number of flakes with negative impressions of flake scars on the dorsal surface increases. There will also be an average decrease in the size range of flakes because as the flaking becomes more precise, there is a tendency for fewer and fewer flakes to be produced at each blow (Stahle and Dunn 1982). This characteristic of the reduction sequence is also reflected in the increasing proportion of flakes to debitage. In this sense debitage refers to by-product waste material resulting from flake removal. Flakes proper can be distinguished from debitage if a point of applied force (striking platform) is either present or implied (Sullivan and Rozen 1985). Finally, the last stages of adze finishing and subsequent adze reworking or repair will involve the production of a small amount of waste flakes with polish surfaces.

Thus in an analysis of a debitage assemblage, absolute measures of size variability are informative, as are the nominal variables cortex, polish, scarring and point of impact. While recognising the continuous nature of stone working techniques, for the purposes of this study adze working can be divided into three groups of tasks. Each of these would result in distinctive waste flakes when considered at the assemblage level. This is summarised in Table 4.3.

The maximum length and width of each stone flake from Anai'o was measured following Leach (1969). The degree of scarring, and the presence of polish and cortex were coded as in Table 4.4 and the results shown in Table 4.5. The mean length of the flakes was 28.0 mm with a standard deviation of 9.7, the length distribution was unimodal and with a definite (1.8) positive skew resulting from a small number of very large flakes (Fig. 4.13). A surprisingly large number of flakes (48%) had no obvious or implied point of impact and represent shatter accompanying flake removal.

In a more complex situation a quantified methodology should be adopted in conjunction with experimental data specific to rock type and reduction technique, as advocated by Amick and Maudlin (1989) for example. But because the Anai'o assemblage is small and homogeneous it is unnecessary to go to these lengths to provide a testable estimate of its position within a general adze reduction sequence. Approximately 90% of the flakes were without cortex and 60% showed evidence of prior flake removal which strongly suggests that the Anai'o flake assemblage resulted primarily from activities taking place in the late stages of adze production. The 14% of flakes with polish also indicate that adze maintenance and repair activities are represented. Nevertheless the small number of large flakes and high proportion of shatter suggests that some other activities might also be represented.

Stage of production	Flake assemblage attributes
Primary core preparation	Wide size range of flakes, many flakes with no striking platform and many flakes with cortex. Few flakes with negative scars of conchoidal fracture on dorsal surface.
Roughout production	Narrower size range, fewer flakes have cortex and more have a striking platform. Increasing number of flakes with negative flake scars on dorsal surface.
Adze finishing and reworking	Size range decreases further, fewer flakes with cortex, some flakes display polish. Large proportion of flakes with negative flake scars on dorsal surface.

TABLE 4.3. Hypothetical phases in a stone reduction sequence and some characteristics of the resulting flake assemblage.

POTTERY

Two sherds of pottery were recovered from Anai'o: one from Layer 4, and another from the surface in a disturbed area of

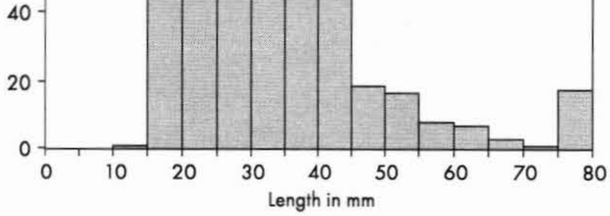

FIGURE 4.13. Histogram showing size distribution of basalt flakes. Note positive (1.8) skew.

	A	B	C
Scarring	Absent	One scar	Two or more scars present
Cortex	Absent	Present on one surface	Present on two or more surfaces
Polish	Absent	Present on one surface	Present on two or more surfaces

TABLE 4.4. Flake attribute coding system.

	A	B	C	Total
Scarring	39.5	27.4	33.1	100.0%
Cortex	91.2	6.6	2.2	100.0%
Polish	85.8	12.3	1.9	100.0%

TABLE 4.5. Attributes of the Anai'o flake assemblage (n = 592).

the site (Walter 1990:238). Both sherds were undecorated coarse-grained body sherds of an orange/brown colour with black temper inclusions. The sherds measured 35 mm by 29 mm in size with a thickness of 4 mm (Sample AN 501) and 18 mm by 13 mm with a thickness of 4 mm (Sample AN 700) (Fig. 4.14).

A temper analysis carried out on sherd AN 501 by William Dickinson of the Department of Geosciences, University of Arizona, indicated a temper source somewhere within the island arcs fringing the south-west Pacific basin. A microscopic examination of temper inclusions suggests that AN 700 is of a similar origin. The source of the Anai'o sherds is identified on the basis of the presence of microlitic varieties of volcanic rock in the temper material. These are of a type common in the island arcs of the south-west periphery of the Pacific basin

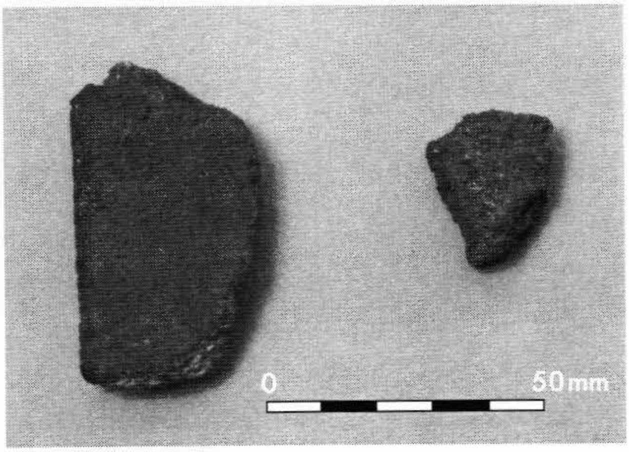

FIGURE 4.14. Sherds of plainware pottery. Sample AN 501 on left has been cut along left face for petrographic analysis. AN 700 on right.

(Solomons, Vanuatu, Fiji, Tonga), but rare or absent within the Pacific basin proper. In particular the quartzose materials present in the AN 501 temper are not found at all within the intra-oceanic archipelagos and appear most similar, on a variety of grounds, to samples from Tongatapu (Walter and Dickinson 1989:468). Altogether three pottery sherds have been recovered from the southern Cook Islands, the third was found by Sinoto in the Vairakaia site on the nearby island of Atiu (Altonn 1988). The temper of this last sherd was dissimilar to those from Anai'o and a Melanesian origin has been suggested, although local manufacture has not been positively ruled out (Altonn 1988).

One problem in assigning a Tongan origin to the Anai'o sherd is that pottery production in the main Tongan islands is believed to have ceased by the first few centuries A.D., and by no later than 800 A.D. in the northern island of Niuatoputapu (Kirch 1988). This places a minimum age of around 600 years on the sherds prior to their deposition in the Anai'o sands. This problem can be resolved via a number of alternative scenarios. The sherds might have been found in secondary deposition, having been transported to Anai'o from a ceramic bearing horizon elsewhere on Ma'uke or nearby islands. This may mean that the southern Cook Islands received visits or even settlement from northern Tonga before the cessation of pottery production there. Alternatively, given the evidence of contact between Fiji/West Polynesia and the Cook Islands summarised in Chapters 5 and 11, the sherd may have arrived from West Polynesia much later, even several centuries after the cessation of pottery production, perhaps as an heirloom item. A final hypothetical scenario is that pottery production continued somewhere in the Tongan islands much later than is currently believed. The first two alternatives are both compatible with contemporary knowledge of Polynesian settlement history and post-settlement voyaging practices and further research in the southern Cook Islands is likely to result in one of these alternatives being proved correct. The final option seems unlikely given the level of archaeological reconnaissance that has taken place in the Kingdom of Tonga.

MISCELLANEOUS

A range of small tools of stone, shell and bone were also recovered. Food processing equipment included 28 *Turbo* shells which exhibited wear polish indicating their possible use as scrapers or vegetable peelers. Four coconut graters were found which show a great deal of continuity in form with the steel coconut scraper used throughout the Cook Islands today (Fig. 4.15). Scrapers of *Codakia* and *Asaphis* shell may also have been used for peeling vegetables or for working fibre (Fig. 4.16). Shell and bone chisels included *Terebra* shell chisels (Fig. 4.17). Pearlshell and bone tattooing chisels attest to the use of this art form early in the Ma'uke sequence (Fig. 4.18). These were the first tattooing chisels found in the southern

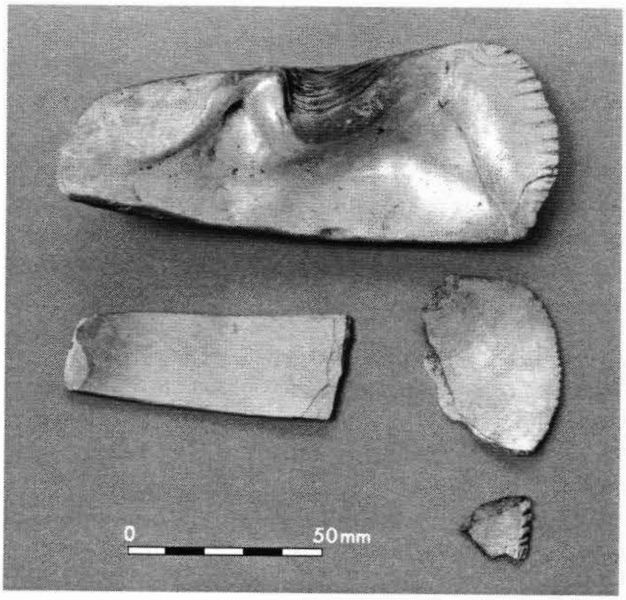

FIGURE 4.15. Pearlshell coconut graters or *kana*.

Cook Islands although other very similar specimens have subsequently been recovered from Tangatatau (Kirch *et al.* 1995:Fig. 7). A large stone sinker measuring 140 mm in diameter was recovered from the site during the 1970s (Fig. 4.19) and several small ground coral artefacts similar to the traditional Cook Island slingstone or maka were also found during excavation (Fig. 4.20). These artefact types are well known ethnographically, they are common in surface collections, and calcite examples have now been reported from the Tangatatau shelter (Kirch *et al.* 1995). Several of the Anai'o specimens displayed faint pecked bands similar to that found on the large sinker. Being made of *Porites* coral, they seem too light to function efficiently either as fishing sinkers or as slingstones.

Finally, a single echinoderm boring tool was recovered and this might have been used for working the central hole in fishhook blanks (Fig. 4.8, upper left).

THE EAST POLYNESIAN ARCHAIC

The concept of an archaic assemblage has been very important in the development of East Polynesian archaeology. As discussed above, it derives from the observation that across the main archipelagos of East Polynesia we have an 'early' period of cultures which look remarkably similar to one another. In the Marquesas the type sites for the archaic are Hane (Ua Huka) and Ha'atuatua (Nuku Hiva). Other Marquesan sites with archaic horizons include Ho'oumi (Nuku Hiva), Hanatekua (Hiva Oa) and Hanamiai (Tahuata). In the Society Islands the archaic type sites are Maupiti and Fa'ahia/Vaito'otia (Huahine). Fa'ahia/Vaito'otia is a single site lying across two

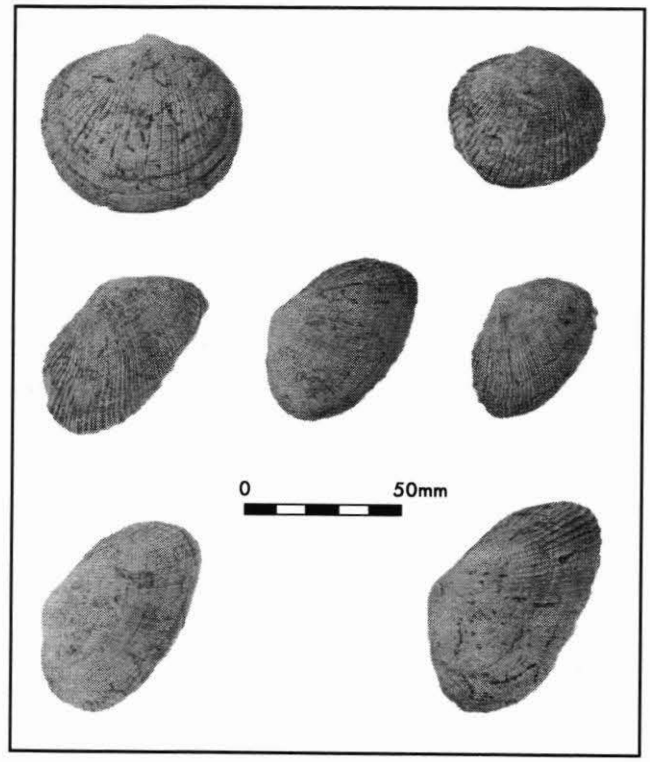

FIGURE 4.16. Shell scrapers. Top two specimens *Codakia* sp. all others *Asaphis violascens.*

distinct land units (Fa'ahia and Vaito'otia). For historical reasons each section was excavated separately and each land unit has always been written up separately. Nevertheless there is no stratigraphic reason to split the site into different units and I do not distinguish the two sections in the following discussion. Wairau Bar is the most important and widely cited archaic site in New Zealand although there are many others in both the North and South Islands. Although technically not

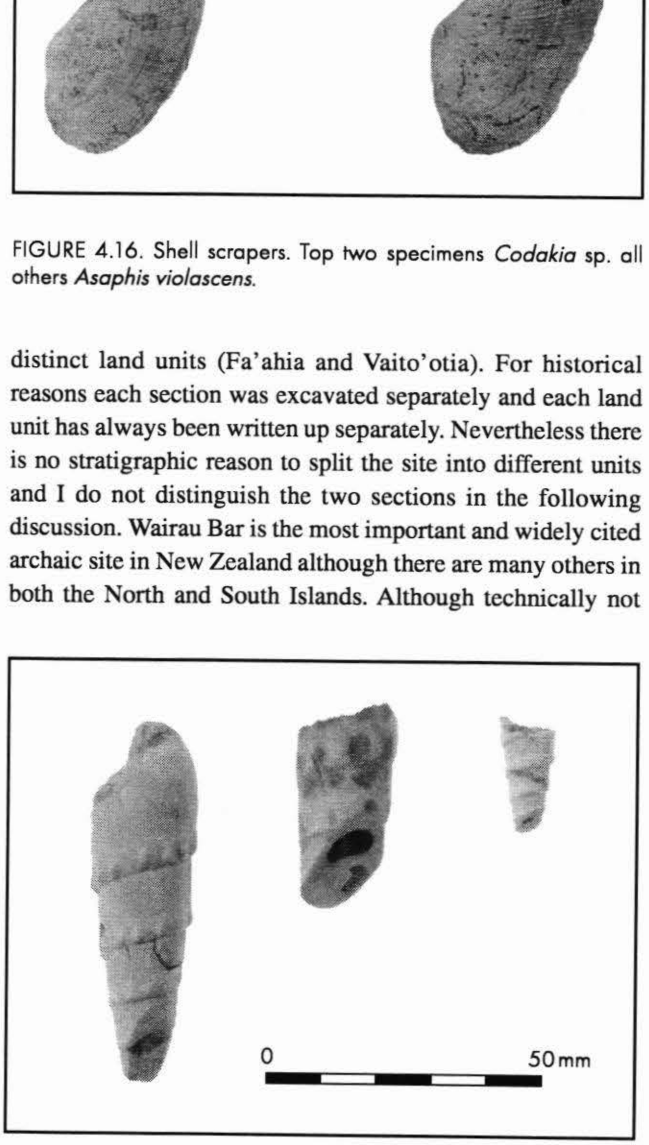

FIGURE 4.17. *Terebra* shell chisels.

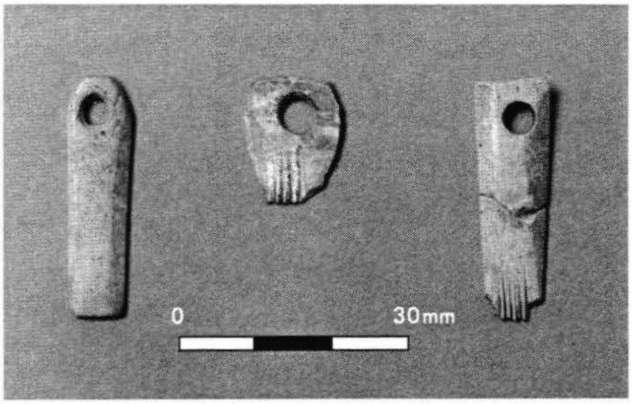

FIGURE 4.18. Tattooing chisels. From left: mammal bone with straight (uncombed) blade, pearlshell with combed blade, mammal bone with combed blade.

included within the boundaries of the archaic tradition (see Kirch 1986) Hawaii has a number of sites with rich early assemblages of material culture. These include Bellows Dune (Oahu), Halawa (Molokai), Pu'uali'i and Waiahukini (Hawaii).

For years there was no equivalent type site in the Cook Islands and the extent to which the Cook islands shared in the archaic tradition was unknown. The Anai'o site shows that the archaic is well represented in the Cook Island archipelago and it provides an excellent opportunity to extend our knowledge of regional variation in this critical period of East Polynesian prehistory. In this section I compare a range of Anai'o artefact classes with those from other early East Polynesian sites including those listed above.

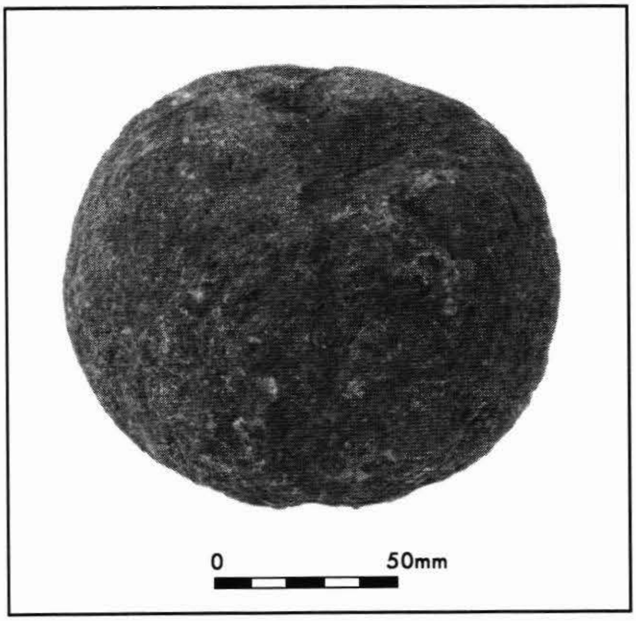

FIGURE 4.19. Coral sinker or fishing weight showing pecked lashing band running down centre of specimen.

One-piece hooks

The shell one-piece hook is one of the most diagnostic items of the archaic assemblage and a number of different types have been described. So far, the Marquesan assemblages display greater typological variability than those of other island groups, although this is no doubt partly due to the greater relative size of the Marquesan sample. The Anai'o assemblage extends the known range of a number of archaic hook forms into the Cook Islands, but offers no new types.

The acute recurved point type has been reported from Hane, Ha'atuatua, Hanatekua and Ho'oumi in the Marquesas and is also represented in bone hooks from the early Hawaiian sites of Pu'uali'i and Waiahukini (Rolett 1993; Walter 1996b). Although the only definite example of this hook at Anai'o is a broken point fragment (Fig. 4.4, lower left) there are several other unclassifiable specimens which may be members of this type (Fig. 4.4, upper row). The acute recurved point hooks have not yet been identified from early sites in the Society Islands but they are known there from late phase assemblages and they are also common in late assemblages from Pukapuka in the northern Cook Islands (Chikamori and Yoshida 1988).

A similar form, although one which has a lower average shank/point ratio, is the obtuse recurved point type. This type

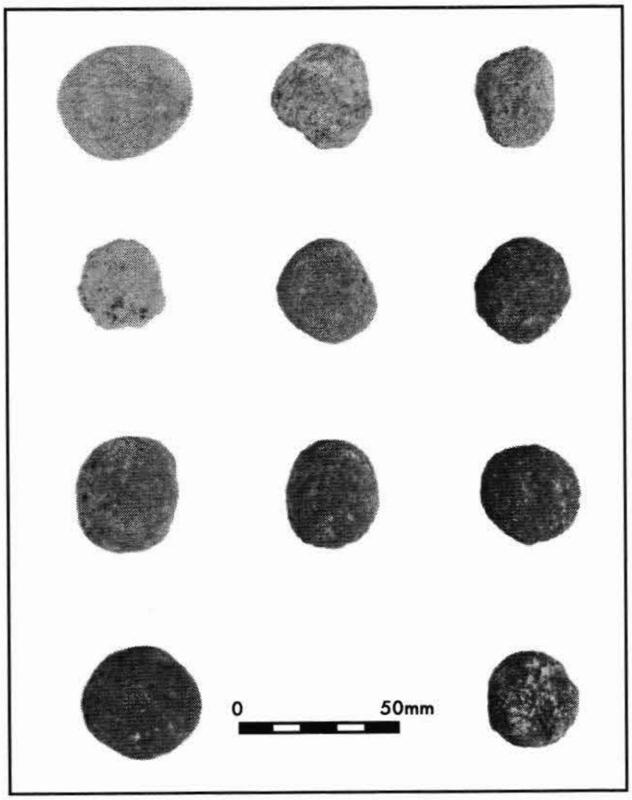

FIGURE 4.20. Small coral sinkers or slingstones some showing faint pecked bands for lashing.

was not recovered from Anai'o, but was present in the Moturakau assemblage from Aitutaki and from the Marquesan sites of Ha'atuatua, Hanatekua and Ho'oumi as well as Pu'uali'i in Hawaii (Allen 1992a, 1996; Rolett 1993; Walter 1996b). The obtuse recurved point hook is not reported from the Society Islands so the Aitutaki example serves to extend the archaic range of this type out of the Marquesas. The curved shank hook is another very common type in early Marquesan (Hane, Ha'atuatua, Hanatekua), Society Islands (Fa'ahia and Vaito'otia), Hawaiian (Bellows Dune and Pu'uali'i) and New Zealand assemblages (Rolett 1993; Walter 1996b). A single broken specimen was found at Anai'o (Fig. 4.2, lower left) and it was also present at Moturakau (Allen 1992a). Several probable specimens of the circular hook type were found at Anai'o (Figs 4.1 and 4.2) and these have also been recovered from the Marquesas at Hane, Hanatekua and Hanamiai, from Pu'uali'i in Hawaii and Maupiti in the Society Islands (Walter 1996b). They are also known from Easter Island and New Zealand.

In addition to the types listed above, Anai'o also contained examples of the Suggs/Rolett jabbing and rotating types and the latter was also found at Moturakau. In summary, the hook types recovered from Anai'o are among the more common types found in the Marquesan archaic and in fact, Anai'o may be described as containing a sub-set of the Marquesan assemblage. No unique hook types were identified and many of the Anai'o forms persist in other East Polynesian sites to the late prehistoric period.

Adzes

Where the fishhook assemblage from Anai'o shows closest affinity with the Marquesan kit, the adzes are more like those of the Society Islands. A range of typologies have been developed for the Polynesian adze but most archaeologists agree that cross-section is the most useful single attribute for chronological studies and straight morphological comparisons (Duff 1977; Ottino 1985; Rolett 1998). This seemingly simple variable has proven difficult however, as different authors not only use different terms for the same cross-section but also define cross-sections differently. In an attempt to minimise ambiguity in the following discussion cross-sections are described here with the back down following Emory (1968). Adzes of the following cross-section were recovered from Anai'o: lenticular (2), quadrangular (2), reverse triangular (1), reverse trapezoidal (2). The above classification by cross-section differs slightly from that offered in Walter (1990) which followed the conventions of Duff (1959). The reverse trapezoidal adzes would fall into the Duff (1959) quadrangular or rectangular classes used in New Zealand. However, since the backs of two Anai'o specimens are very slightly narrower than their faces and this attribute is included in most tropical East Polynesian classifications, I now include them in the reverse trapezoidal category. Also following Duff, the Walter (1990) descriptions followed the convention of describing the adzes face down. The reversal of this convention affects the cross-section description of only one specimen (reverse triangular becomes triangular).

The lenticular cross-section adze is widely distributed in Melanesia and in West Polynesia. Emory reports 14 lenticular adzes from Hane (1968:160; see also Sinoto 1966) but Suggs (1961) reports only the closely related plano-convex forms from the early Nuku Hiva sites. The Anai'o specimens are similar to the Hane forms and slightly flatter than the lenticular specimens reported from Fa'ahia/Vaito'otia (Sinoto and Han 1981:11, Fig. 16b). The (untanged) quadrangular cross-section adze which is common in several variations from Samoan assemblages (Green and Davidson 1969) is found at Fa'ahia/ Vaito'otia and at Halawa in Hawaii (Kirch 1975) as well as Anai'o. The Anai'o specimen is slightly rounded in cross-section and this places it closest to some of the Type 2 forms of Duff (1959) which occur in the New Zealand archaic. The closest type in the Nuku Hiva sites is Suggs' Mouaka type (Suggs 1961:107, Fig. 4.10a) which I would describe as trapezoidal (as would Emory, see 1968:Fig. 3).

Reversed trapezoidal adzes are distinctive of the Marquesan archaic sites having been identified from Hane (Sinoto 1966), Hanamiai (Rolett 1998), Ho'oumi (Suggs 1961) and Ha'atuatua (Sinoto 1966; Suggs 1961). Two specimens were found at Anai'o and there are a number of unprovenanced specimens in the Cook Island Museum. Reversed trapezoidal adzes have also been reported from Fa'ahia/Vaito'otia (Sinoto and Han 1981), Maupiti (Emory 1968), from the Hawaiian sites of Halawa and Bellows Dune and from early Easter Island sites (Emory 1968; Walter 1996b). New Zealand examples of the reversed trapezoidal adze would fall into the Type 2 category of Duff (1959).

The triangular adze is found in the Cook Islands (both at Anai'o and in the museum collection), and is a distinctive artefact from the New Zealand archaic where tanged varieties are commonly referred to as the 'hogback' adze. This form was recovered from Maupiti (Emory and Sinoto 1964) and examples are also known from Hawaiian sites (see Emory 1968:Fig. 3(6)). In the Marquesas this form is well known and often referred to as the Koma Type after Suggs (1961:111). Suggs believed that the Koma adze occurred late (Expansion Phase) in the Marquesas and suggested that it might have been a later introduction from the Society Islands. The only specimen from Anai'o is a fragment, but I have seen unprovenanced Ma'uke specimens which probably derive form the site, and there are other unprovenanced adzes of this type in the Cook Island Museum. Similar forms have been recovered from Urei'a (Bellwood 1978a).

The archaic adzes of East Polynesia come in a variety of cross-sections, each of which can be found across all the archipelagos of the region, including New Zealand and Hawaii. The Marquesas have the greatest variety of adzes and all the Anai'o forms are found in the Marquesas. Nevertheless the early Cook Island adze kit seems closer to that of the Society Islands, and to a lesser extent New Zealand. The quadrangular/trapezoidal adzes from Anai'o and other Cook Island sources are very similar to Maupiti and Fa'ahia/Vaito'otia adzes, and similar too to the New Zealand Duff Type 2 adzes. Many unprovenanced specimens of the tanged triangular (hogback) adze are present in Cook Island collections where it is clearly an early adze type. The hogback is more typical of early Society Island assemblages than those of the Marquesas. It may also be relevant to note that the late Cook Island and Society Island adze kits are nearly indistinguishable, both being dominated by the reversed triangular tanged adze (Duff Type 3A).

Ornaments and tattooing chisels

After adzes and fishhooks, personal ornaments are amongst the most characteristic item of archaic material culture and certain forms, such as the whale tooth pendants and reel units, are considered type fossils of the archaic tradition (Davidson 1984:Figs 57-58). The best known assemblages of archaic ornaments come from the burial sites of Wairau Bar and Maupiti. Anai'o contained only a small number of ornaments but most of these were undiagnostic pearlshell pendants or shell necklace units which could have come from any tropical Polynesian assemblage. The only highly diagnostic item, a curved calcite pendant or necklace piece is unique to Anai'o (Fig. 4.11). The only significant similarity between Anai'o and outside sites however, was in the presence of pierced fish tooth necklace units which were found also at Fa'ahia/Vaito'otia and are broadly similar to some pierced tooth units from Wairau Bar (Davidson 1984:Fig. 59; Duff 1977:Plate 8b).

Tattooing has been an East Polynesian practice since the earliest periods of settlement and tattooing chisels have been recovered from early sites in Hawaii, New Zealand, the Marquesas, the Society Islands and the Cook Islands. Two bone and one pearlshell tattooing chisels were recovered from Anai'o (Fig. 4.18). One each of the bone and pearlshell specimens were combed and all three had proximal holes to accommodate a circular cross-section handle. Eight bone tattooing chisels have also been recovered from Tangatatau on Mangaia of which two are illustrated in Kirch *et al.* (1995:Fig. 7). The extreme similarity between the Anai'o and Tangatatau forms leads to the suggestion that the proximal drilled form is the standard Cook Island type. These differ significantly from the early Marquesan and Society Island forms which have an opening at the top (instead of a hole) together with hafting notches to accommodate the handle. Tattooing chisels of this form have been recovered from Hane, Hanamiai and Fa'ahia/Vaito'otia (Rolett and Conte 1995:223, Fig. 15; see also Davidson 1984:Fig. 66, top left).

Pearlshell tattooing chisels appear to be broader than bone varieties. The pearlshell specimen from Anai'o is about as broad as the Marquesan and Society Island artefacts while the bone ones are narrower and similar to those from New Zealand, where bone is also the more common manufacturing material (Davidson 1984:Fig. 66). In summary the Cook Island specimens display enough similarity to define a Cook Island 'type' and also share some attributes in common with some New Zealand forms. These latter attributes include: the proximal hole which is found on many New Zealand specimens, a relatively narrow blade and the use of bone.

Pottery

East Polynesia is generally regarded as aceramic but very small collections of pot sherds have been collected from the archaic Marquesan sites of Ha'atuatua (Sinoto 1970; Suggs 1961), Ho'oumi (Suggs 1961) and Hane (Sinoto and Kellum 1965). Surface collected sherds have also been recovered from the Atuona Valley on Hiva Oa (Kirch, Dickinson and Hunt 1988). Some of these Marquesan sherds have been assigned a possible Fijian origin on the basis of thin-section petrography (Dickenson and Shutler 1974), others contain inclusions which point to a local temper source. This latter result has led Green to suggest that the sherds may be in secondary deposition and that there are earlier ceramic horizons elsewhere in the archipelago (Green 1974:247). Regardless of whether the Marquesan sherds were produced locally or imported, the presence of this distinctly West Polynesian trait in the Marquesas helped for years to support the 'authorised version' of East Polynesian settlement.

The Anai'o sherds are similar to those from the Marquesas, all falling within the Polynesian Plainware range. However, since there are only 17 sherds in total from East Polynesia it is difficult to determine where any set of these fall within the continuum of post-Lapita ceramic technology. The discovery of ceramics on Ma'uke and more recently on Atiu (see above) further weakens the argument for a direct West Polynesia-Marquesas connection. Instead, the scattered ceramic material supports the view that, along with other items of material culture, small quantities of pottery were transported around East Polynesia for several centuries following the establishment of permanent communities. I deem it unlikely, given the quality of archaeological survey which has taken place, that there are extensive, early ceramic horizons waiting to be discovered in East Polynesia, but I do predict that small quantities of ceramics will be located in the Society Islands and the Australs, and will continue to turn up elsewhere in the southern Cook Islands.

