A MID-HOLOCENE DEPOPULATION OF THE AUSTRALIAN SOUTHWEST

William C. Ferguson

A thesis submitted for the degree of Doctor of Philosophy
of The Australian National University.

June 1985

I certify that the materials included within this thesis are my original work except where otherwise noted in the text.

William C. Ferguson

12 June 1985

ACKNOWLEDGEMENTS

I thank first:

My supervisor, Mr F. W. Shawcross, and my head of department, Prof D.J. Mulvaney whose concern and encouragement made it all possible;

In the west, my first mentors in Australian Prehistory, Mr C.E. Dortch and Prof S.J. Hallam, whose work laid the foundations for this study and whose continued interest and active assistance facilitated the long-distance field programme;

In Albany, Mr D. A. P. West, who gave unstintingly of his time, his considerable local knowledge and his influence to help produce this first basic understanding of the prehistory of the Albany Region.

I thank the following senior colleagues and fellow graduate students who each contributed to the final form of this thesis by their support or critical reservations in seminars and discussions, advice on methodology, loans of unpublished data, and suggestions of relevant references: Ms J. Anderson, Mr P. Bindon, Ms C. Bird, Mr D. Bulbeck, Dr. K. Dickson, Mr W. Dix, Mr I. Farrington, Dr J. Flenniken, Mr P. Hiscock, Dr I. Johnson, Dr R. Jones, Dr J. Kamminga, Mr I. Kirkby, Ms S. Le Souëf, Dr I. McBryde, Ms K. Morse, Mr R. Pearce, Dr N. Peterson, Mr M. Pickering, Dr J. Rhodes, Ms M. Smith, Mr C. Tassel, Dr J.P. White, Ms E. Williams, Mr. D. Witter, Dr K-H. Wyrwoll; and especially Prof J. Golson and Dr P. Hughes for their enthusiastic encouragement at the "Or did they all go to Northcliffe?" seminar, Dept of Prehistory, RSPacS, The A.N.U., 16 October 1981, and Dr G. Hope for his confounding question at the "Changing Artifact Densities in the Forested Block" presentation, ANZAAS, 14 May 1982.

I thank the Western Australian Museum: it's Director, John Bannister; the Registrar of Aboriginal Sites Office for permission to conduct the field work, and Bruce Wright, Vera Novak, Peter Randolph and Liz Bloor for assistance; the Department of Archaeology for permission to collect artifacts and loans of equipment; the Department of Anthropology, Jean d'Espeissis, and Mance Lofgren, for

assistance in studying their collection; and especially the Albany Residency Museum which provided a base of operations for the field research; its Curators, Cris Tassel and Valerie Milne, and its Staff, Alan, Ted, Yvonne, Janette, Christine, and Gaye.

I thank the Australian Institute of Aboriginal Studies for supply of a vehicle for field research, October 1979; the Department of Anthropology, University of Western Australia for loans of equipment; the Australian Institute of Anatomy and David Kauss for aid in studying the collection; and the Western Australian Department of Agriculture, Albany Division, for the use of their library.

I thank the Western Australian National Parks Department and John Watson for permission to excavate in the Stirling Range National Park, and Ranger Martin Lloyd and his wife, Viv, for their kind hospitality.

I thank Albany Shire Council, Harry Riggs, and K.F Bentley for permission to excavate on council property; Kalgan Hall Reserve trustees, Alan Anderson, Jack James, and Murray Maxton for permission to excavate on the reserve; and Patrick and Ellen Metcalf, our hosts at Mindijup.

I thank Tony and Dawn Kelly, owners of Moorillup Pool, for permission to excavate on their property and much kind hospitality; and Sax Maynard for the use of the shearer's quarters at Hilltop.

I thank Mark Bennett for his wonderful photographs and his friendship; Mary West for her wealth of information and her kind hospitality; and from among the many other people of the Albany-Mt. Barker-Denmark area who gave of their interest, time, information, assistance and hospitality: Bart and Diane, Stan Bennett, Craig Bingham, Godfrey Colbung, Denny Douglas, Bill Finley, Eric Harley, Jardine Jamison, Mrs. Kitson, Ian Lally, Pam Luscomb, John McBride, Denis Maddon, Bob Patterson, Stan Smith, Matt Stephens, Margaret Tassel, Ted and Helme, Arthur Webb, Ian West, and, Homer White.

I thank the staff of the Department of Prehistory and Anthropology, Arts, The A.N.U. for long-term support: Helen Nicol, Debbie Douglas, David McGreggor, and Bob Dohwy.

I especially thank my very underpaid field research assistants Ellen Crawford and Linda Strawbridge; and the others who voluntarily gave of their time, interest and effort to assist in the surveys and excavations: A. Bartu, C. Beek, S. and S. Bennett, G. Benson, A. Beverage, S. Beverage, C. Bird, E. Bunbury, D. Dalton, J. Dekker, J. Eaton, I. Kirkby, S. Kirkby, P. Lindsay, A. Lockhart, P. Lockhart, R. McKinny, S. Mangan, D. Mayerhofer, S. Maynard, K. Morse, M. Pickering, R. Reynolds, M. Smith, C. Stockwell, D. and D. Trew, K. Ward, D.A.P. West, and M. Zlatnik.

Most of all, I thank Janenne Eaton who served as a long-term unpaid research assistant, drew the artifacts, inked most of the line drawings, proof-read the manuscript, and put up with it all for six years.

Table of Contents

Volume I

Volume II

LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION: APPROACHING A REGIONAL PROBLEM

This thesis is an exercise in regional archaeology. It focuses on the Australian Southwest, one of the continent's clearly recognizable natural and cultural areas; and it attempts to provide an explanation for a region-wide archaeological phenomenon, one which could not be explained by either traditional site-oriented research or reference to pan-Australian archaeological phenomena.

Evidence is presented to suggest that during the terminal Pleistocene and early Holocene periods this extreme southwest corner of the continent was progressively abandoned by its formerly large human population, and that from about 6000 BP to about 4000 BP the entire region was virtually depopulated. It is the result of six years of research undertaken to verify the author's prediction that such an event was likely to have occurred (Ferguson 1981:632-4).

This prediction was a logical consequence of the combination of two already established models: one, an ethnohistory based model of the interaction between the region's protohistoric forager society and its environment (Hallam 1975); and the other, a model of gross changes in that environment over time (Wyrwoll 1979). The argument was originally presented in brief as an entirely speculative attempt to explain an unexpected archaeological phenomenon observed during the author's previous site-oriented research in the region. It is here developed in full.

In the pages below the Australian Southwest natural and cultural area is defined and delineated, refined versions of the cultural ecology and palaeoclimatic models for the region are presented, and the methodology and results of the series of archaeological tests designed to support the models and verify the prediction are detailed. The field research is concentrated in a single portion of the region, and the chapters of the thesis progress from the general to the particular: from the overall region; through the field research area, site localities, the sites themselves, and the excavations; to the analysis of the artifacts. Each of these various levels of focus has a part to play in the understanding of the greater problem. They are integrated in the concluding chapter where attention is once again on the region as a whole, and a region-wide test of the depopulation hypothesis is presented and discussed.

THE ORIGIN OF THE DEPOPULATION HYPOTHESIS: ABANDONMENT OF THE QUININUP BROOK SITE COMPLEX

The possibility that there may have been a reduction in the intensity of occupation in the Australian Southwest during the mid-Holocene was first suggested by research at the Quininup Brook Site Complex where the author conducted excavations in 1977 (Ferguson 1977; 1980a; 1981). These excavations revealed a stratified sequence of stone artifacts which began well below the lowest radiocarbon date of 18,500±1700 BP, but which terminated completely at about 6000 BP.

Final abandonment of the site complex is easily explained.

These sites were originally located well inland, on a ridge overlooking a vast coastal plain, but during the period of their occupation sea level rose as a result of world wide eustatic changes. At about 6000 BP, when the sea reached its present position only 100 metres away from the sites, the surrounding resource catchment area would have been totally destroyed.

Strangely, however, the process of abandonment appeared to have begun as much as 4000 years earlier. The majority of the artifacts in the excavations were found in levels dated from before about 18,000 BP to just after about 10,000 BP. Above these levels artifact numbers declined sharply, and then progressively dwindled to only a few isolated finds in the the levels just below the cut-off date (Ferguson 1981:table 1). No evidence was available from the excavations or the study of the surrounding environment to explain why the decline in the intensity of occupation began so early.

In his final report on the excavations, the author speculated that the early decline may have occurred as a result of changing regional environmental circumstances quite separate from the rise of sea level. An examination of the then published data on the palaeoclimate suggested that, following a relatively arid late Pleistocene, the early to mid-Holocene of the Australian Southwest was characterised by increasingly wetter conditions which peaked between 7000 and 5000 years ago. One of the major results of the greater precipitation would have been a dramatic increase in the distribution of the thick sclerophyll forests which even today dominate a large portion of the region. This seemed significant

because a previously published review of the local ethnohistorical literature (Hallam 1975) had suggested that in the ethnographic present these forests supported a considerably lower Aboriginal population than the more open woodland areas which border them.

It was suggested, therefore, that if the prehistoric population of the region had maintained a similar pattern of interaction with their environment over time, and if both models were correct in essence; then the apparent decline in the intensity of occupation at Quininup Brook was probably not a site-specific phenomenon, but was more likely a result of a regional trend to lower population densities as the spreading forests reduced the overall amount of prime exploitable land available at this time. It was assumed that this trend would have been maintained until the establishment of the relatively drier, modern climatic regime in the late Holocene reduced the forests to their present area of distribution (Ferguson 1981).

QUESTIONS RAISED BY THE INTERPRETATION OF QUININUP BROOK

Ultimate acceptance of the interpretation of Quininup Brook requires the validation of two statements: first, that there was a mid-Holocene depopulation of the Australian Southwest; and second, that it was caused by adverse climatic change. Evaluation of the first statement is a fairly straight-forward procedure, and its validity can be supported if affirmative answers can be supplied for two basic questions:

1. Is the Quininup Brook relative artifact density sequence representative of a regional phenomenon: that is, can it be

shown that there were proportionally fewer artifacts discarded during the mid-Holocene throughout the greater area of the Australian Southwest?

2. If so, what does this mean: is it valid to assume that proof of fewer artifacts necessarily implies less human activity in this situation?

To provide an acceptable answer for the first question, all that is required is that a sufficiently large and representative sample of regional excavations be collected and correctly interpreted, but an acceptable answer to the second question is likely to be more difficult to obtain. Implicit in the interpretation of Quininup Brook was the unexamined assumption that since artifacts are products of human activity, the frequency of artifact finds can be seen to indicate the intensity of that activity.

This is a fairly common assumption in archaeology, and it has recently been used in Australia to suggest varying intensity of occupation on archaeological sites over both space and time (Shawcross and Kaye 1980; Hughes and Lampert 1982). Different activities, however, produce differing amounts of residue; and no absolute correlation can be expected. Recent criticism (Hiscock 1981), while not rejecting the assumption outright, stressed that it must be ascertained just what activities artifacts represent before their relative density distribution can be used to infer a similarly arranged intensity of occupation.

Affirmative answers to these two questions would be strong evidence that a depopulation of the region had occurred; but although

suggestive, this would not necessarily imply that the depopulation was a result of wetter environmental conditions. There are many possible causes for such a depopulation, and three more questions need affirmative answers before this cause can be singled out as the most likely:

3. Is Hallam's model of the protohistoric cultural ecology basically correct? Specifically, can it be shown that in the ethnographic present the region's population made more use of the open woodland areas than of the densely forested areas?
4. If so, was there temporal continuity? Can it be shown that this type of interaction between the population and its environment has a history that extends back through the mid-Holocene period in question?
5. Is the model of the palaeoclimatic sequence essentially correct? Specifically, can it be shown that it was wetter in the Australian Southwest during the mid-Holocene than it was before and after this time?

An acceptable answer to question three could be provided by an analysis of comparable archaeological samples from both forest and woodland portions of the region to see if there is more evidence of human activity in the former than in the latter during the most recent past. Correct interpretation will be difficult, however. Given the assumption of palaeoclimatic change, the boundaries of these environmental zones will have changed drastically over time; and given the overall uniformity of Australian archaeological assemblages

from all ages, temporal control of surface collections is usually tenuous.

The same general uniformity of Australian archaeological assemblages over time which renders temporal control difficult, is usually seen as supporting acceptance of an affirmative answer to question four since it suggests continuity in the technological aspects of the society. It should be possible to demonstrate whether or not such uniformity really exists by comparative analysis of dated assemblages. Similarity in the choice of site location over time, if it could be demonstrated, would also provide support; but, ultimately, it will always be impossible to convince those who argue for possible alterations in the prehistoric exploitation pattern which are archaeologically invisible, and therefore untestable.

Direct evidence to provide an acceptable answer to the final question, whether or not the mid-Holocene was really wetter than the previous and subsequent periods, undoubtedly requires more palaeoclimatic research in the natural sciences. The work done so far is not extensive, and although most studies suggest increasing rainfall at this time, there is at least one (Kendrick 1977) which suggests the complete opposite.

Providing such evidence is not normally within the province of an archaeologist unless he or she also doubles as a specialist in one of the natural sciences. In this case, however, possible indirect support could be provided from archaeological research on a regional basis if affirmative answers are accepted or assumed for all the other questions, and if temporal control of the regional sample of

dated excavations is sufficiently refined.

The palaeoclimatic model suggests that spread of the forests in the terminal Pleistocene and early Holocene was a slow process; taking thousands of years, and spreading from the currently most densely forested regions outward. If this was the cause of a mid-Holocene depopulation, given that a mid-Holocene depopulation and a contemporary environmental adaption similar to that proposed for the ethnographic present can be demonstrated; the timing for the beginning of that depopulation should progress in a similar pattern across the region. Currently forested areas should have been depopulated before currently more open areas, and areas in the south of the region should have been depopulated before areas in the north of the region.

ANSWERING THE QUININUP BROOK QUESTIONS: THE STRUCTURE OF THE THESIS

This thesis provides the information needed to evaluate the two statements that there was a mid-Holocene depopulation of the Australian Southwest, and that it occurred as a result of environmental deterioration caused by spreading forests. Its structure is designed to answer the questions presented above, and its primary goal, therefore, is to collect and analyse a sufficiently large and representative sample of dated artifact sequences so that the answer to the first question can be accepted with confidence. Unless it can be shown that there were definitely many fewer artifacts discarded in the region at this time, the answers to all the

other questions are irrelevant.

If any sample is to be seen as representative, the population from which it is to be taken must first be clearly defined. In this case, the relevant population is defined as all the archaeological remains within the the area of the Australian Southwest. Chapter 2 delineates this region, establishing that it is a coherent whole and sufficiently different from the surrounding areas. It also includes detailed presentations of both the cultural ecology and palaeoenvironmental models

The sample itself should be as large as possible, and a decision was made to include all the artifacts within the layers of excavated stratigraphic sequences that can be securely dated to the late Pleistocene and Holocene periods. Only those excavations with sequences dated by the radiocarbon method are considered acceptable because of the high degree of temporal precision desired.

Prior to the field research conducted for this thesis there were seventeen excavations in the region that met this criterion. Considering that the Australian Southwest encompasses over 220,000 square kilometres, only a little smaller than California or West Germany, this was a very small sample. Moreover, because these sites were mostly clustered in two relatively tight groupings on the west coast, their ability to represent the entire region was somewhat doubtful. Consequently, as part of this research, an extensive field programme was undertaken to increase both the distribution and the size of the sample.

On the South coast of the region, reasonably distant from the

two clusters of dated sites, a sufficiently large and previously unexplored area containing both forest and woodland vegetation zones was selected as field research area. Within this approximately 6000 square kilometre area, in four field seasons from 1979 through 1981, surveys were conducted resulting in the location of 182 archaeological sites, and the six of these which seemed most likely to contribute sequences for the sample were excavated. One excavation proved unprofitable but the other five increased the regional sample size by thirty percent to a total of twenty two sites.

The history, environment, and proto-historic cultural ecology of the field research area, which is called "Mokaré's Domain", are discussed in Chapter 3. That chapter also includes details of the method and results of a representative, area-wide archaeological survey conducted to provide an answer to the third question; whether or not there is evidence for more human activity in the woodland zones than in the forest zones during the recent past.

Chapter 4 presents the logic, method, and results of purposive surveys in the area conducted to locate those sites with the long artifact sequences necessary to provide the expanded regional sample. It describes the sites and their environments, and it argues that these sites can be seen to support at least a partial continuity in the settlement pattern over time.

Chapter 5 details the method and results of the excavations conducted at these sites. It introduces the methodology which controls for variation in the sedimentation rate and allows the artifact density sequences to be tied to an absolute time scale; and

presents the results of a preliminary test of the depopulation hypothesis based only on the local sample. This test demonstrates that these sites have a relatively low artifact-find rate in levels dated to the mid-Holocene period, and suggests that this phenomenon appears earliest in sites found in the areas now most heavily forested.

Whether or not this reduction in the amount of artifacts can legitimately be interpreted as indicating a reduction in the intensity of occupation in the region is the second question that this thesis must answer. This requires an understanding of what past activities are represented by the artifacts, and whether or not these activities are represented in basically the same proportions throughout all the relevant levels of the excavations.

Chapter 6 presents a description and analysis of the artifacts collected during the surveys and excavations in Mokaré's Domain. The first part of the analysis is directed toward determining what possible functions the stone residue served in its cultural context. This is always difficult, but all possible lines of evidence are pursued.

The second part of the analysis is undertaken to determine if there is a basic continuity in the types of artifacts and their relative proportions over time. This is probably more important to the argument than the functional analysis. Although it may be sometimes impossible to confidently ascribe a function to a given artifact type, if it can be shown that the same basic suite of artifacts is present in the various levels, then it can be argued that it is legitimate to infer

that no matter what precise activities are represented, these were similar throughout the sequence.

The concluding discussion in Chapter 6 argues that strong enough evidence exists to suggest that the relative density of artifacts in the relevant late Pleistocene through mid-Holocene levels of the Mokaré's Domain excavations implies a similar relative intensity of human activity. Although reservations are expressed about whether a comparable statement can be made regarding the late Holocene levels of the excavations, where some new stone reduction techniques and artifact types appear; this occurs after the proposed period of depopulation and is not especially germane. Consequently, it is concluded that acceptance of the depopulation hypothesis is warranted for these sites at least.

It is not possible to subject the sequences of the region-wide sample to the same sort of scrutiny as those from Mokaré's Domain. The tens of thousands of artifacts involved were, for the most part, collected by other researchers, and sufficient description is not usually available. For the final test of the depopulation hypothesis, it is necessary to assume that these sequences generally possess the same high degree of continuity as those which were examined in detail; and that if there is a notable drop in the numbers of artifacts found in mid-Holocene levels, it likewise can be taken as suggesting a lessening of human activity at this time. For only one site is there any evidence that the assumption is unwarranted, and this evidence helps to explain why, initially, this sequence does not appear to follow the predicted pattern.

The regional sample is examined in Chapter 7, and special emphasis is placed on determining the time for the beginning of the period of relatively fewer artifacts in each different part of the region. In this concluding chapter, the entire argument is brought together and the relevance of this research to the wider field of Australian archaeology is discussed.

THEORETICAL GUIDELINES:

1: AUSTRALIAN REGIONAL ARCHAEOLOGY

Following the lead of anthropologists who generally regard all Aboriginal groups as but localized versions of a single pan-Australian culture (Meggitt 1964, Elkin 1970), prehistorians initially stressed the "vast continuities in time and space" of Australian archaeology (Jones 1973:278), seeing them as "a primary fact of Australian prehistory and a basic limitation which its prehistorians face" (Mulvaney 1975:69). Recently, however, more emphasis has been placed on the diversity now apparent in both the archaeological and ethnographic records; and regional studies are being strongly advocated (Mulvaney 1978:44; 1981:19, White and O'Connell 1982:99-102, Flood 1983:12).

This thesis is seen as a step toward the development of a formalized concept of Australian regional archaeology. It attempts to show by example that, if this concept is subsumed under the wider theoretical scope of spatial archaeology and linked firmly to the principles of cultural ecology, it can be used as an aid in the explanation of much of the spatial variation in Australian Prehistory.

Explicitly regional approaches to Australian archaeology began in earnest during the 1960's (e.g. McBryde 1962; 1974, Lampert 1966; 1971a; 1971b, Jones 1968, 1971, C. White 1967; 1971, Coutts 1967; 1970), and are now virtually the norm. Most of these studies have in common: a concern for the inter-relationship between the prehistoric "culture" and its environment, a field research strategy involving extensive survey and multiple excavations, and a format of explanation which first examines the evidence at a regional level and then attempts to integrate the conclusions into the overall framework of Australian Prehistory. The success of individual studies naturally varies considerably, but the basic research design has been highly productive to the discipline. With the exception of the not inconsequential substitution of "human population" for "culture" as a focus of study, there is no need to alter this basic design for the present research.

Problems have often existed in the implementation of the final stage of this type of research, however, because until recently no continental model of Australian archaeological regions within which to place the individual studies had been developed. Research areas and relevant areas for comparison have been usually selected on an ad hoc basis and for idiosyncratic reasons. The boundaries of the region being studied have tended to be drawn in an arbitrary fashion with an eye to logistics more than to cultural and environmental reality, and exactly what distinguishes the circumscribed region from the neighboring regions, or makes it a representative sample of a greater region, has rarely been clear. The validity of comparisons between

regions has consequently often been somewhat doubtful.

The problem develops from the underlying uniformity of the culture from one end of the continent to the other, and from the basic overall uniformity of the continent itself. Both culture and environment change substantially with distance, but the gradations are generally subtle, and it is often difficult to know just where to draw the line demarcating one "sub-cultural" region from another.

As a result, attempts to compare Australian regional studies on a continent-wide basis, have often fallen back on the admittedly unsatisfactory practice of using modern political boundaries as a framework (McCarthy 1970, Mulvaney 1975). Alternatively, recent thematic works comparing and contrasting different adaptations have either eschewed any framework at all, presenting their examples sequentially as isolates (Gould 1980), or grouped their examples into vague "generalized resource zones" (Bowdler 1981).

In this study the boundaries of the region being researched are carefully developed on both environmental and cultural criteria; and, for comparative purposes, are firmly bound to a recently proposed model of pan-continental regional diversity (Peterson 1976).

Peterson's framework of "natural and cultural areas" appeals primarily because it has, implicitly at least, a cultural-ecological basis. It assumes that there is an interaction between culture and environment which in part contributes to the structure of that culture, and suggests that since there is often a relative homogeneity of environment within hydraulic drainage basins, these might form a

basis for dividing the continent into cultural regions for two reasons: (1) the basic homogeneity of environment within the basin should produce a similar homogeneity in those facets of the culture directly involved with exploiting that environment, and (2) because the divides between these basins are often the least productive and most poorly watered land areas and form at least a partial barrier to human movement, interaction between individuals and groups tends to be focused mainly within the drainage basins producing at least some degree of isolation. Assumptions similar to these have produced the framework long in use for dividing North America into cultural regions (Kroeber 1939).

Australia is divided into twelve major continental drainage divisions (*Atlas of Australian Resources* 1967), and Peterson noted that there appears to be a gross fit between these divisions and known cultural groupings. The fit is not exact, of course. Adjustments have been necessary in the American situation (compare Kroeber's divisions with later versions in Driver 1961 and Willey 1966), and detailed examination of only those areas well known to him, required Peterson to adjust the original twelve drainage divisions into a model composed of seventeen natural and cultural areas (Fig. 1.1).

Peterson stressed the provisional nature of his model, advising that if it is to be of any real use, each individual division will need to be examined in detail, compared with the adjacent regions, and the boundaries adjusted in light of local conditions (1976:67). This aspect tends to be overlooked in purely destructive criticisms of the

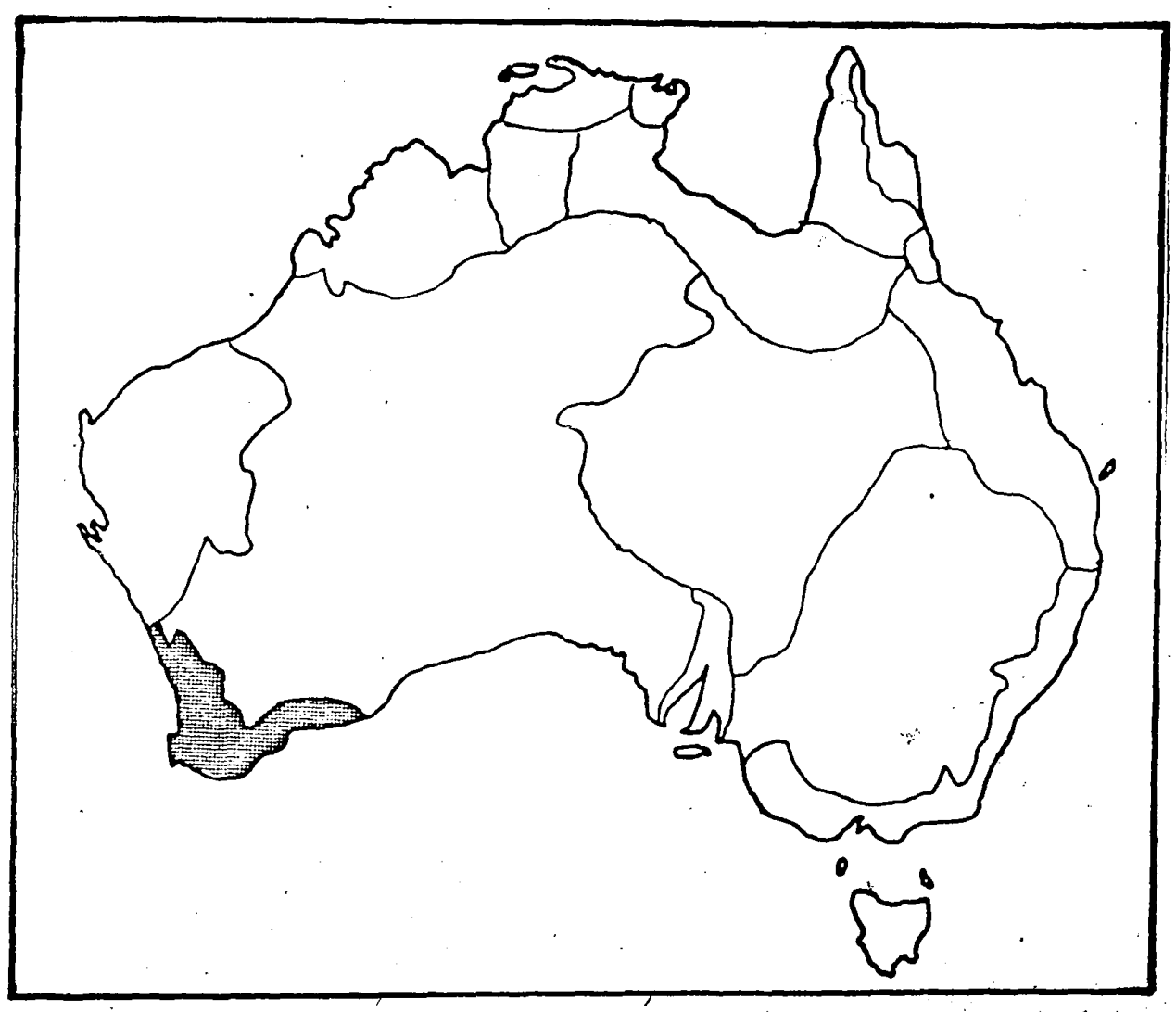


FIGURE 1.1. MODEL OF AUSTRALIAN NATURAL AND CULTURAL AREAS:
These were originally based on the major continental drainage divisions but altered somewhat by Peterson (1976). The shaded area is the South-west Coast Drainage Division, the region which is investigated in this thesis.

drainage basin hypothesis (White and O'Connell 1982:100-2). The hypothesis only provides a point of beginning in the search for the natural and cultural areas of Australia. The eventual model, if it is to be generally accepted and used, will require the work of many, perhaps generations of researchers; and must ultimately be based on the consideration of all known cultural and environmental variables.

The search for the Australian Southwest natural and cultural area began with an examination of the South-west Coast Drainage Division, one of those not studied in detail by Peterson. It is not altogether suprising that, after examination of the overall environmental and cultural context, factors other than topography alone are chosen for final delineation of the boundaries. That these boundaries approximate the drainage basin as closely as they do should be gratifying to Peterson, for without his model it would have been difficult to know where to start.

The Australian Southwest, as will be shown below, is relatively easy to define and radically different from its neighboring regions. It seems "made" to be fit into the "natural and cultural area" model. This is the first attempt to use Peterson's model for the purposes of establishing a pan-continental structure for Australian regional archaeology known to the author, and it is hoped that the success of this endeavour will encourage other archaeologists to also attempt to tie their research areas into this framework.

II: SPATIAL ARCHAEOLOGY

Although ultimately regional in scope, in presenting its

argument this research focuses on various levels of archaeological spatial data, from the distribution of sites across the entire region down to the arrangement of artifacts within very small parts of the individual sites. The framework which integrates these individual focuses into a coherent whole is provided by the concepts which David Clarke provisionally codified under the term "spatial archaeology" (1977). Spatial archaeology is:

> ...the retrieval of information from archaeological spatial relationships and the study of the spatial consequences of former hominid activity patterns within and between features and structures and their articulation within sites, site systems and their environments: the study of the flow and integration of activities within and between structures, sites and resource spaces from the micro to the semi-micro and macro scales of aggregation (Clarke 1977:9)

Archaeology can be defined in essence as the study of the attributes of prehistoric artifacts. There is a conceivably infinite number of attributes possible for any given artifact, but they can be divided into two immutable classes: attributes of form, and attributes of context. Both classes of attributes have been recognized and studied since the beginning of the discipline, and huge bodies of literature codifying various approaches to their study have been developed.

Spatial archaeology is a provisional attempt to provide an overall body of theory which encompasses all the many previous approaches to the second class of attributes. This goal is

theoretically possible since all attributes of this class are unified by their ability to be expressed in terms of linear distance, and Clarke suggested that spatial archaeology could subsume and use the methods of: "settlement archaeology, site system analysis, regional studies, territorial analyses, locational analyses, catchment area studies, distribution mapping, density studies, within-site and within-structure analyses or even stratigraphic studies," (1977:1).

The present research, while not neglecting attributes of form, concentrates primarily on the study of attributes of artifact context, both stratigraphic and distributional; and, in answering the various questions specific to the research, uses existing research methodology from virtually all of the sub-fields listed above. Clarke's provisional formulations have informed the research since its conception, and his very flexible approach to amalgamating the various "scales of aggregation" has been adopted.

Several previous hierarchical systems of integration have been developed, mostly within the field of "settlement pattern studies" (Trigger 1970, Chang 1972, Rouse 1972, Butzer 1972). These tend to be more-or-less rigid typologies, and are normally tied closely to the social structure of more truly "settled" societies. They are not easily altered for use with mobile forager populations. Clarke's system avoids these problems. In his own formulation he uses the terms "micro patterns" to discuss spatial arrangements within structures, "semi-micro patterns" for within sites, and "macro patterns" for between sites. He clearly states, however, that these levels of resolution are arbitrary, merely terms of convenience, which could be

altered by further subdivision or the choice of other criteria (1977:14).

For this study, where three levels of inter-site patterns were distinguished, a typology is used which recognizes micro, semi-micro, meso , semi-macro, and macro scales of patterning. The obviously ordinal structure of the overall system enables the various levels of research focus to be smoothly integrated; and although these terms seem awkward, even laughable, at first, they carry few inherent connotations from previous use or misuse and can easily be defined in a research specific manner.

Briefly, an *archaeological site* is a defined locus of artifact aggregation, and the *macro pattern* is the distribution of archaeological sites across the maximum area of focus: in this case, the region, the Australian Southwest. A *semi-macro pattern* is the distribution of sites within any designated major sub-portion of that area: here, usually the field research area, Mokaré's Domain. The term *meso pattern* refers to the distribution of sites within a given distance from any designated point within that sub-portion: usually in this research, that point is a topographical feature and the relevant area is roughly similar in size to a "site catchment area" (Vita Finzi & Higgs 1970). The *semi-micro pattern* is the distribution of artifacts within an entire site and the *micro pattern* is the distribution of artifacts within any designated sub-portion of a site. Each of these various levels of focus provides the sample units from which generalizations are made about the level above, and they are discussed in more detail in the relevant chapters below.

Spatial archaeology, although deemed beneficial to the planning and organization of this research, is not what Clarke hoped it would be. It is not an overriding "theory" of spatial phenomena in archaeology. In the final section of this posthumously published paper, he suggested that although there was archaeological theory implicit in what archaeologists do, it was not possible to formulate it specifically at this time. Instead he turned to the spatial theories used in other social sciences, primarily economics and geography; examining how they have been and could be used in archaeology. All of them were found wanting in some way or another, but he concluded his investigation with a statement which is used here as a guide: "The theory and models that would be most useful to the archaeologist..., are those to be developed from anthropological spatial theory" (1977:27). Hence:

III: CULTURAL ECOLOGY.

Cultural ecology was developed by Julian Steward (1955). It has had considerable influence in American anthropology, although it is now often coupled with more advanced approaches which study ecosystems (Lee 1979) or processual ecology (Orlove 1980). Steward saw cultural ecology as a heuristic device which could enable him to understand the effect of environments upon culture: "to ascertain whether the adjustments of human societies to their environment require particular modes of behaviour or whether they permit latitude for a certain range of possible behaviour patterns" (1955:36).

Pragmatically, he ignored many facets of both the environment

and the society, focusing instead upon those aspects which were most closely related to subsistence and economic features of the society. These features he calls the "cultural core", and his system of analysis contains three steps: (1) an analysis of the interrelationship of the exploitive or productive technology and the environment, (2) an analysis of the behaviour patterns involved in the exploitation of a particular area by means of a particular technology, and (3) an analysis of to what extent the behaviour patterns entailed in exploiting the environment affect other aspects of the culture (1955:40-1).

Cultural ecology has not been widely used in Australian anthropology. In contrast to overseas trends, few anthropologists on this continent take much interest in the interrelationships of culture and environment at all. There are some exceptions to this (Thomson 1939, Strehlow 1965, Stanner 1965, Peterson 1973; 1975; 1976), but the only explicit use of Steward's system known to the author is by Lawrence (1969). Lawrence applied it with some success in comparing the economies of several Australian societies. He found that the environment here at least affected the "type" of the economy practiced; and specifically, that it altered the size and mobility of the hunting unit, the population supported by the given area, and the techniques and equipment employed in gaining a living (1969:223-4).

As spatial archaeology provides the framework for integrating the various levels of archaeological focus, so cultural ecology is the link between the archaeology and both ethnology and the natural sciences (M. Harris 1968:655,685). There can be no question that

every artifact provides direct evidence of some form of interaction between humans and their environment. The material from which the artifact was shaped is of necessity part of that environment, and by definition, an artifact is made or modified by a human.

Further, because, as is argued in Chapter 6 , the vast majority of the stone artifacts from the Australian Southwest are directly related to interactions which are part of the subsistence and economic aspects of the society, they are expressions of "cultural core" activities and therefore a worthy subject for study within Steward's basic framework. Their attributes of form can be used to suggest the nature of some cultural core interactions, and their attributes of context can be used to suggest the spatial distribution of these interactions within the environment.

In this research, Steward's three steps of analysis are implemented through the presentation of a series of cultural ecology models which are developed initially from ethnohistorical information and then tested and refined by comparison against the archaeological record. As a result, a reasonably good understanding of how this society interacted with its environment over time is achieved. Steward's ultimate question, whether or not these forms of interaction precluded other types of adaptation, remains essentially unanswered. However, the evidence presented in this thesis suggests that this society did not change its basic form of adaptation, even when changing environmental conditions created a situation where that adaptation can be seen as less productive and less successful.

The Use of Ethnohistorical Materials:

One of the strengths of this study is the wealth of material written about the Aborigines of the Australian Southwest by late 18th and early 19th Century European explorers and colonists. Only through the use of these documents could this explanation of the archaeological record be presented.

Recourse to this type of material as an aid in the understanding of archaeological phenomena is a long established practice in prehistory. It has been codified under various terms, such as "the direct historical method" (Steward 1942) or "text aided prehistory" (Hawkes 1954); and more recently has been included as a form of "ethnoarchaeology" (Gould 1977a). Errors in application have been frequent, however, as is stressed in recent criticisms of the use of ethnohistory in the Australian context (e.g. McBryde 1979, White and O'Connell 1982:17-22).

The two main problems seem to be: (1) a failure to approach the materials with a sound historical method which examines the credentials of the author, takes account of the social and environmental contexts in which they were written, and then judiciously compares one source against another; and (2) a tendency to assume continuity of the life ways being described into prehistoric times without evidence that this is the case.

In using ethnohistorical materials in this thesis, a concerted effort has been made to avoid these pitfalls. Whenever possible, details of the historical circumstances in which a source document was written have been gathered and the credibility of the author

assessed. It is always remembered that these documents were written during a period of social change, that they are selective in their content because of the limited opportunities for observation and the incomplete understanding of the observer, and that the possibility of the informants purposefully misleading the observer is always present.

This is, however, an essentially archaeological thesis, and lack of space usually precludes inclusion of the deliberations surrounding the use of a given document for the reader's evaluation. In Chapter 3, a short history of the field research area is presented. This places many of the main ethnohistorical sources in context, evaluates their credibility, and provides an example of the types of materials being used. It is impossible to do this for the innumerable writings from the Southwest as a whole, but evaluations of many of the sources are provided in Crawford (1981), Hallam (1975; 1978; 1983), and Meagher (1974).

More important, the ethnohistory used in this thesis is not seen as an end in itself, a final explanation; and continuity is never assumed. These materials are used entirely in the development of archaeological models, best guesses of how things *may* have been on the basis of the available information; and the goal of this thesis is to detail the method and results of the tests which were conducted to examine the validity of these models against the archaeological record.

CHAPTER 2

MACRO PATTERNS:

FORESTS AND FORAGERS IN THE AUSTRALIAN SOUTHWEST

The western coasts of Australia were mapped in outline by Dutch mariners during the 17th Century, and in January 1696 Willem de Vlamingh marched a column of eighty cuirassed and helmeted soldiers inland across the sand hills near the Swan River for several kilometres. The heat was extreme; the landscape boring and seemingly unproductive. The few shy indigenes wore no gold trinkets, and there appeared to be nothing whatsoever worth conquering. Vlamingh's report damned the place, and 130 years passed before Europeans again took enough interest in the region to establish even a temporary settlement (Appleyard and Manford 1979).

A brief history of that earliest settlement is provided in the next chapter. This chapter concentrates on the environment and on the forager society which inhabited it for at least 40,000 years before Vlamingh arrived. It defines the region as a natural and cultural area, provides details of internal environmental variation, develops a model of protohistoric cultural ecology based on early European records, and presents a model of palaeoclimatic change based on recent Quaternary research.

Defining the Region

The concept of a "natural and cultural area" presupposes a joint distribution of significant cultural and environmental phenomena. For

the far southwestern corner of Western Australia, each of these phenomena has previously been studied and mapped separately within its respective discipline; so the tactic used to define the Australian Southwest as a natural and cultural area was simply to plot the various already defined boundaries and search for congruence. Following Peterson's (1976) stress on the importance of topography, the investigation began with the boundary of the drainage division.

The South-West Coast Drainage Division:

The environment which is characteristic of the South-West Coast drainage division (Fig. 2-1a) is relatively homogeneous, and is strikingly different from that characteristic of the two neighboring drainage divisions. As the *Atlas of Australian Resources* (1967) says, the South-west Coast division "stands out like an oasis in the the south-west corner of a 2-million square mile (5,000,000 square kilometre) expanse of arid and semi-arid country."

To the north is the Indian Ocean drainage division where the few rivers usually flow only after cyclones. In no part of that division is there an annual run-off as great as 25 mm, and evaporation normally exceeds rainfall in all months. To the east is the Western Plateau division, an area of over 2,600,000 square kilometres of uncoordinated drainage, and the *Atlas* states that it can properly be called a desert. It has no rivers at all, and no run-off. In contrast, the South-West Coast division is very wet. It has an overall run-off of over 50 mm annually, and in some of its many river basins this exceeds 200mm.

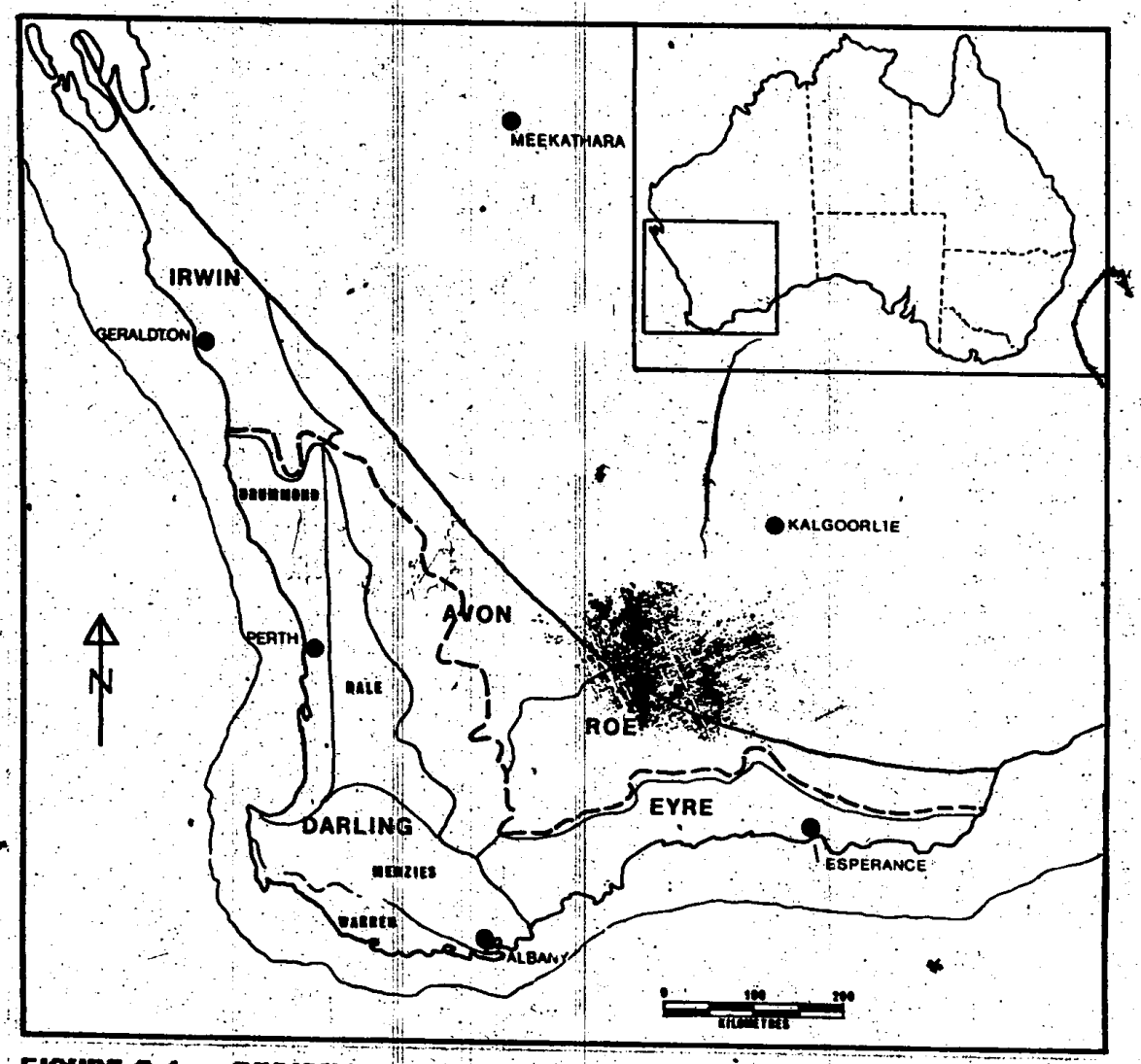


FIGURE 2.1a. REGIONAL ENVIRONMENTAL BOUNDARIES:
The thick black line dividing the Southwest from the inland is the 175 mm winter (May-October isohyet which denotes the boundary of the South-west Botanical Province.The dashed line is the boundary of the South-west Coast Drainage Division. The internal divisions are Botanical Districts and Sub-Districts after Beard (1979a), and the line off the coast is the 150 m. isobath which approximates the coastline at extreme low sea level during the late Pleistocene.

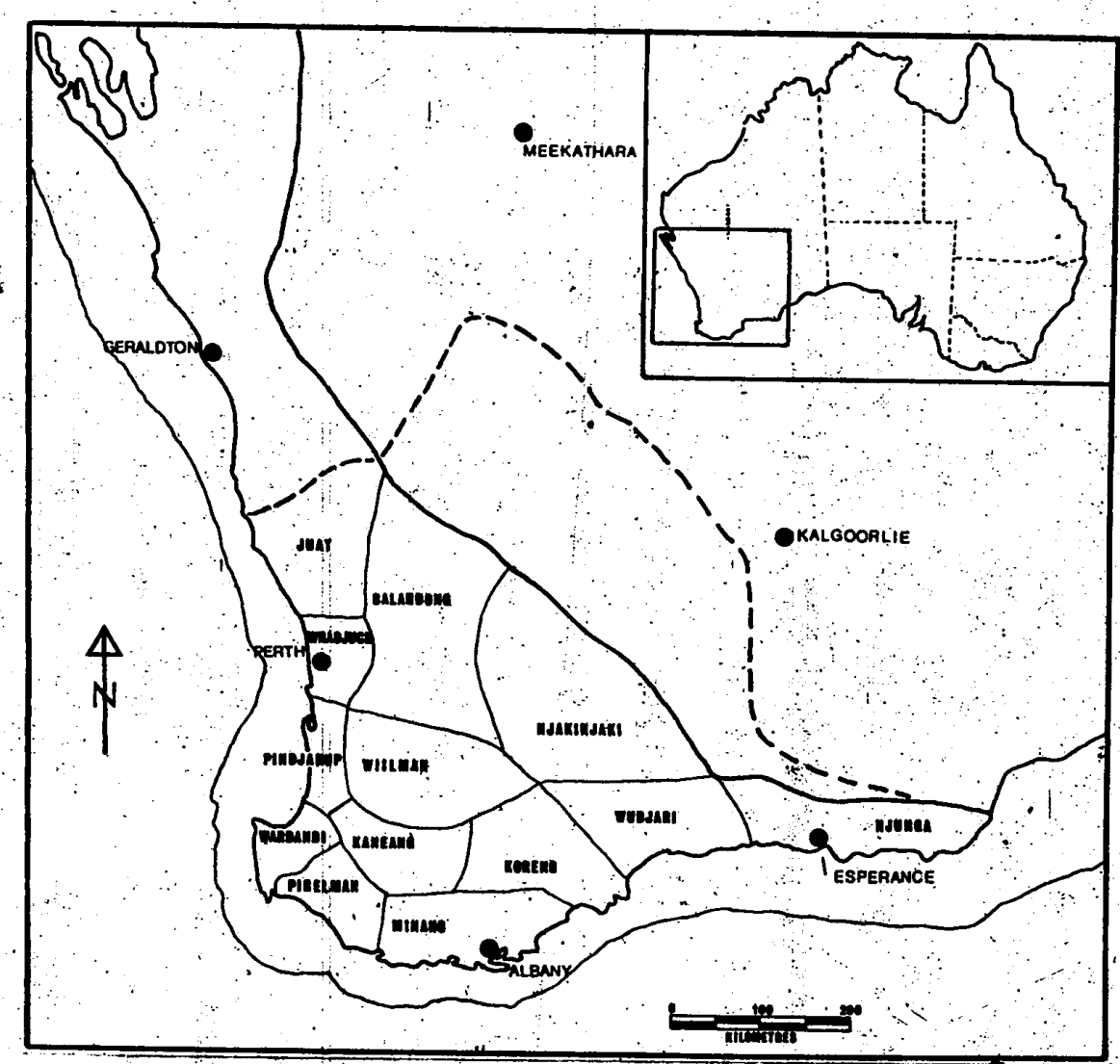


FIGURE 2.1b. REGIONAL CULTURAL BOUNDARIES;
The thick black line dividing the southwest from the inland is the western limit of the initiatory practices of subincision and circumcision. The dashed line maps the extent of the Nyungar language dialects. The internal divisions are named dialectical units after Tindale (1940,1974). See text for discussion.

The divides that mark the extent of the South-West Coast division, however, do not correspond directly with any known cultural boundaries. They are quite low, often indistinct, and they do not possess one of Peterson's presumed characteristics: they are not more poorly watered and less productive than the land to either side of them. The pattern of rainfall across the southwest of Western Australia is such that these divides receive considerably more moisture than the majority of the Indian Ocean and Western Plateau divisions do. Consequently, they form no real barrier, and almost everywhere the environment characteristic of the Southwest spreads across them to include areas of the adjacent divisons.

Peterson's basic principle, that relatively barren divides between watersheds tend to provide a location for significant cultural boundaries, is born out in this study; but on a smaller scale, and it is the divides between river basins, not those between major drainage divisions which are important. This is discussed below. For the Australian Southwest overall, however, it appears that it is not the topography, but the rainfall which is the primary factor in determining the boundaries of the natural area; and that the South-west Coast drainage division is but part of a slightly larger environmental region.

Rainfall and the South-west Botanical Province:

Rainfall is quite high in the Australian Southwest; in some places on the south coast it exceeds 1500 mm annually. The region has a Mediterranean type climate with a marked summer drought, but

the winter rainfall is notably reliable. This contrasts with the areas to the north and east where rainfall is both very low and totally unpredictable. Botanists have long noted the relevance of the area of reliable rainfall to the distribution of that flora which they found restricted to the Southwest (Diels 1906); and Gardner (1942) found that the location of the 175 mm winter (May to October) isohyet substantiated his field observations when he established a boundary for the now accepted "South-west Botanical Province" (Fig. 2-1a).

This line is without a doubt the one significant boundary that marks off the Southwest as a natural region. Included within it is all of the South-west Coast drainage division, some areas of uncoordinated drainage from the Western Plateau, and coastal portions of the Indian Ocean drainage division. Not suprisingly, the faunal distribution also approximates this line (Woodward 1900), and it has been previously used by some researchers to denote a boundary for archaeological purposes (Ride 1958, Dortch 1977).

The map (Fig. 2-1a) shows the results of the latest botanical research in the area, with Gardners's South-west Botanical Province divided into botanical districts and sub-districts following Beard (1979a). The Province includes an area of about 220,150 square kilometres and is mainly composed of forest and woodland associations with numerous small zones of sand heath and swamp. It has rich and varied flora which is radically different from the low, monotonous scrub which is characteristic of the adjacent regions.

There is also a very high degree of endemism in this isolated, wet corner of Australia. Gardner (1942) points out that over 75

percent of the species found here are found nowhere else, and a comparison of the floras from southeastern and southwestern Australia suggests that this isolated situation was probably established as early as the Miocene (Merchant 1973). The environment of the Australian Southwest is unique, and it has been unique since long before the initial colonizing of the continent by human beings.

Matching the Cultural Area:

Berndt (1973, 1979a) has singled out two traits as definitive of the Aboriginal culture which occupied the extreme southwest corner of Australia at the time of the European invasion: the Nyungar language, and a set of socio-religious practices which he elsewhere calls the "Old Australian Tradition" (Berndt 1979b:17-19). Following Berndt, it is here assumed that the joint distribution of these traits establishes the cultural area of the Australian Southwest, but for reasons discussed below there has been an adjustment of one of the boundaries he proposed.

Members of the Old Australian Tradition, most notably, do not practice the twin initiation rites of circumcision and sub-incision which are wide spread in the desert to the east. Their initiation practices are, instead, limited to the piercing of the septum and cicitrization on various parts of the upper body (Berndt 1979a:84). Tindale (1940;1974) has mapped the boundary between these ceremonial practices and those of the Western Desert Tradition (Fig. 2-1b.), and significantly, this line coincides with the boundary of the

natural area (the 175 mm winter isohyet) almost exactly for a distance of over 1200 kilometres. The Old Australian Tradition is not, however, limited exclusively to the Australian Southwest. It also holds sway in coastal portions of the Indian Ocean drainage division far to the north, but these people are excluded from the region because they do not speak a Nyungar language.

The Nyungar language is a sub-group of the Pama Nyungan pan-Australian phylic family (Wurm 1972). Like the initiation rites of the Old Australian Tradition, this language is not confined exclusively to the Australian Southwest. It is also spoken by some inhabitants of the Western Plateau already excluded from the culture area by their adherence to the Western Desert Tradition (Fig. 2-1b.). In his study, Berndt placed the northern limit of this language's distribution to the north of Geraldton, but as a result of the research conducted for this Thesis it has been placed approximately 200 kilometres further south, on the divide between the Moore and Hill Rivers.

Berndt was following the results of recent salvage linguistic surveys undertaken by Douglas (1968; 1973; 1976), and Douglas found a few living speakers of the language in the Geraldton area. Post European invasion disturbance of the traditional Aboriginal settlement pattern has been extensive, however, and it is likely that Nyungar speaking Aborigines went north to Geraldton with the Europeans when it was originally settled from Perth (Hammond 1933:11-15, Douglas 1976:7). Wurm (1972) does place this boundary further south than Douglas, but his map is of so small a scale, it is

impossible to determine exactly where he placed it, and nowhere in his writing is it clear what criteria he used for placing his boundary where he did.

The choice of the divide between the Moore and Hill Rivers as the location for this boundary is initially based on ethnohistorical sources: George Fletcher Moore, in his pioneer study of the language begun in the 1830's, stated that it was only spoken south of the Moore River (Moore 1884:vii); and Bishop Salvado described in detail two languages spoken in the vicinity of the New Norcia Mission which he established on the upper reaches of the Moore River (Salvado 1851:255-66). The one spoken to the east of the Mission is obviously a dialect of Nyungar, but the one spoken to the north definitely is not (F. Morphy *pers. comm.*).

The divide between the Moore and Hill Rivers is wide, barren, and poorly watered, and is now virtually uninhabited. It provides an excellent site for a major cultural boundary if Peterson's assumptions are correct, and there is also some archaeological evidence which suggests support for this location as the northward limit of the Nyungar culture of the Australian Southwest. Archaeological surveys conducted along the coasts of the region (Dortch 1980a; 1984a, Morse 1982, Dortch, Kendrick and Morse 1984) have noted that shell middens regularly occur as far south as the small town of Lancelin, halfway between the Moore and Hill Rivers, but no further (Dortch 1980a:26). This is relevant to the placement of the cultural area boundary because, as is discussed in detail below, unlike most coastal Australian Aborigines including those living

immediately to the north of them, the Nyungar did not normally eat shell-fish.

Summary and Discussion:

The map (Fig. 2-2.) outlines the boundaries of the Australian Southwest natural and cultural area. The inset shows these readjusted boundaries within Peterson's (1976) continental drainage division model. With the exception of the two most northerly and arid river basins (the Hill and the Arrowsmith), the area includes all of the South-west Coast drainage division, and the adjacent wetter margins of the Western Plateau division. The environment of the area is unique, and its boundaries approximate those of the South-west Botanical Province except that the majority of the relatively arid Irwin Botanical District lying north of the Moore-Hill divide has been deleted. Culturally the area is distinct and uniform in that the inhabitants possess common socio-religious practices and langauge. They also possess many other traits in common which are not found outside the area, and these points will be developed below.

The map inset (Fig. 2-2) has left the portion of the South-west Coast drainage divison which was deleted from the redefined Australian Southwest natural and cultural area as a small bounded region within the continental model, but it is not assumed that this will ultimately be regarded as a separate natural and cultural area in its own right. It has not been studied in detail during this research, and of which other natural and cultural area it rightly should be considered a part, depends on the eventual definitions of those areas.

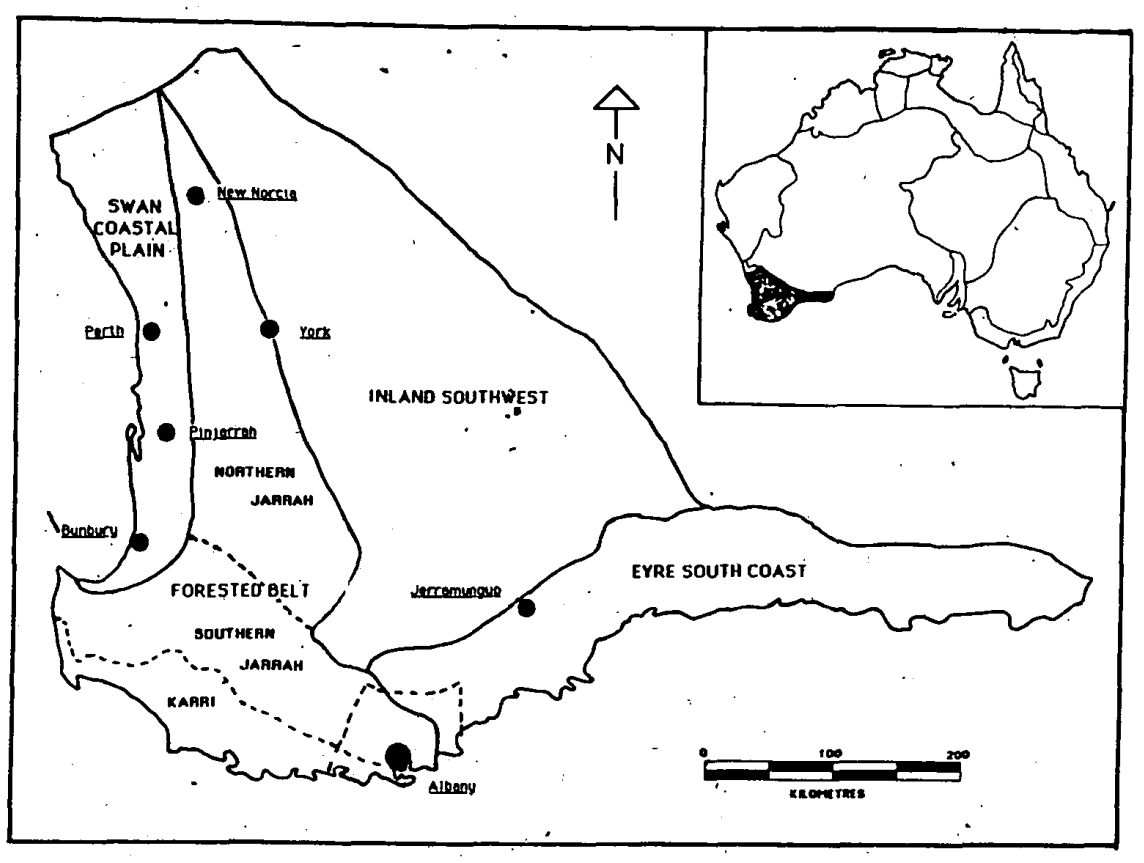


FIGURE 2.2. THE AUSTRALIAN SOUTHWEST:
The map shows the boundaries of the Australian Southwest Natural and Cultural Area as defined in the text. The internal divisions are major environmental zones, and the Forested Belt is further divided into three types of forest. The locations shown by black dots are places for which detailed ethnohistorical information is available; and the dashed line around the town of Albany on the south coast denotes the boundaries of Mokaré's Domain, the field research area for this thesis, which is discussed in the next chapter.

The sub-divisions of the Australian Southwest shown on the map are areas of relatively uniform environment within the region, and these will be discussed in the next section.

The Australian Southwest natural and cultural area is presented here as a spatial model for archaeological purposes. It is a second stage model, a refinement of Peterson's original, but the validity of its boundaries will need to be tested against the archaeological record. This should be ultimately possible. It has already been suggested that the presence or absence of regularly occurring shell middens along the coast provides one such test. There are also some composite implements with stone components which are unique to the region. At least one of these, the chopping stone from a *Kodja* hatchet, is easily recognizable in an archaeological context. With enough research, distribution maps of this artifact could provide another test of the model. This research will require a massive amount of survey and may require decades before an acceptable answer is avaliable, but a beginning is presented later in this study, and there is a preliminary distribution map of known *Kodja* stone finds in Chapter 6.

Undoubtedly many other possible ways of testing these boundaries exist. We are limited only by our lack of knowledge of the archaeological record and the imagination of our archaeologists. The precise locations of the boundaries aside, however, the basic concept of the model, that there is an Australian Southwest natural and cultural area, can be tested in ways similar to that which is the main focus of this thesis. The logical archaeological implications of

modelled interactions between the area-specific environment and culture can be predicted, and the validity of these predictions subsequently tried against the archaeological record.

Internal Environmental Variation

The Southwest is relatively uniform in both topography and geology (Fig 2.3a), but due primarily to the steep rainfall gradient (Fig 2.3b), there are quite sharp changes in the dominant types of vegetation which enable it to be divided into four distinct major environmental zones (Fig. 2.2). These are introduced briefly in this section as an initial guide to an understanding of the overall environment of the area. Additional details which are specifically relevant to the exploitation patterns of the Nyungar are included in later sections of the Chapter.

The Forested Belt:

The Forested Belt is the term used here to denote that portion of the Southwest dominated by thick sclerophyll forests, and its boundaries are synonymous with those of the Dale, Menzies, and Warren Botanical Subdistricts as defined by Beard (1979a). This zone bisects the natural and cultural area from south to north, and is basically wedge-shaped. It is approximately 300 kilometres wide along the south coast and gradually tapers away to nothing at the northern boundary of the region. There are really only two dominant types of trees, Karri (*Eucalyptus diversicolor*) and Jarrah (*E. marginata*); but there are three main types of forest.

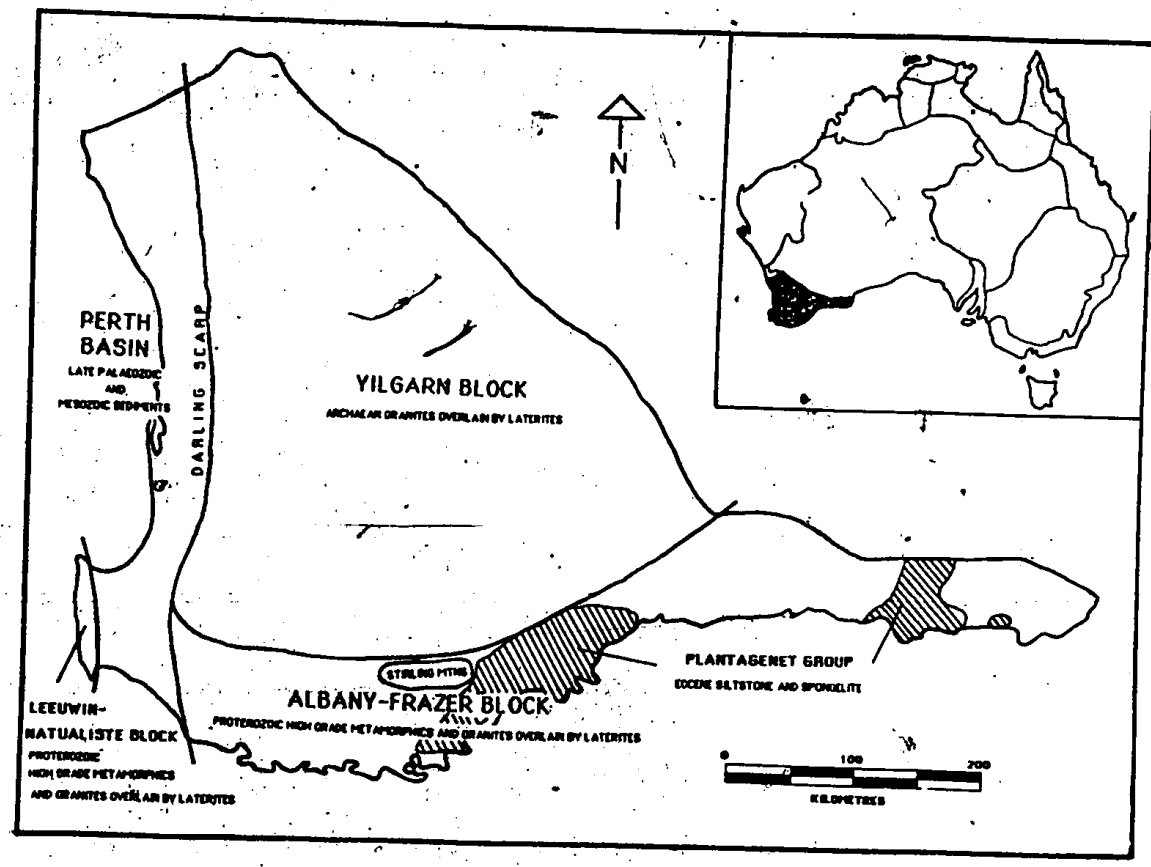


FIGURE 2.3a. MAJOR GEOLOGICAL FEATURES (After Johnstone, *et. al.* 1973).

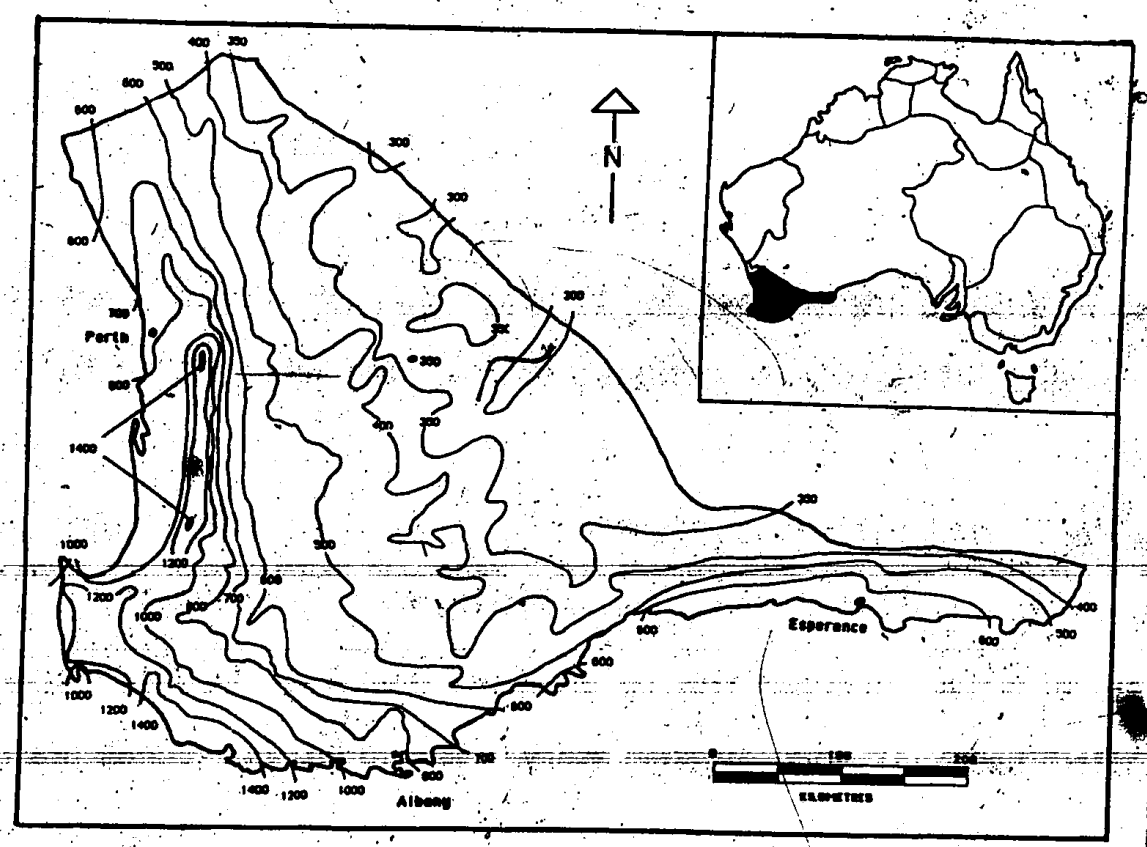


FIGURE 2.3b. RAINFALL (After Western Australian Year Book 1980).

THE KARRI FOREST: The Karri forest is concentrated along the south coast, in a narrow strip running from the west coast to Albany. It extends less than 100 kilometres inland at its widest point. It is co-extensive with the Warren Botanical Sub-district; and covers the southern portions of the Leeuwin-Naturaliste block and the Perth basin, and the southwest corner of the Yilgarn block. This is deeply dissected, undulating country of generally low relief.

The Karri forest is a tall wet sclerophyll forest (Rossiter and Ozanne 1970:202) with a general canopy level of about 70 metres in height. There is a thick continuous understory of soft leaved plants about three metres high which is dotted with ten metre high trees of various species, and there is a ground cover of creepers and shrubs (Beard 1979b).

The distribution of these trees is dependent upon two factors, the climate and the soil. The Karri requires a cool, moist climate where the effective rainfall lasts for at least eight months of the year. Although luxuriant growth requires at least 1000 mm of rainfall per year, it will grow with as little as 700 mm if the eight month requirement is fulfilled. However, no matter how high the rainfall, Karri will not grow except on suitable soils. Karri grows on red loams, red podzols, and on some yellow podzols; but it avoids laterites, sands and the poorer yellow podsols (McArthur and Clifton 1975).

THE SOUTHERN JARRAH FOREST: The Southern Jarrah Forest extends northward from the Karri Forest for about 100 kilometres. It is distributed primarily on the dissected laterites which overlie the

Archaean granites at the western edge of the Yilgarn block. The Jarrah grows on these laterites and on poorer sandy soils. The rainfall across this area varies from 1000 to 600 mm per annum, but is reliable for seven to eight months of the year.

The Southern Jarrah forest is less uniform than the Karri Forest. It is a mixed wet-sclerophyll and dry-sclerophyll forest (Christensen and Kimber 1975:87), and would be more properly called a Jarrah-Marri forest, because Marri (*Eucalyptus calophylla*) normally accompanies the Jarrah in proportions varying from 50 percent downwards. Also, towards the drier inland boundary of the zone, the forest opens out into woodland with an increasing admixture of Marri and Wandoo (*E. redunca*). In the forests proper, the canopy is from 20 to 30 metres in height. There is a lower layer of smaller trees at about seven metres, and a normally dense understory of sclerophyll shrubs at about one to two metres (Beard 1979b).

THE NORTHERN JARRAH FOREST: The Northern Jarrah Forest is a dry sclerophyll forest, co-extensive with the Dale Botanical Sub-district. It is distributed on the western edge of the Yilgarn block, again growing primarily on the dissected laterites which overlie the granite basement (Shea, *et.al.* 1975).

It is similar to the Southern Jarrah Forest, but it becomes more open to the north, has less Marri, and there is a considerable difference in the understory. These forests are thickest on their western margin, along the Darling Scarp. In the east and north where the rainfall decreases, they thin rapidly to open Wandoo and York Gum (*E. loxophleba*) woodlands (Beard 1979c).

The Swan Coastal Plain:

The Swan Coastal Plain is a narrow strip of land lying between the Indian Ocean and the Darling Scarp, and averaging about 30 kilometres in width. It is part of the sedimentary Perth Basin, and its boundaries include the Drummond Botanical Sub-district and southern portions of the Irwin Botanical District.

The Swan Coastal Plain is relatively fertile and well watered. Its soils are primarily a series of sand dunes of differing ages and composition which run parallel to the coast. These are relics of several Quaternary beach stands, and in places they are partially overlain with alluvium washed down from the Yilgarn block to the east. (McArthur and Bettenay 1960). A number of large rivers which form extensive estuaries traverse the Plain, and there are numerous interdunal swamps and lakes usually found at the intersections of the different dune systems.