Miscellaneous artefacts

A wide range of general purpose food processing and manufacturing tools have been reported from archaic assemblages. Pearlshell coconut scrapers and graters identical to the Anai'o specimens have been recovered from Huahine (Fig. 4.15; Sinoto and Han 1981:Plates 19a, 19b, 20a, 20b), and less similar forms have also been found in the Marquesan archaic (Suggs 1961; Walter 1996b). Echinoderm spine abraders are very common in East Polynesian assemblages and were most likely used to work shell, perhaps in fishhook manufacture. Interestingly, although these were probably 'casual' tools which were not formally modified in any way prior to use, they show very distinctive patterns of variation across East Polynesia. At Anai'o and Moturakau the echinoderm spine abraders were all worked from the distal end. In contrast, the abraders from the Society Island archaic sites and from the early South Point assemblages on Hawai'i, are more commonly worked from the proximal end. In the Marquesas, both variations are represented but there is some temporal distinction between the two forms. At Hanamiai the distal type is more common in the archaic levels with the proximal form becoming predominant later in the sequence (Rolett 1998).

Although there are now large, well provenanced assemblages available from early sites, there is still a paucity of detailed, quantitative descriptions of early East Polynesian material culture. Summary tables including descriptions of 'type' specimens have been made available from many excavations, but detailed information on variation, especially in the shell tool classes is still unavailable. Impressive collections of excavated East Polynesian artefacts in the Bishop Museum in Honolulu and other regional museums urgently await detailed examination and until this happens, in depth comparative studies of type and style are not going to be possible.

The comparison between the Anai'o assemblage and those from other early East Polynesian sites serves to demonstrate that the Cook Islands are represented within the archaic tradition. Some of the distinctive archaic items have not yet been recovered from Cook Island sites but the Anai'o assemblage falls well within the archaic range, as represented by the type sites of the Marquesas, New Zealand and Society Islands. In some areas the Anai'o artefacts group with those from other Cook Island sites hinting at the existence of distinctive Cook Island types. Some classes of artefact share similarities with those of the Societies while others have closer affinity with the Marquesas or New Zealand. This patchy pattern of trait distribution appears to be the norm in East Polynesia and as we accumulate larger and larger assemblages it is becoming clear that detailed settlement models cannot be created by tracing the distribution of single artefact forms. The pattern that is emerging is one of complex overlapping distributions of artefact types and styles. This pattern is inconsistent with a stepping stone model of colonisation and is best interpreted as supporting a network model of cultural interaction. In this model, island societies are exposed to material culture innovations through an interaction network. Artefactual assemblages from individual islands reflect a range of selective and adaptive processes taking place within the context of information flow, rather than the inheritance of traits from an immediate ancestral community. This issue is discussed in more depth in Chapter 11.

CHAPTER 5. BASALT SOURCING

The problem of inter-island sailing underlies some of the most important issues in the archaeology of the south-west Pacific. Colonisation strategies, the timing of island settlement and the origin of founding populations are among the more common topics of discussion, but of equal or greater importance is the role of interaction versus isolation in the trajectories of post-colonisation culture change. Traditionally, archaeologists have used distribution studies to map patterns of human interaction across time and space, often applying some form of stylistic or typological analysis. But as the technologies became available, Pacific archaeologists turned as well to sourcing studies, given that the appearance at Point A of a piece of displaced geology from Point B (in the form of pottery temper for example) is unambiguous evidence of importation when these two points are separated by kilometres of deep ocean.

Because we are dealing with islands, evidence of importation tends to stand out dramatically in the Polynesian archaeological record. This is partly because of the uneven distribution of industrial source material which means that in many contexts a single flake of stone or sherd of pottery is as obviously foreign as a Roman coin. The implication of importation also stands out in an island environment where the presence of non-local materials is evidence of significant human events in the form of open sea voyaging, often over very long stretches of dangerous, unpredictable ocean. For this reason many Pacific archaeologists are routinely involved in the sourcing of material culture from archaeological sites. Nevertheless, once sources have been identified, to go further and comment on the cultural meaning behind episodes of communication, or even to infer trade and exchange does require a more complicated line of argument.

West of Samoa, pottery and obsidian have proved useful for sourcing studies but in East Polynesia where just 17 sherds of Oceanic pottery have been recovered from sites east of Samoa, ceramics are of little value. Furthermore the distribution of volcanic glass in archaeological sites is only of regional significance (Sheppard *et al.* 1989; Smith *et al.* 1977; Weisler 1990). As a result, East Polynesian archaeologists have developed a range of techniques for the sourcing of basalts. Samples tested include adzes and a variety of other core tools, flake debitage, flake tools and oven stones. At the least technical level various attempts have been made to use simple macroscopic descriptions (Best 1989; Dye 1987) but with only limited success (Weisler 1993b:38). Petrographic thin-section analysis has been used (Best 1989; Best *et al.* 1992; Cleghorn *et al.* 1985; Sheppard *et al.* 1997), but the best results of this technique use it in combination with geochemical analysis (for example Sheppard *et al.* 1997; see also Weisler 1993b:39-44). Geochemical analysis of major, minor and trace elements has mainly relied on X-ray fluorescence (XRF) techniques, of which there are both destructive (Best *et al.* 1992; Walter 1990, Walter and Sheppard 1996) and non-destructive (EDXRF) methods available (Weisler 1993b). Less common techniques include instrumental neutron activation (INAA) (Ayres and Goles 1990) and ion-microprobe analysis (Allen and Johnson 1997). In addition, some experimental work has also been attempted at the University of Auckland using proton induced X-ray emission (PIXE) technology. Reviews of sourcing methods used on Pacific basalts are contained in a recent work by Weisler (1997).

The first geochemical characterisation of the Anai'o material was carried out using destructive XRF analysis of major and minor elements (Walter 1990). This analysis drew on a small sample size and the results, while instructive, reflected this limitation. Nevertheless, as the first attempt at basalt sourcing in the southern Cook Islands it served as a useful trial run and provided guidelines in designing a more thorough sampling programme. Subsequently, additional Anai'o samples were included in a study by Best *et al.* (1992) and more recently a much larger database of geological and archaeological samples from the southern Cook Islands was assembled and analysed using both geochemical and petrographic techniques (Sheppard *et al.* 1997).

CHARACTERISATION OF BASALTS

The following characterisation of Ma'uke stone tools draws on the results of a number of XRF based geochemical studies which have included Anai'o and other Cook Island samples.

The Ma'uke archaeological samples from these earlier studies have been selected out, and analysed using cluster algorithms to determine the number of sources required to account for their measured geochemical variation. A source origin is then assigned to each of these clusters by referring to a range of previously published geochemical studies of geological source material. A simple sort of the Ma'uke assemblage into 'early' and 'late' sets provides the basis for investigating changes through time in the use of stone on the island.

The Anai'o material used in the study is assigned to a 'early' phase. Surface collected reversed triangular (apex on back) adzes in private collections on Ma'uke and similar adzes in Cook Island Museum have been assigned to a 'late' phase. The justification for this simple two-phase sort is based on the typological observation that late prehistoric adzes in the Cook group are dominated by the reversed triangular (Duff Type) 3A types (Duff 1968). Furthermore, the surface collected adzes were found among the late prehistoric settlement zones along the inner edges of the makatea and within the confines of the inland village (see Chapter 11). Obviously this type of chronological treatment is inadequate in the long term but the patterns of change which emerge from this analysis allow a testable hypothesis to be proposed concerning change in stone resource utilisation on the island.

Much of the geochemical data on which this present study is based derives from a sampling programme carried out by the author in collaboration with Peter Sheppard of the Anthropology Department, University of Auckland. This programme resulted in the sampling of close to the full range of potential industrial grade basalts occurring in the islands of Ma'uke, Mitiaro, Atiu, Aitutaki, Mangaia and Rarotonga as well as a large set of archaeological samples (see Sheppard *et al.* 1997). The sources for both archaeological and geological samples as well as the geochemical results used in this study are listed below.

The archaeological sample

The Anai'o samples used in this study derive from a number of sources. Three adze fragments and one sample from a basalt block from Layer 4 were selected and submitted for XRF analysis of major and minor elements with results reported in Walter (1990). Because the sampling technique used was destructive (see below) the adze sample was kept to a minimum. Since that analysis was carried out, four flakes from Layer 4 were tested for major, minor, and trace elements by Best *et al.* (1992) as part of their study of the Samoan quarry, Tataga Matau. Flakes were selected on the basis of size criteria. Prior to sampling the outer rind of weathered material was first removed and few flakes in the assemblage were large enough to give an adequate sample following this procedure. More recently, two Cook Island Museum adzes (R65.70 and R65.72) which are believed to be from the Anai'o site were sampled along with a larger set of Cook Island adzes by Sheppard and Walter (see Sheppard *et al.* 1997). The other archaeological samples from Ma'uke consist of a small number of surface finds some of which were collected by the author while others were taken from the stone tool collection in the Cook Island Museum on Rarotonga (Sheppard *et al.* 1997).

Archaeological samples from elsewhere in the archipelago were collected from a number of sources. A set of 40 adzes from the Cook Island Museum was sampled in 1992 as part of a wider study of basalt variation within the southern Cook Island adze industry (Sheppard *et al.* 1997). This set included the Anai'o specimens (R65.70 and R65.72) referred to above as well as some surface collected samples. Selection of the Museum adzes for geochemical analysis was carried out using a primary sort of provenanced adzes to island and a secondary sort into sub-groups defined on the basis of physical characteristics (colour, grain size, phenocrysts). In this way it was hoped to obtain a sample of close to the full range of variation present within Cook Island stone tools. Within each sub-group broken adze fragments were cored to extract samples for petrographic thin-sections and geochemical analysis.

The geological sample

Ma'uke basalt sources occur as localised scatters of small, highly weathered cobbles along the inner edges of the makatea. The largest and best known source is located at a place known tantalisingly as Te Rua o te Toki which translates as The Adze Pit, although there is no actual pit visible. On hand examination this material is soft and very weathered and appears quite unsuitable for adze making. Similar, although lower density, scatters of basalt can be found in other places on the island and these are probably similar to the sources mentioned by Turner and Jarrard (1982). In January 1993 a new source was located in the interior uplands of the Araki district which provides less weathered and larger cobbles than I have seen elsewhere. These cobbles split to reveal a fine grained material which is suitable for tool use.

Other geological samples discussed below were collected elsewhere in the archipelago in December 1992 and December 1996 as part of the southern Cook Island sampling programme referenced above. These samples were analysed for major, minor and trace elements using XRF techniques. The sampling procedures, laboratory methods and results are detailed in Sheppard *et al.* (n.d) and summarised below. The geological samples collected during the 1996 collection programme on Mangaia have not yet been processed so this report draws on the XRF results from a single source on the island sampled by Julie Endicott and reported in Weisler *et al.* (1994).

Laboratory analysis

The archaeological samples tested by Walter (1990) and Sheppard *et al.* (1997) were obtained using several techniques. In processing the first Anai'o materials and other archaeological samples reported in Walter (1990) a section was sawn from the broken ends of each adze fragment and from the basalt block using a continuous rimmed diamond tipped geological saw in the Anthropology Department, University of Auckland. The other archaeological samples were derived either by total processing (the flakes) or by coring into the adzes. This latter technique was deemed necessary because the high rate of weathering of Cook Island basalt made it difficult to obtain in any other manner the three grams of fresh rock required for XRF work (Best *et al.* 1992:53). Broken adzes were selected where possible and a diamond tipped coring bit of 10 mm diameter, producing an 8 mm core was used to core into the broken face. The holes were then filled with two part emmerkit epoxy putty that was tinted and textured to match the original. Following the removal of a thin-section from the base of each drilled core for petrographic analysis the remaining fraction was held for XRF analysis.

All archaeological and geological samples referred to in this chapter except the Mangaian samples reported by Weisler *et al.* (1994) were processed in the Geology Department, University of Auckland. Samples were reduced to powder in a ball mill and glass fusion discs were prepared for major and minor elemental analysis and briquettes for trace elements. When sample sizes were small, samples were prepared by first making a pressed briquette, running the trace element analysis and then extracting the powder to be fused into a glass disc for major element analysis.

Major, minor and trace elements were determined using an automated Phillips PW 1410 XRF spectrometer and multistandard calibration lines. X-ray intensities were compared for each element using the following international rock standards for comparison: PR, MRG, JB-1, W-1, AVG-1, JG-1, GH, GA, GZ, SY-Z, NIM-S, NIM-L. The methods used for major element analysis are detailed in Sheppard, Walter and Parker (1997) and Walter and Sheppard (1996). In running the trace elements, corrections were made for background curvature, tube line overlaps, matrix effects and machine drift. Raw data was reduced following a set of computer methods outlined in Parker and Willis (1977), although the actual software packages differed.

A range of statistical and graphical methods was used to process the raw results of the XRF analysis. To discover patterns of similarity within the data, an average linkage cluster analysis was carried out on standardised log 10 transformed values. The transformation is designed to give the data equal weighting in multivariate analysis (Bishop and Neff 1989:63).

RESULTS

The Ma'uke samples were separated from other Cook Island samples and an average linkage cluster analysis of major and minor elements was carried out by the author using the computer package Statistica for Windows©, Release 4.5. The raw results of the geochemical analyses and cluster membership for each sample are shown in Tables 5.1 and 5.2. Data for other samples cited in this chapter are reported in full elsewhere (see below). Figure 5.1 is a graphical representation of the results of the cluster analysis of major and minor elements for all geological and archaeological samples from Ma'uke except the Te Rua o te Toki source. This latter sample differed so greatly from the others that it tended to mask all other variation in the assemblage. The differences were chiefly in the high water and iron, and low silica content of the Te Rua o te Toki sample, and since these are characteristics of weathering and the rock is visibly soft, this source can be discounted as a potential industrial material.

The dendrogram produced as a result of the cluster algorithm organises each sample into a branching structure according to its similarity to each potential neighbour. This 'tree' gives a good visual representation of internal relationships and assemblage variability. However, it is clear that some decision needs to be made by the researcher about which branches are significant, and which are not. In this study, I have assigned each adze sample to a particular cluster which is deemed meaningful on both archaeological and geochemical grounds. The justification for each cluster and the question of whether they each represent an independent source is covered below. Some adzes were clearly unique, within the parameters of variation of this small data set, and are not considered to form meaningful low-level clusters with other samples. These outliers have been assigned cluster names for simplicity of discussion despite the logical inconsistency of a 'cluster of one'. Again, the justification for not including these samples in higher level clusters is given below.

The ultimate goal of basalt sourcing studies in the Pacific is to trace long term changes in patterns of interaction and exchange within and between archipelagos. Being able to do this requires data sets of archaeological basalts from well dated contexts spanning full island sequences. At present, these data sets do not exist for Ma'uke. As a first attempt to outline patterns of temporal change in the use of basalts in Ma'uke prehistory the samples have been divided into two sets, 'early' and 'late', on the basis of simple criteria outlined above. In the following summary the geochemical data is discussed in relation to this binary sort and this is followed by an interpretation of change in patterns of Ma'uke stone use through time.

Sample	Provenance	Cluster	SiO_2	TiO_2	AL_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Total	LOI
Anai'o-E	Anai'o, Layer 4	3a	41.46	4.24	14.50	16.9	0.26	6.39	8.14	4.76	1.67	1.20	99.5	0.29
Anai'o-F	Anai'o, Layer 4	1	49.45	2.73	16.60	11.9	0.20	4.19	7.13	4.55	1.88	1.00	99.6	0.05
Anai'o-G	Anai'o, Layer 4	3a	41.11	4.23	14.30	17.1	0.27	6.31	8.18	4.30	1.69	1.21	98.7	0.75
Anai'o-M	Anai'o, Layer 4	1	47.92	3.43	15.50	13.6	0.21	4.77	7.74	3.91	1.54	0.81	99.4	0.01
Flake-1	Anai'o, Layer 4	1	46.41	4.51	15.27	14.31	0.22	5.90	8.35	3.43	1.23	0.59	100.2	-
Flake-2	Anai'o, Layer 4	7	44.13	3.69	16.35	13.31	0.22	5.41	10.11	4.02	1.14	0.49	98.9	-
Flake-3	Anai'o, Layer 4	7	43.73	3.70	16.29	13.53	0.21	5.45	10.35	3.98	1.04	0.49	98.8	-
Flake-4	Anai'o, Layer 4	7	44.12	3.75	16.55	13.13	0.18	4.91	10.62	3.73	0.86	0.50	98.4	-
R65-70	Anai'o adze, C.I. Museum	8	43.56	4.51	15.60	12.3	0.23	5.29	9.95	4.01	2.17	0.93	98.6	1.32
R65-72	Anai'o adze, C.I. Museum	8	43.33	4.41	15.80	12.10	0.20	4.94	9.92	4.04	2.20	0.95	97.9	0.98
Araki	Surface find, Araki district	5	42.74	4.34	14.50	13.60	0.20	5.07	11.10	3.33	2.42	1.12	98.4	0.55
Areora	Surface find, Areora Village	6	42.25	3.42	15.10	14.50	0.20	5.35	11.20	4.05	1.23	0.60	97.9	1.20
Makatea	Surface find, Makatea district	4a	41.83	3.83	17.2	12.30	0.19	3.58	8.78	4.50	1.85	1.30	95.4	2.90
Ngatiarua	Surface find, Ngatiarua Village	2	42.05	3.33	14.10	12.70	0.24	8.64	10.80	3.52	2.15	0.74	98.3	0.82
R65-56	Unprovenanced Ma'uke, C.I. Museum	4b	43.12	3.04	16.40	11.30	0.25	4.00	9.14	4.49	1.80	0.79	94.3	3.88
R65-57	Unprovenanced Ma'uke, C.I. Museum	4b	43.89	3.14	16.80	11.00	0.22	3.76	8.80	4.13	1.79	0.85	94.4	3.49
R65-62	Unprovenanced Ma'uke, C.I. Museum	4b	43.92	3.64	16.10	11.70	0.18	3.79	8.80	4.13	1.79	0.72	94.8	3.07
Geo-1	Geological sample, Araki district	3b	41.33	4.82	14.50	15.00	0.26	6.61	9.19	4.42	1.11	0.80	98.0	1.36
Geo-2	Geological sample, Araki district	3b	41.54	4.75	14.40	15.50	0.23	6.70	9.30	3.72	2.43	0.82	99.4	0.74
Geo-3	Geological sample, Araki district	3b	41.37	4.79	14.20	15.10	0.28	6.48	8.94	4.29	1.70	0.77	97.9	1.18
Te Rua	Geological sample, Te Rua o te Toki	-	12.80	7.97	21.95	24.47	0.27	6.31	8.18	4.30	1.69	1.21	89.2	12.10

TABLE 5.1. Results of XRF analysis of Major elements, Ma'uke samples.

Sample	Provenance	Cluster	Nb	Zr	Y	Sr	Rb	Th	Pb	Zn	Ni	Cr	V	Ba	La
Geo-1	Geological sample, Araki district	3b	85.0	322.0	36.0	960.0	24.0	9.0	7.0	106.0	20.0	8.0	242.0	592.0	69.0
Geo-2	Geological sample, Araki district	3b	87.0	336.0	37.0	980.0	59.0	10.0	6.0	106.0	26.0	7.0	234.0	606.0	67.0
Geo-3	Geological sample, Araki district	3b	87.0	330.0	40.0	963.0	30.0	7.0	5.0	108.0	21.0	7.0	251.0	595.0	72.0
R65-70	Anai'o adze, C.I. Museum	8	55.0	325.0	32.0	1059.0	55.0	11.0	11.0	126.0	55.0	49.0	293.0	652.0	53.0
R65-72	Anai'o adze, C.I. Museum	8	60.0	343.0	35.0	1074.0	55.0	9.0	10.0	122.0	50.0	62.0	281.0	682.0	54.0
Ngatiarua	Surface find, Ngatiarua Village	2	64.0	249.0	29.0	899.0	53.0	13.0	13.0	116.0	191.0	228.0	261.0	526.0	61.0
R65-56	Unprovenanced Ma'uke, C.I. Museum	4b	85.0	317.0	34.0	894.0	59.0	15.0	14.0	117.0	35.0	59.0	217.0	540.0	82.0
R65-57	Unprovenanced Ma'uke, C.I. Museum	4b	87.0	325.0	38.0	844.0	58.0	12.0	8.0	134.0	26.0	33.0	209.0	575.0	87.0
R65-62	Unprovenanced Ma'uke, C.I. Museum	4b	73.0	302.0	34.0	745.0	53.0	11.0	9.0	130.0	39.0	29.0	266.0	451.0	67.0

TABLE 5.2. Results of XRF analysis of Trace elements, Ma'uke samples.

'Early' period Ma'uke sources

Samples of Anai'o material fall into a total of four clusters of which at least three and possibly four are interpreted as independent sources (Tables 5.1 and 5.2, Fig. 5.1). Finding geological matches for these sources requires a good understanding of regional geological variability (Best *et al.* 1992; Sheppard *et al.* 1997; Weisler 1993a, 1993b). Considerable work has now been carried out in this field and in the following analysis the results of a number of regional studies are used to provide the best fit for the Anai'o samples.

The first Anai'o cluster, Cluster 1, is made up of two adze samples and one adze flake (Anai'o adzes F and M and Flake 1). This is a first order cluster meaning that these three samples fall out of the branching tree at the first sort which in turn indicates that they share attributes differentiating them from all other samples in the analysis. Their most distinctive attribute is their high silica content. When the samples in Cluster 1 were included in the Sheppard *et al.* (1997) analysis they proved dissimilar to all Cook Island geological sources and an extra-archipelago origin is strongly indicated. In a study of the distribution of basalts from the Tataga Matau adze quarry in

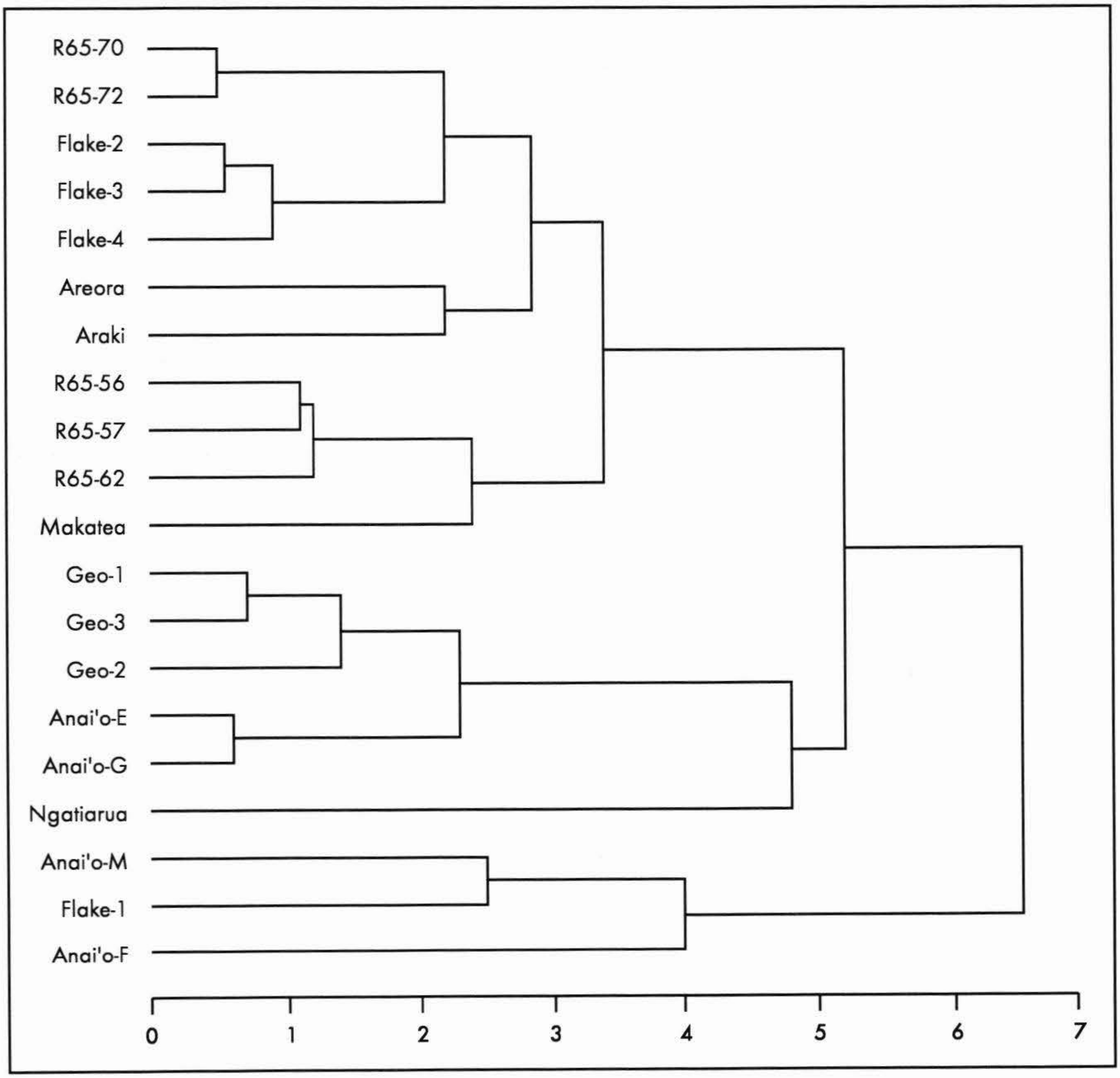

FIGURE 5.1. Dendrogram showing divisions of the average linkage cluster analysis of Ma'uke geological and archaeological basalt specimens.

American Samoa, Best *et al.* (1992) used plots of P_2O_5 against Log TiO_2/Fe_2O_3 to discriminate sources. They found that the Anai'o-M adze fell well within the Tataga Matau cluster (Best *et al.* 1992:53, Fig. 5). In addition they included these samples in an average linkage cluster analysis incorporating West Polynesian and East Melanesian samples. This analysis placed Flake 1 into an envelope made up mainly of geological samples from the base of the hill below the Tataga Matau quarry but also including adzes from a variety of sources in West Polynesia/East Melanesia (Taumako, Tokelau, Samoa, Lau (Fiji)) (Best *et al.* 1992:54, Table 1). In this same analysis the other Anai'o adze sample (Anai'o-F) clustered with samples from the east Tutuila Asiapa source and with an archaeological adze from the Nupani site (RE-51) in the Outer Reef Islands. On the basis of these geochemical grounds there is now strong support for the view that the Anai'o occupants had access to stone which was also being used by West Polynesian/East Melanesian adze makers and Cluster 1 is interpreted as Samoan, probably from Tataga Matau or another Tutuila source.

Cluster 3 is made up of two Sub-clusters. Sub-cluster 3b is a very tight and consistent grouping of the three geological samples from the Araki source (Geo-1, Geo-2 and Geo-3). These samples group at the next highest level with two Anai'o adzes, Anai'o-E and Anai'o-G (Sub-cluster 3a). All five samples show marked internal similarity in trace elements and petrography (see also Sheppard *et al.* 1997) and Cluster 3 is accepted as a valid cluster representing the source envelope for the local basalt. Whether the Sub-cluster 3a adzes are from the same exact site as the Araki geological material sampled in 1993 is uncertain. It is probable that there are (or were) a number of exposures of basalt cobbles on Ma'uke deriving from a single flow, but with some minor geochemical variation resulting from factors such as differential weathering.

Cluster 7, consisting of the three remaining Anai'o flakes, is a tight and well defined cluster supporting the view that the three flakes come from the same location. However, when these Ma'uke samples were included in the larger cluster analysis reported in Sheppard *et al.* (1997), they fell with the surface collected Ma'uke specimen from Areora (Cluster 6), into a problematic grouping of adzes from Aitutaki (n = 1) Mitiaro, (n = 2), Mangaia (n = 2) and geological samples from the Mangaian Mata'are source and from a source on Atiu. Trace element plots alone appeared to provide better discrimination and when this was done, the Anai'o flakes plotted very close to the local Araki source (Sheppard *et al.* 1997). Thus on the basis of the data available I can not eliminate the possibility that Cluster 7 and Cluster 3 are from the same or nearby sources, perhaps two exposures of a similar Ma'uke flow. Alternatively, Cluster 7 might be from a source elsewhere in the southern Cooks and if this is the case, the most likely island is either Rarotonga or Mangaia. What does appear evident however, is that trace element analysis shows these flake samples to be quite different to the other adzes included in Cluster 3. A possible explanation for the contradictory results provided by majors versus trace element ratios could involve petrogenesis: partial mixing and fractionation for example (Sheppard *et al.* 1997).

The final cluster is Cluster 8 which contains two Museum adzes (R65.70 and R65.72). These adzes are quadrangular to trapezoidal in cross-section and are of a fine-grained, dark grey to black stone. On the basis of the entry in the Museum accession book and on information given to me by Ma'ukean informants on Rarotonga I believe that they originate from Anai'o. When these adzes were included in the much larger database of all Cook Island samples they fell into a large and diverse group suggestive of a Rarotongan source. The internal variability of this group, however, points not to a single quarry, but to a suite of geologically related sources, perhaps in adjacent valleys and probably in the Arorangi District (Sheppard *et al.* 1997).

'Late' period Ma'uke sources

Late' phase samples fall into four clusters, Cluster 2, Cluster 4, Cluster 5 and Cluster 6, and these may derive from three or perhaps four sources. Cluster 2 contains only one sample, a broken reverse triangular adze which was surface collected by the author in Ngatiarua village in 1993. This specimen stood apart in the clustering (Fig. 5.1) and in hand specimen is different to all other Ma'uke adzes seen by the author and there is no justification in grouping it with other samples into a higher order cluster. It is described in thin-section as containing "...10-15% phenocrysts of euhedral pink clinopyroxene and euhedral olivine. The ground mass is a fine-grained porphyritic interlocking network of unoriented clinopyroxene and plagioclase lathes with some intersitial felsic patches" (Sheppard *et al.* 1997). In thin-section it is identical to a Rarotongan sample in the Cook Island Museum (R65.338) and both stand out in having very high chromium and low aluminium values. A Rarotongan source is indicated and the most similar geological samples are from Tokerau River on the west coast of Rarotonga.

A second source used in the 'late' phase of Ma'uke prehistory is represented by Cluster 4 in Figure 5.1 consisting of three reverse triangular adzes (R65.56, R65.57 R65.62) from the Cook Island Museum collection and a surface collected adze from the Makatea district. When included in the larger Cook Island set, these fell into a group which included two other Ngaputoru adzes (one each from Mitiaro and Atiu) and two from Mangaia (Sheppard *et al.* 1997). These adzes were remarkably similar in trace elements and petrography and there is a strong possibility that they are from a single distinctive source. All potential Ngaputoru sources have been sampled and none show any match with Cluster 4. The source is also unlikely to be on Rarotonga since the Rarotongan adze collection, by far the largest sample tested, contained no specimens of this type. It is the opinion of Sheppard *et al.* (1997) that these adzes are from a hitherto undiscovered Mangaian source, perhaps the Ruapetau source mentioned by Gill (1876:117).

A third source in use in the 'late' phase of Ma'uke prehistory is represented by Cluster 5, a single surface collected adze from the Araki district. The potential cluster formed by this sample and the single adze comprising Cluster 6 was not accepted because of the large differences between the two in terms of trace elements and petrography. In the Sheppard *et al.* (1997) analysis this sample was part of a very large cluster of adzes and geological samples believed to be of Rarotongan origin. These samples did not form a tight cluster but on petrographic grounds and on the basis of both major and trace element analysis they are believed to source to a series of exposures, perhaps in adjacent valleys, of a single flow. The two Anai'o adzes (R65.70 and R65.72) making up Cluster 8 fell into the same source envelope in the Sheppard *et al.* (1997) analysis and are believed to source to the same general area, although they are probably not from the same extraction site as the Cluster 5 adze.

The last source inferred from the clustering analysis is represented by Cluster 6, a single adze from Areora village. This source is very close geochemically to some low silica basinite adzes from Aitutaki (n = 1) and Mitiaro (n = 2), and to an Atiu geological sample and Sheppard *et al.* (1997) argue that the source geological location is on Atiu.

SUMMARY

There is still a serious deficiency of well dated and provenanced Cook Island adzes, especially from late contexts, and there is every indication that a number of source areas have yet to be located. Nevertheless, the materials analysis summarised above provides some interesting glimpses of changing patterns of basalt use in Ma'uke prehistory, and provides a basis for defining a number of testable hypotheses about resource exploitation and changing patterns of interaction in southern Cook Island prehistory.

By the time of Anai'o's occupation, local Ma'uke sources had been discovered and the Anai'o inhabitants were using at least one such source for stone tool manufacture. On the basis of oral tradition (the reference to Te Rua o te Toki) these sources were small and of very low density, requiring excavation to recover cobbles of sufficient size. There are a number of very small and localised surface scatters of highly weathered basalt cobbles but only the Araki cobbles contain a core of fine-grained material structurally suitable for manufacturing stone tools. Nevertheless, it is doubtful that there are any cobbles remaining at Araki which would be large enough to make adzes and this source may have been exhausted by over use. The cobbles are exposed within a shallow (less than 1 m deep x *ca* 5 m in length) depression on the edges of an eroded slope in the islands central interior which may be the result of prehistoric extraction activities. In addition to Araki, Te Rua o te Toki is very likely to have been another source depleted rapidly with only the name remaining to remind us of its former role.

In addition to these local sources, stone from a variety of outside locations was also being used during the 'early' (Anai'o) phase. Evidence of extra-archipelago exchange is provided by the identification of Samoan basalts within the Anai'o assemblage. This is now supplemented by samples of similar origin reported from strata on Moturakau dated to the late 13th to mid-15th century A.D. (Allen 1992; Allen and Johnson 1997) and from the Tangatatau shelter on Mangaia dating between 1000 and 1500 A.D. (Kirch *et al.* 1992, 1995; Weisler 1993b). Finally, an analysis of the Ngati Tiare cache of Samoan type adzes from Rarotonga which has been dated between the early 14th to late 15th century is now also well provenanced to Samoa (Walter and Sheppard 1996).

A number of questions remain unanswered about the importation of the Samoan basalts found at Anai'o but given the wide distribution of Tataga Matau stone now documented, a number of tentative deductions can be made. First, beyond Ma'uke, Samoan stone is found in strata post-dating the earliest occupation phases suggesting the possibility that this material was transported to the southern Cooks following initial colonisation. Second, while at least one island must have had direct contact with Samoa, it is very likely that the Anai'o samples were obtained indirectly, that is, from a secondary Cooks source. The most likely indirect source is Rarotonga which is known to have supplied other basalt to Ma'uke during this period (see above) and also to have received Samoan stone (Walter and Sheppard 1996). Whether the Anai'o samples arrived with the first colonists of Ma'uke or in later voyagers can not be determined until the exact position of Anai'o relative to first colonisation of the island and archipelago is known. Either alternative is possible given the level of voyaging that was apparently taking place during and immediately following the occupation of Anai'o. The Samoan basalt source was not available to the residents of Ma'uke for long since it is not represented in stone tools assigned to the 'late' (Post-Anai'o) phase of Ma'uke prehistory.

The other imported stone found at Anai'o was from a Rarotongan source, which is likely to be located in the northern half of the island (Arorangi District). Although highly distinctive, this material contains enough variability to suggest a series of extraction points, perhaps in adjacent river valleys, rather than a quarry. So far, 23 adzes made of this material have been identified from Mangaia, Aitutaki, Rarotonga, Mitiaro, Ma'uke and Atiu. In addition to the Anai'o samples, at least one surface fragment of a 3A adze appears to be from the same source. This source was discovered early in Cook Island prehistory, and was rapidly distributed widely throughout the southern Group.

Following the occupation of Anai'o the patterns of stone use on the island changed. Continued access to one of the Rarotongan sources is hinted at in the presence of a single sample (the Araki surface find) but in general, the shift is towards the exploitation of a series of Ngaputoru and Mangaian sources which were widely distributed throughout communities in Atiu, Aitutaki, Mitiaro and Mangaia. A possible interpretation of this pattern based on the hypothesis that Anai'o lies close to the settlement date for Ma'uke, is that the first colonists arrived on the island with (probably indirect) access to Samoan basalt and knowledge of some large, highly accessible sources on the northern coasts of Rarotonga. They located local sources on the island rapidly, but these were soon worked out. Elsewhere in the southern Cooks, there is similar evidence for the early use of Rarotongan and local sources as well as the isolated appearance of Samoan basalts. Later in prehistory there was a decline in the use of Rarotongan basalts in Ngaputoru and Mangaia and these were supplemented or perhaps even replaced by sources on Atiu and Mangaia. Stone from these last two islands soon became widely distributed along the chain from Aitutaki through Ngaputoru. The stone of Aitutaki which is predominantly a poor quality, low silica nephelinite was not transported beyond Aitutaki (Sheppard *et al.* 1997).

The changes that occurred in basalt use during the Ma'uke sequence reflect wider changes in patterns of voyaging and interaction in the archipelago. Furthermore, the basalt data supports similar conclusions drawn from the analysis of other material culture classes. During the earliest archaeologically represented phases of Cook Island prehistory a wide area voyaging network facilitated the transport of basalts, from sources both within and beyond the Cook Islands, throughout the archipelago. Pearlshell, which probably originated in the lagoons of the northern atolls, was also being transported and communities like Anai'o were utilising it for the manufacture of a wide range of small tool classes. Small quantities of ceramics and other exotic items have also been recovered from Anai'o and it is likely that a variety of perishable goods, not to mention intangible commodities, were also being exchanged.

The evidence for the existence of a voyaging network in the 'early' phase of Cook Island prehistory lends support to the interaction model for the development of the 'archaic' outlined in Chapter 1. In this model, cultural homogeneity was maintained through the maintenance of high levels of cultural interaction via the medium of an interaction network. The Anai'o data not only demonstrates that such a network existed, but indicates its importance in the economy of these early Cook Island communities. The data from Ma'uke and other islands also provides evidence that the voyaging network started to collapse in the southern Cook Islands from about the beginning of the 15th century A.D. (Chapter 4). Evidence for this has been summarised above in relation to the decline in the use of exotic stone in the 'late' phases of prehistory. This is mirrored in the decline in pearlshell use and its replacement throughout the southern Cook Islands by *Turbo* shell (Fig. 11.2). Imports from outside the archipelago (pottery, stone and pearlshell) have not yet been reported from 'late' period sites and the exchange of source material originating within the southern Cooks was severely reduced. Some of the factors which may have underpinned processes of network contraction are outlined in Chapter 11 along with a discussion of the effect these change had on early Cook Island society.

CHAPTER 6. FISH AND FISHING

Variation in Polynesian economic systems has been widely discussed in the archaeological literature, often with reference to the relationship between terrestrial production and political economics (Earle 1978; Goldman 1970; Kirch 1983, 1984; Sahlins 1958). Pacific fishing systems also vary across Polynesia, both in practice and in material culture, and this variation has been highlighted in a number of regional studies (Anderson 1986; Anell 1955; Goto 1990; Kirch and Dye 1979; Rolett 1998). In addition to the role of cultural and historic variables, adaptive responses to local ecologies have played a major role in structuring these patterns of regional variation. This is effected not only in the form and distribution of fishing technology but also in species choice, and in the strategies employed in the exploitation of specific marine zones.

The Pacific Ocean contains a similar range of vertebrate fauna throughout most of the tropical waters, but different local ecologies have developed as a result of different geomorphological and meteorological conditions. The rich lagoon environments of the equatorial atolls contrast with the narrow fringing reefs of the raised coral reef islands and despite the similarity in species diversity, quite different technologies are appropriate for their exploitation.

The Anai'o faunal assemblage is analysed below in reference to two issues. First, an assessment of relative taxonomic abundance contributes towards an understanding of prehistoric Ma'uke fishing practices. The fishbone and material culture assemblages are then compared with those from other recently excavated sites to provide a basis for discussing the wider southern Cook Island fishing adaptation.

Second, the Anai'o material is discussed in reference to ecological adaptation and particularly, the question of makatea island adaptation. The raised reef islands of Ngaputoru offer a number of quite narrow and specialised exploitation niches and it is interesting to consider whether there might be discernible regularities in fishing adaptations attributable to ecological patterning which can be recognised in the structure of the Anai'o assemblage. This question is addressed through a comparison of the Anai'o material with other island assemblages and by drawing on ethnographic observations of Ma'uke fishing practice.

METHODOLOGY

The Anai'o fishbone assemblage was first analysed in 1989 using a method devised by Anderson (1973) and standardised by Leach (1986). In this method, taxonomic identifications are made on the basis of five distinctive mouth parts (maxilla, premaxilla, dentary, articular and quadrate) and on a range of 'special' bones (see Butler 1988 for a discussion of the use of 'specials' in Pacific fishbone analysis). This is a very good method for assessing relative abundance figures expressed as MNI but beyond this it is somewhat limited. The focus on mouth parts also leaves a vast proportion of a fishbone assemblage remaining undescribed. In the Anai'o case 83% of the bones were assigned to the class 'unidentified' which essentially means that they did not contribute to the analysis.

Because of a wider interest in assemblage structure, the fishbones have been reanalysed and an attempt made to assign each bone to categories of both element and taxa. As many elements as possible have been used to make taxonomic identifications. Identifications were made using the Pacific fishbone reference collection at the University of Otago which contains over 250 specimens in 32 families and 72 genera (Walter *et al.* 1996). Many bones still remain in a *taxonomic* category 'unidentified', but the only specimens in the *element* category 'unidentified' are fragments with no landmark features. This approach is unlikely to substantially increase MNI values but it provides a fuller description of the assemblage which can be used in comparative studies.

Fishbone are reported here using MNE (Minimum Number of Elements), NISP (Number of Identified Specimens) and MNI (Minimum Number of Individuals) values. There has been considerable debate in the archaeological literature over which of these, or other indices, are most appropriate in faunal analysis (Grayson 1984). The main theoretical problem with MNI is that of aggregation, where the use of analytical units of different size gives rise to different quantitative results. This is a particular problem at a site like Anai'o which has a wide horizontal exposure. As a single value MNI can be argued to be of limited value in reporting fishbone assemblages, but taken in combination with NISP or MNE it is often quite informative, and that is why it is used here. Although NISP and MNE eliminate the aggregation problem, they provide others. For example, there is a potential for biases in element and taxonomy counts to occur when dealing with species which have large numbers of a particular identifiable element (Grayson 1984; Klein and Cruz Uribe 1984:25; Ringrose 1993:125). This arises in Pacific fishbone assemblages with species such as Diodontidae which have several hundred identifiable spines per individual (Nagaoka 1993:193). This problem can be entirely eliminated if researchers report the raw data on which the NISP values are based. Other problems arise when differential butchering practices are applied to different taxa resulting in the transport of a different range of element parts to the site. However, the advantage of NISP and MNE is that these values report a far higher proportion of the potential information contained in an archaeological assemblage.

RESULTS

If recovery rates and identification processes are unbiased the ratio of left to right bones for paired elements should be close to one, depending on sample size. The observed ratios of left to right mouth bones for Serranidae, the most common taxa in the assemblage, is 0.90 and for all paired bones across taxa it is 0.89. At these levels, the null hypothesis that lefts and rights are equally represented cannot be rejected at the 0.01 significance level. A total of 1816 bones were recovered of which 1116 were identified to element and 346 to taxa within 16 different families.

Species composition

The results of the identifications for Layers 2 and 4 are shown in Tables 6.1 and 6.2 and Figure 6.1. These tables provide counts of all identified and sided elements for each taxa identified in the Anai'o assemblage. NISP, MNE and MNI values are also provided. Rank order abundance values for each layer are listed in Table 6.3. This table also shows the effect on rank order abundance values of increasing the range of elements used for identification purposes. In the first column, rank orders are based on a consideration of all elements (A.E.) while the second column shows the same value calculated using mouth parts only (M.P.). In both calculations Serranidae dominate, but below Serranidae there are some interesting differences in rank order. Only two of the first five ranked taxa in Layer 2 appear within the first five ranks of Layer 4. In both layers one taxon which is highly susceptible to producing inflated NISP values is present above rank five. In Layer 2 this is Diodontidae (rank order = 2), and in Layer 4 it is *Elasmobranchi* (rank order = 3). Both these taxa are identified on the basis of multiple elements (dermal spines and vertebral plates respectively). When rank order is assessed on the basis of mouth parts alone (Table 6.3, column M.P.), the bias disappears and four of the five highest ranked taxa for each layer are the same; Serranidae, Labridae, Holocentridae and Carangidae. Lutjanidae make up the fifth taxon in Layer 2 and Lethrinidae in Layer 4. In both layers Scaridae ranks next.

As Table 6.3 indicates, the use of a wider range of elements does not necessarily have the effect of drastically altering rank order abundance values. This phenomenon is well understood in Pacific faunal analysis where even the use of a single paired bone has been shown to be effective in describing the relative abundances of fish families (Anderson *et al.* 1996; Rolett 1998).

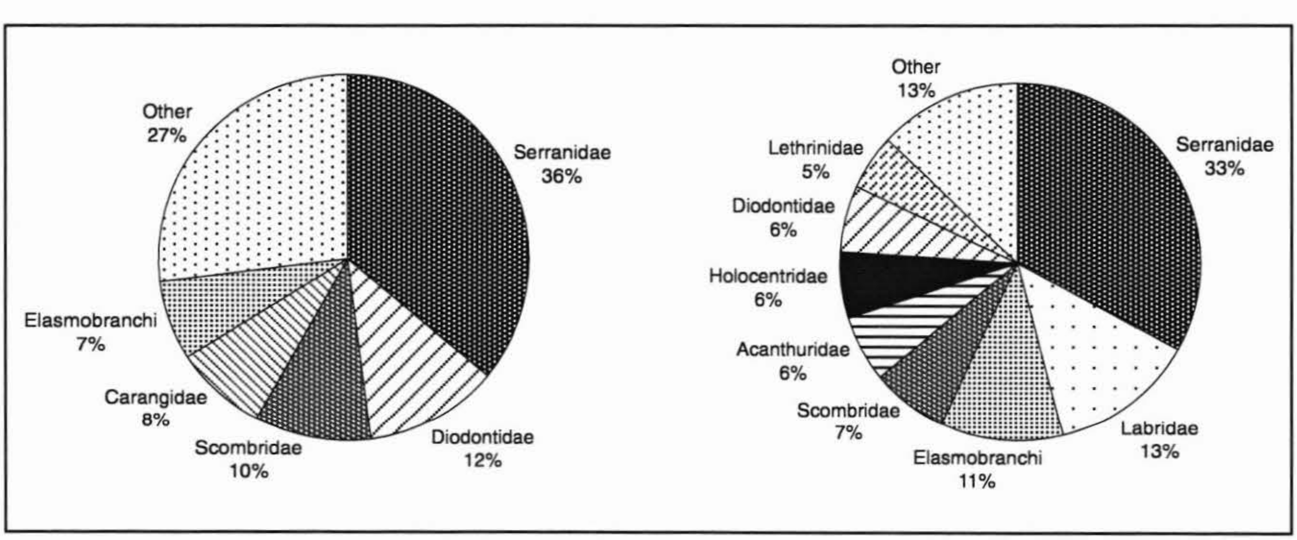

FIGURE 6.1. NISP of fishbones from Layers 2 and 4. All identified to family level except shark.

Taxon	Element	Left	Right	Unsided	Total	MNE	NISP	MNI
Acanthuridae	Dorsal spine/Pterygiophore	–	–	1	1			
	Pterygiophore	–	–	1	1			
						2	2	1
Carangidae	Articular	1	–	–	1			
	Dentary	1	–	–	1			
	Quadrate	1	–	–	1			
	Scute	–	–	2	2			
						5	5	1
Labridae	Dentary	1	–	–	1			
	Premaxilla	2	–	–	2			
						3	3	2
Diodontidae	Dentary	–	–	1	1			
	Dermal spine	–	–	6	6			
						7	7	1
Elasmobranchi	Vertebra	–	–	4	4			
						4	4	1
Holocentridae	Articular	1	–	–	1			
	Premaxilla	1	–	–	1			
	Preopercular	1	–	–	1			
						3	3	1
Lethrinidae	Tooth	–	–	1	1			
						1	1	1
Lutjanidae	Maxilla	–	1	–	1			
	Quadrate	1	1	–	2			
						3	3	2
Mullidae	Maxilla	–	1	–	1			
						1	1	1
Scaridae	Dentary	–	–	1	1			
	Pharangeal	–	–	1	1			
	Sup phar clus	1	–	–	1			
						3	3	1
Scombridae	Caudal peduncle	–	–	2	2			
	Maxilla	–	1	–	1			
	Vertebra	–	–	3	3			
						6	6	1
Serranidae	Articular	3	3	–	6			
	Cleithrum	1	–	–	1			
	Dentary	1	3	–	4			
	Maxilla	3	–	–	3			
	Premaxilla	2	1	–	3			
	Quadrate	1	3	–	4			
						21	21	6
Teleost sp.	Articular	–	2	–	2			
	Caudal peduncle	–	–	1	1			
	Ceratohyal	–	–	1	1			
	Cleithrum	2	2	4	8			
	Dentary	–	1	–	1			
	Dorsal spine	–	–	13	13			
	Hyomandibular	1	2	–	3			
	Interopercular	–	–	1	1			
	Maxilla	1	–	–	1			
	Misc spines/rays	–	–	2	2			
	Opercular	–	–	1	1			
	Pharangeal	–	–	1	1			
	Preopercular	1	1	3	5			
	Pterygiophore	–	–	12	12			
	Vertebra	–	–	41	41			
	Vomer	–	–	1	1			
	Fragments	–	–	60	60			
						94	154	8
TOTAL						153	213	27

TABLE 6.1. Element counts and taxonomic identification of fishbone from Layer 2.

Taxon	Element	Left	Right	Unsided	Total	MNE	NISP	MNI
Acanthuridae	Dorsal spine	0	0	4	4			
	Dorsal spine/pterygiophore	0	0	2	2			
	Pterygiophore	0	0	11	11	17	17	5
Apharaedae	Premaxilla	0	1	0	1	1	1	1
Balistidae	Cage	0	0	3	3			
	Dorsal spine	0	0	3	3	6	6	3
Carangidae	Articular	1	1	0	2			
	Dentary	0	1	0	1			
	Maxilla	0	1	0	1			
	Premaxilla	2	1	0	3			
	Quadrate	0	2	0	2	9	9	2
Cirrhitidae	Articular	0	1	0	1	1	1	1
Labridae	Articular	0	1	0	1			
	Dentary	1	1	0	2			
	Inf phar clus	0	0	14	14			
	Maxilla	0	1	0	1			
	Premaxilla	0	4	0	4			
	Quadrate	2	2	1	5			
	Sup phar clus	3	4	3	10	37	37	14
Diodontidae	Dentary	0	0	1	1			
	Dermal spine	0	0	15	15	16	16	1
Elasmobranchi	Tooth	0	0	6	6			
	Vertebra	0	0	27	27	33	33	1
Holocentridae	Articular	2	2	0	4			
	Maxilla	0	1	0	1			
	Opercular	0	0	2	2			
	Premaxilla	0	2	0	2			
	Preopercular	4	0	0	4			
	Quadrate	4	0	0	4	17	17	4
Lethrinidae	Articular	2	1	0	3			
	Dentary	2	4	0	6			
	Premaxilla	1	1	0	2			
	Tooth	0	0	2	2	13	13	4
Lutjanidae	Ceratohyal	0	1	0	1			
	Dentary	1	0	0	1			
	Preopercular	1	0	0	1			
	Quadrate	1	0	0	1	4	4	1
Mullidae	Dentary	1	0	0	1	1	1	1
Muraenidae	Articular	2	1	0	3			
	Dentary	1	1	0	2			
	Vomer	0	0	1	1	6	6	2
Scaridae	Dentary	2	0	0	2			
	Premaxilla	3	1	0	4			
	Sup phar clus	2	0	0	2			
Scombridae	Articular	1	1	0	2			
	Caudal peduncle	0	0	2	2			
	Tooth	0	0	1	1			
	Vertebra	0	0	15	15	20	20	2
Serranidae	Articular	8	12	0	20			
	Dentary	7	8	0	15			
	Maxilla	15	9	0	24			
	Premaxilla	12	11	0	23			
	Quadrate	9	6	1	16	98	98	15

TABLE 6.2. Element counts and taxonomic identification of fishbone from Layer 4.

Taxon	Element	Left	Right	Unsided	Total	MNE	NISP	MNI
Teleost sp.	Articular	5	0	1	6			
	Basipterygium	0	0	1	1			
	Branchiostegal	0	0	11	11			
	Caudal peduncle	0	0	11	11			
	Ceratobranchial	0	0	3	3			
	Ceratohyal	2	2	3	7			
	Cleithrum	0	2	26	28			
	Dentary	4	1	0	5			
	Dermal spine	0	0	2	2			
	Dorsal spine	0	0	143	143			
	Ectopterygoid	0	0	2	2			
	Epibranchial	0	0	1	1			
	Epihyal	0	0	2	2			
	Hyomandibular	1	2	1	4			
	Interopercular	0	1	1	2			
	Maxilla	3	1	1	5			
	Misc spines/rays	0	0	27	27			
	Opercular	1	2	8	11			
	Paraspehnoid	0	0	7	7			
	Post temporal	0	0	3	3			
	Premaxilla	0	3	3	6			
	Preopercular	7	7	24	38			
	Pterygiophore	0	0	28	28			
	Quadrate	1	3	5	9			
	Radial	0	0	1	1			
	Scale	0	0	1	1			
	Supracleithrum	1	1	1	3			
	Tooth	0	0	1	1			
	Vertebra	0	0	302	302			
	Vomer	0	0	1	1			
	Fragments	1	0	639	640			
						676	1316	13
TOTAL						963	1603	73

TABLE 6.2 *(continued)*. Element counts and taxonomic identification of fishbone from Layer 4.

Taxon	Layer 2		Layer 4	
	A.E.	M.P.	A.E.	M.P.
Acanthuridae	10	-	5.5	-
Apharaedae	-	-	14.33	10.25
Balistidae	-	-	11.5	-
Carangidae	4	2.33	9	5
Cirrhitidae	-	-	14.33	10.25
Labridae	6.25	2.33	2	2
Diodontidae	2	7	7	10.25
Elasmobranchi	5	-	3	-
Holocentridae	6.25	5.5	5.5	3.5
Lethrinidae	11	10	8	3.5
Lutjanidae	6.25	2.33	13	8.5
Mullidae	12	7	14.33	10.25
Muraenidae	-	-	11.5	7
Scaridae	6.25	5.5	10	6
Scombridae	3	7	4	8.5
Serranidae	1	1	1	1

TABLE 6.3. Rank order of identified taxa. A.E. column based on all identifiable elements, M.P. column based on mouth parts (5 paired bones plus pharangeals).

If the sole aim is to provide these types of measure the use of either dentary or premaxilla alone should be enough to provide an accurate estimate. Note however, that there are a number of fish families which are very important in the modern Polynesian subsistence fishery which are under-represented in archaeological assemblages. In terms of numbers of fish taken I would estimate that in Ngaputoru, Acanthuridae, Exocoetidae and Mullidae would fall in the first five ranks but these families are extremely rare in midden collections. It remains to be seen how the inclusion of otoliths, vertebra and other elements will affect relative abundance figures for these fish.

Fishing techniques

Estimating fish catch methods from taxonomic abundance figures is problematic because there is a variety of potential catch methods for any given taxa. Yet there are strong dynamics operating between ecology, technology and taxonomy and the potential exists for quite detailed interpretations of capture strategy from Pacific fishbone assemblages given the right base data. This includes quantitative information on local fishing practices, catch counts in ecological and technological context as well as a consideration of the social dimension of fishing in

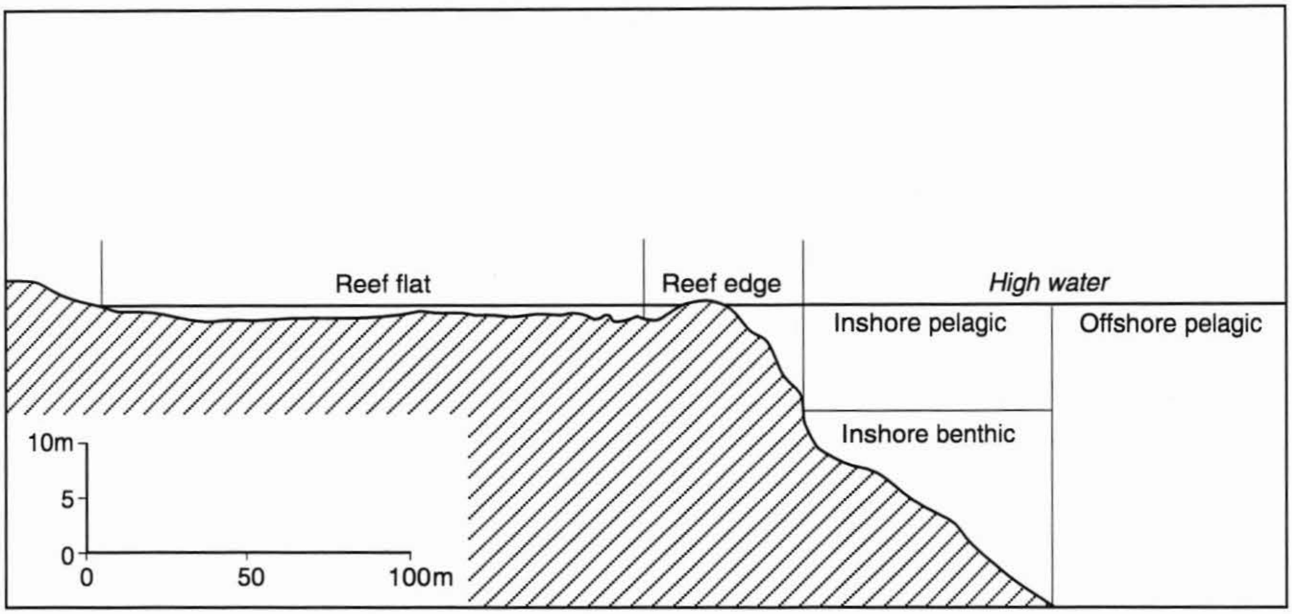

FIGURE 6.2. Section through Ma'uke coast showing location of five fishing zones.

the local communities. Given that this type of detailed data is rarely available, a good first indication of fishing strategies can be obtained by considering the preferred habitats and feeding behaviour of the identified fish taxa in the context of broadly defined exploitation zones. This information is summarised below in relation to five marine exploitation zones which are defined on the basis of fish habitat and my own observations of Ma'uke fishing practices (Fig. 6.2; Walter 1990, 1991).

Offshore pelagic zone. The offshore pelagic zone begins about 1 km offshore at the point where the underlying coral shelf of the island drops off steeply to the deep sea floor. In this zone, fishers target the surface swimming predators in the family Scombridae using lures, and angle at depth for *Sphyraena* sp. (barracouda), *Ruvettus ruvettus* (oil fish) and rarely, shark.

Inshore pelagic zone. This is the surface zone above the sloping coral shelf. It extends for approximately a kilometre offshore before the shelf plunges steeply to the ocean floor. In this zone schools of pelagic fish can be caught from canoes using lures and baited hooks. Target species include members of the families Scombridae, Carangidae, Exocoetidae and shark. The fish caught in the inshore pelagic zone include many smaller varieties (like *Decapterus pinnulatus*) which feed close to the reef (Walter 1988) as well as the predators which prey on these species. The inshore pelagic zone is fished on a more casual basis with less commitment in terms of time, labour and capital investment than the offshore pelagic zone, and the fish caught tend to be smaller. Night fishing for Exocoetidae is one of the specialised fishing practices carried out in this zone.

Inshore benthic zone. This zone lies below the inshore pelagic zone and includes a very different range of ecological niches. In this zone fishers target the reef fish which live and feed around the living coral faces and along the basal coral shelf. Fish are taken here from stationary canoes in depths of 30-40 m using baited drop lines. The target fish include Holocentrids, Carangids, Lethrinids, Lutjanids, Serranids and Labrids. Fishing can take place at day time or at night with simple hand lines. There is some overlap in species movement and fishing practice between the inshore benthic zone and the reef edge zone. In this study the two zones are distinguished by the fact that the inshore benthic zone is fished from an offshore position while the reef edge zone is fished by land based fishers. Several families (Holocentridae for example) are more commonly taken in the inshore benthic zone and all catch species tend to be larger than those taken in the reef edge zone. In addition to vertebrate fauna, octopus and *Tridacna* are also taken in this zone.

One of the most important fishing techniques used in the inshore benthic zone today is spearing which is carried out with modern fins, face masks, snorkel and some type of steel spear. Diving usually takes place during daylight but it is a very productive, although less widely practiced, night time activity also. Divers enter the water from the reef edge and work along the inner face of the reef just outside the surge zone. They also dive to the bottom and take fish around the coral outcrops of the sea floor. The most common fish taken here are in the families Acanthuridae, Scaridae, Holocentridae, Serranidae, Labridae and occasionally, Carangidae, Lethrinidae and Lutjanidae. In prehistory divers probably operated closer to the reef edge than is deemed prudent today, simply because of the difficulty of targeting fish in the deeper water without masks. In this case, the most common target species are likely to have been Acanthuridae followed perhaps by Scarids and Labrids. This is based on the observation that Acanthuridae dominate the catch of divers working along the walls of the harbour passages of Ma'uke and Mitiaro today. These sheltered reef edge zones are modern constructions and would not have been available as fishing sites in prehistory.

Diving is greatly facilitated today by modern equipment and has recently supplanted canoe based inshore benthic fishing which would have been the usual way to target the inshore coral reef species of this zone in prehistory. Diving is more efficient for the exploitation of the inshore benthic zone than canoe based fishing as the capital investment is low and divers are highly mobile being able to move rapidly with their equipment to wherever conditions are favourable on any given day.

Reef edge zone. The reef edge zone includes the algal ridge and the passages and surge channels which intersect the ridge. This zone produces a narrower range of species than the offshore zone but can be fished in any reasonable tide or weather conditions with minimal capital or time expenditure. The most numerous species taken from the reef edge zone are from the Serranidae family which occupy the surge channels, and underlying reef crevices. Labridae are also caught in this zone, but the larger members of these families are more often taken in the inshore benthic zone. The usual form of fishing is short-line angling using bamboo poles and baited hooks. Some Ma'ukeans have brought western style casting rods to the island but these are not as efficient as the traditional bamboo rods. This is because the structure of the reef prevents casting, or more accurately it restricts the retrieval of a cast line through the surf zone.