The vegetation consists primarily of *Eucalyptus* woodland and *Banksia* low woodland, interspersed with heath, *Acacia* thickets, and scrub formations. Open forests of Tuart (*E. gamphocephala*) are concentrated along the southern and western parts of the plain, growing where the underlying calcarenite is close to the surface (Beard 1979c).

The Inland Southwest:

The Inland Southwest incorporates the portions of the Avon and Roe Botanical Districts which are included within the natural and

cultural area. Rainfall here is lower, ranging from 650 mm to 300 mm annually. Much of this area has uncoordinated drainage and there are numerous salt lakes. It is a gently undulating plateau of low relief, and the soils are mainly sands overlying clays with some hard setting loams on the slopes and bottom lands. Here the forests are replaced by *Eucalyptus* open woodlands which grade into mallee and scrub heaths along the eastern margins (Beard 1979c).

The Eyre South Coast:

The Eyre South Coast corresponds to the Eyre Botanical District. Although this coastal region receives more rain than the inland, due to the poverty of its leached-out sandy soils, it is normally unable to support more vegetation than heath with an open layer of stunted mallee. True mallee is restricted to the hills and valleys, and woodlands are virtually non-existent. The geology is mainly Eocene marine sediments with outcrops of granites and quartzites (Beard 1979b).

In the eastern portions of this zone where the environment begins to resemble the more arid Western Desert, the local Nyungar (the dialectical grouping called "Njunga" on Figure 2.1b) developed a partially transitional life-style. For example: although they did not subincise, they did practice a form of circumcision (Tindale 1974). Extensive ethnohistoric information is lacking for this area, but presumably, given the nature of the environment, their adaptation differed somewhat from the normative overview presented below.

The Nyungar: Foragers of the Woodlands.

Population Size and Social Order:

There is no really good estimate of how many Nyungar there were when the Europeans arrived, but the overall population size was quite small. The most quoted figure is by Radcliffe-Browne (1930a) who estimated about one person for every 10.36 square kilometres. This is probably an overestimate, since this level of density was possibly only reached in the most thickly populated parts of the Swan Coastal Plain.

Hallam (1978) has done an extensive study of this aspect of Nyungar society. She has carefully examined the ethnohistorical records for the region around Perth; and after checking all Aborigines mentioned by name, has come up with a figure similar to Radcliffe-Browne's for that area. She also presents apparently quite reasonable figures compiled by Bishop Salvado in the 1840's for the Northern Jarrah, New Norcia area which are somewhat lower, about 1 person for every 12.95 square kilometres. For the Albany area which includes both Southern Jarrah and Karri forests, Le Souëf (1980) has suggested a much lower figure, 1 person for every 25.9 square kilometres. This last study was done using Hallam's method, but the source material was not as detailed, and it is probably an underestimate. Another attempt to provide a population figure for the Albany area using different methods is included in the next chapter. It provides a significantly higher estimate, but no way of testing the validity of either figure seems possible.

The only real unit of political organization among the Nyungar was the land holding family (Hallam 1975, Meagher and Ride 1979). These units were linked very loosely together into bands on the basis of extended kinship networks; but the structural details of these networks apparently varied considerably from one part of the region to the next, and ultimate authority always rested with the individual family heads (Radcliffe-Browne 1930b).

There has been an attempt to organize the kinship bands of the Southwest into thirteen tribes on the basis of language unity (Tindale 1940; 1974). These are shown on Figure 2.1b; but the concept of "tribe" is of doubtful validity in the Australian context (Berndt 1959), and these divisions should be considered as dialectical units of the Nyungar language without political ramifications (Berndt 1979a).

Details of the patterns of social interaction and territoriality among the Nyungar are discussed in the next chapter where an ethnohistory based model of cultural ecology for an individual Nyungar land holding family is presented.

A Singular Focus of Adaptation.

For some reason, explicable perhaps in their routes of migration into the region, the Nyungar ignored much of the economic potential of the thousands of kilometres of rich ocean shoreline. In spite of the many rivers and extensive estuaries, they were without watercraft of any kind, and they did not even swim (Flinders 1814:66, King 1827:137-8, Lockyer 1827:465-9, Barker 1830-31:20-1-30, Nind

1831:32, Wilson 1835:260,283, Browne 1856:268, Eyre 1859:218, Roth 1903:65).

They had no fish hooks or nets (Flinders 1814:66, Nind 1831:33, Roth 1903:47). They fished in the shallows of rivers, estuaries, and harbours with spears; and they constructed fish traps of stone and wood to aid them in this endeavour (Baudin 1800-3:173,178,487, Vancouver 1801:148, Peron and Freycinet 1807:151, Lockyer 1827:479,485, King 1827:16:122, Fremantle 1829-32:39, Irwin 1835:23, Wilson 1835:283, Grey 1841:275, Backhouse 1843:527, Browne 1856:260, Chauncey 1878:248-9, Roth 1903:47, Hammond 1933:25,46). They might also take a young or sick seal which washed onto the beach from one of the thriving island colonies just off-shore (Vancouver 1801:139-40, King 1827:127, Nind 1831:34, Grey 1841:278), but that is all.

The rich oyster beds in King George Sound, on the south coast, appear to have been untouched until the Europeans arrived (Vancouver 1801:142-3); and although the ethnohistory is both comparatively mute and somewhat contradictory on the subject, there is little question that traditionally the Nyungar probably resorted to eating shell-fish only as a rare starvation food (Vancouver 1801:140, Nind 1831:33, Grey 1841:84, 288,290, Jackman 1855:200). The very few, very small scatters of shells with stone artifacts which have been discovered after extensive archaeological survey (Dortch 1980a; 1984a, Dortch, Kendrick, and Morse 1984) possibly even result only from the recorded usage of shell-fish as bait to attract fish into the shallows (Nind 1831:33), and their shells as tools (King 1827:138,

Grey 1841:266, Roth 1903:68) and ornaments (King 1827:143, Parker 1886:337, Hassell 1975:79).

The Nyungar were primarily oriented to the dry land, but like the sea, the areas of dense forest were comparatively marginal to their economy. The primary focus was the rich woodlands which surrounded and wound through the forests. Hallam (1975) has already documented the ethnohistoric evidence which suggests this aspect of Nyungar adaptation as part of her major study of the burning regime which they used to keep the woodlands free of undergrowth.

Direct evidence is provided by two early explorations from the Swan Coastal Plain to the inland and back, one through the Northern Jarrah forest (Erskine 1833) and one through the Southern Jarrah forest (Grey 1841:1, 310-28). On both sides of the forests, these authors reported meetings with Aborigines and evidence of Aboriginal activities: large recently burnt areas, trackways, and huts. In the forested areas in between, however, they neither met Aborigines or saw any traces of their activities. Grey, especially, described the difficulty of traversing through the thick undergrowth of this country, and although he expressly searched for Aborigines as guides, he could find none.

Hallam suggests these were not isolated instances. She provides other less direct, but similar, references to the difficulty of moving in the forests when a local Aboriginal guide was not obtained in advance (Bannister 1833, Anon. 1833, Hammond 1936); and for contrast, presents countless references to sightings of Aborigines or their traces, and to ease of movement in the open parklike landscape

of the frequently fired woodlands. In total, it is a reasonably strong ethnohistorical argument, and although certainly not unquestionable on the basis of this evidence alone, the nature of these forests give it a strong logical plausibility.

The thick undergrowth which is the norm in these forests and often the extremely close spacing of the trees themselves, inhibits movement and limits visibility to the extent that hunting animals without firearms is virtually impossible. Moreover there are extremely few game animals which inhabit these areas in any case. This lack of available game was noted in the ethnohistorical record (Grey 1841:1,321-2, Bannister 1833:103), and has been substantiated by modern scientific study.

The Western Grey Kangaroo (*Macropus fuliginosus*) and the Brush Wallaby (*Macropus irma*) are the most common and wide spread large macropods in the region. Extensive survey has shown that their numbers vary inversely with the amount of undergrowth in the area they inhabit. Their populations are highest in the open woodlands and lowest in the Karri forest, where the wallaby are totally absent (Christensen and Kimber 1975:98-9).

Nor are the forests as rich in plant resources as might be expected from the density of the vegetation. Temperate, mid-latitude deciduous and evergreen forests are generally considered to be among the least productive environments in the world (D. Harris 1969:5), and these forests are specially so. The Southwest is noted for one of the highest levels of plant species diversity in Australia, but this masks the fact that the heavily forested areas, quite unlike the generally

mixed forest of eastern Australia (Rule 1967:14), are normally dominated by one or two species of Eucalypts with as few as 100 associated species (Marchant 1973).

The region's great variety of species is concentrated at the forest edge, in the woodlands, and along the banks of the rivers, lakes and swamps. There are some known Aboriginal food plants which do grow in the forests proper (compare lists of forest species in Christensen and Kimber 1975 with lists of ethnohistorical plant foods in Meagher 1974), but they are thinly spread and access is often extremely difficult.

In the next chapter, the results of a controlled archaeological survey to test this spatial model of Aboriginal land use are reported, and the test provides strong support for Hallam's suggestion of much greater prehistoric occupation in the woodland areas than in the forests. Before going on to the details of Aboriginal adaptation to the Southwest woodlands, however, a short discussion seems warranted on why, if the forests were so unproductive, the Nyungar just didn't burn them and turn them into woodland.

The Nyungar did burn the forests, around the edges, and they kept corridors open for movement through them (Hallam 1975), but burning in these forests is extremely labour intensive. The build up of forest litter is quite rapid. In the drier Northern Jarrah studies show that litter accumulates at a rate as high as 18.4 tonnes per hectare over a period of six years (O'Connell, *et.al* 1978), and accumulation is estimated to be at least three times faster in the Karri forest (Christensen and Kimber 1975:87). It is possible to turn

the drier parts of the Jarrah into woodland, but burning must be done on an annual basis (Christensen and Kimber 1975:105).

The Karri, especially, does not respond well to burning, with either hot or cool fires. With so much potential fuel, a hot fire in this forest is disasterous and produces a uniform and complete destruction rather than the desired mosaic of burnt and unburnt areas (Christensen and Kimber 1975:104-5). Moreover, the Karri regenerates from soil-stored seed, and regeneration is rapid in the ashbed of such a fire (Loneragan and Loneragan 1964). Regrowth is very rapid in youth, and Karri almost immediately forms dense clumps of pure stands in a recently burnt area (Rule 1967:14). Cool fires, on the other hand, produce an entirely different type of problem: "the fire killed thickets of undergrowth, grown so densely that they fall over in one solid mass, present an obstacle almost as formidable as a zareeba made of African thorn tree" (Rule 1967:14).

An Economy Based on Generalized Foraging and Extreme Mobility:

The Nyungar procured their sustenance fresh from nature on a day-to-day basis, and the storage of foodstuffs formed only a very minor part of their exploitation strategy. They exploited a wide variety of food resources, and there does not seem to have been any strong reliance on a limited number of dominant staple resources. There was, rather, an emphasis on the comprehensive use of a diversified and widely scattered resource base.

An extensive but minimal listing of food resources, the seasons of their availability, and the methods of use, has been presented by

Meagher (1974). The information was gathered primarily from the ethnohistorical literature, and some additions to the list from similar sources are included in Meagher and Ride (1979) and Hallam (1974a:1975). These resources include almost everything possibly edible other than shellfish: mammals, birds and eggs, reptiles, frogs, fish and fresh-water crayfish, insects and grubs, roots, bulbs, seeds, nuts, fruits, nectars and edible gums, fungi and even moulds.

This emphasis on the exploitation of a diversified and widely scattered resource base required the population to be highly mobile. The ethnohistorical sources are dotted with remarks like "they were seldom stationary" (Nind 1831:28), or that "their time is entirely spent in moving from place to place" (Lyon 1833:150). Only two authors, however, give any indication of exactly how long they normally spent in one place. Jackman (1855:164) says that they rarely stayed anywhere more than two or three days; and Hammond (1933:25) says that they stayed often only one day, and rarely more than a week in one place. Since fresh-water was almost universally available and much of the resource base was fairly evenly but thinly scattered across the woodlands, they did not necessarily always use a "base-camp" strategy; but foraged the daily food while moving slowly from one place to another, sometimes even camping alongside a kill (Nind 1831:37, Collie 1834:319, Grey 1841:263, Salvado 1851:154, Hammond 1933:40).

The reason most often given for why they moved so much was the need or desire to exploit food resources not present in the area where they were currently located (Nind 1831:28, Lyon 1833:150,

Irwin 1835:23, Grey 1841:262, Browne 1856a:259, Roth 1903:59, Hammond 1933:25, Hassell 1975:24). Other reasons include: getting away from the build up of rubbish and consequent insect pests present at anywhere they had camped for very long (Browne 1856a:259, Knight, *et.al* 1886:331, Roth 1903:61); and socio-cultural reasons, a death in the camp (Browne 1856a:259, Hassell 1975:13), visiting others (Lyon 1833:150, Salvado 1851:165), getting off by themselves (Hassell 1975:13), and making it difficult for their enemies to find them (Browne 1856a:259).

Several of the early European writers inferred that there was a rigid seasonal pattern to their movements: that the Nyungar spent their winters inland and their summers on the coast (Stirling 1827:570, Fremantle 1829-32:52, Nind 1831:28, Collie 1834:315) Browne 1856a:260-1). This does not seem to have really been the case when these movements are studied in detail. There was, perhaps, a drift towards the coast as a result of localised water shortages inland in the summer; but as is documented in the next chapter, throughout the region, individuals and groups could be encountered almost everywhere, during any season. The Southwest was a rich environment. Many of the most common staple resources listed in Meagher (1974) were available all year long; and most areas, including the forests, provided at least some foods at all times.

This extremely high mobility in a comparatively rich environment is without parallel in the ethnographies of hunter-gatherers, and should give archaeologists pause in the assumptions they automatically bring to the interpretations of their

sites. The pattern of short stays of a day or two at each camp, a habit of foraging on the move, and the general lack of seasonality in choice of locations render the "base-camp" concept and resulting site-catchment studies somewhat suspect unless it can be shown that the society under study actually had them.

Scheduling (Flannery 1968) for the Nyungar appears to have been a relatively ad hoc process. Several desirable resources became available simultaneously at each season of the year, and each resource could usually be found at several locations. Exactly which combinations of resources they chose to exploit and where they chose to go to exploit them certainly did change from year to year, and the choices they made were probably dictated more by ephemeral social factors than by anything else. The structure of Nyungar foraging groups was extremely fluid, and the entire society was constantly on the move. Which friends or relatives an individual or group wished to join, or which enemy they wished to avoid; and where those people were likely to be at any given time, usually determined the route and destination of any movement more than any specific concern for food resources. There was always plenty to eat, whatever decisions were made.

This theme of casual but constant mobility is stressed in this thesis, because it is apparently unique and because it helps to explain the archaeology. Readers who are initially confused by the concept or doubt its reality are requested to be patient. Documented details of how it operated and the social structure which made it possible are provided in the sections below and developed in the chapter which

follows.

Trackways and Camps:

The movements of the Nyungar foragers, although basically unpredictable at the individual level, were not totally unpatterned. Each family had a specific, most frequented, focal point from which they travelled outward, and to which they always eventually returned. They moved only within an area circumscribed by their friendly relationships with neighboring groups, and there was a tendency to move along well established routes. Over time these routes became defined by well worn trackways described as looking "like cattle pads and just as plain" (Hammond 1933:17).

The entire Southwest was laced with these trackways, and they were common in other parts of Australia as well (e.g. Tindale 1974; 1976, Jones 1971, McBryde 1974, Pretty, *et al.* 1977). Figure 2.4 shows two photographs of ethnographic trackways taken in northern Australia to make it clear just what type of phenomenon is being discussed; but it should be remembered that in the Southwest, where the surrounding vegetation was generally of much greater density, the trackways were probably normally more strongly defined.

In the Southwest the most frequented trackways followed the corridors of easiest movement along riverbanks and through mountain passes, connecting all the main camping places and resource areas into a vast network. Their general routing was undoubtedly conditioned by the overall topography of the region more than any other single factor. There were also innumerable smaller, less

FIGURE 2.4a. TRACKWAY:
Barunguan man walking along an Aboriginal track near mouth of Stewart River, February 1928. Taken from Tindale 1974

FIGURE 2.4b. TRACKWAY:
Aboriginal boys using an Aboriginal Trackway in Western Arnhem Land, late 1960's
Photograph courtesy of Nick Peterson

traversed, but still clearly defined trackways which connected the main network with other less frequented camping places and resource areas. Their routing was probably determined on more immediate considerations and they would have been considerably more ephemeral.

Every Nyungar knew the trackways in his own district well, their routings, where they eventually terminated, and what resources lay along them. They distinguished several grades of trackways on several criteria, just as we distinguish lanes from avenues, and streets from highways. The primary and most used trackways were called *bidi*. In George Fletcher Moore's descriptive vocabulary of the Nyungar language, compiled in the 1830's, this term is defined as meaning: "the main path or track, pursued by the natives in passing from one part of the country to the other, and which leads by the best watering-places" (Moore 1884:8). Several other such terms are defined in this source, including one for wilderness: *Idurlin*, which literally means "trackless; untraversed; without a path" (Moore 1884:69).

When the Europeans came, the Nyungar led them along their trackways, and the early explorers often recorded the routings fairly precisely for future reference. Figure 2.5 is a provisional model of the routings of the main trackways, the *bidi*, across the Southwest which was compiled from these sources. Other, more precise models, based on parts of this overall network are included in later chapters of this thesis where they are used as an aid in defining the boundaries of the field research area and to predict the location of major

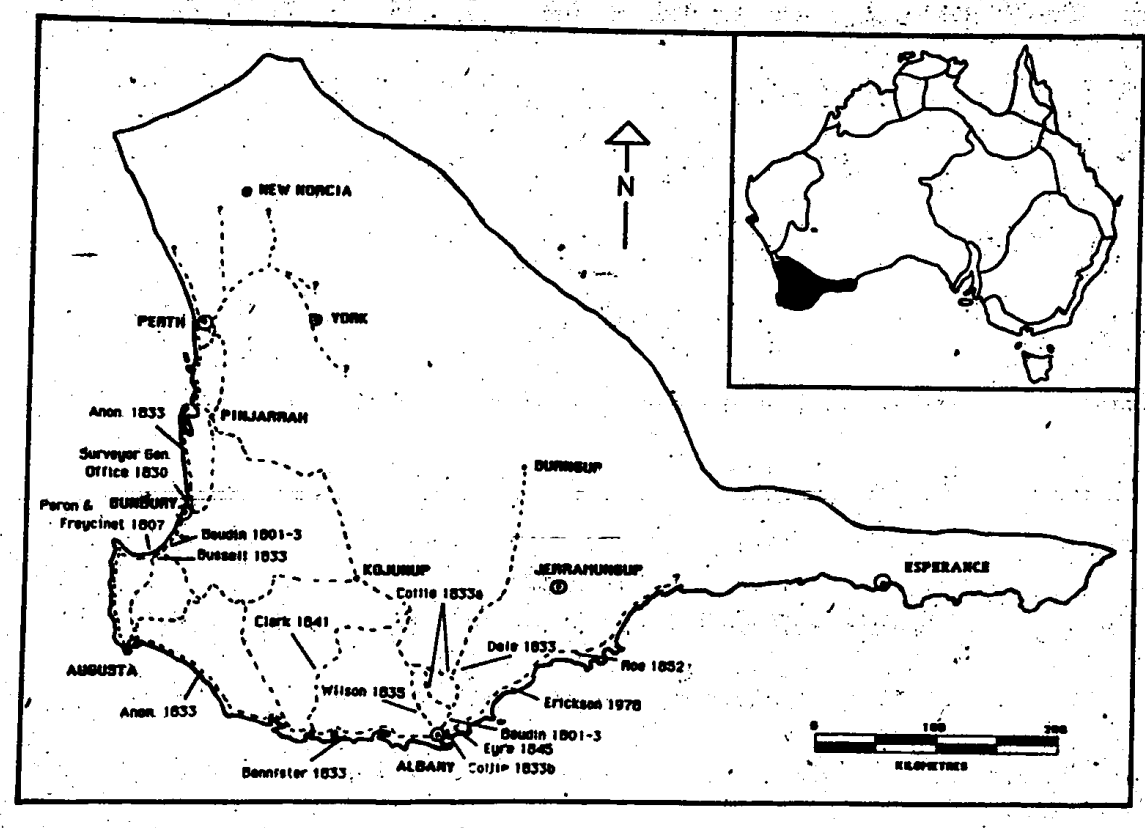


FIGURE 2.5. A MODEL OF THE PROTOHISTORIC TRACKWAY NETWORK: The map shows a provisional model of the routings of the main Nyungar trackways (*Bidi*). It is based on an overview provided by Hammond (1933) and augmented by confirmations and additions from other authors as shown. It should be considered as a bare minimum. Detailed research of sources covering the northern part of the region has not been undertaken by the author, and a good deal of refinement should be possible for all areas. No model of these trackways at this scale can hope to be very accurate, and a large amount of detail available for portions of this nework has been lost.

These routings were plotted in the following manner: (1) If the precise routing of a trackway is clearly stated, it was followed. (2) If no specific routing from one named place to another is given but the trackway is mentioned, a river course was followed if one was available. These routes often followed rivers (Hallam 1975). (3) If no river was present, the routes of modern highways between named places was followed. Early colonial roads were often laid out following the Aboriginal trackways (Hallam 1975). (4) If no highway was present, the shortest route was drawn irrespective of terrain.

archaeological sites.

A reasonably comfortable and adequately watered place to camp for a night can be found within a few hundred metres of almost any given point in the Southwest woodlands, and the Nyungar could and did on occasion camp virtually anywhere they happened to be when they decided it was time to stop foraging for the day. More frequently, however, since they knew the country they were moving through very well, they directed their movements toward a well known and well provisioned spot at which they had previously camped.

The best and most frequented camping spots were, not surprisingly, locations where the main trackways intersected (see Hallam 1975:77 for discussion). There was virtually always someone present at or near these places, although the compositon of the resident population shifted constantly as people came and went (Hammond 1933:20). Good friends and relatives camped with or near each other, and those less closely affiliated camped somewhat further away (Hammond 1933:26, Hassell 1975:73).

The basic unit of the Nyungar camping pattern was a small, temporary hut (Fig. 2.6a), which was roughly between a metre and two metres in height, and 1.3 to 2.3 metres in diameter. This they used as modern campers use a pup tent: as a place to sleep, or to huddle if the weather was exceptionally inclement, but normally all activities except sleeping were carried out in the open air (Hassell 1975:29). These were used year round in the southern parts of the region but only during the winter months in the north (Salvado 1851:166).

This hut was sturdy and reasonably waterproof, and of a

FIGURE 2.6a. A NYUNGAR HUT.
This sketch is of the first Nyungar hut seen by the English. It was drawn by John Sykes, artist on Vancouver's voyage of discovery, 1791. Taken from Chapman (1979).

FIGURE 2.6B. A NYUNGAR CAMP:
This engraving is entitled "A Deserted Indian Village in King George III Sound, New Holland". It is after John Sykes and included in Vancouver (1801) from which it was taken. This source also includes a detailed description of the "village".

standard design throughout the region; but that design was flexible enough that it could be adapted to suit whatever local materials were immediately available (Moore 1884:58). Most importantly, given the fact that the highly mobile life style was such that a Nyungar family might be sleeping in a different location each night for several nights running, it could be built quickly. Irwin (1835:23) says that it took only "a few minutes", and Chauncy (1876:252) actually timed the completion of a "well built and symmetrical hut" by two women at thirty minutes from the time they arrived on the ground and began to collect materials.

Presumably for reasons of sanitation, the Nyungar never reoccupied a hut after it was once abandoned (Chauncy 1876;252); and consequently, there were vast numbers of them in various states of decay dotted across the occupied portions of the Southwest. After "recently burnt ground" and "native path", they are the sign of Aboriginal activity most frequently mentioned in the ethnohistorical record. Fairly precise details of their construction are ubiquitous, and it has been possible to develop what should be an accurate model of what the undisturbed remnants of one would look like in the archaeological record (Fig 2.7). Unfortunately, no suitable situation in which to test this model was found during the field research.

The huts could provide sleeping space for from two (Clark 1842:5) to possibly seven (Hammond 1933:26) persons. There was usually one hut for each nuclear family, but if the family was large, two huts were built hinged together at the openings as in the huts in the middle distance of Figure 2.6b. The single men slept in a separate

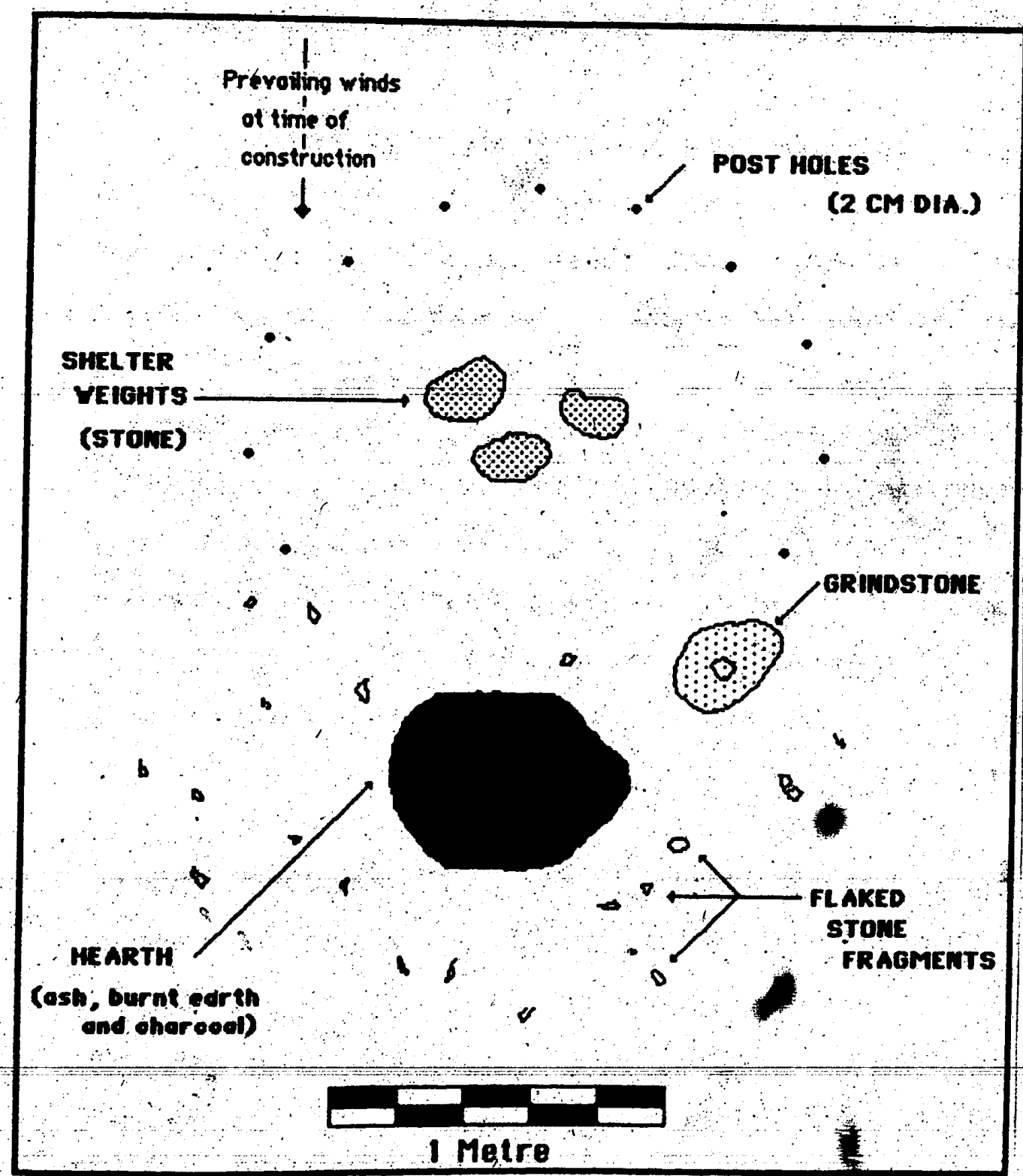


FIGURE 2.7. MODEL OF THE BASIC UNIT OF THE NYUNGAR CAMPING PATTERN:
Little evidence of an overnight stay by a Nyungar family would be preserved in the archaeological record, and the model shows what would probably be the maximum. The minimum, the things that would always be present, is the post holes and the hearth alone. The shelter weights are only mentioned by one author, the Nyungar usually took their grindstones with them when they left, and the stone flakes are an archaeolgist's hopeful vision.

This model is based on comparisons between the information provided by the following sources: Hassell 1975, Roth 1903, Hammond 1933, Salvado 1851, Vancouver 1801, Wilson 1835, Nind 1831, Moore 1884, Peron & Freycinet 1807, Chauncy 1876, Irwin 1835, Clark 1842, Grey 1841, Browne 1856a, Collie 1834, and Knight, *et. al.* 1886.

hut together, and while it was normally the task of the women to build the huts, the single men often built their own (Grey 1841:252, Roth 1903:65).

The huts were arranged across the campground all facing the same way, with the opening away from the prevailing winds; and individual sites were chosen with regard to shelter from the wind and a soft, well drained ground surface, usually sand (Nind 1831:27, Hassell 1975:29, Roth 1903:61). There was usually not very many contemporaneously occupied huts in one spot. Sightings of lone huts are legion, two or three was the norm, and there were rarely more than seven or eight (Nind 1831:28, Browne 1856a:259). They were set on the campground from a few to twenty metres apart (Roth 1903:62), but the Nyungar preferred a certain amount of domestic privacy.

The single men always built their huts well away from the families (Grey 1841:252, Roth 1903;65), and if a large number of people happened to be camping in the same place, they spread out at a considerable distance. During the time Phillip Parker King was anchored at King George Sound in 1821, he was visited by up to 40 Nyungar males per day (1827:137), but these arrived in groups of "never more than three or four" by different trackways, and each group left together in the evening down the same trackway on which they had come (1827:140-1).

These groups rearranged themselves during King's two week stay (1827:148), different combinations coming down different trackways. Although the Nyungar were always moving camp, it was apparently very often primarily for hygiene or social reasons and they

might not necessarily move very far. "Thus influenced by the exigencies of the moment, on breaking up the establishment they may, perhaps, move off for miles from the old position; or they may erect their new wigwams within sight of the old ones," (Browne 1856a:259).

This pattern of constant movement, short stays, and dispersed camps suggests an archaeological model of a Nyungar domestic site where the remains of a single camping event will be quite sparse and very widely scattered. Prime camping areas which are focal points in the overall pattern of exploitation, however, will have been the location of many such camping events within a relatively short time span. Direct superimposition will be rare, at least for as long as the previous huts remain standing, but a lot of disturbance of previous remains can be assumed, specially since the soil can be expected to be usually quite sandy.

In such circumstances relatively dense artifact scatters, if they cannot be shown to be the result of specialized quarrying and/or primary stone reduction activities, are likely to normally represent quite jumbled palimpsests of a very great number of brief camping events, and to have taken a considerable length of time to accumulate. This type of site will probably also be either very large in area, or only one of several such sites in the immediate vicinity.

Portable Material Culture and Economic Facilities:

The Nyungar's material culture was notably uniform throughout the region. There are very similar descriptive inventories presented

in the ethnohistorical records for Jerramungup (Hassell and Davidson 1936, Hassell 1975), Albany (Nind 1831, Browne 1856), Bunbury (Roth 1903), Pinjarra (Hammond 1933), Perth (Moore 1884), York (Chauncey 1876, Parker 1886), and New Norcia (Salvado 1851) (See Fig. 2.2 for locations). Numerous other writings give partial inventories or descriptions of individual implements, and these support the overall picture of uniformity presented by the main sources above. Unfortunately, the very few sources known to the author which describe the material culture in the eastern parts of the region are woefully incomplete, so it is not known if the uniformity extended all the way to the borders with the Western Plateau Region.

The rain and cold necessitated clothing, and both the men and women wore cloaks (*buk'a*) stitched together from several Kangaroo skins. On the south coast these were worn all year round; and, during the winter, the Nyungar carried smouldering banksia cones underneath their cloaks for added warmth. They also regularly smeared their bodies with a mixture of animal fat and ochre. This was normally viewed by the early Europeans as a form of personal adornment, but a few also note its functional purpose in giving added protection against the elements in both summer and winter (Hammond 1933:32, Clark 1842:5).

The men also wore a belt or girdle (*nulbarn*) which was spun by their wives from possum fur, and into which was stuck their hatchet (*kodja*), knives (*loop*), throwing stick (*dowk*), and boomerang (*kylie*) when they were on the move. Smaller items: flaked stone, spear barbs, ochre, etc., were also carried in this

fashion.

The women carried their smaller portable items in a Kangaroo skin bag (*gala*) which was worn slung over the shoulder by a strap. If they had an infant, it rode in another, similar bag (*gunein*). The rather gauche action of turning out a lady's shoulder bag was undertaken separately by Grey (1841:266), Hassell (1975:41), and Salavado (1851:149). The contents varied somewhat, but a total inventory is as follows: a grindstone, stone flakes for spears and knives, spare *kodja* stones, stones for magic, prepared cakes of resin for implements, wattle gum to eat, kangaroo sinews, bone needles, shell to cut hair, a possum skin pouch half full of fur for spinning, spinning sticks, a ball of spun possum fur cord, a "woman's knife", various coloured ochres, grease, feathers and other spare ornaments, untreated kangaroo skins, a spare bag, kangaroo teeth, nose bones, paper bark for use as a drinking cup, wooden drinking straws, fire making materials, recently collected food items, and their husband's spare implements.

In their hands the men carried their spear throwers (*mira*), several spears of three different types (*gidji*), and a narrow wooden shield (*wunda*); and the women carried one or more digging sticks (*wanna*). Thus arrayed they were ready to face their environment. Although it may not always have seemed like it to the women burdened with those bags and children as well, the Nyungar travelled light.

Their technological complexity is rated fairly low, even by Australian standards, at least as measured in one recent study

(Satterthwait 1980). Other than a few additional items of ornament: dog tails, flowers, shells, clay balls, reed and grass beads, and spun possum fur arm and head bands; virtually their entire portable material culture, as recorded in the ethnohistorical literature, was inventoried above.

Little of the Nyungar's portable material culture can be expected to have survived in the porous sandy soils of their model campsites, and the archaeologist will probably normally have to be content with recovering only the very small fraction that was made from stone. This includes: "sharp stones" used in the manufacture of clothing and implements and in the preparation of food stuffs, small sharp chips of stone which are component parts of the knife and one of the spear types, the chopping and pounding stones which are component parts of the hatchet, a small stone for scraping wood which is a component part of the spear thrower, and grindstones. In addition, the ethnohistorical descriptions of the ways in which these stone items were made suggest that a large amount of stone waste which was created as a by-product of the manufacturing process will also be present at former campsites.

The stone component is virtually the only facet of the model of Nyungar portable material culture which can be subjected to testing against the archaeological record, and these artifacts are likely to be the only information the archaeologist has available to suggest the presence of prehistoric human activity. As such they are extremely important, and detailed ethnohistorical models of each of the items listed above are included in Chapter 6 of this thesis.

The Nyungar also had a few non-portable items of material culture which could be of interest to the archaeologist, but some of them were not very "material" and they are best described as *economic facilities*. These include wells dug for water, and various kinds of animal traps.

It rains only very rarely during the summer months in the Australian Southwest, and much of the surface water is evaporated. There is, however, underground water quite near the surface in most areas and the Nyungar dug wells to tap it. These were ubiquitous in the occupied portion of the region; dotted along the trackways and near most camping areas. After "native hut", they are probably the most frequently mentioned sign of Aboriginal activity in the ethnohistorical literature (e.g. Baudin 1800-3:175, Collie 1833a:145-7, Eyre 1845:59, Stokes 1846:390, Fremantle 1829-32:56).

Unforturnately, although the Europeans are constantly looking for and using these wells, they never bother to describe them. All that is clear from most sources is that they were a hole in the ground, and only one author (Chauncy 1876:245) gives any details. According to this source they were a circular shaft, about seventy centimetres in diameter, which could extend to a depth of nearly five metres; but just how such a structure could be made with the equipment available to the Nyungar stretches the imagination. Further discussion of this topic is included in Chapter 5, where the author attempts to determine whether or not the pit feature he has uncovered in an excavation is such a well.

The Nyungar made both fish traps and kangaroo traps. Fish traps could be of wood, stone or a combination of these materials. Archaeological investigations of Southwest fishtraps which discuss the relevant ethnohistorical sources have been published (Dix and Meagher 1976, Dortch and Gardner 1976); and detailed descriptions of the stone fish traps found in the field research area are provided in Chapter 4.

The kangaroo traps were of two kinds: pit traps and stake traps. The former might be recoverable archaeologically, but it would be difficult to demonstrate that is what the pit feature really was. These were dug across the animal runs at some distance from camp (Collie 1834:315), and descriptions of them are numerous (if sometimes contradictory) in the ethnohistorical literature (c.f. Breton 1833:28, Roth 1903:47, Stokes 1846:230, Eyre 1845:277-8, Collie 1834:315). Stake traps would not preserve in the archaeological record and were evidently not very common in any case (Baudin 1800-4:486, Collie 1834:315).

Art:

The Nyungar occasionally decorated some of their wooden implements, and often their bodies, but they practiced little other art that was observed by the early Europeans or has survived in the archaeological record. One instance of rock engraving in the "Panaramitee style" has recently been found (Clarke 1983); and one case of grooving the walls of a limestone cave with the fingers or animal claws is known (Hallam 1971). Three caves with traces of

Photograph courtesy of Nick Peterson.

small inconspicuous paintings have been reported (Hallam 1972: 1975, Morse 1984); but there are no recorded ritual stone arrangements, and portable art (two possibly purposefully scratched limestone plaques and a possible zoomorphic figure in marl) is known from only one site (Dortch 1976, 1980b).

A Model of Palaeoenvironmental Change.

The basic environmental pattern of the Australian Southwest was established in the Tertiary. For perhaps as long as ten million years, changes to the environment have been only changes of degree, primarily an altering of spatial relationships, rather than changes of kind (Merrilees 1979a:121-2). The model sugested below was presented in outline in Ferguson (1981), and is similar in essence to that presented in a recent overview by Wyrwoll (1979:139).

A Late Pleistocene Period of Aridity:

Throughout the Pleistocene there was an overall trend toward greater aridity; and, at the beginning of the period of relevance to this thesis, about 20,000 years ago, much of the continent was gripped in an especially severe drought. This was near the height of the last glaciation, and much of the world's water was locked up in the vast continental ice sheets of the Northern Hemisphere. Sea level was approximately 140 metres below its present level and still dropping (Chappell and Thom 1977:Fig.1). Across the whole of

and Williams 1977, Kershaw 1981).

In the Southwest, Bowler (1976:297-8) examined the lunettes around the salt lakes of the Inland Southwest (Fig. 2.8) as part of his larger study of Australian Pleistocene aridity. A series of radiocarbon dates from these lunettes indicates the occurrence of extensive clay and gypsum dune building, a clear sign of severe aridity (Bowler 1973), during the period from 20 to 15 thousand years ago.

Corresponding evidence is provided by studies of stratified faunal remains in limestone caves in the extreme southwest corner of the forested belt (Fig. 2.8). In Devil's Lair, which is currently in the Karri Forest and dated from about 33,000 BP to the mid-Holocene, there are three trends which suggest increased aridity from about 20 to 13 thousand years ago. There was a major increase in "non-forest" species, including *Perameles*, *Bettongia lesueur*, *Lagorchestes*, *Petrogale*, *Pseudomys albocinereus*, *P. occidentalis*, *Notomys* and *Macroderma*, a massive increase in the number and proportion of lizards; and a corresponding drop in the number and proportion of "forest" species, including *Potorous* and *Setonix* (Balme, Merrilees and Porter 1978:Fig. 12).

This led the researchers to suggest that at the time of deposit the environment surrounding the cave was much more open than at present; that perhaps the current Karri formations were replaced by Jarrah-Marri forest, or even woodland and scrub. They note also,

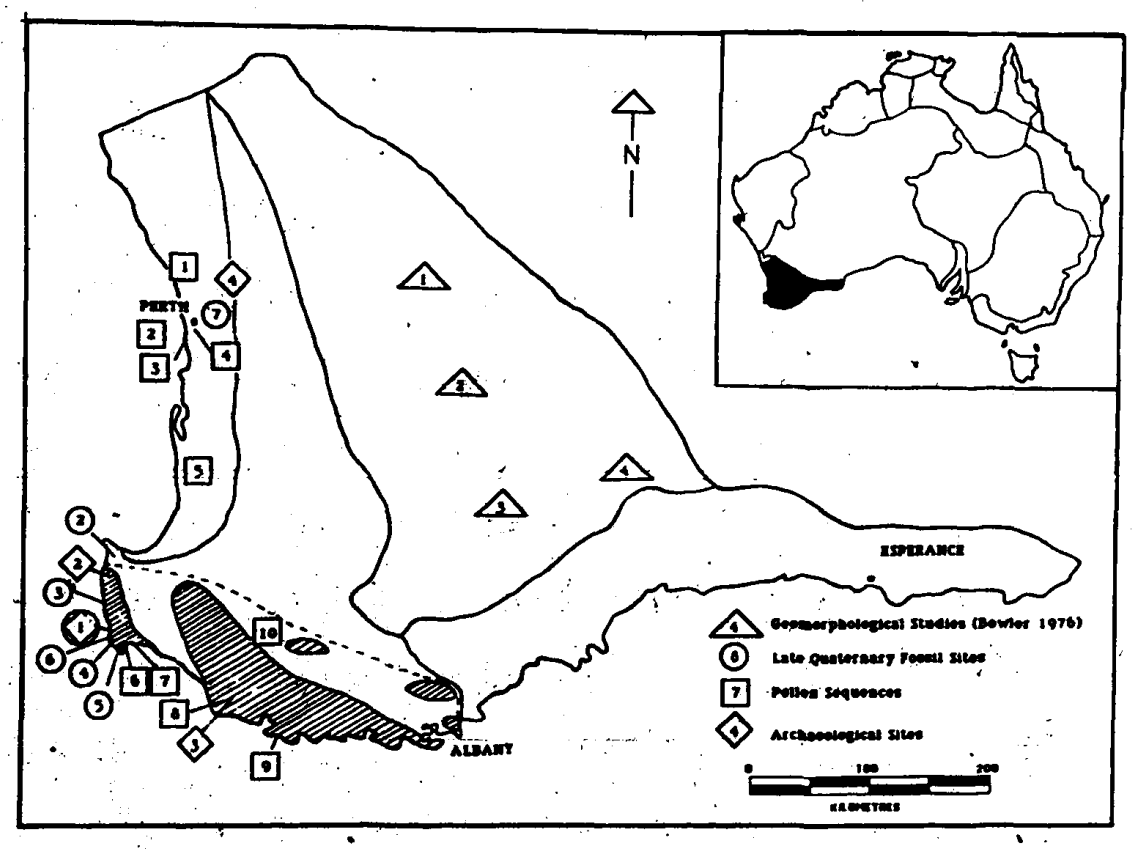


FIGURE 2.8. PALAEOENVIRONMENTAL RESEARCH:
The map shows the locations of the palaeoenvironmental studies discussed in the text. The lunettes dated in Bowler's (1976) geomorphological research are: (1) Korbel, (2) Lake Kurrekutten, (3) Lake Grace, and (4) Lake King. The late Quaternary fossil sites are: (1) Devil's Lair, (2) Yallingup Cave, (3) Mammoth Cave, (4) Deepdene Cave, (5) Skull Cave, (6) Strongs Cave, and (7) Guildford. The pollen sequences are at (1) Yanchep, (2) Rottnest Island , (3) Fremantle, (4) Swan Narrows, (5) Myalup Swamp, (6) Flinders Bay Swamp, (7) Scott River Swamp, (8) Weld Swamp, (9) Boggy Lake, (10) West Lake Muir, and (11) Madura Cave. The archaeological sites are (1) Devil's Lair, (2) Quininup Brook, (3) Northcliffe, and (4) Walyunga.

The shaded areas are the present distribution of Karri trees after Churchill (1968), and the dotted line is their postulated distribution if rainfall increased sufficiently for all outlying formations to be connected to the main body of the forest.

that the vegetation was not totally uniform. There must have been some densely forested areas, thickly vegetated water courses, and areas of open water present nearby at this time (Balme, Merrilees and Porter 1978:59-64).

Further, Merrilees (1979b) has conducted a regional study of one of these "non-forest" animals mentioned above, a locally extinct rock wallaby, *Petrogale* (probably *P. penicillata*). This animal is known to require quite an open environment, but its remains are present in many of the limestone caves of this now forested region (Fig 2.8). Most of the deposits are undated, but dates from Deepdene Cave where *Petrogale* are present in large numbers reinforce those from Devils Lair, suggesting that populations of this species were flourishing in the region at about 19,000 BP.

Direct evidence of this late Pleistocene aridity in the Australian Southwest is not available from palynological studies within the region. The dated cores from the only major local pollen study (Churchill 1968) do not extend this far back in time. Indirect support is possibly available, however, in that at Scott River Swamp (Fig 2.8) a remnant peat deposit, which was truncated by fire at 9340 BP and subsequently colonized by Karri, contained pollen suggesting a more drought tolerant vegetation of *Melaleuca* and *Agonis* scrub with *Banksia-Dryandra* and *Casuarina* but with no eucalypts at all (Churchill 1968:142). Other, indirect, supporting pollen evidence is possibly supplied by investigations in the neighbouring Western

very dry area supported an even sparser vegetation (Martin 1973).

Evidence for Wetter Conditions at the End of the Pleistocene:

Sometime between about 15 and 13 thousand years BP the period of dune building ceased in the lunettes of the Inland Southwest suggesting that an amelioration of the drought had occurred (Bowler 1976:Table 4). Correspondingly, in Devil's Lair, beginning about 13 to 12 thousand years ago, the trends mentioned above became sharply reversed: the proportion of the deposit made up of "non-forest" mammal species declines rapidly, the proportion of lizards drops dramatically from over 40% to less than 5% of the deposit, and the proportion of "forest" species rapidly increases accordingly (Balme, Merrilees, and Porter 1978:Fig 12).

This was a time when world climates were warming. The continental glaciers were melting, releasing their stored water: and sea levels were rising toward their present levels. In Australia, this period of increasing rainfall appears to have been a continental phenomenon, to have produced conditions considerably wetter than at present, and to have been sustained throughout the terminal Pleistocene and early Holocene (Bowler 1976, Rognon and Williams 1977, Wyrwoll 1977, 1979, Wyrwoll and Milton 1976, Kershaw 1981).

In the Southwest, the increasing rainfall appears to have eventuated in the local extinction of all of the "non-forest" mammals listed above (Merrilees 1979a:Table 2). None are known in the region

lesueur, *Petrogale*, *Lagorchestes* and *Notomys* are not present at all, and *Perameles* and *Pseudomys albocinereus* drop out of the sequence (Porter 1979). At Yallingup Cave (Fig. 2.8), a thick layer of sand which is covered with drip stone and contains most of these species, is overlain by another thick drip stone capped layer of sand which contains none of them, but does contain *Canis* (Merrilees 1979b:76-7). The range of *Macropus irma*, the bush wallaby noted above as now being one of the most common large macropods in the region, is believed to have contracted northward at this time with recolonization occurring only after the first felling of the forests by Europeans (Baynes, Merrilees and Porter 1976).

The precise timing of the spread of the forests in the terminal Pleistocene and early Holocene can probably best be studied through examination of prehistoric pollen sequences. Only one such research (Churchill 1968) has been undertaken in the region, and more are needed, but it is a major study and does supply the necessary basic outline for at least the latter part of the period under consideration.

Churchill concentrated on the most dominant trees in the region, the Karri, Jarrah and Marri. He first examined the modern distributions and rainfall requirements of these species, and determined that it would require an annual rainfall increase of approximately 250 mm to connect their contiguous modern distributions with their known outliers. He then took cores at ten widely separated locations to study the changing pollen ratios over time (Fig. 2.8). Several of these cores were relevant only to the latter part of the Holocene, and several also are affected by changing

vegetation brought about by the rise of sea level in the Swan Estuary, but in total they suggest the overall pattern of the Southwest's climate during the majority of the Holocene.

The wet period, which from the inland lunettes is dated as beginning between 15 and 13 thousand BP and which was already affecting the faunal composition in Devils Lair by 13 to 12 thousand years BP, is suggested by the overall pattern of pollen in Churchill's cores to have continued well into the Holocene, not peaking until some time between 7 and 5 thousand years BP. It is a long time, and it was considerably wetter than present. At 6850 BP, Karri Forest was present at least 24 kilometres north of its present distribution, in the vicinity of West Lake Muir (Fig. 2.8); and it may be that at this time the Karri outliers were at least tenuously connected with the main area of distribution (Churchill 1968:147).

By 5000 BP, however, this trend has been reversed; and species with greater tolerances for aridity begin to replace those requiring relatively more moisture at Myalup Swamp (shortly after 5270 BP), Weld Swamp (at 4740 BP), and Boggy Lake (at 4600 BP). Although there appear to be several minor fluctations in the late Holocene climate, there are no more major changes, and the basic pattern of modern vegetation has been established (Churchill 1968).

Kendrick's Dry Early Mid-Holocene:

The odd study out of the above overview is by Kendrick (1977). He argued on the basis of a study of fossil molluscs in the Swan River estuary near Guildford (Fig. 2.8) that evidence exists for a drier than

present mid-Holocene. He noted that the mollusc deposit which is dated at 6600±120 BP is composed of species adapted to a higher degree of salinity than is present in this region today; and suggested that for this to have been the case, there would have to have been both lower seasonality and a lower amount of discharge from the river, and hence, less rainfall.

There may, however, have been a greater marine influence on the river at this time than allowed for by Kendrick. He assumed on the basis of information then available (Thom and Chappel 1975) that sea level did not reach its present position until about 6000 BP, but a recent study shows that the beaches just off the mouth of the Swan began aggrading at about 6500 (Woods and Searle 1983). This is good evidence to place the arrival of the sea at its present level about the time Kendrick's shell beds were established. Given the unpredictable effects of such a major event on the ecology of the then much deeper estuary, his argument is much less convincing.

In any case, no other study corroborates it, and all the research outlined above suggests otherwise. It therefore seems reasonable to dismiss it from further consideration in this thesis. It was discussed here only because reference to it has coloured previous interpretations of the region's archaeology.

Macro Patterns - Summary and Discussion:

The Australian Southwest is a definable whole both environmentally and culturally. Compared to neighbouring parts of the continent it is quite moist and rich in potential food resources,

but it is dominated by a dense belt of forests running through it from south to north. The people who inhabited it were extremely mobile, generalized foragers whose overall patterns of exploitation were shaped in part by the forests' basic unproductivity and the difficulty of passage through them.

The expected archaeological expression of this society is basically limited to discarded pieces of flaked stone. These should be thinly scattered across the entirety of that part of the region not dominated by forests; but, excepting at specialized quarry sites, this scatter should be denser along major corridors of easiest movement, and densest at localites where these corridors intersect.

The distribution of the forests, however, has not been stable over time. Major alterations in the climatic regime have caused expansion or contraction of their boundaries for millennia at a time; and assuming continuity in the exploitation strategy, the pattern of artifact density as described above should have expanded or contracted accordingly. During the late Pleistocene arid phase, great numbers of artifacts should have been dropped in some areas now covered by forests, and during the subsequent wet phase, many areas frequented at contact should have been basically unusable.

Given the difficuties in dating, this might be hard to demonstrate from the examination of surface scatters, but it should show up in stratified excavations. Even sites which are located where the immediate vicinity was productive throughout the entire period of prehistory should demonstrate increases and decreases in artifact density at these times. In general, Nyungar campsites were

only a stop on the way to somewhere else. They were frequented just as much because people just happened to be passing through as because of the availability of local resources; and the trackways upon which they were situated would tend to carry more or less traffic as the overall network expanded and contracted.

In 1978 when the pilot version of the mid-Holocene depopulation model was being prepared for the Quininup Brook publication (Ferguson 1981) there were only three other excavated sites in the region which had been dated to the relevant late Pleistocene through mid-Holocene period and published with enough detail so they could be used as tests. They provided at least partial support, but complications were apparent in that their excavators had interpreted them quite differently.

Two sites relatively close to Quininup Brook, Devils Lair and Northcliffe (Fig. 2.9) presented somewhat contradictory results. Northcliffe (Dortch 1975, Dortch and Gardner 1976), appeared to be totally the opposite to what was expected since the bulk of the artifacts there were assumed to have been accumulated in the mid-Holocene. This is a quarry site, however, and there are other odd factors about the deposit and its dating.

Devil's Lair (Dortch 1979a and references), on the other hand seemed to be very much like Quininup Brook. It was well frequented in the late Pleistocene and abandoned in the early to mid-Holocene. The researchers, however, had suggested a very logical site-specific reason for this: it is a small limestone cave and they believed the

entrance had become sealed at about this time.

It was the site of Walyunga (Pearce 1977;1978) far to the north on the edge of the Swan Coastal Plain (Fig. 2.9), however, which provided the classic sequence and suggested that a wide spread mid-Holocene depopulation of the region was a distinct possibility. This site had been frequented continuously from the early Holocene to the present, but a diagram of changes in artifact frequency over time (Pearce 1978:Fig. 5) showed that from about 6000 BP to about 3000 BP there was a radical drop in the recovery of all artifact types as compared to the previous and subsequent periods.

Unfortunately Pearce's explanation for this ran totally counter to what is proposed here. He misinterpreted Churchill as suggesting a dry period at this time, and using Kendrick's study for support, he suggested that the apparent drop in activity on the site resulted from the stress of drought (1978:9). Given the information presented above and the nature of Walyunga's location this seemed illogical. The site is located by a large pool on the Swan River right at the foot of the Darling Scarp. No matter what climatic regime prevailed, this would have always been a comparatively wet area. In extreme drought conditions it would quite likely have been a refuge, and artifact density could even be expected to increase rather than decrease in such circumstances.

The opinions of their investigators aside, however, based on a cursory examination of these sites and Quininup Brook, the score was three to one in favour of a mid-Holocene depopulation of the region, but the possibility of these alternative explanations weakened the

argument considerably. There were numerous questions which required answers before any confidence could be given to the concept, and the author became aware of just how little he knew about these sites and the processes by which they were formed. In the Quininup Brook publication, therefore, only the model was presented as speculation, and a discussion of the available sites was deleted.

In the chapters which follow, the steps taken to answer these questions are detailed, and from here onward there is a departure from concentration on the region as a whole to look at progressively smaller levels of focus. In the final chapter there is a return to the overall region, and the sites briefly mentioned here will be discussed again in more detail.

CHAPTER 3

SEMI-MACRO PATTERNS:

SURVEY OF MOKARE'S DOMAIN

Introduction:

The field research for this thesis was conducted in an area which is located on the south coast of the Australian Southwest and centred on the town of Albany (see Fig 2.2). This chapter introduces the area, and is divided into three parts which present surveys of the area's physical geography, history, and archaeological resources. These provide the necessary context for an understanding of the sites and excavations which are described in the chapters which follow.

This general locality was chosen for purely archaeological reasons, and these are presented in Section III. The precise boundaries of the field research area, however, were determined on culture-ecological criteria, like those of the Australian Southwest as a whole.

In Aboriginal Australia there were only two principal levels of ecologically related population groupings which had any degree of permanence (Peterson 1976:67). The natural and cultural area population was the largest grouping, but this was made up of many smaller, local group populations. Although membership of these local groups fluctuated somewhat, each of them was organized around a nucleus which consisted of a single land-holding family (Stanner 1965:2).

It was Stanner who developed the ecologically related model of

a family-band's territorial organization which has been adopted for use in this research. According to him (1965:2 - his emphasis):

> The evidence allows us to say that each territorial group was associated with both an *estate* and a *range*.... The estate was the traditionally recognized locus ('country', 'home', 'ground', 'dreaming place')...of the territorial group.... The range was the tract or orbit over which the group, including its nucleus and adherents, ordinarily hunted and foraged to maintain life.... Estate and range together may be said to have constituted a *domain*, which was an ecological life-space.

The rich ethnohistorical data from the Albany area enabled a model to be developed of the approximate extent of the estate and range exploited by the Aboriginal family which, in 1826, was traditionally located on the land where Albany was built. The model takes its name from the member of that family most mentioned in the ethnohistorical sources, Mokaré (Fig. 3.1), and the ethnohistorically determined boundaries of Mokaré's domain (Fig. 3.2) were adopted as the boundaries of the archaeological field research for this thesis.

The Mokaré's Domain model is a basically historical construct. Its use to set the boundaries of the archaeological field research area avoided the tendency for these to be placed purely on topographical or logistical grounds; but, since no family-specific artifact types are known, it has no qualities which enable archaeological confirmation of these boundaries. It was initially developed to organize the main aspects of cultural core activities as reported in the ethnohistorical record, and in doing so it has served the thesis well. Much of the vast

Figure 3.1. Portrait of Mokaré:
Mokaré was an Aborigine who lived at King George Sound where the first European settlement in Western Australia was established in 1826. He was friend and informant to many of the early Europeans who wrote about the place, and a good deal is known about his life and times (see text). This portrait was drawn by Louis Auguste de Sainson in 1826 and is included in Dumont D'Urville (1830).

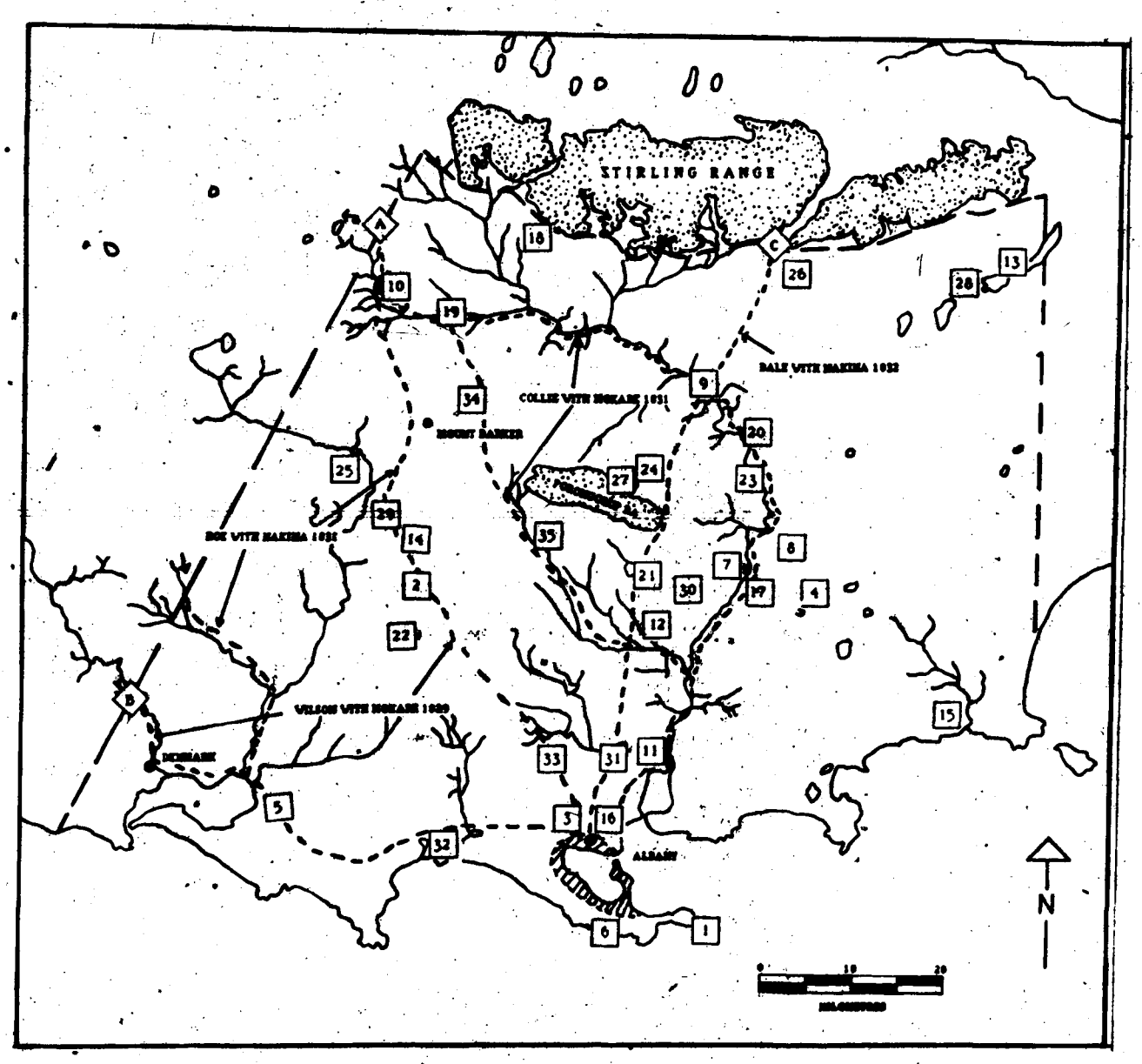


Figure 3.2. Model of Mokaré's Domain:

Mokaré's family's estate was on the shores of Princess Royal Harbour. It approximated the area shown shaded on the map.

The family's range is the area inside the dashed line. The numbered squares on the map represent the places they were known to visit. They are identified and referenced on Table 3.3.

The dotted lines running across the domain are the routes of early explorations of the area which used Mokaré or his brother Nakina as guides, and they are also the routes of some of the main trackways through the region. The places on the map marked by letters inside diamonds are those where a European observer was present when a member of the family came to the end of the country known to him. (See text for explanation.)

amount of interesting detail available on Mokaré and how he lived, however, was necessarily deleted from this essentially archaeological study. That which is directly relevant to this research is reported below in Section II of this chapter and scattered throughout the chapters which follow. The rest has been prepared for publication elsewhere (Ferguson *n.d.*).

Part I: Physical Geography.

Topographical Sketch:

The Town of Albany (S 6° 20' - E 118° 1') is situated on the shores of one of the two nearly land-locked Harbours of King George Sound (Fig. 3.3). Together, the Sound and its extentions form a commodious and well protected anchorage, the only natural facility of this kind along an extensive stretch of Australian coastline. The nearest similar natural harbour is about 1500 kilometres away, up the Indian Ocean coast at Shark Bay. To the east, similar facilities are not found before the Spencer Gulf in South Australia, over 2500 kilometres distant.

The coast on either side of the entrance to the Sound is rugged and retrograding, usually with narrow beaches backed by steep limestone or granite cliffs. Extensive consolidated dunes of recent calcareous sand are built up behind the cliffs, sometimes reaching inland for a distance of up to six kilometres. There are numerous bays and small inlets, but entrance to these is either blocked by sand bars, or they are exposed to the usually tempestuous seas of the Great Southern Ocean.

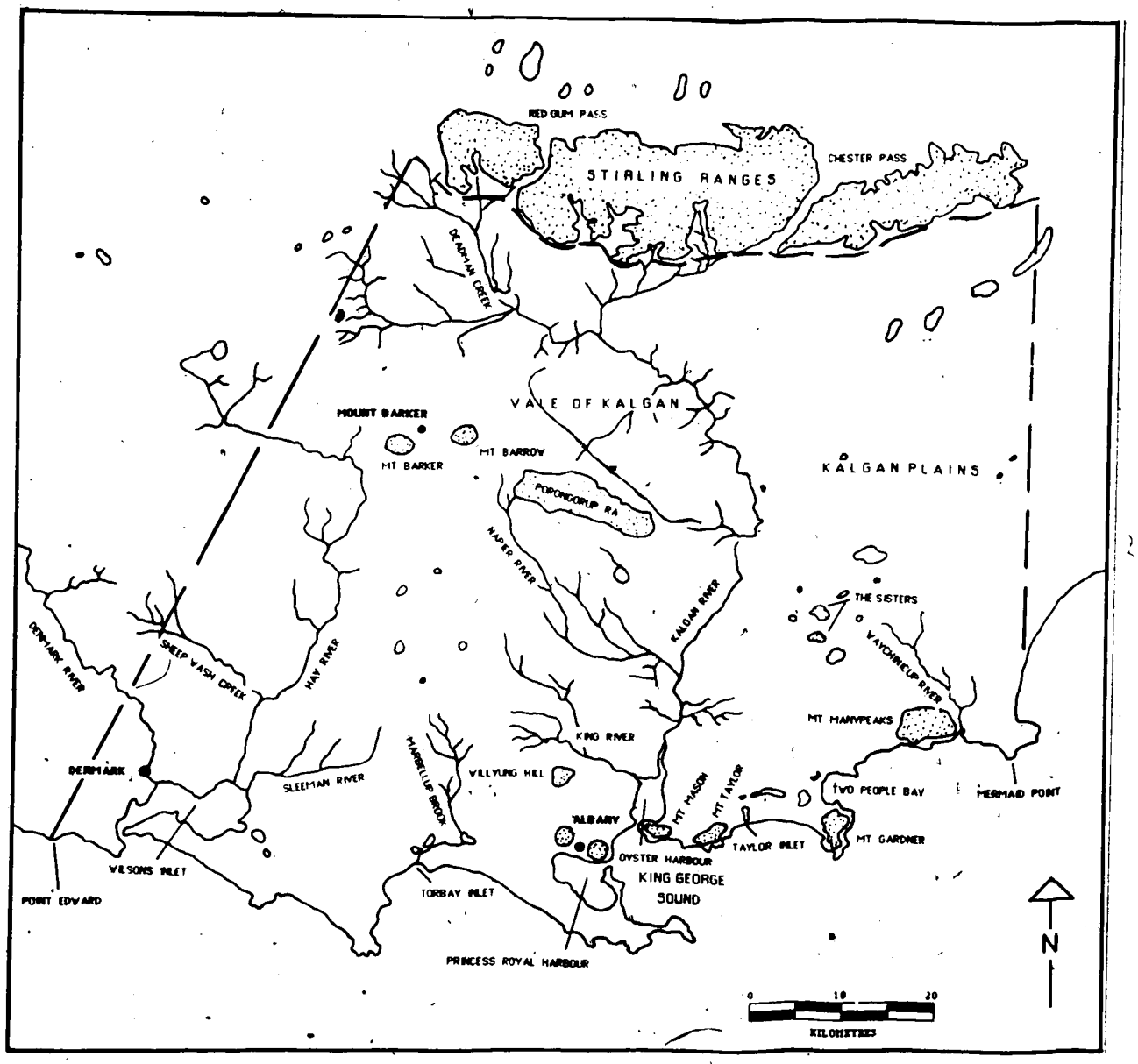


Figure 3.3. Topographic Map of Mokaré's Domain:
The map shows the features named in the text. Prominent areas of high ground are shown by stippling.

The hinterland is an undulating plain of relatively low relief which rises gently to a standard height of about 200 metres above sea level before levelling off in the vicinity of Mount Barker, the only inland community of size in the research area. Approximately seventy five kilometres north of the coast, the Stirling Mountain Range rises abruptly from the plain. The Stirlings are the most marked topographical feature of the region. Several peaks of the range reach a height of over 1000 metres and the range is over sixty five kilometres long, east to west. Except for two passes, they present a substantial barrier to human movement.

The southern base of this range forms the northern limit of the field research area. The eastern boundary is a line drawn due south from the eastern end of the range to the coast near Mermaid Point, and the western boundary runs roughly SSW from the western end of the range to the coast at Edward Point (Fig. 3.3).

In approximately the centre of the research area, a large granite massif juts high above the plain. This is called the Porongorup Range. It is about fiteen kilometres long, east to west, with several peaks rising to over 600 metres. Two isolated peaks, Mt. Barrow (480 m) and Mt. Barker (400 M), with their foothills, extend this region of higher ground to the west.

Several other isolated granite bosses also dot the plain. The largest of these is Mt. Manypeaks, on the coast east of Albany, which rises from the shore to over 500 m in height. West of Manypeaks along the coast are several smaller bosses: Mt. Garner, Mt. Taylor, Mt. Mason, Mt. Martin, Mt. Clarence, and Mt. Melville. The last two stand

on either side of the Town of Albany. Except for Mt. Gardner, none of these is over 200 metres in height, but given the general low altitude of the landscape, they form noticeable topographic features which are visible from a considerable distance. Likewise, similar low bosses further inland, the Sisters - north of Mt. Manypeaks, and Willyung Hill - northeast of Albany, provide distinctive landmarks.

The Kalgan River furnishes the main drainage system for the area. Its head waters are in several small intermittent streams west of the Stirling Range, and it initially flows eastward between the Stirlings and the Porongorups through an area sometimes called the Vale of Kalgan. Northeast of the Porongorups, the Kalgan turns sharply and flows due south to empty into Oyster Harbour. On most of this southern leg, it normally flows year round, and it has entrenched a steep, narrow valley down into the plain.

Two other fairly extensive river systems drain the western part of the research area, and empty into Wilson's Inlet. The first of these, the Hay River, like the Kalgan, flows through a steep, narrow incised valley for most of its course. The second, the Denmark River, primarily provides drainage for the regions to the west, and only the lower five kilometres of its course are in the research area. Several good sized, but shorter, streams drain the coastal regions. The largest of these are Marbellup Brook, and the Sleeman, King and Waychinicup Rivers.

Much of the area, however, has poor drainage, and three major portions of it contain numerous swamps and small lakes. The most extensive is east of the Kalgan, an area often called the Kalgan Plains.

Here because the river receives almost no tributaries from the east, the landscape is virtually flat, and the first European to see it was only slightly exaggerating when he described it as "one continuous swamp" (Wakefield 1827-28:519). A similar but smaller area of swamps and lakes lies between the Hay River and the head waters of the relatively short western tributaries of the Kalgan. Finally there is an extensive system of lakes and swamps lying just behind the coast where the consolidated sand dunes have impounded streams draining to the sea. Mostly, they are permanently cut off from access to the Ocean; but some, such as Wilson's, Torbay, and Taylor Inlets, are saltwater and have periodic access when storms destroy the bars formed across their mouths.