Dip nets take a variety of small reef species on the reef edge including members of the families Acanthuridae, Scaridae, Balistidae and small Carangidae. A range of very specialised techniques using spears and gorges are aimed at specialist feeders such as Muraenidae, and generalised foraging techniques provide a small range of inshore species such as Diodontidae. In addition to the smaller reef fish, some larger Carangidae can be caught just off the reef face by land based fishers during very low tides and calm sea conditions when the fisher is able to move to the extreme edge of the reef and throw a line into the waters of the inshore pelagic zone.

Similarly, it is theoretically possible for many of the fish of the inshore benthic zone to be taken from the reef edge on a raised coral reef island. On Niue for example, I have seen large fish in the families Lutjanidae, Lethrinidae and Mullidae caught from the reef edge zone by angling into the inshore benthic zone. But on Ma'uke, while it is occasionally possible to get lines into the inshore pelagic zone, it is never possible to fish the inshore benthic zone from onshore. Divers also occasionally work along the reef face but it is very dangerous because of the risk of being thrown by waves against the corals of the reef edge. Divers tend to work further offshore and exploit the deeper coral heads and the basal coral shelf of the inshore benthic zone.

The reef edge is an important zone for fishing vertebrate fauna, but is also a source for many other marine foods. These include the gastropods, especially *Turbo* sp., crabs, holothurians and echinoderms. Edible sea weeds are also gathered along the inner edges of the algal reef and the inner reef crevices. In certain seasons and marine conditions, crayfish venture onto the reef at night and can be caught in large numbers using simple foraging methods.

Reef flat. The reef flat is the coral platform between the algal ridge and the littoral zone. On Ma'uke this only ever has a very shallow covering of water but in high tide many of the smaller reef fish which inhabit the passages will pass onto the reef flat where they can be netted with dip nets, narrow seine nets or hooked with short lines. They include Scaridae, Balistidae, Carangidae, Acanthuridae, Ostraciidae, Mullidae, Mugilidae and some others. However, this is not a very productive zone on Ma'uke because the windows of opportunity are narrow, and the reef is shallow. Some specialist methods are also used on the Ma'uke reef flat. Poisoning is outlawed today but it has been used in recent decades. Seine netting and trapping techniques are aimed at schools of juvenile Mullidae species which pass onto the reef flat in large numbers during the period between about December to March. Often the fishing of these species takes place on a large scale communal basis, involving up to 30 or more people at a time.

Summary. Table 6.4 lists the main fishing zones on Ma'uke, the usual exploitation techniques and the target genera. Because each genera can usually be caught in several zones, I have listed the primary capture zone (p) and secondary zone (s) for several families based on contemporary practice. This data is based on observations of Ma'uke fishing practices including quantitative catch information, informal interviews with Ma'uke fishers (both in Ma'uke and in New Zealand) and the participation in many fishing expeditions on Ma'uke.

The Anai'o assemblage

On the basis of the information summarised in Table 6.4, the fishing adaptation represented by the Anai'o assemblage is best interpreted as one based on inshore predation with particular emphasis on the exploitation of the reef edge and inshore benthic zone. A few specimens of larger taxa which could have been caught in the offshore pelagic zone are present but there

Fishing zone	Technique	Target species
Offshore pelagic zone	Trolling	Acanthrocybidae (p) Elasmobranchi (s) Large Scombridae (p) Medium Scombridae (s)
	Angling	Sphyraenidae (p)
Inshore pelagic zone	Trolling	Acanthrocybidae (s) Large Scombridae (s) Medium Scombridae (p) Small Scombridae (p)
	Angling	Carangidae (s) Elasmobranchi (p) Medium Scombridae (p) Small Scombridae (p)
	Netting	Exoceoetidae (p)
Inshore benthic zone	Diving and spearing	Acanthuridae (p) Balistidae (p) Cirrhitidae (s) Coridae (p) Holocentridae (p) Labridae (p) Lethrinidae (p) Lutjanidae (p) Scaridae (p) Serranidae (p & s)[1]
Reef edge	Angling	Cirrhitidae (p) Serranidae, esp *Epinephelus* (p)
	Dip netting	Acanthuridae (s) Balistidae (s) Scaridae (s) Mullidae (p)
Reef flat	Dip netting	Acanthuridae (s) Balistidae (s) Scaridae (s)
	Seine netting & trapping	Mullidae (p)
	Foraging & spearing	Diodontidae (p)

[1] Several genus of the family Serranidae are predominantly caught in this zone, others are more commonly taken in the reef edge zone

TABLE 6.4. Ma'uke marine zones, target species and usual fishing strategies.

is no indication that the Anai'o community was specialising in offshore fishing or that this was anything other than a minor part of their fishing adaptation.

The evidence of the fishbone assemblage agrees well with the evidence from material culture. The fishhook assemblage was dominated by small to medium size specimens about equally divided between rotating and jabbing varieties (in the Emory *et al.* 1959 system). The rotating hooks would have been used in the inshore benthic zone to fish for bottom feeders from stationary canoes. The jabbing hooks would mainly have been used from the reef edge, probably attached to short rods, to catch the species which live and feed in the surge channels. This type of fishing is likely to account for most of the Serranids in the assemblage. The emphasis on angling is reinforced by the lack of material culture evidence for other types of fishing activity. At Hanamiai, Rolett records an increase through time in the presence of net sinkers in the assemblage coinciding with an increase in species expected to be caught in nets (Rolett 1989: Table 7.5, 1998). No net sinkers were recovered from Anai'o and species which are commonly netted ranked low in the fishbone assemblage. No trolling lure shank or points were excavated and this too supports the evidence for an inshore based fishing adaptation.

The Anai'o residents appear to have been targeting the same exploitation zones as the contemporary Ma'uke community. During the period of Anai'o's occupation, the inshore benthic zone would have been fished from stationary or drifting canoes. This method has been replaced by the more efficient diving techniques which exploit the same range of genera. The reef flat is also likely to have been fished but the major target species (small specimens of the Mullidae family) are not represented in the Anai'o midden, probably because they have small, fragile bones that do not preserve well. There is significant continuity in both the selection of genera and target zones between the Anai'o fishing adaptation and that of contemporary Ma'uke.

Comparative study

Fishbone assemblages have been reported from Mangaia and from Aitutaki and these provide interesting comparisons with the Anai'o assemblage. The Urei'a assemblage is from a lagoon shore site on the main island of Aitutaki. The predominant species as measured by NISP are Scaridae, Serranidae, Acanthuridae, Diodontidae and Labridae (Allen 1992a). If the tendency of Diodontidae to inflate NISP values relative to these other families is taken into account, Scaridae clearly stand out as the most significant taxa in all layers at Urei'a. In a more extensive comparative analysis of assemblages from a number of sites on Aitutaki Allen (1996a) reports a similar dominance of Serranidae and Scaridae. The other high ranked families in the Aitutaki assemblages include Carangidae, Lutjanidae, Lethrinidae, Labridae and Holocentridae and this indicates a generalised inshore fishing regime with some emphasis on netting and bait hook fishing (Allen 1992a). The relatively high values for Scaridae on both the mainland sites and the Moturakau Shelter site on a lagoon islet are the main differences between the Ma'uke and Aitutaki assemblages.

In Mangaia, Kirch *et al.* (1995) have reported a large assemblage of fishbone from the stratified Tangatatau rockshelter spanning a period of about 1000 years. The Tangatatau assemblage is fascinating and unique in its high (22% NISP) representation of brackish water fishes (Electrodidae and Anguillaformes). Marine species are dominated by Labridae, Cirrhitidae, Acanthuridae, and Serranidae. A series of Mangaian assemblages have been excavated by Katayama and associates and were analysed in the Museum of New Zealand Archaeozoology Laboratory (Leach *et al.* 1994). While it is difficult to compare the Mangaian and Aitutaki assemblages since Leach *et al.* (1994) do not provide NISP and MNE values and Allen and Steadman (1989) do not report MNI, a number of important differences between the assemblages stand out. The most interesting characteristic of the Mangaian assemblages is the high proportion of Balistidae in the Ngaaitutaki site. Leach *et al.* (1994:13) suggest that this fish may have been caught using a basket trap or hoop net technique. Dip or hoop netting on the reef edge seems the most likely option since this technique is known to have some antiquity in the southern Cooks, and is one of the more common methods (after spearing) for taking Balistidae in the region today. Leach *et al.* (1994:11) also comment on the "surprising and unusual" scarcity of Scaridae, in both the Mangaian and Ma'ukean assemblages. They suggest that Scaridae usually occupy the economic role in the tropic zones that wrasses (Labridae) do in temperate waters. These comments and Allen's (1992a) observations on Scarid exploitation on Aitutaki raise an interesting and important point.

Scaridae, parrotfish, are inshore reef fishes which graze on algal film growing on coral rock along the reef faces, although they occasionally pass through the passages and onto the reef flats. As herbivorous feeders they generally will not take a hook and it is common wisdom among Pacific archaeologists that these fish are never angled. This is not strictly true but the angling techniques aimed at Scarids are very specialised and would never have accounted for any significant proportion of a Scarid catch. Instead, their most common method of capture in Polynesia is either with a net or by spearing around the coral heads. Wherever they are available in Polynesia, parrotfish are frequently a favoured catch fish, as Leach *et al.* (1994) have observed.

On Aitutaki, Allen (1991:418) suggests that the dominance of Scaridae in the fishbone assemblages most likely reflects a naturally high abundance of this family in the Aitutaki ecosystems. It is certainly true that parrotfish are abundant in Aitutaki waters, but this is not entirely relevant since parrotfish are plentiful in most coral reef ecosystems including Ma'uke waters. The important issue is that in Aitutaki fishers can access the parrotfish feeding grounds around the living coral heads far more easily and safely than their counterparts on Ma'uke. On Aitutaki, these environments occur in sheltered locations within the lagoon where it is possible to use seine nets, and to dive with spears as well as along the fringing reefs where parrot fish can be taken using dip nets. On Ma'uke and Mangaia, the reef flat is too shallow for many parrotfish to be caught in nets, and the outer reef face, where Scarids are active, is relatively inaccessible. When diving outside the reef on Ma'uke it is possible to see large numbers of Scaridae along the reef face, and grazing the corals along the basal shelf but they would be difficult to catch using any traditional fishing techniques.

Today Scarids are eaten less commonly on Ma'uke and Mangaia than they are on Rarotonga or Aitutaki, and they are usually caught by divers spearing with modern equipment along the outer edges of the reef face. This highlights the importance of taking very local ecological factors into account when analysing fishbone assemblages and the inadvisability of applying general models of diet and exploitation behaviour. Scaridae are a particularly important indicator species in Polynesian fishbone analysis. They are widely available and almost universally favoured, so factors of cultural preference and availability can be held to be about constant. But their general inability to be caught in quantity using hooks and lures, means that their availability to prehistoric fishers is extremely sensitive to minor differences in ecologies and technology. I suggest that low ratios of Scaridae to some of the other dominant taxa such as Serranidae and Labridae, may prove characteristic of the raised coral reef fishing strategies of the southern Cook Islands.

Additional comments

In this study I attempted to identify all specimens to element level with a view to better understanding the composition of the fishbone assemblage. The results of this are shown in Tables 6.1 and 6.2 and summarised in Table 6.5. The element class 'unidentified' refers to fragments with no recognisable landmark features.

The element composition of the Anai'o assemblage raises a number of interesting issues. Leaving the unidentified fraction aside, the most abundant elements at Anai'o are vertebra and erectile spines which represent exactly 50% (n = 558) of the identified bones. Taxonomic identification of these elements is rarely carried out beyond the identification of a small number of families in which these bones are highly distinctive, as for example, the vertebra of some genera of the family Scombridae. Yet the high ratio of these to other elements warrants further investigation of their application in taxonomic identification in tropical Pacific assemblages.

It is very likely that vertebra are identifiable to at least family level over a wide range of Pacific families (see Casteel 1976) and their potential in Pacific fishbone analysis is currently under-explored. This is particularly evident in view of the fact that vertebra may be one of the more crucial elements for examining issues such as processing, distribution and taphonomy. The inclusion of erectile spines in taxonomic identification can also affect assemblage structures, particularly in reference to those taxa, like Acanthuridae and Balistidae, with one or two distinctive bones per specimen. A NISP value of 19 for Acanthuridae, based on dorsal spine and

Element	Total
Unidentified	700
Vertebra	393
Dorsal spine	165
Articular	52
Pterygiophore	52
Premaxilla	51
Preopercular	49
Dentary	45
Quadrate	44
Maxilla	39
Cleithrum	37
Misc spines/rays	31
Dermal spine	23
Caudal peduncle	16
Inf phar clus	14
Opercular	14
Sup phar clus	13
Branchiostegal	11
Tooth	11
Ceratohyal	9
Hyomandibular	7
Paraspehnoid	7
Palatine	5
Cage	3
Ceratobranchial	3
Dorsal spine/pterygiophore	3
Interopercular	3
Post temporal	3
Supracleithrum	3
Vomer	3
Ectopterygoid	2
Epihyal	2
Pharangeal	2
Scute	2
Basipterygium	1
Epibranchial	1
Radial	1
Scale	1

TABLE 6.5. Summary of fishbone elements recovered from Layers 2 and 4.

pterygiophore, in the present analysis for example, contrasts with a zero count for this family in the earlier (Walter 1991) report which did not include these elements.

The next eight elements in order of ranking include seven paired bones plus pterygiophore and together these comprise 33% of the bones identified to element, with each bone contributing between 3% and 5% of the assemblage total. The seven paired bones include the five mouth parts which are routinely identified, but it is interesting to note that the count for preopercular, which is rarely used for taxonomic identification, ranks higher than either quadrate or maxilla. In the Pacific, Serranidae and Holocentridae are particularly easy to identify on the basis of preopercular and in fact, the two genera of Holocentridae, *Myripristes* and *Sargocentron,* can be distinguished fairly easily on the basis of preopercular even when the samples are fragmented. In the current analysis the use of bones of the opercular series boosted the NISP count for Holocentridae 43% above that based on mouth parts alone. The final paired bone with representation over 3% was cleithrum. This element contains both a fragile portion and a robust and highly distinctive segment. The robust segment consists of the dorsal and ventral process and the anterior ridge which joins them. This element should be able to be identified to the family level at least.

Of the remaining identified elements and leaving aside the 'special' bones which are already being identified by many Pacific researchers, the paired bones opercular, ceratohyal, epihyal, hyomandibular, palatine, post-temporal, supracleithrum and the single bones, parasphenoid, bassioccipital and vomer as well as some caudal bones, have a great deal of potential in expanding both the proportion of bones contributing to taxonomic identification and in wider areas of assemblage structural analysis, including taphonomy. In the interests of facilitating comparative studies of issues beyond relative taxonomic abundance, the reporting of full element identifications in Pacific fishbone analysis is recommended.

The Anai'o assemblage was small, but it gives a strong indication of continuity in the basic form of fishing on Ma'uke over the last 700 years. The Anai'o residents clearly had the technology to exploit the full range of exploitation zones but concentrated on inshore species, with a likely specialisation in inshore benthic angling. Today, the same range of species are taken in the same environmental zone, but this is done with the benefit of modern diving gear which has effectively supplanted canoes and baited lines as the most important fishing strategy in this zone.

The Anai'o fishbone was analysed with a view to identifying all elements present in the assemblage so as to increase the data available for future comparative studies. In the hope that we can move beyond simple relative abundance figures, a standard and more detailed approach to reporting is required. In addition to information on screen sizes used (see Butler 1988:104), the raw data on which NISP, MNE or MNI values are based should be provided. In the future it will also be necessary to go below family level since problems are already showing up with families such as Serranidae which have a number of genera which are fished in different zones using different techniques, but which are not yet routinely distinguished archaeologically. The final factor of species size has not been considered in this study but is clearly important, as Rolett (1998) shows in his study of the prehistory of fishing on Tahuata, Marquesas.

CHAPTER 7. MAMMAL, TURTLE AND BIRD BONE

Polynesian subsistence systems are based on horticultural and arboricultural production, with substantial, but secondary contributions from marine fishing and gathering activities, hunting and the use of domestic fauna. Terrestrial hunting at appreciable levels is often confined to the earlier phases of settlement where brief windows of opportunity allow the hunting of a range of highly susceptible avian faunas (Steadman 1995). The marine fishbone component of the Anai'o assemblage has been described in Chapter 6, the remaining faunal materials represent the results of terrestrial and marine hunting and animal husbandry.

The assemblage consisted of 1020 g of mammal, turtle and bird bone from Layer 4 and 372 g of mammal bone from Layer 2. The bird bone assemblage was surprisingly small, consisting of only 16 bones from Layer 4 of which most were domestic fowl. Terrestrial mammal included the two Polynesian domesticates, pig (*Sus scrofa*) and dog (*Canis familiaris*), and the third introduced mammal, the Polynesian rat (*Rattus exulans*), which was perhaps hunted as a food source. The fruit bat (*Pteropus tonganus*) was also present, but only a single identified bone was recovered. Surprisingly, marine mammal was also represented in the form of a single femur of a fur seal. The only other mammal bone identified at the site was human and a small quantity of marine turtle was also present.

The collection strategy for all midden was discussed in Chapter 3. The bone was bagged in the field, labelled to excavation unit and returned to the Archaeology Laboratory in the Anthropology Department at the University of Auckland. The material was then washed and identified by the author using the faunal reference collections in the Auckland laboratories. Further identification and processing was carried out in the Archaeology Laboratory, University of Otago.

The selection of an appropriate quantification technique in the analysis of midden is governed in the first instance by the nature of the questions asked of the material (see Chapter 6). The aim of this study was to record the overall variability within the assemblage and to use this as a means of gaining a broad picture of the Anai'o subsistence system. For this reason NISP was the preferred measure although MNE and MNI figures are also provided.

RESULTS

The identifiable bone from Layer 2 consisted of only 18 rat bones and a quantity of highly fragmented bone from a larger mammal, probably pig. The results of the faunal analysis for Layer 4 are discussed below in respect of each faunal class, and the bone counts and derived values are summarised in Table 7.1.

Birds

Only 16 bird bones were recovered from the entire Anai'o collection, all from Layer 4. Eleven of these (MNI = 4) were chicken *(Gallus gallus)*, one was a femur of a pigeon, probably Pacific Pigeon *(Ducula pacifica)* and the remaining bones were unidentifiable fragments. *Gallus gallus* is an introduced species, found archaeologically throughout the southern Cook Islands and of contemporary significance in the subsistence system. The Pacific Pigeon is also present on the island and is still hunted, although very rarely.

In Pacific assemblages, including those from New Zealand, the layers closest to the settlement phase frequently contain an abundance of both terrestrial and sea birds. Many of these species, particularly the ground nesting varieties, were easily hunted and extinctions often followed rapidly on human arrival (Steadman 1995). Patterns of rapid decrease in avifaunal remains from stratigraphic sequences are often taken as indicators of human arrival in previously unexploited ecosystems. The Anai'o material then is not indicative of an early phase site. Instead, it is suggestive of a site which was occupied some time following initial human settlement and subsequent impact on bird populations. The important question is, how does the assemblage fit into wider models of bird predation and extinction in the southern Cook Islands? Two other bird bone assemblages from the southern Cook Islands are relevant to this issue.

Genera	Element	NISP	MNE
Arctocephalus forsteri	Femur	1	1
Canis familiaris	Metatarsal	1	1
	Molar	1	1
Chelonia sp.	Bone and carapace	25	-
Pteropus tonganus	Mandible	1	1
Rattus exulans	Atlas	1	1
	Femur	19	19
	Humerus	3	3
	Incisors	5	5
	Mandible	3	3
	Scapular	1	1
	Tibia	13	13
Sus scrofa	Articulated Foot	1	1
	Cranial	13	-
	Femur	3	3
	Foetal Skeleton	5	5
	Frontal	2	2
	Humerus	3	3
	Ischium	6	4
	Mandible	19	6
	Metacarpal (?)	4	4
	Metacarpal (3)	4	4
	Metacarpal (4)	5	5
	Metacarpal (5)	1	1
	Metatarsal	1	1
	Occipital	7	4
	Phalanges	5	5
	Rib	60	37
	Scapular	37	4
	Teeth	81	81
	Tibia	3	3
	Ulna	3	3
	Vertebra	53	29
Unidentified	Fragments	462	-
TOTAL		852	254

TABLE 7.1. Mammal and reptile bone identified from Layer 4.

On the Mangaian site of Tangatatau (MAN-44) Kirch *et al.* (1995) define ten aggregate zones in their analysis of the bird bone assemblage, spanning a period from *ca* 1000 A.D. to the late prehistoric. They report a NISP value of 807 for all species across zones, including the domesticated fowl. This represents a total species count of 32, of which 31 were native species made up of 12 seabirds, two migratory shorebirds and 17 landbirds (Kirch *et al.* 1995:Table 7). Of these, 13 of the landbirds and four of the seabirds are no longer present on the island.

The pattern of bird exploitation recorded from Tangatatau is different to that found in many other Polynesian assemblages. Instead of finding a strong selection for seabirds early in the sequence, the excavators note a heavy reliance on hunted landbirds in the earlier layers, Zones 1A through 4 (Kirch *et al.* 1995:58). Sea birds were found in small numbers from the lowest layers, and increased markedly from Zone 8 through 17 following a decline between Zones 5 and 7. There was also a change in seabird selection from a predominance of terns (*Gygis alba*) in Zones 1A through 4 with a switch to petrels, frigates and shearwaters in the upper zones (Kirch *et al.* 1995:58, Steadman and Kirch 1990:Table 3). The authors argue that Tangatatau is not a settlement phase site but was first occupied some 1400-1500 years after first human settlement of Mangaia, and that the, "...avifauna sampled in Zones 1A and 1B at MAN-44 does not represent a 'pristine' bird community that had existed until cal A.D. 1000 without any human influence" (Kirch *et al.* 1995:59).

The argument for early settlement on Mangaia is based on independent sedimentary, geochemical and pollen evidence (see Chapter 1) and the authors cite the lack of petrels and shearwaters in the early layers of Tangatatau in support (Kirch *et al.* 1995). This fails to explain the presence of petrels and shearwaters in the upper levels of the site but presumably this is interpreted in terms of a reestablishment of these populations. Leaving aside the issue of whether the avifaunal sequence supports a long or short chronology for Mangaia, the evidence unambiguously supports the conclusion that there was a period of heavy impact on bird populations between A.D. 1000 to A.D. 1300.

> "This suggests extirpation or major population reduction within the first three to four centuries of human occupation at MAN-44. The bird bones reveal a primary period of exploitation (and therefore, by inference, population decline) during Zones 1A through 4, dating to ca. cal AD 1000 to 1300...By the end of Zone 5 (ca. cal AD 1350), most species of Mangaian landbirds either were extinct or too rare to be sampled in our excavations." (Kirch *et al.* 1995:58).

The Aitutaki sites reported by Allen and colleagues (Allen 1992a; Allen and Schubel 1990; Allen and Steadman 1990) have small avifaunal assemblages but these are diverse in their content. In total they report 14 species of native bird; four landbirds, three shorebirds and seven seabirds (Allen 1992a:378). Of the landbirds, the ground rail, Sooty Crake *(Porzana tabuensis)*, the Rimatara Lorikeet *(Vini vini)* and a Whistling Duck *(Dendrocygna* sp.*)* are now locally extinct, as are two of the seabirds, the Tahiti Petrel *(Pterodoma rostrata)* and the Red-footed Booby *(Sula sula)*. The two seabirds were probably ground nesters (Allen 1992a:380) making them particularly susceptible to human predation, and therefore, good indicator species of human impact.

The three islands of Ma'uke, Mangaia and Aitutaki each display evidence for avian depletion. In the case of Ma'uke this is actually negative evidence, since no locally extinct species were recovered from an archaeological context. However, the pattern of early extinction is so ubiquitous in Polynesia that the lack of extinct species at Anai'o is reasonably interpreted as supporting the hypothesis of an earlier phase of human predation. Although it is always problematic to draw conclusions from negative evidence, the problem of sample size can be largely disregarded since Anai'o is a large excavation, with good preservation and retrieval and contains other examples of extremely rare faunal specimens (see below).

There is some suggestion in the literature that the rates of avian extinction may have varied according to island type within the southern Cooks. For example since makatea islands were not as thoroughly deforested for agriculture as the higher islands or atolls, extinction rates have been argued to have been slower. This is the view taken by Allen (1992a:383) who suggests that the rate of impact on Aitutaki may have been accelerated because of the lack of potential refuge areas. Kirch *et al.* (1995; see also Steadman and Kirch 1990) concur with this view arguing that refuge areas in the makatea belt may have reduced the pace of bird extinctions on Mangaia.

One of the problems with the avifaunal record is that there is little knowledge at present of the nature of pre-human bird populations in the southern Cook Islands since the bulk of reported assemblages are from archaeological contexts. While it is reasonable to suppose that the pre-human avifauna of Ma'uke was greater than the sum of archaeological and extant populations, precise estimates are lacking. In order to address this problem, excavated and dated samples of bird bone from natural deposits will be sought from Ma'uke over the next few years. Of particular interest is to determine whether nesting seabird populations were ever extant on Ma'uke since the evidence from Aitutaki and Mangaia suggests that these species are likely to be highly sensitive to human predation. As a working hypothesis, however, I would suggest that predation patterns and the pace of extinction while differing according to local environmental parameters, are unlikely to have varied by more than a few hundred years. This hypothesis is based on the proposition that all islands of the group were settled at approximately the same time, and the observation that there is evidence for a significant decline in bird populations between 1000 and 1350 A.D. throughout all the reported sequences of the southern Cook Islands. If predation rates varied significantly or if islands were settled at very different times it is unlikely that the faunal record would display such high levels of agreement.

Pig

Pig is one of the four vertebrate species introduced into the Pacific by Austronesian speakers and transported into Polynesia by descendants of the Lapita peoples. The archaeological record is still patchy on pig distributions, but in a wide range of locations in Polynesia archaeologists have reported pig remains as present in small quantities close to the beginnings of island sequences and have noted an increase in pig remains later in prehistory. This has given rise to a common interpretation of economic change in Polynesian islands which is typified by an increase in the reliance on animal and plant husbandry (Dye 1996; Kirch 1973; Kirch and Yen 1982). Pig is present at Anai'o from the earliest phase of occupation and the structure of the pig bone assemblage suggests that the site was occupied by people who already possessed a well developed husbandry system.

A total of 398 pig bones/teeth were identified in Layer 4 providing an MNI value of 11 for this species (Walter 1990:211). Based on the ratio of pig to other identified mammal bone recovered from the site, it is probable, however, that over 90% of the unidentified mammal bone sample is also pig. The bone was highly fragmented, and the assemblage consisted of very few bones longer than 80 mm in length. In addition to the usual assortment of juvenile and adult bone, the Anai'o assemblage was unique in containing a set of foetal pig bones (Fig. 7.1) which were recovered alongside an oven scoop in Layer 4, Area E. Several cranial, ischium and rib fragments of a juvenile or small adult pig were also found in the vicinity.

While pig is well known as a Polynesian domestic animal, a wide range of cultural practices can account for the presence of pig bone in a Polynesian archaeological site. In the southern Cook Islands today, pig/human interactions take a variety of different forms running through a continuum of practices from the hunting of feral stock through to the use of penned enclosures for fully domestic animals. A brief review of current practice in the islands serves to illustrate the range of choices, and aids in the interpretation of the Anai'o assemblage.

Many families in the southern Cook Islands and most families on the outer islands maintain a small stock of pigs for domestic use. As a broad generalisation, the pig raising practices are fairly casual and of low intensity in the Cook Islands and this is reflected in the linguistics. Cook Islanders use the same word (*angai*) to refer to looking after domestic animals and to the practice of looking after an adopted child. *Angai* literally means 'to feed', and implies a very different relationship to that of 'pig farming'. In the Cook Island English dialect too, people refer to someone as 'feeding pigs' (or chickens) and rarely refer to pig breeders or chicken farmers except in specific reference to larger commercial operations.

Within the continuum of possible approaches to husbandry the most casual approach in the southern Cook Islands is simply to allow pigs to wander free in the villages where they can forage for scraps. Remnants of this system are seen in all islands in the southern Cooks, but since the 'traditional' Polynesian village has given way to a more Western style organisation of housing, this is not a very practical system. It is still normal however, for those families on Ma'uke who maintain fishing or garden shelters, to have free ranging pigs in the vicinity

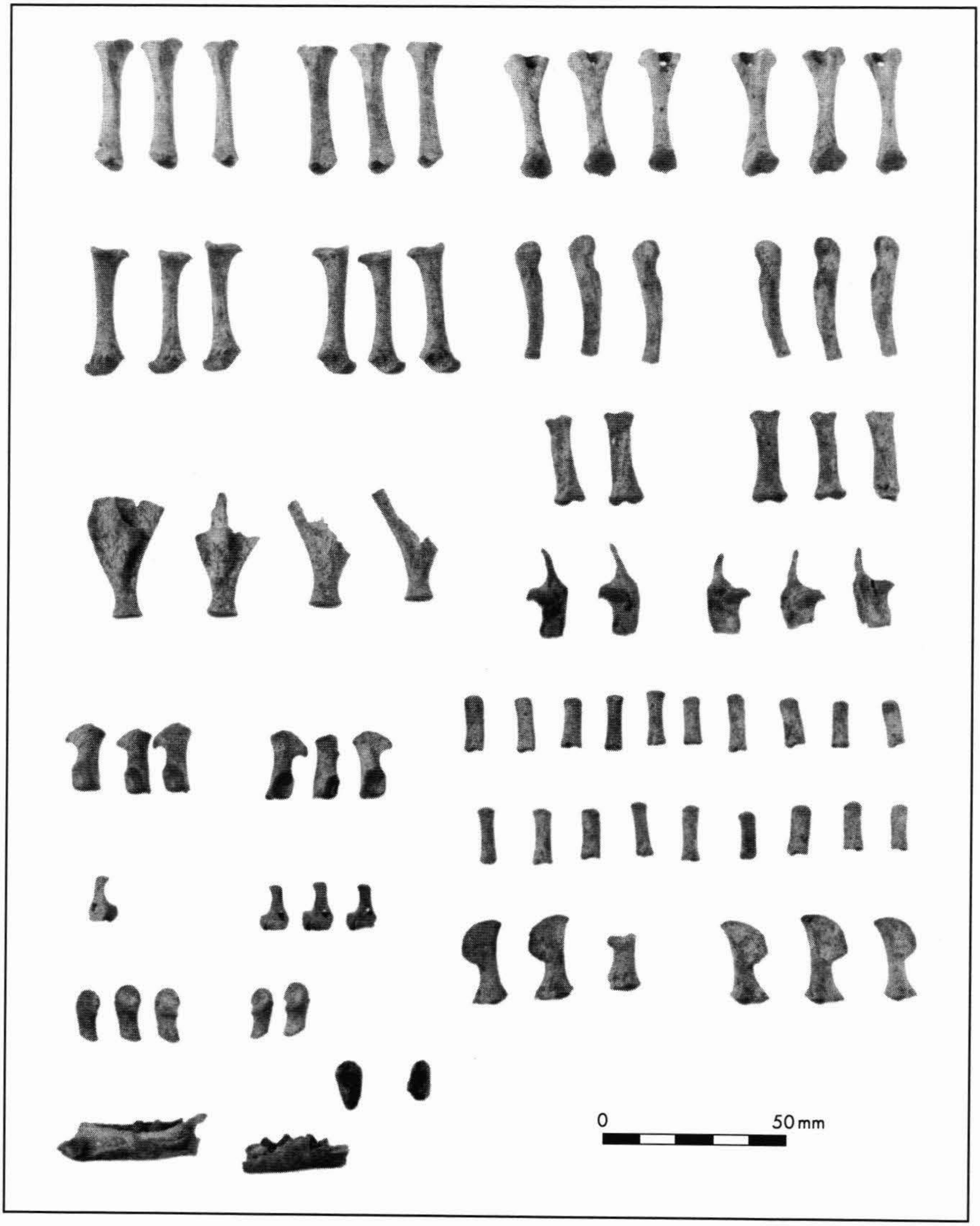

FIGURE 7.1. Foetal pig bones recovered from Area E.

which will gather to forage for scraps when the structure is being occupied, and will fend for themselves at other times. These pigs are considered to be domestic, not feral, so if someone kills one that is not theirs, it is seen as an act of theft not legitimate hunting.

The more common means of keeping pigs is to have one or two animals tethered by a front leg to a tree. Traditionally, the lashing device is woven from the bark of the *Hibiscus tiliaseus* and is known as a *maka*, and this is still used by some families in the outer islands. The pig is usually given only about 3-5 m of rope and the owners visit them daily, taking ripe coconuts as feed and sometimes supplementing this with fresh greens. If a female pig with a litter is tethered, the piglets are allowed to run free until they are old enough to cause a nuisance at which time they are either killed, or tethered themselves. If the pigs are kept close to the household unit, their diet of coconut is augmented with household scraps.

A more intensive husbandry practice has also been observed in Ngaputoru. This involves the construction of a coral rubble enclosure 1-1.2 m high running along the inner or outer edges of the makatea. These pig enclosures range in size from several tens of square meters to over a hectare. The smaller of these enclosures serve as a simple alternative to the use of a tether and are occasionally used on Ma'uke and elsewhere in Ngaputoru. The larger varieties have been observed by the author only on Atiu.

Casual husbandry practices such as are the norm in the southern Cook Islands lead to the development of a feral population very rapidly and so hunting is also an option. One of the traditional methods of hunting pigs was to use dogs, a method still practiced on some islands in the southern Cooks. Another alternative is to use the traditional spring traps. Occasionally feral pig populations get out of control and predate heavily on agricultural crops. While dry crops can be fenced, protecting taro swamps is much more difficult. In the late 1980s pig populations were out of control on Ma'uke and some families were losing up to 90% of their dryland crops, while others had to give up taro production altogether. Since dogs have been prohibited on Ma'uke for several decades, alternative hunting measures were necessary to control the stocks. Spring traps were set by a number of families and those who had access to rifles and could afford bullets used that alternative as well. Some planters moved onto the plantation at critical phases and literally kept the feral pigs out manually. The point of this discussion is to draw attention to the fact that regardless of the formal husbandry practices used, hunting would always have played a significant role in the economic system of Ma'uke, just as it does today.

On the basis of ethnographic observations it is possible to identify some of the practices most likely to have contributed to the Anai'o assemblage, and to eliminate others. If pigs were wandering free in or around the village the faunal remains on the site would be expected to exhibit gnawing marks and other signs of post-depositional disturbance attributable to pig scavenging. While butchery marks were observed on some bone, and rat gnawing on others, there is no evidence, such as puncture marks or crenulated edges, to indicate chewing of bone by any of the larger mammals. Nor do the fracture patterns suggest processing by pigs. Thus, while it is not possible to eliminate this option, there is no empirical evidence in its support.

There is strong evidence, in the form of the age structure of the animals at the site to support the interpretation of a managed system consistent with either pig tethering or the use of small enclosures. A comparison was made of occipital and long bones with laboratory reference specimens of known age from the University of Auckland, Anthropology Department laboratories. All juvenile/adult bones observed (n = 20) matched specimens of around 20 weeks in age (see Figs 7.2 and 7.3). The reference specimens were from commercially bred New Zealand stock fed on high quality commercial pig feed. Such animals are known to grow and mature more quickly than the Cook Island varieties and thus the archaeological specimens are likely to be between eight months to a year old (see also Weinstock 1993). The average killing age observed at Anai'o conforms fairly closely with contemporary killing ages and

FIGURE 7.2. Comparison of pig humerus from Anai'o (right) with 20 week old reference specimen (AU 3120) from University of Auckland Anthropology Department.

FIGURE 7.3. Comparison of two pig ulna from Anai'o (centre and right) with 20 week old reference specimen (AU 3120) from University of Auckland Anthropology Department.

with those reported from the Fa'ahia assemblage on Huahine (Leach *et al.* 1984:194) and from the Hanamiai site in the Marquesas (Rolett and Chiu 1994). The explanation for the culling of pigs at this point in the life cycle is that this is the age at which the piglet is just weaned, and when the major growth spurt is over. It coincides too with two other crucial points in the life cycle of the pig. At this age, the pigs start to venture out on their own and are large enough to create a nuisance of themselves either around the village, or in the plantations. It is also the time when a pig is likely to go feral. Thus in a casual or low intensity operation such as that proposed for Anai'o this is the most practical and economic time to kill them.

Finally, hunting too may be represented in the Anai'o assemblage. It would be unusual for anyone to deliberately kill a pregnant female since they have added economic value yet clearly, a pregnant female was butchered on the site. While it is not possible to eliminate the possibility that the female was a domestic pig, the more likely scenario is that it was hunted. Even if Anai'o was positioned right at the beginning of the Ma'uke sequence it would only take a few years for a feral population to develop on the island.

Fruit bat

A single mandible of the native fruit bat *(Pteropus tonganus)* was recovered from Layer 4. The Fruit bat is no longer present on Ma'uke, and there are no local traditions of the animal (known in the Cook Islands as *moa kirikiri*) ever being present on the island. This, and the extremely small quantity of fruit bat bone in the site, suggests that extirpation may have occurred not long after the occupation of Anai'o. The contemporary distribution range of *Pteropus* in the Cook Islands is greatly reduced from that of prehistoric times. It is no longer found in Ngaputoru or on Aitutaki, but is restricted to the two largest islands in the group, Mangaia and Rarotonga (Hill 1979), where it exists in small numbers and is still occasionally hunted.

Dog

A very small quantity of dog *(Canis familiaris)* was positively identified at Anai'o but it is likely that there is more in the unidentified mammal bone sample. Dog was transported through the Pacific by Polynesians, in most parts of which it was used as a food animal. Dog, however, never attained the importance as a food item as pig in the Cook Islands or elsewhere in tropical Polynesia and the relatively little dog compared to pig suggests that it was never a major component of the Anai'o people's diet. Dog bone has been recovered from sites throughout the northern and southern Cook Islands.

Fur seal

One of the most unusual faunal finds in the site was a single femur of a New Zealand fur seal which was positively identified in comparison with specimens in the marine mammal reference collection in the Archaeology Laboratory at the University of Otago. The New Zealand fur seal breeds in colonies in the South Island of New Zealand but there are also populations in South Australia, Western Australia and New South Wales (King 1983:58). At present, the fur seal is still recovering from heavy predation, first by Polynesians, and more recently by hunters serving the European and Chinese markets. There is good archaeological evidence that prehistoric populations of *Arctocephalus forsteri* were far more widespread in New Zealand, with breeding colonies situated around the northern and eastern coasts of the North Island since the bones of young fur seals and adult females have been recovered from 14th century archaeological sites in the Coromandel region (Smith 1989).

The distribution of fur seal populations expands and contracts during the annual cycle, which in modern times has produced an extensive seasonal migration pattern. During the breeding season between November and January there are congregations of animals around the southern rookeries. At other times sub-adult and male animals disperse with a general movement to the north (King 1983:58). According to Smith (1985, 1989) during much of prehistory when there were breeding colonies in the north, the annual expansion of populations would have meant that seals were available in small numbers over much of New Zealand. During the annual cycles when juveniles leave the colonies and venture further afield it is possible that the odd animal will straggle far from the normal range for this species. For example, in August 1972 and again in September 1973 juvenile specimens of New Zealand fur seal were identified in New Caledonia, the furthest north ever recorded for this species at that time (King 1976, Rancurel 1975). The specimen in the Anai'o site was also a juvenile animal and very likely to have been a straggler, either from a New Zealand or a southern Australian colony. The Anai'o find now represents the northernmost evidence for the movement of New Zealand fur seal.

Notwithstanding Smith's (1985) argument for prehistoric northern breeding grounds, and the undoubted existence of far larger populations of fur seals along the coasts of both New Zealand and Australia in prehistory, the presence of fur seals in Cook Island waters would never have been commonplace. The Anai'o specimen represents an opportunistic kill of a wandering animal far out of its usual territorial range. Interestingly, similar events have occurred periodically over the last century. According to one informant a large pinniped (probably a southern elephant seal (*Mirounga leonina*)) beached on Ma'uke in the 1970s. Another beached at Kimiangatau landing in 1987. This is well out of the normal range for a species which is generally regarded as circumpolar. However, the southern elephant seal is a wider traveller than the New Zealand fur seal and a number of specimens have been recorded in the Indian Ocean including a verified sighting in Mauritius in 1955 (King 1983:119).

Although seals are unknown in other Cook Island or central Polynesian assemblages, Allen (1992a) reports several small specimens of sea mammal (cf Odontoceti) bone from Aitutaki sites and cites Gill's (1885) account of an opportunist hunt on Penrhyn when the islanders drove ashore over three hundred porpoises which had strayed into the lagoon. Kirch *et al.* (1995) also report a small quantity of porpoise bone from Tangatatau on Mangaia.

Marine turtle

There are two species of marine turtle which are infrequent but regular visitors to the shores of the southern Cook Islands. These are *Chelonia mydas* and *Eretmochelys imbricata*. A small quantity of turtle bone was found in Layer 4 at Anai'o and small quantities were also recovered from sites on Mangaia (Kirch *et al.* 1995) and Aitutaki (Allen 1992a). The indication from all southern Cook Island sites in which turtle has been recovered is that it was a minor food item, probably taken opportunistically. This contrasts with the islands of the northern Cooks where turtles are more common and where both the meat and eggs are a prized food item. Today, turtles are rare on Ma'uke but occasionally they visit the islands of Ngaputoru and in January 1994 I observed several specimens of *Chelonia mydas* on Mitiaro. The archaeological evidence does not suggest that there has been any serious impact on turtle stocks by over-hunting in the southern Cook Islands, such as has been reported from Niuatoputapu (Kirch 1988) or Tikopia (Kirch and Yen 1982:285).

Rat

The Polynesian rat (*Rattus exulans*) was a prolific traveller, colonising all the islands of Polynesia visited by Polynesian seafarers. There is some debate over whether the Polynesian rat was a stowaway or whether it was intentionally transported on Oceanic voyages, but it appears in the archaeological sequences at, or perhaps even earlier, than the first record of human settlement in most parts of Polynesia (Anderson 1996). *Rattus exulans* was used as a food animal in many parts of Polynesia, and there are ethnographic records for its use as a food animal in Mangaia (Buck 1944; Gill 1894). The archaeological evidence however, is less straightforward and it is impossible to determine whether the Anai'o specimens were food items or whether they were simply co-occupants of the Anai'o settlement. Allen (1992a:390) cites Buck's (1944) claim that rats were not eaten outside Mangaia but this type of statement is difficult to assess even if backed by an absence of contrary archaeological evidence. Many people are reluctant to admit to practices, like the consumption of rats, which might seem unpleasant to visitors. So today, for example, it is common for Cook Islanders to obscure the role of dog as a food source. *Rattus exulans* remains have been recovered from most archaeological sites in the southern Cook Islands and their status as a food animal remains a possibility.

FAUNAL EXPLOITATION AT ANAI'O

The analysis of vertebrate fauna other than fish from the Anai'o midden broadens the picture of the subsistence economy of this early Ma'uke community. The most remarkable feature of the Anai'o economy is the relatively developed nature of the pig husbandry system. A common pattern in Polynesia is for archaeological sequences to display evidence for a gradual increase in the importance of pig husbandry relative to other sources of dietary protein through time. A strong reliance on hunted species such as birds and turtles in the early phases gives way to a period of increasing land clearance for agriculture and a growth in the use of domestic fauna (Dye 1996; Kirch 1973; Kirch and Yen 1982; Rolett 1996). The evidence from Layer 4 is that pig husbandry was well developed from the beginning of the sequence. Since fish is universally important in Polynesian island societies, a simple method of comparing the relative significance of pig between sites or through time, is to look at the ratio of pig bone to fish bone in the faunal assemblages. This is done by summing the pig and fish bone NISP values and determining percentage figures. The derived index provides a gross comparative measure but can't be converted to quantitative statements on consumption patterns.

In Layer 4, Anai'o, the pig to fish bone ratio is 16:84 which is a surprisingly high value when compared with other early East Polynesian assemblages. At Hanamiai in the Marquesas the ratio of pig to fish only reaches this level (17:83) in Zones AB which lie in the historic era (Rolett 1998). In the earlier prehistoric layers at Hanamiai the ratio of pig to fish is never higher than 5:95, but showing a slow and steady increase through time. The Tangatatau site on Mangaia also has a much lower relative number of pig bones than Anai'o. Like Hanamiai the highest ratio of 5:95 occurs in the historic era (Layer 17) and all earlier levels lie close to 1:99 (Kirch *et al.* 1995:Table 4).

The stratigraphically early importance of pig in the Anai'o sequence might be interpreted as evidence for a phase of economic activity on Ma'uke prior to the occupation of Anai'o. This interpretation could be supported by the paucity of hunted species such as sea birds and fruit bat in the assemblage. Some caution is necessary however since there is no reason to automatically assume that island sequences exhibit the same patterns or rates of change in subsistence systems. Ma'uke may well have been settled by people who rapidly established a thriving pig husbandry system, especially if it was settled from Atiu or another island in the archipelago. Furthermore impacts on local fauna can occur very rapidly, as has been shown in many other Polynesian contexts. It is interesting to note, that despite the reliance on domestic pigs, there is little evidence for the use of domestic fowl at Anai'o.

In addition to pig husbandry the Anai'o residents also relied on hunting for the supply of supplementary meat foods. The evidence for hunting at Anai'o points strongly towards an opportunistic regime, rather than one involving systematic targeting. Hunted species include turtle, sea mammal, fruit bat and perhaps rat. Although there is little direct evidence to draw on, it is certain that the Anai'o community also had a well developed horticultural and arboricultural system. The domestic plant foods together with the animal husbandry, hunting and fishing components point to Anai'o as practicing a typical, broad spectrum Oceanic subsistence system. The economy shows no sign of stress, but may have been engaged in some intensive pig husbandry.

CHAPTER 8. MARINE SHELL

At the Anai'o site shellfish remains occurred at a low density throughout Layers 2 and 4 with particularly high concentrations found around the cooking areas. In these places, *Turbo* was especially common and was frequently found in the ashy fill of ovens and firescoops. Shell also constituted a significant natural component of the Anai'o sands, as indicated by the presence of a high proportion of water rolled-shell in the excavated assemblage. The overwhelming majority of the shell was extremely fragmented with few examples of any complete specimens from the site. The fragmented nature of the assemblage is attributed to post-depositional trampling. This interpretation also finds support in the conditions of recovery of the few complete shell specimens found in the site. Complete or near complete specimens were recovered in three circumstances. *Codakia* and *Asaphis* specimens were often recovered complete, but in all cases they had use wear damage indicating their status as tools and thus they may have been exposed to different taphonomic conditions than the rest of the midden shell. A large number of specimens of small, robust species measuring less than 30 mm in length such as *Drupa, Nerita* and *Patella* were recovered whole since these were too small to be easily damaged by human traffic over a soft sandy substrate. The only true midden specimens larger than this size were recovered from well protected areas such as in the fill of ovens or fire scoops. Despite the fragmented nature of the material, the molluscan assemblage was small, and in contrast to most temperate zone Polynesian coastal settlements, there were no rich, deep shell middens or even any concentrated discard zones.

SAMPLING AND ANALYSIS

In Pacific archaeology excavated shellfish remains are rarely removed in total from the field because the transport costs are often considered disproportionately high relative to the quality of information which such complete collection strategies provide. Instead, common practice is to weigh or in some other way quantify a sample in the field and then to discard the material on completion of the excavation (see Nagaoka 1993:189 for example). The excavation strategies used at Anai'o were designed to provide enough data to produce good estimates of relative abundance and to this end, a simple sampling method was devised which provided two levels of field data. First, a total weight of shell was provided for each layer by using a cumulative count method in which shell was weighed at the completion of each excavation unit. Including water rolled shell (see below) 2009 g of shell was recovered from Layer 2 and 6837 g from Layer 4. Second, a 25% random sample of material was selected by spreading out the shell from each spit level across the quadrangular screen surface as an excavation unit was completed. A single quadrant was randomly selected and all shell from that quadrant was bagged and labelled while the remaining 75% fraction was discarded. On removal to the laboratory all water rolled specimens were removed prior to further analysis.

Pearlshell *(Pinctada margaritifera)* was treated differently both in the field, and in the current analysis. The pearlshell at Anai'o was all imported and used industrially for the manufacture of fishhooks and a range of other small tool classes (Chapter 4). For this reason, all pearlshell encountered in the excavation was collected. Pearlshell is listed in Table 8.1 but the weight of pearlshell is not included in the totals nor is pearlshell included in the relative abundance indexes. Clearly pearlshell ranks very high in the assemblage, but the total weights of shell and the relative abundance indices are intended to measure patterns of dietary choice.

Taxonomic identification of the shell sample was carried out by the author using the Pacific marine shell reference collection in the Anthropology Department laboratory at the University of Auckland. Further analysis was carried out using similar collections in the Anthropology Department at the University of Otago. In both cases standard identification guides were also used (Abbot and Dance 1990; Cernohorsky 1978). The results of the taxonomic identifications were first reported in Walter (1990). In this first analysis MNI was selected as the quantification technique using the procedure of removing from the collection all specimens displaying unique, landmark features which could contribute to MNI construction. This included features such as the whorl apex of gastropod

Taxon	Layer 2 Wt (g)	Percent	Rank	Layer 4 Wt (g)	Percent	Rank
GASTROPODA						
Astrea rhodostoma	21.8	3.0	6	6.1	0.4	
Casmaria sp.				21.1	1.2	9
Cellana sp.	35.0	4.7	3	28.2	1.6	8
Cerithium sp.	7.2	1.0		3.6	0.2	
Conus chaldeus				7.2	0.4	
Conus ebraeus				45.1	2.6	6
Conus sp.	23.8	3.2	5	62.8	3.6	4
Cypraea granulata				2.4	0.1	
Cypraea sp.	61.2	8.3	2	94.0	5.4	2
Drupa speciosa	3.9	0.5		20.7	1.2	10
Nerita plicata	2.0	0.3		0.9	0.1	
Patella flexuosa	28.0	3.8	4	50.8	2.9	5
Terebra sp.				40.6	2.3	7
Tonna sp.	1.4	0.2				
Turbo setosus	473.7	64.2	1	1229.0	70.5	1
Unidentified Gastropoda	21.0	2.8	7	7.1	0.4	
Zebina tridentata				0.8		
PELECYPODA						
Arca sp.	1.1	0.1		9.0	0.5	
Arca ventuosi				8.7	0.5	
Asaphis violascens	20.8	2.8	8	80.7	4.6	3
Chama sp.	8.0	1.1		11.7	0.7	
Codakia sp.	13.8	1.9	9	0.6		
Gafarium sp.	2.4	0.3				
Gloripallium palium	0.8	0.1		1.1	0.1	
Limaria sp.	1.7	0.2				
Pinctada margaritifera	52.4			368.2		
Scutarcopagia scobinata				3.7	0.2	
Tridacna sp.	0.9	0.1				
Unidentified Pelecypoda	9.0	1.2	10	8.4	0.5	
TOTALS	737.5			1744.3		

TABLE 8.1. Weight and rank order of identified molluscs from a 25% shell sample from Layers 2 and 4 following removal of water rolled specimens. *Pinctada* not included in totals (see text).

shells and the hinge sections of bivalves. In the present study, weights are used instead. This is partly because of the aggregation problem discussed in Chapter 6 and partly because MNI is rarely used elsewhere in the Pacific and thus the results can not easily be compared with those from other sites. The shell weights and the relative ranking by weight of the first ten species are shown in Table 8.1 and in Figure 8.1.

RESULTS

The shellfish assemblage from Anai'o was not large, and this is a reflection of the relatively low biomass of collectable molluscan fauna in the Ma'uke inshore zones compared to that of the higher islands of the southern Cook group. The range of taxa present at Anai'o and their rank order within the assemblage closely reflects the marine conditions of the island. In the absence of a sandy shoreline or extensive mudflats, gastropods are more abundant than bivalves along both windward and leeward coasts, as they are also on the coasts of the other raised coral reef islands of the southern Cook group. Not surprisingly, the gastropod shellfish have the highest representation of all species in the Anai'o midden. *Turbo setosus* and *Patella flexuosa* are the two highest ranked species in both cultural layers and there is only minor variation in the relative ranking below this level with *Conus* sp., *Cellana* sp. and *Cypraea* sp. as the next most significant taxa. The bivalve *Asaphis violascens* has a rank order of 5 in Layer 4 but most of these specimens had use modification so their ranking may not reflect subsistence behaviour (see below and Chapter 4).

All except three species represented in the Anai'o molluscan assemblage can be gathered within 100 m of the site today. *Codakia* and *Asaphis* are large bivalves commonly inhabiting muddy estuaries and sandy shore lines (Cernohorsky 1978). Populations of these species are currently extant on Rarotonga and Aitutaki (McCormack n.d.) but are not well

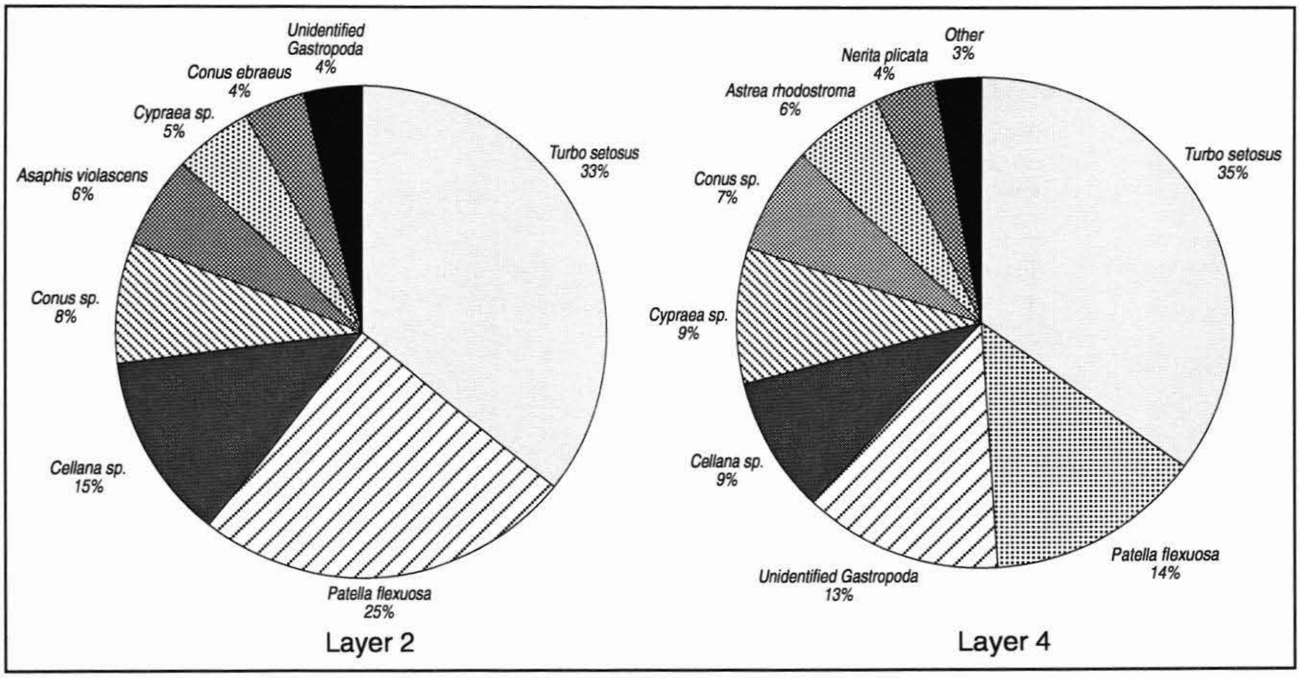

FIGURE 8.1. Proportion by weight of shell taxa identified from Layers 2 and 4.

adapted to the coral reef flats of the makatea islands. All specimens of these species found at Anai'o had been used as tools (see Chapter 4) and in the initial reports on the Anai'o fauna (Walter 1990) it was suggested that they may have been imported into Ma'uke as raw material for tool manufacture. Subsequently, I have observed several very small, solitary specimens of *Asaphis* growing in sheltered, sandy hollows on the Ma'uke reef. It is not impossible that the specimens recovered from Anai'o were gathered locally, but while there is unambiguous evidence for the importation of other commodities in the Anai'o assemblage the possibility that these also were imported cannot be rejected.

Pearlshell

The final non-local shell found at Anai'o was pearlshell (*Pinctada margaritifera*) which was used at Anai'o for industrial purposes (Chapter 4). A total of 368.2 g of pearlshell was found in Layer 4 and 52.4 g in Layer 2. No complete pearlshells were recovered but the size of the hinge portion fragments as well as some of the complete artefacts (Fig. 4.15) suggests that the shell at Anai'o was approaching the maximum size range for the species. Many of the smaller fragments had use wear marks in the form of cuts or griding facets. Pearlshell is not found naturally on Ma'uke and the source of the Anai'o shell has an important bearing on the nature of the exchange systems of the time.

Pearlshell grows best in sheltered lagoons and high quality robust shells, such as those found at Anai'o require depths of at least 5 m, although the best shells are produced at 15 to 25 m (Alagaswami 1968:978). The lagoons of the southern Cook Islands are not generally suitable for pearlshell growth, although a small number of shells have been reported from the Aitutaki lagoon (Allen 1992a; Walter 1990). Pearlshell thrives, however, in the deep warm lagoons of the northern Cook Islands and a successful commercial pearl industry has developed there.

The possibility has been raised that human induced environmental changes may have affected the prehistoric distribution of pearlshell stock in which case pearlshell may once have been more widely available in the southern group (see Allen 1992a, 1994). This might be true for Aitutaki or even Rarotonga but it would not have affected the communities of Ngaputoru (Atiu, Ma'uke, Mitiaro, Takutea) or Mangaia, since they have no lagoons and thus would always have imported their shell. Given the distribution of exotic items in other southern Cook Island sites it is extremely likely that pearlshell was imported into the southern Cook Islands from an outside source, probably from the northern atolls. Of course if pearlshell was available in Aitutaki, shell from there may also have circulated in the Cook Island voyaging network. The closest source today is Palmerston Atoll although all the northern atolls contain suitable supplies (see Fig. 2.1 inset). Basalt adzes have been found on Palmerston, Pukapuka and Rakahanga in the northern Cooks and examples of these can be found in the Cook Island Museum collection on Rarotonga.

Since these atolls do not have volcanic stone supplies, this demonstrates prehistoric contact with communities living in the high volcanic or raised reef islands to the south.

PREDATION STRATEGIES

Although shellfishing is not a major subsistence strategy on Ma'uke, it does make an important supplementary contribution to the diet. In terms of meat weight *Tridacna* is probably the most significant component of the Ma'uke shellfish catch today, but these are taken at depths of six or more metres by skilled divers and thus are not always widely available. In fact, they may never have been readily available in prehistory and there is no archaeological evidence for their use at Anai'o. *Tridacna*, however, are commonly harvested by removing the flesh from the anchored shell, and so the lack of *Tridacna* in the Anai'o midden does not constitute conclusive evidence that they were not exploited by the Anai'o community.

In terms of individual numbers, *Turbo* are the most numerous catch in contemporary Ma'uke. These shellfish inhabit the algal ridges moving back and forth around the surge zones. They never occur in high densities on the reef today, but an hours gathering on most stretches of Ma'uke coastline is likely to supply 40 or more specimens. They are usually anchored deep in the crevices so some moderate skill is required to locate them, but little skill is required to dislodge them. The only other shellfish of the reef flat which has any subsistence importance on Ma'uke today are worm-shells, Vermitidae sp. which are taken by smashing the shell where it is anchored to the reef and removing the shellfish. No specimens of Vermitidae were found at Anai'o but, as with *Tridacna*, this species would be unlikely to appear in a midden context given the usual Ma'uke predation strategies. In addition to these shellfish, *Patella* and a small range of other species are occasionally gathered in very small quantities but are rarely, if ever, the target species in a shellfishing foray.

The lack of dense beds of bivalve species and the small range of larger, reef dwelling, gastropods severely restricts the viability of shellfishing as anything other than a minor and supplementary component to the modern Ma'uke diet. The best interpretation of the Anai'o molluscan material is that it represents a very similar type of low intensity opportunistic reef edge exploitation strategy that can be seen on the island today. The main difference which can be observed between Anai'o predation choices and contemporary practice are that the Anai'o community were probably practicing a broader spectrum gathering strategy than is common today. This is reflected in the relatively wide range of species found in the midden including many species which are not a normal part of the modern Ma'uke diet. Nevertheless, there are no species recorded in the Anai'o midden which would not be considered potential food sources in contemporary Ma'uke society even if they are only gathered rarely.

COMPARISONS

Shellfish assemblages comparable to the Anai'o material have been reported from archaeological sites on Mangaia and Aitutaki. The Aitutaki assemblages reported by Allen (1992) show a number of interesting differences from the Anai'o assemblage and highlight the distinctive nature of the Ma'uke molluscan fauna. First, the density of shellfish remains is much higher in the Aitutaki sites than on Ma'uke. This can be partly accounted for in the fact that some of the Aitutaki sites are rockshelters, and rockshelters have a tendency to concentrate the midden, producing denser assemblages across a range of faunal and artefactual classes. But a more important contribution to this variation can be found in the differences in marine ecology between Ma'uke and Aitutaki. The higher islands of the southern Cooks with lagoons such as Rarotonga and Aitutaki, have a far greater diversity and abundance of molluscan fauna in exploitable locations along the inshore zones than do the makatea islands. A similar argument was made in respect of benthic zone vertebrate fishing in Chapter 6.

In an examination of the ecological zonation of shellfishing strategies on Aitutaki, Allen (1992) divided the exploitable marine environment into three habitat zones; Outer Reef-Intertidal, Lagoon and Subtidal, and Inner Reef-Intertidal. The contribution of these zones to each of the midden assemblages was then quantified in terms of shell weight (Allen 1992). The Outer Reef-Intertidal zone ranks first in shellfish abundance in 16 of the 19 assemblages considered by Allen (1992:365-70). This area includes most of what is contained within the categories of reef edge and reef flat on Ma'uke which are the zones within which all the Anai'o molluscs derive. The Lagoon and Subtidal zone of Aitutaki makes a secondary but substantial contribution to the Aitutaki assemblages but this zone is not present on Ma'uke. In terms of shellfish taxa, the ecological differences between the two islands are reflected in the fact that in all but one of the 20 Aitutaki assemblages for which taxonomic abundance rankings have been given three of the first four ranks are bivalves, while on Ma'uke if we ignore those shells used as tools, bivalves rank no higher than about ten in relative abundance.