Climate:

The study area is well watered but there is a steep rainfall gradient across the region; decreasing from 1250 mm annually in the extreme southwest corner, to well less than half that amount, 500 mm annually in the far northeast (Fig. 3.4). Most of this precipitation falls in the winter months, but there is some rain throughout the year, and neither of the region's two climatological stations which are reported in the *Western Australian Year Book* (1980), Albany and Mt. Barker, experience any month with an average of less than seven wet days (Table 3.1a)

The temperature is relatively mild year round on the coast. The hottest month at Albany is January with a mean maximum of 25.8° C, and the coldest is August with 15.5° C. Occasional heatwaves are

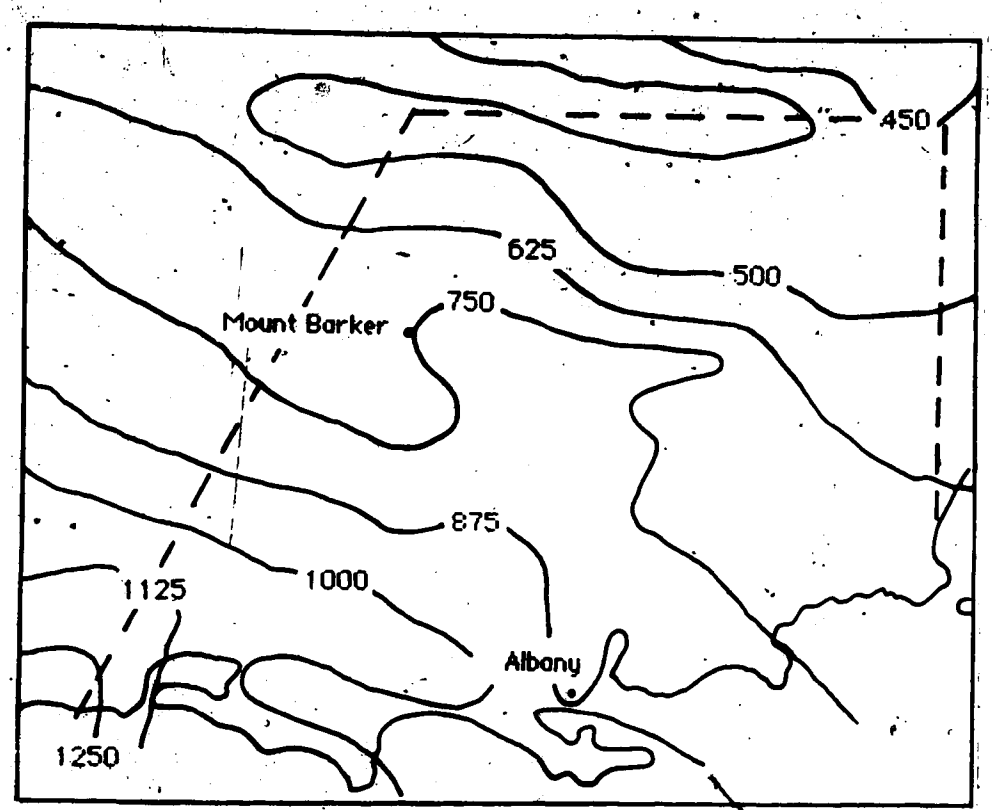


Figure 3.4. Rainfall Gradient over Mokaré's Domain (After *Western Australian Year Book* 1980)

Table 3.1. Climatological Summary (After *Western Australian Yearbook* 1980)

(a.) Average precipitation by month at Albany and Mount Barker since reporting began (over 75 years).

ALBANY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Rainfall-Average(mm)	18	21	29	73	97	95	132	103	78	86	45	32	809
Highest (mm)	68	62	85	127	192	224	204	174	133	172	117	97	966
Lowest (mm)	3	4	7	41	54	45	55	52	43	38	6	5	628
Highest one day	43	36	33	52	40	38	43	44	44	53	28	19	53
Wet Days-Average No.	9	8	11	16	17	19	23	21	19	16	11	9	179
MOUNT BARKER													
Rainfall-Average (mm)	22	24	37	57	86	100	108	94	82	74	42	30	756
Highest (mm)	179	179	129	234	243	209	261	173	157	160	155	87	1095
Lowest (mm)	1	1	4	4	16	43	22	33	18	16	3	1	431
Highest one day	105	72	57	139	69	68	72	48	45	54	64	44	139
Wet Days-Average No.	8	7	10	13	17	19	21	20	18	16	11	10	170

(b.) Average temperature by month at Albany and Mount Barker since reporting began (over 75 years).

ALBANY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temp-Mean max. °C	25.8	25.4	24.2	21.0	18.5	16.3	15.7	15.5	16.7	18.8	21.1	23.9	20.2
Mean min. °C	13.1	13.9	12.9	11.6	9.5	8.1	7.4	6.8	7.4	9.0	10.4	12.4	10.2
Highest max.°C	45.6	41.6	40.5	38.8	32.6	23.6	22.5	22.0	26.8	31.7	41.1	41.1	45.6
Lowest min.°C	5.6	5.1	5.0	5.2	2.9	0.0	1.1	1.4	1.4	2.3	2.9	3.7	0.0
No. days 30° C & over	4.2	4.4	4.0	0.8	0.1	0.0	0.0	0.0	0.0	0.1	1.1	2.7	15.9
No. days 40° C & over	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6
No. days 2° C & under	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.4	0.3	0.0	0.0	0.0	1.2
MOUNT BARKER													
Temp-Mean max. °C	27.4	26.3	24.7	21.0	18.1	15.5	14.6	15.0	16.5	19.2	21.8	24.9	20.4
Mean min. °C	13.2	13.6	12.7	10.8	8.7	7.5	6.0	6.5	6.7	8.3	10.0	12.0	9.7
Highest max. °C	43.9	43.6	40.6	37.2	32.2	24.3	22.2	25.0	29.3	35.6	39.4	42.9	43.9
Lowest min.°C	1.7	3.9	3.6	2.2	0.6	0.0	-0.4	-1.3	-0.6	0.6	1.1	1.1	-1.3
No. days 30°C & over	9.6	7.5	5.2	0.8	0.1	0.0	0.0	0.0	0.0	0.5	2.3	6.1	31.8
No. days 40°C & over	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
No. days 2° C & under	0.0	0.0	0.0	0.0	0.1	0.3	0.7	0.7	0.4	0.0	0.0	0.0	2.2

experienced, but no frost has ever been recorded. Inland the pattern is similar, but slightly more extreme: summers hotter and winters colder. The January mean maximum for Mount Barker is 27.4° C, and in the coldest month, July, it drops to 14.8° C; and frosts occasionally occur during the winter months (Table 3.1b). It should be noted, however, that the icy winds that often blow in from the Southern Ocean in winter add a chill factor which is greatest in the coastal areas. No figures are available for this; but based on field experience, in spite of lower recorded temperatures, the inland is a somewhat more pleasant place to be during these months.

The growing season is quite long, and the months of the year when evaporation exceeds rainfall are few: less than three for the southwest corner around Denmark, and less than five for that part of the region north of Mount Barker (*Western Australian Year Book* 1980:61).

Geology:

The geology of the region is extremely complex, and as of this writing, the 1:250,000 series geological map for the Albany/Mount Barker region has not been published. However, a working dyeline of this map was obtained for use in this research and descriptions of many of the various formations are contained in the state overview (Geological Survey of Western Australia 1975) and in notes accompanying two hydrological surveys which cover most of the research area (Hirschberg 1976, Moncreiff 1977).

The basement rocks are predominantly Precambrian gneisses

with subordinate granites and migmatites. They are from the (possibly Proterozoic) Albany-Frazer Block. This block is similar to the better known (probably Archaean) Yilgarn Block, which borders it immediately north of the research area; with the exception that dolerite dykes are rare. This bedrock is exposed in some of the river valley floors, along portions of the coastline, and as the previously described granitic batholiths, which dominate the plain. The Stirling Range, which rests unconformably on the Yilgarn Block (and possibly on the Albany-Frazer Block as well), is composed of Proterozoic quartz sandstone and phyllite.

In much of the research area, the basement is unconformably overlain by sedimentary formations of the Plantagenet Group (See Cockbain 1968). Two formations are present, both Upper Eocene in age. The lower, Werillup Formation has no surface exposure in the area, and is only found in bore holes where it averages a thickness of 30 to 50 metres (Hirschberg 1976:8). It is composed of dark-coloured siltstone, sandstone, carbonaceous siltstone, lignite, and a small member of limestone. It is suggested that the Formation was deposited during a period when the area was alternatively occupied by shallow seas and peaty swamps (Cockbain 1968).

The upper formation, the Pallinup Siltstone consists of light-coloured, frequently banded, siltstone and spongelite. It rests conformably on the Werillup Formation or unconformably on the basement; and it outcrops over much of the eastern part of the research area, often forming skirts around the protruding granites. This highly silicious material was deposited during a period when the

area was inundated by a shallow transgressive sea (Cockbain 1978); and because the spongelite provides the raw material for many of the artifacts recovered during the fieldwork, a detailed discussion is included in Chapter 6.

Sometime after the deposition of the Plantagenet Group, but still during the Tertiary, extensive laterization took place across the region. Over the entire research area, much of the ground above the water table has a capping of laterite in one of two forms. Over the Plantagenet Group and the various Tertiary clays which sometimes rest upon it (see Teakle 1953:8), the laterite has a strong honeycombed structure which is decomposing into lateritic gravels. Over bed rock, it usually takes the form of a hard, massive duricrust, one to two metres thick.

Soils:

No overall soil survey has been published for the research area; and, as a geological history with so many parent rocks available suggests, they vary incredibly. Predominant are calcareous sands from the coastal dunes, hard-setting loams of the forest floors and a great deal of leached-out, siliceous, aeolian sands; but in this region, any given soil is usually a local phenomenon. Several relatively restricted soil surveys are available for portions of the research area (Bettenay and Poutsma 1962, Boehm and Pym 1950, R. Smith 1950a, 1950b, Teakle 1953), and where applicable, these are included in Chapter 5 as parts of the discussions of individual excavations.

Vegetation:

The highly variable vegetation of the area has been studied in detail by Beard (1979b). Basically, the height and density of the canopy decreases from southwest to northeast dependent upon the rainfall: moving from thick Karri forests, through mixed Jarrah forest and Jarrah woodland, to mallee, and finally scrub heath on sand plain. However, soils, drainage, and the presence of marked topographical features like the Stirling and Porongorup Ranges and Mt. Manypeaks all combine to alter this general pattern.

The research area is divided northwest to southeast by the boundary between the Darling and Eyre Botanical Distiricts (Forested Belt and Eyre South Coast). Two of the Darling sub-districts are present: the Warren (Karri Forest) and the Menzies (Southern Jarrah Forest). Beard (1979b) has further divided each district and sub-district into several vegetation systems (Fig. 3.5). Within each of these a typical pattern of vegetation occurs, and his monograph provides detailed mapping and description for each system.

Those systems which are directly relevant to this study are discussed in later parts of this and succeeding chapters. However, briefly: The Denmark is a Karri forest system; the Hay, Albany and Narrikup are Jarrah forest systems; the Porongorup is a Karri-Jarrah forest system; the Kendenup and East Kalgan are Jarrah woodland systems; the Qualup and Cape Riche are mixed woodland-mallee-heath systems; and the Torndirrup and Manypeaks are coastal heath systems, but both contain small patches of Karri forest.

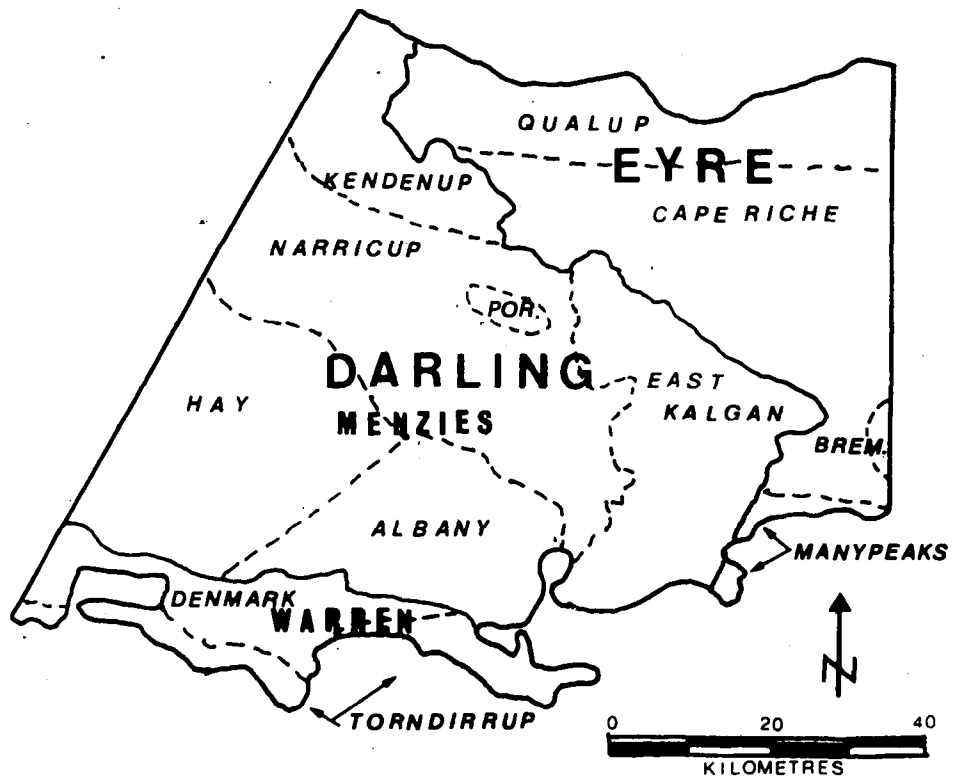


Figure 3.5. The Vegetation Associations of Mokaré's Domain (After Beard 1979b):

The field research area is a zone of floral transition. It overlaps the boundaries of the Eyre Botanical District, and of the Menzies and Warren Subdistricts of the Darling Bontanical District; and it contains portions of twelve of Beard's vegetation systems: the Denmark is a Karri forest system; the Hay, Albany and Narrioup are Jarrah forest systems; the Porongorup (Por.) is a Karri-Jarrah forest system; the Kendenup and East Kalgan are Jarrah woodland sysems; the Qualup and Cape Riche are mixed woodland-mallee-heath systems; and the Tondirrup, Manypeaks and Bremer (Brem.) are coastal shrub and heath systems.

Part II: History.

This section contains a survey of the first fifty years of European history in Mokaré's Domain. It also provides details of the construction of the Mokaré's Domain model and some relevant information provided by that model regarding ethnographic Aboriginal population distribution and movement across the semi-macro pattern area. In reviewing the European history of the area, emphasis is placed on evaluating the credibility of the ethnohistorical sources because these are referenced frequently in some subsequent parts of the Thesis.

European History of the Albany Area, 1791-1840 - The Ethno-historical Sources:

The Albany region has the longest unbroken record of European occupation in Western Australia. Permanent settlement here began at least by 1826, three years before the establishment of the Swan River Colony in the area around Perth. Recorded contact with the Aborigines, however, began much earlier with the sporadic visits of European ships to King George Sound starting in 1791.

For this survey, the first fifty years of contact are divided into three phases: an initial period of exploration lasting from recorded discovery to the establishment of an English garrison in 1826; the garrison period when the European presence was limited to a small coastal outpost of military and convicts from the Colony of New South Wales; and the period of free settlement after about 1831 when

the Swan River Colony took over control of the garrison and European penetration of the hinterland began in earnest.

Each of these periods provides a different type of ethnohistorical record and presents different problems in interpretation. None of the sources can automatically be taken at face value. From the very beginning the presence of Europeans altered the life-ways of the local Aborigines, and change accelerated with prolonged contact. They are the only information available, however, and as a body they provide one of the most extensive and detailed accounts ever written about a single group of contact period Australian Aborigines.

The Exploration of King George Sound 1791-1826:

Although Dutch ships had skirted the Western Australian coast for the two previous centuries, the discovery of the Sound is credited to an Englishman, George Vancouver, in 1791. Besides being a splendidly protected anchorage, it is well watered and timbered, and has good beach facilities for the careening of sailing vessels. During the early exploration of the continent it became a focal point for resupply and refitting of the explorer's ships. They came one or two ship loads at a time, and for the most part did not stay very long.

There were five exploration teams that visited King George Sound in the late 18th and early 19th centuries before the permanent garrison was established (Table 3.2). Vancouver met no Aborigines, and the large French expedition under Baudin in 1803 met very few, but both recorded any evidence of occupation they could find

Table 3.2. Known Visits by European Vessels at King George Sound Prior to Settlement in 1826.

YEAR	SHIP(S)	PURPOSE OF VOYAGE	COMMANDER	LENGTH OF VISIT	MEET WITH ABS.	PRIMARY REF.
1791	Discovery Chatham (Brit.)	Exploration	G. Vancouver	13 Days	No	Vancouver 1801
1800	Elligood (Brit.)	Whaling	C. Dixon	unk.	unk.	Wace & Lovett 1973
1801	Investigator (Brit.)	Exploration	M. Flinders	1 Month	Yes	Flinders 1814
1803	Union (U.S.)	Sealing	I. Pendleton	unk.	unk.	Wace & Lovett 1973
1803	Charles (U.S.)	Sealing	I. Percival	unk.	unk.	Wace & Lovett 1973
1803	Geographé Causarina (Fr.)	Exploration	N. Baudin	1 Month	Yes	Baudin 1800-04
1804	Independence (U.S.)	Sealing	O.F. Smith	unk.	unk.	Wace & Lovett 1973
1807	Hope (U.S.)	Trading	R. Bromley	unk.	unk.	Wace & Lovett 1973
1808	Tonquin (U.S.)	Sealing	R. Bromley	unk.	unk.	Wace & Lovett 1973
1815	Emu (Brit.)	Convict Transport	Lt. Forster, R.N.	unk.	Yes (Hostile)	King 1827
1818	Mermaid (Col.)	Exploration	P.P. King	12 Days	No	King 1827
1820	San Antonio (U.S.?)	unk.	Hemmans	unk.	Yes	King 1827
1821	Bathurst (Col.)	Exploration	P.P. King	14 Days	Yes	King 1827
1822	Bathurst (Col.)	Exploration	P.P. King	23 Days	Yes	King 1827
1822	schooner (name unk.) (U.S.)	Sealing	unk.	unk.	unk.	King 1827
1825	Gov. Hunter (Col.)	Sealing	Robinson	*	Yes (Hostile)	Lockyer 1827
1825	Gov. Brisbane (Col.)	Sealing	Kemp	*	Yes (Hostile)	Lockyer 1827
1826	L'Astrolabe (Fr.)	Exploration	M.J. Dumont D'Urville	17 Days	Yes	Dumont D'Urville 1830

* Each of these ships dropped a whale boat with crew who took up residence at the Sound. At the time of settlement, they had been there "eighteen months" (Lockyer 1827:499)

(Vancouver 1801, Baudin 1800-4, Peron and Freycinet 1807). Flinders in 1801 and King and Dumont D'Urville in the 1820's, however, had considerable intercourse with the natives, and their journals contain extensive descriptions of their activities and material culture (Flinders 1814; King 1827; Dumont D'Urville 1830).

These journals provide the only records of the Aborigines during this period, but since the explorers were professional observers they can be given a great deal of credence. They were the equivalent of hand-picked scientific research teams. Aboard the ships were botanists, zoologists, geologists, astronomers, and the like. They recorded what they saw in minute detail, and they were supported by scientific illustrators. The formalized study of Anthropology was only just beginning, but these people included an interest in the local inhabitants in their attempt to record the total environment. The observations were made over quite short time spans, but this, in some ways, is likely to have a beneficial effect on accurate reporting, because these brief visits, in themselves, would have probably resulted in little disruption to the traditional Aboriginal lifeways.

Several other exploration teams anchored in the Sound later, after the settlement was established. Most notably the Beagle was there several times; first in 1836 on the famous voyage with Darwin aboard as naturalist (Darwin 1831-36, Fitz-Roy 1839, Stokes 1846). By that time, however, the disruption of the Aboriginal culture was well advanced, and brief visits such as these no longer shed much light on their traditional life style.

It must be stressed, however, that the earliest explorers were probably not recording a life style that was as pristine as is sometimes thought. Ships other than those filled with dispassionate scientists were also frequenting the Sound from a very early period; and their presence, especially that of the sealers with their shore based operations, undoubtedly had considerable impact on the Aborigines. Records of these visits are almost non-existent, and the list on Table 3.2 must be considered as a bare minimum.

It has been suggested, in fact, that unrecorded, very early sealing along these shores might have been highly intensive (Wace and Lovett 1973:10). Vancouver's journal, originally published in 1798, stated that the islands off the coast around King George Sound abounded with seals. When Flinders arrived in 1801, he could find no large seal colonies anywhere in the area, but he did find abundant evidence that Europeans other than Vancouver had preceded him on the shores of the Sound (Flinders 1814). Wace and Lovett's suspected culprits are Americans whose first reported presence in the Sound was not until 1803; but whoever they might have been, the effect on the Aborigines was probably considerable (see Plomley 1966 for Robinson's descriptions of the sealers' impact on the Tasmanians).

The Colonial sealing gangs which came toward the end of the period certainly were disrupting Aboriginal life. When the permanent garrison was established in 1826, almost the first official act of its new commandant was to try several of the motley crew then established on the islands in the Sound for kidnap and murder of Aborigines (Lockyer 1827).

It is at the end of this period when people known to be members of Mokaré's family first begin to be mentioned. Mokaré's older brother, Nakina, and a friend from the neighboring estate, Coolbun, were among the Aborigines who traded their implements for King's ships biscuits in 1821 (King 1827), and Mokaré himself spent several hours with the officers from L'Astrolabe in 1826 (Dumont D'Urville 1830). They described him as "quite young with an open face and a more lively manner than any of his companions", and de Sainson drew his portrait (Fig. 3.1).

The Fredrickstown Garrison, 1826-1831:

In December 1826, Major Edmund Lockyer arrived at King George Sound and established an outpost of the New South Wales Colony which he called Fredrickstown. Lockyer's party numbered 52 soldiers and convicts, and over the next five years that the New South Wales authority was in place, the European population rarely exceeded and was usually considerably less than this number.

The first day of settlement, local Aborigines ambushed a party of sawyers, and the expedition's blacksmith was badly wounded. The Major's judicious handling of this event set the tone for one of the most unique situations in the history of European-Aboriginal contact. Lockyer determined that the attack was in retribution for depredations recently visited upon the Aborigines by the sealers living nearby, and wisely ordered no retaliation (Lockyer 1827:465-6). Exactly how the Aborigines felt about this at the time is not recorded, but until at least the early 1840's, there is no other record

of violent altercations between the whites and the natives.

After Lockyer dealt with the sealers, inter-cultural relations at the isolated outpost were remarkably good. Many Aborigines frequented the settlement, often sharing the houses of the whites, with whom they became close friends. Mokaré's family virtually adopted the garrison and worked them into the local social structure. The soldiers, in turn, developed a liking and respect for the Aborigines who were generous, affable, knowledgeable about the country side, and who considerably outnumbered them (Ferguson *n.d.*). This situation provided an unparallelled opportunity for detailed observations about the traditional lifeways of the Aborigines.

The soldiers, however, unlike the explorers who came before them, were not professional observers. The journals and dispatches of Maj. Lockyer, Capt. Wakefield, and Lt. Sleeman, the first three commandants of the garrison, contain numerous mentions of the natives; but such comments are usually only incidental to their daily tasks of running a convict establishment (Lockyer 1827, Wakefield 1827-28; Sleeman 1828-29). These are useful, but no coherent picture of Aboriginal culture emerges from them.

Luckily, the fourth and final commandant of the New South Wales garrison, Capt. Collett Barker, was an exception. He arrived in November of 1829 and for fourteen months kept a daily record which, to a great extent, focused on the lives and activities of Mokaré and his family (C. Barker 1830-31).

There was also another class of settler attached to the garrison who carried on the tradition of scientific investigations

begun by the explorers. These were the Colonial Surgeons, who, unlike most of their fellows, were educated men, and their work allowed them the free time to undertake detailed observations. Two surgeons, Isaac Scott Nind and Thomas Braidwood Wilson, were present for periods of time at Fredrickstown.

Nind, who arrived with Lockyer and shared his house with Mokaré when the latter was in town, was there for nearly three years until October of 1829. He produced a fifty page, environmentally related, ethnography of the local Aborigines which was published in the first volume of the *Proceedings of the Royal Geographical Society* (Nind 1831).

Wilson was only there briefly in 1829, but he made use of the opportunity to undertake the most extensive inland explorations to that date. In his reports of the journey (Wilson 1833-1835) he includes many sagacious observations on the actions, environmental knowledge and beliefs of Mokaré, who was his guide.

The writings from this phase of settlement are based on prolonged and uninterrupted, friendly contact with the Aborigines; and, with some slightly later additions, they form a body of ethnohistorical observations possibly unique in Australia. It cannot be stressed too much how close these relations were. After Nind left, Mokaré began staying with Barker. The two often sat up half the night talking in front of the fire, and Barker tried to record it all before he went to bed.

Both were extremly curious about the other's world-view (Barker 1930-31: 23.4.30, 6.5.30, 25.11.20, etc.), and some very

frustrating discussions of comparative religion are recorded (Barker 1830-31: 1.21.30, etc.). Barker was the only officer at the garrison for much of the time and he grew to rely on Mokaré's companionship and advice so much that when the latter went away for extended periods, he grew frantic and tried to find him (Barker 1830-31: 18.5.30, etc.).

This constant interaction, however, from the very first altered the traditional Aboriginal lifeways. Another one of Lockyer's first acts was to distribute steel tomahawks as gifts (Lockyer 1827). This alone has been shown elsewhere to severely disrupt a traditional Aboriginal society (Sharp 1952). As contact was maintained, the rate of change accelerated; and Barker's journal details some of the events which were to bring about the eventual destruction of the traditional culture (1830-31:1.21.30, 14.5.30, etc).

The Albany Free Settlement 1831-1840:

In March of 1831 the Swan River Colony, established two years before, took control of the settlement at King George Sound. The name of the town was changed to Albany, and command invested in a civilian Government Resident. There were no convicts with the new regime and the military garrison was correspondingly much smaller. Initially the population of Europeans at the Sound dropped considerably. It was the plan of the Swan River Colony to encourage the establishment of free settlers at Albany, but this had a slow start. When the second Government Resident, Sir Richard Spencer, arrived in September of 1833, he found a civilian population of

seventeen, and only one acre under cultivation (R. Glover 1979:11).

Spencer brought his wife and family, established successful farms, and encouraged many others to do likewise. By the time he died in 1839, he had brought about profound changes to the little settlement. Prior to his arrival, however, life at the Sound continued much as it had during the Fredrickstown period, only now the emphasis was upon exploration of the hinterland in search of useable farmland for the proposed free settlers.

The first Government Resident was another scientifically minded surgeon, Dr. Alexander Collie. He, as had the New South Welshmen before him, shared his bachelor's home with Mokaré when Mokaré was staying in the town; and the two of them undertook several long expeditions deep into the surrounding countryside. Collie's journals, dispatches, and articles in Perth newspapers are excellent records of Aboriginal life, their economy, and their knowledge of the environment (Collie 1832; 1833a; 1833b; 1834).

Other officials of the Swan River Colony (soldiers and surveyors) also took extended journeys into the hinterland with Mokaré's brothers as guides during this period. Their observations are not usually as detailed as Collie's, but their journals contain many statements about Aboriginal life and environmental knowledge (Dale 1833, Roe 1831; 1835, Clint 1831).

Collie was as close to Mokaré as any of his predecessors. When Mokaré died in late 1831 Collie dug the grave himself, according to Nyungar tradition, under instructions from Nakina (Collie 1834:327-8). The strength of the relationship is perhaps illustrated

by the fact that when Collie died a couple of years later, it was his last request that his remains be interred beside Mokaré's. The two were buried side by side in a plot upon which the Albany Town Hall now stands (Stephens 1961:73).

The new settlers who followed Spencer to Albany in the 1830's had even less time than the earlier soldiers for writing down observations of the Aborigines. They were too busy trying to tame and civilize the wilderness. Their children, however, sometimes did have this time, and at least one of them made use of it. James Browne arrived at the Sound with his family during the early part of the decade. As a child he evidently spent a good deal of his time in the company of natives. Later in life he went on the international lecture circuit giving a talk on their culture as he observed it. Similar versions of this talk were published in Canada, Hawaii, and Germany (Browne 1856a, 1856b, 1856c). Much of his information may be based on unreferenced publications by Nind, Wilson and Collie, but there are some details of traditional Aboriginal life that are available nowhere else.

Throughout Spencer's period as Government Resident more and more free settlers came to Albany. Although the town remained more-or-less a joint settlement of Europeans and Aborigines until at least 1841 (Eyre 1845:109), the Aborigines with their "uncivilized" ways were becoming less welcome. William Nairn Clark, a lawyer, newspaper editor, land speculator, and duelist, who was there in the late 1830's, made copious notes on the Aboriginal culture. He

presented these, together with an extensive denunciation of the Establishment's attitude toward the natives in the *Perth Inquirer* (Clark 1840; 1841a; 1841b; 1841c; 1842). He was, unfortunately, a lonely and somewhat eccentric voice crying in the wilderness.

Following Spencer's death in July of 1839, Sir George Grey was offered the position as his successor. Grey was already famous for his explorations in the north, and for the closing months of the period under consideration there was once again a Government Resident who cared enough to make detailed observations about what was left of the traditional Aboriginal culture. Most of the information about Aborigines included in his well known journal was gathered during this period; and Grey states that he accepted the post specifically for the purpose of undertaking these observations (Grey 1841:139).

THE MOKARE'S DOMAIN MODEL:

The author is not the first to study Mokaré (e.g Stephens 1961, West 1976, Green 1979; 1981; 1983), and the Mokaré's Domain model especially owes a dept to Sue Le Souëf's excellent BA Honours thesis, *Social Organisation and Territoriality among the Aborigines of King George Sound* (1980). The conceptual structure is somewhat different than that presented here; but the goals are similar, and the methodological tactics are, in part, identical. Her's was a library thesis completed within a restrictive time limit. That many of her placements of the places frequented by the King George Sound Aborigines have been revised in the present research (see Table 3.3) is due principally to this researcher's extensive familiarity with

the large scale maps of the region; and that the boundaries shown on page 80 of her thesis are considerably different from those on Figure 3.2 is due almost entirely to her failure to recognize the contextual nature of the word *will* (sometimes *weal*, *weil* or *weah*).

Depending upon the context, the Nyungar used this word to denote anyone who lived to the north of them, those on the neighbouring estate or people far away about whom they had only heard (see the definition of *wela* in Moore, 1884:76, and note that in the King George Sound dialect the final vowels are dropped, Moore 1884:vii). The men who wrote the ethnohistorical records at Albany did not understand this because intercultural communication was in an imperfect pidgin language at the Sound. Most thought that "the Will" were a specific tribe of people (e.g. Nind 1831, Collie 1834), but some apparently thought that "Will" was a man's name, some unknown but important leader of a group living to the north (Wilson 1835, Barker 1830-31). Le Souëf followed their lead, and in her final demarcations felt the need to leave room for "Will's people", a "community" "which may be termed a tribe", between the Porongorups and the Stirlings (1980:86).

Mokaré's Estate: Mokaré's Estate was on the shores of Princess Royal Harbour (Fig. 3.2). It is certain that it included the area of the northern shore where Albany was built: "the land about the settlement belongs to Mokaré and his brethern" (Wilson 1835:283), and "As the head of the family however whose ground we occupy one must be indulgent to him [Nakina - who in a hungry mood

had just torn the locked door off of the garrison's storage hut]." (Barker 1830-31: 14.5.30).

It also probably included the entire west and south shores, all of the Vancouver Peninsula, and the shores of King George Sound proper for some distance east of Frenchman's Bay (See Ferguson *n.d* for detailed map), if I understand correctly Collie's statement: "Nakina and Waiter [one of Mokaré's younger brothers], whose natal ground has always been understood to be on the shores of Princess Royal Harbour and towards Bald Head, were, or pretended to be highly offended at some of the tribe, who, in their absence, had fired the best of their wallabee ground" (1834:335).

Nind stressed that estates were of "considerable" size (1831:28), and this would be a family holding of at least 30 kilometres of shoreline and the bush behind it for some distance. It was exceedingly rich and varied in resources (Ferguson *n.d*). The extent of estates at King George Sound were precisely defined using trees and other objects as markers, and these were well known by the local Aborigines (Backhouse 1843:542; Grey 1841:2:232); but, unfortunately, these details appear never to have been recorded for Mokaré's estate.

Mokaré's Range: Mokaré's Range included about 6000 square kilometres. It extended inland for about seventy kilometres north of Albany, and along the coast for over one hundred and twenty kilometres (Fig. 3.2). It was determined by circumscribing those of the many places mentioned as having been frequented by Mokaré's

Table 3.3. PLACES FREQUENTED BY MOKARE'S FAMILY AND ADHERENTS:

LOC. NO. FIG. 3.2	PLACE NAME	REFERENCE
1	Bald Head	Barker 12.5.30
2	Lake Barnes	Wilson 1833:14
3	Mt Clarence	Barker 17.4.30
4	Lake Corimup	Barker 12.3.30
5	Cupup Creek	Barker 13.2.31*
6	shore opposite Eclipse Island	Barker 24.4.30
7	Kallamup	Collie 1933a:136*
8	3 miles NE of Kallamup	Collie 1933a:136*
9	Kamballup	Collie 1933a:139
10	Kendenup	Barker 27.2.31
11	King River	Barker 26.1.30*
12	Koiamip	Collie 1834:315*
13	Kojaneerup	Barker 17.10.30
14	Kokokup	Roe 1831:2*
15	Mt. Manypeaks	Barker 1.3.30*
16	Mt. Melville	Barker 3.4.30
17	Mindijup	Barker 22.7.30
18	Mondurup Swamp	Barker 15.1.31
19	Moorillup	Collie 1833a:143
20	Moorulup	Collie 1833b:175
21	Morandee	Dale 1833:162
22	Narrikup	Barker 22.7.1830*
23	Noorubup	Collie 1833a:137
24	Nunarrup Lagoon	Dale 1833:156
25	Lake Ongerup	Barker 13.2.31
26	Pillenorup	Barker 9.5.30*
27	Porongorup	Barker 31.1.31
28	Quaderwardup	Barker 6.6.30
29	Quechinup	Roe 1831:2*
30	Takkenup	Barker 22.11.30*
31	Tannumbangiwar	Collie 1833a:148*
32	Torbay Inlet	Lockyer 1827:478*
33	Williyungup	Barker 14.11.30*
34	Yakerlup	Collie 1833a:144*
35	Yarrenyungerip	Collie 1833a:146*

* This table was based originally on Le Souëf 1980: Notes for Map 5. The asterisk indicates that either the reference and location was not included on her table or that I have altered her interpretation and/or placement of the location.

family or adherents which can be located on modern maps (Table 3.3). The boundaries are only approximations. In only three instances, where European observers were present when a member of the family came to the limits of the country known to him, is it possible to fix these with any degree of precision.

It is reasonably certain that the northern boundary ran along the southern base of the Stirling Mountains. The family was known to frequent places such as Pillinorup Swamp at the very foot of the mountains (Fig. 3.2, No. 26), but when Nakine wished to travel into the mountains proper he had to gain a local guide through mutual acquaintances (Dale 1933:164).

Two similar incidents suggest the western boundary ran approximately southwest from the base of the Stirling Mountains to the coast west of Wilson's Inlet. These were recorded in December 1829 when Mokaré led Dr. Wilson on a journey north and west of the settlement. They followed well established trackways and Mokaré knew the country well. When they reached a place approximately ten kilometres southwest of the mountains (Fig 3.2, A), however, he said that he had come to the limit of the country known to him and that he desired to turn back (Wilson 1835:251). They pressed on at Wilson's insistence, going first west, and then south toward the coast. It was not until they reached a point, just south of Mount Lindsay (Fig. 3.2, B), that the much relieved Mokaré said that he was once again in country that he knew (Wilson 1835:261).

The eastern boundary of the range cannot be fixed accurately because none of the early explorers seem to have accompanied a

member of the family that far. It must have included the lakes at the southeastern foot of the Stirlings (Fig. 3.2, No. 13) and the coastal area around Mount Manypeaks (Fig. 3.2, No. 15), however, because Mokaré and his family were said to frequent these areas.

PROTOHISTORIC POPULATION - DISTRIBUTION AND MOVEMENT:

The Mokaré's Domain model provides a basis for suggesting a protohistoric pattern of population distribution and movement across the field research area. Stanner's model of the populated landscape envisioned "*spaced estates* with *overlapping ranges* and, thus *partially interpenetrative domains and life spaces*"(1965:12 - his emphasis), and the ethnohistorical sources document this pattern in the Southwest.

An area-wide population estimate based on population spacing: The absolute size of Mokaré's family estate is not known, but it possibly covered at least 35 square kilometres. Traditionally located on this estate were Mokaré, his four brothers in various stages of young adulthood, and their families. The names of some, but not all, members of the family are mentioned in the ethnohistorical sources, so Hallam's (1978) multiplier of 2.6 persons for every adult male has been used in order to provide a rough estimate of the estate's traditionally located population.

This suggests a total population of 13, or approximately one person for every 2.7 square kilometres. A great number of other

Aborigines included this estate within their range, and used its resources (different protocols were required depending on the value of the given resource and affinal ties - see Ferguson *n.d.*, Le Souëf 1980 for discussions). Lockyer (1827) once counted 60 Aboriginal males with their attendant women and children fishing with spears at the west end of the Harbour. Using the multiplier, this suggests that, at times, the estate might support up to 156 individuals, or approximately 4.5 persons to every square kilometre.

Estates did not normally abut upon one another, and the distance between them appears to have been highly variable. The closest neighbouring estate to Mokaré's belonged to Coolbung and family. Its extent is not known, but a portion of it lay along the western shore of King George Sound, near the entrance to Oyster Harbour, about three or four kilometres away from Mokaré's ground (Barker 1830-31: 21.131) Here were tradionally located at least three adult males (eight individuals), and probably some others who are not named.

These two families were quite closely allied with a group of families which centred on the shores of Oyster Harbour. It is not known how many families were in this group, but given the estimated ~~size of Mokaré's estate~~ and the available land around Oyster Harbour, there could not have been more than five or six in total. A similar group of families was centred on the Lake Powell-Taylor Inlet area, about twenty five kilometres west of Mokaré's estate (Lockyer 1827), but is not known how close the individual family estates came to Mokaré's.

If family groups were spaced at this distance from one another across the entire 5752 square kilometres of Mokaré's Domain, say five families of 13 people each for every 625 square kilometres; it would suggest an overall population of about one person for every 10 square kilometres, or 575 people traditionally located on estates dotted across the area through which Mokaré's family moved.

This estimate is two and a half times higher than the one person per 25.9 square kilometers proposed by Le Souëf (1980) for roughly the same area based on applying Hallams multiplier to a total of all the males named in Barker's Journal (1830-31). Her's was an admittedly low estimate; and this one, which is equivalent to Hallam's (1978) for the Swan Coastal Plain, may be too high. The basic figures are only educated guesses, and the density of estates and estate clusters may have been higher in fish-rich coastal areas like the King George Sound-Taylor Inlet area. It does, however, provide a reasonable upper limit.

However, Mokaré's family regularly moved within a sixty or seventy kilometre radius from their estate in all possible directions. They shared this area with all others who held estates within it, and if their pattern is typical, they also shared it with all those who held estates within sixty or so kilometres from it. Consequently, the number of individuals who had access to the products of the range and might be moving across it would be considerably larger than just those who held estates there.

Patterns of Movement:

In most ways, the movement patterns of Mokaré's people were totally unpredictable. The family did not necessarily move as a group. The young, unmarried men appear to have been the most mobile, and they were expected to stay with various other groups for long periods at a time to familiarize themselves with the people and resources of those parts of the range (see Ferguson *n.d.* for a discussion of the education programme). Nuclear family segments of the larger land holding family also tended to travel on their own quite often, since they had different relatives by marriage with whom they must maintain visiting relationships (Ferguson *n.d.*). Sometimes large parties would leave together for a distant visit, but return separately in small groups, or vice versa (Barker 1830-31).

Although Nind (1831:28) and Collie (1834:315) are both among the authors who say there was a seasonal pattern to Aboriginal movement in the region, summers inland and winters on the coast; a close look at the ethnohistorical sources from Mokaré's Domain reveals no general seasonal pattern at all. Aborigines were exploiting the coastal area around King George Sound during every month of 1830 (Le Souëf 1980: Table 3). This could have been affected by the "attractive" presence of the garrison, but four of the five earliest explorations into the inland took place in the summer months of December, January, or February, and all encountered individuals and groups of Aboriginals in areas north of the Porongorup Range (Wilson 1835:241, Roe 1831:3, Dale 1833:163,165, Collie (1833b:174).

It should also be noted that Collie, in an official letter to

Governor Stirling (Collie 1832) contradicts himself by writing that the Aborgines gather at King George Sound in both summer and late autumn. Also, Collie once, after the garrison had been established for over five years, met a native near Mount Barker who had never seen a white man (1834). This perhaps suggests that the Aborigine had not been to the coast in all that time, and is explicable if he came from an estate well to the north and was near the southern limits of his range. This suggestion is supported by information given to Wakefield that natives with estates about 80 kilometres NNW of the Sound have good land and never come to the coast, but that "in the summer when water becomes scarce return to the banks of the river and the lake" (Wakefield 1827-28:519).

Even the "real" size of the range was continuously in flux. Due to sporadic feuding between families (Le Souëf 1980: Table 4), areas which were available for exploitation one year might be closed off the next, and vice versa. The potential range at any given time was only that area where the family could expect to gain permission to exploit the resources rather than a hostile reception, and this could vary dramatically in the short term.

The only apparent pattern to their movement is that it was relatively frequent; and, as was discussed in the last Chapter for the Southwest as a whole, that it tended to be concentrated along corridors of fire-maintained woodland which contained the main trackways. The main trackways of Mokaré's Domain are shown on Figure 3.2. and discussed further in Chapter 4: and the probable distribution of artifacts resulting from this type of pattern has

already been described There is, however, one addition to the picture of what the archaeology should be like which is provided by this closer look at Nyungar population distribution, and that is an awareness of approximately how much archaeological residue might be expected.

The daily stone artifact discard of an individual cannot even be guessed at from the ethnohistorical literature available, but given the variety of ecologically necessary functions for which stone was required, it should not be insubstantial. For example, sixty individuals who would need to resharpen their fishing spears all at one place and one time will probably have left considerable residue behind them. The daily activities such as this of a population of upward of 500 people for even 1000 years is likely to have produced an incredible amount of discard. Stone artifacts from the estimated 40,000 years of occupation must virtually cover the landscape, at least in the areas the Aborigines frequented.

This seems to be the case. The representative archaeological survey of Mokaré's Domain described below provides an estimate of almost 5200 sites in the area; and some of them are deeply stratified and over a kilometre across.

Part III: Archaeological Resources

Before this researcher had ever heard of Mokaré, the general area around Albany had been chosen as a field research area because it satisfied three major requirements of the over-all regional study:

(1) It is located in a zone of vegetational transition, and the

immediate vicinity includes large stretches of dense forests, more open woodland, mallee, and scrub heath. This enables archaeological survey to sample and compare the site distributions within the various vegetation systems in order to investigate one of the basic premises of this study: that the protohistoric Aborigines frequented the more open areas more often than they did the forests.

(2) This area also includes, besides a very small portion of the main body of modern Karri forest distribution, two of the most separated Karri outliers. Most of the vegetation structure in the immediate vicinity can be expected to have been severely affected by the proposed spread of the forests in the terminal Pleistocene and early to mid-Holocene (see Fig. 2.8). This enables excavations to examine the effects of changing forest boundaries on stratified archaeological deposits over time in an area where they should be most pronounced.

(3) The Albany location is also well separated from the bulk of previous archaeolgical research in the Southwest and this provides a major extension to that portion of the region which has been sampled. The majority of the other excavations have been limited primarily to the west coast portions of the Forested Belt and the Swan Coastal Plain. The closest previous excavation is at Northcliffe, over 150 km to the west (Dortch 1975; Dortch and Gardner 1976), and the only published archaeological report for the immediate vicinity is a survey of the local stone fish traps (Dix and Meagher 1976).

By the time the field research for this thesis was completed,

this "blank-slate" nature of Mokaré's Domain archaeology had been reversed, and it is now one of the better known portions of the region. Through both representative and purposive surveys 186 sites have been located. Test excavations have been undertaken on seven of the most promising sites; and two of these, Kalgan Hall and Moorillup Pool, have been subjected to more extensive area excavations (Fig 3.6).

The purposive surveys which located the majority of the sites where excavations were conducted and the excavations themselves are described in the next two chapters. The remainder of this chapter is given over to a discussion of the representative survey which located the vast bulk of the sites, and to the relevance of the results of this survey to Hallam's suggestion that the forests were less densely occupied than the more open areas.

A Representative Sample of Site Distribution:

Archaeological survey was undertaken to provide estimates of the number, distribution and variety of archaeological remains within Mokaré's Domain. Its first use was to be as a comparative sample of artifact distribution from within the various major vegetation systems which would serve as a basis for testing Hallam's model, but it provides a basic inventory of the archaeological resources of the area which can serve as a guide for future research whatever its ultimate goal. The results of the test are reported and discussed at the end of this Chapter, the sections immediately below detail the steps taken to gain a representative sample in an environment where

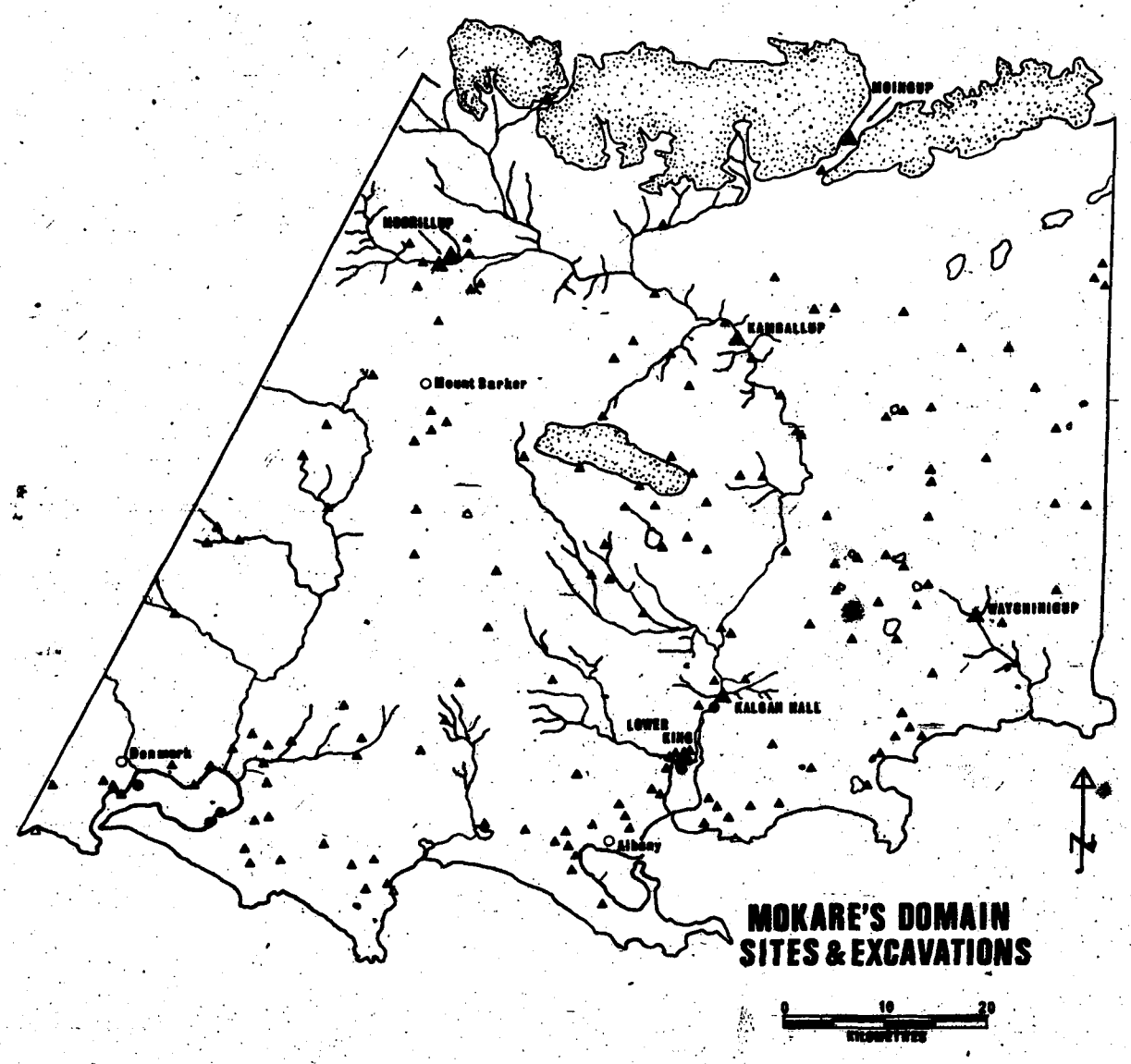


Figure 3.6. Archaeological Investigations in Mokaré's Domain:
The map shows a summary of the field research conducted for the thesis. The small black triangles are surface scatters of stone artifacts recorded during survey, the large, named triangles are sites where excavations were conducted, and the solid black dots are locations of stone fishtraps. In Appendix C of this thesis there is a Site Gazetteer which lists all sites in the area in alphabetical order. Also provided are more detailed maps with border grids so that those sites can be located for a more complete understanding of the text.

it is very difficult to do so.

The Problem of Low Archaeological Visibility: Total coverage of such a large area is unthinkable, and in such a situation some sort of probabilistic sampling technique is generally considered to be the only legitimate way of obtaining a representative sample of the artifact distribution (Binford 1964, authors in Mueller 1975, Flannery 1976, Cherry and Shennon 1978). However, any archaeological survey in this thickly vegetated region must contend with the fact that almost nowhere is the ground visible.

Large portions of the area are covered with forests where the floor is totally obscured by undergrowth and leaf litter. There is little field crop agriculture, and where the forests have been cleared, the land has usually been converted into paddocks which have a thick sod of exotic grasses. Generally, artifacts can only be seen if some disturbance, either natural or cultural, has removed the ground cover and a certain amount of recent sediments.

Overall, it is roughly estimated that as much as 80 to 90 percent of the total land surface is completely obscured. In such a case, the results obtained from the surveying of randomly chosen sample units of landscape is of very dubious validity. The uneven distribution of disturbed areas introduces an indeterminable amount of sample bias (Schiffer, Sullivan and Klinger 1978:8), and there is no way of ascertaining whether a negative report for any given sample unit results from an actual absence of sites or merely from the researcher's inability to see them.

Most of the advocates of probabilistic sampling seem to work in arid environments where artifact visibility (one assumes) is excellent. Few of them seem to be aware of this problem, and those who do note it are not very helpful in suggesting ways by which it can be overcome. Binford (1964:151) simply suggests that "there are many ways to correct complicated sampling conditions" but does not elaborate. Flannery (1976:159) admits that attempts to use quadrat blocks in such a situation would "border on lunacy", and suggests using transects instead, implying that somehow changing the shape of the sample unit will make the ground more visible.

Cherry and Shennon (1978:25) suggest that the problem can be overcome using aerial photography and geophysical or phosphate survey. Aerial photography, in this region at least , would only further obscure the ground by inserting a dense forest canopy between it and the observer; and the other two techniques are unlikely to find sites which normally consist only of scatters of small stone artifacts in leached sands. Even if they could, their use on a project of this scale would be prohibitively costly in time and funds (Dancey 1981:104-108).

Schiffer, Sullivan and Klinger (1978) are the only authors who give serious consideration to the problem, and after extensive discussion they appear to accept that it is insoluble in any pragmatic way. Their only realistic solution, the creation of artificial exposures (shovel sampling, etc.), they consider too low in cost effectiveness for use over more than a very limited area. They suggest that attempts to sample by probabilistic methods in areas of

extremely low visibility should be abandoned, and that instead one should seek out the existing disturbed places for survey. They conclude:

> Although utilization of existing exposures for site discovery makes parameter estimation very difficult, it can lead to efficient discovery of the range of commonly occurring, more obtrusive sites - assuming only moderate bias in exposed places. (Schiffer, Sullivan, and Klinger 1978:7).

The Road Survey Following this argument, the strategy of the sampling procedure used in this research restricted the sample units exclusively to the areas along the approximately 1693 kilometres of two-wheel drive roadways in Mokaré's Domain (Fig 3.7). The roadways are the lines of likely maximal disturbance, and are distributed so that, with the exception of the relatively dry Qualup Vegetation System, they enable an approximately equal proportion of all major environmental zones to be examined. A near total coverage of the disturbances along these roadways was undertaken, and it is suggested that it has resulted in a representative sample of the sites within the research area. Since it is not a probabilistic sampling method, however, this representivity cannot be automatically assumed and must rely on logical argument for acceptance. The discussion is included below, following a description of the methods used.

The Road Survey was conducted in the following manner. The

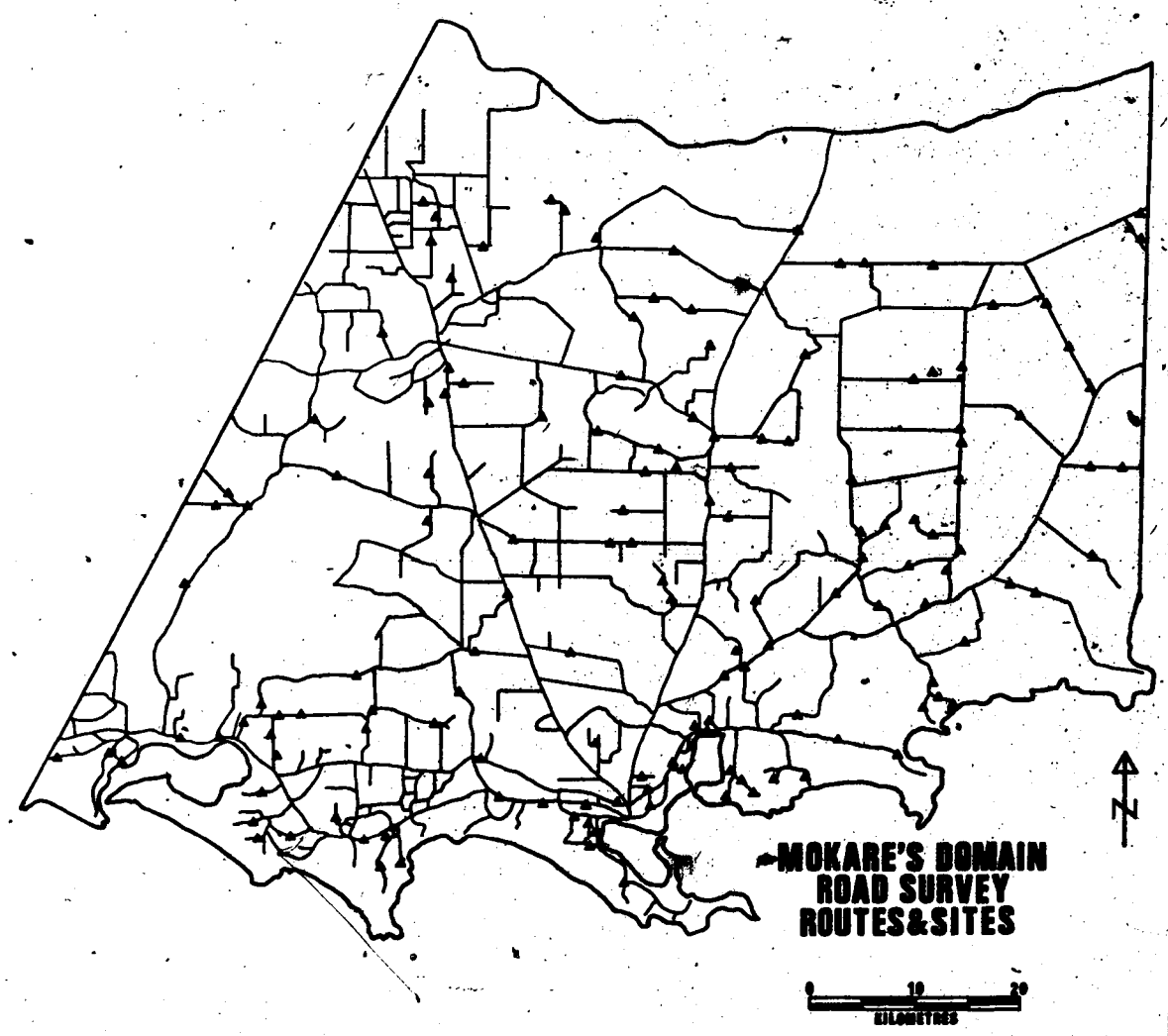


Figure 3.7. The Road Survey - Routes and Sites:
The map shows the overall routings of the two-wheel drive, public roadways in Mokaré's Domain. The sites recorded during the archaeological survey along those routings are shown by the black triangles. In Appendix C, The Site Gazetteer, the Road Survey Routes and the sites found along them are shown in more detail.

survey team normally consisted of two individuals, and the director was always a member of the team. A stretch of road was driven along until a patch of disturbance within about 100 metres of either side of the road and large enough to be seen from a slowly cruising vehicle was encountered. The vehicle was then stopped and investigation of the disturbance proceeded on foot.

In areas where disturbance was present for long stretches of the road (extensive cuttings and firebreaks), or where the road itself was unsurfaced with imported materials, survey was carried out on foot using a technique dubbed "the leap frog method". In these instances, one member of the team was dropped off and the vehicle driven 500m to a kilometre further down the road. The driver would then park the vehicle and proceed forward on foot. The other member of the team would survey the area between his drop-off point and the vehicle. He would then get in and drive on past the member of the team who had been surveying ahead of the vehicle, park, and proceed forward on foot. This pattern was continued until the entire length of the disturbance had been covered.

The Road Survey of Mokaré's Domain took 106 person-days, an average of 16 km per person, per day; and 149 sites were located. For the purposes of argument, it will be considered that the coverage of the available roads was complete, even though two kilometres of roadway were inadvertantly missed and real coverage was only 99.998% complete. Undoubtedly, given the speed at which the area was covered, many smaller disturbances, and some artifacts were missed. Resurvey of some areas using larger crews, however, failed

to turn up any artifacts.

Table 3.4 provides a summary of the results of the Road Survey by vegetation system. To estimate the percentage of each vegetation system sampled, road distance was given a nominal width of 100m. As can be seen from the table, the sample provided by the road survey is only a very small proportion of the total area, an average overall of only .03 %. Coverage is, however, about equal for all major vegetation systems except the Qualup. Unfortunately, few or no roads crossed the smaller vegetation systems; the Porongorup, Torndirrup, Bremer and Manypeaks systems, and no estimates of site densities within them is possible.

Arguing Representivity: Long, narrow, non-probabilistic sample units such as roads, pipelines and trails have been compared to uncontrolled transects (Gumerman 1973, Flannery 1976), and transects have been shown in several experiments to be more successful than quadrat blocks in providing a representative sample of a region (Judge, Ebert and Hitchcock 1975, Matson and Lipe 1975, S. Plog 1976). The results of experiments which compare sampling techniques can be criticised because the value of such a technique depends on the specific nature of the data being sampled (Hole 1980), but, in this instance, the superiority of transects is logical because of what is sometimes called "edge effect" (Schiffer, Sullivan and Klinger 1978). As Matson and Lipe (1975:132) point out: "since a transect plot will crosscut more sites and environmental areas than a quadrat of equal size, it thus will be more representative of the area"

Table 3.4 Results of the Road Survey of Mokaré's Domain:

VEGETATION SYSTEM (Fig. 3.5)	APPROX. SQ. KM. IN VEG. SYSTEM	APPROX. ROAD DISTANCE SURVEYED	NOMINAL SQ. KM. SURVEYED	NOMINAL % OF SYSTEM SURVEYED	NUMBER OF SITES FOUND	DENSITY OF SITES PER SQ. KM.
DARLING						
Menzies						
Kendenup	461	158 K	16	.03	11	.7
Narrioup	1259	469	47	.04	33	.7
Porongorup	52	2	.2	.004	0	-
East Kalgan	680	191	19	.03	31	1.6
Hay	702	180	18	.03	13	.7
Albany	482	193	19	.04	14	.7
Warren						
Denmark	407	240	24	.06	22	.9
Torndirrup	160	4	.4	.003	0	-
EYRE						
Qualup	772	61	6	.007	6	(1.0)
Cape Riche	707	193	19	.03	19	1.0
Bremer	12	0	-	-	-	-
Manypeaks	58	0	-	-	-	-
TOTALS	5752	1691 K	169	.03	149	.9

Uncontrolled transects which were sampled during impact studies of linear threats such as highway and pipeline right-of-ways, and which are similar in some respects to those used in this research, have previously been used to estimate regional site densities and distributions (Trubowitz 1977, Goodyear 1977, Pickering 1982). This has been justified theoretically in spite of the non-probabilistic nature of the sample because the sample units (especially long ones) tend to include sections of all major environmental zones (Gumerman 1973).

Tentative support for the representivity of this type of sample unit has also been provided by experiment. Mueller (1974) projected five simulated right-of-way sample units across an area where 100% of the sites were known, and his results suggest that such samples are an accurate indicator of site density. Two major sources of possible bias have been noted for such surveys, however: they do not provide dispersed sample coverage of environmental and archaeological diversity of the larger region (Cherry and Shennon 1978:32, Goodyear 1977:158), and there is an obvious source of bias pertaining to the geographical placement of the routes by planners and engineers (Goodyear 1977:158, Pickering 1982).

In the Road Survey both of these sources of bias should be eliminated because sampling was with multiple corridors rather than with a single one such as in the cases above. First, dispersed sample coverage is provided in this way; and second, the variable economic demographic, political and geographic factors that determined the routings of the different types of roads in the region dampen the bias.

that might be expected in the planning of only one route. Minor roads in the Albany area, especially older ones, tend to follow the line of least resistance, along stream courses, skirting lakes, etc. Major roads, especially newer ones, tend to run more or less straight across the landscape with placement designed to avoid encountering major obstacles.

It should be noted, however, that the variety of roads may in fact, introduce another type of bias not found in the single corridor surveys mentioned above. Due to factors involving the interworkings of the type of landscape being traversed, the type and age of construction used, and the density of modern population settled along them; the variety and amount of disturbance provided by each road varies considerably. For instance: sand tracks tend to go over the surface of the landscape providing a fairly wide but shallow exposure, while modern, paved carriage ways are often cut down into the landscape. In these latter cases, much of the original disturbance has been covered by the road surface, but the deeper cuttings often expose otherwise well buried deposits.

In the Road Survey all the roads have been treated as equal, but given the variety of road surfaces, construction techniques, and length of time since initial construction and last road-bed maintenance, the number of variables is imponderable. No attempt has been made to quantify these variations, and it can only be hoped that any biases introduced in this manner will cancel each other because there is no pattern in these variations from vegetation system to vegetation system. Each has both old and new roads, sand

tracks and paved dual carriage ways, and almost every possible variation in between.

In conclusion, it seems reasonable to suggest that the Road Survey provides a sample which can be treated as representative of the site distribution in the research area. At least, because the researcher has no control over the routings and construction methods of the roads, little unconscious bias on his part can be expected, and it is further suggested that, given the nature of the region's poor archaeological visibility, this method provides the best possible estimate that could be achieved without unwarranted expenditure. In support of this conclusion, Strawbridge's BA Honours thesis (1982) compared several sampling techniques in an area of 100 square kilometres within Mokaré's Domain and found that as far as estimating overall density, the Road Survey results were comparable with any others.

Site Recording and Purposive Artifact Collection Methods:

Locations at which there were three or more artifacts within a ten metre radius were designated as archaeological sites, and all other artifacts within a radius of 100 metres (or within a larger area, if the scatter was more or less continuous) were considered as belonging to the same site. In the 12 cases where only one or two artifacts were discovered, the location was noted but it was not included in the site totals and no collection was made. In all cases where three or more artifacts were found, the map coordinates were noted, the exposed scatter described, and the relevant details of the

environment (vegetation, soils, current land use, nearest water, etc.) were recorded.

In almost every case, it was virtually impossible to achieve any accurate estimate of the size of a site or the density of the artifact scatter upon it. This was due to the ever present problem of site visibility. Even in a large expanse of exposure, it was normally impossible to determine whether the few artifacts visible were the total remnants of a small site; or whether, because the depth of disturbance often varied considerably, they were only a few of the uppermost representatives from a much larger site most of which was still buried. Estimates were consequently made only of the approximate extent and depth of the disturbance, and the number of artifacts visible.

Collections were purposive, and made with two goals in mind. First and foremost, it was hoped to secure, if possible, artifacts which had a known and limited temporal distribution, so that some method of dating the site was available for use in the proposed test of Hallam's model. Second, it was hoped to obtain a sample of the petrological variety of artifacts on each site, so that in the event that quarry sites could be identified, some idea of the scope and dynamics of dispersion of materials from the quarry could be obtained (see Byrne 1980 for discussion).

Probabilistic sampling methods were not used because (1) the one artifact type with a known temporal distribution makes up only about .40 % of total assemblages (see below) and it would probably be missed, because (2) such methods were extremely difficult and time

consuming to apply to the types of artifact scatters normally encountered, and because, (3) while a representative sample of the artifacts at every site would be desirable, a representative sample of only those artifacts made available for collection through the vagaries of the exposure processes did not seem especially relevant.

Some sort of temporal control for the surface sites is absolutely crucial if they are to be used to examine the relative intensity of Aboriginal usage of different vegetation zones when the areas covered by those zones are assumed to have altered over time. The only known local artifact type with a reasonably well understood temporal distribution is the backed microlith. It enters the region sometime around 4000 BP, and continues to be found, in some places, into modern times (see Chapt. 6 for discussion). Unless the collection technique is designed so that these rare pieces are noted, and a probabilistic technique short of total collection cannot be so designed, there is little point in undertaking the survey in the first place.

Also, no matter what probabilistic method is used, be it truly random, systematic, stratified-random, or cluster sampling; some form of co-ordinate grid must be established over the area from which the sample is to be drawn so that *at least* the first artifact collected can be chosen randomly. This is a labour intensive exercise; and, given the dubious benefit which could be expected because of the already unrepresentative nature of the population being sampled (see below), the expenditure in effort and time seemed unwarranted. Even "leash" type sampling techniques (Binford 1964:153) are exceedingly

difficult to implement when the artifact "scatter" consists only of a strip of stones lying at the bottom of a narrow drainage ditch; or even worse, when the only artifacts exposed are protruding from the face of a vertical or near vertical cutting.

Even if the time and energy had been expended to use a probabilistic sampling method, it would not have been representative of the sites themselves, but *only* of the artifacts which were exposed. There seems to be an implicit assumption in most research of this nature that these are, in turn, representative of the artifacts which are not exposed; but the author has previously found this assumption to be invalid, at least in situations where sand deposits are subject to wind deflation processes, one of the most common situations in this region.

Research comparing the relative compositions of assemblages taken from a deflation surface and two stratified excavations in undeflated deposits on either side of it at Quininup Brook suggested that almost 90% of artifacts less than 10 mm in length (there, about 94% of the total excavated assemblages) had been blown away by the wind. A short search in the recently redeposited sands which had built up downwind from that site found that many larger artifacts had also been removed from the assemblage in this manner, including a few chunky granite fragments up to 2.5 grams in weight (Ferguson 1977:10-21; 1981:616-8).

For the Mokaré's Domain research, consequently, all refined statements concerning relative assemblage composition are based on the excavated assemblages. Surface collections are only used to

establish rough temporal control, suggest basic petrological composition, and to provide easily obtainable additional examples of the various artifact types for study in conjunction with the functional analysis of the excavated assemblages.

The surface collections were made in the following manner. For sites with 25 or less artifacts exposed, a total collection was made. For sites with more than 25 but less than 100 artifacts exposed, only 25 artifacts were collected. These were selected in the following manner: after the extent, size and basic composition of the scatter had been ascertained, *one artifact was chosen and it and the 24 artifacts closest to it were collected.* For larger scatters, this process was repeated in more than one location, and collections were always made in multiples of 25 artifacts: 50, 100, 200.

The choice of the first artifact was dictated by the goals of the collection process. If a backed microlith was present, it was chosen to begin the collection. If not, the petrological purpose became the prime motivation for collection, and a piece of material different from the majority of the artifacts on the site was chosen as a place to begin. This insured that some indication of the variety of the materials present was secured, but, of course, biased against true representivity.

Subjectively, other than over-representation of backed microliths and a slight bias toward greatest petrological variety, this collection method probably does provide a reasonably representative sample of the exposed artifacts, but there is no way this can be

demonstrated. Further details on the artifacts collected in the Road Survey are presented in Chapter 6 where the results of petrological and the functional analyses are discussed.

Testing Hallam's Model:

The primary purpose of the Road Survey was to provide a representative sample of the density of sites within the various vegetation systems so that Hallam's ethnohistorical model, that the forests were less frequented than the woodlands, could be examined. One previous report of archaeological survey in the region has addressed itself to this problem (Pearce 1982).

Pearce conducted an impact survey in the extreme southern reaches of the Northern Jarrah forest near Collie, and found nearly 300 sites. He criticised Hallam's model because he interpreted her as suggesting that there would be no sites in the forest at all, and demonstrated that his survey produced a site density of approximately one site per square kilometre which was equal to the density she proposed for the Swan Coastal Plain on the basis of her surveys (Hallam 1978).

There can be no doubt that there was some usage of the forest in proto-historic times (Hallam 1975:110), especially along stream courses where Pearce found the majority of his sites. The density argument is germane; but, unfortunately, the surveys of the two different vegetation regions were conducted by such radically different methods that any comparison of density estimates is

extremely suspect. Moreover, Pearce provides no temporal control, and given that the distributions of vegetation zones have been altered over time by climatic change, there is really no way of knowing what the surrounding vegetation was like at the time any given site was being frequented.

Dating of surface assemblages is difficult in Australia where temporally restricted artifact types are rare. In the Southwest, there are only the backed microliths, and it is fortunate that they do not appear in the region until after the last major Holocene climatic change occurred. This means that any site with backed microliths must have been frequented during the modern climatic regime, and modern vegetation systems can be used in a study of their relative distributions.

The presence of backed microliths at a site implies that it must have been frequented at least during the late Holocene, but it may have also been frequented at other times. The absence of backed microliths only means that no dating of a site is possible by this method. The site may have been occupied at any and all times, including the late Holocene. Since backed microliths form only a tiny percentage of late Holocene artifacts, many late Holocene sites will not be known to be such: because they did not contain backed microliths in the first place, because no backed microliths were exposed on the surface, or because the exposed backed microliths were inadvertently missed during the collection.

Conditions of exposure are roughly similar along the roads of Mokaré's Domain in all vegetation systems, however, and collection

techniques were identical at all sites. Although only a small proportion of late Holocene sites can be identified in this way, unless some other factor is involved, that proportion should be approximately the same regardless of the density of the surrounding vegetation.

It can be seen from Table 3.5, where the major vegetation systems are arranged by vegetation density, that overall site density is about one and a half times higher in the more open vegetation systems than in the forested vegetation systems. The difference is created more by the extremely high site density in the East Kalgan woodland system than by anything else, however. Without this association, the difference virtually disappears. There is even one woodland system, the Kendenup, which is actually lower in density than the Denmark Karri forest system, but because these sites represent all prehistoric climatic regimes, such an unclear picture is not suprising.

When only the sites with backed microliths on them are considered, however, a strong positive correlation of site density with more open vegetation systems is immediately apparent (Table 3.5). The average density of sites with backed microliths in the four forested vegetation systems (.083 per square kilometre) is about four times lower than that in the four more open vegetation systems (.333 per square kilometre), and the highest density of the forested systems (the Narricup with .13 per square kilometre) is about half that of the lowest density of the more open systems (the Kendenup with .25 per square kilometre).

Table 3.5. Numbers and Densities of Sites from which Microliths were Collected in both Forested and More Open Vegetation Systems:

VEGETATION SYSTEM	NOMINAL SQ. KM. SURVEYED	NUMBER OF SITES FOUND	DENSITY OF SITES PER SQ. KM.	NUMBER OF SITES WITH MICROLITHS	PERCENT OF SITES WITH MICROLITHS	DENSITY OF SITES WITH MICROLITHS PER SQ. KM.
FORESTED						
Narrikup	47	33	.7	6	18	.13
Hay	18	13	.7	2	15	.11
Albany	19	14	.7	0	0	0
Denmark	24	22	.9	1	5	.04
Total	108	82	.76	9	11	.083
MORE OPEN						
Kendenup	16	11	.7	4	36	.25
East Kalgan	19	31	1.6	8	26	.42
Qualup	6	6	1.0	2	33	.33
Cape Riche	19	19	1.0	6	32	.32
Total	60	67	1.12	20	30	.333
GRAND TOTAL	168	149	.87	29	19	.172

A Chi-Square test was conducted to confirm the significance of the apparent strong tendency for sites with microliths to be located in more open vegetation areas.(Table 3.6). The numbers of sites with and without microliths were correlated with the numbers of sites in forested and non forested systems, and the resultant Chi Square value of 8.24 suggests that the positive correlation of microlithic sites with open vegetation systems is significant at the .005 level.

There seem to be only two possible explanations for this phenomenon:

(1) There is a far greater density of late Holocene sites in the more open areas than in the forested areas; or

(2) There is a "functional" correlation between backed microliths and open vegetation areas. That is: it is possible that there are approximately equal amounts of late Holocene sites in both areas, but because backed microliths were used less in the forested systems, they formed a larger proportion of the tool kit in the open systems and are therefore more visible in the archaeological record from these areas.

Due to the non-representative nature of the surface collections their relative artifact proportions cannot be used to examine this second possibility. Excavations were undertaken in both areas, however (see Chapt 5.), and the relative artifact proportions of the assemblages recovered from them can be used for this purpose. A comparison of these assemblages suggests that although there are many fewer sites containing microliths in the forested areas, those

TABLE 3.6 : CHI SQUARE TEST CORRELATING SITES CONTAINING BACKED MICROLITHS WITH VEGETATION SYSTEMS

FORMULA (BRUNING AND KINTZ 1977:231)

$$x^2 = \frac{N(AD - BC)^2}{(A+B)(C+D)(A+C)(B+D)}$$

WHEN A, B, C, AND D ARE NUMBERS FROM THE CONTINGENCY TABLE →

A	B
C	D

		FOREST YES	FOREST NO	
MICROLITHS	YES	9	20	29
	NO	73	47	120
		82	69	149

$x^2 = 8.24$

SIGNIFICANCE > .005

that do have them have proportionately just as many as the sites in the open areas.

Table 3.7 shows that there is only one site from a forest area with excavations which can be dated to the late Holocene, Kalgan Hall; but one of the two excavations there is large, and it provides a good sized sample for comparative puposes. It has microliths in both trenches, and these make up about 0.43 per cent of the total microlithic period assemblage.

There are six sites from the more open areas which can be dated to the late Holocene. Although the percentage of microliths varies greatly from trench to trench because of the small size of some of the samples, the overall total of 0.34 per cent is very comparable to that in the forested regions; and this suggests that backed microliths made up an approximately equal proportion of the contemporary tool kit in both areas.

The prehistoric function of the backed microliths has yet to be convincingly established (see Chapt. 6 for discussion), but whatever they were used for, they seem to have been used in approximately equal amounts wherever their users were residing. It therefore seems reasonable to discount the second, "functional" explanation, and conclude that the tendency for sites containing backed microliths to be located in the more open areas is a purely "temporal" phenomenon: that there is simply a greater density of sites from the current climatic regime in the more open vegetation systems than in the forest systems.

This is the first temporally controlled and arguably

Table 3.7: Comparison of Backed Microliths as a Percentage of Total Backed Microlithic Period Artifacts from Forested and More Open Vegetation Systems Based on Excavated Assemblages.

TRENCH	TOTAL MICROLITHIC PERIOD ARTIFACTS	NUMBER OF MICROLITHS	MICROLITHS AS PERCENT OF TOTAL ARTIFACTS
FOREST			
KALGAN HALL 1	321	6	1.87
KALGAN HALL 2	5198	19	0.37
Total	5519	24	0.43
NON-FOREST			
KAMBALLUP POOL 1	10	1	10.00
KAMBALLUP POOL 2	231	1	0.43
MOORILLUP CROSSING 1	25	2	8.00
MOORILLUP POOL 1	322	0	0.00
MOORILLUP POOL 2	2272	5	0.22
MOINGUP SPRING 1	22	1	4.55
WAYCHINICUP RIVER 1	41	0	0.00
WAYCHINICUP RIVER 2	38	0	0,00
Total	1961	10	0.34
GRAND TOTAL	8480	34	0.40

representative survey conducted using comparable survey techniques in both forest and non-forest areas of the Australian Southwest. Its results strongly support Hallam's ethnohistorically derived model that the Nyungar of the ethnographic present frequented the forested areas of the region far less than the non-forest areas. Further, it suggests that this preference for the more open vegetation areas is not a purely recent adaptation, but that it has a continuity which extends back in time through at least the period when backed microliths were part of the tool kit, for about 4000 years.

Semi Macro Patterns: Summary.

The field research area is approximately equal to the area exploited by a family band during the ethnographic present. It has a highly varied environment, and is rich in both ethnographic and archaeological resources which can be used in the study of the cultural-ecological adaptations of its prehistoric inhabitants.

A first use of these resources, to examine the pattern of site distribution over the semi-macro pattern area, provides strong support for the proposal presented in the last chapter that a similar pattern of site distribution prevailed over the entire macro pattern area. In the next chapter, these same resources are used to gain a more detailed understanding of the pattern of site distribution around selected topographical locations within Mokaré's Domain.

CHAPTER 4
MESO PATTERNS:
SURVEY IN MOKARE'S DOMAIN

Purposive Survey:

The field research in Mokaré's Domain was to provide the basis for an initial test of the mid-Holocene depopulation model; and as such, its primary goal was to locate and examine stratified archaeolgical deposits in which the artifact sequences included at least the entire Holocene period. The excavations and the sequences are discussed in the next chapter. This chapter focuses on meso patterns, the distribution of sites around given points on the landscape. It introduces the sites at which the excavations took place, details the survey methods by which they were located, and describes their environmental and archaeological contexts.

To pursue the primary aim of the research, purposive survey techniques were used. From the study of the Nyungar camping pattern discussed in the last two chapters, a rough concept of the type of site which would provide the desired long artifact sequences was developed. Assuming a basic continuity in the pattern through time, this would be a place to which the prehistoric inhabitants returned time and again for their short, one to three day, camping episodes; and, because of the projected changes in the environment over time, it would have to be a place central enough in the prehistoric exploitation and communication network that it would have been continually frequented regardless of alterations in the immediately

surrounding subsistence resources.

In order to locate this type of site, several localities within Mokaré's Domain were chosen for intensive off-road survey. These localities were determined by the use of low-level predictive models developed from an examination of the protohistoric network of Aboriginal trackways. Initially they were just points on a map; points from which to survey outward in search of a place to excavate. This type of survey located the majority of sites which were excavated. Only one of the named excavation locations on the map (Fig. 3.6), Waychinicup River, was a site discovered in the road survey.

The purposive survey discovered a wide variety of archaeological remains, including some categories not found in the road survey; and, although serious survey normally proceeded no further than the discovery of a site believed to be of the type desired for excavation, the presence of these different types of sites and facilities in close proximity to one another provoked questions about their functions and inter-relationships.

Each locality has a considerably different environment from any of the others, and each presents a somewhat different suite of archaeological phenomena to investigate. A thorough investigation of any one of them would be a thesis project in itself. What is included here is basically descriptive, and the focus of interest is on the main, repeatedly frequented campsite, if one was found. These localities are presented below, organized under the type of predictive model which caused them to be included in the study, and because of space limitations only those where excavations were conducted are

included.

Topographically Optimal Nodes - Lowest fords and Mountain passes:

At the most basic level, this model derives from the truism that major geographical barriers such as unfordable bodies of water and impassable mountain ranges will restrict and direct the pattern of human movement over a landscape. Some archaeological ramifications of this principle become obvious after an examination of the routings of Aboriginal trackways on the Swan Coastal Plain as they were recorded in the ethnohistorical sources (Fig 4.1a).

Hallam, in her discussion of these trackways (1975:66-71), described their general placement using the terminology of network analysis. The trackways, and the corridors of "easy movement" along which they ran, were the paths of the network: and the ethnohistorically recorded campsites were the nodes in the network, located where the paths intersected. What was implied is that nodes were not primarily located to make full use of immediately local subsistence resources, but rather more with with an eye to ease of communications.

This can be seen more clearly in the abstracted network model of the Swan Coastal Plain trackways (Fig 4.1b) where the Ocean, unfordable parts of the rivers, and the steep slopes of the Darling Scarp are shown as shaded barriers. Main trackways are routed to skirt the barriers, and major camp sites are located at the lowest fords of rivers and near the entrances to mountain passes. It is

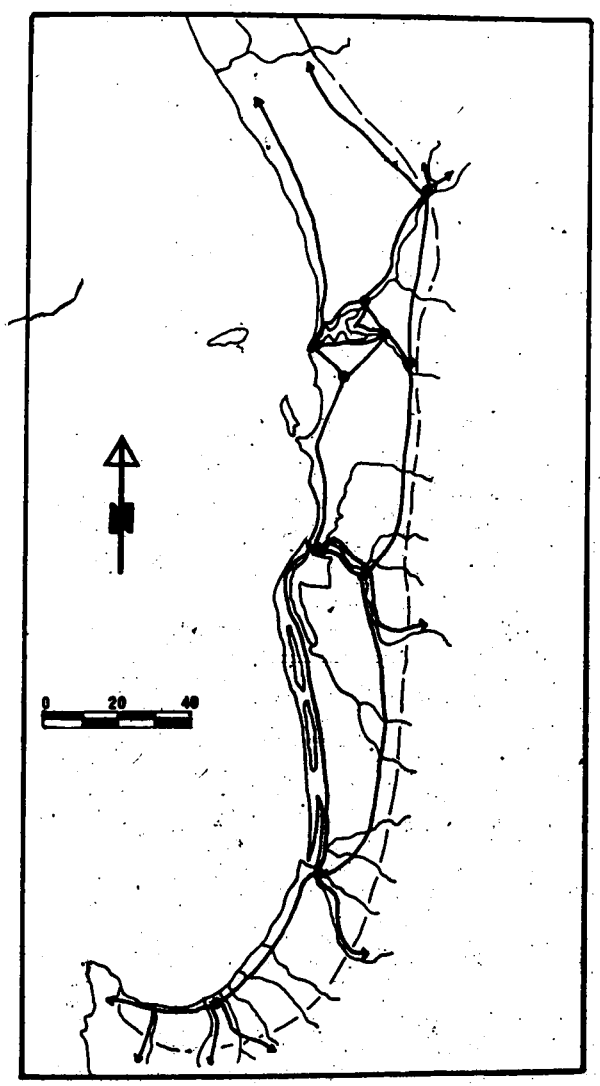


FIGURE 4.1a. Model of Swan Coastal Plain Trackways: (See Hammond 1933, Hallam 1975).

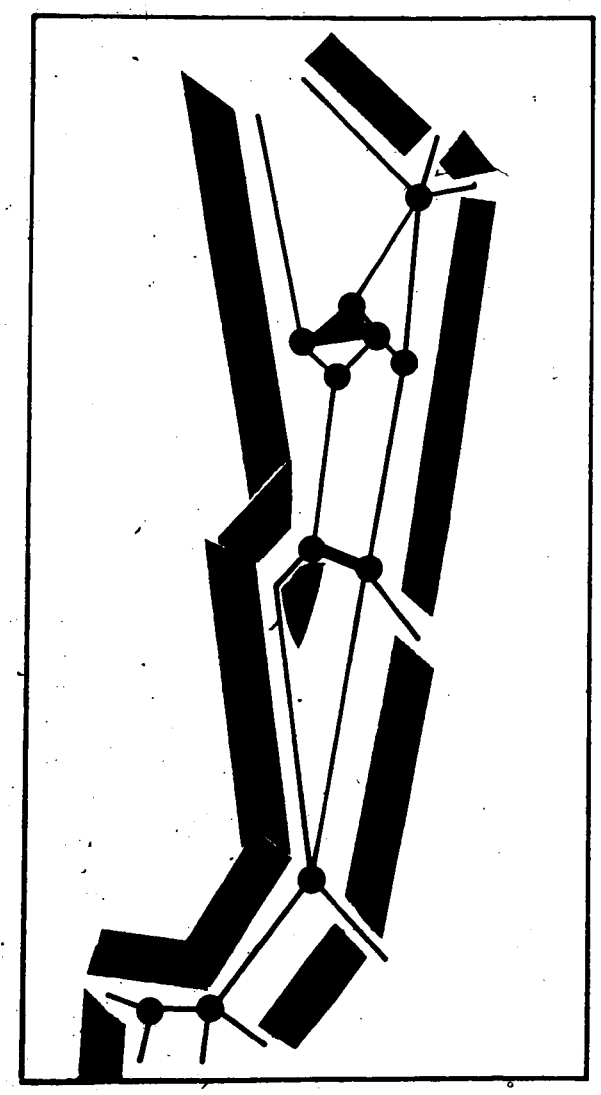


FIGURE 4.1b. Abstract Network Model Trackway System: (See text).

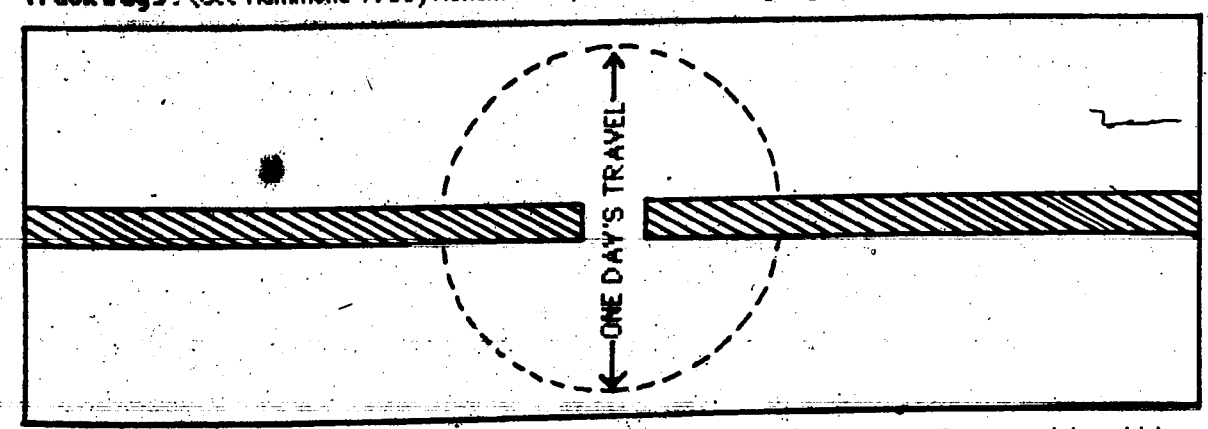


FIGURE 4.1c. Model of Barrier Crossing Access Zone: Members of any society which exploits both sides of the barrier will have to choose an overnight resting place somewhere within the circled area (see text).

suggested that these locations, in general, probably provide no more in the way of immediately available subsistence resources than most others. In some cases they may provide even somewhat less.

The archaeological site location model developed from this observation should be applicable when dealing with any society, in any landscape. It simply states that: - given any substantial topographical barrier to human movement, and given that the society under study exploited both sides of the barrier, there will be an overnight resting place for that society within a radius of one half day's travel from the centre of any barrier crossing point (Fig. 4.1c).

In practice, the distribution of subsistence resources, especially water, restricts the potential location of sites within the barrier crossing access zone even further. It is important to note, also, that since topograghical barriers and their crossing points tend to be relatively long term features of a landscape, sites located primarily as a consequence of their access to the crossings are likely to have been frequented over a considerably longer time span than those whose location was chosen for more ephemeral reasons.

Initial survey in the field research area was directed by this model. Seven localities were chosen for concentrated reconnaissance: the lowest fords of the Denmark, Hay, Sleeman, King and Kalgan Rivers; and Red Gum and Chester Passes through the Stirling Range (Fig. 4.2). Survey was begun at the crossing points and expanded outward. In no case was the entire half-day's walk radius examined, and archaeological visibility in some of these areas was very close to nil. Sites were, however, discovered quite near to all the crossings

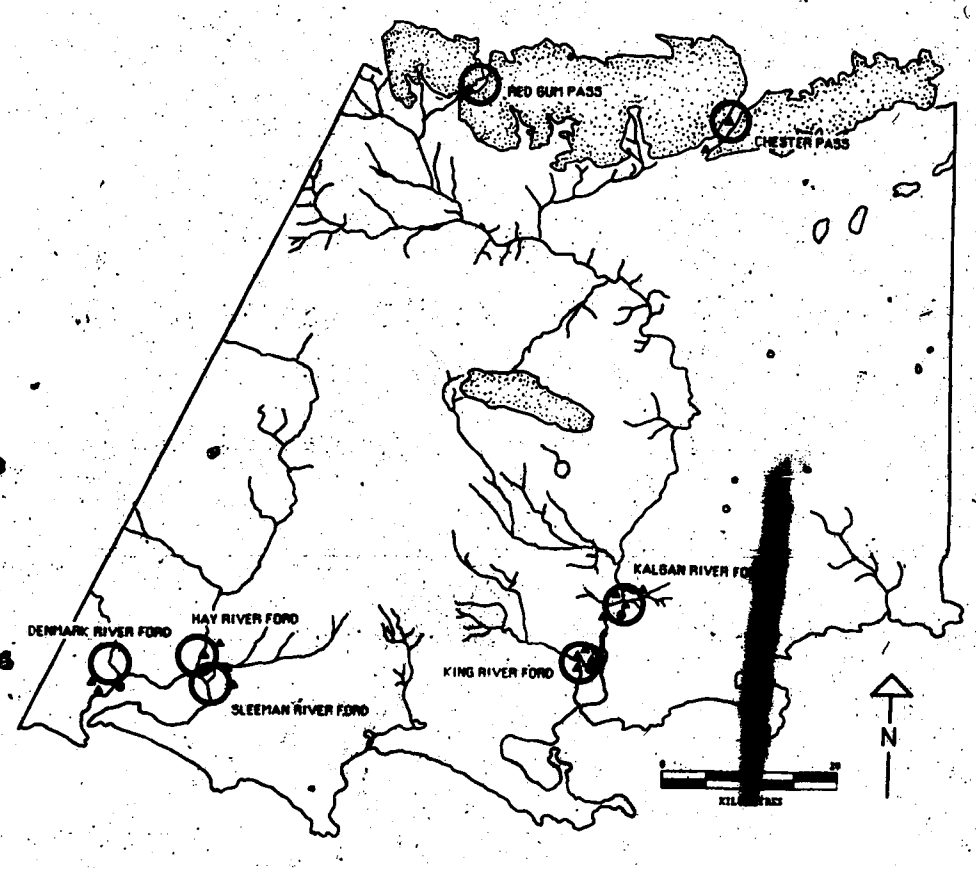


FIGURE 4.2. TOPOGRAPHICALLY OPTIMAL NODES IN MOKARE'S DOMAIN:
The map shows seven places predicted to have been topographically optimal nodes in the prehistoric exploitation and communications network of the field research area. The triangles are sites found during the survey. The areas inside the circles are considerably smaller than the one half day's travel radius shown on the barrier crossing access zone model in Figure 4.1c.

except the fords of the Denmark and Sleeman Rivers; and test trenches were dug at the sites in association with the lowest fords on the King and Kalgan Rivers, and at Moingup Spring in Chester Pass. One of these, at the Kalgan River ford, revealed a deposit which warranted further excavation. This site was later shown to contain an unbroken sequence of occupation extending from well before 19,000 BP up to the the ethnographic present; and accordingly, this survey technique is considered a qualified success.

Lowest Ford on the Kalgan River:

The lowest highwater ford on the Kalgan river is located 15 kilometres inland from the coast (Fig.4.2). This is also the extent of the tidal reach up the river. Below this point during high tide, or when the river is in flood, the Kalgan River and Oyster harbour form a significant barrier to east-west pedestrian movement. A bridge now spans the mouth of the River ten kilometres downstream, but before this was built, early European movement was affected by the location of the ford and early European settlement attracted there. Although nothing ever came of the plan, the area around the ford was originally laid out as a townsite in 1831, and the first of several bridges was built there in 1855 (D.A.P. West *pers. comm.*). It is now the site of the tiny Kalgan Township which was established about 1904, and which boasts tourist tea rooms, a decrepit town hall (formerly the school) and about a dozen houses.

Of all the river fords examined, this one was considered the most likely to produce the type of site desired for excavation since

the River below here provided the longest and most substantial barrier. The ease of discovery of a major, repeatedly frequented campsite here, however, was somewhat phenomenal. The researcher drove to the ford, parked in a graded parking lot overlooking the local swimming hole in the pool immediately below the ford, got out, walked 15 metres to a partially overgrown road cutting about two metres high, and found masses of *in situ* artifacts jutting out of it. Because the part of this site which has not been bulldozed away to provide space for the bridge approach and the parking lot is the ground on which the Kalgan Town Hall now sets, it was recorded as the "Kalgan Hall Site" (Fig. 4.3).

Vegetation regrowth is rapid in this area and archaeological visibility extremely limited except in areas of major and recent disturbance. The extent of the site in former times cannot be determined with any degree of accuracy, but the few artifact scatters found within the immediate vicinity of the ford were all considered to be part of the Kalgan Hall site. Survey further afield was also severely hampered by an almost total lack of visibility, and was soon virtually abandoned. It is doubtful that even the stone fish traps just downstream from the ford (see below) would have been found, if they had not been already recorded by others (Dix and Meagher 1976), and their specific location pointed out by local informants. The only other sites within the Kalgan ford meso pattern area, which was arbitrarily chosen as a four kilometre radius of the ford, were found during the Road survey.

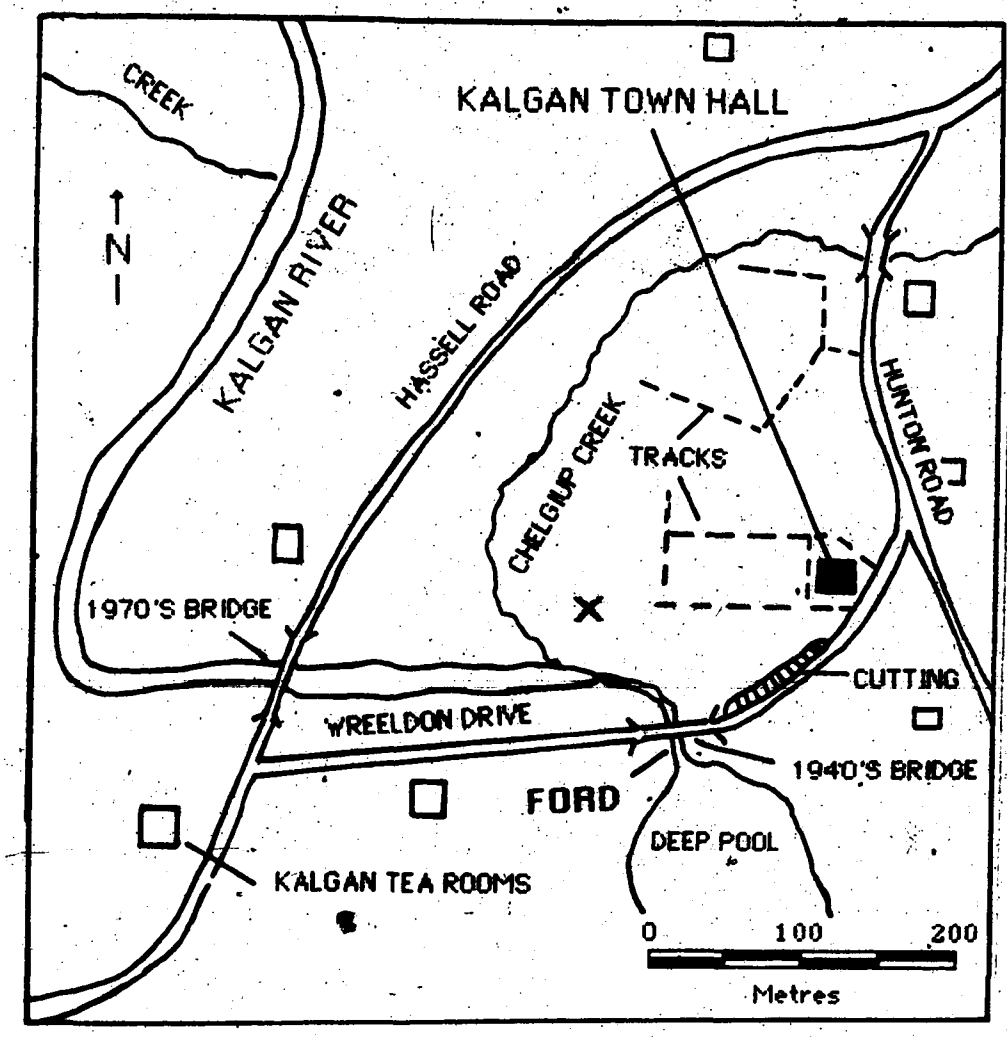


FIGURE 4.3. MAP OF AREA AROUND LOWEST FORD ON THE KALGAN RIVER:

This area around the ford is generally heavily forested except where recent disturbance has occured. Artifacts were found in the cutting on Wreeldon Drive just west of the 1940's bridge, in all tracks around the town hall and between Chelgiup Creek and Hunton Road, in a small cutting on the north side of Hassell Road near the junction with Hunton Road, and in a small human excavation of unknown origin on the east side of Chelgiup Creek near its confluence with the Kalgan (shown with an X on the map).

Meso Pattern Area This area is part of the Southern Jarrah Forest and the environment is relatively uniform. The land surface is a generally flat and undulating plain, varying from about 20 to 60 metres above sea level away from the River. The River itself is incised down into the plain. The valley is very narrow, never more than 150 metres wide; and the banks are very steep, usually rising sharply from the river to a height of 10 to 20 metres before reaching the level of the plain (Fig 4.4). Seven creeks enter the river as it cuts across the meso pattern area (Fig. 4.5) These are mostly small and unnamed with the exception of the somewhat larger Chelgiup Creek which flows from the east to enter the river about 50 metres above the ford.

The soils are generally thin and sandy, overlying massive Tertiary laterite which in turn overlies the basement gneiss (Fig 4.5). Along Chelgiup Creek there is an outcropping of the Pallinup Siltstone which may be the source of some of the spongelite artifacts found in the area (Fig 4.4). Along the river in places where the valley is widest there are small deposits of alluvial clays, silts and gravels.

Most of the area is within the Narrikup vegetation system of the Menzies Botanical sub-district. Before clearing, it was, for the most part, an unbroken stretch of vigorous Jarrah forest. The canopy is about 20 to 30 metres high, composed of a mixture of Jarrah and Marri. There is a very thick sclerophyll understory, a partial list of which is given in Beard (1979b:26). Along the banks of the river are stands of Albany Blackbutt (*Eucalyptus staeri*), Redheart (*E. decipiens*), and Native Cedar (*Agonis juniperina*). In some small

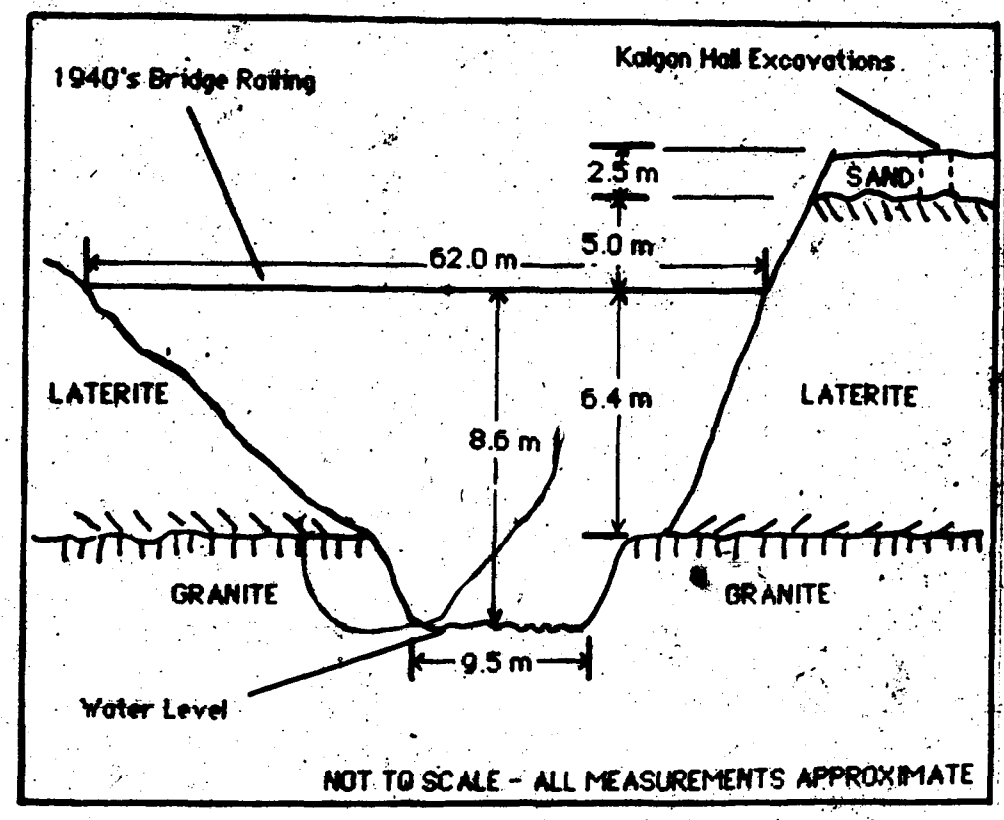


FIGURE 4.4. CROSS-SECTION OF KALGAN RIVER VALLEY AT THE LOWEST FORD:

The river moves very rapidly through the gorge at this point. When it is not in flood, the water here is generally somewhat less than 50 centimetres deep. There are rocks standing up above the water level at the ford; so at these times, it is possible to cross dry without getting one's feet wet. Immediately down stream there is a small cascade where the river debouches into a 12 metre deep pool.

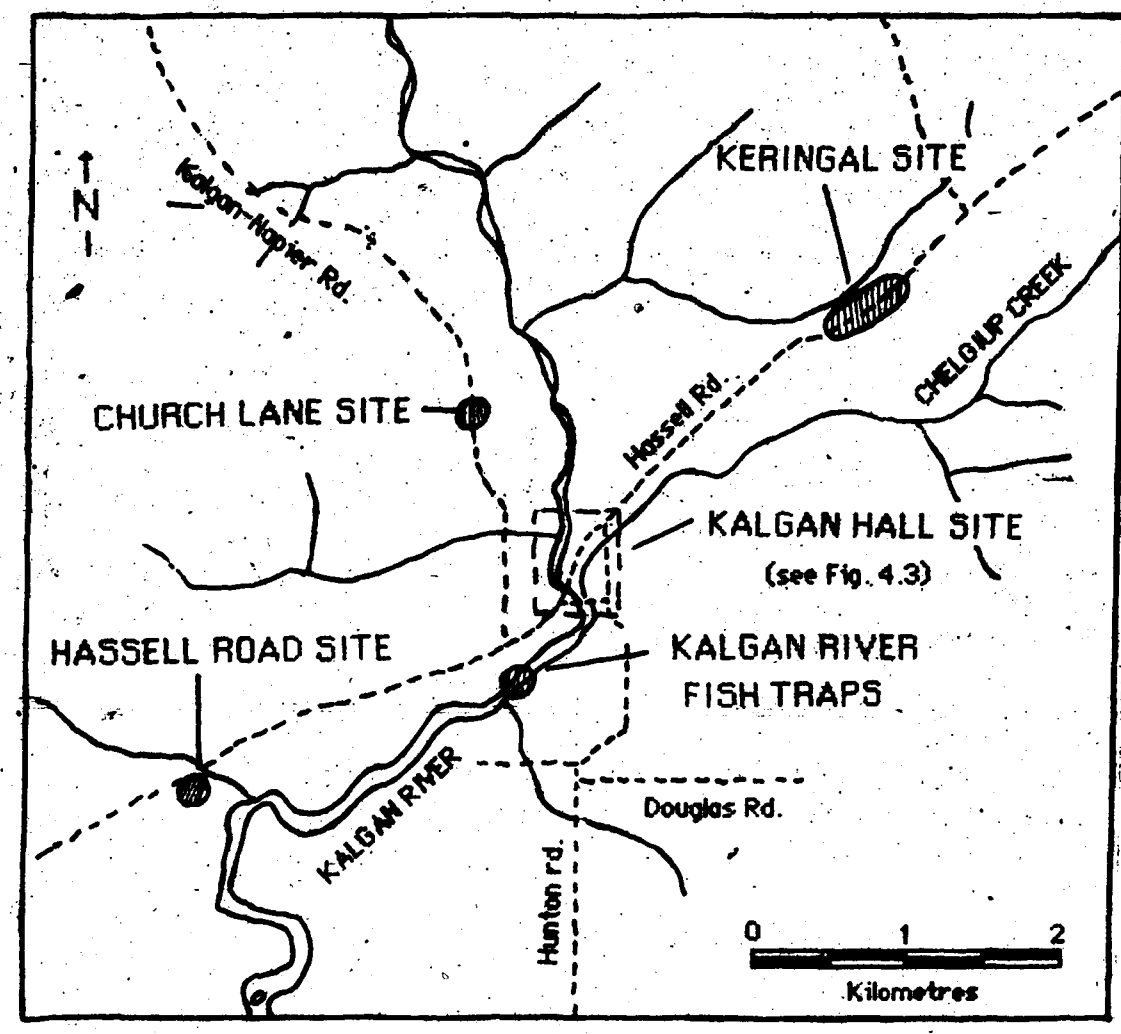


FIGURE 4.5. MESO PATTERN AREA AROUND THE LOWEST FORD ON THE KALGAN RIVER: (See text).

swampy areas along the creeks, paperbarks (*Melaleuca cuticularis*) and tea tree (*M. dense*) predominate (Beard 1979b:30).

About two and a half kilometres east of the ford, Beard has drawn the boundary of the East Kalgan vegetation system. Here the soils are poorer and more poorly drained, and the vegetation grades into Jarrah-Sheoak low forest, and woodland. The canopy is less than 15 metres high, the tree trunks thinner and more crowded, and the Marri drops out of the association to be replaced by Blackbutt and Sheoak (*Casuarina fraserana*). The understory remains thick and is similar to that of the Jarrah forest proper (Beard 1979b:26-27).

The Jarrah forest does not, in general, provide a wide variety of known aboriginal food plants. Dr. Kingsley Dickson, a botanist specializing in aboriginal food plants visited the Kalgan Hall site during excavation, and after a brief examination of the area identified only two. The first, the Australian Bluebell (*Sollya heterophylla*), called by the natives, *Kurubo* (Moore 1884:46) is a small bush with edible berries. These were in season during December when the excavation was taking place. The second, the native onion (*Haemodorus spicatum*), is ubiquitous to sandy soils of the Southwest and recorded variously as being called by the natives: *Mean* (Backhouse 1843:527) *meen* (Collie 1834:319) *meernes* (Nind 1831:243) and *mini* (Moore 1884:153). While not highly prized, this bulb was available at all times of the year and was a staple of the local diet (see Meagher 1974:25 for discussion).

Several of the ethnohistorical sources record journeys along the river through the meso pattern area, and note traces of Aboriginal

activities. The variety of features mentioned include: Stone fish traps in the river (Baudin 1801-3:487, Peron and Freycinet 1807:151 Lockyer 1827:479, Dumont D'Urville 1830:276), wooden fish weirs at the mouths of streams (Lockyer 1827:479, Dumont D'Urville 1830:276), kangaroo stake traps (Baudin 1801-3:486, Peron and Freycinet 1807:150, Collie 1833b:170), huts (Collie 1833b:170, Dumont D'Urville 1830:277), trackways (Collie 1833b:170, Dumont D'Urville 1830:277), and hearths (Baudin 1801-3:478, Peron and Freycinet 1897:152). The last two sources say that at the time their expedition travelled here, the entire area along the river had recently been burnt by Aboriginal firing. The only source which specifically mentions the ford is Eyre (1845:105). He was shown its location by Wylie, the King George Sound Aborigine who accompanied him; and they crossed over it on the 6th of July 1841, the last day of their epic journey across the continent.

Besides the main site at the ford, four other sites were located within the meso pattern area. Three of these are artifact scatters of varying sizes, and the fourth is the complex of stone fish traps. The largest of the outlying scatters, the Keringal Site, is approximately two and a half kilometres N.E. of the ford, on the southern bank of an unnamed creek (Fig. 4.3). It was found during the road survey, and artifacts are exposed in a white sand cutting for about 500 metres along the south side of Hassell Road. The relative density and length of exposure suggests this is a fairly large site; but it is well buried, probably under 50 to 70 centimetres of recent sediment since no artifacts are exposed in the extensive and deep fire breaks just

behind the cutting. Generalized cutting and scraping implements, detritus from a wide variety of petrological materials, and a fragment of a Dolerite grindstone were among the artifacts collected there, so it seems likely that Keringal was probably also a camping site. A backed microlith was present, so this site was frequented at least during the late Holocene period.

The other two scatters are much smaller. Two and one half kilometres southwest of the ford on the south side of another unnamed creek is the Hassell Road site. Here there is no archaeological visibility except for one area approximately ten metres square where thin, white sand overlying laterite is exposed around a farm paddock gate. The collection at Hassell Road totalled thirteen artifacts including two microliths. The last "scatter", called the Church Lane site, consisted of only three spongelite flakes found widely distributed over a fairly large area of disturbance on the Kalgan-Napier road, approximately 1.3 kilometres N.N.W. of the ford.

The stone fish traps were previously reported as the "Kalgan River Fish Traps" in Dix and Meagher (1976:182) where they are briefly mentioned but not fully described. They are about 500 metres down stream from the ford (Fig. 4.6). These fish traps work with the ebb and flow of the tide up the River. When the tide is high (Fig. 4.7a), the stones are submerged and fish can swim freely through the area; but when the tide is low (Fig. 4.7b), the stones protrude above the water and fish would be trapped within the enclosures where, presumably, they could be easily speared. The complex shown in the plan (Fig.4.6) is all that remains of what, from the ethnohistorical

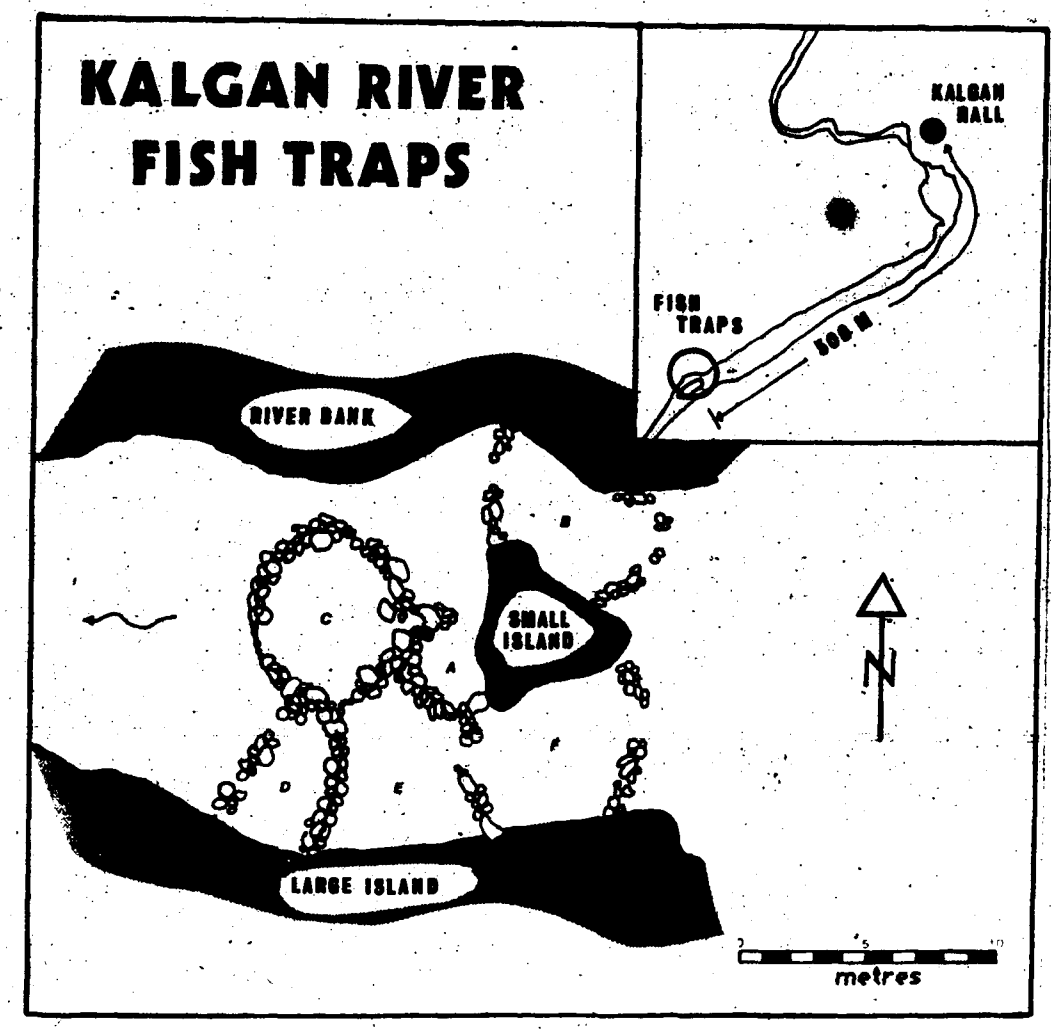


FIGURE 4.6. PLAN OF THE KALGAN RIVER FISH TRAPS:
These are all that remain of a formerly much larger complex of fish traps along this part of the River. The examination of three one metre sections of Circle C suggest that there are between 30 and 32 stones per linear metre of fish trap construction. These stones generally vary between 10 and 70 cm in diameter but some are much larger and may have been in place before the traps were built.

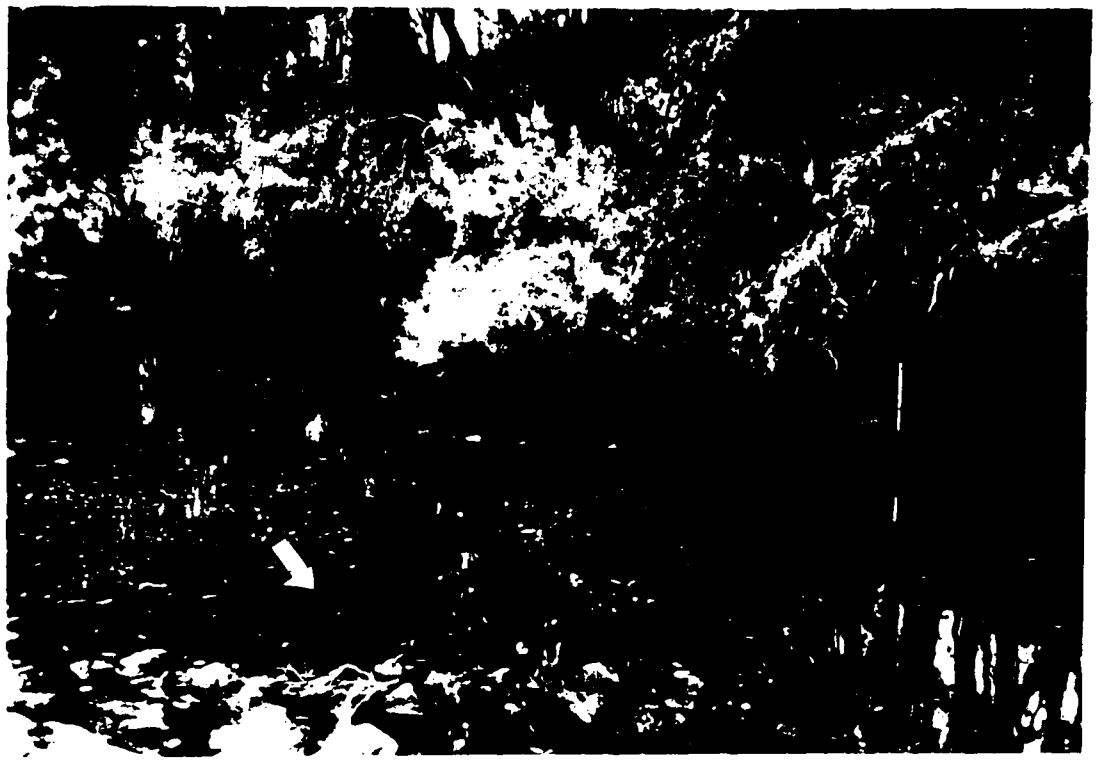


FIGURE 4.7a. KALGAN RIVER FISH TRAPS AT HIGH TIDE:
This is a photo of Circle C on the plan (Fig. 4.6) taken at high tide. Compare with photo below and note large stone inside circle marked with arrow which is just visible below the water in this photo.

FIGURE 4.7b. KALGAN RIVER FISH TRAPS AT LOW TIDE.

sources cited above, was a much more extensive complex. These are out of what is now the main channel of the River which was dredged in the early part of this century to allow boats to reach as far as the ford (D.A.P. West *pers. comm.*). It may have been as a result of this dredging that the majority of the traps were destroyed.

Replicative experiments were conducted during the field research in an attempt to estimate how long it would take to construct these fish traps. This was done so that a work-effort value system (Renfrew 1973) might be applied to compare the importance of this locality with others, such as the Lower King ford (see below) where other complexes of fish traps are known to exist. Several one metre long sections of the traps were examined to determine approximately how many stones were used to build them, and it is estimated that there are between 3700 and 4100 stones in the traps shown on Figure 4.6. These stones are immediately available in the bed of the river around the traps, and after several experiments it was determined that one individual could move an additional five stones into place on the existing traps in two minutes without straining. (These stones were later removed and returned to the bed of the river.)

If the fairly automatic (lift and toss) methods used in the replicative experiments were those used in the original construction, then it is estimated that it would require one individual from 24 to 27 hours of constant and intensive labour to build the part of the complex which remains. Since probably no more than ten individuals could fit into the work space available around the existing traps, and

since it is doubtful that they would have worked without a pause, it should have taken at least four hours of reasonably hard labour by the maximum sized work party to build them.

Summary and discussion: The lowest ford on the Kalgan River was predicted to have been a node of long-duration in the prehistoric exploitation and communication network of the Albany region, and the archaeological evidence suggests that it was. Five sites, including a complex of stone fish traps, were found without intensive survey within a short walk of the ford, and excavations at the Kalgan Hall site discussed in the next chapter show that the location was frequented from well before about 19,000 years ago through to the ethnographic present.

Establishing when and for how long sites known only from surface scatters were occcupied is usally quite difficult in Australia. However, unless the three artifacts at the Church Lane site are considerably older than 19,000 years, all the sites in the meso pattern are contemporaneous with some period of occupation at Kalgan Hall. The presence of backed microliths at the Keringal and Hassell Road sites suggests that at least part of their occupation took place sometime after 4000 BP. Likewise, the fish traps can be roughly dated to the later period of occupation at Kalgan Hall since their use is based on the ebbing and flowing of the tide, and such conditions would not have been present until the sea rose to its present level at about 6000 BP (Chappell and Thom 1977).

Although it provided the stimulus for survey of the area, the presence of the ford alone is almost definitely not responsible for the

apparent intensity of occupation at this location during any period of prehistory. In the late Holocene the fish traps, too, would have been a powerful draw, since they could have been a major source of food supply and this is the only spot on the entire river at which they could be built. Either the ford or the fish traps alone would have probably been sufficient to concentrate activity in this area, and together they must have created an unusually attractive location.

Neither of them, however, either alone or together, can be considered the necessary cause for occupation at this location. At about 18,000 years ago, when comparatively very intensive occupation took place by what is now the ford, the sea level was approximately 150 m below its present level (Chappell and Thom 1977). The fish traps could not have then been operational, and the lowest ford on the Kalgan River would have been many kilometres further down stream. Apparently, some factor or factors unknown provided sufficient stimulus to focus prehistoric activity at this spot. All that can be suggested is that the ecotonal conditions along the banks of the River would have always provided a somewhat different set of resources to the surrounding countryside; and, during the projected drier than present phase in the late Pleistocene, the large pool immediately below the ford which is now about twelve metres deep may have been a reliable source of water in times of drought.

The Lowest Ford on the King River:

The lowest ford on the King River is located about one

kilometre above its mouth. The next ford is a further two and a half kilometres upstream; and below the lowest ford, Oyster Harbour forms a barrier to east-west pedestrian movement approximately seven kilometres long. As it is only eight kilometres from the heart of Albany, this area was settled in the early 1830's. It is now called Lower King, and has been subdivided for residential development. The precise location of the ford in protohistoric times is known because Collie surveyed in the "usual wading-place of the natives" on February 9th, 1832 (1833b:168). His map is reproduced as Figure 4.8.

This locality is mentioned by Barker as a gathering place of the local Aborigines (26.1.1830); and it is the site of a spectacular complex of fish traps which were mentioned by Vancouver (1801) and King (1827). These traps have been mapped in detail by Dix and Meagher (see Fig. 4.9), and are now on the Register of the National Estate. Unfortunately, given so much reason to expect a large, much frequented prehistoric camping place near here, the success of the topographically optimal node model was not repeated at Lower King, and no site of this type was found.

Archaeological visibility is extremely limited. The River in this area forms the boundary between the Albany and Narrikup vegetation systems (Beard 1979b). These are both Jarrah forest systems, the undergrowth is very dense, and regeneration after any disturbance is extremely rapid. Along the River there are thick stands of Jarrah-Marri forest, and virtually impenetrable tea tree, paper bark and samphire (*Arthocnemum*, *Sarcocornia*, *etc.*) swampland. On the high ground, where the soils are poor,

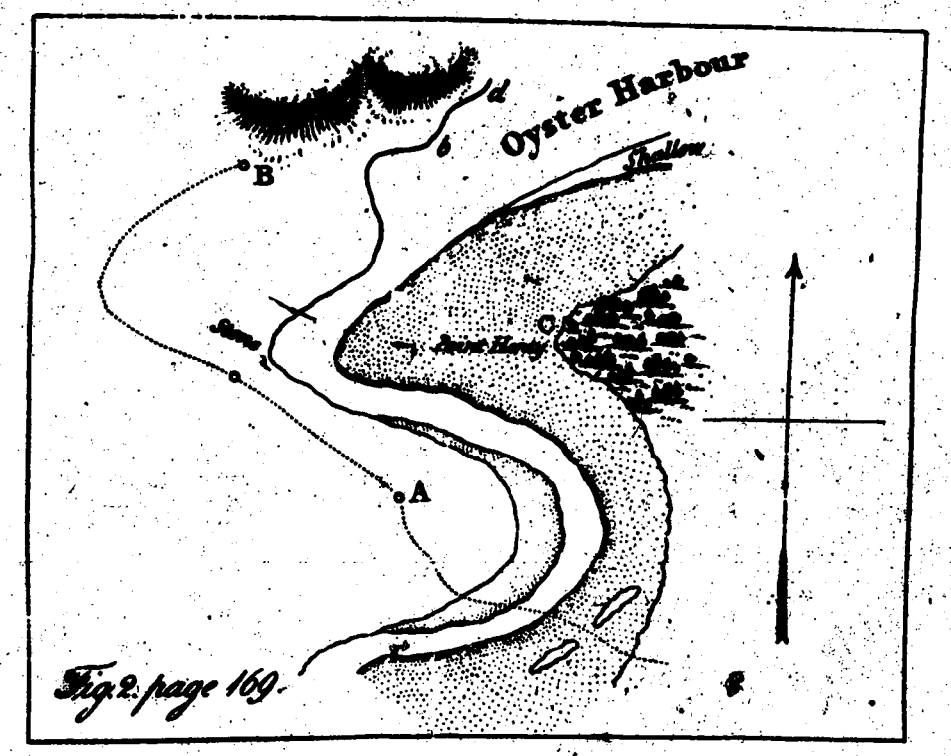


FIGURE 4.8. COLLIE'S MAP OF THE LOWER KING FORD:

This map is included as an inset on the large map in the back cover pocket of Cross (1833). The area has been changed since this map was drawn in that a causeway has been extended out from Point Henty and a bridge now crosses from there to the opposite shore. The Europeans did not use this ford too often because the bottom was muddy and horses tended to get mired (Collie 1833b, Eyre 1845). The north arrow on the drawing is incorrectly placed.

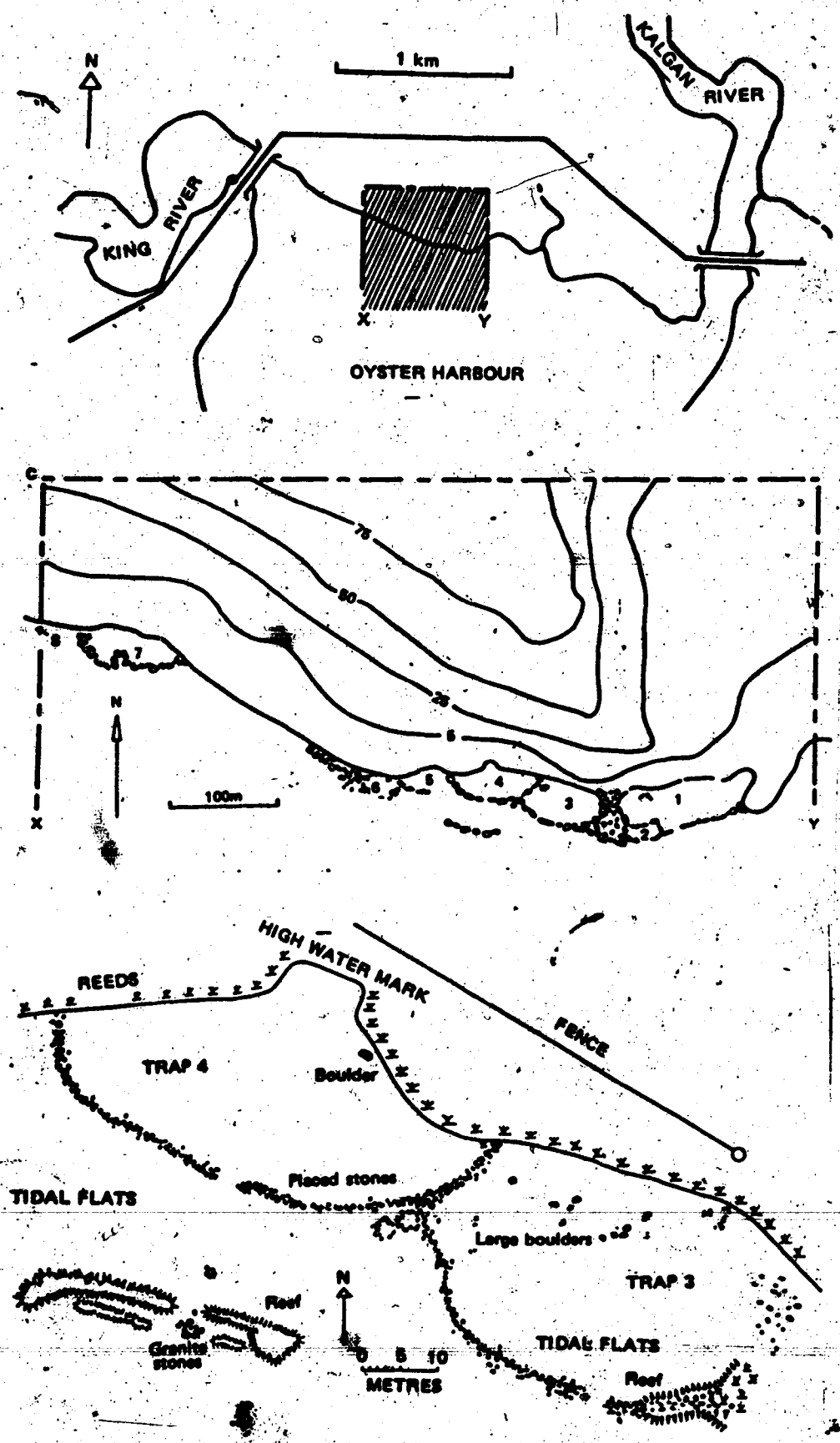


FIGURE 4.9. PLANS OF OYSTER HARBOUR FISH TRAPS (from Dix and Meagher 1976).

Jarrah-Sheoak low forest predominates. Several small scatters of artifacts were found within two kilometres of the ford (Fig. 4.10), and a test excavation was conducted at the Kalgan Heights Estate site on the bluff above the fish traps (Fig. 4.11), but no stratified deposit was uncovered.

The fish traps at Lower King were not examined in detail during the field work, and Dix and Meagher do not attempt to estimate how many stones they contain. The construction is similar enough to those at the Kalgan Ford locality, however, to estimate from the maps (Fig. 4.9) there should be about 2,130,000 stones involved overall. If this is the case, then their construction must have minimally required well over 14,000 person hours of unstinting labour; and on work-effort value criteria, Lower King must have been a very important place indeed!

There can be little doubt that one or several large camping sites do exist in this area, and possibly the labour intensive creation of artificial exposures through shovel sampling is warranted here. The author considered using this procedure in the Lower King Ford Site area (Fig. 4.10) where several small scatters were found in what tiny amounts of exposure were available, but neither time nor crew size would allow for it.

Chester Pass:

Chester Pass is in the Stirling Mountains (Fig. 4.2). The pass itself is just outside the boundaries of Mokaré's Domain but it was included in the research with its southern approaches as part of the

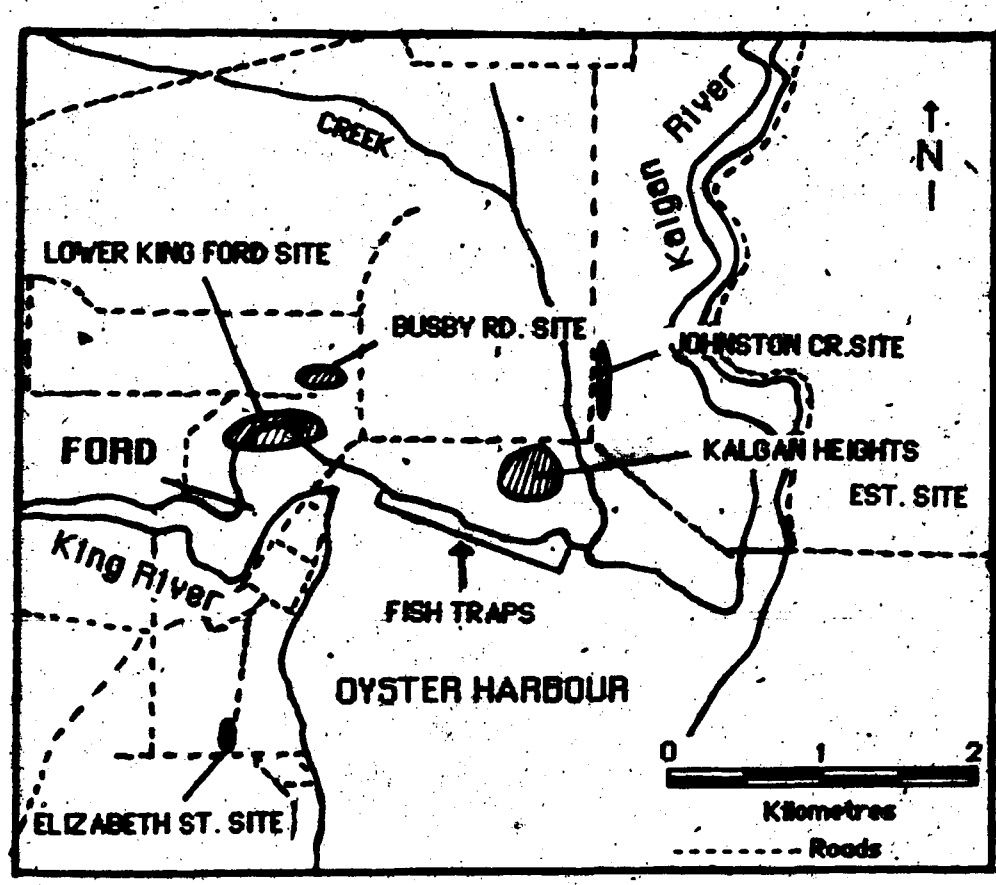


FIGURE 4.10. LOWER KING MESO PATTERN AREA:

Artifact scatters were relatively small and sparse at all sites shown on the map. At the Lower King Ford site several very small scatters (3 or 4 artifacts) were found in modern fisherman's trackways and small disturbances of several kinds. At both Johnston Creek and Elizabeth Street, scatters of over 25 artifacts were found in low cuttings, and at Busby Road 18 artifacts were found in a drainage ditch. The Kalgan Heights Estate site is shown on Figure 4.11.

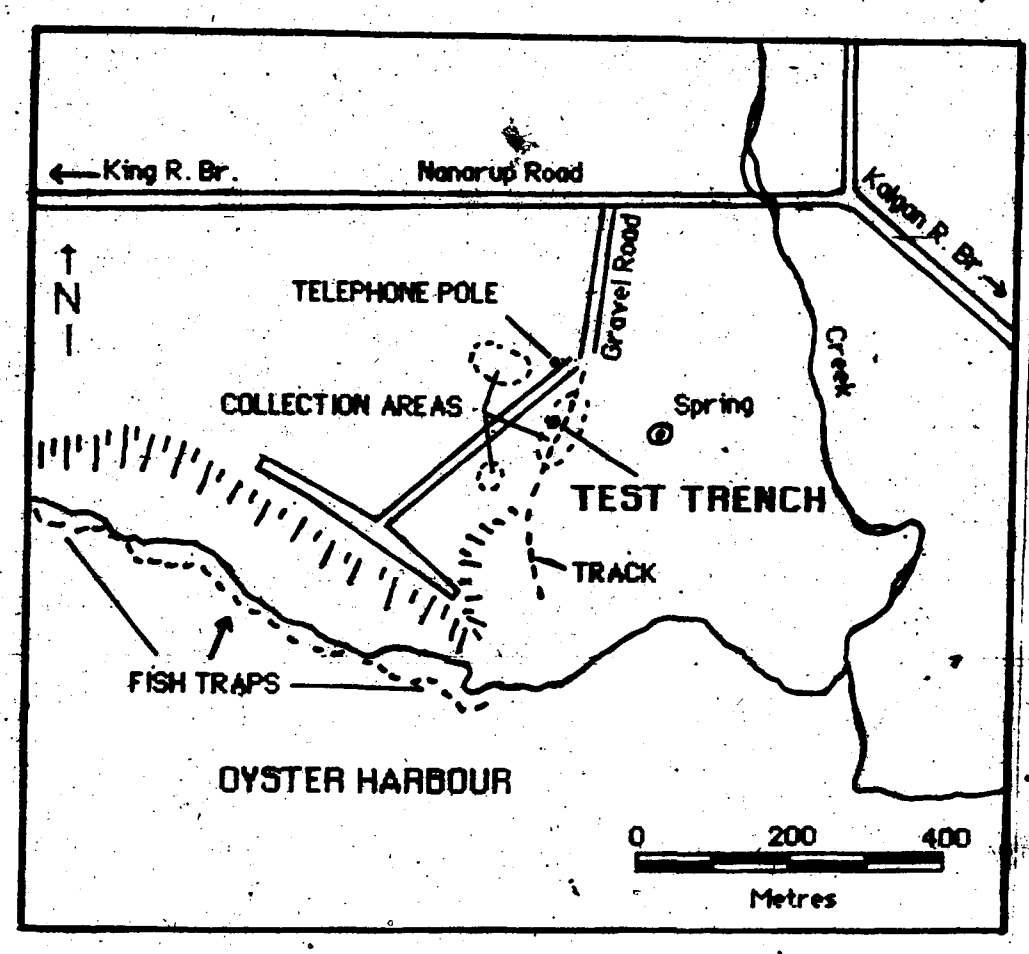


FIGURE 4.11. KALGAN HEIGHTS ESTATE SITE:

The site is located on the bluff above the Oyster Harbour Fish Traps. Artifacts were very sparse and found only in one area of shallow fire breaks, a pit dug as the foundation for a new house, and in a small sand track. A one by one metre test trench was set out just on the west site of the sand track, 75 to 76 metres south and 0 to 1 metres west of a nail driven into the telephone pole on the west side of the gravel road just under 200 metres south of the junction with Nanarup Road. The nail is on the east side, one metre from the base of the pole.

The trench was taken to a depth of 165 cm, but no artifacts were found except on the surface. The deposit was a white sand which contained some charcoal.

investigations of the topographically optimal nodes. The slopes of the Stirling range are very steep, and they form an unbroken barrier to north-south movement of any kind for approximately 25 kilometres on either side of the pass. During protohistoric times, Mokaré's people did not exploit both sides of the barrier, but their neighbours to the north did (Dale 1833).

Chester Pass is approximately nineteen kilometres long (Fig. 4.12). The relatively level floor of the pass varies in height from 220 to 310 metres above sea level, and is approximately one kilometre wide at its greatest extent. On either side, the archaean sandstone peaks of the range rise up abruptly, and reach 1000 metres in height at the summit of Toolbrunup Peak. Moingup Spring, just south of the summit of the pass is the only source of permanent water within the pass itself; but a large freshwater lake, Pillenorup Swamp, lies at the southern base of the range only two kilometres east of the entrance to the pass.

The soils within the pass are relatively young and undeveloped, formed primarily of colluvium brought down from the slopes. The vegetation of the Range is distinctive enough for Beard (1979b) to class it separately as the Stirling Range vegetation system. In the pass the vegetation is mixed eucalyptus woodland, dominated by Yate (*Eucalyptus cornuta*) and Marri. The surrounding lower slopes are covered with Jarrah mallee-heath, and the flat areas around the southern entrance to the pass with Tallerack (*E. tetragona*) mallee-heath.

This area is part of the Stirling Range National Park and

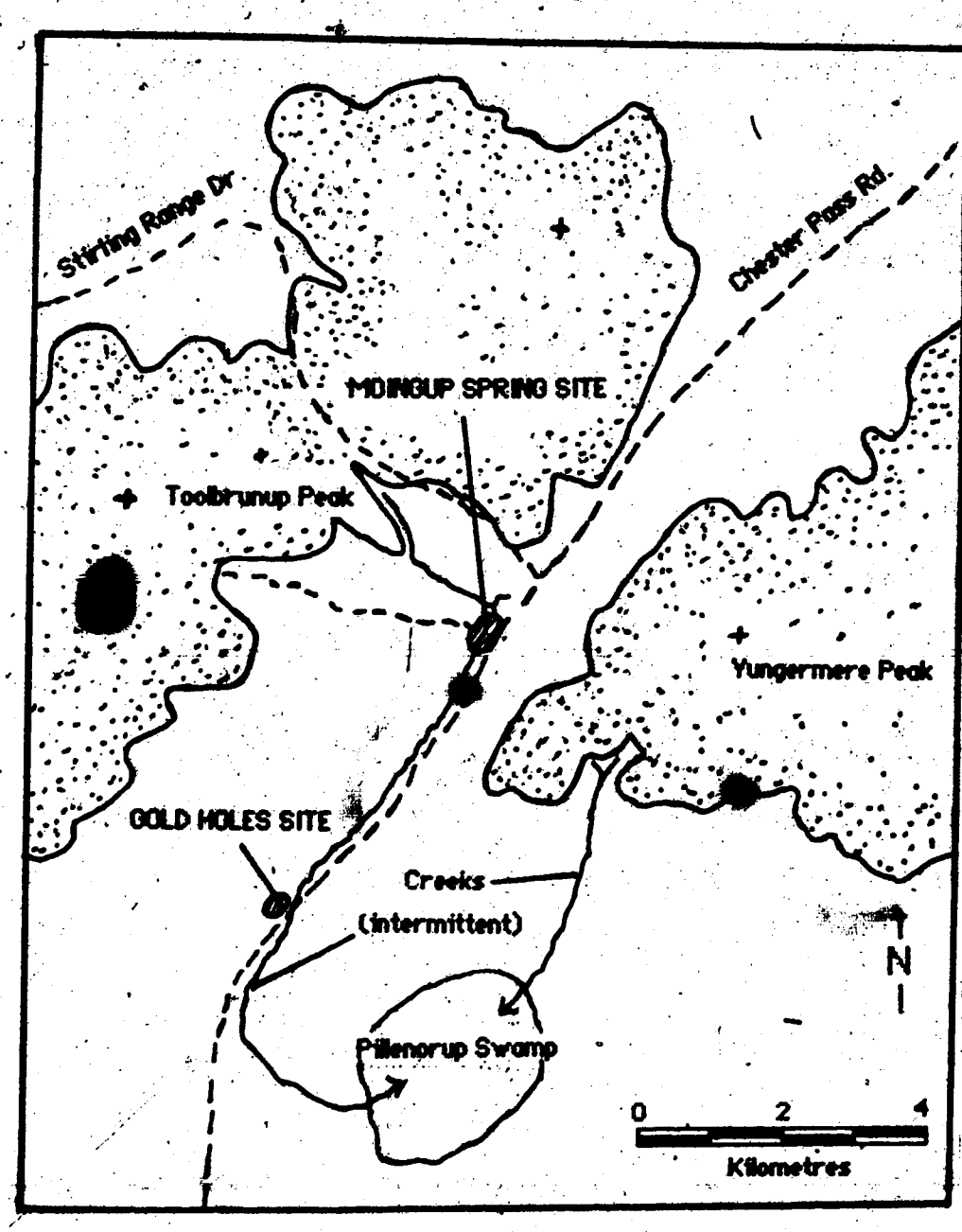


FIGURE 4.12. CHESTER PASS MESO PATTERN AREA:

disturbance of the ground cover is non-existent except for small patches along the highway, in the vicinity of the small campgrounds and picnic areas, and in the very few firebreaks which the rangers maintain. Intensive off-road survey was conducted in locations which seemed likely to contain sites, but only one very small artifact scatter was found; and this was in an area where the sandy soil was only a few centimetres thick, and stratification could not be expected.

The Western Australian Museum, however, has a small collection of artifacts recorded as being found at the Moingup Spring campground, in the centre of the pass. A survey of that area produced no further surface artifacts, but the local ranger mentioned that during the digging of post holes for a fence, he had found what he thought was a "layer of chipped stone". A test excavation which is described in the next chapter was conducted beside the fence and a few stratified artifacts were recovered, but radiocarbon dating shows that they were all from the last millenium BP. The layer of chipped stone was a natural phenomenon.

The single surface scatter was found in disturbed areas of the Gold Holes picnic ground, four and a half kilometres south of Moingup Spring. Here, in a shallow sandy sediment, approximately 20 to 30 centimetres thick and overlying laterite, five artifacts were recovered.

Pillenorup Swamp is the most likely place for a major camping place in this area. It has permanent water, excellent swamp resources and is mentioned in the ethnohistorical literature as a

place known to have been frequented by the Aborigines (Barker 9.5.1830). An entire day was spent surveying areas around this swamp, but there is no disturbance anywhere near it except for one shallow fire break, and nothing was discovered.

Topographically Optimal Nodes - An evaluation of the model:

The near total lack of archaeological visibility in Mokoré's Domain presents a formidable obstacle to the researcher who wishes to locate deeply stratified sites, and the model was employed to focus survey at localities where this type of site could be assumed to exist. Its first application at the lowest ford on the Kalgan scored a direct and immediate success; but, overall, the time and effort the survey crews spent forcing their way though the dense undergrowth at these localities was largely unrewarded. Simply knowing that the type of site desired must exist somewhere in the vicinity does not, in practice, make it any easier to see. It does, in fact, add an extreme frustration factor which is not present if the survey method relies primarily on blind luck, as in the road survey technique. This researcher limped for several days after kicking a Jarrah tree when it was finally decided to abandon the survey at Lower King.