Although there is insufficient data from other raised coral reef islands in the southern Cook Islands to make any conclusive statements, the differences between the Aitutaki and Ma'uke assemblages suggest that it may be possible to predict some distinguishing characteristics of molluscan assemblages from makatea islands. Such assemblages are likely to display low values for any measure of diversity, a high abundance ranking for *Turbo* and low rankings for bivalve species. It is in terms of relative ranking of the first four or five taxa that the major differences are likely to show between the raised reef assemblages and those from other island forms.

Although there is little difference in relative abundance values between Layers 2 and 4, some important differences show up in terms of shellfish size. There is a close correlation between the size of a *Turbo* operculum and the size of the shell. A study by the author of live shellfish along the eastern reefs of Niue gives an r^2 value of 0.962 for the relationship between the independent variable (opercular max length) and the dependent variable (shell height) based on a sample size of 255 individuals. On Aitutaki Allen (1992:Fig. 8.11) has described a uniformity in opercular sizes across assemblages suggesting a long term stability in the population structure of the predated species. In contrast, a graph of opercular diameter for the Tangatatau assemblage provided by Kirch *et al.* (1995:Fig. 9) indicates some decline in size from early to late levels at the site which is attributed to predation (Kirch *et al.* 1995:59). In the Anai'o assemblage there is a noticeable difference in the size distribution of opercular in the two Layers (Fig. 8.2). A t-test on unmatched samples based on an assumption of unequal variance rejects the null hypothesis that the two samples could be from the same underlying population at 0.05 alpha ($p = 0.038$).

The main difference between the two distributions is that the Layer 4 assemblage includes a wider range of size classes than Layer 2, and most significantly, it contains more small specimens. The interpretation offered here is that the bimodal distribution indicated in the Layer 4 plot reflects two distinct reservoir populations supplying *Turbo* to the Anai'o community. The large shellfish specimens are likely to derive from the algal ridge zone where the larger specimens are found today. The small shellfish derive from a second population located in a region more sensitive to predation pressures than the algal ridge. This may have been the region between the algal ridge and the strandline where *Turbo* are occasionally taken, but never today in large quantities. The drop off in the smaller specimens by Layer 2 suggests that this zone was particularly sensitive to human predation.

It is also interesting to note that the Anai'o specimens tend towards the larger end of the range for any described assemblage from the southern Cook Islands. The range for Layer 4 is 12-34 mm and for Layer 2 it is 21-34 mm. The maximum sizes at Anai'o are higher than at Moturakau (see Allen 1992:Fig. 8.11), and about the same size as the largest 2% of the Mangaian shellfish described by Kirch *et al.* (1995:Fig. 9). If human predation activity affects the structure of *Turbo* populations, this suggests that the population on which the Anai'o shellfishers were predating had not suffered any sustained impact by human foragers.

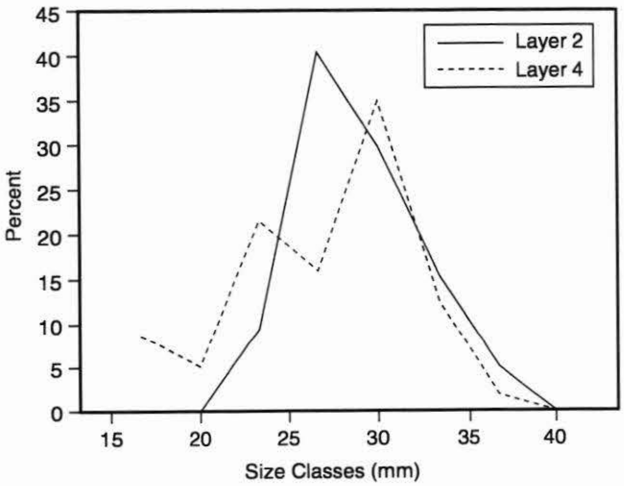

FIGURE 8.2. Distribution of size classes for *Turbo setosus* operculum from Layers 2 and 4.

CHAPTER 9. LANDSNAILS

Landsnail shells are a significant fraction of the soil matrix on many archaeological sites and they can provide archaeologists with a great deal of useful palaeoenvironmental information (Evans 1969). The value of landsnails in palaeoenvironmental reconstruction lies chiefly in their sensitivity to habitat, their quality of preservation and their relative ease of identification to at least the genus level and usually to species (Evans 1972:3-5; Lowe and Walker 1984). In the Pacific, landsnail analysis is not as widely used as in Europe and North America, but a number of archaeologists have drawn on landsnails to provide a record of environmental change in a single or multi-site setting (see for example, Christensen and Kirch 1981, 1986; Hunt 1980; Kirch 1975, 1993; Schilt 1984).

Landsnail analysis in Pacific archaeology has been particularly (some would say exclusively) successful in relation to marker or indicator species. There are a number of adventive snail species in the Pacific some of which accompanied the Polynesian migrations, while others were introduced on the later European exploratory voyages or with the first commercial shipping (Cooke 1926; Gould 1993). The sudden appearance of any of these in a soil profile can be used as an indicator of initial human arrival on an island. Some of the Polynesian adventives are strongly associated with taro production and such species have been used in Polynesian archaeology to map phases of wet-field horticultural expansion. The indicator status of the adventives has been exploited particularly in Kirch's work and is summarised in Kirch (1984:136).

In a more exhaustive historical review of landsnails in Polynesian archaeology Craig (1995) has pointed out a number of outstanding problems in the use of landsnails for palaeoenvironmental reconstruction in the region. The major problem, and one that has been recognised for some time, is that landsnail species are distributed according to micro rather than macro-habitat zonation. This means that samples in archaeological deposits may not reflect the wider environmental zone but may represent instead, only the immediate vicinity of the catchment at the time of the formation of the death assemblage and this might have been an area of no more than a few dozen square metres (see also Evans 1972:112).

This poses little problem when dealing with very specific and relatively uniform vegetation zones, such as a taro plantation. But, leaving aside the adventive species, simply listing and counting genera present in sites does not greatly assist environmental reconstruction since no one species or combination of species has been shown to comprise a consistently reliable environmental marker at the scale which interests archaeologists, and there is little quantitative data available on inter-habitat variation (Craig 1995). A careful reading of the Polynesian literature reflects this situation. The most reliable and positive interpretations of landsnail data deal with the adventive snails and with a few "extremely environmentally sensitive species" (Craig 1995:176). Statements about wider assemblage composition tend to include some general information on preferred habitats but avoid overt statements on palaeoenvironmental conditions. The Cook Island literature provides a very good example of this conservative approach, and the present study is no exception.

On Aitutaki, Allen (1992a) provided the first detailed listing of snail species from archaeological excavations in the southern Cook Islands. Adventive species were plentiful in the lower layers of the Ureia and Hosea sites, and this was interpreted as supporting the argument that human settlement of the island occurred prior to the 10th century A.D. dates from Ureia which represent the earliest dated cultural horizon in the southern Cook Islands (Allen 1992a). On Mangaia, Kirch *et al.* (1992) used landsnail data from the Tangatatau site to support a sequence of expanding wet-field taro production. The argument hinged on the association of *Melania* sp. which live in and around the ditches and canals of the Mangaian irrigation systems and which increase in numbers throughout the Tangatatau sequence (Kirch *et al.* 1992:175; Kirch *et al.* 1995:60).

METHODOLOGY

The landsnail sample from Anai'o was extracted in the laboratory from bulk soil samples collected for reference purposes. One litre samples of soil were taken from Layers 1,

Genera	Ecological status	Samples (%) per Layer 1	2	3a	3b	4	5	n =
Orobophana flavescens	Endemic	0	1	5	0	0	1	7
Georissa sp.	Adventive	56	16	74	0	10	15	170
Omphalotropis cf. Variablili	Adventive	3	0	0	0	0	0	5
Omphalotropis sp.	Adventive	0	0	0	29	0	46	82
Lamellidea pusilla	Adventive	14	60	0	43	21	11	315
Lamellidea oblonga	Possibly endemic	6	6	0	0	0	0	33
Tornatellides oblongus	Adventive	0	0	5	0	0	0	1
Gastrocopta pediculus	Adventive	5	10	5	0	21	0	55
Gastrocopta sp.	Adventive	0	0	0	0	0	0	1
Libera fraturcula	Endemic	0	0	5	0	3	14	26
Sinployea sp.	Endemic	14	5	0	14	0	13	59
Lamellaxis gracilis	Adventive	2	2	5	14	45	0	26

TABLE 9.1. Identified landsnails from all layers.

2, 4 and 5 and two one litre samples were taken from Layer 3. The two Layer 3 samples are labelled 3a and 3b in Table 9.1.

Each one litre sample was placed in a 5 litre container of water, the water was stirred and the snail shells which floated to the surface were removed by hand (see Evans 1972). The process of stirring and removing shells was repeated several times and each sample was left in water for 24 hours. Identifications were carried out by Jacquie Craig with the assistance of Frank Climo using reference collections from the University of Otago Archaeology Laboratory and from the Museum of New Zealand, in Wellington. The results of the identifications are shown in Table 9.1.

RESULTS

Adventive species are present throughout all the layers, including Layer 5 which could be interpreted as indicating the presence of humans on the island before the initial settlement of the site. Similar observations have been made on Aitutaki (Allen 1992a) and Mangaia (Kirch *et al.* 1992, 1995) where adventive species have been reported from the earliest archaeological horizons. The appearance of adventive species in these early contexts however, does not necessarily imply that human arrival occurred very much earlier than the cultural levels since it is possible for snails to spread very rapidly in new environments (Gould 1993:38). At Hanamiai for example, Rolett demonstrated, "...a dramatic faunal succession, with a nearly complete change in the composition of the landsnail fauna, from native to introduced species" (1989:198, see also Fig. 5.14). This change occurred in less than 300 years.

Several of the species found in Layer 4 are closely associated with crop plants, these include in particular, *Lamellaxis* sp. and *Lamellidea* sp. This supports the general conclusion of the archaeology that agriculture was present from the first establishment of Anai'o. The final observation which is of interest is the presence in the site of *Sinployea* sp., which were found throughout most of the sequence in small proportions. According to Solem (1982:94) this genus has not been recorded previously from Ma'uke, and Craig (1995:111) believes it may have become extinct during the Ma'uke sequence. *Sinployea* sp. were found in virtually all environments in nearby Mitiaro including archaeological contexts, and on this basis one would expect them to have been present on Ma'uke. Nevertheless, *Sinployea* sp. have very localised distributions in the Cook Islands (Craig 1995:110; Solem 1982:94) and might well have become extinct following the introduction of adventive species with the first Polynesian arrivals to Ma'uke.

CHAPTER 10. SPATIAL ANALYSIS

Stratified sites in East Polynesia, including those in New Zealand and Hawaii, tend to be either rockshelters, with rich concentrated deposits, or open settlements with more sparse and heterogeneous layers. These latter sites often occur as long contiguous horizons in dunes or beach ridges into which low density domestic kitchen waste is well mixed. Although these sites are sometimes described as 'middens', they frequently contain a wealth of structural information reflecting their initial formation as living surfaces. Many formative sites in East Polynesian archaeology are of this type; Hane and Ha'atuatua are good examples. Historically, while areal excavation techniques have often been practiced, the excavation and reporting of stratified sites in East Polynesia has stressed the vertical rather than the horizontal dimension. In these types of study, the emphasis is on adaptation and culture change, as expressed in stratigraphical changes in material culture and faunal remains. The excavation reports from Hane for example indicate the presence of living surfaces including preserved structures but most discussions of the site have stressed faunal and artefactual changes through time (Kirch 1973; Sinoto and Kellum 1965; Sweeny, Graves and Hunt 1993).

At Anai'o, which is a typical open site, the excavation techniques focussed on the horizontal dimension where the emphasis was on the distribution of features, material culture and faunal remains. This synchronic approach to site investigation aims at providing data from which to infer the spatial organisation of behaviour at the individual, household and community level. The interpretation of intra-site spatial patterning commonly adopts a hierarchical approach to unit formation. At Anai'o three levels of analysis were used, these levels are discussed below with definitions given of the basic units involved and some explanation of the underlying assumptions.

Level 1 consists of features and finds positioned in three dimensional space. These are the smallest culturally meaningful excavation units in spatial analysis, consisting of all items on a site whose position is attributable to past human behaviour. Specifically, these include artefacts, features, faunal remains and portifacts (anything deliberately carried onto a site and abandoned but which may not contain attributes of use or modification).

Level 2 is the first analytical unit and is made up of clusters of the lower order elements. These clusters fall into two categories at Anai'o. Structures consist of groups of features whose distribution pattern implies that they relate to the same building unit. Activity areas comprise spatially discrete clusters of artefacts or faunal material, with an implication that each individual element within the cluster owes its final position to the same episode of human behaviour. Minimally this episode might be a single adze sharpening event which took place over 20 minutes or it could be several years of continuous localised discard resulting in the accumulation of a deep concentrated patch of shell or bone.

Level 3 is the activity zone and this represents the highest order analytical unit used at Anai'o. An activity zone consists of a group of one or more structures and associated activity areas. The distribution of activity zones reflects the manner in which individuals and larger groups on the site organised their activities in relation to one another. There are both implicit and explicit rules underlying these patterns of organisation and understanding these is the ultimate goal of spatial archaeology.

Features and artefacts have been individually and collectively discussed in earlier chapters. The following discussion deals with the higher order units of Levels 2 and 3 (structures, activity areas and activity zones), and then offers some interpretations of the rules and ideas which might underlie the observed distribution patterns.

STRUCTURES

Structures were defined by clusters or arrangements of various features including postholes, stone alignments, stone paving and laid surfaces of sand or kirikiri. Accompanying characteristics of most structures included various types of cooking or burning feature plus activity areas. The structures, of which six were defined at Anai'o, varied in a number of categories including: size, density of midden, floor type, presence and position of cooking/burning features and presence or absence of manufacturing activities. Of these characteristics, size is the most difficult to define since none of the structures were able to be excavated in full, although enough detail was exposed in all cases to give a good indication of relative sizes. Table 10.1 shows the distribution of variation amongst the excavated structures including a conservative estimate of floor area.

Before looking at differences between the structures which might reflect functional variation, it is interesting to note some features which they share in common. First, all the structures preserved a clear distinction between internal and external space. This was primarily reflected in the contrast between flooring materials within and surrounding the structures. With Structures 1, 2, 4 and 5 this was achieved by the importation and laying down of an artificial surface of kirikiri and with Structures 3 and 6 by maintaining a cleared sandy interior. In the case of Structure 3, an external surface of kirikiri was also laid, and in both Structures 3 and 6 the distinction between internal and external was highlighted by the presence of a definite border region, a line of coral boulders (Structure 3), and a shallow ditch or drip line (Structure 6).

Secondly, the structures were all rectangular, which on the basis of ethnographic (Buck 1927, 1934, 1944) and archaeological (Bellwood 1978a; Walter 1996a) descriptions can now be defined as the standard form for the prehistoric southern Cook Island house. Quadrangular house construction is an architectural trait shared with New Zealand where there are also no archaeological examples of round-ended houses. In contrast round-ended or ovoid houses are common in West Polynesia and in early phases of most East Polynesian island sequences including the Society Islands (Green *et al.* 1967), Easter Island (Bahn and Flenley 1992:97) and Hawaii (Kirch 1975:67). They have not yet been confirmed in the early phases of Marquesan and Tuamotuan prehistory but they are certainly present there in late phase associations (Suggs 1961:164; Emory 1933).

Function

In assigning function to the different structure types priority is given to those attributes which directly reflect the manner in which the structures were actually used; the distribution patterns of midden and artefacts. On the basis of the variation summarised in Table 10.1 the structures can be divided into three classes: cooking shelters, dwelling structures and a third class tentatively identified as a communal structure.

Cooking shelters. Structures 1, 2 and 5 are interpreted as cooking shelters. These three structures contained abundant debris from cooking or food preparation, activities which were carried out both within and immediately adjacent to the actual buildings. The floors were rich in midden, and darkly stained with charcoal and ash and they all contained oven stones and signs of food preparation and consumption. Adjacent to the structures were the remains of small-scale domestic tasks such as shell and stone working, but no evidence for intensive manufacturing activities. These structures were also closely associated with underground cooking facilities. Structures 2 and 5 were the only structures which contained an internal umu, and Structure 1 lay within a zone of inter-cutting umu features. Although these three structures are believed to have

Structure	M.E.L.[1]	Discard	Floor	Cooking/burning features Internal	Cooking/burning features External	Verandah[2]	Activities
Structure 1	2.8 m	Midden, ash, oven stones, charcoal	Kirikiri	Absent	Hearth	Present, roofed	Small scale shell working
Structure 2	3.2 m	Midden, ash, oven stones, charcoal	Kirikiri	Umu	Hearth	Present, ?roofed	Small scale shell working and stone tool maintenance
Structure 3	4.7 m	Small amount of bone	Coral sand	Absent	Hearth	Kirikiri bordered with coral boulders	Intensive stone flaking activities
Structure 4	4.7 m	Small amount of bone	Kirikiri	Absent	Firescoop	Unknown	None apparent
Structure 5	1.6 m	Midden, ash, oven stones, charcoal	Coral slabs and kirikiri	Umu	Absent	None	Small scale shell working and stone tool maintenance
Structure 6	7.4 m	Small amount of bone	Grey sand	Absent	Absent	Unknown	None apparent

[1] M.E.L. (maximum excavated length). Maximum exposed length of floor measured parallel to an implied wall line.

[2] See text

TABLE 10.1. Attributes of structures.

had a similar function, Structure 5 was much smaller and may have been no more than a roofed oven.

Dwelling structures. Structures 3 and 4 were slightly larger units than those classified as cooking shelters and contained a number of wider, deeper postholes suggesting that they were of more sturdy construction. In both cases the internal floors were clean and there was no evidence for intensive cooking or food preparation and they contained no internal cooking or burning features. Their designation as dwellings is based on ethnographic evidence although it is recognised that they may have had some specialist function not clearly reflected in the available excavation data.

Communal structure. Structure 6 was the largest on the site and was the only structure excavated which contained a central posthole. This large posthole was lined with coral blocks and the post may have supported a central roof beam. Structure 6 produced a quite different array of artefact types than those found in association with the other structures. The most significant distinction was that in and around the other structures the distribution of artefacts suggested either random discard of broken items or abandonment of materials during stages of use or manufacture. Structure 6, however, contained the only complete shell and coral artefacts on the site including a number of complete fishhooks and coral files. It did not produce any evidence for manufacturing or cooking and very little midden. Like Structures 4 and 5, the floor of Structure 6 was kept very clean. There are few clear ethnographic parallels to draw on but it is possible that this structure may have been a canoe house or perhaps a men's house.

Activity areas

Patterns of artefact and feature clustering allowed the identification of four types of activity area; stone working, shell working, food preparation and storage. In respect of shell and stone working, the number and density of manufacturing by-products and the range of associated tools in each of the working areas, makes it is possible to distinguish two types of working floor; multiple-event and single-event floors. A multiple-event floor is defined as one in which manufacturing debris accumulated as a result of the extended use of an area as a manufacturing workshop. These floors contain a variety of artefacts and a range of debris suggesting that more than one manufacturing event took place. Single-event floors contain debris which accumulated as a result of a single or minimal number of work episodes and the implication is that these areas were not set aside specifically for manufacture.

Stone working areas. Stone working activities were represented by clusters of stone flakes, stone working tools and by part finished stone tools. The overall density of flakes throughout the site was low, at about 0.25 per m2, but the distribution was discontinuous and nine areas of tight clustering were recorded. These flaking areas contained 92% of the flakes recovered from the site and there the densities rose to as high as 150 flakes per m2. Eight of these clusters were in Area B and one in Area C. The quantity and mean sizes of flakes recovered from each of these nine clusters is shown in Table 10.2. As discussed in Chapter 4 the activities represented in these flaking areas are dominated by those pertaining to the final stages of adze manufacture; the final flaking of preforms and adze sharpening or reworking. The tools which were found within and nearby the flaking areas also point to the type of activities associated with the final working of stone adzes, including grinding, and adze resharpening. These are listed in Table 10.3.

In Layer 4, one multiple-event stone working floor and five single-event floors were recorded. The multiple-event floor is represented by Flaking Area 1 which itself consists of four smaller but virtually contiguous clusters (1a to 1d) (Fig. 3.7). Because these four smaller clusters were so close and were all associated with a single structure, they are taken to represent components of a single large activity area. The focus of these activities was the verandah area of Structure 3. In this multiple-

Flaking area	Location	Quantity	Mean length (mm)	sd length	Mean wt (g)	sd weight
1a	Area 4M (inside Structure 3)	13	33	9.0	5.2	2.0
1b	Areas4M (outside Structure 3)	243	33	13.8	6.4	2.2
1c	Area 3L-4L (inside Structure 3)	56	28	15.7	7.8	3.0
1d	Area 4L (outside Structure 3)	107	23	11.6	3.9	1.3
1 (Total)		419	29	12.3	5.9	2.2
2	See Plans	31	26	10.8	4.1	1.7
3	See Plans	19	31	8.7	5.2	1.6
4	See Plans	15	28	15.9	8.4	2.3
5	See Plans	18	6	4.2	1.0	0.5
6	See Plans	43	32	11.9	6.4	2.4

TABLE 10.2. Stone flakes recovered from flaking areas 1 to 6.

Flaking area	Artefact
1	Flaked and part-ground adze (lenticular) Flaked and part-ground chisel (52 mm in length) Flaked adze roughout (quadrangular) Flaked adze/chisel roughout (80 mm in length) Polished adze fragment (blade end) 3 x coral grinding stones Large basalt core (1.952 kg) 6 x polished adze flakes
2	Flaked and part-ground adze fragment (65 mm in length)
4	Core tool, flaked with retouched edges (65 x 45 x 30 mm) Basalt sharpening stone (17mm long and wide x 2 mm)
5	Flaked and part-ground adze fragment (33 mm) Flaked adze roughout (butt end) Basalt lap-stone (55 mm in length) 1 x polished adze flake

TABLE 10.3. Stone tools from flaking areas 1 to 6.

event floor a range of different tasks associated with various stages of stone tool production were carried out. These include the flaking, grinding and polishing of preforms as well as some working of other tools such as chisels and scrapers. The only artefacts usually associated with adze working which were not identified in Flaking Area 1 were hammer-stones and none of these were found anywhere at Anai'o. Judging by the number of flakes and the range of different tools in Flaking Area 1, this workshop must have been in use over an extended period of time.

The single-event floors representing discard activities from a single flaking event fall into two broad categories. Flaking Areas 2, 3 and 4 were located very close to Flaking Area 1 and are interpreted as satellite activity areas from Flaking Area 1. Flaking Areas 5 and 6 were located close to hearths or cooking areas and represent a single short period of low intensity flaking, most likely the resharpening of an adze blade.

Shell working areas. The shell being worked at Anai'o was mainly pearlshell and it was used to make fishhooks, tattooing chisels, ornaments, coconut graters and a small range of other items (Table 4.1). The shell working activities were all represented by single event floors and there were no examples of intensive shell manufacturing having taken place anywhere within the excavated areas of the site. In contrast to the stone working areas, shell working activity areas were not primarily defined by clusters of waste fragments, but by the presence of part-finished products, such as fishhook tabs, and sea urchin spine or coral abraders which were used to work the shell. Shell working activities took place around the outside of most of the structures on the site, and particularly around the cooking houses. The low intensity, spatially diffuse manufacture of shell tools suggests that this may have been a non-specialist activity. Almost anywhere on the site where there is evidence of people involved in some type of domestic activity, there is also some evidence of shell working having taken place. The differences between the shell and stone working areas defines the difference between specialist and casual manufacturing activities. At Anai'o the manufacture of stone tools, or the finishing of preforms, was a task carried out by a small number of individuals on a very localised basis, probably by one or more resident craft specialists. This contrasts with the resharpening of adze blades and the manufacture of shell tools which were activities carried out on a less specialised basis by a wider range of individuals and in a wider range of locations.

Cooking and food preparation areas. Cooking and food preparation was one of the most highly visible types of activity found in Layer 4. These areas are represented at Anai'o by clusters of umu pits containing charcoal enriched soils, burnt and shattered oven stones, shell and other types of organic refuse. Dense scatters of bone and shell, lenses of ash and other oven rake out materials were found close by, as were the occasional items of food processing equipment. Examples were found in Area C, and in the southern parts of Area B including Structures 1 and 2. Although only two small shelters were excavated in this latter area, it is probable that the kirikiri which was very loosely scattered through much of this portion of the site derived from a number of crude cooking shelters which had been built and rebuilt around the many inter-cutting umu. In addition to these types of cooking activity, small scale ember cooking took place in a variety of locations. These small scale cooking areas contain only a single shallow scoop, and there are no heavy concentrations of mixed midden, dark charcoal staining or other kitchen materials. Examples of these areas include some of the small hearths and oven scoops close to Structure 3 as well as the large shallow firescoop lying to the west of Structure 4 (Fig. 3.10).

Storage areas. The storage of some type of foodstuff is implied by the presence throughout Layer 4 of a number of pits most of which were circular in plan with square cut sides and bases and filled with fine, light grey sand. The exact function of the pits is unclear although it is unlikely that they were used as fermentation pits. Fermentation pits, used to prepare and store breadfruit paste, are characteristically infilled with loamy sand and often have round bottomed bases (Cox 1980; Kirch 1982:115, 120). The Anai'o pits are only superficially similar and do not contain any organically enriched soils or any evidence for burning. Nor are these features similar to the discard pits excavated at Anakena on Easter Island (Martinsson-Wallin and Wallin 1994:177). Plan and section views of some pits from Layer 4 are shown in Figures 3.8 and 3.9. One possible interpretation is that they were used to store and ripen tree crops such as banana, or coconut. The storage pits in Layer 4 occurred throughout the site but were mainly encountered in the lower levels of the layer and seemed to be particularly clustered in the northern part of Area B (Fig. 3.8).

ACTIVITY ZONES

At the next higher level of spatial interpretation the relationship between structures and activity areas forms the basis for identifying activity zones. Activity zones represent regularities in the choices involved in situating different types of task within the site. These choices reflect the social habits of work which are based on a combination of practical considerations of convenience, efficiency and safety, and on community held cultural ideals and values. Of the four types of activity area identified in Layer 4, the manufacturing areas (shell and stone working areas) and the cooking areas show some regularities in their patterns of distribution. Several activity zones can be identified.

Kitchen zones

The clustering of cooking debris and other evidence of food preparation defines the southernmost portions of Area B as a kitchen zone. There the soils were deeply stained with charcoal and contained a large number of umu and a very high proportion of midden debris, oven stones and ash. Two structures in this area were identified as cooking shelters, and scatters of kirikiri flooring material and postholes suggest that other similar structures had been present in this area. This kitchen zone was a specific, although not exclusive, focus for food preparation activities over a long period of the site's use.

Manufacturing zones

Manufacturing zones are defined by regularities in the distribution patterns of shell and stone working areas in relation to structures and other features. They were found in two particular locations at Anai'o. The first of these were the verandah areas and outer edges of the structure walls which was where the majority of manufacturing tasks were situated. On all three cooking shelters the outer walls were the locus for small scale shell working and stone flaking, and denser distributions of stone flakes and associated tools attest to the use of the verandah of Structure 3 as the major stone tool manufacturing area on the site. The second location for manufacturing was the kitchen zones where small scale tool maintenance activities were carried out. Throughout the site stone and shell tool working was found in proximity to cooking or burning features and midden, and was distinctly absent from locations where cooking was under-represented (Structure 6 for example).

In addition to identifying specific activity zones on the site attention is also drawn to the fact that no specific discard zone was identified. A large quantity of midden was found on the site, but this was mixed into the general matrix of Layer 4 suggesting that a high proportion of the residues of cooking and eating may have been casually discarded, within the village itself. The Anai'o residents clearly possessed domestic animals but there was little taphonomic evidence in the form of gnawing marks on the bone to suggest that these animals were wandering unhindered throughout the village. Thus it is also possible that much of the food remains processed at Anai'o was being carried away from the site and fed to the pigs, rather than being dumped into trash heaps as is more commonly found in New Zealand coastal settlement sites.

ETHNOGRAPHIC OBSERVATIONS

In this section the spatial distribution of site components is interpreted in relation to social organisation and cultural practice and some ethnographic comparisons are made with contemporary Ma'uke society. The first issue to consider is what type of habitation does Anai'o represent in social terms.

On the basis of the broad range of faunal and artefactual materials, the form and distribution of structures and the density of the living surfaces present, the social group occupying Anai'o is interpreted as a community and the site as its primary residential zone. The definition of community used here follows that of Murdoch (1949) as, "...the maximal group of persons who normally reside together in face-to-face association" (see also Chang 1958:303; Renfrew 1978:102; Trigger 1978:118; Walter 1993:72). This distinguishes the community from a range of other social units which might also have a residential component such as, for example, groups who occupy garden shelters, fishing camps or other temporary site complexes.

Small scale tribal societies occupy a wide range of different settlement types and these vary according to the spatial relationship between primary dwelling units. In general these range along a continuum from nucleated settlements or villages where the inter-household space comprises part of the everyday living area of the community, to highly dispersed settlement forms where the households are separated from one another by gardens, wasteland or hunting zones and this space is crossed by pathways or tracks (Walter 1993, 1996a). Thus the settlement form for a given community is defined as much by the open space as it is by the direct evidence of human activity. Anai'o is a nucleated residential site best described as a hamlet or small village. A village is a permanently occupied residential site where the majority of everyday domestic tasks carried out by community members take place within its boundaries.

A Cook Island community consists of a residential grouping of families united through the recognition of kinship links to one or more eponymous ancestors. Although the spatial definition of these groupings vary, the primary unit is always the household cluster. This is the smallest residential unit of Cook Island society (Walter 1996a), and in modern Ma'uke villages consists of a dwelling structure, cooking shelter, latrine and a variety of working areas in proximity to these other units.

These form the residential unit for an extended family or ngutuare consisting of up to eight individuals spanning two or perhaps three generations.

Within the Anai'o site, the use of space bears some striking parallels to the manner in which space is utilised within a contemporary Ma'uke settlement. The household cluster can be identified at Anai'o in the association of structures and related activity areas in Area C. There a small well built cooking facility (Structure 5) lay several metres to the south of a dwelling structure (Structure 6). The cooking shelter was the site, not only of food preparation activities, but also of a variety of small scale tool manufacturing or maintenance tasks which were probably all carried out by family members. This pattern of work activity is paralleled in the modern Ma'uke household where the cooking shelter serves as a focus for a wide variety of household activities (see below).

Other similarities in the use of domestic space between Anai'o and modern Ma'uke settlements can be found in the distribution of activity zones within the site. In modern Ma'uke villages the kitchens are multi-function zones, used not only for cooking and food preparation but also for carrying out a range of everyday domestic tasks. The pattern of activities around the hearths and kitchen zones at Anai'o shows striking parallels to modern practice. Similarly, a common location for work activities in the modern Ma'uke settlement is the house verandah or porotito. The porotito are used as casual meeting areas and as places where members of the household carry out both generalised and specialised domestic tasks in a communal atmosphere. This pattern too can be observed at Anai'o with special reference to Structures 1, 2 and 3.