Even the success of the Kalgan Hall site is in some ways hollow. This site would have undoubtedly been discovered by the road survey if the purposive survey had not gotten there first; and because the exposure in the cutting demonstrated its deeply stratified nature, like the Waychinicup River site described below, it would probably have been excavated.

Still, this survey technique *did* lead to the discovery of the site with the longest sequence and densest artifact deposit excavated during the research. Moreover, because the model provided in advance a relatively indisputable, if only partial, reason for the repeated frequenting of this location, it enables some control over an otherwise almost unanswerable challenge to the mid-Holocene depopulation hypothesis.

Although it may be shown in every site excavated in the entire region that levels dated to the mid-Holocene have proportionately many fewer artifacts than those above and below them, it still cannot be automatically assumed that the region was depopulated at this time. There is an alternative explanation that, instead, there was merely a major change in the choice of site location during this period, that the people were still there, but that the mid-Holocene sites have simply not been discovered. The knowledge that Kalgan Hall was of virtual necessity a central node in any network of exploitation and communication which included both sides of the Kalgan River allows for an argument that the "change in choice of site location" explanation is unlikely in this instance.

At least after 6000 BP when this became the lowest ford on the River, if people were present in the area and moving about at all, then they should have been passing through this location. In the next chapter it will be shown that although the [illegible] evidence that the site was much frequented during the late Pleistocene, it was not until two thousand years after the time when the lowest ford factor became operational and the fish traps could have been built that the site once

again became a major focus for human activity.

Protohistoric Nodes:

Survey work on the topographical optimal node model was begun before the ethnohistorical sources relating to the research area had been consulted. Afterwards, it was felt that with their aid further use could be made of the exploitation and communication network concept to locate major, and (if there was a continuity in the protohistoric pattern back through time) long term sites.

Several of the writers state specifically that during their journeys inland they were led along well worn trackways (Collie 1833a; 1833b, Dale 1833, Bannister 1833, Wilson 1833; 1835) and it seems reasonable to assume that this was usually the case even when it wasn't mentioned. Since Hallam (1975:66-71) noted that major sites were located where major trackways intersected, usually at places of permanent water, it was possible that if the routes of the inland journeys were plotted, major sites might be found near the places where they intersected. This is a predictive model of site location; but, of course, its application is limited only to areas where the ethnohistorical data is sufficiently detailed for a rudimentary exploitation and communication network model to be constructed.

Seven intersections were noted after mapping (Fig. 4.13). One of these was eliminated from possible survey since it was located in the built up area of Albany. Time allowed a survey to be conducted at only four of the others: Moorillup Pool, Kamballup Pool, Napier Crossing, and the Kalgan-Napier confluence. Again ground

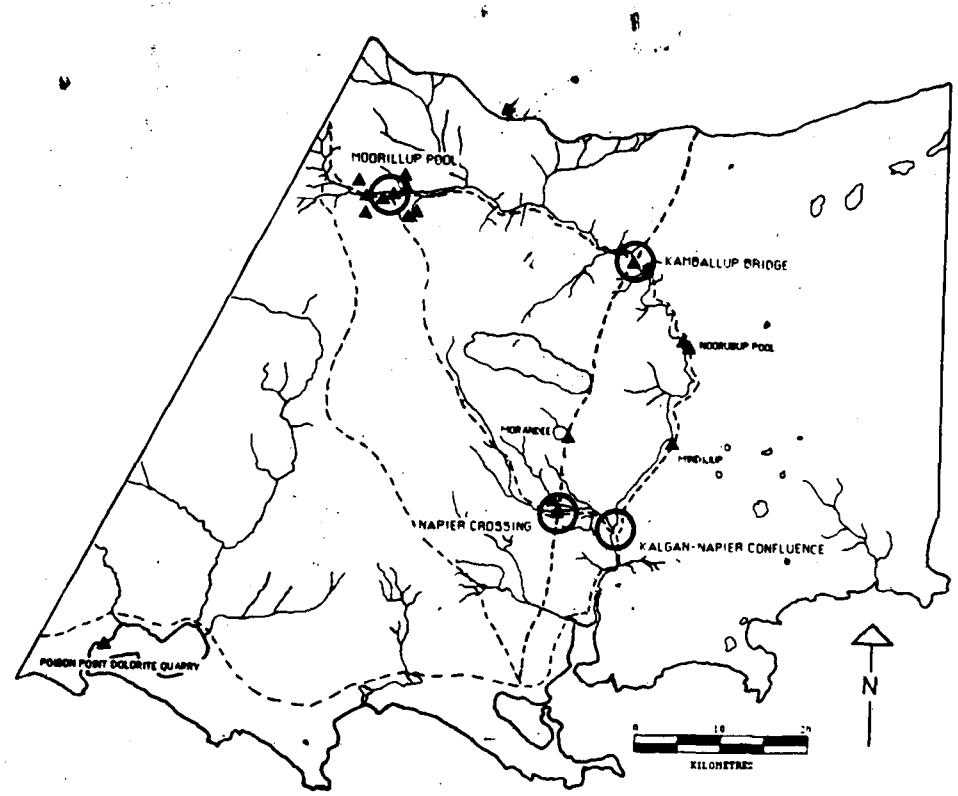


FIGURE 4.13. PROTOHISTORIC NODES OF MOKARE'S DOMAIN:
The circled areas on the map are those modelled as major nodes in the protohistoric exploitation and communication network across the field research area. The triangles are sites found during the survey. The named sites away from the node areas are other sites found with the aid of ethnohistorical sources.

reconnaissance was begun at the predicted point of intersection and expanded outward; and again, archaeological visibility was often almost non-existent. Sites were discovered at three of the four proposed protohistoric nodes investigated, and test trenches were dug at two sites near Moorillup Pool and at Kamballup Pool. Since the Moorillup Crossing excavation revealed a stratified artifact sequence extending from about the terminal Pleistocene through to near recent times, this model, too, has proved of use in pursuing the primary goal of the field research.

Moorillup Pool:

The area around Moorillup Pool features often in the early ethnohistorical sources. The pool is the highest permanent water on the Kalgan, approximately 90 kilometres upstream from the lowest ford at Kalgan Hall; and many of the major Aboriginal trackways came together in this vicinity (Fig. 4.13). Wilson and Mokaré camped just west of here on the 4th of December 1829 while travelling on the trackway which ran north from Albany through the lake country on the poorly drained divide between the tributaries of the Hay and the Kalgan (Wilson 1835:239-42). Collie arrived from the east on 30 April 1831, after travelling with Mokaré on the main trackway up the Kalgan from the coast. They camped beside the pool, and left the next morning following yet another major trackway which went south to the foot of Mt. Barrow and then followed the Napier River down to rejoin the Kalgan south of the Porongurups (Collie 1833a). Even in the 1860's it remained an important locality in the Aboriginal

exploitation and communications network and Carbarup, the hill immediately to the south of the pool is mentioned by Hammond (1933:20) as one of the "official places" of the Nyungar, near which someone was almost always camping. Collie's journal entry gives some idea of why this was so:

> We crossed the channel and proceeded W. 1/2 N. one mile, and W.S.S. one mile and a half, through a generally open forest country, good towards the hollows, gravelly on the heights, but on both grassy, although on the latter the grass was thin, and on both much dried; to the river again, at a place called Moor-illup, much frequented by the natives of King George's Sound and Will tribe, and apparently quite as much by the natives of the two elements of earth and air. Here Mokaré expected to find some of his neighbours, the Wills, whose place of resort this, he gave me to understand, is in a more especial manner, and from who he expected further information respecting the cattle.
>
> Not only at Moor-illup, but at every pond of the river where we stopped, the traces of man, beast, and bird, are strongly marked; and the great numbers of kangaroo, and several emu, not to mention a fair proportion of ducks, cockatoos, pigeons, &c. seen daily at this place, shew that both the hunter and sportsman would find abundant amusement, and the settler no slight acquisition to his larder (Collie 1833a:143)

Collie's enthusiasm for the area sparked interest in it as a location for an inland settlement, and in 1835 the surveyor, Roe,

mapped a proposed townsite here (Mercer *n.d.*:146). The plan was not taken up, but in 1840, the area became part of the first successful inland pastoral station, the Hassell estate, which was centred at Kendenup, ten kilometres further upstream (Rowe 1979).

Moorillup is located on the narrow upper reaches of the Vale of Kalgan flood plain. It is surrounded to the west, north and south by undulating hills which reach to a height of 150 m above the valley floor at the summit of Carberup Hill, five kilometres southeast of the pool. On the dyeline geological map, the soils on these hills are shown as colluvium and various sands, and the Pallinup siltstone, Laterite and the basement granite-gneiss all outcrop nearby.

This area is a part of the woodland dominated Kendenup vegetation system. On the slopes, mixed Jarrah, Marri, and Wandoo woodland predominates, but on the narrow valley floor this is replaced by Wandoo and Yate woodland. Redheart is found in the depressions, and Paperbark in the swamp areas along the river and creeks (Beard 1979b).

The area has a long and varied agricultural history (Rowe 1979). Most of it is now cleared and turned into paddocks planted with exotic grasses for the grazing of sheep. The sod is generally quite thick, and in 1979 an initial survey by the author alone failed to find any evidence for Aboriginal occupation. The ethnohistorical sources, however, were insistent about the importance of the locality, so another survey using a larger crew was undertaken the following year. This time enough evidence was found to suggest that the area was worth a concentrated investigation. Eventually, with

extensive survey and the aid of local informants, eleven sites were located within about four kilometres of the pool, and two test trenches and one area excavation were dug on what was finally determined to be a very large camping site centred on the pool itself (Fig.4.14).

The main site at which the excavations took place, is focused on the pool and extends for over a kilometre on both sides of the river. Initially, because of the thickness of the sod in the intervening area, it was considered that the west and east ends of this area were two separate sites, and they were called Moorillup Crossing and Moorillup Pool respectively. However, subsequent investigation carried out during the summer while vegetation growth was most restricted, suggests that there is probably a continuous scatter between these points, as artifacts were found in almost every small bare area. This is quite a spectacular site, and the various other sites found in the area are interesting as points of contrast.

Beginning approximately one kilometre below the pool and extending along the river for about one and a half kilometres is a swampy area, vegetated primarily with Tate and Paperbark. The area is shown on the map as Sanders-Deadman Swamp, and here the situation is reversed from that at the main site. Archaeological visibility is generally quite good: the soil is clay and unvegetated except for the trees, and literally hundreds of these were blown over in the cyclone of 1978 exposing previously buried soil in their roots. Seven small artifact scatters were found in this area, varying from three to about 50 artifacts in number, and exposure around them was

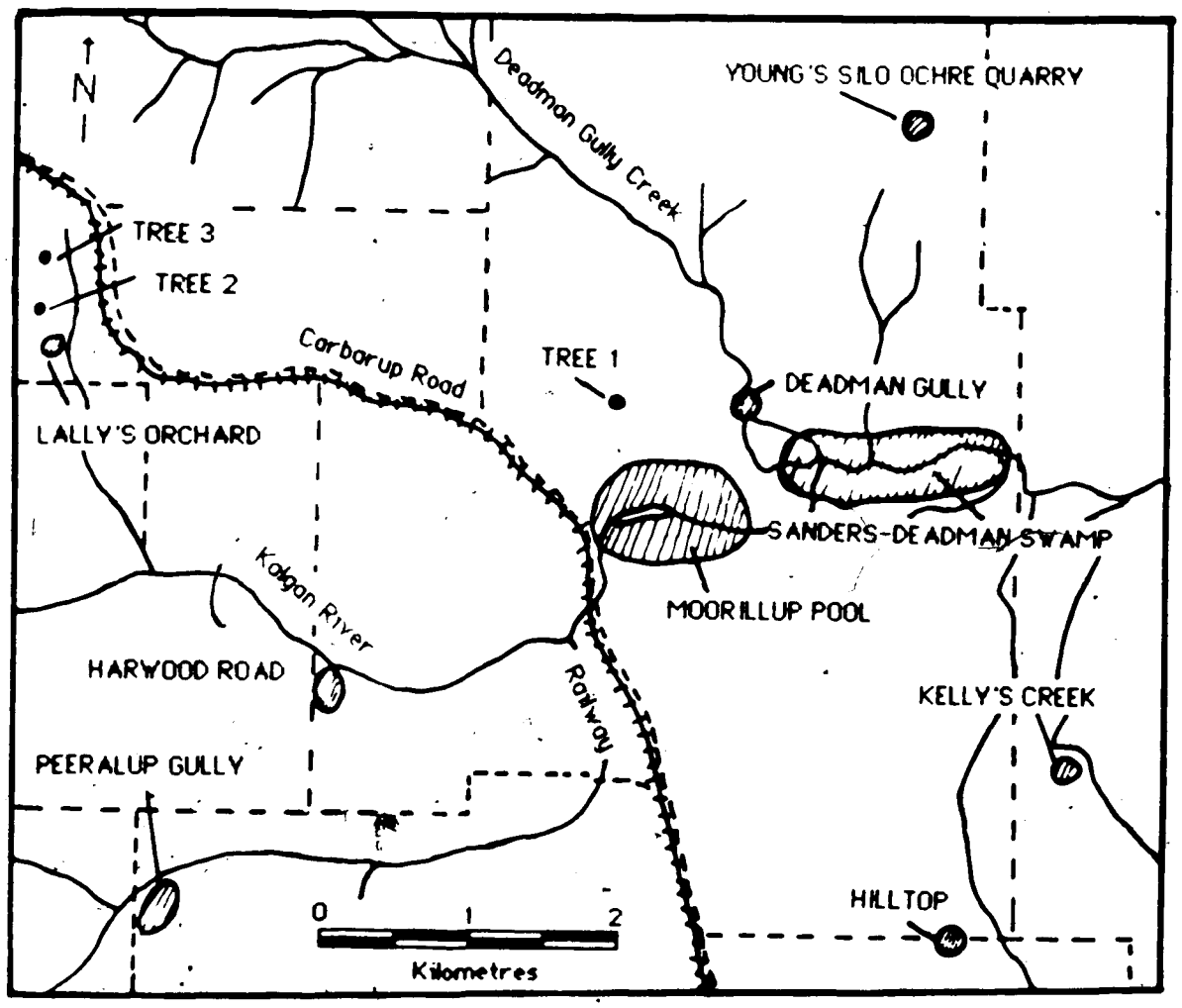


FIGURE 4.14. MOORILLUP POOL MESO PATTERN AREA:

sufficient to suggest that these were all the artifacts present at each location. It is doubtful that anyone would camp in this damp, mosquito infested area, and these are provisionally considered to be locations where brief activities such as implement maintenance took place during exploitation of swamp resources. This entire swamp area has been considered as a single site.

Four other scatters of flaked stone artifacts were also found within the meso pattern area. Lalley's Orchard, approximately four kilometres east of the main site, is a site of unkown function shown by a few artifacts scattered in a deeply ploughed area. Hillview, approximately two kilometres southeast of the main site, is only a small scatter, about 50 small chips of different parent materials, exposed where a telephone cable has been buried. The other two, Harwood Road and Peeralup Gully are large scatters which probably represent camping sites to the southwest of the Pool. Both of these sites had microliths exposed on the surface.

Two other sites, Deadman's Gully and Kelly Creek, have no flaked stone but three and four grindstones were found respectively at these sites. If these grindstones are in primary position and not a result of European transport, the sites must be specialized vegetable processing locations of some kind.

North of Sanders-Deadman Swamp about two kilometres is a series of break-aways composed of yellow, white and red ochres which was called Young's Silo Ochre Quarry (Fig. 4.15). Aboriginal quarrying here has not yet been firmly demonstrated, primarily because European mining of the ochre is known to have occurred in the

FIGURE 4.15. YOUNG'S SILO OCHRE QUARRY:

The majority of the ochre exposed, including that in the photo, is yellow. Red and white ochre also occur, but in smaller amounts. The ground in front of the ochre face is littered with broken pieces of the material, and a small scatter of stone artifacts was also found there.

past (I. Lalley *pers. comm*). There were, however, a few stone artifacts including a backed microlith scattered in front of the ochre face which show that the Aborigines visited the location, and suggest that they may have made use of this exceedingly high quality pigment.

The remaining three sites are economic facilities which for want of a better term are called "possum trees" (Fig. 4.16,17). These are very old, ring-barked Wandoo which have notches cut into their trunks, presumably as steps for climbing, and a hole or holes cut into hollow portions of them high up the trunks, presumably so that nesting possums could be extracted. These presumptions are based on statements by Ian Lalley, a local farmer who pointed out these trees to me, and numerous detailed descriptions of the Nyungar possum hunting techniques included in the ethnohistorical literature (e.g. Nind 1831:31-2, Salvado 1851:155-6, Moore 1874:19,45, Roth 1903:68, Hammond 1933:37, Hassell 1975:15).

Mr. Lalley cleared the land to the north of the pool, and in the 1940's when he began, he had Aboriginal helpers. They were using axes, and came to know each tree on the sixty five hectares individually. In those days there must have been about fifty of these "possum trees" on the land. Lalley noticed the markings on them, asked the Aborigines about them, and they told him what they were for. Later, in the 1950's, he used a bulldozer for the clearing, the Aborigines were gone, and he stopped paying attention to the trees as individual entities. It wasn't until he was about to push down the magnificent specimen with the many sets of foot holes shown in Figure 4.16, that he realized it might be the last of its kind on the

FIGURE 4.16a ATTEMPTING TO STUDY POSSUM TREE NO. 1

This [illegible] in circumference one metre [illegible] probably ring-barked by the Hassells in the 1840's or 1850's. It has two [illegible] holes cut into its upper limbs. The lowest one is [illegible] above the ground and the extended random 3 pole could not be reached. Like the other trees the top the ladder [illegible] the land cruiser. There are 25 separate foot holes cut into the tree but [illegible] and the twist tank [illegible] fig. 17.

FIGURE 4.16b THE EXTRACTION HOLE IN TREE NO. 3

FIGURE 4.17a. TOE HOLD NO. 7 ON TREE NO. 1.
This toe hold which is 4.55 metres from the ground appears to have been made with a tool tool and exhibits very little regrowth.

FIGURE 4.17b. TOE HOLD NO. 12 ON TREE NO. 1.
This toe hold is 3.8 metres from the ground and is partially overgrown. Several sets of toe holds on this tree have totally overgrown leaving welted scars.

property. He saved it, and later when a bush fire went through the area and it caught fire, he ran through the flames and saved it again. He was able to find only two more still standing on the property, and he saved them, too. They stand alone in totally cleared paddocks, and one day the wind will blow them down.

If Lalley is right in his estimate of about 50 "possum trees" per 65 hectares, then there must have been thousands of them in the meso pattern area around Moorillup Pool during protohistoric times. They were obviously, from the numerous sets of steps and multiple extraction holes on individual specimens, a reusable economic facility for both possums and Aborigines alike. It can even be speculated that the creation of the extraction holes by the Aborigines made these trees a more attractive habitat for future generations of possums. They are a possible subject for work-effort value studies, and replicative experiments should be undertaken while these trees still exist as models. This would not be as straight-forward as the fish trap studies, however, as the skill-factors involved in cutting and climbing these trees using a *Kadja* are of a much different level than simply lifting and tossing stones.

Summary and Discussion: The rich, open woodland area around Moorillup pool is the kind of environment which was modelled in Chapter 2 as the preferred habitat for the Nyungar of protohistoric times. The relatively brief survey of the region conducted during this research discovered a wealth of quite varied archaeological remains, and the excavations at the main site by the pool, which was the

largest of any encountered in the survey, show that the area was repeatedly frequented at least since the terminal Pleistocene, and probably at earlier times as well.

The presence of microliths suggests that at least three other sites in the meso pattern area, including the ochre quarry, were utilized during the present climatic regime, and, on both preservation and the probable use of metal tools in one instance, the possum trees can be assumed to have been utilized during ethnohistorical times. A broader understanding of the antiquity of the use of the Youngs Silo Ochre quarry may be possible if the ochre fragments found in the lower levels of the Moorillup Crossing trench can be shown to have come from there, but this has not yet been attempted.

The author is certain that he has only discovered a small fraction of the archaeological resources of the area, and to say that it warrants further research hardly gives it the emphasis it deserves. While the excavations at the main site have contributed a sequence to the main focus of this research, no true understanding of the place and importance of this "official place" of the Nyungar has been achieved.

Kamballup Pool:

The area centred on the bridge over the Kalgan River at Kamballup was chosen for intensive off-road survey because the routes of two of the inland explorations crossed near here (Fig. 4.13). Collie mentions Kamballup in his journal (1833a:140), but only as a

name given by Mokaré to a locality they passed through while travelling along the river from Albany to Moorillup on 29 April 1831. Eight months later, on 22 January 1832, Dale and Nakina crossed the river somewhere near this point on their journey overland from Albany to Chester Pass (Dale 1833:163). Today, this locality is still a junction for travel in the north-central part of Mokaré's Domain. It has two houses, a meeting hall, a roadhouse, and the only bridge along a 25 kilometre stretch of the river.

Kamballup is situated at the eastern end of the Vale of Kalgan, about halfway between the Porongorup and Stirling Ranges. Although it is over fifty kilometres from the coast, it is still only 120 metres above sea level, and the immediately surrounding landscape is generally flat and featureless. The dyeline geological map shows that the sandy soils of the area overlie beds of the Plantagenet Group, and there are outcrops of this formation, laterite, and basement granite-gneiss dotted throughout the vicinity. This is part of the Cape Riche vegetation system of the Eyre Botanical District. The predominant vegetation is Jarrah and Tallerack mallee-heath formations, but there is a narrow, 200 to 300 metre wide band of more favourable Wandoo-Yate woodland with occasional paperbark swamps along the river.

Off-road survey was concentrated along the banks of the river and four areas of artifact scatter were found in close proximity to the bridge. Since the Road Survey discovered no other sites within a five kilometre radius, these are the only sites known within the meso pattern area (Fig. 4.18). Two test excavations were conducted at the

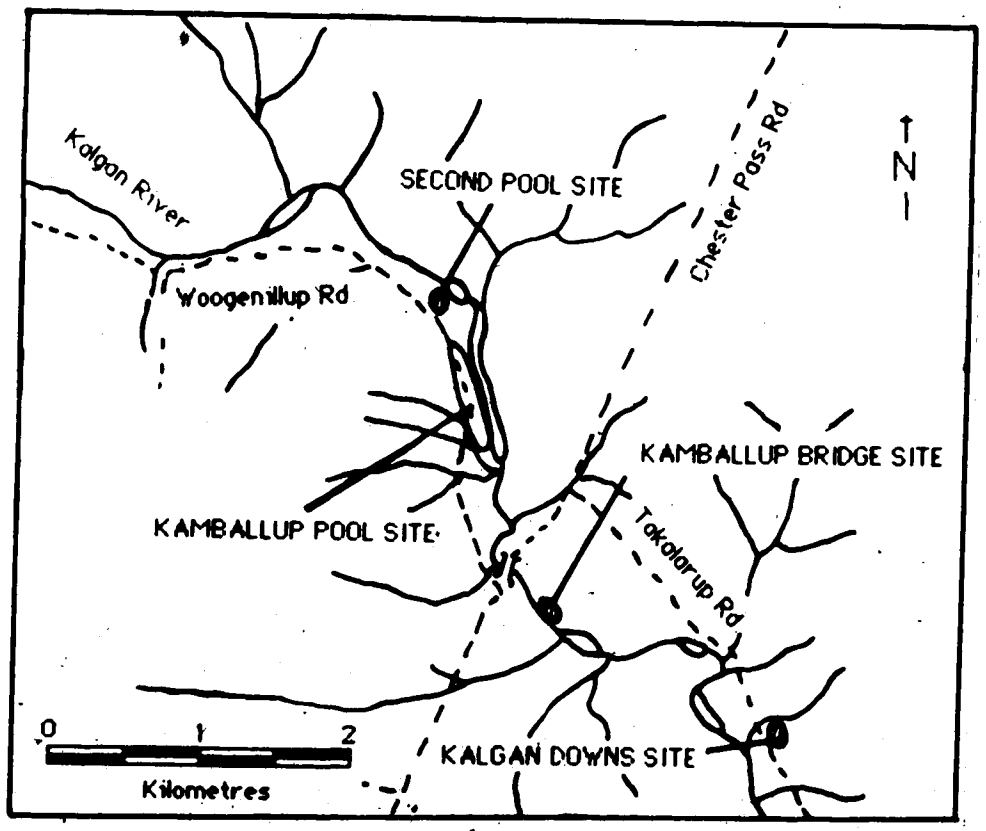


FIGURE 4.18. KAMBALLUP BRIDGE MESO PATTERN AREA:

largest and most promising site, called Kamballup Pool, about 800 metres upstream from the bridge.

The Kamballup Pool site is about 100 metres wide and 800 metres long. It is situated on the western bank of the river, just above where a small, unnamed creek joins. This creek parallels the river for a distance before joining at the base of the pool, and the site is located north of the confluence on a 100 to 200 metre wide sandy stretch of land between the creek and the Pool (Fig. 4.19).

This is an area of open Wandoo and Yate woodland which is fallow and gazetted for public recreation. The ground cover is a mixture of exotic grasses and native shrubs averaging less than a metre in height. It is quite thick, and visibility is zero outside of the recently disturbed areas. Disturbances are limited to a shallow sand track which runs parallel to the river down the centre of the area, and several shallow excavations where local farmers have been burying the carcasses of dead sheep. Artifacts were found exposed all along the track for a distance of 700 metres north of a causeway built over the creek and in most other exposed places. Fifty artifacts were collected in the first survey including two grindstones and three backed microliths.

The other three sites were very small scatters. Approximately two kilometres down stream at the Kalgan Downs site, twelve artifacts were found eroding from a cutting along Takalarup Road. About 100 metres below the bridge seventeen more artifacts were found on the east side of the river mixed with European rubbish in a disturbance caused by stock coming down to water. Finally, about

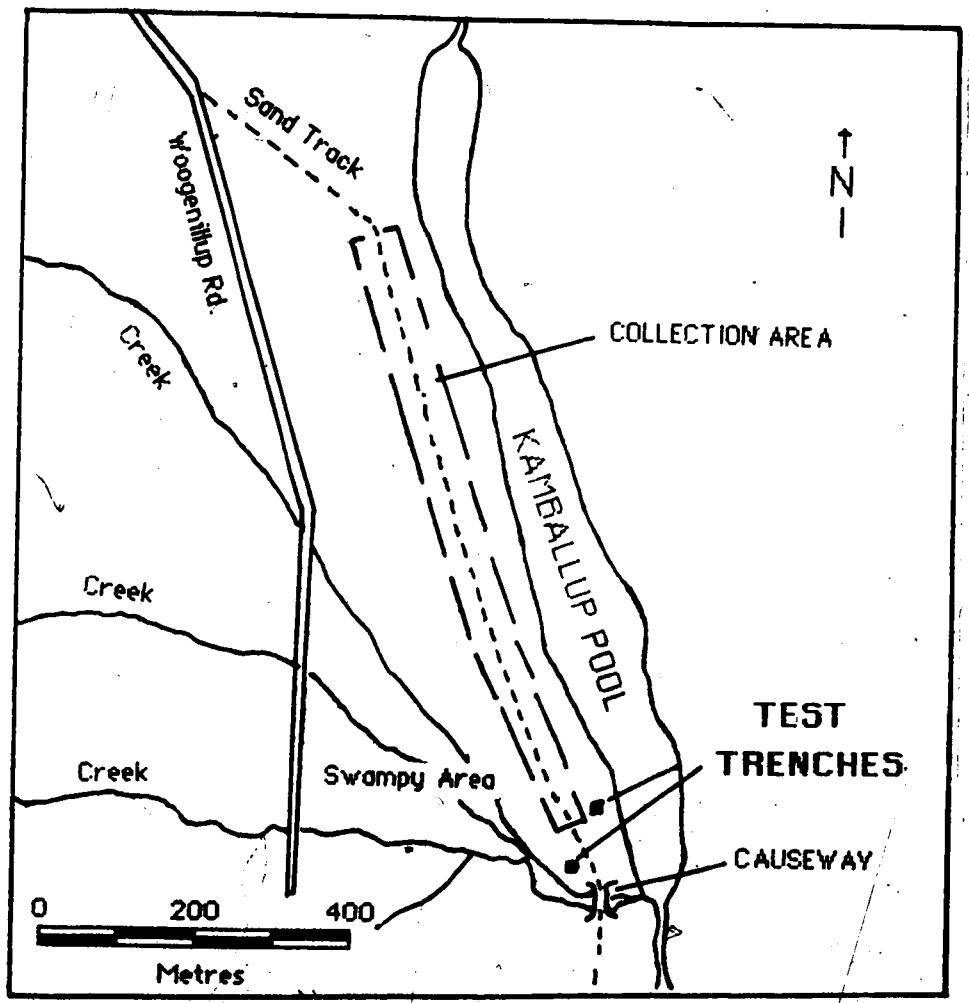


FIGURE 4.19. AREA IMMEDIATELY AROUND KAMBALLUP POOL:
The map shows the area of collection and of test excavations at the Kamballup Pool site. Further details on the locations of the trenches are included in the next chapter.

two kilometres upstream from the bridge, on the west side of the river, twenty five artifacts were found in overgrown fire breaks beside a small pool. No microliths or other retouched implements were found at any of these sites.

The Kamballup Pool site is located where the narrow strip of open woodland on the banks of the Kalgan River stands out as a distinctive ecotone in the relatively uniform mallee-heath which surrounds it. The excavations show that it was frequented for at least the last four to five thousand years. These are only a very small sample of a very large site, however, and a longer history of occupation is definitely possible. There are also several other large, permanent pools along the River in this area, and, logically, all or at least most of them should have been the focus for prehistoric Aboriginal activity.

Protohistoric Nodes - An evaluation of the model:

The use of this model produced relatively good results. It helped locate two major sites and many other smaller one in areas where the road survey would not have found them. Like the previous model, it does not eliminate the problem of site visibility, but it does narrow down the area of focus somewhat so that resurvey of targeted localities has more promise of success. Its use has also provided undeniable evidence of continuity in at least some aspects of the choice of camping locations from the ethnographic present back to the terminal Pleistocene.

A slightly different use of the ethnohistorical references also

aided in the location of a few sites. These, for the most part, were simply places where the explorers camped on their journeys and which were named in their journals. Four of these were examined and sites were found at all of them (see Fig. 4.20), but no excavations were undertaken.

Road Survey Meso Patterns:

During the road survey a few areas of site clustering were noted, and one locality, on the Kalgan Plains around the North and South Sisters, stood out as a probable major focus of prehistoric activity (Fig. 4.21). This area is of interest because it is in the eastern part of Mokaré's Domain for which little ethnohistorical information is available. The Europeans were not very interested in the area east of the River because the soils are notably poor, but the Aborigines obviously found it attractive. This is part of the East Kalgan vegetation system where, as was noted in the last chapter, the site density is almost twice the overall average; and as can be seen from the map, there are ten sites within a radius of five kilometers of a point between these two small granite bosses.

Several of these sites are quite large, and the many permanent swamps that ring the Sisters are the obvious attraction. No off-road survey was attempted in this area, but probably many more sites would be found around here if one looked. It is one of the localities the author had hoped to investigate in more detail, and when deciding on a road survey site for excavation, this area was the first to be considered. None of the sites recorded in the immediate vicinity,

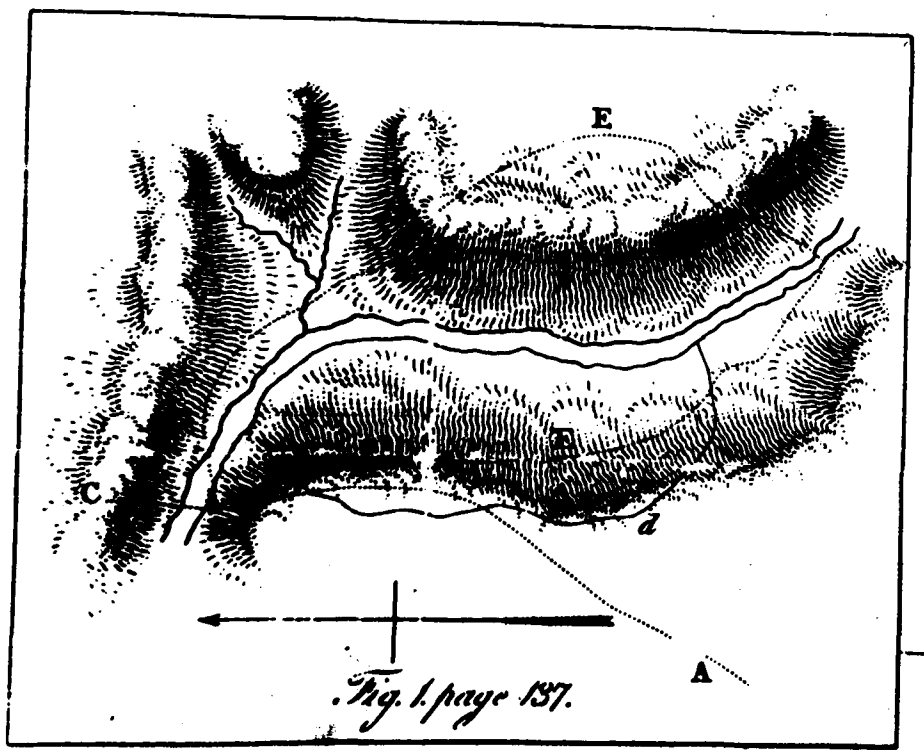


FIGURE 4.20. COLLIE'S MAP OF NOORUBUP POOL:
This map is also included as an inset on the large map in Cross (1833), and this time the north arrow is pointing in the right direction. Collie camped at point B with Mokaré on May 3rd, 1831. Survey in the area found stone artifacts in the back dirt of rabbit holes right at this location.

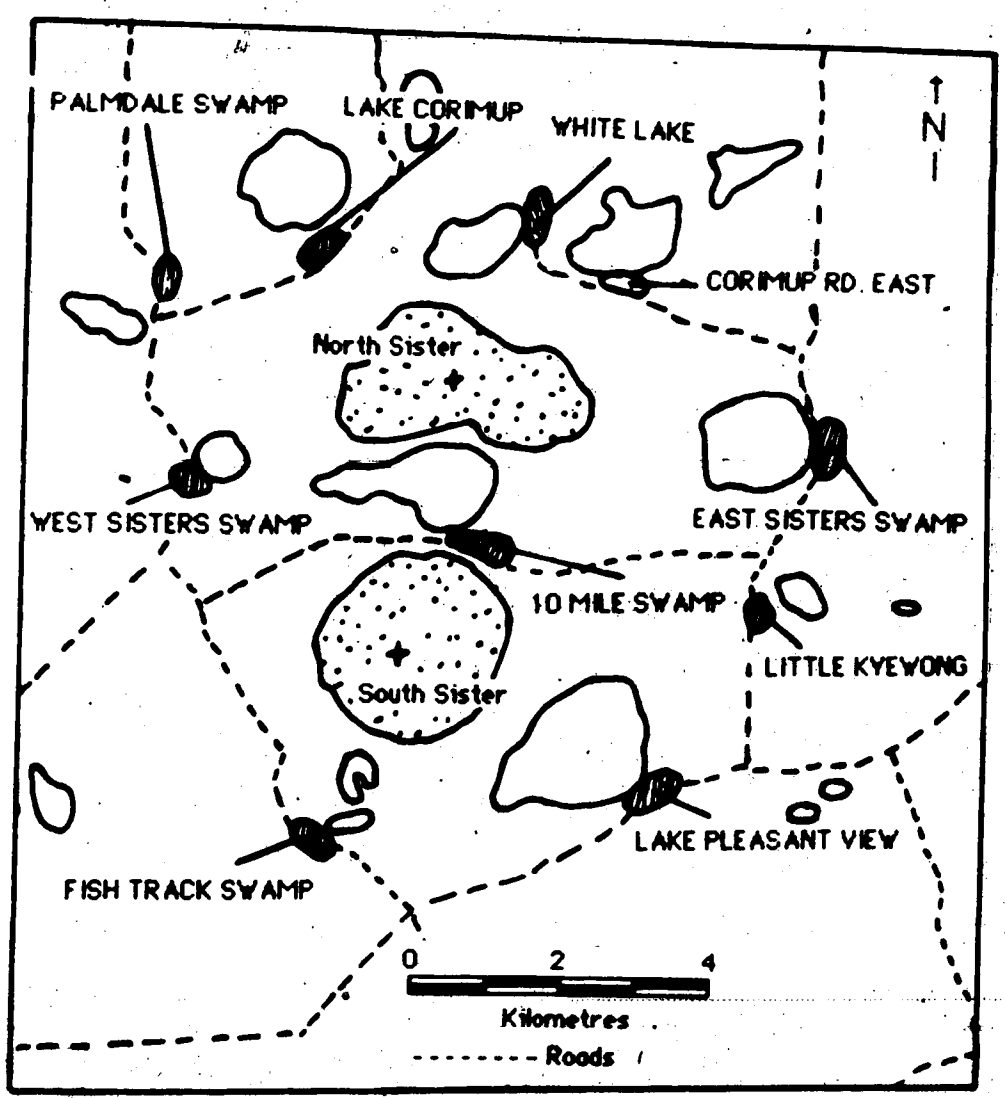


FIGURE 4.21: THE SISTERS MESO PATTERN AREA:
The Kalgan Plains are quite flat and in this area generally about 100 to 120 m above sea level. They are poorly drained and any land under about 100 m is swampy. The stippled areas on the map are from 140 to 230 m above sea level and can be seen from many kilometres away. Many other swamps and sites lie just outside the area shown on the map.

which are mainly in areas of deflated dunes, could be automatically assumed to provide a stratified sequence, however, and the time remaining in the last field season did not allow for any more empty or near empty test excavations. Moving out from the Sisters the first road survey site which did satisfy this criterion was Waychinicup River, just over ten kilometres due east of summit of the South Sister.

Waychinicup River:

The Waychinicup River site is located in mallee-heath country, approximately 35 kilometres east of Albany. It was discovered during the course of the road survey on Cheyne Beach Road, 1.1 kilometres east of the junction with Hassell Road (Fig. 4.22). The country surrounding the site is a poorly drained sand plain averaging from 60 to 80 metres above sea level. The site itself is at the north end of a long, narrow reed swamp which is formed where the courses of the river and an unnamed creek parallel each other over low ground above their confluence.

The basement granite-gneiss is exposed at only one place in the vicinity; on the summit of a low hill 1.5 kilometres west of the site. Over most of the area the sandy soils overlie laterite, and there is an outcrop of this formation on the west side of the swamp about a kilometre from the site. The dyeline geological map also shows that the stream courses have cut through the laterite to expose beds of the Plantagenet Group in the area where the site is located, but no outcrops were found during the survey.

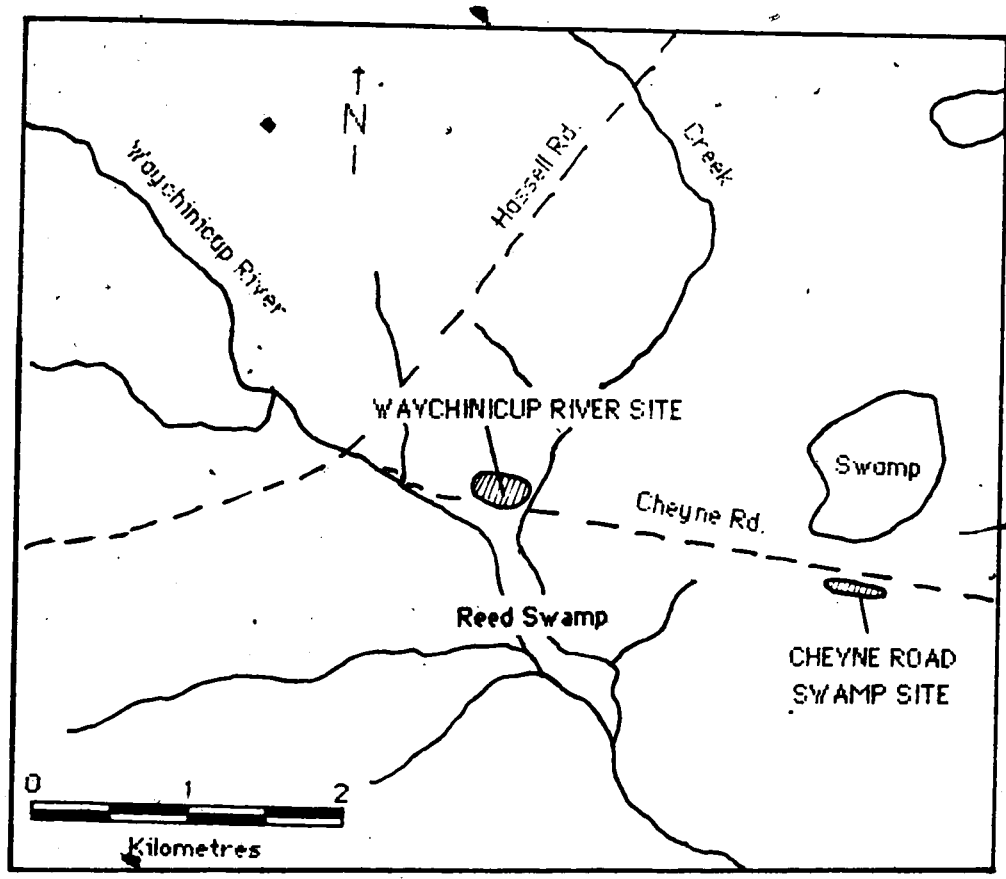


FIGURE 4.22. WAYCHINICUP MESO PATTERN AREA:

The site lies just within the East Kalgan vegetation association almost on the boundary with the Eyre Botanical District. The East Kalgan is an association composed mainly of Jarrah Woodland formations, but there is no Jarrah closer than about two kilometres to the north. The area surrounding the site is dominated by a wide variety of shrubs less than one metre high (see Beard 1979b:47 for a partial species listing). There are some taller shrubs and a few widely spaced, stunted mallee forms of Albany Blackbutt. The swamp and the permanently damp areas of the stream courses are choked with an exotic, *Lepidosperma angustatum*, the common sword sedge (K. Dickson, pers. comm.). Approximately seven kilometres southwest of the site, on the slopes of Mt Manypeaks, is the furthest outlier of Karri forest.

The heath vegetation forms a fairly dense ground cover, and since most of the land within the meso pattern area of the site has never been taken up for farming, disturbances are minimal. No off-road survey was conducted except in the area immediately around the site, and only one other site is known within a five kilometre radius. This is the Cheyne Road Swamp site, one kilometre to the east (Fig 4.22). Six artifacts including one piece of retouched glass were found there, widely scattered in low cuttings where the road runs past a large unnamed swamp.

At the Waychinicup River site nearly all of the exposed evidence of prehistoric occupation was found concentrated toward the bottom of a short length of one metre high cutting on the north side of the road about thirty metres west of the creek (Fig 4.23). One stone

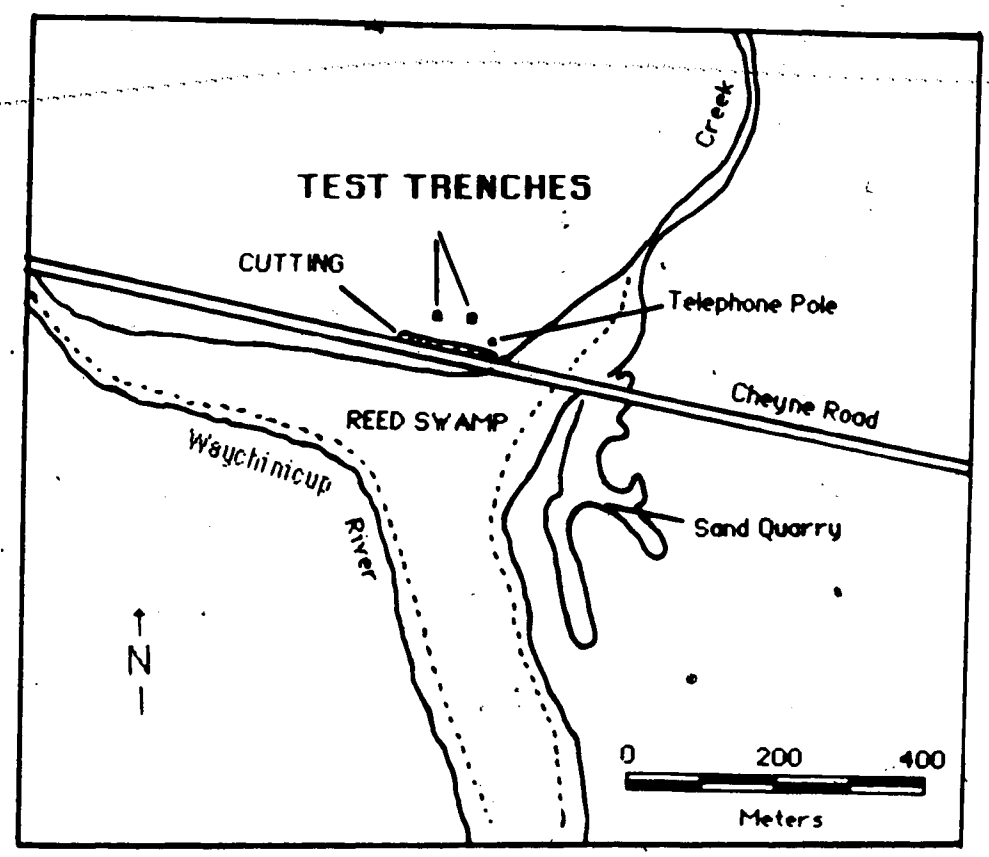


FIGURE 4.23. AREA IMMEDIATELY AROUND WAYCHINICUP RIVER SITE:
The map shows collection areas mentioned in the text. Further details on the location of the test trenches is included in the next chapter.

flake was found in a shallow disturbance near a power pole on top of the cutting; but extensive survey of the surrounding heath and in a small sand quarry which is east of the creek and south of the road, failed to turn up anything more. Consequently, no estimation of the area covered by the site can be given.

There were, however, a great number of artifacts in the cutting. Fifty were collected in situ from a stratified band not more than 30 cm wide and four m long, and many more had fallen out of the cutting into the drainage ditch below. This density suggested that a fairly large site lay buried beneath the heath north of the road, and two test excavations were undertaken in the hope they would provide additional trans-Holocene sequences to examine for evidence of a mid-Holocene depopulation. This undertaking met with success; and these sequences, which are discussed in the next chapter, suggest that the locality was frequented by Aborigines from at least the beginning of the Holocene era to sometime near the ethnographic present.

Meso Patterns - Summary and Discussion:

The meso pattern, the distribution of sites around any given point on the landscape, is the first of the descending levels of archaeological spatial patterning examined in this thesis to be based purely on archaeological criteria. No attempt has been made to tie it to a level of socio-cultural organization, as was the case with the macro and semi-macro patterns. The concept was used flexibly, and actual area considered as relevant in each case was set more or less

arbitrarily. This level of focus was necessitated in this research by the use of the site location techniques which predicted that major sites would be situated near modelled trackway intersections, but it is relevant to any archaeolgical research where sites are not to be considered in isolation from their immediately surrounding environmental and archaeological contexts.

In application here, the site distributions at six localities in Mokare's Domain were described in some detail. Each of these provided a considerably different environmental area for study; progressing from the dense forest country around the lowest ford on the Kalgan, through the lush woodlands around Moorillup Pool, to the sparse heath country around the Waychinicup River site. This broad representation of environments is fundamental to the eventual acceptance of the mid-Holocene depopulation hypothesis. Those who favour an alternative "change in choice of site location" explanation will have little fuel for their argument if it can be shown that almost all logically feasible types of possible locations are already included within the sample.

The field survey in Mokare's Domain detailed in this chapter was exploratory. It was the first examination of an area in which the archaeological resources were previously almost totally unknown, and it was done with the specific purpose of locating a few stratified sites which could provide artifact sequences for inclusion in the regional sample. This was successful, but in the process the researcher suffered from a certain amount of "embarrassment of riches" in that in his rapid coverage of the area he discovered a lot

more archaeological phenomena than time allowed him to investigate with the care and intensity they deserve. The descriptions in this chapter of the localities around Kalgan Hall, Lower King, Chester Pass, Moorillup Pool, Kamballup Pool, The Sisters, and Waychinicup River should be considered as what they are: brief notes concerning initial discovery. All of these localites will require further research if their role in the prehistory of the region is to be fully understood.

CHAPTER 5

SEMI-MICRO AND MICRO PATTERNS: EXCAVATIONS - THE ARTIFACT DENSITY SEQUENCES OF MOKARE'S DOMAIN

Introduction:

This Chapter examines the buried archaeological deposits in Mokaré's Domain and demonstrates that there are relatively many fewer artifacts in levels which can be dated to the mid-Holocene period, than in levels which can be dated to the preceding late Pleistocene and early Holocene periods. It opens with an introductory section which details the rationale and methods of excavation, and then reports the results of the excavations conducted during the field research site by site. In discussion the emphasis is on the vertical structure of the cultural deposits; and, through the use of both tables and diagrams, a clear picture is presented of the varying amounts of artifact finds by depth in centimetres as they were recovered from each of the excavations. These are called *relative artifact density sequences*.

In the summary and discussion section at the end of each site presentation, analysis is undertaken to establish control for variations in sedimentation rates, and these 'raw' density sequences are modified to fit onto an absolute time frame. The methodolgy involves the use of *depth/age graphs* (Hughes 1977, Hughes and Djohadze 1980) and the construction of *millennial density models*, and it is described in detail during the summary and

discussion of the first site, Kalgan Hall.

At the end of the Chapter there is a section which integrates and compares the findings from each of the sites. This completes the first stage of the pilot test of the mid-Holocene depopulation hypothesis. The second and final stage, the evaluation of whether or not the temporal variations in artifact densities shown here can be used to suggest similar variations in the density of human populations, is presented in the following Chapter where the formal attributes of the artifact assemblages are described and analysed.

Excavations:

Nine exploratory Test Trenches and two larger Area Excavations were dug at six sites during the field research. The primary goal of all the excavations was to provide a representative sample of artifact density sequences from those sites; and, in most instances, multiple excavations were conducted at each site to control for possible intra-site variations. The area excavations had an important secondary purpose, however. It was hoped that if enough of the horizontal deposit could be exposed, the study of the micro-patterns, the distribution of artifacts across portions of the site, could aid in an understanding of just what activities took place on the sites.

The area excavations were therefore undertaken at places where the previous test excavations suggested that micro-patterns might be preserved. Such places are not very common in the generally uniform sandy soils of the much frequented open sites which were

examined, and both area excavations met with only limited success in this secondary research goal. These excavations do, however, provide density sequences which are based on much larger artifact samples than those from test excavations; and they are, in that way, more reliably representative of the stratigraphic deposits at the sites.

Test Trenches - method: For the exploratory excavations, the sites were sketch-mapped, and an arbitrary temporary on-site datum was established, usually by simply driving a stake into the ground near where the excavation was to be located. This was later plotted with a dumpy level and tape in relation to some more-or-less permanent feature denoted as the off-site datum. The location for a test trench was chosen "intuitively", and after the various, appropriate permissions had been obtained, a 1 x 1 metre square was aligned north-south at some established angle and distance from the on-site datum.

Test trenches were numbered consecutively for each site, and were always 1 x 1 m squares. The on-site datum served only for horizontal control in these excavations, and depths were recorded from the surface of the ground at the highest corner of the trench.

After the vegetation cover had been removed, excavation proceeded by natural strata when such were present and easily identifiable. In lieu of, and within natural strata, excavation proceeded by 10 cm spits, or in the few cases where the deposit was specially complicated, in 5 cm spits. Levels were established by measuring down from the surface in the designated corner of the

trench with a metal tape, and were maintained across the floor of the trench with a carpenter's level.

Digging was done with trowel and dustpan. All sediments were put into buckets and sieved through a 2 mm mesh. Excavation was continued at least until bedrock, a tertiary sediment, or the water table was reached except in the trench at Kalgan Heights Estate (Fig 4.11) which was abandoned 160 cm below the lowest artifact, and in the two trenches at Waychinicup River which are discussed below. After completion, all sections were drawn and photographed, and loose soil samples were taken at 10 cm depth intervals. All test excavations were backfilled immediately upon completion of these tasks.

During excavation, artifacts recovered *in situ* were recorded three dimensionally, and all features were drawn and photographed. All artifacts from each spit were given the same "core" registration number. *In situ* artifacts and "interesting" pieces were given sub-numbers of the spit registration number in the manner described in detail below.

Charcoal was collected *in situ* when large concentrations were present and collected from the sieve when it was scattered in small fragments throughout the spit. It was placed in double, clean plastic bags with the tag noting its location in the outside bag.

Area Excavations - method: For the area excavations, a one metre grid was established over the site using a tape and dumpy level. The zero point was either the previous on-site datum or a new one

established for that purpose. The grid lines were numbered consecutively North, South, East and West of the datum, and each grid square named for its corner closest to the datum. In the area to be excavated, the one metre squares were further divided into four lettered squares, called quads, 50 cm. on a side (see Figs. 5.4 and 5.29 below).

The area excavation trenches were initially 16 square metre areas, four metres on a side. They were numbered using the consecutive sequence already established at each site. This size and shape was considered minimal if the modelled camping micro-patterns (Fig. 2.7) were to be identified; but alterations to the basic plan were envisioned should it prove desirable during the course of excavation, and in both instances this proved to be the case.

Excavation procedures followed those used in the test excavations except depth control was from below the on-site datum and maintained using a dumpy level, and 5 cm spits were used for greater control. Artifact finds were recorded and bagged by quad. All artifacts found per spit within a quad were given the same registration number. For example: the registration number X2107 might be given to all the artifacts from grid square 14S/01W, quad A, 55-60 cm below datum at Moorillup Pool. *In situ* artifacts and interesting pieces recovered from the sieve were given sub-numbers on the spot: X2107.1, X2107.2, and so on.

In situ measurements were *approximated* in the following way. Chaining pins (surveyor's arrows) were permanently inserted into the deposit at all metre grid intersections, and a faint mark

reproducing the grid line was drawn on the surface between the pins using a carpenters level as a straight-edge. Horizontal *in situ* measurements in centimetres from datum were taken from these lines. As the excavation progressed, the pins were pushed straight downward; and they were checked every one or two days with the dumpy level to insure that they did not get out of line.

In situ depths were *estimated* within the 5 cm spit. If there was some reason for doubt, the carpenters level was rested on the surface of the adjacent unexcavated quad so that it extended out over the artifact, and a measurement taken down from that. (Most of the excavation crew had less faith than the Director in their ability to divide 5 cm into five parts by eye, so they always did this.) These measurements were written in the notebook behind the sub-number for that artifact. Then a piece of tape with the sub-number on it was wrapped around the artifact and it was dropped into the quad bag. This process required only one individual to carry it out, it is very fast, and it is of sufficient accuracy given the nature of the deposits involved. All artifacts recovered in a day's excavation were washed and numbered that night before anybody went to bed.

Charcoal was collected by grid square and spit in the manner outlined for the test trenchs above. All sediments were sieved in a like manner except that a 5 mm mesh was used for the clay sediments from Moorillup Pool. Features, sections and soil samples were also done as above except that oriented column blocks of soil were taken in addition to the loose samples. The trenches were backfilled using earthmoving equipment.

The Kalgan Hall Site:

The site at the Kalgan ford is on the grounds of the Kalgan Town Hall, east of the river, on the bluff immediately adjacent to the ford (Fig. 4.3). The river barrier has funnelled European as well as Aboriginal activity through this location, so much of the site has experienced a good deal of recent disturbance. Several roads have passed through the site. Prior to its destruction in the flood of 1938, a low bridge spanned the river at the ford, and a deep cutting remains on the west side of the site where the access road dropped down to it. The high bridge over the ford was built in 1940, and the construction of Wreeldon Road and the adjacent parking lot at that time removed the southern parts of the site. In 1970, a second high bridge was built about a hundred metres up river. This bridge now carries the bulk of the traffic.

On the part of the site remaining there is the town hall and its out-buildings, several sand tracks, and a deep long bulldozer cutting where sand was removed for road maintenance. The remainder of the block is forested with tall Jarrah and Marri trees and a thick undergrowth of native and exotic plants (Fig. 5.1).

An off site datum was established by driving a spike into the concrete of the corner of the northeast abuttment of the 1940 Bridge. For the main area excavation, Trench 2, an on-site datum was established 50.47 m east, 32.63 m north, and 4.52 m above this point, and a grid laid out across the site as described above. Test Trench 1 has been subsequently tied into this grid (Fig. 5.2).

Figure 5.1a. Kalgan Hall Site Vegetation Cover:
The photograph was taken looking north at the area where the Trench 2 Area Excavation was conducted before the vegetation was cleared.

Figure 5.1b. Kalgan Hall Site After Clearing:
This photo was taken from approximately the same place as the one above one day later

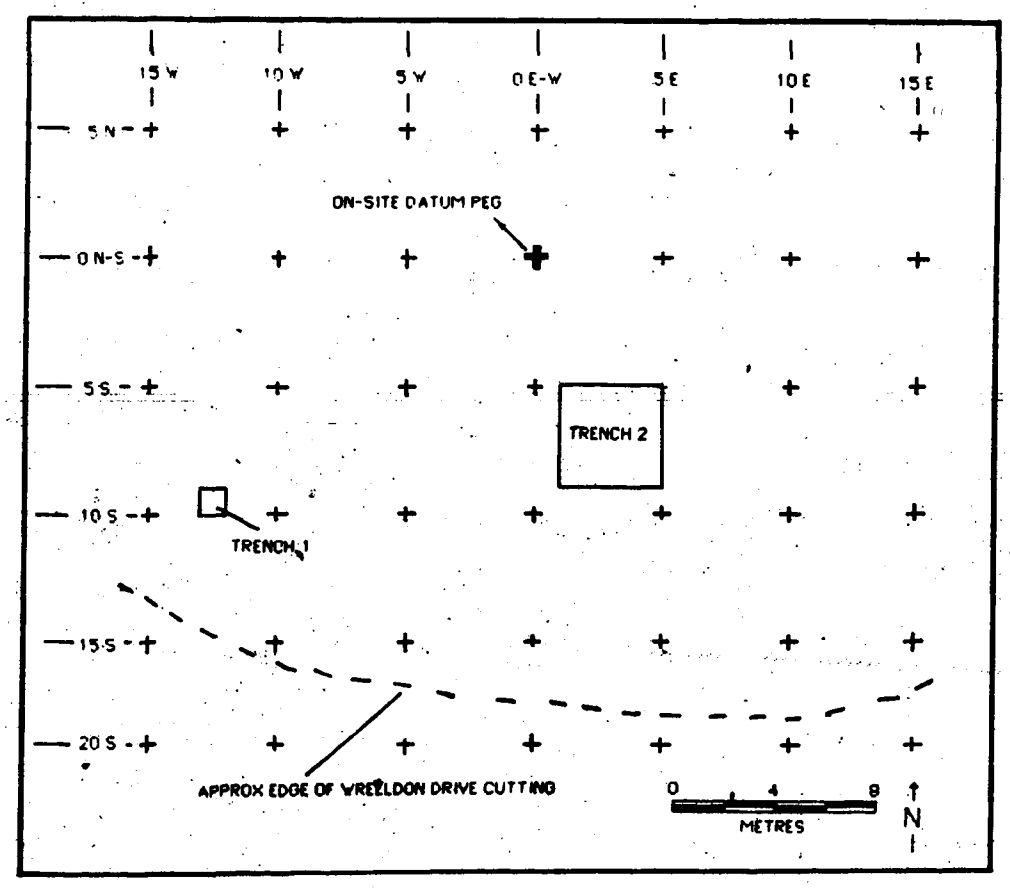


Figure 5.2. Kalgan Hall Site Grid:
This is a plan of the grid established over the part of the Kalgan Hall Site where the excavations were conducted, and shows the locations of the trenches in relationship to the on-site datum. The off-site datum is a spike in the concrete of the northeast corner of the 1940 Bridge where Wreeldon Drive crosses the Kalgan River. It is 50.47 m west, 32.63 m south, and 4.52 m below the on-site datum.

Test Trench 1:

Test Trench 1 is a 1 x 2 metre trench set out nine metres south and twelve metres west of the on-site datum. The trench was excavated in 5 and 10 cm spits to a depth of 186 cm below the surface of the NE corner of the trench, which is 38.5 cm below the on-site datum.

The sediments revealed in section (Fig 5.3) consist of three basic strata. Layer I is a sandy soil, probably aeolian in origin, with a weakly developed humic horizon. It extends from the surface to a depth varying between about 35 and 40 cm.; and consists of grey sands (Table 5.1) in tiny microstrata only a few millimetres thick which are interspersed with ashy microstrata generally about the same thickness. A few ashy lenses of greater thickness are also present.

These areas of ash have a "greasy" feel and leave a smear when rubbed between the fingers. They contain large amounts of small charcoal particles and sometimes larger pieces as well. Samples of this sediment were taken for possible future study, but have not yet been processed.

Through this stratum at about 25 cm. DBS (depth below surface) in the northwest corner of the trench is an intermittent band of brown sand only 3 cm thick at its widest point. Below this band on the east side of the trench is a continuation of Layer I; only here the banded grey sands are a somewhat darker grey, probably because of the inclusion of greater amounts of charcoal. Many roots and rootlets are present, and continue to a depth of about 80 cm.

KALGAN HALL - TRENCH 1

NORTH SECTION

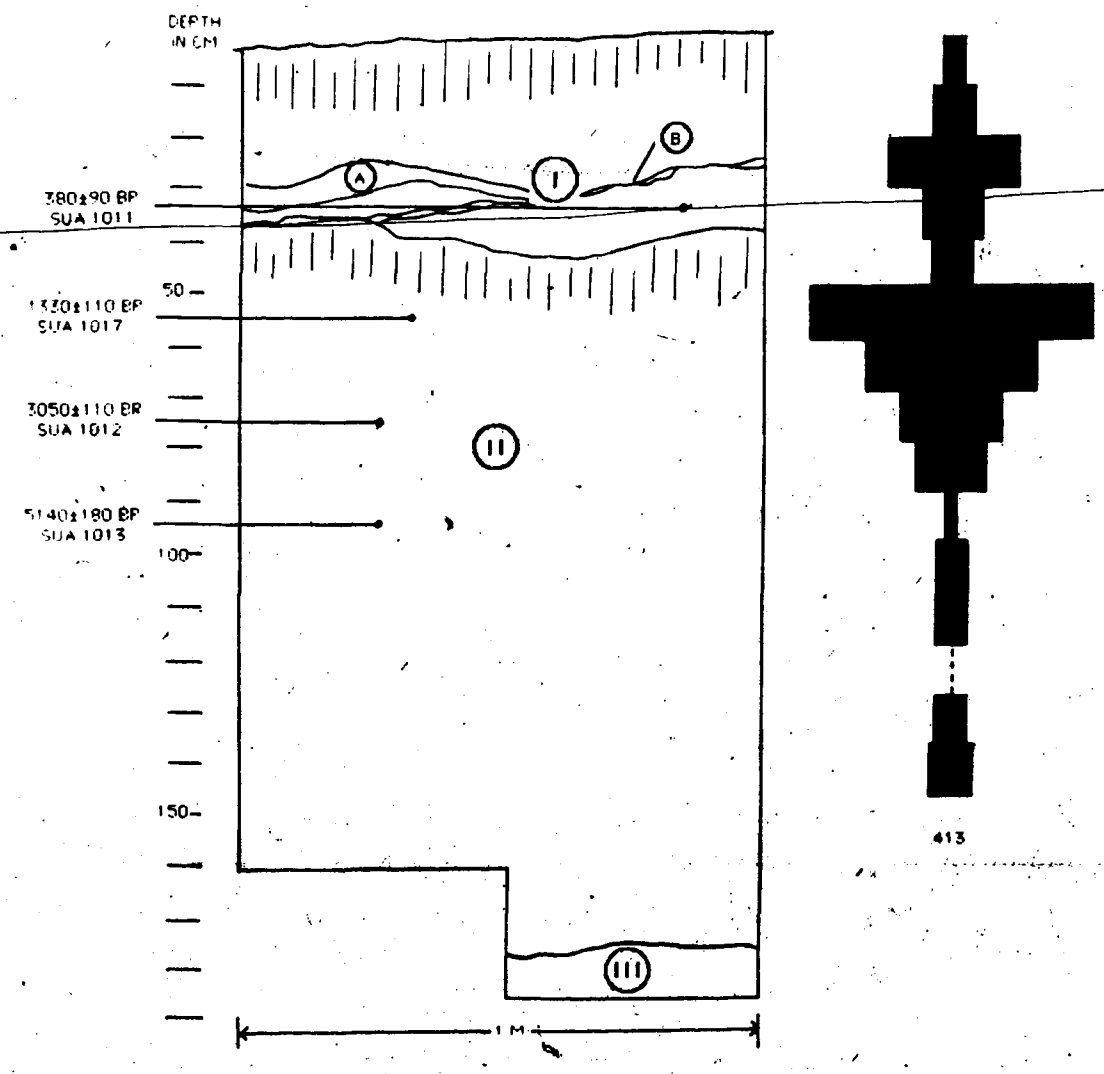


Figure 5.3. Section and Density Sequence Diagram of Kalgan Hall Trench 1: The diagram at the right of the section is a proportional representation of the total flaked stone artifacts recovered from each ten centimetres of depth below the surface. The number at the bottom of the diagram is the total of flaked stone artifacts recovered from the trench. See text for explanation of sediments.

TABLE 5.1. KALGAN HALL TRENCH 1 PHYSICAL DESCRIPTION OF SEDIMENTS

SAMPLE Cm DBS	MUNSELL COLOUR (DRY SAMPLE)	GRAIN SIZE* 0	1	2	3	4	>4	COMMENTS
10-20 (Level I)	10 YR 6/1 light grey to grey	1	2	14	38	39	6	fine to very fine sand of sub-angular to sub-rounded quartz grains with large amounts of organics and charcoal. Slightly acid (pH 5).
30-40 (Level II)	10 YR 5/1 grey	1	3	18	36	36	6	as above. (pH 5.5).
50-60	10 YR 7/1 light grey	1	5	20	37	33	4	as above but with less organics and charcoal.
90-100	10 YR 7/3 very pale brown	T	5	20	39	32	4	as above but with less organics and charcoal.
120-130	7 YR 4/4 brown to dark brown	T	3	13	39	41	4	as above but with variable iron staining and only a trace of organics and charcoal. (pH 6).
160-170	10 YR 6/4 light yellowish brown	1	2	11	35	47	6	as above but grains slightly more rounded and includes laterite pebbles up to 8 mm dia.

*Shows percentage of 50g dry subsample caught in 0,1,2,3,& 4 Ø sieves after shaking on an "Endrook" mechanical sorter for 15 minutes.

Layer II is another sandy soil, probably aeolian in origin. It is divided from Layer I by a thick, weathered humic horizon which is a uniform very dark grey in colour. As the humic content decreases with depth, this grey becomes steadily lighter. At approximately 100 cm DBS it grades into mottled light and dark browns; and these colours continue to grow richer and more contrasted until Layer III is encountered at approximately 178 cm DBS. Layer III is Tertiary laterite. It is weathered and crumbly on the surface, but quickly becomes too solid to excavate.

Cultural Materials Worked glass artifacts were found from the surface to 30 cm DBS, and stone artifacts were found from the surface to 150 cm. DBS. Table 5.2 shows the classifications of the artifacts by depth, and these classifications are discussed in detail in Chapter 6. Concentrations occur between 30 and 35 cm DBS, and between 50 and 80 cm. DBS in the zone from which backed microliths were recovered. Below the lowest backed microlith, artifact numbers decline rapidly, only beginning to increase again at the very bottom of the sequence between 130 and 150 cm DBS (Fig. 5.3 - density sequence diagram.)

No recognizable horizontal micro patterns were identified in this small trench, except for what is interpreted to be a hearth-centred activity area encountered between the intermittent band of brown sand in Layer I and the top of Layer II humic horizon. Nine artifacts including two implements were recovered *in situ* from association with this hearth and an additional 20 small flakes and

TABLE 5.2. KALGAN HALL TRENCH 1 ARTIFACT FINDS BY DEPTH BELOW SURFACE*

CM	FLAKED STONE														OTHER					
	DEBITAGE						IMPLEMENTS						TOT	TOT	ARTIFACTS					GRAND
DBS	RM	CP	FK	FF	CO	BC	ML	SI	CI	AX	PI	MI	IMP	FLKD	GP	MP	E	OCR	TOT	TOT
10	1	1	4	1	0	0	0	1	0	0	0	0	1	8	0	0	2	0	2	10
20	0	10	5	1	0	1	0	0	0	0	0	0	0	17	0	0	1	0	1	18
30	0	16	4	2	1	0	0	0	0	0	0	0	0	23	0	0	1	0	1	24
35	0	17	7	1	2	0	0	1	0	0	0	1	2	29	0	0	0	0	0	29
40	0	16	5	2	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	23
50	2	6	5	2	1	0	0	0	0	0	0	0	0	16	0	0	0	0	0	16
60	2	77	29	2	1	0	1	0	0	0	0	0	1	112	0	0	0	0	0	112
70	0	37	17	2	0	0	3	0	0	0	0	0	3	59	0	0	0	0	0	59
80	0	30	9	1	0	0	2	0	0	0	0	0	2	42	0	0	0	4	0	46
90	0	19	8	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	27
100	0	4	1	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	5
110	0	5	8	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	13
120	0	10	1	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	11
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140	0	7	3	0	0	1	0	0	0	0	0	0	0	11	0	0	0	0	0	11
150	0	10	5	1	0	1	0	0	0	0	0	0	0	17	0	0	0	0	0	17
187	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	5	265	111	15	5	3	6	2	0	0	0	1	9	413	0	0	4	4	8	421

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FK - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

chips of varying petrology were recovered from the sieve.

Radiocarbon Dates: Charcoal was plentiful in the upper portion of the excavation and four dates have been returned for the sequence (see Fig. 5.3). The hearth described above as lying just over the buried humic horizon, between 30 and 35 cm DBS, was dated at 380±90 B.P (SUA 1011). The charcoal associated with the uppermost backed microlith, between 50 and 60 cm DBS, was dated at 1330±110 BP (SUA 1017), and that associated with the lowest backed microlith, between 70 and 80 cm DBS, at 3050±110 BP (SUA 1012). The lowest charcoal in suitable quantity for dating was between 90 and 100 cm DBS, and it provided a date of 5140±180BP (SUA 1013).

Area Excavation: Trench 2:

Trench 2 at Kalgan Hall is a 4 x 4 metre area excavation set out between five and nine metres south, and one and five metres east of the on-site datum. The surface of the site here slopes slightly downward to south and west, with a total drop of about 26 cm. over the 5.66 m diagonal running from 5S/5E to 9S/1E (Fig 5.4). Before clearing for the excavation, the vegetation was a very thick cover of native and exotic understory plants with several fallen and rotting trees (Fig. 5.1a). The entire 16 square metres was excavated in 5 cm. level spits to a depth of 85 to 90 cm BD (Below on-site Datum), and the 2 x 2 metre northwest quarter of the trench was taken down below the lowest artifact to 200 cm BD. A single 1 x 1 square, 5S/1E was continued down another 50 cm to tertiary laterite (Fig. 5. 5).

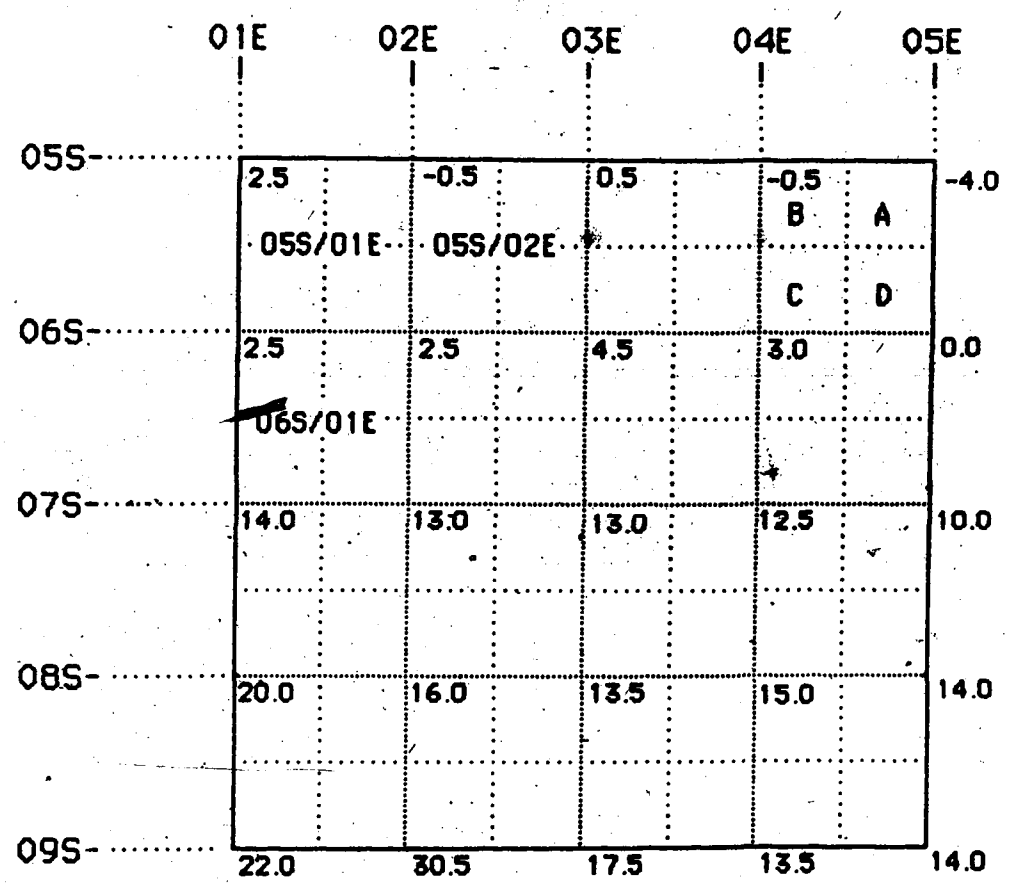


Figure 5.4. Excavation Plan of Kalqan Hall Trench 2:
The excavation is divided into one metre squares which are referred to by the grid co-ordinates of the NW corner of the square as shown by example in the squares in the upper left hand corner of the diagram. Each square is further divided into four quads lettered as those in the upper right hand grid square. The numbers in the upper left hand corner of each square record the surface height of that grid intersection in centimetres below the on-site datum.

Figure 5.5a. Stages of Kalgan Hall Trench 2 excavation I:
The photograph shows upper levels of trench being excavated.

Figure 5.5b. Stages of Kalgan Hall Trench 2 excavation II:
This photo shows the completed excavation which was continued down to Tertiary laterite only in the NW corner of the Trench.

KALGAN HALL - TRENCH 2
NORTH SECTION

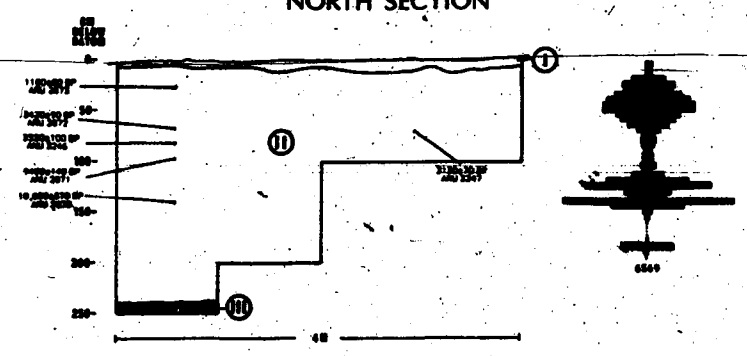


Figure 5.6. Section and Density Sequence Diagram of Kalgan Kall Trench 2: The spit totals which provide the data for the density sequence diagram at the right of the section have been multiplied by 16 over the number of grid squares excavated to provide comparability. The number at the bottom of the diagram is the actual number of flaked stone artifacts found. See text for explanation of sediments.

The statigraphic sequence (Fig. 5.6) is similar to that in Trench 1 except that here almost all of Layer I and a small portion of Layer II have been removed. The humic horizon at the top of Layer II is found only about 5 cm. below the surface on the north side of the trench, and it is absent altogether on the south side of the trench. Also Layer II is considerably thicker, about 240 cm, rather than about 140 cm as in Trench 1. The soil above about 80 cm BD is penetrated by numerous roots, both large and small; and although it is a mottled light brown upon exposure, it dries instantly to a uniform light grey. Below about 80 cm BD, the humic content lessens and colours become richer as a result of variable iron staining (Fig. 5. 5 - Table 5.3).

Otherwise, Layer II is strikingly uniform. No identifiable soil changes or features were noted in the north or west sections. The south section reveals only two small ash lenses, and one long, thin charcoal lens which is just under the ground surface in squares 08S/03E and 08S/04E and is probably the remnants of a very recent fire. In the west section there is one small ash lens, and a lens of a strange composition which appears to be an abandoned insect nest of some sort (Fig. 5.7a).

Only two other distinct isolated changes in soil composition were noted within this stratum during the excavation. These are very hard-packed and probably baked mixtures of various sediments and charcoal which were found in the levels between 40 and 80 cm BD in squares 05S/03-04E and in 06S/03-04E (Fig. 5.7b). They were nominated as Features 1 and 2, and appear to have resulted from fires burning under the surface of the ground. This might have resulted

TABLE 5.3. KALGAN HALL TRENCH 2 PHYSICAL DESCRIPTION OF SEDIMENTS

SAMPLE Cm DBS	MUNSELL COLOUR (DRY SAMPLE)	GRAIN SIZE* 0	1	2	3	4	>4	COMMENTS
0-10	10 YR 5/1 grey	3	5	10	40	37	5	fine to very fine sand of sub-angular to rounded quartz grains with large amounts of organics and charcoal. Slightly acid (pH 5.5).
40-44	10 YR 7/1 light grey	T	2	17	40	37	4	as above.
95-110	10 YR 7/3 very pale brown	T	2	14	40	39	5	as above but with much less organics and charcoal.(pH 6).
145-160	10 YR 6/6 brownish yellow	0	1	8	36	49	6	as above but with variable iron staining and only a trace of organics and charcoal.
200-215	7 YR 4/6 strong brown	0	1	9	39	45	6	as above but quartz grains generally more rounded and iron staining more complete. Coarser fractions (1& 2 Ø) made up of smaller grains glued together with iron.
Feat 1,	10 YR 6/3 pale brown	2	5	18	40	31	4	Primarily a fine to very fine sand of sub rounded quartz grains but with at least 10% charcoal particles. The coarser fractions are primarily a conglomerate of quartz grains and small particles of charcoal fused together. These usually break apart under pressure
Feat 2,	10 YR 5/4 yellowish brown	T	2	14	40	40	4	as above but with less charcoal and less fusing of grains into conglomerates

*shows percentage of 50g dry subsample caught in 0,1,2,3,& 4 Ø sieves after shaking on an "Endrook" mechanical sorter for 15 minutes.

Figure 5.7a. Kalgan Hall Trench 2 east section:
The "insect nest" mentioned in the text is shown as the discoloured lens in the centre of the section

Figure 5.7b. Kalgan Hall Trench 2 Features 1 and 2:
The features described in the text are the unexcavated, irregular-shaped sediments on the upper level. The long, narrow feature on the lower level is a root cast which may be associated with Feature 2.

TABLE 5.4. KALGAN HALL TRENCH 2 ARTIFACT FINDS BY DEPTH BELOW DATUM*

CM	FLAKED STONE															OTHER					
	DEBITAGE						IMPLEMENTS						TOT	TOT	ARTIFACTS						GRAND
BD	RM	CP	FK	FF	CO	BC	ML	SI	CI	AX	PI	MI	IMP	FLKD	GP	MP	E	OCR	TOT		TOT
5	0	16	3	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0		19
10	0	17	15	6	0	0	1	0	1	0	0	0	2	40	0	0	9	0	0		49
15	0	33	10	1	0	0	0	0	1	0	0	0	1	45	0	2	2	3	7		52
20	0	212	41	6	1	1	0	1	0	0	0	0	1	262	0	4	12	1	17		279
25	0	319	33	9	2	1	0	2	1	0	0	0	3	367	0	1	8	3	12		379
30	0	261	62	12	2	2	1	0	0	0	0	0	1	340	0	1	0	0	1		341
35	0	418	77	10	2	2	1	0	0	0	0	0	1	510	1	3	1	3	8		518
40	1	501	105	13	2	1	2	3	2	0	1	0	8	631	0	2	0	15	17		648
45	0	526	112	20	2	2	5	3	1	1	0	0	10	672	2	0	0	30	32		704
50	0	539	107	14	0	2	2	3	1	0	0	0	6	668	0	4	0	12	16		684
55	0	402	76	9	2	0	4	2	1	0	0	0	7	496	0	1	0	8	9		505
60	1	329	66	9	5	0	2	5	2	0	0	0	9	419	1	0	0	12	13		432
65	1	258	49	4	1	0	0	1	0	0	0	0	1	314	0	4	0	3	7		321
70	0	105	26	5	0	0	1	1	0	0	0	0	2	138	1	2	0	14	17		155
75	4	71	17	4	0	0	0	1	1	0	0	0	2	98	0	7	0	7	14		112
80	4	78	18	5	0	1	0	1	0	0	0	0	1	107	0	10	0	18	28		135
85	5	69	7	6	2	0	0	0	0	0	0	0	0	89	0	0	0	6	6		95
90	0	28	3	1	0	0	0	1	0	0	0	0	1	33	2	0	0	3	5		38
95	0	17	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0		17
100	0	12	2	2	1	0	0	0	1	0	0	0	1	18	0	0	0	0	0		18
105	0	25	4	1	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0		30
110	0	14	0	1	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0		15
115	0	35	1	0	0	0	0	0	0	0	0	0	0	36	0	0	0	1	1		37
120	0	122	26	1	2	0	0	1	1	0	0	0	2	153	0	0	0	4	4		157
125	3	201	63	9	1	0	0	1	0	0	0	0	1	278	0	1	0	2	3		281
130	0	69	19	0	0	0	0	0	1	0	0	0	1	89	0	0	0	1	1		90
135	0	63	10	1	0	0	0	1	0	0	0	0	1	75	0	0	0	0	0		75
140	2	217	102	10	3	0	0	2	0	0	0	0	2	336	2	0	0	0	2		338
145	0	113	22	0	0	2	0	2	0	0	0	0	2	139	0	0	0	0	0		139
150	0	14	2	2	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0		18
155	0	7	1	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0		8
160	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0		2
165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
175	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		1
180	0	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0		5
185	0	63	31	2	0	2	0	0	0	0	0	0	0	98	0	0	0	0	0		98
190	0	6	5	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0		11
195	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0		2
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
TOTAL	21	5170	1115	163	28	16	19	31	14	1	1	0	66	6579	9	42	33	145	229		6808

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FK - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

from prehistoric human activity, such as the pit-cooking of kangaroos (Grey 1841:174-5, Salvado 1851:155); or from a natural cause, like the roots of trees burning in a bush fire.

Cultural Materials: Stone artifacts were found from the surface to 195 cm BD (Table 5.4). As in Trench 1, the zone containing backed microliths begins below the Layer II humic horizon (between 25 and 30 cm BD), and continues to a depth of between 65 and 70 cm B.D. One backed microlith was found out of this zone, above the Layer II humic horizon, just under the surface in square 05S/01E; but it is assumed that this piece has been redeposited from a disturbed area of the site.

The density of the artifacts varies considerably with depth (Fig.5.6 - density sequence diagram). It is relatively high in the zone containing backed microliths reaching a maximum average of 10.8 artifacts per quad per spit, or 838 artifacts per m^3 of sediment, between 40 and 50 cm BD. Below this zone, density decreases rapidly reaching a minimum of .82 artifacts per quad per spit, or 66 artifacts per m^3 sediment, between 85 and 90 cm BD. The zone of low density continues until about 115 cm BD when artifact finds increase dramatically. From this level to where the cultural deposit terminates at 195 cm BD, density fluctuates widely with depth, reaching a trench maximum of 21 artifacts per quad per spit or 1680 artifacts per m^3 or sediment, between 134 and 140 cm BD.

Radiocarbon Dates: Charcoal was relatively plentiful in the

excavation above 100 cm BD, but was scarce below that. Seven samples were submitted for dating and six of these provide a good chronology for the occupation (Fig. 5.6). The uppermost backed microlith, between 25 and 30 cm BD, was dated at 1180±80 BP (ANU 2873) from charcoal fragments scattered within the same square and spit as the microlith. The lowermost backed microlith, between 65 and 70 cm BD, was dated at 3420±90 BP (ANU 2872) in the same manner. The zone of low artifact density provided charcoal for two dates: 3530±100 BP (ANU 3246) between 80 and 85 cm BD, and 9450±140 BP (ANU 2871) between 95 and 100 cm BD. The lowest charcoal in suitable quantity for dating was in the area of highest artifact density, between 135 and 140 cm BD, and it provided a minimum age for occupation of the site of 18,850±370 BP (ANU 2870).

The seventh sample submitted was from a charcoal concentration in Feature 2 between 76 and 80 cm BD, and it provided a date of 3130±70 BP (ANU 3247). This appears to date the feature as three to four hundred years younger than the unbaked sands surrounding it on the same level, and supports the suggestion that it results from a subsurface fire.

Micro Patterns: The hearth-centred activity area lying just over the Layer II humic horizon in Trench 1 suggests the possibility that camping micro-patterns of the last millennnium might be present and identifiable at the Kalgan Hall Site; but because the majority of Layer I and parts of the humic horizon of Layer II have

been removed from the deposit where Trench 2 was located, the hoped for postholes of Nyungar huts could not be found. Throughout Layer II, although hundreds of artifacts were recovered *in situ*, no readily recognizable horizontal micro-patterns were discerned. The statistical analysis of the quad by quad artifact finds which is planned as a study separate from this Thesis, however, may eventually provide information of this kind.

Summary and Discussion:

The cultural deposit at the Kalgan Hall site is found within two superimposed sandy soils which overlie Tertiary laterite. These three sedimentary Levels are represented in both excavations and suggest relatively uniform stratigraphy in the area of the site where they are located. A basic summary of the structure of the cultural deposit and its dating is shown on Figure 5.8 where the two trenches have been aligned using the top of the Layer II humic horizon as a guide.

Each trench covers a somewhat different time span, but their sequences overlap during most of the middle to late Holocene; and using the information provided by both trenches it is possible to suggest a rough history of occupation at the site. It began to be frequented sometime in the late Pleistocene before 19000 years BP, and was frequented more-or-less continuously until, on the basis of the retouched glass artifacts in Trench 1, the ethnographic present.

At first glance the structure and dating of the deposit for Trench 2 shown on Fig. 5.8 suggests that many fewer artifacts are

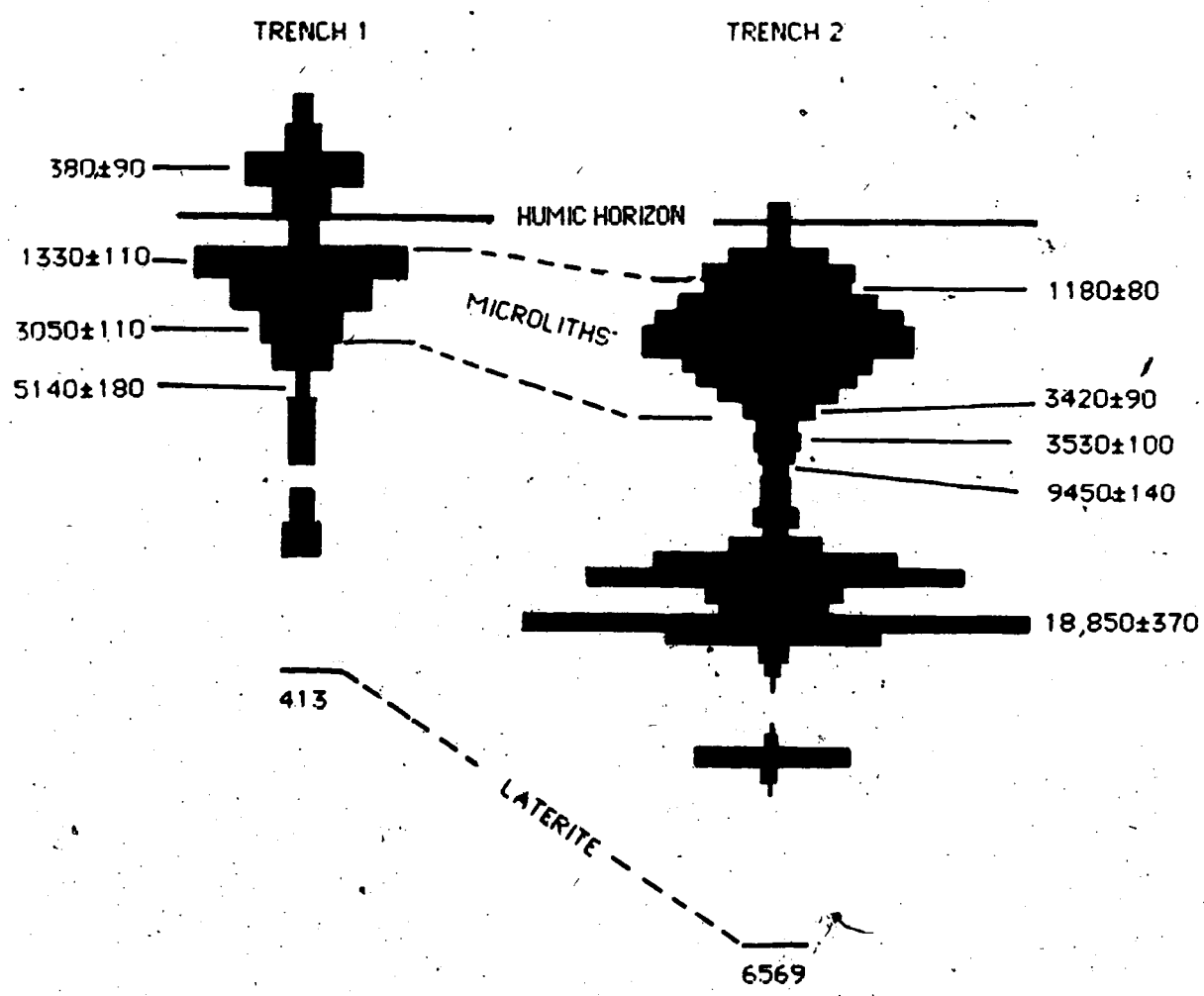


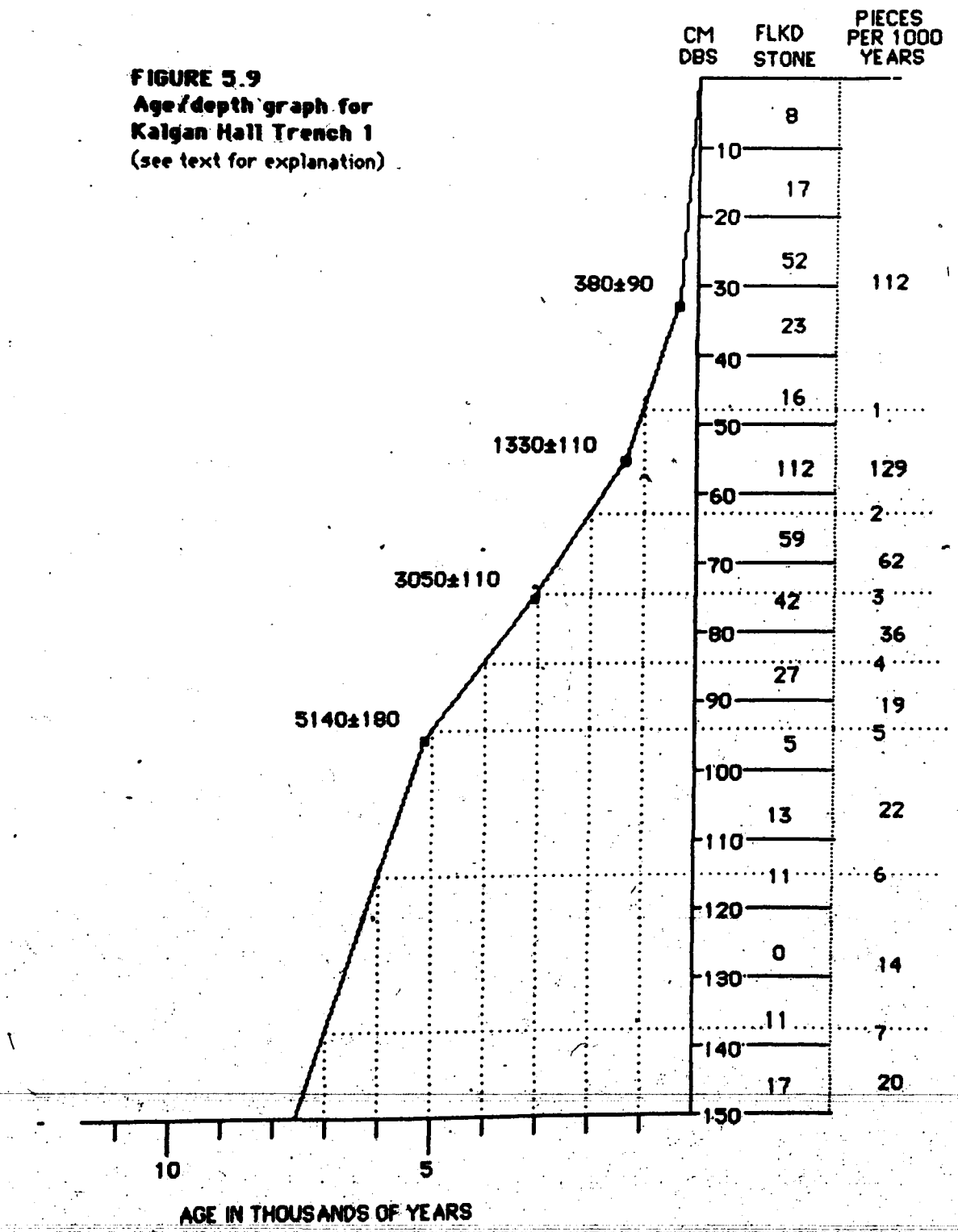
Figure 5.8. Comparison of Kalgan Hall Trenches 1 and 2:
See text for discussion.

found in the mid-Holocene levels of the trench than in those levels dated to previous or subsequent times. This would be as predicted on the basis of the mid-Holocene depopulation model, but the radiocarbon dates indicate that there have been noticeable changes in the sedimentation rate. For instance, it took almost 6000 years for the 10 cm of sediment to build up between 85 and 95 cm BD; while, immediately above it, the 10 cm between 70 and 80 cm appears to have built up in about one hundred years.

The diagram in Figure 5.8 provides an accurate picture of relative artifact density by depth of deposit, but it is quite a false picture of relative artifact density by age of deposit. As will be seen, radical shifts in the sediment deposition rate are quite common in Australian Southwest sites, and some control for this variable must be established before an analysis comparing the relevant time periods can be undertaken.

Depth/Age Graphs: The first step in the analysis of the relative artifact density sequence for each trench is the construction of a depth/age graph (Hughes 1977, Hughes and Djohadze 1980). This is a simple mechanical device which controls for sedimentation rate, and enables the artifact finds by depth to be divided into millennial increments with a degree of accuracy dependent upon the number and location of absolute dates for that sequence. Figure 5.9 shows the depth/age graph for Kalgan hall Trench 1. The depth of excavation in centimetres with the number of artifacts recovered from each spit is listed down the right side of the graph, and the age in thousands of

FIGURE 5.9
Age/depth graph for Kalgan Hall Trench 1
(see text for explanation)



years is listed across the bottom.

The radiocarbon determinations taken from the trench are then plotted onto the graph, and a "curve" is drawn to connect them. Below the lowest radiocarbon determination, the location of the curve is only an estimate based on the average sedimentation rate above that date. This practice differs from that of Hughes who projected a true curve below the lowest radiocarbon date to estimate the earliest occupation of the site. Since neither method is subject to verification without further dates, both are equally valid, and this one tends to dampen criticism that too great an age is being claimed for a deposit.

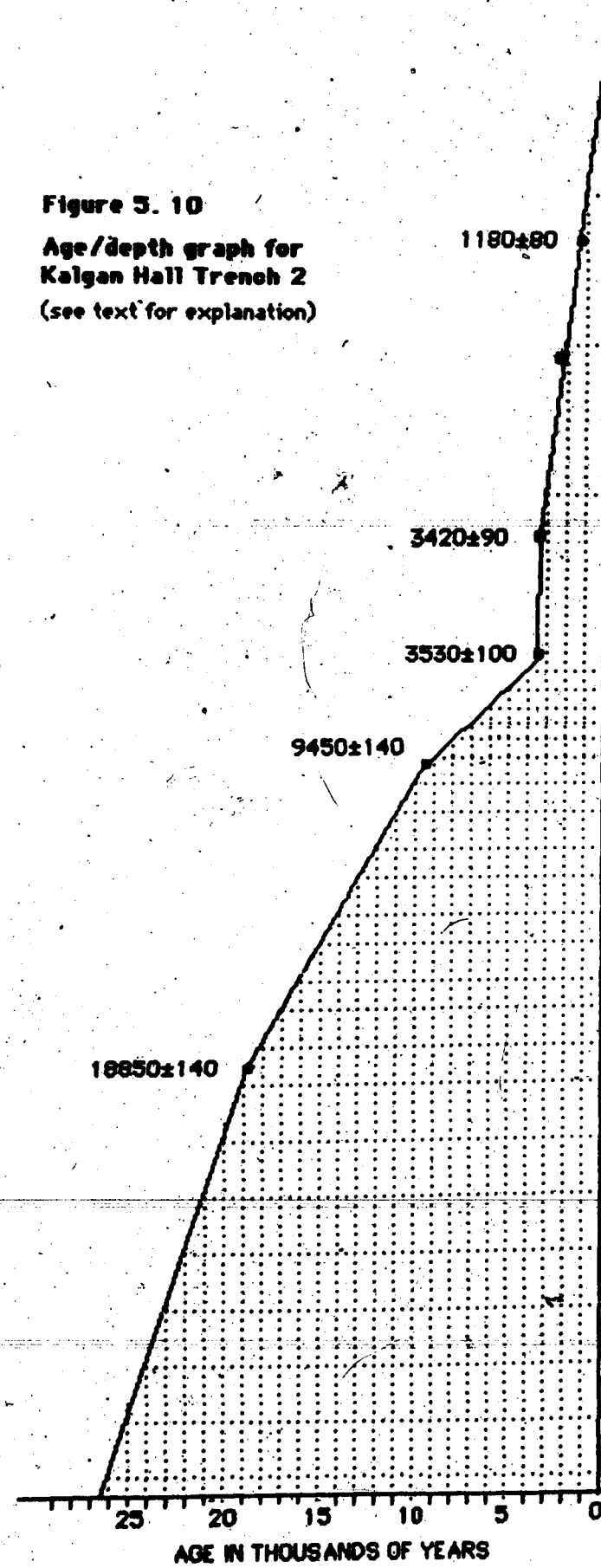
After the curve is plotted, it is a simple mechanical procedure to fix the artifact finds onto an absolute time scale. A line is first drawn vertically from the millennial increments at the bottom of the graph to the curve, then horizontally to divide off the depth of the deposit included within that increment. Finally the number of artifacts found within each increment is totalled, with artifacts from spits which cover parts of two or more millennia being divided proportionally. In situations where trench area varies with depth, as in Kalgan Hall Trench 2, it is necessary to multiply the total of artifacts from each spit by a constant, before dividing into millennial increments, if the totals are to be statisically comparable (Fig. 5.10).

The depth/age graph is a model of what artifact finds per millennium would be, *if* sedimentation rates remained constant between radiocarbon dates. It provides the best possible estimates of age for the various levels of artifacts that are obtainable on

Figure 5. 10

Age/depth graph for Kalgan Hall Trench 2

(see text for explanation)



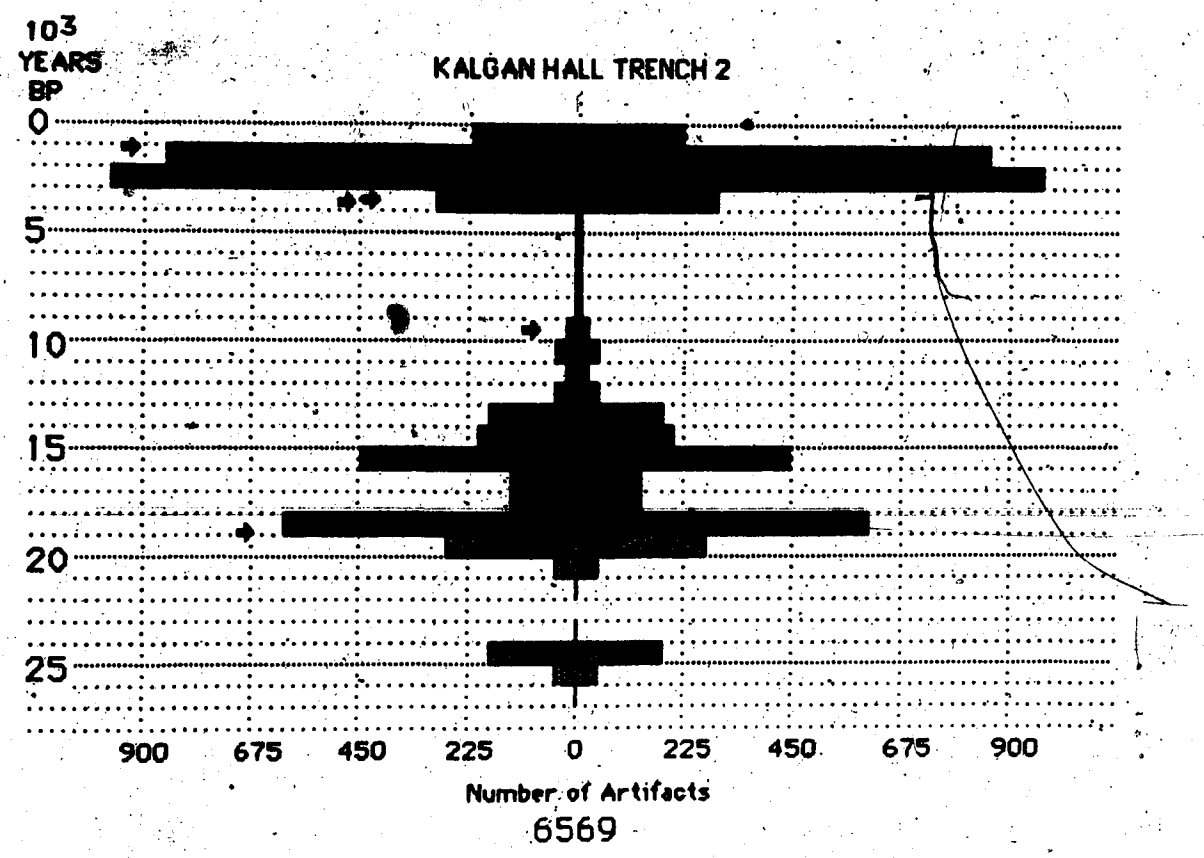
CM below datum	M^2	FLKD STONE	$\times 16/M^2$	PIECES PER 1000 YEARS
	8	19	38	
10	12	40	53	
	12	45	60	505
	16	262	262	
20				1
	16	367	367	
	16	340	340	
30				1924
	16	510	510	
	16	631	631	
40				2
	16	672	672	
	16	668	668	
50				2166
	16	496	496	
	16	419	419	
60				3
	16	314	314	
	16	138	138	
70				667
	16	98	98	
	16	107	107	
80				
	16	89	89	
				4
	10	33	53	5
90				6 ≈ 28 each
	4	17	68	7
				8
	4	18	72	9 54
100				10
	4	30	120	11 104
	4	15	60	12 68
110				
	4	36	144	13 80
	4	153	612	14 378
120				15 451
	4	278	1112	1013
	4	89	356	16 310
130				17
	4	75	300	18 300
	4	336	1344	19 1344
140				
	4	139	556	592
	4	18	72	20
150				78
	4	8	32	21
	4	2	8	8
160				
	4	0	0	22
	4	0	0	0
170				23
	4	1	4	14
	4	5	20	24
180				402
	4	98	392	25
	4	11	44	48
190				
	4	2	8	26 4

current information. Because the possibility of some undetected change in sedimentation rates is always present, it is not a perfect model. However, no more reliably accurate model can be produced unless further dates for a sequence are obtained; and for the excavations in Mokaré's Domain, dates were obtained at every level where sufficient charcoal was available.

The depth/age graph is most accurate, but as a model it fails to provide the desired visual impact and immediate understanding such as is gained through the use of the artifact density sequence diagrams like those in Figure 5.8. The column of numbers which results from using the graph is satisfactory for statistical procedures, but some sort of graphic display is necessary as an aid to the discussion.

Millennial Density Models: Millennial density models provide a graphic display of the data generated by the depth/age graph. They were developed for use in this thesis and considerable care was taken so that, at a glance, they provide complete information about both the temporal structure of the sequence and of the comparative reliability of the data. Figure 5.11 is the millennial density model for Kalgan Hall Trench 2. It is similar in concept to a "battleship curve", and reminiscent of the artifact density sequence diagrams; only here it is the millennial artifact totals from the depth/age graph, instead of the artifact finds by depth, being shown in their relative proportions.

The comparative reliability of these models is dependent upon the number and placement of the radiocarbon dates and on the



6569

Figure 5.11. Millennial Density Model for Kalgan Hall Trench 2:
See text for explanation.

absolute size of the artifact sample being analysed. The total of artifacts in the sequence is written in larger numerals at the bottom of the model. Figure 5.11 displays the largest individual sample of the trenches from Mokaré's Domain, and it should be more accurate than those models which represent only a few hundred artifacts. It is also controlled by five radiocarbon determinations which are placed so that the basic structure of the sequence is unquestionable. That part of the sequence where the sedimentation rate is controlled by radiocarbon dates is shown in black; and that part which lies below the lowest date, where the sedimentation is merely a projected average of the levels above, is shown in lighter shading. The locations in time of the individual dates, the control points of the model, are indicated by the small arrows along the left side of the sequence. The horizontal scale at the bottom is approximate and shows the millennial totals after the various levels have beeen multiplied by a constant.

The millennial density model for Kalgan Hall Trench 2 (Fig. 5.11) displays an overall form which will be seen to be typical of Australian Southwest sites which cover the entire Holocene period. There are two temporal concentrations of artifacts; one within the last four thousand years, and one between about thirteen and twenty thousand years ago. Between these two concentrations, there is a long period in which relatively few artifacts were dropped in the area of the excavation.

That part of the sequence above about 10,000 BP is well controlled by radiocarbon dates. For these levels, there can be little

question that the appearance of the model quite closely reflects reality. The bottom of the upper concentration of artifacts is securely dated; and, although there are six thousand years between the dates in the fourth millennium and the next lowest date, there are so few artifacts in this period that it would not significantly change the basic proportions of the model even if the sedimentation rate was very erratic and they were all deposited during the same millennium. The only probable anomaly is the under-representation of artifacts in the last millennium BP which results from the pre-excavation removal of the soil above the Layer II humic horizon.

Between about 10,000 BP and the bottom of the sequence there is less control over the sedimentation rate, and the relative millennial densities shown on the model might not be precisely accurate. There can be no question that between about 10,000 BP and 19,000 BP many more artifacts were deposited in the area where the trench is located than in the subsequent early and mid-Holocene periods. The average find rate between 19 and 10 thousand is 450 artifacts per millennium; 1400 percent greater than the average find rate of 32 artifacts per millennium in the period from ten to four thousand BP. It remains uncertain, however, exactly when this dramatic decline occurred.

The model suggests that if sedimentation rates were relatively constant, the decline would have taken place around 13000 BP, but this is only an estimate. All that can be said in confidence is that some time after about 19,000 BP, but before about 10,000 BP, rates of artifact finds decline to less than 10 percent of their previous

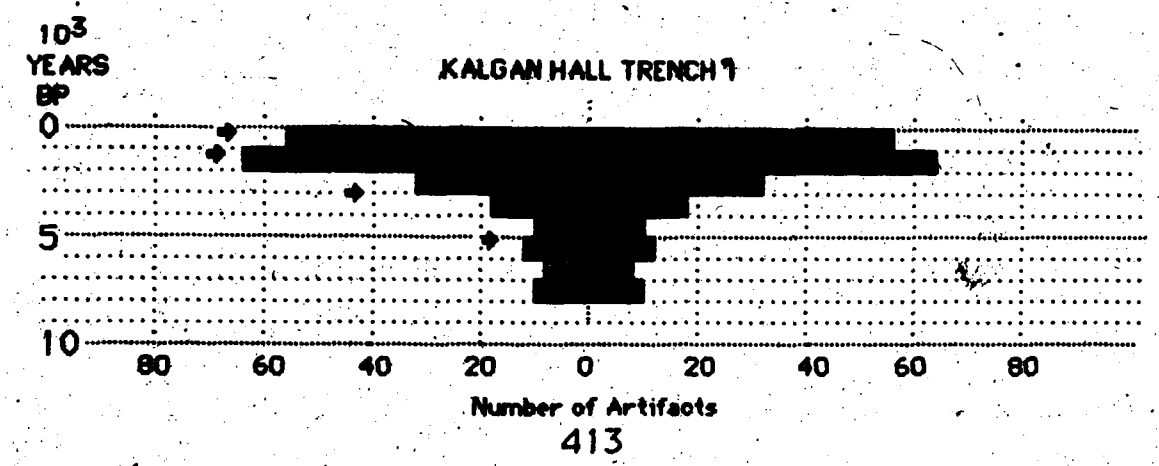


Figure 5.12. Millennial Density Model for Kalgan Hall Trench 1:
See text for explanation.

levels; and these low rates are maintained until about 4000 BP when, over two millennia, they suddenly increase by appoximately 7500 percent.

For all the sites investigated there is the possibility that the portion which was excavated does not supply an adequate sample of the past occupation over time. It is possible, for instance, that during the early and middle Holocene at Kalgan Hall, occupation continued as before, but the precise location was somewhat different, and it is not represented in this trench. The possibility cannot be conclusively eliminated, but the other trench, Trench 1, has a millennial density model similar to Trench 2, as far as it goes (Fig. 5.12), and supports a suggestion that this is probably a site-wide phenomenon. It is a large site, however, and further tests of this suggestion would be desirable.

The Moorillup Pool Site:

Excavations were undertaken at both the upstream and downstream ends of the large site surrounding Moorillup Pool (Figure 5.13). The area of the site slopes slightly toward the river and the natural woodland vegetation has been almost entirely replaced by paddocks with reasonably thick sod (Figs. 5.14 and 5.15). Disturbance of the surface levels of the site has been extensive. Virtually the entire area of the site has been ploughed on more than one occasion to a depth of 12 to 20 cm; and, in the 1920's (Mr. A. Kelly - *pers. comm.*), the west end of the site north of the river was put under

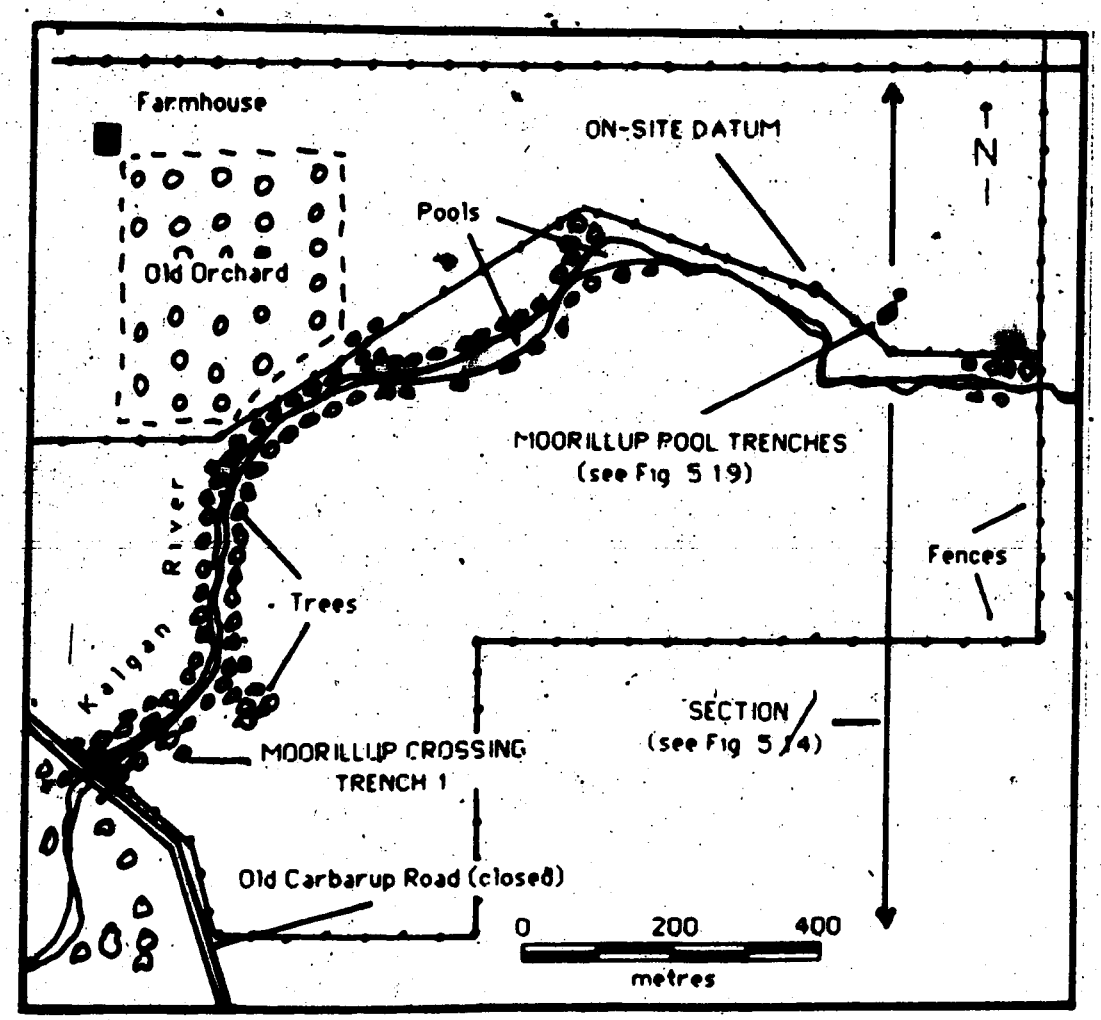


Figure 5.13. Map of Moorillup Pool Site:

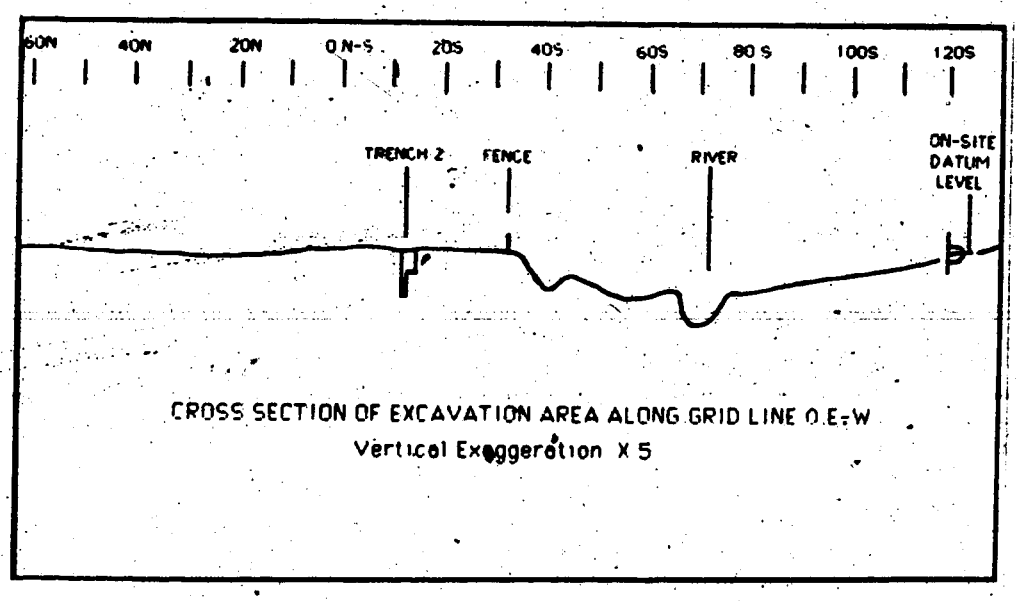


Figure 5.14. Cross-Section of Moorillup Peel Site:
The location of the section is shown on the map, Figure 5.13. Only the central portion of the section is shown in this illustration. The grid across the top of the drawing is in ten metre increments.

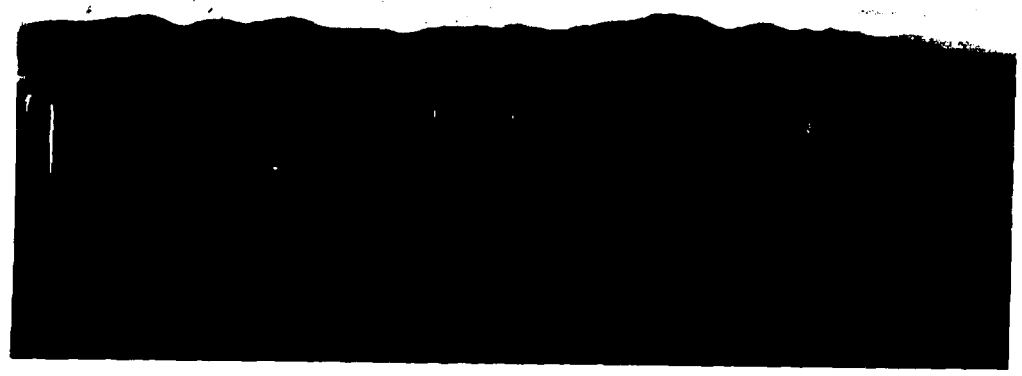


Figure 5.15a. Moorillup Pool Site area I:
The photograph was taken looking north from the lower slopes of Carbarup Hill across the Vale of Kalgan to the Stirling Range in the distance. The Moorillup Pool site is in the centre distance, about two kilometres distant from the photographer.

Figure 5.15b. Moorillup Pool Site area II:
This photo was taken looking southwest across the site. The trench in the foreground is Moorillup Pool Trench 2 and 2A. The Moorillup Crossing trench was sited near the line of trees in the far distance, almost directly behind the figure.

mixed orchard, part of which still remains.

An on-site datum was established as the uppermost point on the head of a large spike driven into the west side of a very large strainer post in a fenceline just north of the river on the east end of the site (Fig. 5.13). Since the excavations were carried out so far apart, two secondary on-site datum stakes tied into this point were used to locate the trenches and as a basis for the grid established over the east end of the site (see below). A problem existed because there is nothing within about a kilometre of the centre of the site which is both permanent and visible enough to serve as an off-site datum. The problem was solved through the volunteer efforts of a professional surveyor who tied the excavations into the Plantagenet Shire Plat (see Appendix B).

Moorillup Crossing Test Trench 1

Moorillup Crossing Trench 1 is a 1 x 1 metre test excavation set out between 832 and 833 m west and 627.5 and 628.5 m south of the on-site datum. This is on the south side of the River near the western end of the site in an area of paddock. The sod was removed to approximately 5 cm below the surface and the trench excavated with trowel and dust pan in 10 cm spits to a depth of 140 cm. All depths given are from the surface at the SW corner of the trench. All excavated sediments were dry sieved through a 2 mm screen.

The stratigraphic sequence is composed of two sediments (Fig. 5.16). Layer I is a fine aeolian sand. (Table 5.5) It is brown to dark brown in the weakly developed humic horizon, but lightens to a very

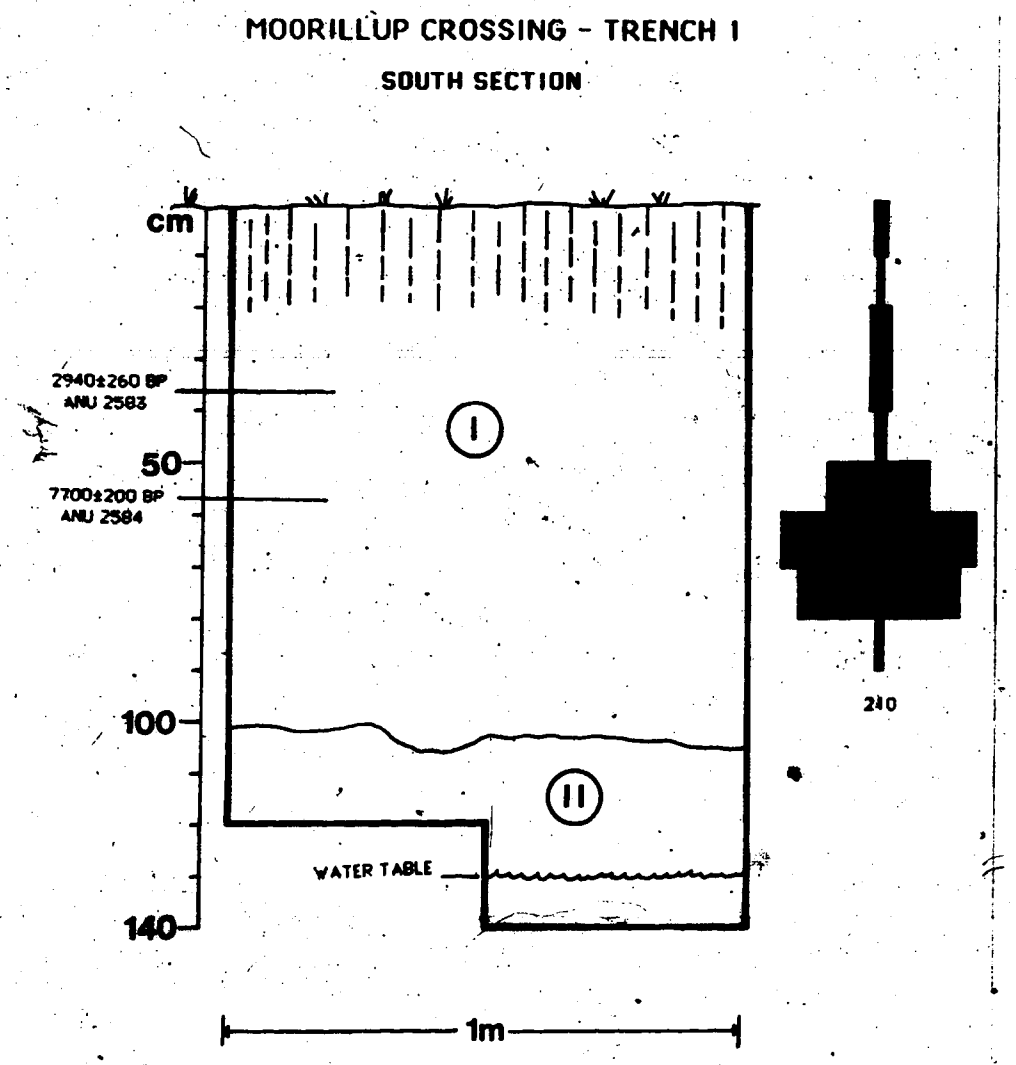


Figure 5.16. Section and Density Sequence Diagram of Moorillup Crossing Trench 1: See text for explanation of sediments.

TABLE 5.5. MOORILLUP CROSSING TRENCH 1 PHYSICAL DESCRIPTION OF SEDIMENTS

SAMPLE Cm DBS	MUNSELL COLOUR (DRY SAMPLE)	GRAIN SIZE* 0	1	2	3	4	>4	COMMENTS
10 (Level I)	10 YR 4/3 brown to dark brown	1	5	30	41	19	4	fine sand of sub-angular to sub-rounded quartz grains with large amounts of organics and charcoal. Slightly acid (pH 5.5).
50	10 YR 5/1 very pale brown	1	4	24	44	23	4	as above.
90	10 YR 8/4 very pale brown	T	3	28	49	17	3	as above but with less organics and charcoal. (pH 5)
110 (Level II)	10 YR 8/4 very pale brown	1	9	48	33	8	1	medium sand of sub-angular to sub-rounded grains with only a trace of charcoal. (pH. 6)
130	10 YR 7/4 very pale brown	1	12	55	26	5	1	as above.

*shows percentage of 50g dry subsample caught in 0,1,2,3,& 4 Ø sieves after shaking on an "Endrock" mechanical sorter for 15 minutes.

pale brown with depth. Root penetration is only in the top 20 cm, small amounts of charcoal are present to 70 cm DBS, and some light and variable iron staining is evident below 35 cm D.B.S. Layer II is a medium grained alluvial sand, which is also very pale brown in colour. It is minimally 40 cm thick but continues below the water table. Since excavation was terminated at this point the ultimate depth of the stratum and what lies beneath it is unknown.

Cultural Materials: A total of 215 flaked stone artifacts and five pieces of ochre were recovered from the trench (Table 5.6). Artifacts were present from just below the surface to 83 cm DBS in Layer I. No artifacts were found in Layer II. Backed microliths were present between 20 and 40 cm DBS, but finds were generally relatively sparse until about 50 cm DBS. Most of the artifacts are found between that depth and the bottom of the sequence (Fig. 5.16 - density sequence diagram).

Radiocarbon Dates Two charcoal samples were submitted for dating. A date of 2960±260 BP (ANU 2583) was received for the spit 30 to 40 cm DBS which contained the lowest microlith found in the trench. The lowest charcoal in quantity suitable for dating was found between 50 and 60 cm DBS. It produced a date of 7700±200 BP (ANU 2584), which dates the top of the main artifact concentration in the trench (Fig 5. 16).

TABLE 5.6. MOORILLUP CROSSING TRENCH 1 ARTIFACT FINDS BY DEPTH BELOW SURFACE*

CM	FLAKED STONE														OTHER					
	DEBITAGE						IMPLEMENTS						TOT	TOT	ARTIFACTS					GRAND
DBS	RM	CP	FK	FF	CO	BC	ML	SI	CI	AX	PI	MI	IMP	FLKD	GP	MP	E	OCR	TOT	TOT
10	0	2	3	1	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	6
20	0	1	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3
30	0	2	3	0	1	0	1	0	0	0	0	0	1	7	0	0	0	0	0	7
40	0	5	2	0	0	0	1	0	0	0	0	0	1	8	0	0	0	0	0	8
50	0	3	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4
60	0	28	10	0	0	0	0	0	0	0	1	0	1	39	0	0	0	2	2	41
70	0	48	27	1	0	0	0	0	0	0	0	0	0	76	0	0	0	1	1	77
80	0	29	25	10	0	1	0	0	0	0	0	0	0	65	0	0	0	2	2	67
90	0	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	119	74	12	1	1	2	0	0	0	1	0	3	210	0	0	0	5	5	215

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FK - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

Moorillup Pool Test Trench 1:

Moorillup Pool Test Trench 1 was a 1 x 1 m excavation placed between 91.85 and 92.95 m east and 10.85 and 11.85 m south of the on-site datum. This is on the north side of the river near the east end of the site (Fig. 5.13). The surface vegetation is close cropped exotic grasses. In some places nearby, the vegetation cover is patchy and some artifacts, including a small grindstone, were exposed on the surface. All depths are given below the ground surface in the southeast corner of the trench.

The sod was removed to approximately 5 cm and sieved through a 2 mm mesh. Excavation proceeded in 10 cm spits to a depth of approximately 60 cm DBS where a significant stratigraphic change was noted. Two natural strata were then removed as units to a depth of approximately 80 cm DBS, and subsequently the southeast quarter of the trench was taken down in 10 cm spits to a depth of 132 cm.

Moorillup Pool presents a more complex stratigraphy than the other sites excavated in Mokaré's Domain. In this pilot excavation, five strata were provisionally identified, and these are described in the caption of Figure 5.17. However, a re-analysis was conducted at the subsequent and immediately adjacent area excavation, Trench 2, which produced a better understanding of these sediments. This is presented below with the discussion of that excavation..

Cultural Materials: Three hundred and thirty one flaked stone artifacts were recovered in Moorillup Pool Trench 1 (Table 5.7). All but three of them were recovered from Layer I and the majority of

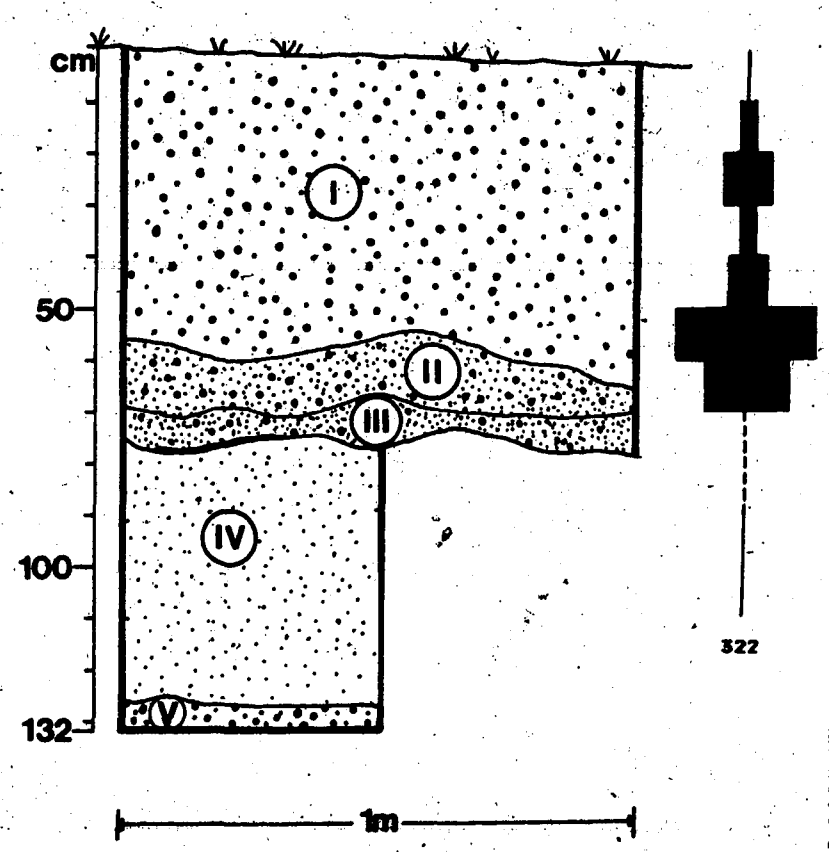


Figure 5.17. Section and Density Sequence Diagram of Moorillup Pool Trench 1: The section shows the first attempt at describing the stratigraphy from Moorillup Pool. Layer I is a brown fine sand, Layer II is a yellow brown sandy clay, and Layer III is another similiar clay which is less sandy, lighter and more yellow in colour. Layer IV is a very hard dark greyish brown clay. On its surface there are patches of a white calcareous clay and there are solid elongated vertical carbonate concretions streaming down through it. Layer V is a medium yellow brown sand. Further excavations in the area provided a significantly different interpretation of these sediments (See Fig. 5.20).

TABLE 5.7. MOORILLUP POOL TRENCH 1 ARTIFACT FINDS BY DEPTH BELOW SURFACE*

CM	FLAKED STONE														OTHER					
	DEBITAGE						IMPLEMENTS						TOT	TOT	ARTIFACTS					GRAND
DBS	RM	CP	FK	FF	CO	BC	ML	SI	CI	AX	PI	MI	IMP	FLKD	GP	MP	E	OCR	TOT	TOT
10	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
20	0	9	4	2	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	15
30	1	22	17	5	0	1	0	0	1	0	0	0	1	47	0	0	0	0	0	47
40	1	5	9	0	0	0	0	0	0	0	0	0	0	15	0	0	0	1	1	16
50	0	15	21	1	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	37
60	0	76	45	4	0	1	0	1	0	0	0	0	1	127	0	2	0	1	3	130
70	0	40	31	5	0	1	0	0	0	0	0	0	0	77	0	3	0	2	5	82
100	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
110	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
120	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
132	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	168	129	18	0	3	0	1	1	0	0	0	2	322	0	5	0	4	9	331

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FL - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

those (213) were found in a band, approximately 5 cm thick, overlying the interface with Layer II. Figure 5.18 shows a plan of this area: 59 artifacts were found in situ and 154 were recovered from the sieve. Also in this area were two large patches of charcoal and ash which were interpreted as hearth areas, three pieces of ochre, and five manuports.

At this level an intensive attempt was made to find the post holes which could provide evidence of camping patterns similar to those of the ethnographic Nyungar. This resulted in the featuring of 38 wormcasts, root casts, charcoal stains and clay balls. These efforts were not entirely fruitless, however, since one provisional post hole was eventually found within the central hearth area. (Fig. 5.18). It went approximately 8 to 9 cm down into the clay of Layer II, was 1.1 cm in diameter, and tapered to a point. It was infilled with a dark brown sandy sediment.

The discovery of this single post hole suggested that camping patterns might be identifed here if enough area was excavated. Further, the presence of three artifacts well down in the clay in association with traces of charcoal suggested a much more extensive investigation of this deposit was warranted. Consequently, an area excavation was planned for the immediate vicinity. Because the extremely hard clay sediments were very difficult to excavate within the confines of a 1 x 1 metre test trench, this excavation was abandoned. No microliths were found in this trench, and no charcoal samples were submitted for dating.

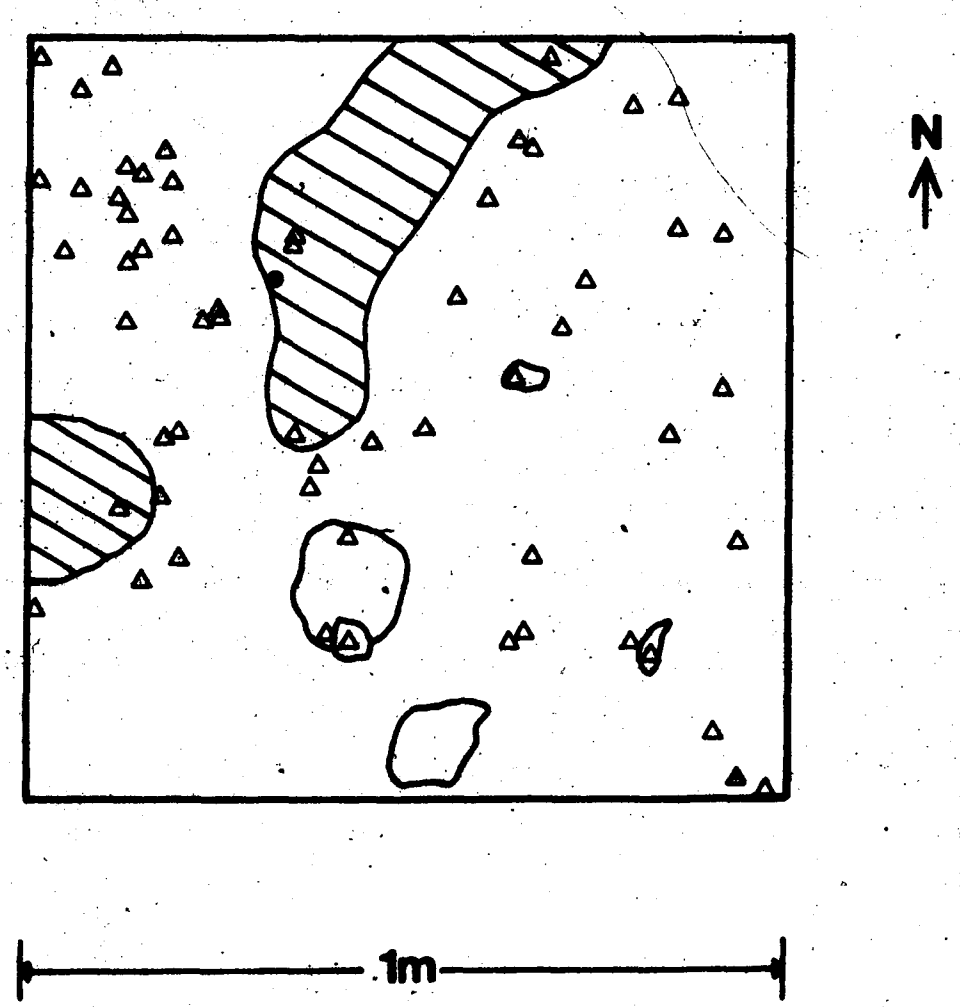


Figure 5.18. Plan of Meerilup Pool Trench 1 at interface of sand and clay layers: The plan shows the locations of the 59 artifacts found *in situ* as small triangles. The shaded areas are concentrations of charcoal and ash, and the hollow encircled areas are large manuports. The single post hole found on this level is shown by the black dot within the hearth area in the central upper left. 154 other artifacts from this level were recovered from the sieve.

Moorillup Pool Area Excavation Trench 2:

A secondary on-site datum stake was driven into the ground 92 m east of on-site datum shown on Figure 5.13. This stake served as the 0 N-S/0 E-W point for a metre grid established over this section of the site. Trench 2 at Moorillup Pool was originally planned as a 4 x 4 metre area excavation set out 14 to 18 m south and 4 to 8 metres west of this secondary on-site datum (Fig. 5.19). However, unexpected variations in the stratigraphy encountered during the excavation necessitated changes to this plan. Only the northeast 2 x 2 metre square of the original plan was excavated, and an extension, Trench 2A, to the east and north was added. This resulted in the 12 metre square "Z" shaped excavation shown on the diagram. In the discussion below, all depth "BD" are given below on-site datum.

The surface of the ground where the trench is located slopes downward to the south and west. Table 5.8 shows the surface elevations below the on-site datum at the grid intersections of the trench. The sod was removed to a depth of approximately 5 cm below the surface and sieved. Excavation was in 5 cm. arbitrary spits within the sand described as Layer I in the test excavation, and the totality of this sediment was removed to the surface of the clay.

In the northeast corner of Trench 2A, square 12S/00W, a 1 x 1 metre sondage was excavated in 10 cm spits from the surface of the clay to the ground water table at approximately 200 cm. BD. As the section (Fig 5.20) reveals, the stratigraphy appears considerably more complex that that described for the test excavation, and previously unnoticed divisions were found within both the sand and clay.

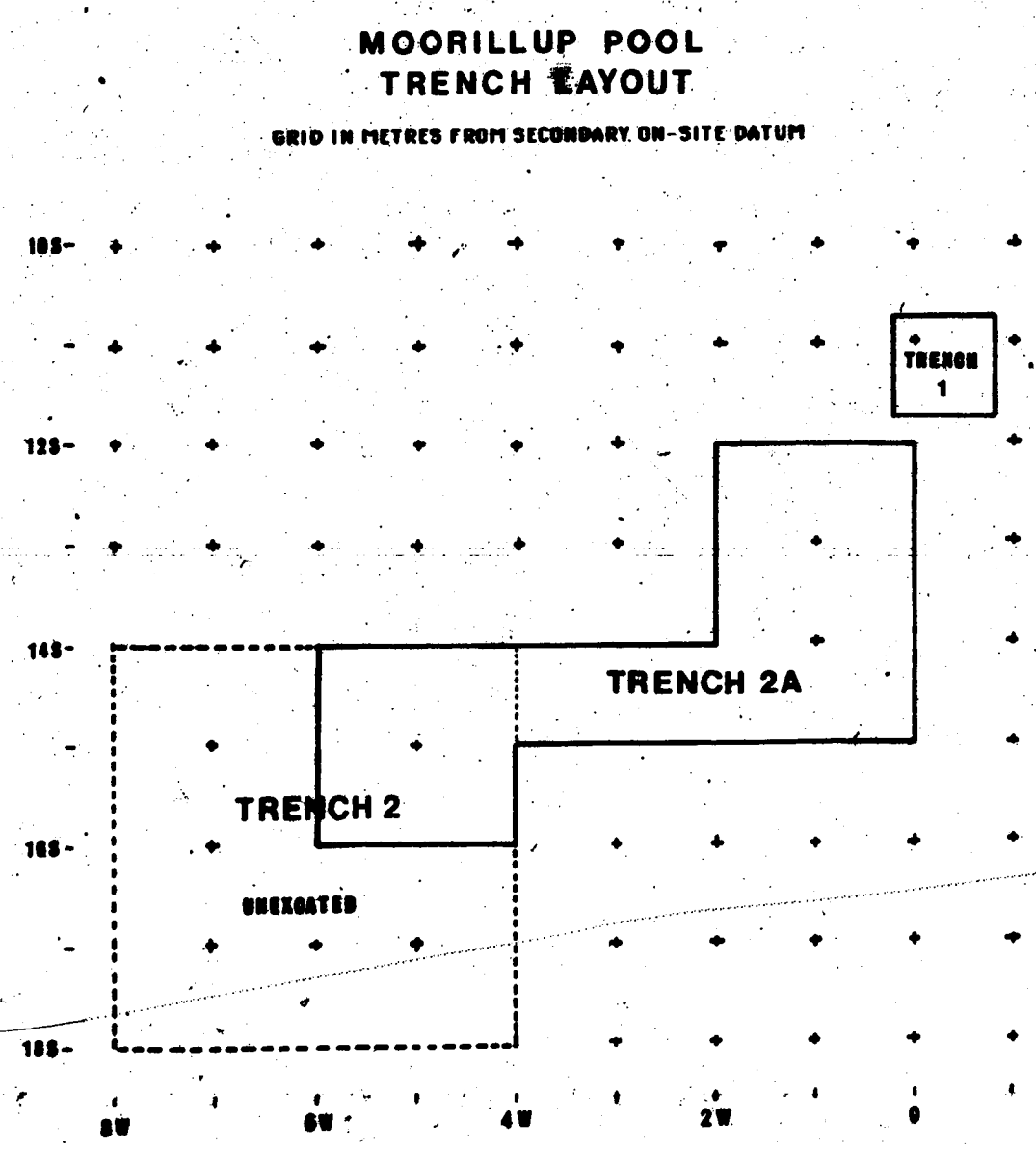


Figure 5.19. Excavation Plan of Moorillup Pool Trench 2and 2A: The plan shows part of the grid established over the east end of the Moorillup Pool site, and the locational relationship of the two trenches. Surface heights of the relevant grid intersections below the on-site datum are shown on Table 5.8.