At Anai'o a distinction can also be drawn between private and public space within the settlement. The kitchen zone encompassing the structures and features in the south part of Area B is interpreted as a public zone, an area which was accessed widely by a large number of individuals. The quantity of umu and small structures in this zone, the heavy staining of the soils and the large quantity of kitchen debris suggests that this area was more heavily utilised than other excavated parts of the site. In contrast, private zones are associated with the dwellings and the communal structure. Structure 3 was the site of specialist manufacturing activities and several near complete adzes had been left lying on the verandah amongst the waste flakes of basalt. This suggests that the verandah of this structure was not subject to general public access and, judging by the fact that a large piece of fine-grained basalt was cached within the structure, this may have been the private residence of an adze making specialist. Both this and Structure 4 were clean and free of organic refuse or signs of having sustained heavy human traffic. Similarly, Structure 6 does not appear to have been heavily accessed. Good quality, complete artefacts were found within and adjacent to the structure, and the floor and surrounding surface were clean and had a low density of midden.

Finally, gender is recognised as being influential in defining the disposition of activities in Polynesian communities although the role of gender in settlement pattern analysis in Polynesia is still under-explored. It is very likely that the distribution pattern of activities and features in Layer 4 does encode information on the role and organisation of gender in this early Ma'uke community, but it is difficult to make any confident statements about this. Adopting a cautious approach and drawing carefully on ethnohistoric data it may be possible to distinguish single gender activity zones from those involving both male and female residents. The kitchen zone, for example, may be interpreted as a non-gender specific activity area on the basis of both archaeological and ethnographic evidence. The archaeological evidence in support of this statement is simply the range of activities represented around the kitchen zone. Unless one gender was exclusively responsible for all cooking, food preparation and stone and shell tool maintenance at Anai'o (a possible but unlikely scenario) both female and male residents were probably present and active in the kitchen zones. Ethnographic evidence supports this conclusion. In modern Ma'uke villages males and females both participate in cooking activities although there are clearly defined limits to their respective tasks as well as some considerable overlap. The cooking house is the place where male and female family members gather and perform their domestic tasks communally, including food preparation and the general maintenance and manufacture of subsistence tools. This is the pattern of work suggested in the archaeology of the cooking shelters at Anai'o.

In contrast, two areas of the site may have been single gender areas. The verandah of Structure 3 was used to manufacture stone tools and according to the few oral accounts which refer to adze making this appears to have been a male activity in the southern Cook Islands (Buck 1934; Gill 1876). The possibility that Structure 6 may have been a men's house has also been raised. This large structure contained little evidence of domestic activity but did contain a variety of shell fishhooks which are associated with men's houses elsewhere in Polynesia (Firth 1957; Kirch and Yen 1982).

MA'UKEAN USE OF SPACE

The discussion above refers to the synchronic aspects of spatial organisation in the Anai'o settlement as determined by the surface features of Layer 4. By comparing these features with those recorded below the surface of the layer it is possible to investigate patterns of change in the nature of spatial organisation through the duration of this settlement phase. Such investigation reveals evidence for both continuity and change in the organisation of activities during the span of the Layer 4 occupation.

Continuity is best represented by the activities recorded in the south-east part of Area B. This part of the site was reused as a kitchen zone for the entire duration of the Occupation 1 habitation. The location of the ovens shifted several metres to the north through time but remained within the same general vicinity. The ovens were probably all contained within structures at the time of use and both the oven pits and the structures were continually being refurbished and reconstructed. The midden refuse around the ovens suggests that food was eaten as well as cooked in the vicinity of the cooking shelters and, as argued above, there is some evidence to suggest that this kitchen zone may represent a relatively public area.

In contrast to the continuity demonstrated in the location of the food preparation areas, considerable change took place in the use of other zones within the site. In the northern parts of Area B, for example, food storage was carried out for some time but later the zone was built over and replaced by a large structure. Presumably at this time the storage area was shifted elsewhere on the site.

Elements of continuity were noted between the Anai'o settlement and the ethnographic present in the spatial organisation of activities. In particular I would point to the manner in which activities were clustered around the verandahs and outer edges of structures. This appears to be a fundamental principle in the East Polynesian pattern of spatial use with a long standing tradition. It is particularly interesting to note how the function of the verandah has changed through time and space. In the southern Cook Islands and elsewhere in East Polynesia the verandah areas continue to be important meeting and casual work areas in contemporary society. However, late in prehistory, the verandah area began to take on political significance in the southern Cook Islands with the construction of elaborate stone paepae, including the elegant T-shaped paepae of Rarotonga, which were used as meeting places for the local Mataiapo and other title holders in a district (Bellwood 1978a). In New Zealand even greater developmental changes have taken place. First, the term paepae has undergone a semantic shift referring not to the house platform as it does in the Cook Islands and elsewhere in East Polynesia, but to the outer verandah edging. The paepae of the meeting house has taken on special ritual significance with formal etiquette attached to its use during social and political events. The anterior space in front of the house is similarly treated as an area of special significance in political gatherings. Thus strong lines of continuity in spatial use extend from the early Cook Island settlements, through late prehistoric Cook Island and New Zealand settings and on into the present.

CHAPTER 11. CONCLUSIONS

When the first work took place at Anai'o in 1985 the archaeology of the southern Cook Islands was still underdeveloped in comparison with the other major archipelagos of East Polynesia. Two large survey programmes had been carried out by New Zealand based teams and these had laid a good foundation from which to address more problem oriented research goals (Bellwood 1978a; Trotter 1974). In a series of papers in the 1970s Bellwood had discussed settlement patterns and variations in ecological adaptation and had provided some exploratory discussions about how these issues related to land tenure systems and sociopolitical change (Bellwood 1971, 1978a, 1979). Duff (1968, 1974) had reviewed the adzes from the southern group and proposed a culture history sequence which drew on the adze data. This all took place against the backdrop of important pioneering ethnographic work by Peter Buck (1927, 1934, 1944).

In spite of this large body of fieldwork and published material there were several gaps in Cook Island archaeological knowledge. No excavations of deep stratified sites had taken place and consequently, archaeologists had yet to establish an excavation based culture history sequence which is usually a first step in a regional archaeology programme. Furthermore, while Buck had provided first rate descriptions of the material culture of the 1920s there were no substantial provenanced collections of archaeological material culture available for comparison with other Polynesian assemblages. As a result the position of the Cook Islands within the settlement history of East Polynesia had not been established on the basis of excavation data. This was the historical context within which the Anai'o excavations were situated.

Because Anai'o had only minimal stratification the excavations could not address any of those basic culture history problems which require stratified horizons. Instead, the excavation procedure emphasised the horizontal or spatial dimension rather than the vertical or temporal. In taking this approach, the Anai'o excavations have made two contributions to Polynesian archaeology, beyond those pertaining specifically to the prehistory of Ma'uke.

First, the excavations provided one of the more detailed records of the spatial organisation of an important East Polynesian site type, the archaic coastal village. Across much of East Polynesia, including New Zealand, there are a small number of early coastal horizons, frequently described as middens, which contain abundant material culture and often structural features as well. These sites are not strictly middens but represent densely occupied, although not necessarily large, settlement complexes and include such prominent sites as Hane, Ha'atuatua, Hanamiai, Wairau Bar and Fa'ahia/Vaito'otia. The importance of these sites in the history of Pacific archaeology is that they have provided large assemblages of material culture and have been formative in the establishment of culture history sequences for their respective islands and archipelagos. The nucleated habitation complexes which many of these sites appear to have been were uncommon in late prehistory and tend to be concentrated in the archaic phase of East Polynesian prehistory (see Walter 1996b).

While the detailed settlement pattern surveys, the oral traditions and the ethnohistoric material pertaining to land tenure, sociopolitical organisation and economics serve to document the last several hundred years of Cook Island prehistory, sites such as Anai'o provide a glimpse of a more distant and varied past. Unfortunately, while the material culture from many East Polynesian sites like Anai'o has been well described less is known about the organisation and use of space within these settlements despite the potential to use such information to produce testable models of social organisation and household economics. French and American teams working on Huahine have been producing the most outstanding spatial information from an early coastal village (Fa'ahia/Vaito'otia) and when a synthesis of these excavations is available it will provide an invaluable comparison with Anai'o (see Pigeot 1986, 1987; Sinoto 1978; Sinoto and McCoy 1975a, 1975b).

Second, the Anai'o excavations make a unique contribution to the study of variability in Polynesian social organisation by providing a detailed study of a single community as it existed at a single point in time. As a social unit, the community is a universally meaningful concept, but in terms of associated settlement types and architectural forms, the potential variations are extensive. In Polynesia the study of the community has mainly been addressed through the use of settlement pattern methodologies. This is because the community is represented in many times and places in the Pacific by widely dispersed sets of special function settlement types, as is seen, for example, in the work of Green *et al.* (1967) in the 'Opunohu Valley or McCoy (1973) on Easter Island. Settlement pattern studies provide a low resolution view of the community where the emphasis is mainly on geographic, ecological and political features (see Clarke 1977). Household dynamics and the networks of inter-household interaction which serve to bind the community into a corporate whole are unable to be clearly resolved.

Because villages like Anai'o are nucleated residential zones, intra-site studies can provide a much finer resolution. At Anai'o this was achieved by adopting a hierarchical approach to spatial analysis in which the smallest archaeologically visible social unit was the individual. Beyond the individual it was possible to define the household, or domestic group, through its archaeological correlate the household cluster (see Gnivecki 1987:179; Winter 1976), and above this the community. In villages a wide subset of the everyday activities of community members is often represented archaeologically within a spatially confined area, and problems of unit contemporaneity are minimised. Thus a much wider range of household and community activities can be defined using the intra-site approach than can be achieved in wide area settlement pattern work. The Anai'o work attempted first to define the spatial organisation of a single community and then described that community's subsistence economic system, material culture, organisation of domestic and manufacturing activities and exchange behaviour. Through this a detailed picture was provided of a 14th century A.D. Ma'ukean community.

In previous chapters, the Anai'o excavations were discussed and results analysed in relation to a number of research objectives. To reiterate, these objectives were: (1) to increase our knowledge of the Cook Island aspect of the East Polynesian archaic; (2) to use the Anai'o data to examine the history of exchange in Cook Island society and the wider role of interaction in early East Polynesian prehistory; (3) to assist in the development of a culture history sequence for Ma'uke, and the southern Cook Islands; (4) to investigate subsistence economic practices; (5) to add to our knowledge of prehistoric Cook Island technology through an analysis of material culture; (6) to investigate the spatial aspects of individual and social behaviour at the site; and (7) to discuss adaptation in Ngaputoru. Several of these issues were dealt with at length in individual chapters while others have not yet been discussed. In the following sections each of these issues is summarised in turn.

THE EAST POLYNESIAN ARCHAIC

By the beginning of the 1980s archaic assemblages had been identified and type sites described from across most of East Polynesia. The major knowledge gap lay within the Cook Islands which archaeologists assumed to have been part of the 'archaic tradition', but from where they were unable to identify type sites or describe assemblages. The excavation of Anai'o provided both a type site and an artefact assemblage.

The material culture of the Anai'o site fell well within the parameters of an archaic assemblage. Some of the most diagnostic forms were absent, reel necklace units and whale tooth pendants for example, but the most common archaic goods, such as shell one-piece hooks and untanged trapezoidal and quadrangular adzes, were well represented. The Anai'o data once more confirms the observation that during the 'early' period of East Polynesian prehistory sites from different island groups look very similar to one another. Quantifying this similarity however, still remains difficult because detailed typological and stylistic information is not yet available, despite the large assemblages of archaic materials which sit in museum collections. Nevertheless, comparing the Anai'o materials with artefacts from other Cook Island and East Polynesian assemblages highlighted some interesting distribution patterns.

The most important observation is that the Anai'o artefacts show highly variable patterns of association with those from other island groups. Some classes of material are most similar to New Zealand specimens, while some group with the Marquesas or Societies. Some items seem to group into distinctive and unique Cook Island types. This distribution pattern is consistent with a network model of interaction where ideas and innovations circulate throughout a voyaging network. As demonstrated above, and in Chapter 4 a voyaging or interaction network was in place in the Cook Islands up until at least the 15th century A.D. Similar networks were in place elsewhere in East Polynesia (Weisler 1993b) and the articulation between these networks was responsible for the observed patterns of homogeneity within the region. In this environment of information flow, traits are adopted and adapted according to local criteria and the result is a patchy, unpredictable pattern of trait distribution. The corollary of this is that single traits, no matter how narrowly circumscribed, are unreliable indicators of direct historical origins.

Some archaeologists have interpreted the archaic material culture as an 'expression of a common social tradition' (see Childe 1950:2) implying that it represents a specific phase of East Polynesian cultural history (see Sinoto and McCoy 1975:10). The archaic sites are spread over a vast area of the Pacific, however, and a close examination of the dates for individual sites shows that together, they also span a lengthy period of time, at least 800 years (Walter 1996b). This argues against the interpretation of an 'archaic culture'. Instead, the interaction model explanation is that the archaic represents a phase in East Polynesian prehistory during which time aspects of homogeneity were maintained through regular voyaging and the transmission of ideas and artefacts. This interaction model of Polynesian settlement and culture change has been circulating in various forms for some time (see summary in Rolett 1993). Anai'o, however, was the first site to provide a detailed picture of what such an interaction network would like from the point of view of a participating community and to offer concrete support for the model.

EXCHANGE AND INTERACTION IN EAST POLYNESIA

Exchange in Oceanic societies is most easily identified in the archaeological record by the appearance of exotic materials in island sequences. But exchange is only one and perhaps not even the most important, feature of Oceanic communication networks as the classic descriptions of Kula demonstrate (Malinowski 1961). In the southern Cooks, a single source (the missionary John Williams) reporting observations in Ngaputoru between the years 1823 and 1830 records the people on these islands setting out on inter-island canoe voyages for purposes as diverse as warfare, marriage, to attend feasts and to obtain resources (Williams 1838).

Chapter 5 reported on the sourcing of the Anai'o basaltic tools and of a collection of surface collected adzes from the island, and commented on changing patterns of interaction in Ma'uke prehistory. Beyond Ma'uke, there is now a growing body of geochemical sourcing information available for the Cook Island industrial basalts. Together with the time/space distribution of ceramics and pearlshell artefacts this provides further information on the history of prehistoric exchange in the archipelago.

Towards a chronology of interaction

We still do not have enough well dated and described stratigraphic horizons in the southern Cooks to define a detailed chronological sequence, such as the phase model used in the Marquesas for example. Because of this, it is difficult to develop a firm chronology of interaction in the archipelago. However, by adopting the practice, developed in Chapter 5, of dividing the archaeological material into 'early' and 'late' sets a very simple historical model of exchange can be advanced. The 'early' artefactual assemblages are those which have been radiocarbon dated to the 14th century A.D. or earlier, and this covers the earliest one or two cultural horizons from each island where archaeological work has been carried out. 'Late' period assemblages are represented by surface collections which are dominated by the reverse triangular tanged (3A) adzes, known to be the most common adze type in the last few centuries of the prehistoric period (Duff 1968, 1974). Clearly, this is not an adequate system of sub-dividing Cook Island prehistory but until finer dating models are available, it serves the purposes of exploring gross patterns of change in voyaging behaviour.

'Early' period exchange. The 'early' period of southern Cook Island prehistory saw the widest distribution of extra-archipelago sources. The dated ceramics so far recovered all fall within this period and demonstrate contact with Tonga (the Anai'o sherds) and Fiji (the Atiu sherd) (see Chapter 4). All the Samoan basalt so far identified in the Cook Island archaeological record also falls into this time period. Tataga Matau basalt from Tutuila has now been identified from 13th to mid-15th century layers at Moturakau, Aitutaki (Allen and Johnson 1997), from 11th century and slightly later layers at Tangatatau, Mangaia (Weisler *et al.* 1995) and from Anai'o, (see Chapter 5). From Rarotonga, the Ngati Tiare adze cache, which has now also been sourced to Samoa, dates to about the early 14th century A.D. (Walter and Sheppard 1996). In addition to the Samoan sources, several adzes found on Mangaia and Rarotonga originate from an Austral/Society Island source (Sheppard *et al.* 1996). These are undated, but are typologically early and are provisionally assigned to this early phase of the sequence.

Pearlshell (*Pinctada margaritifera*) is also most widely distributed throughout the archipelago during the early part of the sequence, and so far has been found in every site which falls within the 'early' time span. Modern *Pinctada* populations are extremely limited in the southern Cook Islands and the argument was advanced in Chapter 8 that the pearlshell found at Anai'o, and in other early archaeological contexts in the southern Cooks, originated in the northern atolls. The most likely origin based on proximity is Palmerston atoll but the use of some local stock from the Aitutaki lagoon is possible. Nevertheless, regardless of whether pearlshell originated within or beyond the southern Group, it is certainly exotic to most islands. Its wide distribution throughout all islands in the archipelago during the 'early' period demonstrates the existence of an efficient intra-archipelago interaction network stretching from Mangaia in the south to Aitutaki in the north.

In addition to the extra-archipelago materials, Rarotongan basalt was also being exchanged within the archipelago. A source located in the northern Rarotongan valleys was present in Layer 4 at Anai'o and has also been detected on Mangaia, Aitutaki, and Mitiaro (Sheppard *et al.* 1997). On the basis of the distribution of materials identified as exotic to their island of discovery, a testable, hypothetical model of the 'early' interaction network can be described.

The 'early' network was essentially an intra-archipelago system of regular voyaging which linked the islands of the southern Cooks. Raw materials such as basalt, pearlshell and other industrial materials as well as perishable goods circulated throughout the network. The efficiency of the network and its importance within the early economy of the southern Cook Islands is indicated by the heavy reliance placed on pearlshell in Mangaia and Ngaputoru. For several centuries this was the main manufacturing material for a wide range of small tool classes in these islands despite the nearest source lying hundreds of kilometres to the north.

Regular links between nearest neighbours probably formed the nucleus of the southern Cook Island interaction network and most exchange within this network was probably 'down the line'. Although exotic materials from West Polynesia were also distributed throughout 'early' period sites it is unlikely that regular voyaging networks spanned this wide sea gap. It is more likely that raw materials and other cultural items from Fiji/West Polynesia were occasionally fed into the Cook Island network via rare voyaging events and circulated between islands. The Cook island network overlapped or articulated with similar voyaging networks in the Society/Austral region to the east allowing the transmission of materials and ideas in both directions. This hypothetical interaction network is illustrated in Figure 11.1.

'Late' period exchange. Archaeological sequences from throughout the southern Cooks record evidence for changes in the nature of exchange from about the 15th century A.D. This change is best categorised as involving a steady contraction of the interaction network and the cessation of importation from beyond the archipelago. This contraction is most clearly illustrated in the decline in the use of pearlshell in the southern Cooks and its replacement by *Turbo*. Figure 11.2 shows the proportion of pearlshell to *Turbo* in ten dated stratigraphic zones from sites on Mitiaro, Aitutaki, Mangaia and Ma'uke. The date ranges for the individual zones vary in length and many overlap making it difficult to order the sites purely by chronology. Therefore, the sites in the figure have been arranged to provide the best graphical fit so that assemblages with the highest proportion of pearlshell are placed at the base. The dates for the Figure 11.2 assemblages are calibrated and reported at 1 sigma after Stuiver and Reimer (1986) and confirm the

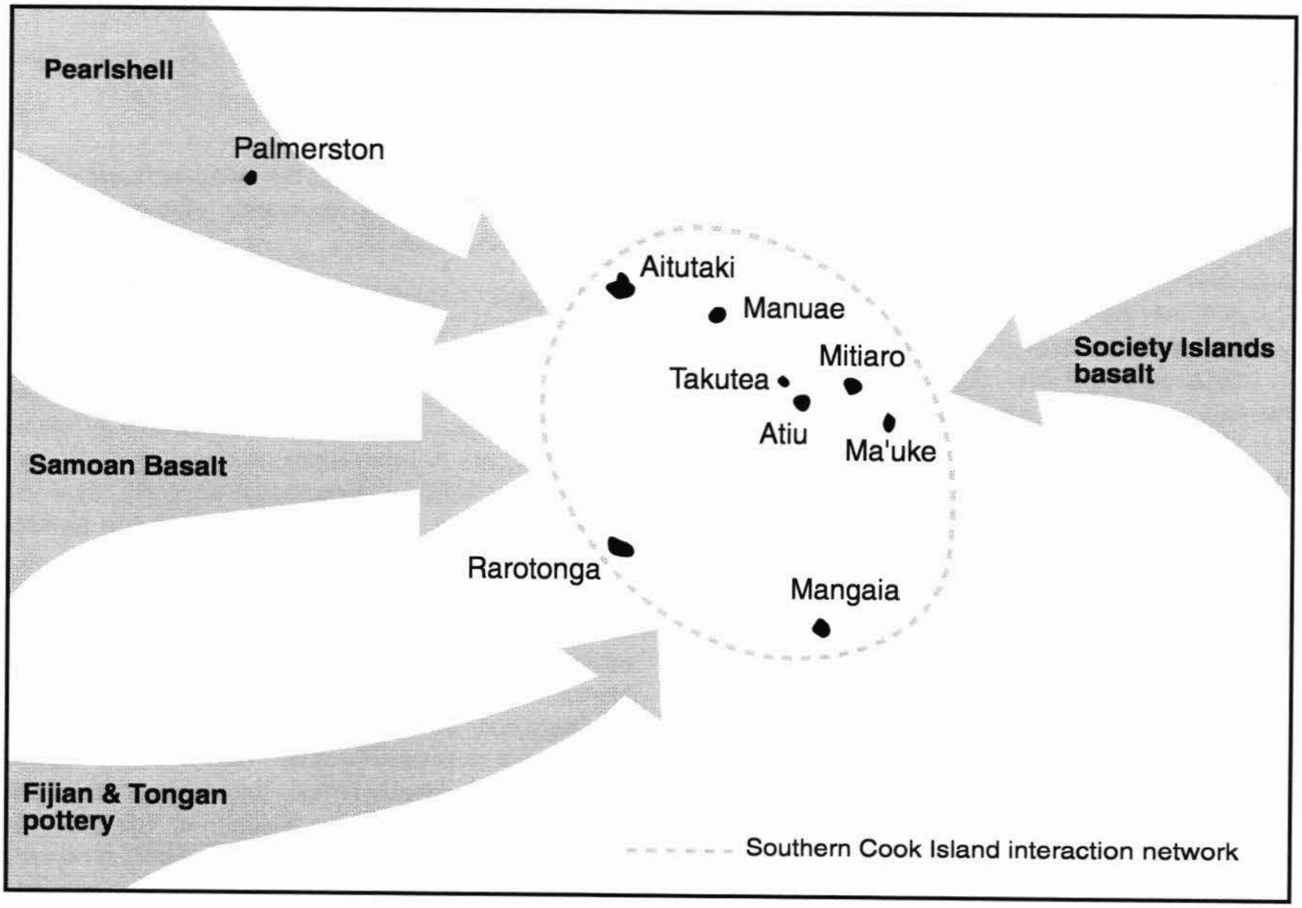

FIGURE 11.1. Hypothetical interaction network during 'early' phase of Cook Island prehistory based on sourcing data discussed in text. Regular voyaging linked islands within the southern Cook Island archipelago. Irregular voyaging events occasionally fed exotic materials into the central interaction network.

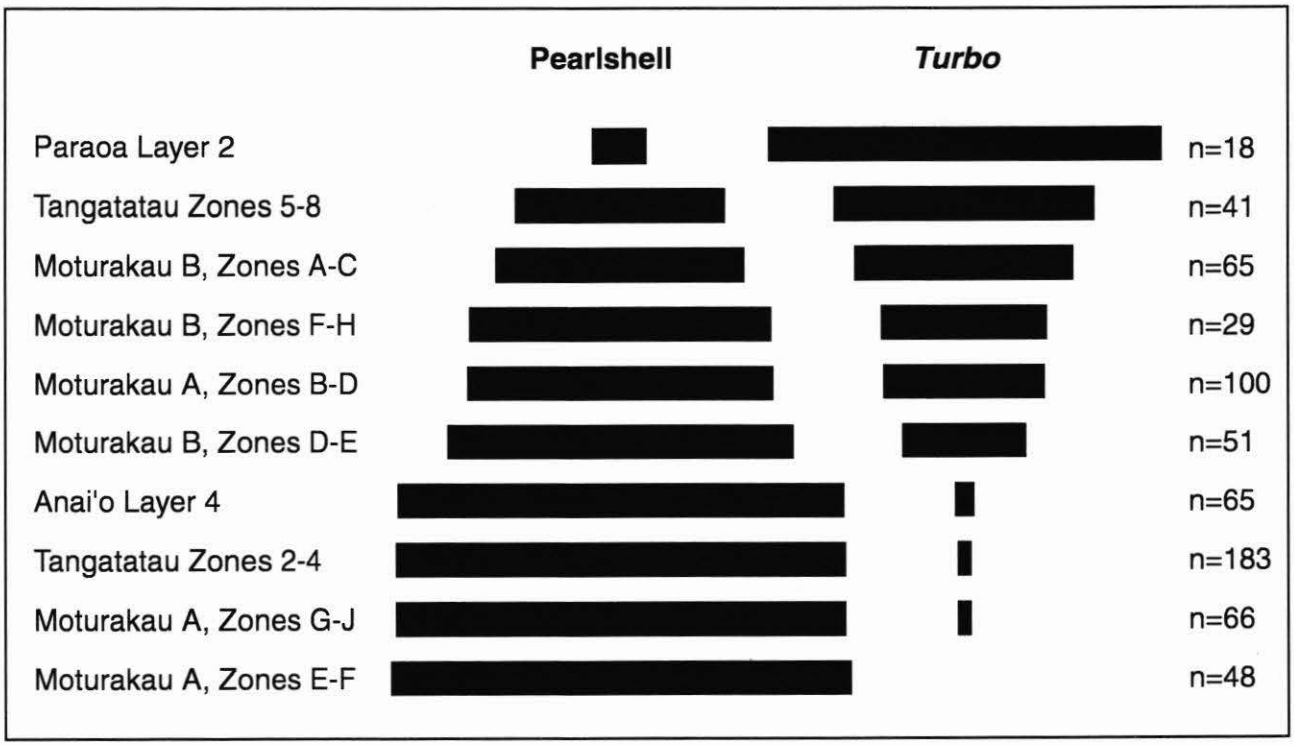

FIGURE 11.2. Relative proportions of pearlshell and *Turbo* fishhooks from strata on Aitutaki, Mangaia, Mitiaro and Ma'uke. Strata ordered according to 'best fit' with dates provided in Chapter 11 (from Walter and Campbell 1996).

argument for a chronological decline in the use of pearlshell. From Moturakau the dates are: Shelter A, Zones B-D, 1319-1433 A.D., Zones E-F, 1280-1393 A.D., Zones G-J, 1043-1203 A.D., Shelter B, Zones A-C 18th Century to modern, Zones D-E 1439-1619 A.D., Zones F-H, late 13th to early 15th (based on four dates in this range) (Allen 1992a:Appendix C). The Tangatatau zones and date ranges are based on summary statements reported in Kirch *et al.* (1995:52 and Table 1): Zones 2-4, 1000-1400 A.D., Zones 5-8, 1400-1700 A.D. (see also Walter and Campbell 1996). As discussed in Chapter 4, pearlshell is the most suitable raw material for one-piece hook manufacture and therefore its decline is best interpreted in terms of reduced availability rather than as a deliberate technological decision.

As well as a general decline in the availability of pearlshell, the 'late' period also saw changes in patterns of stone use on Ma'uke, and elsewhere in the archipelago. The southern group as a whole underwent a shift towards the exploitation of Atiuan and Mangaian sources and away from the use of Rarotongan material (Chapter 5, Sheppard *et al.* 1997). In fact, Rarotongan stone declined in use so dramatically as to suggest that Rarotonga may have withdrawn quite effectively from the interaction network. This is reinforced by the observation that non-local stone has not yet been shown to be present in the inventory of 'late' Rarotongan material culture (Sheppard *et al.* 1997). In the 'late' period the Mangaian stone sources became distributed in a chain from Mangaia, through Ngaputoru into Aitutaki.

A hypothetical model of the late period interaction network in the southern Cook Islands is illustrated in Figure 11.3. Interaction was largely restricted to nearest neighbours and was no longer a major medium for the regular long distance transport of exotic materials like pearlshell. Oral tradition clearly indicates that the islands of Ngaputoru maintained regular contact with one another during late prehistory, as one would expect given that they are inter-visible. It is probable that the majority of inter-island voyages took place in this region, and that Ngaputoru formed the backbone of the late southern Cook Island interaction network. Out of this core region less frequent voyaging extended along a chain through Manuae to Aitutaki and more occasionally, south to Mangaia. Rarotonga in the west and Palmerston in the north may or may not have had irregular links to the backbone, but the bulk of the traffic flowed along the Ma'uke-Aitutaki chain with greatest movement occurring within Ngaputoru. This model is consistent with the distribution of exotic materials as currently understood, but must be assessed against future sourcing results.

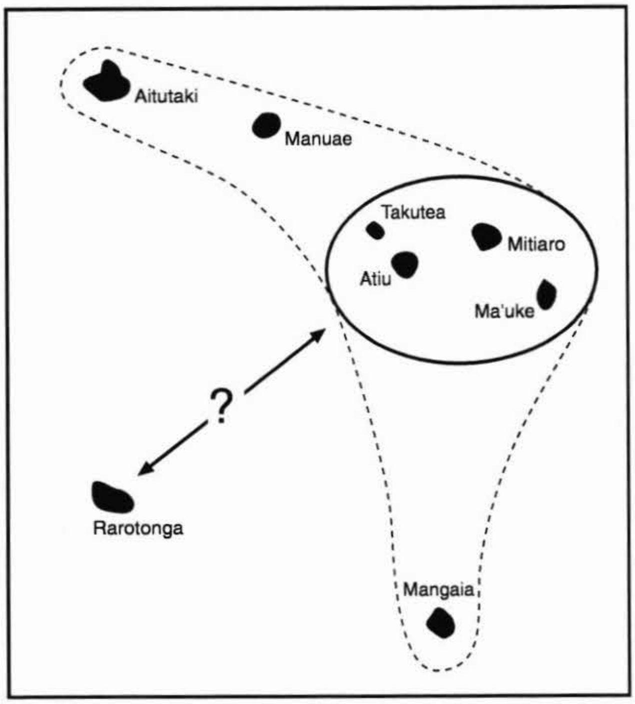

FIGURE 11.3. Hypothetical interaction network during 'late' phase of Cook Island prehistory based on sourcing data discussed in text. A chain of voyaging linked islands from Mangaia to Aitutaki with most frequent interaction occurring within the intervisible islands of Ngaputoru. There is no evidence for the importation of pearlshell from the northern atolls and it is uncertain whether Rarotonga participated in the interaction network. No extra archipelago sources were circulated in this 'late' interaction network.

COOK ISLAND CULTURE HISTORY

Culture history as an archaeological paradigm has been widely maligned in the last few decades but many of the more pragmatic archaeologists, and especially field archaeologists, see culture history as performing an invaluable role in archaeological inquiry. Culture history sequences seek to plot the distribution of archaeological phenomena in space and time and thus provide a three dimensional model of the archaeological record (Kirch 1988:14). The archaeological phenomenon of interest in contemporary Polynesian studies includes material culture, ecological adaptation, subsistence strategies, ideology and sociopolitical organisation. The Anai'o excavations contribute in a general sense to the construction of a culture history sequence for Ma'uke and the southern Cook Islands by addressing a number of these issues in detail and situating the results within a well defined time frame. The final construction of a sequence now requires the results of the Anai'o investigations to be matched with data from elsewhere in the archipelago, as is already possible to some extent with the material culture. The results of the Anai'o excavation also allow us to address one of the more immediate concerns of culture history programmes in Polynesia, the issue of colonisation and settlement history.

Colonisation issues

The Anai'o data alone does not allow any absolute statements to be made about the date of Ma'uke settlement, but the faunal record as it bears on predation strategies, and allows a good estimate to be made of the relative position of Anai'o in relation to first settlement of the island. In Remote Oceania a short phase of intensive hunting and gathering of easily exploited fauna frequently occurs when islands are first settled. In East Polynesia this evidence is found in the archaeological record of the Marquesas (Rolett 1998), Hawaii (Olson and James 1984), the Cook Islands (Kirch *et al.* 1991, 1992, 1995), Henderson Island (Weisler 1995) and New Zealand (Anderson 1989). The rich resources likely to be encountered on uninhabited East Polynesian islands include a variety of marine foods including several genera of molluscan fauna and turtles, plus a range of land and sea birds of which the latter may include colonial and ground nesting varieties. These reserves are known to be fragile (Steadman 1995) and evidence for population decline frequently occurs very quickly after the arrival of human colonists.

The coastal resources of Ma'uke may have been particularly sensitive to human predation since the reef is narrow, shallow and very easily fished and because of this, the reef edge invertebrate assemblage should be a good indicator of predation pressure. On the contrary however, the marine molluscan fauna from Layer 4 conveys an ambiguous message about predation pressures at this period of Ma'uke prehistory. The *Turbo* specimens from Layer 4 were large, in fact they approach the maximum size range for the species and this might be interpreted as indicating that Anai'o lies close to the beginning of the Ma'uke sequence. On the other hand, change in the size classes of molluscs is likely to occur on a localised basis under a very wide variety of natural and cultural stimuli. Archaeologists have yet to determine the levels of predation which would affect the mean sizes of *Turbo* over a given foraging ground, nor have they demonstrated that it is possible to distinguish change caused by predation from that caused by natural phenomena.

In contrast to the molluscan record, impacts on sea bird populations are often highly visible archaeologically and relatively easy to interpret. Unfortunately, no sea bird specimens were present in the Anai'o midden, which means that either there never were sea birds on the island or that they were hunted out prior to the occupation of Anai'o. A third possibility is that the Anai'o residents simply chose not to hunt sea birds, but this is implausible. Since sea birds are found in early archaeological deposits elsewhere in the group (Allen 1991a; Kirch *et al.* 1992, 1995) the evidence is best interpreted in terms of there having been some sea bird predation on the island prior to occupation of the Anai'o ridge. Whether the hunting was carried out by resident populations, or by hunting parties from elsewhere in Ngaputoru is discussed below.

The terrestrial faunal data from Layer 4 also indirectly supports the contention that hunting occurred on the island before the occupation of the site. The fruit bat *Pteropus tonganus* is eaten rarely today on Mangaia and Rarotonga and is still an important food source in parts of West Polynesia. Fruit bats are extinct on Ma'uke and elsewhere in Ngaputoru, undoubtedly as a result of human predation, but a single specimen was recovered from Layer 4 suggesting that it was still available in the early 14th century A.D. Nevertheless it was probably rare at this time and well on the way to extinction by the time Anai'o was abandoned. Ma'ukeans have no knowledge of the prior existence of fruit bats on the island except via the excavation data. The final line of ecological evidence pointing to a human presence on Ma'uke prior to the occupation of Anai'o is the presence in Layer 5 (the pre-cultural layer) of adventive terrestrial snail species (Chapter 9).

Having established that people were present on Ma'uke prior to the establishment of a village at Anai'o, the next problem is to determine how far removed Anai'o was from first settlement of the island, and what this tells us about Cook Island colonisation as a whole. To address this issue it is necessary to provide some clarification about what is meant by colonisation, and the archaeological signature of this event.

Recently the East Polynesian dating debate has descended into a discussion about the meaning of colonisation and the naming and definition of different phases in alternative colonisation models. Irwin (1992) and Graves and Addison (1995) have suggested that archaeologists are guilty of conflating a number of separate events under the same general term. According to Graves and Addison (1995) colonisation is made up of three processes. *Discovery* involves the outcome of a successful exploration voyage and may or may not involve settlement or even landfall, while *colonisation* involves the placement of humans on a discovered island. (In fact, a more accurate term for the latter would be *exploitation* since according to their definition, this process may not entail the establishment of colonies, it might just involve seasonal or irregular visitation for the purposes of resource exploitation). Their third process is *establishment* during which period the island becomes occupied by a resident population which has reached a stable size and demographic structure (Graves and Addison 1995:387). The authors argue that the temporal gap between any two of these processes can vary in different island situations and they outline four possible models for island settlement based on permutations in timing (Graves and Addison 1995:388). Archaeologists also distinguish between the colonisation event, and the archaeological record of that event. In New Zealand, for example, various authors have proposed quite different theories of settlement based on expectations of either a long or short period of archaeological invisibility following the establishment of permanent populations (see Anderson 1991; McGlone *et al.* 1994; Sutton 1987).

In my view this concern with models and with the naming and defining of different phases of colonisation is unnecessarily complicated and detracts from the basic issue of archaeological interest, which is when did an island start to become part of the human or cultural world. The date at which an island is first sighted can never be established archaeologically nor can we determine how wide the gap was between that event and the establishment of the first colonies. However, given the mobility of early Polynesian communities as evidenced in the vast areas of ocean colonised and the extent to which early communities relied on offshore exchange systems, it seems very unlikely that much time passed between these two events. On the other hand, I believe that there is a clearly and unambiguously marked period in most island sequences when human beings first appear in the archaeological record.

In the Cook Islands this lies is the range *ca* 950 to 1250 A.D., a period which loosely embraces the earliest cultural horizons from each of the islands where extended archaeological survey has been carried out. It has already been noted that this is also the period when evidence appears for a decline in bird populations in the archaeological record of Mangaia and other islands in the group (Chapter 7; Kirch *et al.* 1995:58). One could argue that this period actually marks the archaeological visibility horizon for Graves and Addison's (1995) *establishment* phase, but given the amount of survey work which has taken place this can not be far displaced from the actual time when humans first arrived on the landscape.

The period of sudden archaeological visibility between *ca* 950 and 1250 A.D. represents the colonisation phase for the southern Cook Islands. Colonisation may have begun slowly with a few small sites on one or two islands but it involved rapid exploration, adaptation and expansion by highly mobile groups, and it was complete in about three hundred years. During the colonisation phase there is likely to have been great variability in matters of settlement size and economic specialisation but it is questionable whether archaeological tools will ever be precise enough to recognise all this variation and sort it into temporal order. We probably have not yet found the very first sites on any island, but for each island in the southern Cooks the earliest sites will fall somewhere within those few hundred years.

The interpretation of Cook Island colonisation offered here is based on the view that we now have enough archaeological fieldwork from a range of islands to justify placing our confidence in the archaeological evidence, and de-emphasising, although not necessarily abandoning, the hypothesis that we have missing horizons. In other words, we are now in a position to build our sequences on the data to hand, while remaining open to the possibility that future archaeological evidence could result is a reappraisal of our understanding.

The evidence as it stands at present suggests that the islands of the southern Cooks were all discovered at approximately the same time, as has been suggested in respect of other archipelagos such as Hawaii (Graves and Addison 1996). People started to arrive in the southern Cook Islands to establish colonies by about 950 A.D. The higher, more ecologically diverse islands such as Rarotonga and perhaps Aitutaki would have been settled first. Elsewhere permanent settlement may have been delayed a century or more.

Ma'uke was probably settled a bit later in the colonisation period because of its proximity to a far richer and more ecologically diverse island, Atiu. Human intrusion into Ma'uke would probably have commenced with periodic visits by hunting parties from Atiu or perhaps from elsewhere in the archipelago. This practice occurred elsewhere in the Cook Islands, as is seen, for example, in the relationship which exists to this day between Pukapuka and Nassau, Aitutaki and Manuae, Atiu and Takutea, and there are many other examples of islands as 'offshore food stores' elsewhere in Polynesia (see Weisler 1995). During this colonisation phase voyaging took place regularly and was the medium for the exchange of a range of raw materials. Notwithstanding the possibility that both the upper and lower limits of the colonisation phase may some day be lowered slightly, the current evidence suggests that colonisation was complete by the beginning of the 14th century across the southern Cook group. Anai'o is a late colonisation phase site and may well be the first large, permanent village to have been established on Ma'uke.

SUBSISTENCE ECONOMICS

The faunal assemblage from Anai'o was small in comparison with many Polynesian sites and in particular the Anai'o material stood out in the extreme paucity of bird bones. The fish, terrestrial vertebrate and marine invertebrate assemblages were described and analysed in Chapters 6, 7 and 8 respectively. On the basis of these assemblages, supplemented with information provided by the artefactual record, a reasonably detailed picture can be constructed of the subsistence economic system of the Anai'o community.

Despite the variation in Polynesian production systems there are two general observations which are often made about subsistence practices in Polynesian island societies. The first is the importance of strandline and terrestrial hunting in settlement phase communities, and the second is the increasing importance of pig husbandry and horticulture later in prehistory (Anderson 1996; Dye 1996; Kirch 1973; Kirch and Yen 1982, for example). In reference to both these generalisations, the Anai'o economy is definitely a 'phase two' system. The evidence for hunting was restricted to the exploitation of fruit bat (*Pteropus tonganus*) which by the Anai'o phase was probably close to extinction. There was also some hunting of turtle and fur seal, but this would have been no different to the opportunistic practices which occur in nearly all Polynesian island communities to the present day and certainly does not imply any type of specialisation. There is no evidence for sea bird exploitation and little evidence for the exploitation of terrestrial birds.

Aspects of the pig husbandry system were inferred on the basis of ethnographic models and a study of pig bone size/age estimates and taphonomy. Conformity in the age range of specimens indicated that the pig population was managed and a system of tethering or penning similar to that practiced in the islands today was suggested, although the system may have included the hunting of feral stock as well. Dog too was probably eaten and may also have been used in hunting although there is no actual archaeological evidence to support this latter suggestion. The last of the Polynesian domesticates, *Gallus gallus*, is also represented in the Anai'o midden, but in very small amounts. Finally *Rattus exulans* the ubiquitous Polynesian rat was also present at Anai'o. The species is an excellent colonist and was carried from its homeland in Southeast Asia throughout the Pacific by humans (Matisoo-Smith 1994). It was also eaten in many Pacific communities, but there is no obvious way of demonstrating that it was a food item at Anai'o and one suspects that it would have been present in the village and midden regardless of its status in the subsistence economy of the community.

The vertebrate fishing component of the Anai'o subsistence system is also well defined. The fishbone assemblage was small in size but it represented a wide range of specimens inhabiting a variety of ecological zones. There was evidence for a specialisation in the exploitation of the inshore fishing zones of the reef edge where specimens such as Serranidae, Labridae, Carangidae and Holocentridae would have been targeted using baited one-piece hooks. Acanthuridae, Scaridae and a number of other specimens would have been taken using dip nets along the surge channels of the reef edge. Pelagic offshore specimens taken using a trolling technology are also represented but the majority of fish from the Anai'o midden were very likely to have been caught within several hundred metres of the site. The taxa present and their relative proportion represent a low intensity exploitation of the locally available genera of the reef edge and there is no indication of the targeting of any particular species. The fishhooks from Anai'o support these conclusions, although the lack of any excavated trolling lures (one was recovered from the site in the 1970s) is surprising given the quantity of Scombridae present in the midden.

The other marine components of the Anai'o subsistence system are the shellfish, crustacea and echinoderms taken along the reef flat and reef edge. There was little attempt to systematically collect or quantify the crustacea or echinoderma although some statements were made about the range of items represented in the midden. In environments such as Ma'uke, it is unlikely that any of these items (plus shellfish) could have been other than a minor and supplemental component to the diet since they can not be collected in bulk as they can in New Zealand or in the mudflats and shallow lagoons of Melanesia. Even in Aitutaki and Rarotonga the potential for shellfish gathering is greater than on Ma'uke or other makatea islands with shallow reef flats.

Just as the horticultural part of the economy contains an invisible component, so too does the faunal portion. *Tridacna* was not recorded from Anai'o but is eaten widely on Ma'uke today. Apart from the odd smaller specimen found on the reef flat, this shellfish is taken at some depth and the shell is rarely taken out of the water so it would be unlikely to appear in a midden if similar exploitation strategies were utilised in prehistory. It seems unlikely, however, that *Tridacna* would ever have been a major component of the prehistoric diet on Ma'uke given the difficulty of exploiting the local reserves but this possibility can not be discounted. More significant perhaps is octopus which can be easily caught in large numbers along the Ma'uke coasts. Octopus leaves little direct trace in the record although octopus lures are easily identified. No such lures were found at Anai'o but octopus can be caught in many different ways and it is very likely to have been a significant part of the protein intake of any coastal community such as Anai'o. Finally, Holothurians (sea cucumbers) are widely eaten throughout the Cook Islands where people take either the gonads or the whole individual. In either case, there would be no archaeological record of such a practice.

While the faunal component of the Anai'o diet is relatively easy to reconstruct the contribution of plant foods is more difficult to determine. Common sense and ethnographic precedent tells us that the Anai'o community practiced horticulture. Unfortunately, however, conditions were not conducive to the preservation of vegetative remains at Anai'o, as they were at Tangatatau for example (Kirch *et al.* 1995). Coconut shell fragments in carbonised form were recovered from a number of hearths and umu, and several coconut graters also attest to the use of this crop at Anai'o. Coconut, *Cocos nucifera*, is likely to have colonised Polynesia just ahead of human groups and claims have been made based on pollen evidence that it was present in Ngaputoru (Atiu) at least 1,000 years before the settlement of Anai'o (Flenley 1989). Other indirect evidence for the horticultural component of the Anai'o economy includes the presence of shell vegetable peelers. The site lies about 1 km from a large swamp system (Makatea swamp) which is one of the main taro planting zones on the island today. A paved track leads though the makatea beds from the Anai'o site to the edges of the swamp and since the track is known to be prehistoric, it is possible that it was first constructed to serve members of the Anai'o community travelling to their inland taro beds.

In summary, the subsistence economic system of the Anai'o community involved the interaction of a number of practices targeted at a wide range of different exploitation zones. Opportunistic and selective hunting and gathering of both marine and terrestrial fauna took place alongside fishing and animal husbandry. The mainstay of the diet however, was likely to have involved horticultural and arboricultural activities. Table 11.1 provides a summary of the Anai'o economic system plus an outline of the evidence cited in support of the different components. In a general sense the Anai'o economy compares closely with the broad spectrum systems typical of established communities throughout tropical Polynesia. These are typified by horticultural practices based on a suite of dry and wet crops, supplemented by a very wide range of faunal items including both hunted, fished and domestic varieties. In detail however the Anai'o economy reflects a specific adaptation to the local ecosystems (see below) and in fact, if the western component was extracted from the modern Ma'uke diet what we would be left with in most households is a system remarkably similar to that seen at Anai'o.

MATERIAL CULTURE

The portable material culture from Anai'o represents the most diverse assemblage of artefacts recovered from a Cook Island site and includes the first excavated examples of a number of artefact classes including pottery, coconut graters, tattooing chisels and a range of small manufacturing tools. It also includes slingstones which had previously only been known from surface collections. The variability in artefact classes reflects the status of Anai'o as a small village or hamlet, a site type that might be expected to contain a far wider sample of the full range of artefact types in circulation at a given time than rockshelters, or many classes of single function site.

The Anai'o adzes as well as the small manufacturing tools fall well within the range of materials recovered from sites of similar age elsewhere in East Polynesia. The adzes were untanged and did not include any examples of the typical late phase, tanged reverse triangular forms. The fishhooks were the first reported collection of shell one-piece fishhooks from the archipelago, although one or two individual hooks had already been described (Bellwood 1978a). Of particular interest is the fact that the fishhooks were manufactured *in situ* and the

Economic practice	Archaeological evidence	
	Direct	Indirect
Arboriculture (coconut)	Carbonised coconut shell	Coconut scrapers and graters
Horticulture (root and corm crops)		Vegetable peelers, ethnographic analogy
Terrestrial gathering of wild plant foods		Ethnographic analogy
Inshore reef fishing with baited hooks	Faunal assemblage	Fishhooks
Inshore reef edge fishing (octopus)		Ethnographic analogy
Offshore trolling	Faunal assemblage	Trolling lures
Reef edge netting	Faunal assemblage	Ethnographic analogy
Reef edge foraging (molluscs, crustacea, echinoderma)	Faunal assemblage	
Reef edge foraging (holothurians)		Ethnographic analogy
Animal husbandry (Pig, dog, chicken)	Faunal assemblage	
Terrestrial hunting (bird, bat, pig)	Faunal assemblage	Spear points
Opportunistic gathering/hunting (fur seal, turtle)	Faunal assemblage	

TABLE 11.1. Summary of the subsistence economic system of the Anai'o community.

entire manufacturing and use life of this artefact form can be seen at the site. The raw material pearlshell was recovered in the form of waste debris from manufacture as well as in the form of part finished products in various stages of formation. The hooks were made using coral and echinoderm spine tools which were found in association with pearlshell fragments allowing the identification of various forms of hook manufacturing zone (see Chapter 10). The hooks themselves were found in finished form but more commonly they were broken. Many appear to have been broken in use and may have been removed from the lines and discarded by the fishers after returning to the site from a fishing expedition.

While the portable material culture all fell well within the envelope of variation formed by the sub-set of assemblages known as 'archaic' (see Bellwood 1978b; Kirch 1986:16; Walter 1996b), it is interesting to note the lack of evidence for round-ended houses at the site. The round-ended house form has a long tradition in West Polynesia and in fact is still in general use there. However, while it is less common than in West Polynesia it is also known archaeologically from East Polynesia (see Chapter 10). It has not yet been reported from the southern Cook Island archaeological record. The sample size of excavated houses from stratified sites is still very low with examples only from Anai'o and Ngati Tiare (Bellwood 1978a). But many surface house platforms have been reported and these too are all rectangular in form, leading to the hypothesis that the rectangular house form may have been the standard for house construction throughout the southern Cook Island sequence (see also Walter 1996b). The only other region of East Polynesia where round-ended houses have not been reported either archaeologically or ethnographically is New Zealand, and it may therefore be possible that the New Zealand construction tradition is derived from the southern Cook Islands.

SPATIAL ARCHAEOLOGY

The preservation conditions at Anai'o offered unique opportunities for the study of intra-site spatial organisation, and the theoretical starting point for this investigation was the concept of the community. This is a somewhat fluid concept in Polynesia because there are mechanisms in place which allow communities to split, or to fuse with other communities according to changing social and economic needs. However, this does not detract from its usefulness in describing and interpreting intra and inter-site settlement patterns and in fact it is an especially useful concept in Polynesia where the typical chiefdom system emphasises flexibility within a branching, hierarchical kin structure (Goldman 1970). In this system functioning social units, including residential units, can be formed and reformed at any node in the tree. Of the various alternative settlement forms adopted by communities, Anai'o was shown to be a small village or hamlet; a settlement type in which the household units are clustered, and the space between individual households comprises part of the everyday living and working area of community members.

Within the Anai'o village a range of different structures were identified and through association with other excavation units, an attempt was made to assign them to functional categories. Drawing heavily on ethnographic observation it was possible to identify the form of at least one household cluster and to determine the manner in which household activities were organised in relation to the dwelling units. In doing this, some elements of continuity with contemporary Ma'uke society in regard to the use of space within the household unit were highlighted. Towards addressing other culturally defined aspects of spatial behaviour an interpretation of the relationship between private and public space in the village was advanced and the role of gender briefly discussed.

Renfrew (1978:102) has pointed out that the village is the most common site type amongst sedentary neolithic communities, but this may not be true in East Polynesia for all of prehistory, and there is certainly no evidence that such was the case in the southern Cook Islands. Instead, the distribution of surface features on many islands in the Cook group and elsewhere in East Polynesia has led to the identification of a more dispersed type of settlement pattern as the norm. In this settlement pattern there are no nucleated habitation zones but instead, individual households are spread out over the community land holding. Communal sites such as marae are also scattered within the community land, although there is often some clustering of households (especially those of higher ranking families) around the more important of these sites (Descantes 1990; Green *et al.* 1967; McCoy 1975). On Ma'uke there is evidence for both the nucleated and the dispersed settlement forms in prehistory, but at opposite ends of the prehistoric sequence (Walter 1993; see also Chapter 2).

In Chapter 2 I described a dispersed settlement pattern associated with the last few centuries of Ma'uke prehistory. The contrast with Anai'o is striking and leads to the conclusion that there have been some significant changes in the nature of community spatial organisation in the centuries following the abandonment of the Anai'o site. The main changes were a move from coastal to inland habitation and from a nucleated to a dispersed pattern of community spatial organisation. This process of change was not unique to Ma'uke but may have been common throughout the southern Cooks (Walter 1991, 1993, 1996b). In Ngaputoru coastal settlement had ceased prior to the arrival of European explorers and by that time was rare elsewhere in the southern Cook Islands. Instead, the habitations were scattered over the inland planting soils with a selection for the ecotones between valued resource areas as described in Chapter 2 for Ma'uke (see Bellwood 1971; Crocombe 1964; Walter 1996b).

In reference to Ma'uke the adoption of a dispersed inland settlement pattern and the abandonment of nucleated coastal settlements is interpreted as reflecting an increasing competition for the quality agricultural soils within the overall economic system. This is likely to have resulted from a combined process of population increase, an over-predation of easily exploited marine and terrestrial species, and some possible loss of planting zones through human induced erosion and sedimentation of the inner slopes (Walter 1993). All these factors encouraged agricultural expansion and the development of intensive and highly managed forms of agricultural production. As increasing political controls were placed over the production system the development of rigid land tenure rules ensued and in Ma'uke these centred around the concept of direct occupation. It is in the context of increasing pressure on the agricultural zones and the adoption of labour intensive and cooperative agricultural activities that strong territorial based polities emerged, and this is connected too with the growth of the marae complex. Offshore exchange systems declined at the same time, probably as a result of an increase in the importance and complexity of local political systems. The cost of sustaining offshore voyaging networks became an increasing burden in the changing economic and political climate as more emphasis was placed on the concept of maintaining local land rights.

ADAPTATION IN NGAPUTORU

The raised coral reef or makatea island is one of the three most common island forms in Polynesia along with the volcanic high island and the atoll, and is the dominant island type in the southern Cooks. There is a great deal of individual variation within any of these island types but this overlies a recognisably distinct pattern of geomorphology and ecological zonation. It has also been pointed out that a relationship exists between basic island form and Polynesian adaptive strategies which may be reflected in such areas as settlement pattern, economics and sociopolitical organisation (Bellwood 1971; Davidson 1967; Kirch 1984; Sahlins 1958). The makatea islands of Ngaputoru have a unique environment and ecology within the Cook Islands and are regarded too as being culturally and historically distinct, although not radically so. Some possible relationships between cultural adaptation and environmental variables within the makatea islands of Ngaputoru are explored below.

The three raised coral reef islands of Ngaputoru differ enormously in a range of variables. Atiu is high and well watered, it has a central lake surrounded by extensive swamp land and large patches of high quality volcanic soils. It also contains several permanent streams in which outcrops of workable basalt are exposed. Mitiaro is very low and very dry. It has a central brackish lake but no natural swamp suitable for taro production, very restricted occurrences of dry volcanic garden soils and it has no surface exposures of volcanic stone. Ma'uke fits somewhere in between. It is higher than Mitiaro and lower than Atiu and contains reasonable expanses of both dry and wet plantation soils. There are no workable basalt sources on the island today, but limited surface exposures of flakable rock may have been worked out in prehistory.

Despite these differences, the Ngaputoru islands share many similarities. These include: a patchy resource distribution within a broad concentric pattern of zonation, a wide low belt of Pleistocene corals lying between the volcanic inland zone and the sea, an absence of lagoons or sheltered deepwater marine zones, a paucity of stone resources, limited access to surface freshwater, and an erosion regime in which sediments move towards the centre of the island as opposed to the coast. The distinction between the north-west and south-east coastlines is also particularly well marked on the Ngaputoru islands. The north-west coast is the sheltered leeward coast on all three islands, and is wetter and the vegetation patterns more varied. The leeward reefs are more sheltered and there it is relatively safe and easy to access the passages with canoes, and to exploit the fishing zones of the outer reef edge.

The Cook Islands suffer an approximate ten year cycle of hurricane activity and in Ngaputoru these storms invariably hit from the north-west. This has resulted in the formation of a storm built beach ridge up to 200 m in width and several metres deep along the leeward coasts. These are very suitable for human habitation and support all the modern coastal villages of Ngaputoru. The south-eastern or windward coasts by comparison are dry and barren with low stunted vegetation. The reefs on the windward coast are also rough and dangerous and there is only a very thin deposit of sand over the raised reef beds. These factors have all influenced settlement patterns, economic strategies and the overall nature of the archaeological record.

The most distinctive feature of Ngaputoru settlement patterns is the significance of the inland/coastal division. Throughout Polynesia an important distinction is drawn between coastal (tai) and inland ('uta). However, in terms of practical economic activity, on atolls and high islands the relationship between tai and 'uta exists more in the nature of a continuum than a dichotomy. As Finney (1966) has shown in Tahiti, there is no real physical division or barrier between these two zones on high islands, and the distinction in terms of settlement pattern and economic activity is arbitrary.

In Ngaputoru however the distinction between tai and 'uta is very real, and pervades many aspects of everyday life. The raised reef beds constitute a hazardous barrier between the inland region and the coast and the only access between the two zones is via a small number of paved tracks which must be traversed slowly, carefully and in single file. As a result, the implications of coastal versus inland settlement are highly significant. In Ngaputoru coastal settlements such as Anai'o appear to have been restricted to the early part of the sequence (see above) and then to the historic period (see Walter 1996b).

According to the model of settlement pattern change outlined above, the movement to inland habitation followed increasing competition for the agricultural soils and was related to the concept of land rights being mediated through a process of direct occupation. Once the priorities of settlement shifted towards inland habitation, the coastal settlement form could no longer be supported since coastal based communities were placed at a very significant disadvantage to inland based groups. The hypothesis arising from this observation is that a prehistoric settlement pattern including both coastal based and inland based villages would be unstable in Ngaputoru and the two settlement types could not coexist for long.

The coastal environment and marine ecology of the raised reef islands of Ngaputoru has also led to the emergence of a distinctive pattern of marine exploitation which contrasts with the patterns found in the lagoon ecosystems of the northern atolls, or of Rarotonga and Aitutaki. This is characterised by a very low shellfish component to the subsistence system and one dominated by the gastropods as opposed to bivalves. Vertebrate fishing targets benthic carnivores from reef edge zones and thus there is a lower proportion of Scaridae taken than would be expected in other Polynesian fishing systems. Fishing strategies dominated by a baited hook technology have evolved, and this reliance on reef edge angling is reflected in both the fishhook assemblage from Anai'o and in the relative abundance figures for fish taxa.

It is also worth considering what the role of makatea islands in the Cook/Austral region might have been in the development of the classic East Polynesian fishing kit. The Polynesian ancestors entered East Polynesia with a one-piece fishing kit but it was never an important part of the West Polynesian/Lapita material culture, except in some of the Outliers (Davidson 1971; Yen and Gordon 1973). One of the major innovations of the East Polynesians was to take the one-piece hook technology and to develop it into a diverse range of specialist types. The baited one-piece hook is a technology which is adapted, not for lagoonal ecosystems, but for the exploitation of rocky or coralline ledges or reefs. It is highly suitable for the rocky shores of New Zealand, and similar conditions in the Marquesas Islands have in the past, been seen as fundamental in the development of this technology. However, the one-piece hook is more central to the successful exploitation of makatea island marine environments than to any other island type since the range of exploitable zones in these islands is very much reduced. The Cook/Austral chain consisting of a large number of makatea islands close to the West Polynesian homelands could have played a more central role in the development of the East Polynesian one-piece hook kit than is presently apparent.

CONCLUSIONS

The initial objectives of the Anai'o excavations were to provide data suitable for addressing broad culture historical issues, especially those pertaining to problems of East Polynesian colonisation and culture change (Walter 1990). Since then I have become increasingly interested in the site itself and the life of the people who occupied it. This encouraged me to attempt to construct an archaeological ethnography of the Anai'o community. Anai'o accords a unique opportunity to focus on the historically particular and this report uses the excavation data to reconstruct economic, technological, social and behavioural features of life within that settlement.

One particular feature of Anai'o which stood out was the extent to which the community was dependent on interaction with outside islands. This highlights the fact that although we are dealing with small island societies, these are not closed systems. While we may be able to trace patterns of social change and more directly, economic and technological change in an island context, ecological models focussing on the single island will never provide completely satisfactory explanations for these changes. In this study I advanced the notion that changes in settlement pattern, technology and subsistence practices, as glimpsed in the archaeological record of Ma'uke, were tied to dynamics which operated at the archipelago wide level and perhaps higher. These were the dynamics of interaction and of the exchange systems which linked distant island communities. Sourcing studies are now allowing us to investigate these processes more completely. It would be useful too for archaeologists to adopt a more synchronic approach to the East Polynesian archaeological record and to provide detailed studies of single time/space units instead of concentrating on the problems of stratigraphic change.

The Anai'o site was excavated by Ma'ukeans and many of the intellectual directions taken were in response to queries raised by the Ma'uke community. There are many sites on the island which are of great historical importance and Anai'o now ranks as one of the most significant of these. There is still debate amongst the Ma'uke people about where exactly Anai'o fits into the traditional history of the island. There are some who associate it in some way with the founding ancestor 'Uke. This follows the logic of precedence; 'Uke was the first man and this is the earliest site so there must be some connection. There are others who place less emphasis on chronology and associate the site with the traditional stories of events carried out along the Anai'o coastline.

Some Ma'uke people were struck by the elements of continuity, especially in material culture, and were captivated to find coconut graters in pearlshell identical in form to the steel kana which are found today in every household on the island. The fishermen too were able to discuss the functional attributes of the various hook forms we excavated. In contrast, many people were puzzled and disconcerted by the 'foreignness' of Anai'o. There were no stories relating to such a large and impressive site and no oral traditions ever mentioned the use of pearlshell, which was used to manufacture such a wide variety of items in the Anai'o village. Although the hook forms were familiar, no one had ever seen or heard of these being made of shell. Despite the diversity of reaction and interpretation however, Anai'o is undoubtedly one of the most historically and culturally significant sites on Ma'uke, if not in the southern Cook Islands.

The site today lies under an abandoned coconut plantation. Much of it is still undisturbed and the last time I visited there, in December 1996, broken tools, oven stones and other material could still be seen scattered along the raised reef beds immediately behind the site. There is no immediate danger to Anai'o but there is an urgent need for the Cook Island authorities, whether these be at the village, island or national level, to initiate programmes of cultural resource management such that sites like Anai'o which are of such scientific and cultural importance might be protected against future damage.

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