Table 5.8: Surface elevations below Moorillup on-site datum at Moorillup Pool Trench 2 and 2A grid intersections.

GRID SOUTH	WEST	CM BELOW DATUM
12	00	3.0
12	01	5.0
12	02	5.0
13	00	4.0
13	01	7.0
13	02	10.0
14	00	8.0
14	01	9.5
14	02	13.0
14	03	14.0
14	04	17.0
14	05	20.0
14	06	22.0
15	00	7.0
15	01	10.0
15	02	13.5
15	03	16.0
15	04	17.0
15	05	20.0
15	06	21.0
16	04	17.0
16	05	19.0
16	06	23.0

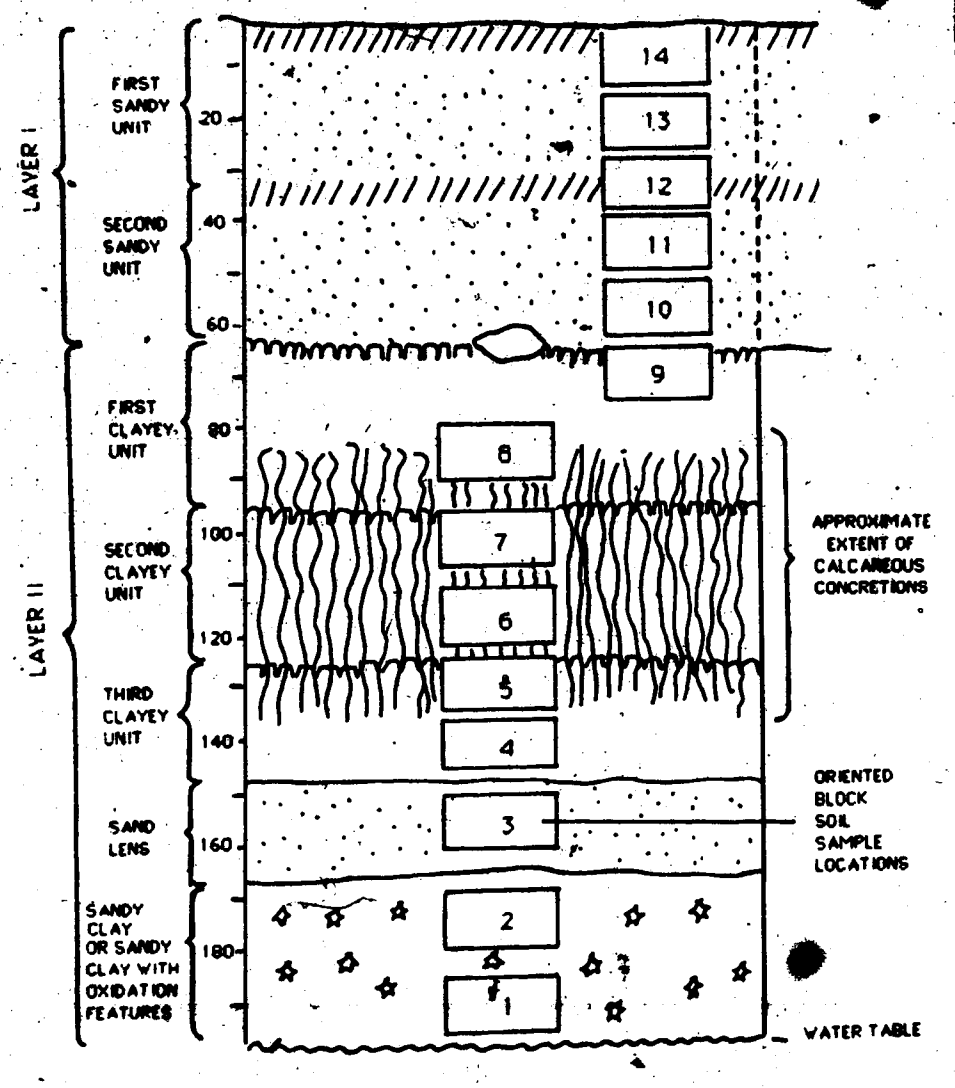


Figure 5.20. Section of Moorillup Pool Trench 2A:
See text for discussion

Although oriented column block and loose soil samples were taken, these have not yet been fully analysed, so for this still preliminary discussion, the sediments have been divided into two major strata. The sands from the ground surface to the clay interface are nominated as Layer I and the entire clay complex is Layer II.

Within Layer I there are two units divided by a very faint humic horizon which can be seen in most areas of the trench when the lighting is suitable, and which was identified by its increased organic component during the analysis of the sand (Table 5.9). The only other variation to the generally uniform nature of this layer is the inclusion of a clay lens. This extends into the trench in square 12S/01W between 40 and 80 cm BD, and is discussed below.

Within Layer II, five units have now been tentatively identified. The sand encountered at the bottom of Test Trench 1 is now known to be a lens since it extends into Trench 2 for only 20 cm; and the two narrow sandy-clay strata recorded at the top of the clay layer in Trench 1 are [illegible]visible in Trench 2. Here, the clay between the surface of Layer II and the top of the sand lens, at approximately 150 cm BD, has been provisionally divided into three units. However, because the structure of the sediments is obscured by a dense concentration of vertical calcareous concretions (see photo Fig. 5.21a), confirmation of the divisions awaits analysis of the column block samples. Below the sand lens, from approximately 165 cm B.D. to the water table, is clayey sand or sandy clay that contains orange oxidation features. As in the test trench, charcoal was abundant in Layer I but rare in Layer II.

TABLE 5.9. MOORILLUP POOL TRENCH 2 PHYSICAL DESCRIPTION OF SEDIMENTS

SAMPLE Cm DBS	MUNSELL COLOUR (DRY SAMPLE)	GRAIN SIZE* 0	1	2	3	4	>4	COMMENTS
15 (Level I)	10 YR 4/2 dark greyish brown	T	4	27	40	22	7	fine sand of sub-angular to rounded quartz grains with large amounts of organics and charcoal. Slightly acid (pH 6).
25	10 YR 5/3 brown	T	10	24	40	20	6	as above but with less charcoal and organics
35	10 YR 5/2 greyish brown	2	6	26	43	19	4	as above but with slightly more organics and charcoal.
45	10 YR 5/3 brown	1	5	26	41	21	6	as above but with less organics and charcoal.
55	10 YR 5/3 brown	2	7	27	39	19	6	as above.

*shows percentage of 50g dry subsample caught in 0,1,2,3,& 4 Ø sieves after shaking on an "Endrook" mechanical sorter for 15 minutes.

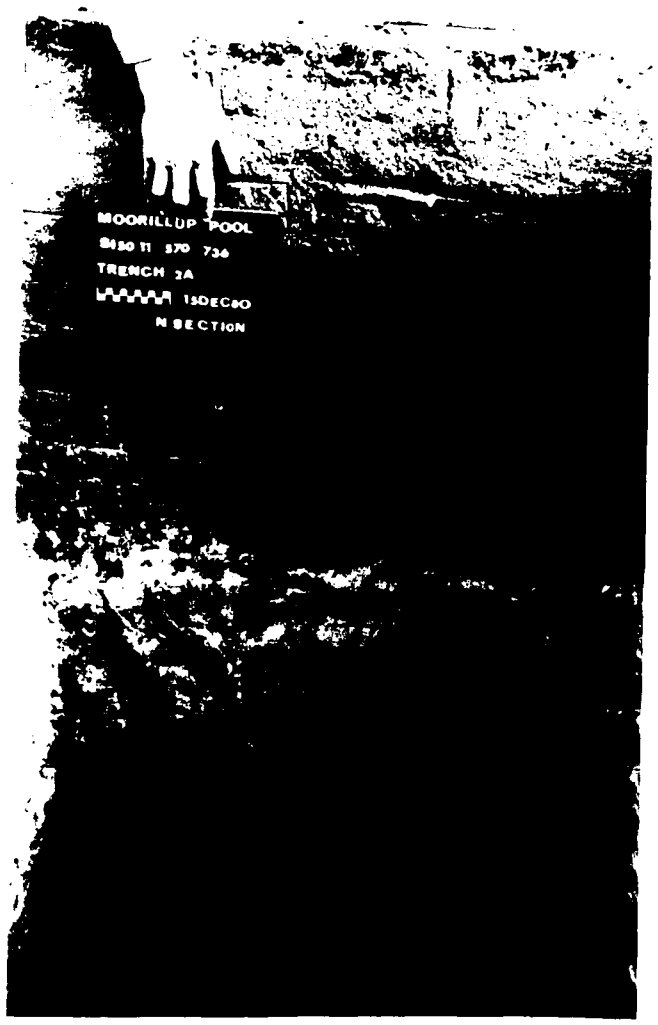


Figure 5.21a. Portion of North section Moorillup Pool Trench 2A:
The photograph shows the north section of the *sondage* in grid square 12S/00W. The lowest artifact in the Trench was taken from the hole toward the bottom of the section.

Figure 5.21b. Slope of Layer I/II interface Moorillup Pool Trench 2:
This photo shows the slope of the clay surface in the west end of the trench and the second, smaller *sondage* in grid square 15S/05W.

The depth of the Layer II surface varies considerably across the trench (Fig. 5.22). The highest point is in square 14S/03W at 66 cm B.D. To the west of this point it slopes steeply downward to a depth of 152 cm. BD in square 15S/05W. In some places this slope is nearly vertical and even undercut (Fig 5.22, section B-B), and it is possible that this area may be part of an old river bank (Fig 5.21b). East of the crest, the clay surface drops slightly and then evens out, but there is a large pit (Pit 1) dug down into it in squares 13S/01W and 14S/01W. (Fig. 23).

In almost every part of the trench, the surface of the clay was very smooth. North of Pit 1, however, this surface has been disturbed. Portions of it have been removed, and small masses of disturbed clay sediments have been either left there or dropped there (Fig 5.22, section C-C). North of this disturbed area is where the clay lens mentioned above protruded into the trench, and this lens and Pit 1 may be related.

The pit is oval, and just over one metre deep into the clay of Layer II (188 cm BD). It is approximately 75 cm wide east-west and 140 cm long north-south. It was filled with the sands of Layer I to a depth of 125 cm. BD, and below this level there is a complex of pit fill composed mostly of clay. Three separate fills were tentatively identified but have not as yet been analysed.

Pit 1 is probably a humanly produced feature. It is certainly unlike the burrow of any other animal or any known hydraulic feature of the river; and it does not resemble the basin shaped disturbance created by the roots of a tree which has been blown over. It is

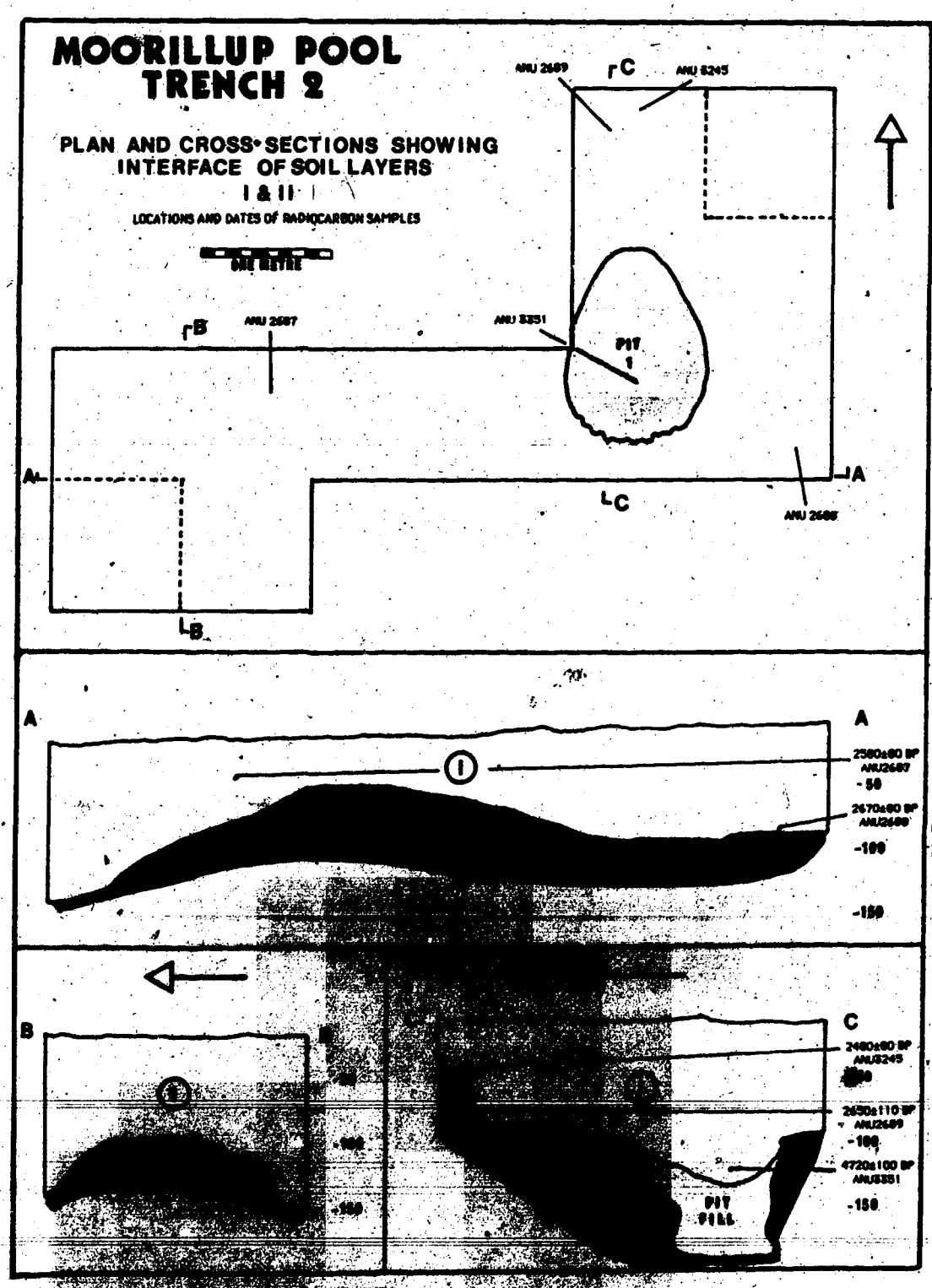


Figure 5.22. Plan and Sections Layer I/II Interface Moorillup Pool Trench 2 and 2A

Figure 5.23a. Pit 1 Moorillup Pool Trench 2A - I:
The photograph shows Pit 1 just after its discovery in grid square 14S/01W.

Figure 5.23b. Pit 1 Moorillup Pool Trench 2A - II:
This photo shows Pit 1 during final sectioning.

perhaps a well or soak, although firm evidence for this suggestion is lacking at present. Hopefully, analysis of the sediments from the pit fill and the clay lens in square 12S/01W will enable a more conclusive statement to be made.

Cultural Materials: All but 72 of the 3057 artifacts recovered from the trench were found in Layer I (Table 5.10). Density varies with depth across the trench within this Layer, and the pattern suggests that occupation may have taken place on an uneven surface which roughly followed the underlying clay surface. This can be seen in Figure 5.24 where the density sequences from each individual excavated grid square are compared; and, consequently, an over-all density sequence would be misleading. Microliths were scarce in this deposit but were found from near the surface to just above the clay.

Within Layer II of the *sondage* in 12S/00W, 53 artifacts were recovered. They are mainly concentrated within the top 25 cm below the interface, between 65 and 90 cm BD. A smaller concentration is apparent between 105-130 cm BD. Below that only three artifacts were recovered, the lowest between 180 and 185 BD (Table 5.10). A single microlith was found in this Layer, just below the interface with Layer I in 15S/05W.

Radiocarbon Dates Six radio carbon determinations have been received for Trench 2 and 2A (Figs. 5.22, 5.24). Five of these are from Layer I where charcoal was plentiful, and the last was on a small sample of charcoal taken from the Pit 1 pitfill. Small amounts

TABLE 5.10. MOORILLUP POOL TRENCH 2 ARTIFACT FINDS *

LEVEL /DBS	FLAKED STONE DEBITAGE RM	CP	FK	FF	CO	BC	IMPLEMENTS ML	SI	CI	AX	PI	MI	TOT IMP	TOT FLKD	OTHER ARTIFACTS GP	MP	E	OCR	TOT	GRAND TOT
LEVEL I																				
TOTAL	7	1664	1054	135	17	19	4	17	13	2	0	2	38	2931	1	25	2	80	108	3039
LEVEL II																				
12S/00W																				
65-70	0	6	4	1	0	0	0	0	0	0	0	0	0	11	0	0	0	1	1	12
70-75	0	4	4	1	0	0	0	0	0	0	0	0	0	9	0	2	0	0	2	11
75-80	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
80-85	0	6	5	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	11
85-90	0	1	5	0	0	1	0	0	0	0	0	0	0	7	0	0	0	0	0	7
90-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95-100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100-105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105-110	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
110-115	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3
115-120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120-125	0	2	1	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3
125-130	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
130-135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135-140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140-145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145-150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150-155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155-160	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
160-170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170-175	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
175-180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180-185	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
185-200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	20	24	3	2	1	0	0	0	0	0	0	0	50	0	2	0	1	3	53
15S/05W																				
TOTAL	1	24	12	3	0	1	1	0	0	0	0	0	1	42	0	0	0	0	0	42
LEVEL II																				
TOTAL	1	44	36	6	2	2	1	0	0	0	0	0	1	92	0	2	0	1	3	95
TRENCH																				
TOTAL	8	1708	1807	141	19	21	5	17	13	2	0	2	39	3023	1	27	2	81	111	3134

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FK - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

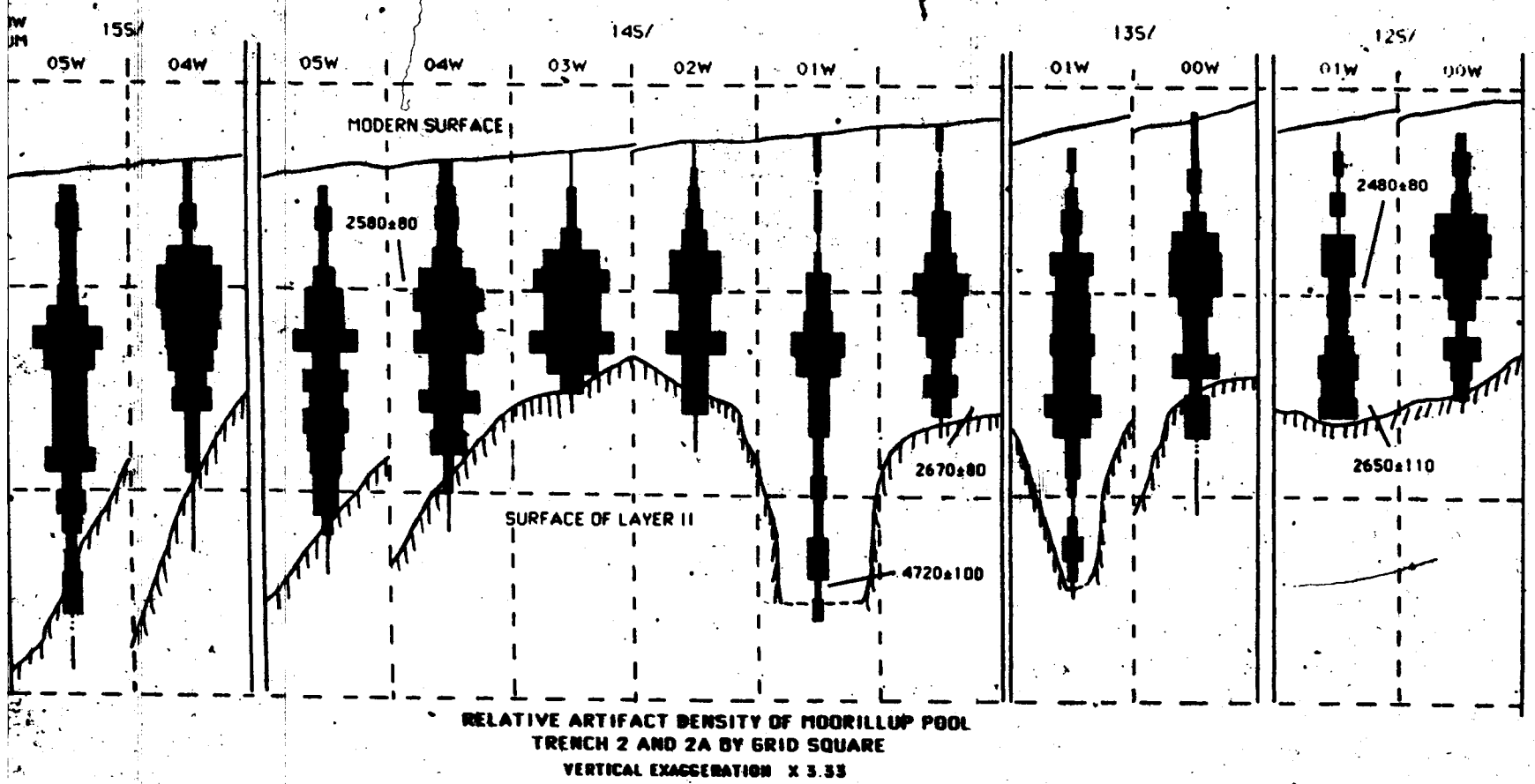


Figure 5.24. Grid square density sequences Moorillup Pool Trench 2 and 2A.

of charcoal were also recovered in Layer II to a depth of about 185 cm, but none of the samples taken was large enough to date by methods currently available at The A.N.U. Radiocarbon Laboratory (J. Head - *pers. comm*).

The radiocarbon dates for Layer I suggest that the bulk of the deposit probably built up very rapidly, in 100 to 200 years. Two samples were submitted from just above the sand-clay interface. A sample from between 75 and 80 cm in 14S/00W provided a date of 2670±80 BP (ANU 2688); and from 75 to 80 cm BD in 12S/01W, between the clay lens and the surface of Layer II, an almost identical date of 2650±110 BP (ANU 2689) was received. Likewise, two dates taken from higher up in the deposit are also quite similar. A sample taken from a hearth between 45 and 50 cm BD. in 14S/04W was dated at 2580±80 BP (ANU 2687); and one from between 45 and 50 cm BD in 12S/01W, just above the clay lens, at 2480 ±80 BP (ANU 3245).

One sample was submitted in an attempt to date the bottom of Layer I within Pit 1 between 115 and 120 cm BD. It returned a date of 4720±100 BP (ANU 3351) suggesting that the pit was at least partially filled two thousand years before the main occupation in Layer I began, and is not connected with that occupation. An attempt was made to date the clay pit-fill. A sample was submitted from between 135 and 140 cm BD in 14S/01W, but it returned a "modern" date (ANU 3244). This sample was very small, approximately 10% of the quantity needed for a confident date, and the consistency of the other dates in the trench suggests that it may somehow have been contaminated. On advice from John Head of the ANU Radiocarbon

Laboratory, it has been disregarded during the analysis of the site, but the possibility remains that the deposit may have been disturbed.

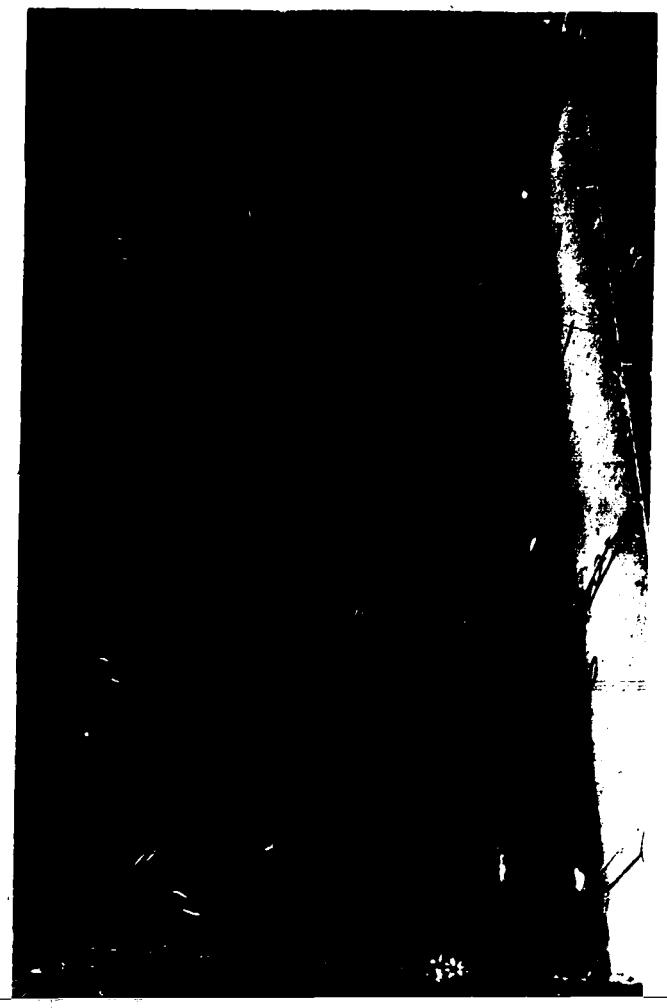
Micro Patterns: No post holes were identified in Trench 2 and 2A. Five areas of notable charcoal concentrations were encountered, and these are provisionally designated as hearths. Hearth 1, between 40-50 cm BD in 14S/04W, was initially thought to be the focus of a hearth-centred activity area (Fig. 5.25b). There is, however, no change in the sediments which might suggest that this was a "living floor", and attempts to conjoin the fragments of stone recovered from around the hearth proved fruitless. Consequently, and since there are no more artifacts at this level than in the ones immediately below it, this apparent "activity area" is possibly more a result of excavation techniques than of the original depositional situation.

The largest concentration of charcoal, Hearth 5, between 65 and 75 cm BD in 12S/00W and 12S/01W, was located at the interface between Layers I and II. This is probably an extension of the concentration of cultural materials found on the same level in the adjacent Trench 1, but there were no great numbers of artifacts associated with it.

Summary and Discussion:

Moorillup Pool is a very large and complex site. Excavations at either end of the site produced quite different sequences, and suggest that the focus of occupation changed with time. The earliest date

Figure 5.25a. Lowest artifact *in situ* Moorillup Pool Trench 2A.



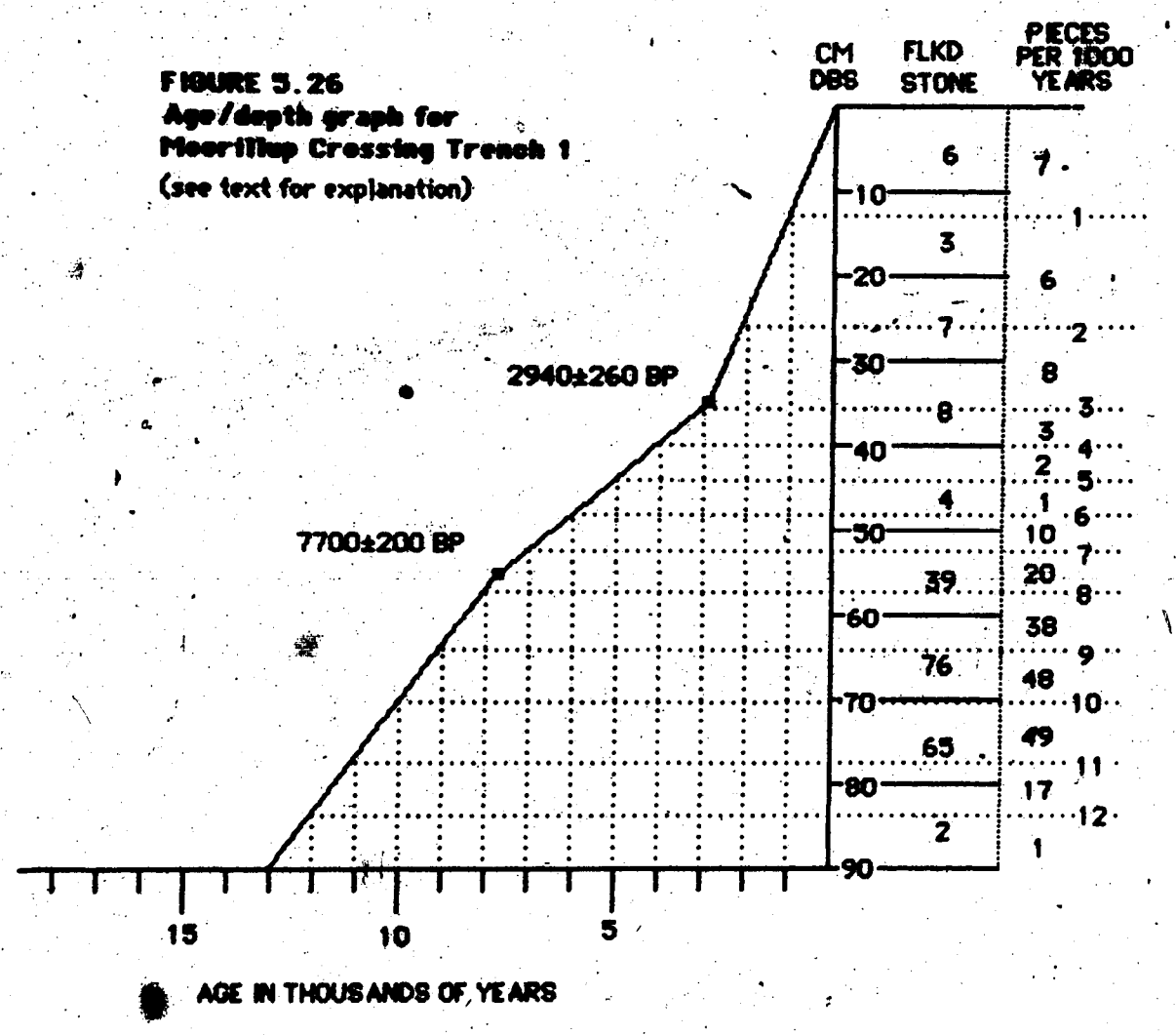
recovered was 7700±200 BP from Moorillup Crossing 1; but the bulk of the artifacts in that trench lie below this date, and the site has probably been frequented from the late Pleistocene.

At the eastern end of the site, north of the River, intensive occupation seems to have been limited to the middle of the third millennium BP. However, previous frequenting of this part of the site is suggested by the probably humanly produced Pit 1 which had already begun to fill with aeolian sands around 5000 years ago. This pit would have been dug down into the clay from at least the present surface of Layer II at sometime before that. Since the deposits now overlying the clay do not appear to date from earlier than 3000 BP, it is possible to speculate that the surface sediments present when the pit was dug and any artifacts they may have contained have been removed, possibly by scouring flood-waters. Removal must have occurred during the early to middle Holocene or before; and some occupation at a possibly much earlier period than this is suggested by the artifacts which were recovered from well down within the clay Layer.

Depth/age Graphs and Millennial Density Models: A depth/age graph (Fig 5.26) and a millennial density model (Fig 5.27) were constructed for Moorillup Crossing Trench 1. The sample of artifacts is small and the sequence is controlled by only two radiocarbon dates; but these dates are well placed so that the basic structure of the sequence is clear.

As at Kalgan Hall there are two temporal concentrations of

FIGURE 5.26
Age/depth graph for Moorillup Crossing Trench 1
(see text for explanation)



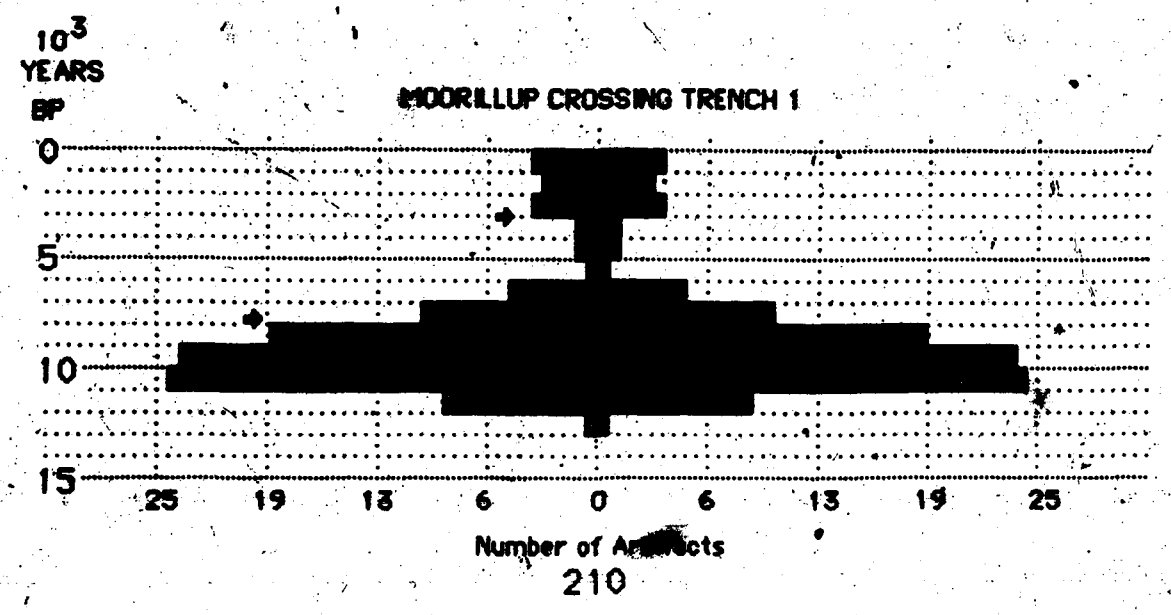


Figure 5.27. Millennial Density Model for Moorillup Crossing Trench 1.

artifacts. Here, the bottom of the smaller upper concentration is securely dated to around three thousand years BP. This is preceded by a period of relatively fewer artifact finds per millennium which probably began between six and eight thousand years ago. Preceeding that is a comparatively very large concentration of artifacts, apparently centred around the terminal Pleistocene.

There is a possibility that this lower concentration is spread out over more of the late Pleistocene millennia than suggested. There is no controlling date lower than about 8000 BP and the beginning of the sequence may have been somewhat earlier than projected on the basis of the average trench sedimentation rate. It is clear, however, that many more artifacts were deposited here during the late Pleistocene and early Holocene period than in the subsequent mid-Holocene period.

Given the relationship between the artifact find rate and relative population densities argued in the next chapter, it can be suggested on the basis of this sequence that population was relatively high around Moorillup Pool from sometime before the terminal Pleistocene until about 8000 BP. Between about 8000 BP and about 6000 BP, however, there is a 95% reduction in artifact finds per millennium; and this suggests that from then until about 3000 BP, when the find rate once again increases, the site was comparatively depopulated.

No depth/age graphs or millennial density models were drawn for Moorillup Pool Trenches 1 and 2. Over 98% of the artifacts are dated to after the third millennium, and there is a strong possibility

that some pre-5000 BP deposits have been removed. These trenches do not provide trans-Holocene sequences against which to test the model. They do, however, provide some inferential support that the upper part of the sequence from the Moorillup Crossing trench can be seen as representative of site-wide occupational phenomena during the middle to late Holocene. On this part of the site, although the deposition of the Layer 1 sands appears to have begun just after about 5000 BP in Pit 1, there is no evidence of any occupation until the massive deposition of artifacts which began after 3000 BP. This is at about the same time the Moorillup Crossing sequence experiences almost a 200 % increase in the rate of artifact finds per millennium.

This is a very large site and the sampling problem is especially acute. More excavations in other areas of it are necessary to test the picture provided by the Moorillup Crossing Trench. So far, however, there is evidence of relatively intensive occupation of the west end of the site during the late Pleistocene and early Holocene, and evidence of relatively intensive occupation of both ends of the site during the late Holocene; but there is virtually no evidence of occupation during the intervening mid-Holocene period at all.

It should be mentioned before going on to the next site that there is a noticeable difference in the times at which the depopulation appears to begin in the Kalgan Hall and Moorillup Crossing sequences. At Kalgan Hall it seems to begin sometime before 10,000 BP; and, here, not until at least 8000 BP. This will be discussed, and a possible reason for it will be suggested at the end of this chapter where the sequences from Mokaré's Domain are compared

with one another

The Waychinicup River Site:

The Waychinicup River site is located north of Cheyne Beach Road, one kilometre east of Hassell Road (Fig. 4.22). An arbitrary on-site datum was established by driving a stake into the ground behind the cutting approximately 30 m north of the centre of Cheyne Beach Road. Later, a temporary off-site datum was established by driving a spike into the first power pole west of the creek. The on-site datum is 26.33m and 330° N of this point. Two 1 x 1 m test trenches were set out in relation to the on-site datum. Trench 1 is from 2 to 3 m south and 0 to 1 m east of the on-site datum; and trench 2 is from 0 to 1 m south and 22.5 to 23.5 m west of the on-site datum (Fig.5.28).

The surface of the site in this area slopes gradually downward to the south and east. The highest (southwest) corner of Trench 1 is 16 cm lower than the highest (northeast) corner of Trench 2. Both trenches were excavated in 10 cm spits and all depth measurements are given from below the surface at the highest corner for each respective trench.

Stratigraphy - Trench 1: Trench 1 was excavated to ground water at 160 cm DBS, and the stratigraphic sequence is composed of two sedimentary layers (Fig. 5.29). Layer 1 is a white, very fine to fine sand with a silt and clay fraction of about 10% (Table 5.11a). In the upper levels it includes enough charcoal and small organic fragments to alter the sediment colour to light grey; but this

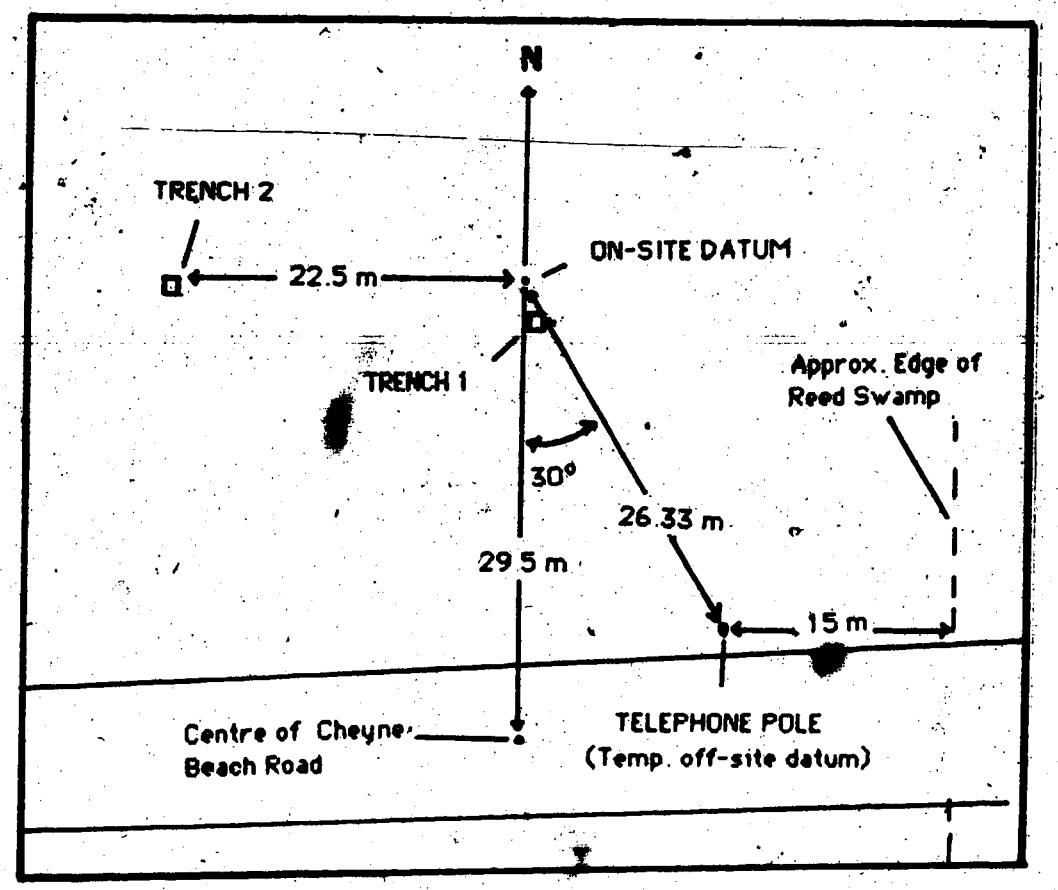


Figure 5.28. Location of Yaychiniosp River Trenches and Datum.
(See also Figure 4.23)

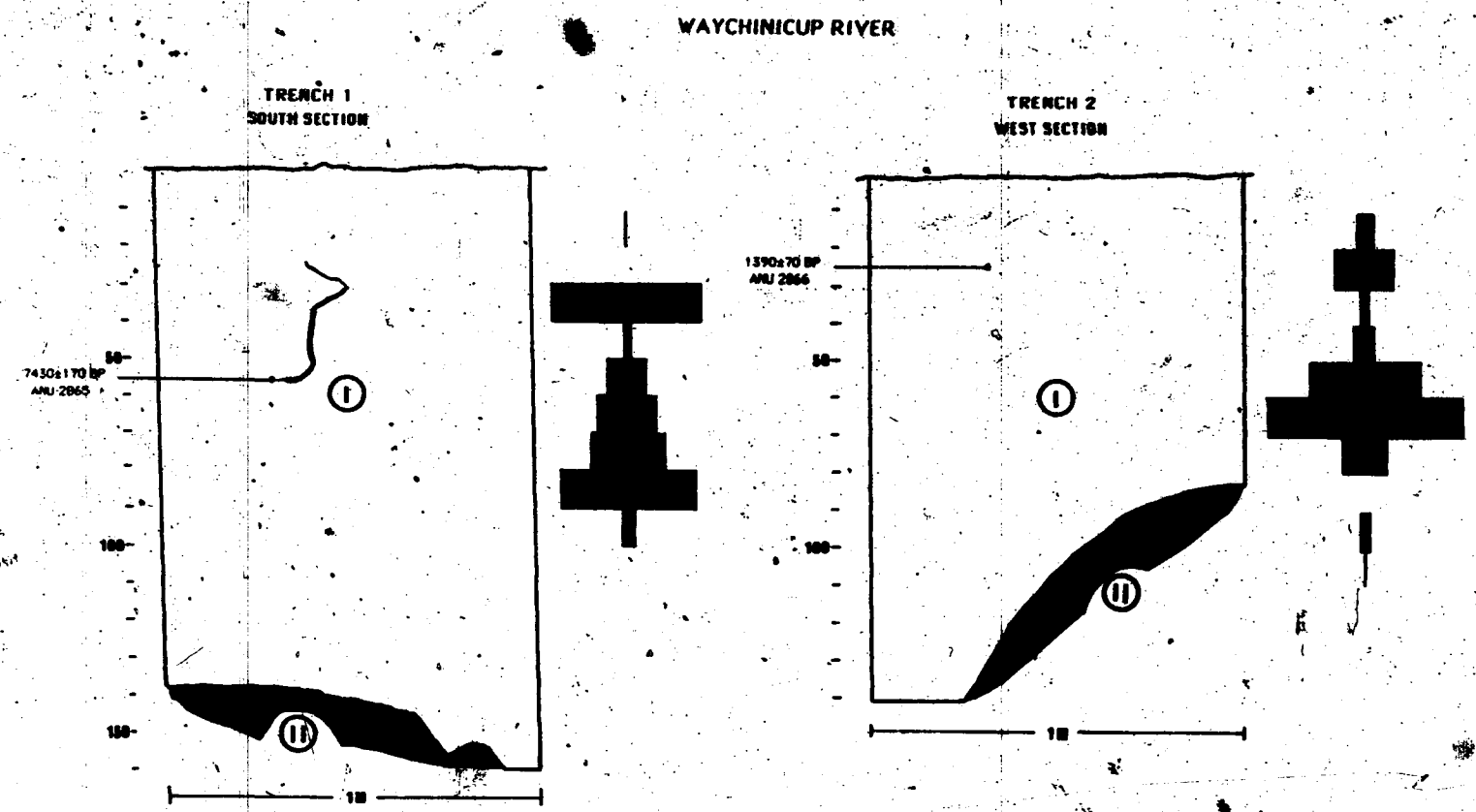


Figure 5.29. Sections and Density Sequence Diagrams of Waychinicup River Trenches 1 and 2.

TABLE 5.11a. WAYCHINICUP RIVER TRENCH 1 PHYSICAL DESCRIPTION OF SEDIMENTS

SAMPLE Cm DBS	MUNSELL COLOUR (DRY SAMPLE)	GRAIN SIZE* 0	1	2	3	4	>4	COMMENTS
20	10 YR 7/1 light grey	0	3	10	26	52	9	very fine sand of rounded to sub-rounded quartz grains with 10 to 20 % organics and charcoal. Slightly acid (pH 5.5).
70	10 YR 8/2 white	0	3	7	21	59	10	as above but with only a trace of organics and charcoal

TABLE 5.11b. WAYCHINICUP RIVER TRENCH 2 PHYSICAL DESCRIPTION OF SEDIMENTS

SAMPLE Cm DBS	MUNSELL COLOUR (DRY SAMPLE)	GRAIN SIZE* 0	1	2	3	4	>4	COMMENTS
20	10 YR 7/1 light grey	0	3	4	19	62	12	very fine sand of rounded to sub-rounded quartz grains with 10 to 20 % organics and charcoal. Slightly acid (pH 5.5).
70	10 YR 8/2 white	0	3	6	21	61	9	as above but with only a trace of organics and charcoal

*shows percentage of 50g dry subsample caught in 0,1,2,3,& 4 Ø sieves after shaking on an "Endrock" mechanical sorter for 15 minutes.

decreases rapidly with depth, and only a trace of these components remains below about 70 cm DBS. Between 110 and 140 cm DBS, there is a layer of gravel composed of laterite and spongelite pebbles up to 20 mm in diameter included within the sands of Layer I. The gravel forms about 20% of the sediment samples taken at this depth, but when it is removed, there is very little alteration in the proportions of sand grain sizes from the samples which were collected above or below.

Layer I lies unconformably on a red brown, very hard packed clay and/or silt. The surface of Layer II, which is very uneven and gullied, varies from 138 cm DBS in the southeast corner of the trench to below 160 cm DBS on the west side. This sediment has an abominable odour (as one of the crew put it, "like a sewer"), and this may suggest that it has a high component of decayed vegetable materials. Layer II was not excavated and the strata which underlie it are unknown.

Trench 2: The stratigraphic sequence in Trench 2 is composed of the same two Layers (Fig. 5.29). The white sands of Layer I extend from the surface to at least a depth of 140 cm DBS, and the only noticeable difference from Trench 1 is that here the gravel layer is found 30 cm higher, between 80 and 110 cm DBS. Layer II also begins higher (at 82 cm DBS in the northwest corner of the trench), and is more deeply gullied than in Trench 1. This excavation was abandoned when there was still an approximately 30 cm^2 triangle of Layer I remaining in the southwest corner of the trench, because the excavator could only reach the unexcavated sand by lying head

downward on the steeply sloping surface of slippery, smelly Layer II.

Cultural materials - Trench 1: With the exception of a single spongelite chip found at 15 cm DBS, all the cultural materials from Trench 1 were concentrated between 37 and 93 DBS (Table 5.12). Overall density was fairly low with only 133 items recovered, and no backed microliths were found. There appears to have been two episodes of occupation separated by an 8 cm hiatus of sterile sands between 42 and 50 cm DBS. Two thirds of the artifacts belong to the older episode, and are found between 50 and 93 cm DBS. Artifact numbers are highest in the lower levels of this zone, and taper off toward the top of it (Fig 5.29 - density sequence diagram). Above the hiatus, the remaining third of the artifacts are found concentrated between 30 and 42 cm DBS.

Trench 2: Artifacts are found in Trench 2 between 10 and 80 cm DBS and a total of 225 were collected (Table 5.13). As in the case of Trench 1, no backed microliths are present and, the majority of artifacts are found in the lower cultural levels. Eighty-five percent of the stone was recovered from the 30 cm between 50 cm DBS and the bottom of the sequence. Above 50 cm DBS finds decrease dramatically. The remaining 15% of the artifacts are spread out over the upper 40 cm of the cultural deposit, with the highest proportion of them being found in the top 20 cm between 10 and 30 cm DBS (Fig. 5.29 - density sequence diagram).

TABLE 5.12. WAYCHINICUP RIVER TRENCH 1 ARTIFACT FINDS BY DEPTH BELOW SURFACE*

CM	FLAKED STONE												#		OTHER					
	DEBITAGE						IMPLEMENTS						TOT	TOT	ARTIFACTS					GRAND
DBS	RM	CP	FK	FF	CO	BC	ML	SI	CI	AX	PI	MI	IMP	FLKD	GP	MP	E	OCR	TOT	TOT
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	17	20	3	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	40
50	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
60	0	8	1	1	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	10
70	0	10	5	1	0	0	0	0	0	0	0	0	0	16	0	0	0	2	2	18
80	0	11	6	1	0	0	0	0	0	0	0	1	1	19	0	1	0	0	1	20
90	0	17	16	2	0	1	0	0	0	0	0	0	0	36	0	0	0	2	2	38
100	0	1	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3
160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	67	50	8	0	1	0	0	0	0	0	1	1	127	0	1	0	4	5	132

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FK - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

TABLE 5.13. WAYCHINICUP RIVER TRENCH 2 ARTIFACT FINDS BY DEPTH BELOW SURFACE*

CM	FLAKED STONE															OTHER					
	DEBITAGE						IMPLEMENTS						TOT	TOT	ARTIFACTS						GRAND
DBS	RM	CP	FK	FF	CO	BC	ML	SI	CI	AX	PI	MI	IMP	FLKD	GP	MP	E	OCR	TOT		TOT
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
20	0	2	6	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0		8
30	0	10	13	2	2	0	0	1	1	0	0	0	2	31	0	0	0	1	1		32
40	0	1	4	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0		5
50	0	8	2	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0		10
60	0	34	23	2	0	0	0	0	1	0	0	0	1	60	0	0	0	1	1		61
70	0	58	42	4	0	0	0	0	0	0	0	0	0	104	0	0	0	1	1		105
80	0	9	11	2	0	0	0	1	0	0	0	0	1	23	0	0	0	0	0		23
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
100	1	0	1	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0		3
110	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		1
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
TOTAL	1	122	103	13	2	0	0	2	2	0	0	0	4	245	0	0	0	3	3		248

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FK - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

Radiocarbon Dates: Charcoal is rare in the excavated portions of the site. Only one sample large enough for dating was collected from each trench. For Trench 1, a sample was submitted from between 50 and 60 cm DBS, the upper most level of the lower occupation episode; and it returned a date of 7430±170 BP (ANU 2865). From Trench 2, a sample submitted for the upper part of the sequence, between 20 and 30 cm DBS provided a date of 1390±70 BP (ANU 2866).

Summary and Discussion:

Two test excavations were conducted slightly over 20 metres apart, and based on the quite similar stratigraphic and cultural sequences revealed in those excavations, the following history of the site's occupation can be suggested. Occupation took place on an aggrading fine white aeolian sand. In both trenches the majority of artifacts are found concentrated in the lower portions of the cultural deposit, and a date for the top of this concentration in Trench 1 suggests that the majority of occupation took place before about 7500 BP. Immediately thereafter, the amount of stone residue producing activity on the site appears to have been drastically reduced, and in Trench 1 it seems to have ceased entirely for a period. Toward the top of the deposit, however, there is again a slight increase in evidence for occupation; and a date from the upper levels of Trench 2 suggests that this had occurred by 1500 BP.

Depth/age graphs and Millennial Density Models: The

Waychinicup River excavations present a problem in the construction of depth/age graphs because graphs which are controlled by only a single date do not allow for any change in the rate of sediment accumulation within the sequence. It was suggested above that both Waychinicup River trenches probably represented the same basic occupational sequence. This seems reasonable since they are not far apart and both reveal cultural deposits with very similar vertical structures. However, a graph for Trench 1 would assume a constant sedimentation rate of about 7.4 cm per millennium, and suggest that the deposit began to build up over 13,500 years ago; whereas a graph for Trench 2 would assume a constant sedimentation rate of about 17.9 cm per millennium, suggesting a maximum age for the deposit of only about 6000 years. Such great disparity in sedimentation rates seems highly unlikely in two such similar trenches so close together, especially since the greater depth of Layer 1 in Trench 1, which is the downslope trench, suggests it must have experienced a slightly higher overall sedimentation rate than Trench 2; rather than the reverse as would be suggested by the single date graphs.

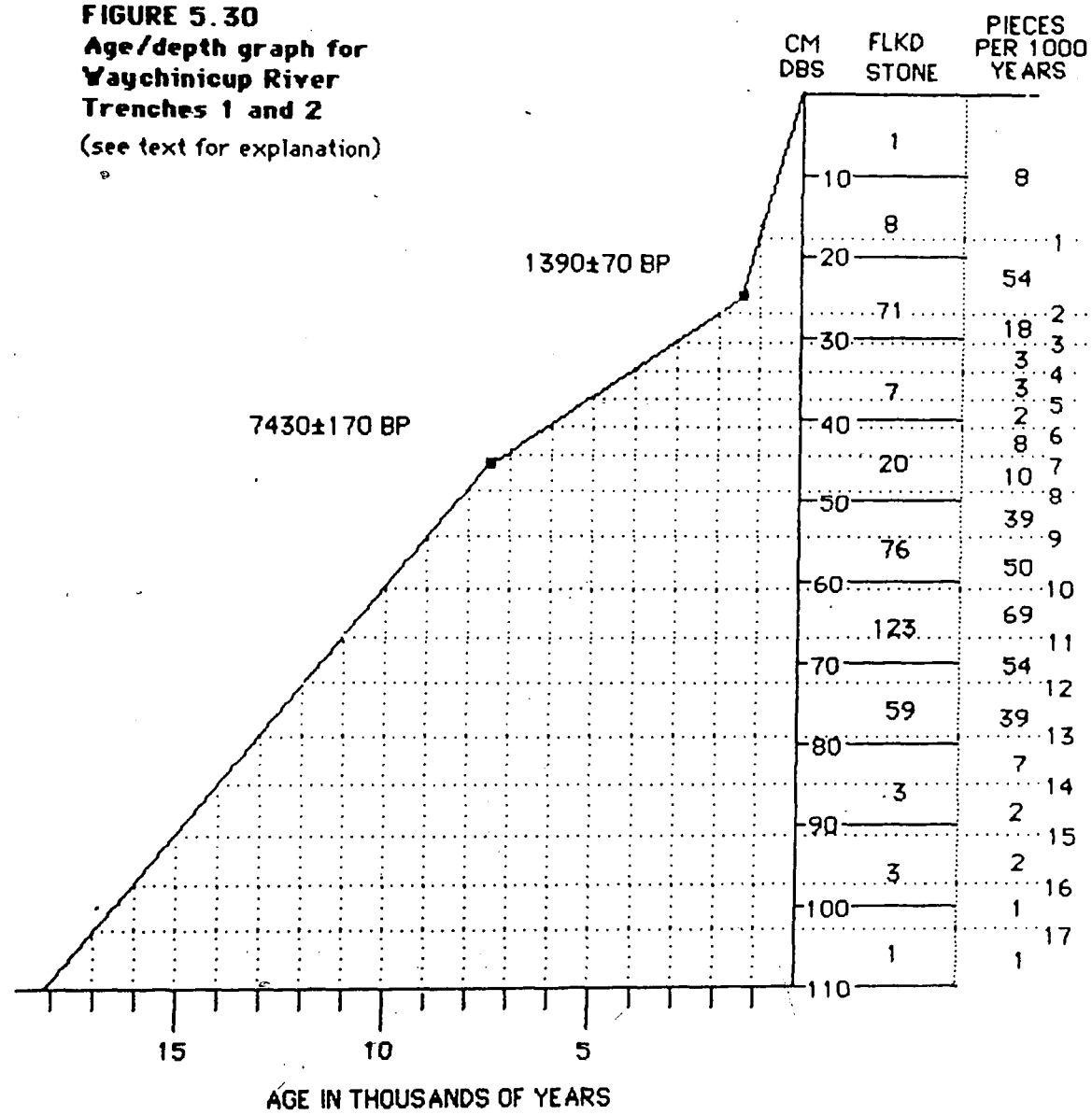
Consequently, it was decided to assume that both trenches *do* represent the same occupational sequence, and to align and merge the two artifact sequences so that both radiocarbon dates could be used in a single graph. Alignment was accomplished by moving the entire Trench 1 sequence upward by 10 cm. This was done to partially compensate for the fact that there are 30 cm of sterile sand (except for one chip between 10 and 20 cm) above the Trench 1 sequence, while there is only 10 cm above the Trench 2 sequence. It brings the

two upper artifact concentrations onto the same level, and aligns the upper portions of the lower concentrations. The legitimacy of this step is subject to question; but if the two trenches represent the same occupational sequence as is here assumed, it seems the best possible way of ordering them for integration.

After realignment of Trench 1 upward, the artifact finds from both trenches were totalled by 10 cm depths, the two date determinations plotted on a graph, and the depth/age curve drawn (Fig. 5.30). The resulting millennial density model (Fig. 5.31) is virtually identical to that of Moorillup Crossing (Fig. 5.26). Control is not as well placed for the concentration in the late Holocene, and the timing for the end of the period of relatively low millenial density is not as secure; but it appears to be similarly at about 3000 BP. The beginning of this period, however, is securely dated in Trench 1 at Waychinicup River, and the apparent reduction of 95% in the rate of finds per millennium between about 6000 and 8000 BP is the same at both sites.

Further excavation is needed at Waychinicup River to provide more adequate dating of the deposit, and this millennial density model must be seen as less reliable than those for Kalgan Hall and Moorillup Crossing. It does, however, exhibit the same now familiar pattern for trans-Holocene sequences in the Australian Southwest. There is evidence of relatively intensive occupation in the late Pleistocene and/or early Holocene; and this is followed by a period of relatively little evidence of human activity in the mid-Holocene which lasts until about 4000 to 3000 BP.

FIGURE 5.30
Age/depth graph for Waychinicup River Trenches 1 and 2
(see text for explanation)



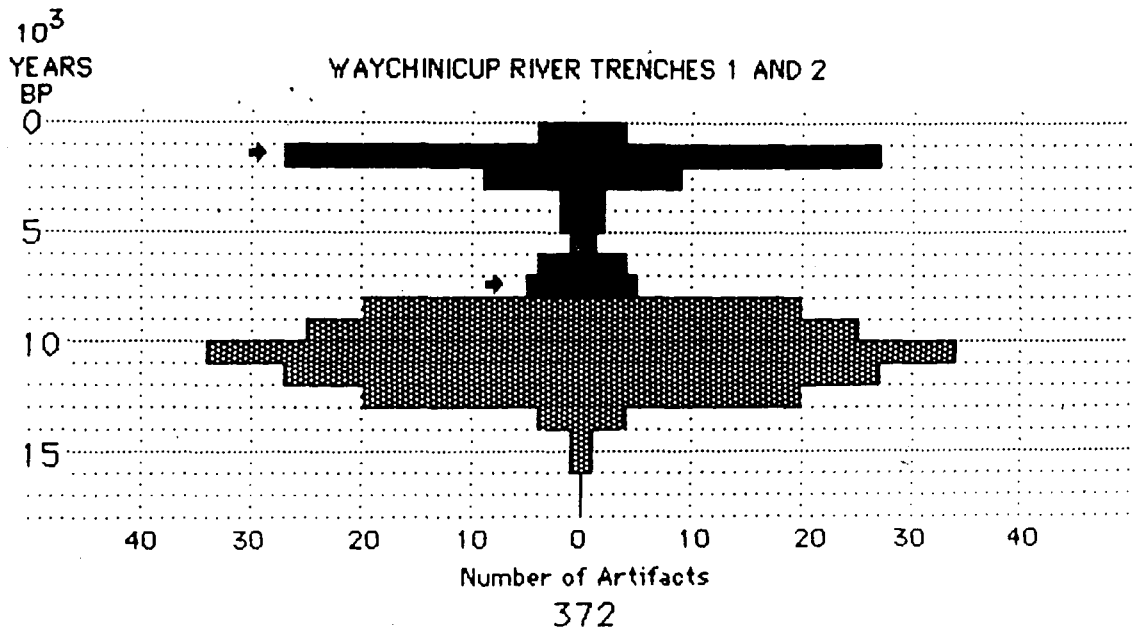


Figure5.31. Millennial Density Model for Waychinicup River Trench 1 & 2

The Kamballup Pool Site:

The Kamballup Pool site is located on the west side of the Kalgan River about 800 metres upstream from the Kamballup bridge (Figs. 4.18 & 4.19). A temporary datum was established on a nail driven into the most northerly retaining post on the river side of the causeway (Fig. 5.32). A 1 x 1 metre square, Trench 1, was set out from 34 to 35 metres north and 13 to 14 metres west of this point. This trench was just beside the track near the highest concentration of exposed artifacts. Excavation was begun, but it soon became apparent that this area had been disturbed in the recent past, probably during the construction of the causeway. The sediments excavated contained a large amount of imported gravels and several large lumps of clay. Seventeen artifacts were recovered (Table 5.14), but this excavation was abandoned at a depth of 30 cm DBS because of increasing evidence of disturbance with depth.

A second 1 x 1 metre square, Trench 2, was then set out from 90 to 91 metres north and 0 to 1 metres west of datum, in an area well away from any recent disturbance. It is on the results of this excavation that the minimal understanding of the site's prehistoric occupation is based.

Trench 2: Trench 2 was excavated to a depth of 150 cm below the ground surface at the southwest corner of the square. Two sedimentary units were encountered (Fig. 5.33). Layer I is a fine to very fine sand with a component of charcoal and organic materials

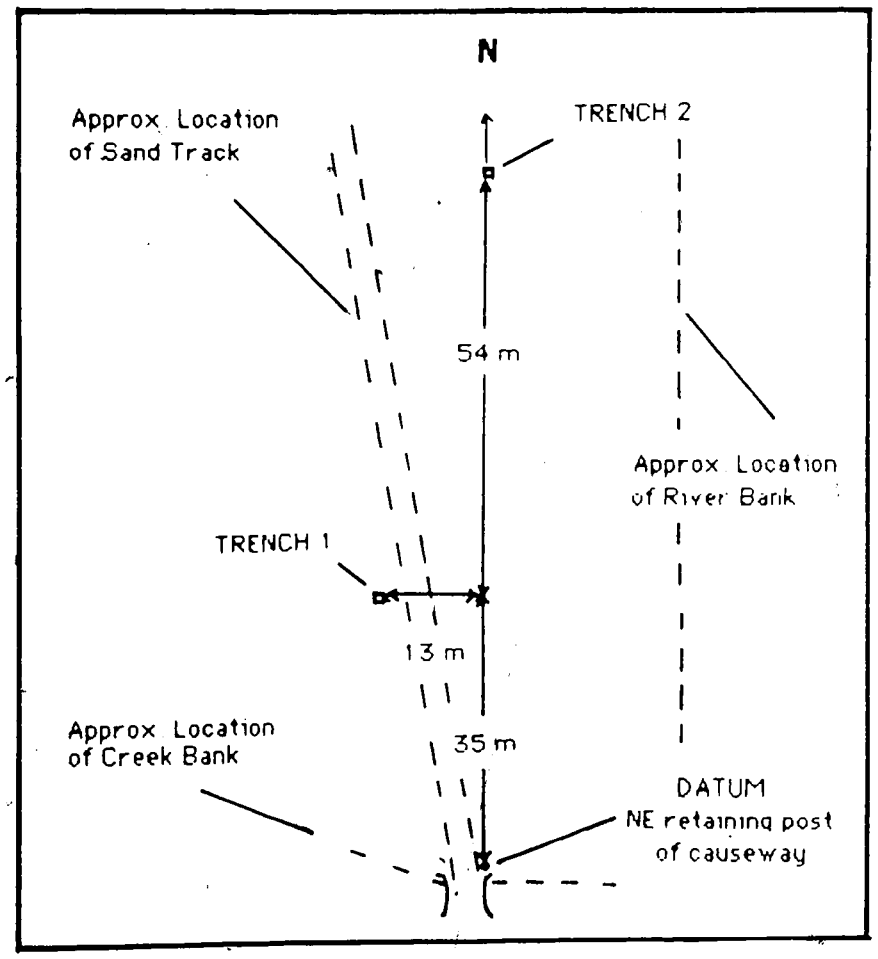


Figure 5.32. Location of Kamballup Pool Trenches and Datum.
(See also Figure 4.19)

TABLE 5.14. KAMBALLUP POOL TRENCH 1 ARTIFACT FINDS BY DEPTH BELOW SURFACE*

CM	FLAKED STONE														OTHER					
	DEBITAGE						IMPLEMENTS						TOT	TOT	ARTIFACTS					GRAND
DBS	RM	CP	FK	FF	CO	BC	ML	SI	CI	AX	PI	MI	IMP	FLKD	GP	MP	E	OCR	TOT	TOT
10	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
20	0	3	4	0	0	0	1	1	0	0	0	0	2	9	0	0	0	0	0	9
30	0	4	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	3	3	8
TOTAL	0	7	5	0	1	0	1	1	0	0	0	0	2	15	0	0	0	3	3	18

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FK - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

KAMBALLUP POOL - TRENCH 2

WEST SECTION

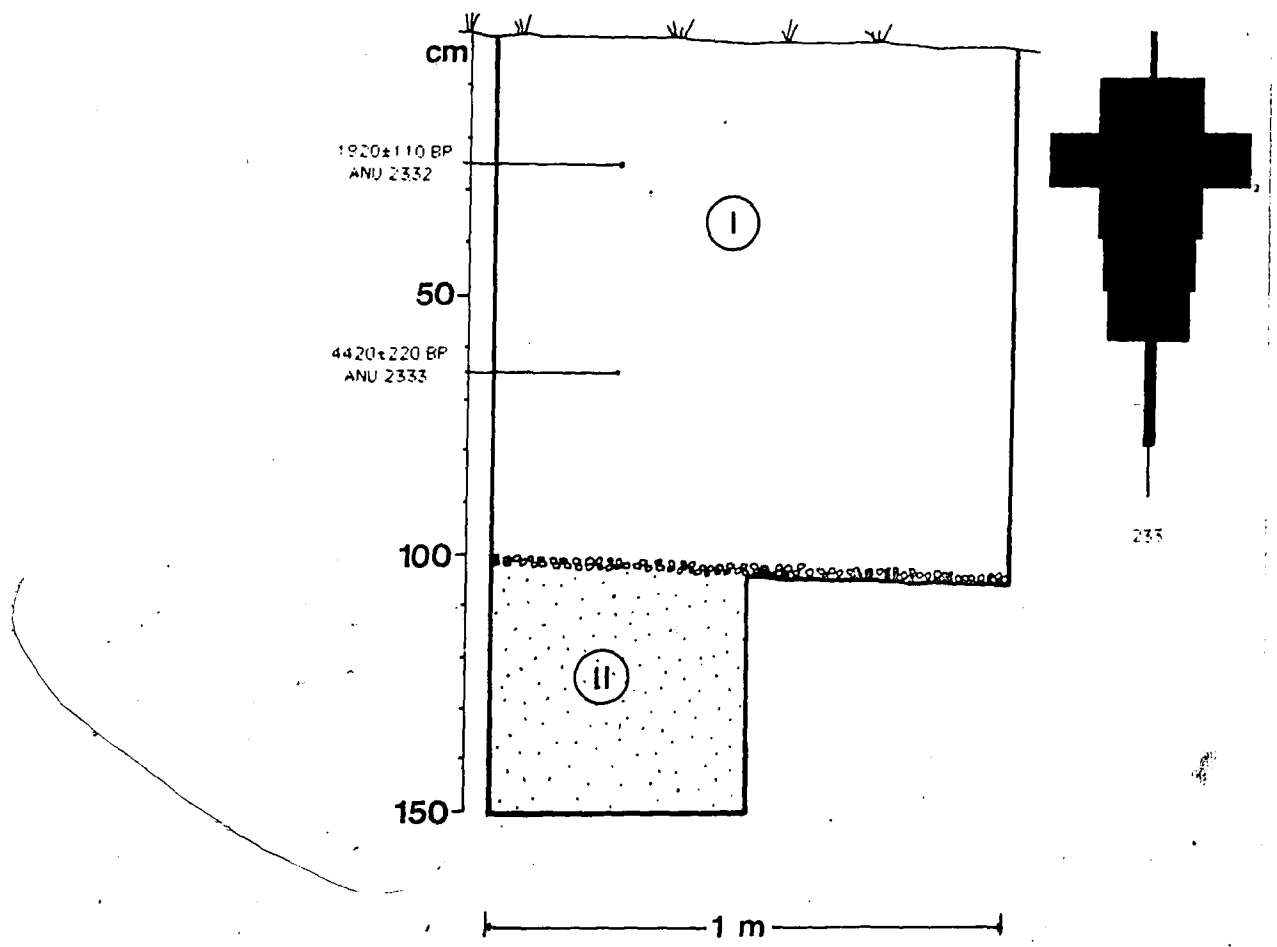


Figure 5.33. Section and Density Sequence Diagram of Kamballup Pool Trench 2.

TABLE 5.15. KAMBALLUP POOL TRENCH 2 PHYSICAL DESCRIPTION OF SEDIMENTS

SAMPLE Cm DBS	MUNSELL COLOUR (DRY SAMPLE)	GRAIN SIZE* 0	1	2	3	4	>4	COMMENTS
10	7 YR 3/4 dark brown	0	1	13	50	31	5	fine to very fine sand of sub-rounded quartz grains with large amounts of organics and charcoal. Slightly acid (pH 6).
30	5 YR 4/6 yellowish red	T	1	12	50	31	6	as above but with less organics.
50	5 YR 5/6 yellowish red	T	1	12	50	32	5	as above but with less charcoal
70	7.5 YR 6/8 reddish yellow	T	1	12	46	36	5	as above but with less organics and charcoal.
90	7.5 YR 7/6 reddish yellow	0	1	13	44	36	6	as above.

*shows percentage of 50g dry subsample caught in 0,1,2,3,& 4 Ø sieves after shaking on an "Endrock" mechanical sorter for 15 minutes.

which decrease with depth (Table 5.15). There is variable ironstaining of the sandgrains which increases with depth, and the colour varies from dark brown near the surface, to reddish yellow at 90 cm DBS. At the bottom of this sediment there is a 2 cm thick band of well rounded laterite pebbles up to 1.5 cm in diameter. These pebbles rest upon Layer II, a very ancient looking clay with extensive polygonal cracking which extends to about 30 cm below its surface. It is primarily yellow in colour but varies considerably, with dark brown, red, and blue patches. It contains no artifacts, root casts, charcoal, or pebbles. This incredibly hard sediment was excavated for only 50 cm, and its total depth is unknown.

Cultural Materials: A total of 253 artifacts was recovered from Trench 2 (Table 5.16). These were found from just below the surface to a depth of 83 cm DBS. A single backed microlith was discovered between 50 and 60 cm DBS. Artifact density is highest between 10 and 30 cm DBS. Over half the artifacts are found in these two spits. Below 30 cm finds taper off gradually with each spit having a lower density than the one above it (Fig. 5.33 - density sequence diagram).

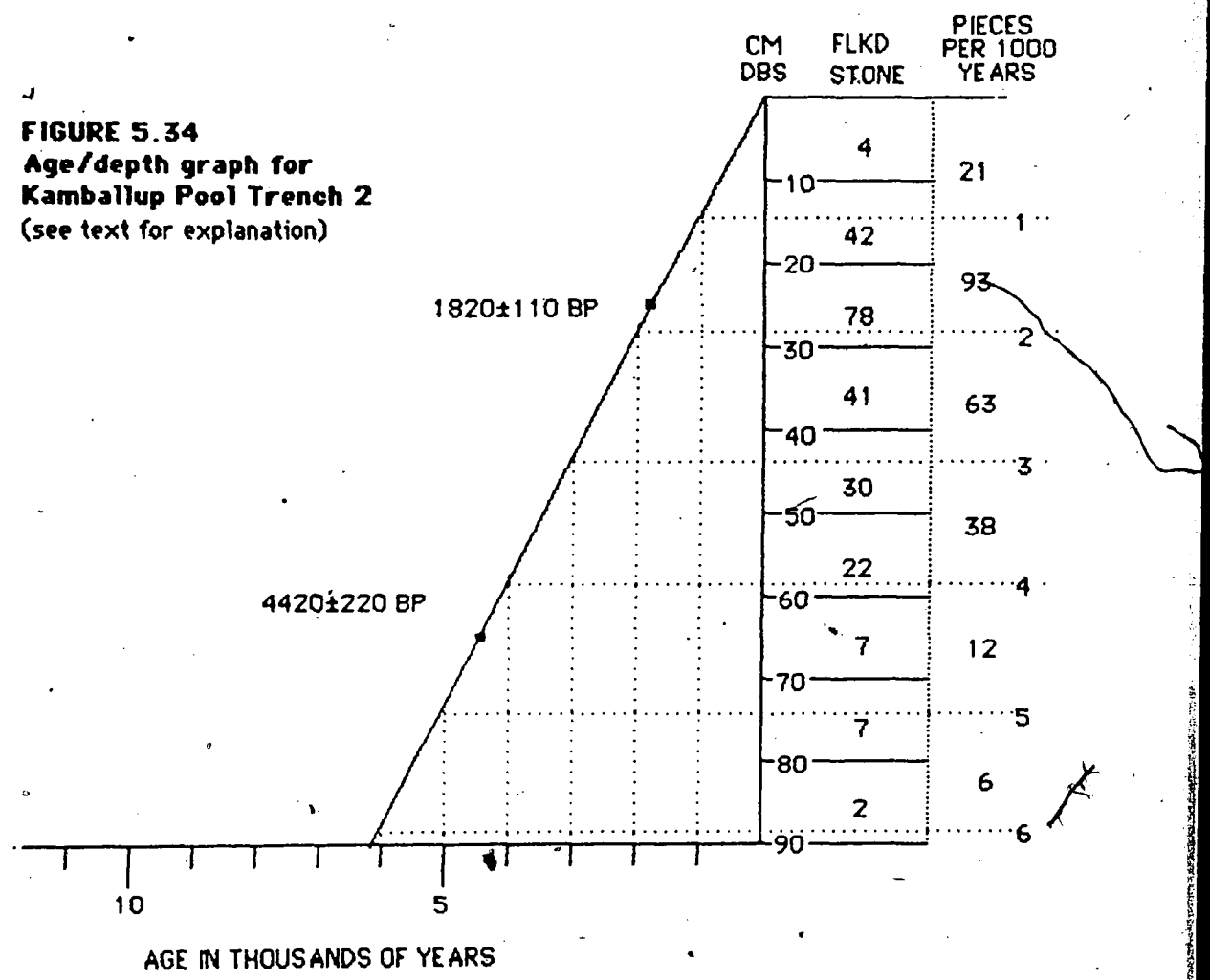
Radiocarbon Dates: Charcoal is plentiful in the trench to a depth of 70 cm DBS, and two samples were submitted for age determination. The lowest sample, from betwen 60 and 70 cm DBS returned a date of 4420±220 BP (ANU 2333), suggesting that occupation of the site began not long before then; and a sample from

TABLE 5.16. KAMBALLUP POOL TRENCH 2 ARTIFACT FINDS BY DEPTH BELOW SURFACE*

CM	FLAKED STONE														OTHER					
	DEBITAGE						IMPLEMENTS						TOT	TOT	ARTIFACTS					GRAND
DBS	RM	CP	FK	FF	CO	BC	ML	SI	CI	AX	PI	MI	IMP	FLKD	GP	MP	E	OCR	TOT	TOT
10	0	3	0	0	0	0	0	1	0	0	0	0	1	4	0	0	1	0	1	5
20	0	33	5	0	1	2	0	1	0	0	0	0	1	42	0	0	0	2	2	44
30	0	49	23	6	0	0	0	0	0	0	0	0	0	78	0	0	0	1	1	79
40	0	33	5	3	0	0	0	0	0	0	0	0	0	41	0	0	0	0	0	41
50	0	19	9	2	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	30
60	0	11	8	2	0	0	1	0	0	0	0	0	1	22	0	1	0	0	1	23
70	0	2	5	0	0	0	0	0	0	0	0	0	0	7	0	0	0	5	5	12
80	0	1	4	1	0	0	0	0	0	0	0	1	1	7	0	0	0	0	0	7
90	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	151	61	14	1	2	1	2	0	0	0	1	4	233	0	1	1	8	10	243

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FK - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

FIGURE 5.34
Age/depth graph for Kamballup Pool Trench 2
(see text for explanation)



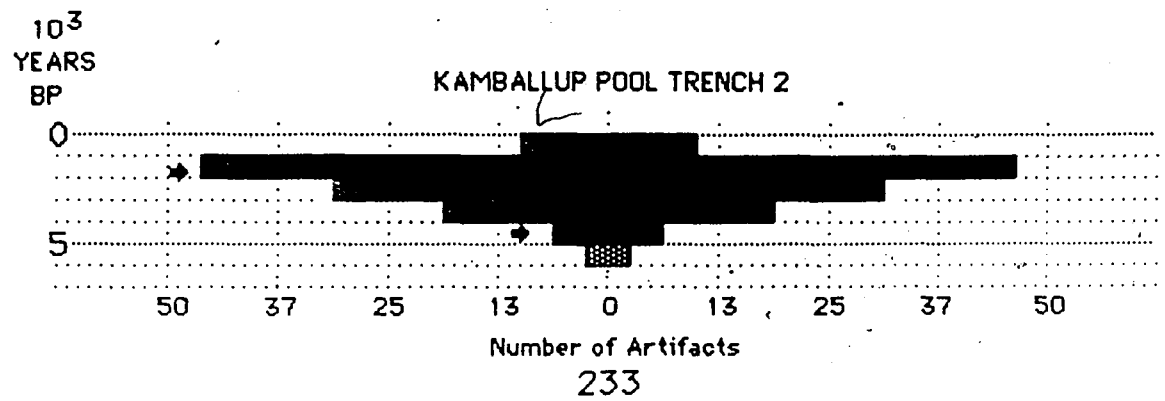


Figure 5.35. Millennial Density Model for Kamballup Pool Trench 2.

between 20 to 30 cm DBS, the area of the highest artifact density, returned a date of 1820±110 BP (ANU 2332).

Summary and Discussion:

There is no evidence for late Pleistocene or early Holocene occupation at Kamballup Pool. On the basis of Trench 2, it appears that occupation began when there was already 17 cm of sand built up on the old clay surface of Layer II sometime before about 4500 BP. A depth/age graph was constructed for this Trench (Fig. 5.34), and the resulting millennial density model (Fig. 5.35) is similar in structure to the upper portions of the models for Kalgan Hall, Moorillup Crossing and Waychinicup River. Relatively few artifacts are found before about four thousand BP, and the vast bulk of them are concentrated between that date and the present. Although no early Holocene levels are present to demonstrate a subsequent depopulation, the scanty finds from the mid-Holocene period may be taken as suggestive of one. This site is very large, however, and more excavations are desirable to check the conclusions based on this one test excavation.

The Moingup Spring Site:

The main camp ground for the Stirling Range National Park is at Moingup Spring in Chester Pass (Fig. 4.12). Disturbance in this area is extensive, but generally shallow, and no surface scatter was found. An arbitrary on-site datum was established by driving a stake into the ground approximately 100 metres NNE of the spring, and two

metres north of where the rangers had built their fence. This was subsequently tied to a more permanent datum established at the top of the third row of bricks on the southwest corner of the campground's toilet block. The on-site datum is 22.8 meters on a line 28° west of south from this point (Fig. 5.36). A 1 x 1 metre test trench was set out from 1 to 2 m east, and 0 to 1 m south of the on-site datum. The surface of the site in this area is covered with native and exotic grasses, leaf litter and kangaroo droppings. Ranger Martin Lloyd stated that to his knowledge this area has never been disturbed.

Test Trench 1 was excavated to a depth of 105 cm DBS at the NE corner of the Trench (Fig. 5.37), and two basic sediments were encountered. Layer I is a fine to very fine sand with a clay and silt fraction of about 10% (Table 5.17). It is brown in colour near the top and composed primarily of sub-rounded to sub-angular quartz grains with a relatively high amount of charcoal and organic materials. With depth, the amount of organics decreases and colour lightens to a very pale brown. At two places within this stratum (between 30 and 45 cm DBS and between 80 and 95 cm DBS) there are layers of relatively tightly packed sub-angular quartz and sandstone pebbles to 5 cm in diameter. This is evidently what the Ranger meant by "layer of chipped stone" but these stones are not artificially fractured and have been tentatively identified as scree. Layer II is a very hard, light orange clay. It was first encountered at about 95 cm DBS, and has a very irregular surface, but since the excavation was terminated at 105 cm DBS, the depth of this stratum and the nature of the strata

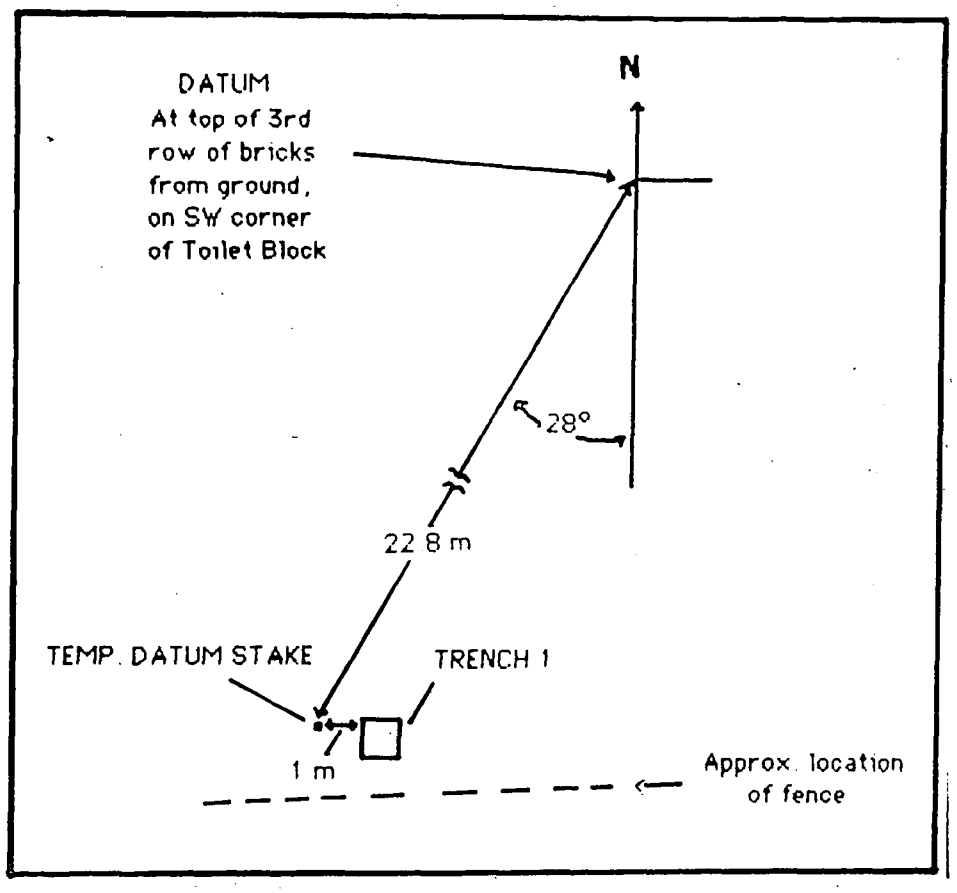


Figure 5.36. Location of Moingup Spring Trench and Datum.

MOINGUP SPRING - TRENCH 1

EAST SECTION

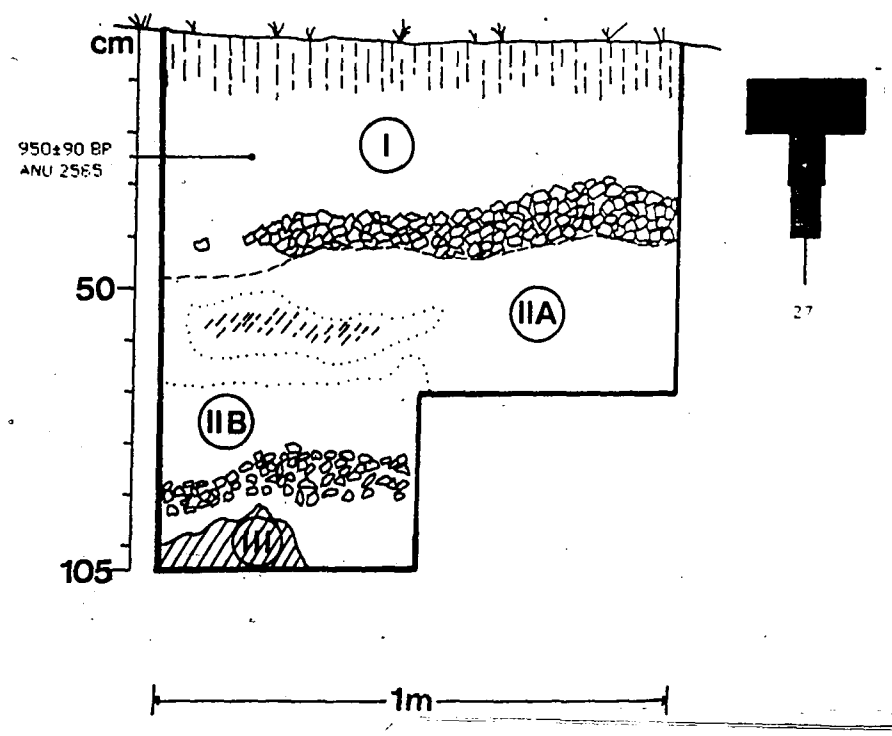


Figure 5.37. Section and Density Sequence Diagram of Moingup Spring Trench 1.

TABLE 5.17. MOINGUP SPRING TRENCH 1 PHYSICAL DESCRIPTION OF SEDIMENTS

SAMPLE Cm DBS	MUNSELL COLOUR (DRY SAMPLE)	GRAIN SIZE* 0	1	2	3	4	>4	COMMENTS
10	7 YR 5/2 light grey to grey	T	1	19	43	27	10	fine sand of sub-angular to sub-rounded quartz grains with large amounts of organics and charcoal. Slightly acid (pH 5).
40	10 YR 7/3 very pale brown	20	3	12	34	23	8	as above but including a gravel of sub-angular pebbles of quartz and sandstone to 7 mm in dia and with less organics and charcoal
60	10 YR 7/4 very pale brown	T	1	10	38	37	14	fine to very fine sand similiar to that of 1st sample without gravel inclusion and with less organics and charcoal.
90	10 YR 8/3 very pale brown	37	3	9	24	19	8	fine sand similar to that of 2nd sample but with more gravel and less charcoal and organics.

*shows percentage of 50g dry subsample caught in 0,1,2,3,& 4 Ø sieves after shaking on an "Endrock" mechanical sorter for 15 minutes.

TABLE 5.18. MOINGUP SPRING TRENCH 1 ARTIFACT FINDS BY DEPTH BELOW SURFACE*

CM	FLAKED STONE DEBITAGE						IMPLEMENTS						TOT	TOT	OTHER ARTIFACTS					GRAND
DBS	RM	CP	FK	FF	CO	BC	ML	SI	CI	AX	PI	MI	IMP	FLKD	GP	MP	E	OCR	TOT	TOT
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	7	4	1	0	0	1	0	0	0	0	0	1	13	0	0	0	3	3	16
30	0	5	2	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	7
43	0	2	3	0	1	0	0	0	0	0	0	0	0	6	0	0	0	0	0	6
53	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	15	9	1	1	0	1	0	0	0	0	0	1	27	0	0	0	3	3	30

* ARTIFACT TYPE ABBREVIATIONS: RM - Raw Material, CP - Chip, FK - Flake, FF - Flaked Fragment, CO - Core, BC - Bi-polar Core, ML - Backed Microlith, SI - Scraping Implement, CI - Cutting Implement, AX - Chopping Implement, PI - Piercing Implement, MI - Multi-purpose Implement, GP - Ground and/or Pecked piece, MP - Manuport, E - Artifact of European Material, OCR - Ochre. These classifications are fully described and further subdivided in Chapter 6.

upon which it rests are unknown.

Cultural Materials and Radiocarbon Date: Only thirty one artifacts were recovered from the trench (Table 5.18). They were found between 10 and 50 cm DBS, and concentrated in the upper parts of that zone (Fig 5.37 - density sequence diagram).

Charcoal was plentiful to a depth of 30 cm DBS, and a sample from 20 to 30 cm DBS was submitted for dating. It returned a date of 950±90 BP (ANU 2585) suggesting that the occupational deposit is restricted to about the last one or two millennia BP.

Summary and Discussion:

No depth/age graph or millennial density model was constructed for this site, as there was only one radiocarbon date and the sample was so small. The entire evidence for occupation seems limited to the last one or two thousand years; and, by themselves, one-period sites like this have little direct bearing on the mid-Holocene depopulation argument. All that can be said is that the excavation at this site supplies no evidence of mid-Holocene occupation of the region. However, the site has been examined by only a single test excavation which may be only peripheral to a major occupation deposit which lies buried nearby, and more excavations in the campground area are warranted to investigate this possibility.

Comparison of the Artifact Sequences from Mokaré's Domain:

The first point that should be stressed is that no relatively large deposits of artifacts dated to the mid-Holocene period are found in the excavations in Mokaré's Domain. Artifacts from this period are found at four of the five sites discussed above, but in all cases they are juxtaposed to much larger concentrations of artifacts from the preceding and/or subsequent periods.

At Kalgan Hall, Moorillup Pool and Waychinicup River, the three sites with sequences which cover the entire Holocene, there are relatively large concentrations of artifacts dated to the late Pleistocene and/or early Holocene, and in every case the rate of artifact finds per millennium during the mid-Holocene is less than 10 percent of that of these earlier levels. Only at Waychinicup River, where some problems were encountered in constructing the depth/age graph, can there be any doubt at all that this is the case.

There is, however, a major difference in *when* the transition from relatively high to relatively low millennial density rates occurred at Kalgan Hall, on the one hand, and Moorillup Pool and Waychinicup River on the other. At Kalgan Hall the exact dating is uncertain, but this transition took place sometime before about 10,000 BP, and at Moorillup Pool and Waychinicup River it appears not to have begun until about 8000 BP.

On the basis of these three sites alone, this discrepancy could be seen as anomalous to an argument that the reduction of artifact density is a regional phenomenon based ultimately on climatic change. It might be assumed that sites which are as close together as these

should probably experience the effects of the climatic pressure at about the same point in time. The modern environment surrounding these sites is quite different, however. Kalgan Hall is in the forest, and Moorillup Pool and Waychinicup River are in more open woodland areas; and it can be argued that the variation in transition times observed here is part of a pattern which is fully explainable and predictable within the already established confines of the mid-Holocene depopulation model.

The model suggests that it is not the climatic change of increased rainfall itself, but the increased vegetation density around the sites resulting from that rainfall which directly causes the reduction of artifact numbers. It seems logical that areas already most densely vegetated when the climatic change occurred would be those most likely to first show the effects of that pressure, and that there might be a substantial lag time before those in the contemporaneously more open areas were noticeably influenced.

If such a pattern could be shown to exist; if the transition from high millennial densities to low millennial densities was consistently earlier in currently relatively dense vegetation areas than in currently relatively open areas, then it would be a significant sign of support for the model. It would provide a strong counter to the alternative hypothesis that the drop in artifacts across the region resulted from *decreased* rainfall and the pressure of drought; for if this were the case, then we should expect exactly the opposite pattern to occur: Currently drier areas should show evidence of this drought pressure before those currently wetter areas which would

most likely be refuges.

The three sites in Mokaré's Domain provide too small a sample to do more than suggest that any pattern exists, and this will be examined again in the concluding Chapter where the sites from the entire Southwest region are discussed. It is necessary first, however, to examine the artifacts recovered from the Mokaré's Domain excavations. It has been shown that in every relevant sequence in the field research area there are a great many fewer artifacts in the mid-Holocene period than previously, but it remains to be argued that relative densities can be used in this instance to suggest relative amounts of human activity, and consequently, relative human population densities.

CHAPTER 6
FUNCTION AND CONTINUITY OF THE FLAKED STONE ARTIFACTS

Introduction:

This chapter presents the classification and analysis of the artifacts recovered from Mokaré's Domain. Its ultimate goal is to demonstrate, from information provided by the formal and contextual attributes of these artifacts, that the drop in artifact numbers shown in all the trans-Holocene sites of Mokaré's Domain can logically be taken to suggest a roughly corresponding drop in the human population of the region during this time period. As the title indicates, two aspects of the assemblage are emphasised: the functions of the individual artifacts; themselves; and the continuity of excavated assemblages over time. To satisfy the ultimate goal, it is necessary to determine both what range of human activities the artifacts represent; and if the same activities, in approximately the same proportions, are present throughout the sequence.

Initial Classifications:

The 15,396 artifacts collected during the surveys and excavations in Mokaré's Domain were initially classified into general categories according to their basic raw material attribute (Table 6.1), and almost 98% of the items which survived the poor preservation conditions were made of stone. Except for a boomerang of doubtful origin (Fig. 6.1), no wooden, bone or shell artifacts were

TABLE 6.1. Initial Classifications of Artifacts Collected From Mokaré's Domain based on Raw Material .

COLLECTION	STONE			OTHER			TOTAL
	FLAKED	GROUND AND/OR PECKED	MANU-PORTS	WOOD	OCHRE	EURO MAT'L	
KH1	413	--	--	--	4	4	421
KH2	6579	9	42	--	145	33	6808
KP1	15	--	--	--	3	--	18
KP2	233	1	--	--	8	1	243
MC1	210	--	--	--	5	--	215
MP1	322	--	5	--	4	--	331
MP2	3023	1	27	--	81	2	3134
MS1	27	--	--	--	3	--	30
WR1	127	--	1	--	4	--	132
WR2	245	--	--	--	3	--	248
SURFACE	3796	10	3	1	--	7	3817
TOTAL	14990	20	79	1	260	47	15397

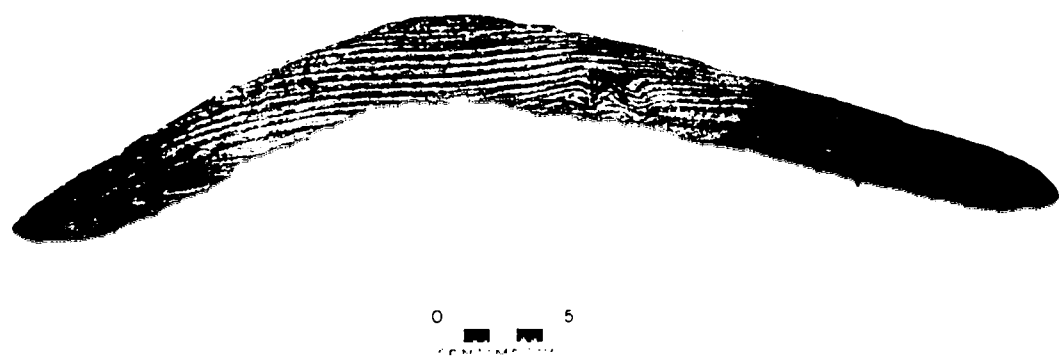


FIGURE 6 1 : **BOOMERANG.**

The photograph shows the boomerang found broken into two pieces on the surface of the Hylne Site, on the west side of Oyster Harbour. It was lying in association with a light scatter of quartz artifacts, and is quite weathered. It is doubtful, however, that it is really a prehistoric artifact. No other wooden implements were found preserved in the research area, and it appears to be made from a relatively soft wood.

recovered. Most of the non-stone artifacts were fragments of various coloured pigments ("ochre"): white, yellow, and several shades of red. Neither these, nor the artifacts of introduced European materials (glass, pipe clay, and metal), have been included in the analysis.

In the initial classification the stone artifacts were divided into three groups according to the type of humanly induced mechanical action which reduced them to their present form. Over 99 % of the stones collected appear to have been reduced by knapping, and their classification and analysis provides the bulk of this chapter. Only 20 items have been either abraded (ground) and/or "pecked"; and the 71 manuports show no evidence of humanly induced reduction, being considered as artifacts only because of their locational attributes. The manuports have not been included in the analysis, and the ground and/or pecked pieces are briefly described later in the chapter.

Flaked Stone - The organization of the Chapter:

The attributes which suggest that a stone has been flaked by humans are well known to archaeologists. Descriptions of these attributes and how they can be distinguished from natural fractures are included in the introductory paragraphs of every basic book on stone artifacts, although the terminology that is used varies somewhat (*cf.*, Semenov 1964; Brit Mus. Pubs 1968, Crabtree 1972, McCarthy 1976, Bordes 1979).

The presence of materials showing these attributes in a deposit minimally indicates that the activity of stone reduction took place on or near that site. This type of activity is virtually essential

for the maintenance of life in the vast majority of pre-metallurgical societies. Stone supplies the almost irreplaceable, hard, sharp-edged material used for hatchet heads, knife blades, and woodworking implements that are necessary for the shaping of wooden implements required for the procurement of food supplies (i.e. spears, spear throwers, digging sticks, hatchet handles, etc.). Stone flaking is so basic to such a wide variety of "cultural core" activities that, with some qualifications, it can be suggested that less evidence of stone flaking implies less of all these other activities as well.

The sheer quantity of flaked stone, however, is not necessarily suggestive of the amount of stone flaking which has taken place. The amounts of residue produced are dependent upon three basic factors: (1) the nature and availability of the raw material used, (2) the techniques of stone reduction employed, and (3) the types and nature of the desired end products to which the stone reduction was directed. Before concluding that the variations in amounts of stone noted in the excavations can be used to suggest a similar variation in the amount of stone flaking activity, these variables must be examined for comparability between the different levels.

Each of these three variables is considered separately below. The first step in the classification and analysis was undertaken to establish control for the raw material variable, and all the flaked stone was examined and classified into petrological categories which are described and discussed in the next section.

Next, the stones were examined for information regarding the types of the stone flaking processes which were employed by the

stone workers. Initially they were divided into two categories on the basis of the presence or absence of secondary retouch and/or macroscopic use-wear. Those pieces which did not possess these attributes are assumed to be "debitage" (Crabtree 1972:58), a by-product of the stone working activity. Those which did, are classified as "implements", and assumed to be the desired end-products of the stone flaking process.

The debitage is presented following the petrology section. It is classified into descriptive types, and the basic stone reduction techniques in evidence are discussed. The implements require more extensive handling. They not only provide additional information regarding the stoneworking process, but are the primary source for inference about what activities besides stoneworking took place at the sites.

The sections describing the implements focus on identifying these activities. The artifacts are compared with models of functional types developed from ethnographic observations and replicative experiments, and functional classifications are always employed where it is possible to do so. Ultimately, it will be argued that the activities represented by these implements are for the most part "cultural core" activities, those involved in the interaction between the prehistoric population and its environment; and further, that these activities are so essential to the subsistence aspects of the prehistoric economy that unless they were replaced by alternative activities which fulfill the same functions, the maintenance of human life would not have been possible.

At the end of each section the aspect of the stoneworking process under discussion is examined for continuity over time. Although the argument is a regional one, for reasons which will be discussed, this must be done on a site by site basis. The samples are too small for millennium by millennium comparison, so each site has been divided into three temporal periods. Period I corresponds roughly to the late Pleistocene-early Holocene, before the sudden drop in artifact numbers. As was discussed in the last chapter, the length of this period is somewhat different in Kalgan Hall than in Moorillup Crossing and Waychinicup River. In Kalgan Hall it ends sometime before about 9000 BP, and in the other two sites it lasts until about 7000 BP. Period II covers the levels where artifact numbers are depressed in the mid-Holocene, and lasts in all sites until about 4000 BP. Period III covers the last 4000 years of the Holocene when artifact numbers are again relatively large.

NATURE AND CONTINUITY OF RAW MATERIAL USAGE:

The nature of the raw material being used affects the way it is reduced. The petrology, shape, size, weathering, and ease of procurement of any given piece will all contribute to determining the amount of stone artifacts produced by its reduction (Flenniken and White 1985). This section describes the types of materials which were used in Mokaré's Domain, discusses their procurement, and examines whether or not there was any change in the choice of material over time.

It has been previously observed that the procurement of stone

among the Australian Aborigines can often be a very opportunistic process (Gould 1977a: 1977b, Hayden 1977; 1979, Ferguson 1980b; Flenniken and White 1985). Almost any type of stone, even those which possess very few of the qualities necessary for controlled stone knapping, will be picked up and used if it is readily at hand and more suitable stone is not.

This certainly appears to be the case in Mokaré's Domain. Adequate stone for flaking is readily available over most of the research area, and the prehistoric inhabitants appear to have generally used whichever rock was closest to hand for their stone working activities. Among the flaked stone collected there is a very wide range of rock types: much quartz and some quartzite; an initially bewildering variety of chert and indurated sandstone; and a number of very coarse grained pieces which have been tentatively identified as migmatite, granite-gneiss, and porphyry. These rocks and their natural distribution in the landscape are discussed below. In the summary and discussion at the end of this section the "local procurement" strategy is discussed, and it is suggested on the basis of the stratified assemblages that this strategy has not altered significantly throughout the period covered by the excavations.

Stone Types:

No detailed study by a professional petrologist of stone artifacts in the area which includes Mokaré's Domain has yet been

completed, although one was begun at about the same time as the research reported here. Samples collected in the Mokaré's Domain research were to be included in the analysis and several were submitted to the petrologist; but that project was abandoned and no report on the samples was received. Subsequently, a range of samples was sent to another petrologist who has promised to provide a basic analysis. However, as of the date of this writing some three years later, no report has been received.

Consequently, the author's provisional field classifications are used below to describe the stone types. These are based on his undergraduate training in geology, approximately eight years of field experience which includes periods of working closely with geologists in joint archaeological-geomorphological research (e.g. Bordes, *et. al.* 1979), and discussions with an invertebrate palaeontologist, Mr. C. Tassel, who advised on the field recognition of sponge spicules. Identifications were made from comparative hand-samples using a hand lens, and no thin-sectioning was attempted. Terminology follows the American Geological Institute's *Dictionary of Geological Terms, Revised Edition* (1976), although it is realised that geological nomenclature is in a period of constant revision and some of the terms used may be out of date.

The classification system lumps all the flaked stone into six categories. These are shown on Table 6.2, and are described individually below. As will be seen, the situation is quite complex, and these general classifications may mask some information regarding precise sources of stone, but pending a specialist

TABLE 6.2a. Petrological Composition of Assemblage by Piece Count:

	QUARTZ		SPONGELITE DERIVED		POS.SPONG DERIVED		DOLERITE		GRANITIC		OTHER		TOTAL
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.
KH 1	294	71.2	117	28.4	1	.2	0	0	0	0	1	.2	413
KH 2	3488	53.0	2990	45.4	63	1.0	0	0	28	.4	10	.2	6579
KP 1	9	60.0	5	33.3	0	0	1	6.7	0	0	0	0	15
KP 2	141	60.5	54	23.2	15	6.4	0	0	5	2.1	18	7.7	233
MC 1	164	78.1	31	14.8	12	5.7	0	0	3	1.4	0	0	210
MP 1	192	59.6	46	14.3	72	22.4	4	1.2	3	.9	5	1.5	322
MP 2	2153	71.2	497	16.4	262	8.7	12	.4	65	2.2	34	1.2	3023
MS 1	18	66.7	8	29.6	1	3.7	0	0	0	0	0	0	27
WR 1	5	3.9	122	96.1	0	0	0	0	0	0	0	0	127
WR 2	8	3.3	237	96.7	0	0	0	0	0	0	0	0	245
SURFACE	2025	53.3	1622	42.7	87	2.3	51	1.3	5	.1	6	.1	3796
TOTAL	8497	56.7	5729	38.2	513	3.4	68	.5	109	.7	74	.5	14990

TABLE 6.2b. Petrological Composition of Assemblage by Weight in Grams:

	QUARTZ		SPONGELITE DERIVED		POS.SPONG DERIVED		DOLERITE		GRANITIC		OTHER		TOTAL
	G	%	G	%	G	%	G	%	G	%	G	%	G
KH 1	192	63.2	68	22.5	40	13.2	0	0	0	0	2	.7	302
KH 2	2671	55.5	1831	38.0	104	2.2	0	0	120	2.5	91	1.9	4817
KP 1	2	22.2	6	66.7	0	0	1	11.1	0	0	0	0	9
KP 2	80	30.9	17	6.6	51	19.7	0	0	7	2.7	104	40.1	259
MC 1	192	78.0	14	5.7	37	15.0	0	0	3	1.2	0	0	246
MP 1	236	52.9	60	13.5	36	8.1	15	3.4	15	3.4	84	18.8	446
MP 2	2535	48.3	635	12.1	514	9.8	27	.5	1306	25.0	222	4.3	5236
MS 1	7	18.9	29	78.3	1	2.7	0	0	0	0	0	0	37
WR 1	18	6.6	254	93.4	0	0	0	0	0	0	0	0	272
WR 2	42	7.0	554	93.0	0	0	0	0	0	0	0	0	596
SURFACE	5897	39.4	7374	49.3	751	5.0	597	4.0	251	1.7	93	.6	14963
TOTAL	11869	43.7	10842	40.0	1534	5.6	640	2.4	1702	6.3	596	2.2	27183

petrological study of the region, it is believed to be of sufficient refinement for the purposes of this research.

Quartz: This classification includes varieties of rock crystal quartz, and white milky quartz. Much of this material was probably sourced from veins in the granite which outcrops at many locations across the research area, but quite a large number of pieces showing the remains of pebble cortex were also noted, suggesting that stream bed or shoreline sources were also used.

Just over half of the flaked stone pieces recovered were made of this material (Table 6.2a). There is, however, a tendency for the quartz to be reduced into smaller pieces than the other materials, and if the proportion of each stone type's contribution is measured by weight, quartz comprises only 43.7 % of the total (Table 6.2b).

Spongelite-Derived and Possibly Spongelite-Derived: These two classifications contain a wide variety of stones which are believed to come from the Pallinup Siltstone, a formation of the Plantagenet Group (Cockbain 1968). This formation was deposited during the Upper Eocene when shallow seas transgressed over the eastern portions of the research area. As the name implies, the sediments were extremely rich in sponge spicules; and, with time, an almost totally siliceous environment was developed.

Weathered boulders of this material are present on the surface over large areas of Mokaré's Domain. In areas where the forest and woodlands have been cleared for paddocks, large piles and fences

made from these boulders are common. Where the land has not been cleared and the boulders lie in place, many are found split into fragments, presumably from the heat of bush fires.

Examination of a number of these split boulders showed them to be highly variable in composition. Many are mostly made of leached and friable materials, but with inclusions of varying sizes which produce acceptable to excellent conchoidal fractures when struck with a hammerstone. These flakable inclusions, for the most part, would be described as types of opaline cherts, but totally silicified small lenses of sand or even pebbles are not infrequent.

The variety of useable materials that may be seen within a single boulder suggests that any attempts to source the artifacts derived from this formation to specific localities is likely to be very difficult if not impossible. For instance, a boulder examined in the bushland near the Fish Track Site, at the base of the South Sister, contained three inclusions of stone which were of suitable size and quality to be flaked: one was a pink, totally translucent type of chert which had white sponge spicules running through it; the second was a cream-coloured, opaque type of chert with sponge spicules visible on the fracture surface, and the third was a small lense of striped, light brown and yellow, very fine sandstone-like material showing no macroscopic evidence of sponge spicules.

The classification, "spongelite-derived", indicates that the artifact so classified either contains macroscopically visible sponge spicules or very closely resembles in colour and texture other pieces from the same assemblage which do contain sponge spicules. This is

the second largest petrological type, making up about 40 % of the total by both piece count and weight, and together the quartz and the spongelite-derived classifications account for over 95 % of the artifacts found.

The "possibly spongelite-derived" artifacts contain no visible sponge spicules, but exhibit other characteristics which resemble those seen in artifacts which do bear sponge spicules. This is the third largest category of stone artifacts, and if all these artifacts do indeed come from the Pallinup Siltstone, then by weight that formation provides slightly more material to the overall total than the quartz (Table 6.2b). It must be admitted, however, that this classification may also include some pieces of exotic chert, indurated sandstone and silcrete which have been imported into the region.

No areas were located during the survey where it can be confidently suggested that prehistoric inhabitants of the region were actually quarrying for stone in the Pallinup Siltstone. One place, on the east side of Lake Morande, south of the Porongorups, had a number of broken boulders of the material scattered across the surface, and there were numerous flakes which showed attributes which suggest that they were detached by human action. However, this area is known to have been frequented by amateur and professional palaeontologists searching for fossils which also abound in the formation (P. Bindon - Pers. Comm.), and without careful replicative studies it is impossible to confidently distinguish between flakes detached by a hammerstone and those detached with a geo-pick.

Dolerite: This is a very tough-grained stone, and although it flakes with a good conchoidal fracture when struck with enough force, it seems not to have been popular among the prehistoric inhabitants of the region for general uses. It makes up only .05 % of the total assemblage by count, and considerably more than half of the pieces collected came from two quarry locations on the shores of Wilsons Inlet (Poison Point Dolerite Quarry and Chipping Stations and Cherryup Dolerite Quarry).

The quarry and chipping stations at Poison Point were discovered because Hammond (1933:38) stated that this area was an important source of a very tough, "very dark grey, almost blue, colour" stone which was much prized for the making of *kodja* hatchets. On the shores of the Inlet, below Poison Point, there is a large number of boulders of this material which show the signs that large flakes have been detached from them, and some flakes and flaked fragments were found around them. Up on the bluff above these boulders, no dolerite naturally occurs, but there are three areas where the hillside is quite thickly strewn with smaller flakes of the material. It is suggested that these were "chipping stations", or work-shop areas for reducing the materials sourced at the shoreline. It may be that final shaping and assembly of *kodja* hatchets also took place here, because the only non-dolerite artifact found in the area was a piece of silcrete-like, possibly spongelite-derived material which has provisionally been identified as a broken *kodja* stone (see below). The Cherryup Quarry was found as a result of information provided by an informant, and is similar to Poison Point five kilometres to the

west, except that no chipping stations were located nearby.

Granitic Materials: This category includes a variety of very coarse-grained igneous and metamorphic stones which, although they possess few attributes suitable for controlled flaking, show attributes which suggest that they were indeed flaked. They are mostly large pieces, flakes and flaked fragments, which although they account for only 0.7 % of the total artifacts by count, make up 6.3 % by weight. Only one of these, a chopping implement found in Trench 2 at Moorilup Pool, showed any evidence of secondary retouch or use wear.

Other: All artifacts collected which could not be placed into one of the above categories were grouped into this one. Included are a variety of chalcedonic cherts, some quartzites and silcretes, and a few stones which defy description by a non-petrologist. This residual classification accounts for only 0.5 % of the total assemblage by count, but because some of them are quite large they make up 2.2 % of the total weight. Notable among the larger pieces is a quartzite artifact, which although it initially saw service as a grindstone, was subsequently flaked, and turned into a scraping implement.

Discussion - Continuity through Time:

It was suggested above that the type of raw material used would affect the quantity of residue produced by the stone reduction process. Some evidence for this has been provided by showing the

tendency for quartz materials to be reduced into smaller pieces than the spongelite derived materials, but it has not been possible to gain a more refined understanding of how this factor would operate in the case of the materials recovered from Mokaré's Domain.

Originally, replicative knapping experiments were planned to examine this aspect, but there are too many variables which need to be considered (too much variation of material within the major petrological categories, and too many different patterns of reduction evident in the assemblage) for such experiments to be manageable in the time allowed. It can only be accepted that the different materials do produce different amounts of residue, depending on the type of reduction techniques employed and the ultimate goals of that reduction; and that, if any major change is apparent in the petrological proportions of an excavated assemblage over time, it may well suggest that the different levels are not comparable for our purposes.

Figure 6.2 shows the petrological proportions of the three trans-Holocene sequences divided into the three periods discussed in the introduction to this chapter. Each site has a distinctive mix of petrological materials which is noticeably different from any of the other sites, and which remains reasonably constant over time. The variations that do appear probably have more to do with sample size than anything else. It should be noted that in all sites only 79 artifacts out of the 15,396 collected can be dated to the mid-Holocene, Period II.

The petrological composition of the assemblages reflects a

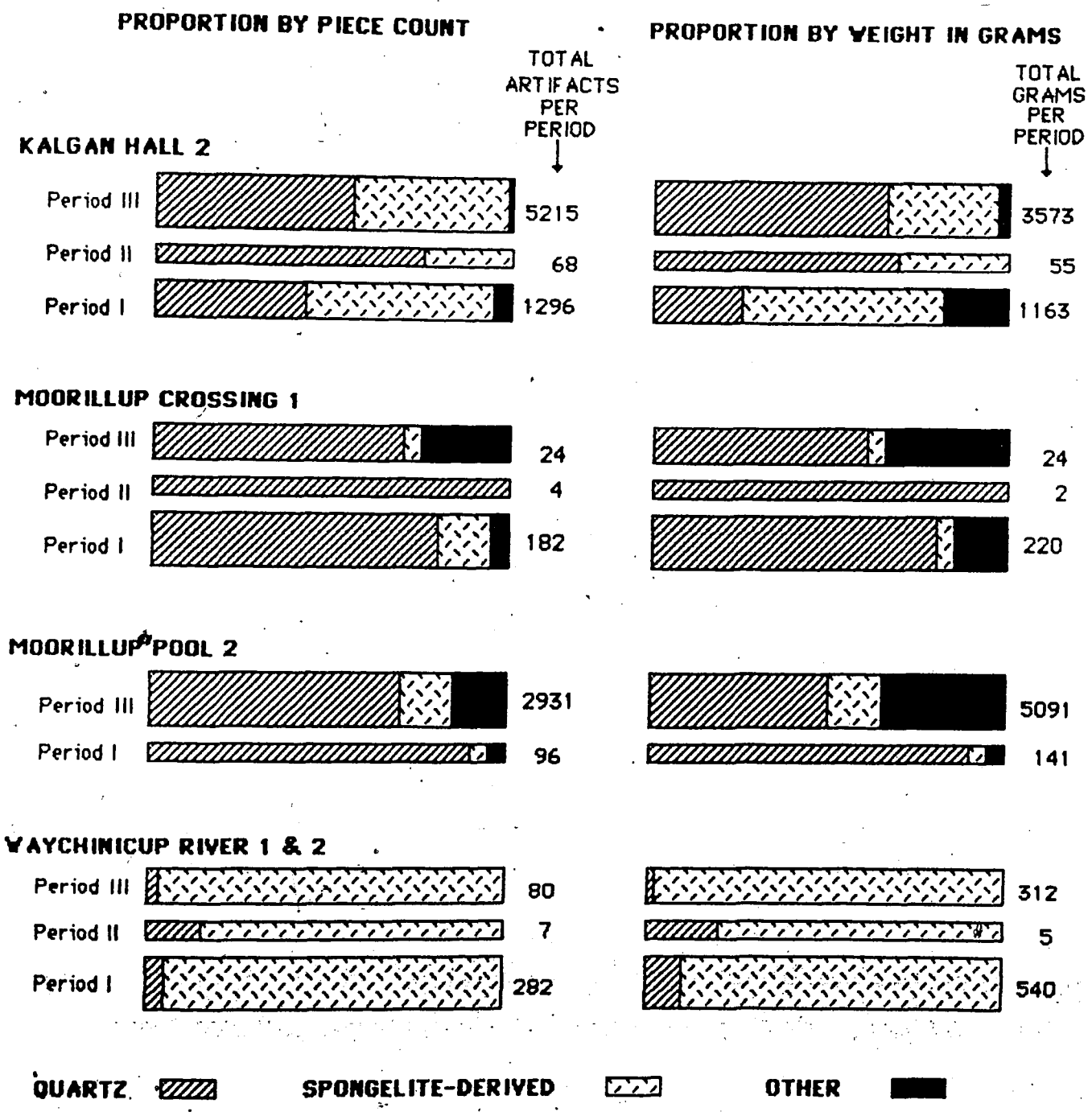


FIGURE 6.2. CHANGES IN PETROLOGICAL TYPE PROPORTIONS OVER TIME.

general trend in the research area. The quartz is readily available over most of the research area, and the spongelite-derived materials can be obtained from almost anywhere in the eastern part of the region. Both types of stone were found on surface sites in every part of Mokaré's Domain but, in general, sites in the western portions of the region have higher proportions of quartz, whereas those in the east have higher proportions of spongelite-derived materials, and the possibly spongelite-derived artifacts are most abundant in the northern areas.

Waychinicup River, the furthest east of the excavated sites, has an assemblage almost entirely of spongelite-derived materials with only a small percentage of quartz which remains virtually constant for the three time periods (Fig. 6.2).

Kalgan Hall, which is close to the centre of the research area, has a more equal mix of the two materials, and here there appears to be a slight trend to more use of quartz at the expense of spongelite-derived and other materials over time. This is especially noticeable if the proportion by weight is used for comparison; but two large flaked fragments in Period 1, one of a granitic material and one of a spongelite-derived material, and each weighing about 100 grams, are the primary reason for this. If they are removed, the weight and piece-count graphs appear very similar.

Moorillup Pool is the furthest west of the sites, and consequently has the highest proportion of quartz with only a relatively small proportion of spongelite-derived materials. It is also the furthest north of the sites, and in this case possibly

spongelite-derived materials make up the bulk of the "other" category.

Because there are so few artifacts in Period III of the Moorillup Crossing Trench, Moorillup Pool Trench 2 is shown for comparison. In spite of the differences in sample size, both Period I and Period III appear to be quite similar in both of the trenches, and there is a suggestion of a slight trend to less use of quartz over time.

These trends toward the use of more quartz at Kalgan Hall and less quartz at Moorillup Pool may affect the amount of residue produced by equal amounts of stone knapping, but because they are so slight it seems reasonable to suggest that probably no great bias has been introduced into the density sequences by the choice of raw material alone.

PATTERNS OF STONE REDUCTION - The Debitage:

As with the choice of raw material, the manner in which stone was reduced to produce a desired implement was casual and highly opportunistic. This aspect of Aboriginal stone technology is stressed in a recent overview of Australian stone implement manufacturing techniques (Flenniken and White 1985.), and it appears to be borne out in the study of the Mokaré's Domain assemblages. In general, suitable flakes were chosen for the task at hand rather than being consciously designed to a regular formal pattern, and the minimum amount of flaking required to make a particular shape was employed.

Flenniken and White (1985) also stress the highly conservative nature of Australian stone working. They suggest that throughout Australian prehistory only one basic stone reduction sequence was

used, that (except in isolated late Holocene instances) reduction was solely by percussion, and that the most frequent reduction techniques employed were free-hand percussion and bipolar reduction. These general points are also supported by this current research.

In the paragraphs which follow, the debitage - those artifacts which have been determined to be only by-products of the stone reduction process, are divided into descriptive categories (Table 6.3). The discussion accompanying each category emphasises the evidence which each category provides regarding the patterns of stone reduction in Mokaré's Domain.

At the end of this section there is a discussion of the evidence for and against continuity in the stone working technology through the Holocene period. The way in which the raw material is reduced to produce the desired stone implements affects the amount of stone residue which is deposited in the archaeological record, and any major change in reduction methods might render the assumption of relativity between amounts of flaked stone and prehistoric populations untenable.

Raw Material: This category was established as an afterthought to provide a place for a few, very small pieces of stone which had been inadvertantly included in the flaked stone assemblage at early stages of the classification; but which, on close examination, showed no evidence of any stoneworking at all. The largest of these pieces is less than 15 mm on its longest dimension. The majority are of quartz, and probably broken from larger pieces of raw material

TABLE 6.3. NUMBERS AND PERCENTAGES OF BASIC FLAKED STONE CLASSIFICATIONS

	RAW MATL		CHIPS		FLAKES		FL FRAG		P F CORES		BI-P CORES		IMPLEM		TOTAL
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
KH 1	5	1	265	64	111	27	15	4	5	1	3	1	9	2	413
KH 2	21	0	5170	79	1115	17	163	2	28	0	16	0	66	1	6579
KP 1	0	0	7	47	5	33	0	0	1	7	0	0	2	13	15
KP 2	0	0	151	65	61	26	14	6	1	0	2	1	4	2	233
MC 1	0	0	119	57	74	35	12	6	1	0	1	0	3	1	210
MP 1	2	1	168	52	129	40	18	6	0	0	3	1	2	1	322
MP 2	8	0	1708	57	1087	36	141	5	19	1	21	1	39	1	3023
MS 1	0	0	15	56	9	33	1	4	1	4	0	0	1	4	27
WR 1	0	0	67	53	50	39	8	6	0	0	1	1	1	1	127
WR 2	1	0	122	50	103	42	13	5	2	1	0	0	4	2	245
SURFACE	11	0	923	24	2253	59	363	10	76	2	29	1	141	4	3796
TOTAL	48	0	8715	58	4997	33	748	5	134	1	76	1	272	2	14990

brought on to the sites. Technically these are manuports and should have been so classified in the initial artifact classifications (Table 6.1), but their inclusion in that category late in the classification process would have required major alterations in already established table totals. Since they make up only 0.32 percent of the flaked stone assemblage and consequently do not affect any of the proportion based arguments below, their continued inclusion with the flaked stone is harmless.

Chips. Chips are pieces of flaked stone which measure no more than 10mm on their longest axis and which have no attributes which suggest that they should be classified with the implements. This is by far the largest class of artifacts. It makes up 53% of the individual pieces found, and this is undoubtedly an under-representation of their contribution to the total at the time of deposition. All these pieces weigh less than one gram, and casual experiments suggest that when exposed on the surface artifacts of up to two grams in weight can be removed from a site by normal strength winds (Ferguson 1977, 1981). Support for this concept is provided by comparing the percentage of chips recovered in the surface collections of Mokaré's Domain (24 %) with those of the excavated collections (69.6 %) on Table 6.3.

These tiny flakes, splinters, and fragments of stone could have been produced at any stage of the reduction sequence: from initial cortex removal; through the shaping, subsequent use, and any refurbishing of an implement, to accidental reduction of the

exhausted implement by human or natural agencies after discard. They are considered to be generally non-diagnostic, and were not further analysed.

Flakes: Included in this classification, which comprises about one third of the total flaked stone assemblage, are the pieces with a maximum dimension of greater than 10 mm which show evidence that they were purposefully struck from a larger piece of raw material. Presumably most of them were detached during core reduction and initial roughing out of implement blanks. Ideally, they should each show a point and bulb of percussion, compression rings, and radiating fissures, but these attributes are not necessarily present on every piece classified as a flake. There are various reasons for this: because, as in the case of many quartz artifacts, the materials from which they are made do not readily show these characteristic attributes; because they were produced by the bipolar stone working method where these attributes are not necessarily present (White 1968, Crabtree 1972, Flenniken & White 1985); because the parts of the flake showing these attributes has been broken off; and etc.

These artifacts are all considered to be waste from the stone working process, and none show evidence of further working, or macroscopic use wear. Many do have sharp edges suitable for cutting organic materials, however, and may have been utilized for cutting relatively soft materials which would have produced little edge-damage. Microscopic investigation of these implements could, in some cases, clarify this question.

Included within this category are many pieces which might have been classified as "blades" by other researchers because they meet a minimal definition of being twice as long as they are wide. This seemed not to be a worthwhile distinction because the casual stone working techniques employed in the Southwest, especially bi-polar reduction, unintentionally produces many flakes which satisfy this basic criteria. The author's previous analysis of stone assemblages from this region (Ferguson 1980a; 1980b; 1981) revealed no evidence that the prehistoric stone knappers had consciously sought to produce flakes of this nature, and it was felt that the use of the term might imply purposeful blade production when none was intended.

However, during the examination of the flakes collected in this research it was noticed that some of them do possess attributes, like parallel lateral edges and longitudinal dorsal ridges, which would be included in a more detailed definition of a blade (*cf.*, Bordes and Crabtree 1968; Crabtree 1972), and suggest, therefore, that purposeful blades were indeed being produced in the region. This observation was reinforced by the presence of three small "bladelet" cores and of three retouched and utilized implements made on "true" blades within the assemblage (see below). No attempt was made to quantify the flakes which might be considered to be "true" blades, but a subjective impression suggests that there were very few; and the proveniences of the bladelet cores and implements on blades suggest that the purposeful production of this flake sub-type was restricted to the late Holocene, as suggested by Dortch (1977).

Flaked Fragments: Flaked fragments are artifacts which have from one to three negative flake scars indicating that pieces have been struck from them, and which possess no other distinctive characteristics to allow them to be classified elsewhere. These are abundant in the sites, comprising about 5 % of the total assemblage (Table 6.3).

They can be considered cores in the strictest sense of the word, but they are extremely varied and amorphous. They are considered to be a sign of a very casual and opportunistic attitude to stone flaking; a situation where any available piece large enough to produce a suitable size flake for the task at hand is picked up and knapped without previous preparation, to be discarded immediately, as soon as that single flake is available for use. As with the flakes, these sometimes have sharp edges and may have been used for cutting but no macroscopic use wear was observed.

Percussion Flaked Cores: These are pieces on which all or the majority of the surface is covered with negative flake scars. There are 136 percussion flaked cores, approximately 1 % of the assemblage (Table 6.3). They were further divided into four sub-classifications based on their number of striking platforms and overall morphology. These are described individually below, and some descriptive statistics for them are presented on Table 6.4.

Single Platform cores: These, as the name implies,

TABLE 6.4. SELECTED DESCRIPTIVE STATISTICS FOR CORES

CORE*		LENGTH (mm)			WIDTH (mm)			THICKNESS (mm)			WEIGHT (g)		
TYPE	No.	RANGE	MEAN	SD	RANGE	MEAN	SD	RANGE	MEAN	SD	RANGE	MEAN	SD
1A	20	10-70	28.9	15.3	5-54	25.9	13.8	7-44	19.5	9.2	1-194	26.6	48.6
1B	3	13-17	14.8	2.1	12-15	13.7	1.5	15-17	16.3	1.2	2-4	2.7	1.2
2	9	9-67	43.0	22.4	9-62	38.1	20.2	9-55	34.3	18.5	1-198	79.3	79.5
3	12	15-107	35.9	23.7	14-70	31.1	14.6	8-60	16.8	14.0	1-40	12.6	12.2
4	84	9-77	30.7	15.2	7-72	25.0	13.2	5-58	18.1	10.1	1-235	22.6	45.0
5A	64	9-33	20.1	5.7	4-37	15.5	6.7	3-27	8.2	3.6	1-13	2.8	2.5
5B	7	11-31	20.6	7.3	10-28	18.4	6.1	4-15	8.0	3.7	1-7	3.1	2.1

*CORE TYPES:

1A. SINGLE PLATFORM - FLAKE
1B. SINGLE PLATFORM - BLADELET
2. GLOBULAR
3. BI-CONICAL
4. AMORPHOUS
5A. BI-POLAR
5B. QUADRA-POLAR

appear to have been reduced using a single flat surface as a striking platform and detaching flakes all around its margin. They vary greatly in size, weighing from 12 g to 194 g. The measurements shown on Table 6.4 were taken with the piece resting on its platform: the length and width being respectively the longest horizontal axis and the longest horizontal perpendicular measurement to that axis; and the breadth the vertical measurement from the platform to the highest point. When seen this way, they are approximately round in plan and tend to be "dome shaped" in section. Twenty six cores of this nature were collected. Three were incomplete, and another three, because they displayed regular, small, narrow flake scars were further sub-classified as "Bladelet" cores. An additional eleven single platform cores showed attributes which suggested that they had been used as scraping implements, and are classified and discussed below.

Twelve single platform cores were recovered from datable contexts. They were found in Moorillup Pool Tr. 2, and in the upper levels of Kamballup Pool Tr. 2, and both trenches at Kalgan Hall. The oldest one recorded was dated to before 10,000 BP in Kalgan Hall Tr. 2, and is estimated on the basis of the depth-age graph to be about 17000 years old. The only datable bladelet core was found above a date of 1820±110 BP in Kamballup Pool Trench 2.

Globular Cores: These are multi-platform cores which

have a spherical, "ball" shape. This shape comes from the core being turned during the process of reduction with each successive flake being detached using the negative flake scar of the previous one as a striking platform (Crabtree 1972:11). Nine of these were collected, and they display the same wide range of sizes noted with the single platform cores (Table 6.4). Only three were found in datable contexts, but their proveniences suggest that this method of core reduction may have had considerable duration in the Australian Southwest. One is dated to later than 380±90 BP near the top of Kalgan Hall Tr. 1, and one was found deep in the clay at Moorillup Pool Tr 2. The actual date of this clay deposit is unknown but it is certainly older than about 5000 years.

Bi-Conical Cores: These are multi-platform cores of a type previously noted in the Australian Southwest (Ferguson 1980a), and described succinctly elsewhere as "double-domed disks with wavey margins" (Stockton 1971). They appear to have been made by alternatively striking a flake from each dome using the negative scar of the flake previously detached as a striking platform (Crabtree 1972:38-9). The measurements on Table 6.4 were taken with the length being the longest axis of the disk and the width being the longest margin-to-margin perpendicular to that axis. The breadth is the longest perpendicular axis from the top of one dome through to the other. Of the twelve collected, only one was in a datable

context, and that was dated to between about 3500 BP and 1000 BP in Kalgan Hall Trench 2.

Amorphous cores: This final sub-classification includes the majority of the percussion flaked cores collected. As the name implies, they display no regular morphology, but are instead just a collection of variable shaped stones, each with its surface largely or entirely covered with negative flake scars. There is no apparent pattern to the detachment of the flakes from these cores. It is assumed that one platform may be used until exhausted, and then another suitable platform is chosen - probably on the negative scar of a previously detached flake, and so on, until the core is finally discarded.

Eighty-nine of these, including five incomplete ones, were recovered. They were found in datable contexts in Kalgan Hall 2, Moorillup Crossing 1, Moorillup Pool 2, Meingup Spring 1, and Waychinicup River 1. They are found throughout the period of prehistory revealed in the sites, as is typified by Kalgan Hall 2, where 19 of them were found and dated from before 18,850±370 BP to after 1180±80 BP.

In considering the importance of these morphological sub-classifications and their relevance to the reduction sequence, it was noted that Flenniken and White (1985) mention that single platform cores could be transformed into multi-platform cores at any stage of the reduction process. This suggests that at least some of

the sub-types are only ephemeral stages in the reduction sequence, and some thought was given to the possibility that one core sub-type could be transformed to another by further reduction. Without undertaking replicative experiments, it is suggested that if properly approached, any of the cores might be turned into any of the others. This could be done casually and easily in some cases, but would require conscious planning in others. Figure 6.3 is a diagram showing the possible directions of transformation, with those which could be done easily without forethought shown as solid lines, and those which would require design shown as dotted lines.

Bipolar Cores Bipolar cores are pieces of stone which show battering scars on opposed margins, with negative flake scars invading the piece below the battering on both faces. Pieces such as these were formerly thought to be functional implements, called *pieces écaillées* or fabricators; and were suggested to have been used as chisels or wedges (Semenov 1964:149-50; McCarthy, Bramell and Noone 1946:34). However, both ethnographic observations (White 1968a) and repeated replicative experiments (Crabtree 1972, Flenniken and White 1985) strongly suggest that their distinctive morphological attributes result instead from a piece of stone being placed upon an anvil and battered on the top with a hammerstone in an effort to drive off small flakes.

Seventy-six of these pieces were collected. Eight of them show evidence that they had been re-oriented during the battering and could more properly be called tetra-polar cores. This phenomenon has

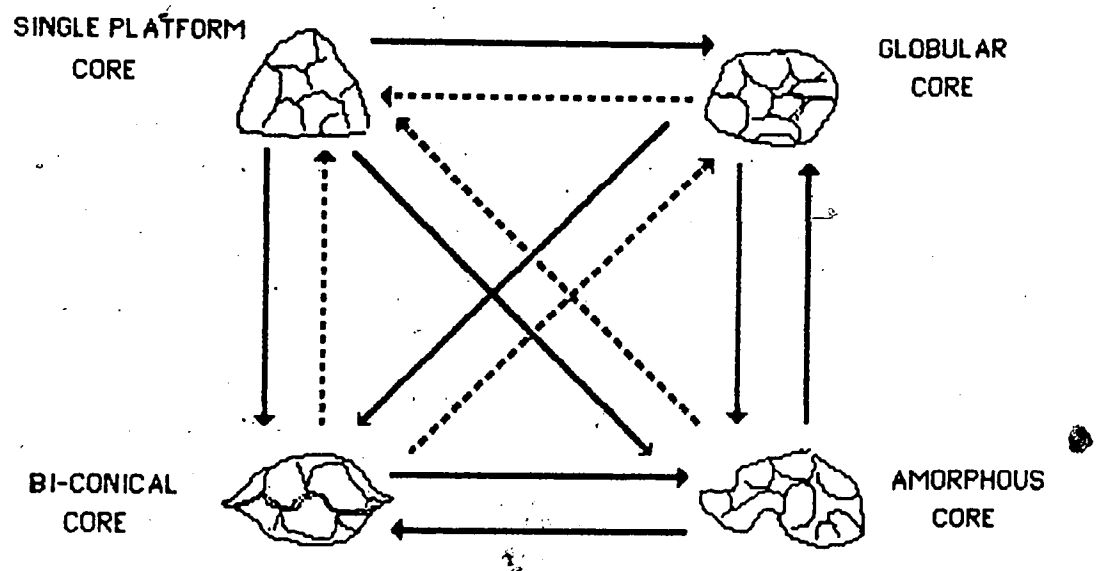


FIGURE 6.3. POSSIBLE TRANSFORMATIONS OF CORE TYPES WITH FURTHER REDUCTION. Those transformations which could be accomplished easily with little or no forethought are shown as solid lines, and those which could be done only with deliberate design are shown as dotted lines

previously been noted to occur occasionally in Southwest assemblages (Ferguson 1981:623). One tetra-polar and four bi-polar cores were incomplete, and not included on Table 6.4.

Fourty-seven of these cores were found in datable contexts, and indicate that the bipolar reduction technique has been practiced throughout the entire sequence. The oldest one found was in the lowest cultural level of Kalgan Hall 2, and estimated to be about 26,000 years old on the basis of the depth-age graph. They were also found in the lowest levels of Waychinicup River 1 and Moorillup Crossing 1. They are found in virtually every time period of Kalgan Hall 2, and are abundant in the late Holocene levels of Moorillup Pool 2.

Discussion - Continuity through Time:

With the exception of the appearance of a small amount of purposeful blade production in the late Holocene, there appears to be no major change in the basic methods of stone reduction in the period of concern here. Only direct free-hand percussion and bipolar techniques are in evidence, and both are present throughout the sequence. As with the choice of raw material, discussed in the last section, this aspect of stone working displays a high degree of continuity over time; and probably does not account for the major decline in artifact numbers during the mid-Holocene.

Table 6.5 shows some evidence for this by presenting the core types described above on the basis of presence or absence in each of the three periods previously discussed. With the exception of the

TABLE 6.5. CONTINUITY OF CORE TYPES OVER TIME.

The presence of a core type in the Mokaré's Domain assemblages is indicated by an **X** in the appropriate location. Core types not found during a given period in the Mokaré's Domain assemblages, but known elsewhere in the Australian Southwest for that period are indicated with a **K**, and a superscript number to indicate one of the locations at which it has been found.

	FLAKED FRAG.	SINGLE PLAT.	GLOBULAR	BI-CONIC	AMORPH	BIPOLAR	BLADELET
PERIOD III	X	X	X	X	X	X	X
PERIOD II	X				X	K[1]	
PERIOD I	X	X	X	K[2]	X	X	

1. Walyunga (Pearce 1978)
2. Quininup Brook (Ferguson 1981)

bladelet cores, all types are found in at least Periods I and III. The more common types of cores are also found in Period II, but since the sample of artifacts of any kind for this period is so small, it is not surprising that no examples of the rarer varieties have been noted.

In an attempt to clarify this situation, the reports of other excavated assemblages in the region were consulted to see if the core types were in evidence there. Some instances were noted (shown on Table 6.5), but as we shall see in the next chapter, there are very few artifacts dated to the mid-Holocene period anywhere in the Southwest.

No attempt was made to compare quantities of different percussion core sub-types over time. The actual numbers of artifacts involved are very small, and the ease with which one sub-type could be transformed to another suggests that the distinctions made are not too important, in any case. It was possible, however, to gain some idea of whether or not the ratio of percussion cores to bi-polar cores remained constant over time.

This needs to be done on a site by site basis. As was shown, each site has its own mix of raw materials, and the type of stone used dictates to a considerable degree how it is reduced. Only Kalgan Hall Trench 2, where 44 cores of both types were found (Table 5.4) provides a large enough sample; and comparison is really possible only between Periods I and III. This sample is admittedly quite small, but comparision suggests that these different basic reduction techniques remained in essentially equal proportions. There is 1

percussion core to every 0.57 bi-polar core in Period I, and 1 to 0.63 in Period III.

Cores of all types form a slightly lower percentage of the artifacts found in the late Holocene (Period III - 0.59 %) than in the late Pleistocene (Period 1 - 0.85 %) of Kalgan Hall Trench 2; a pattern also followed by the flaked fragments which drop from 3.6 % of the assemblage in Period I, to 2.4 % in Period III. This may suggest some type of discontinuity exits, perhaps a tendency to reduce individual cores more extensively in the late Holocene. Even though there has been continuity in actual reduction methods employed, if there has been a change in the amount of reduction applied to the raw material, it might severely affect the number of artifacts to head of population ratio.

One quick indicator of such trends, if they existed, could be a change in the proportion of small flakes (chips) to large flakes in the assemblages. More extensive reduction might show in a tendency for the basic debitage to get smaller over time. Figure 6.4, where the proportions of chips to flakes in the excavation assemblages are shown divided according to the three time periods, suggests that this is not the case.

In Kalgan Hall 2, where relatively large samples make comparisons between Periods I and III the most reliable, there is virtually no change in the proportions. In the other trenches, greater variations in the proportions occur, but there is no coherent trend. At Moorillup Crossing and Waychinicup River, the flakes appear to get

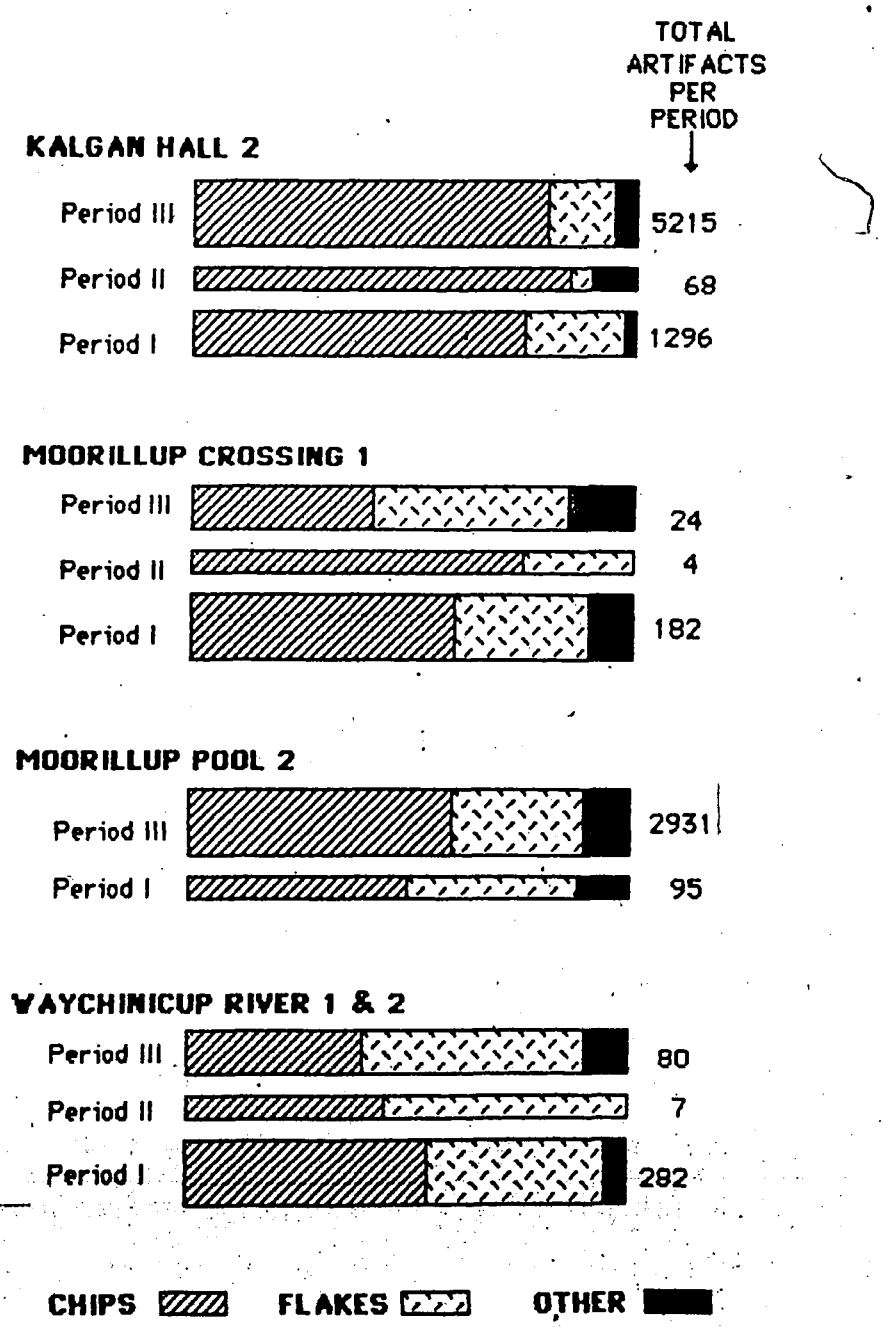


FIGURE 6.4. CHANGES IN PROPORTIONS OF CHIPS AND FLAKES OVER TIME.

larger with time, and at Moorillup Pool, they tend to get smaller.

Why there are proportionally fewer cores and flaked fragments in the late Holocene assemblage of Kalgan Hall remains somewhat of a mystery. Possibilities that the knappers of that period used larger pieces of raw material to begin the reduction process, or that more flakes and chips from reduction undertaken elsewhere were brought onto the site, have been considered; but there is no way of testing these. This is the only noticeable change in the proportions of the assemblage. It may represent, in conjunction with the appearance of blade technology, a significant discontinuity between Periods I and III, or it may be meaningless in real terms. Further consideration of variations in the stone reduction technology variable as a potential problem in equating numbers of stone artifacts with amounts of human population in the region is presented in the next section.

THE FLAKED STONE IMPLEMENTS.

This section deals with the 272 pieces of flaked stone in the Mokaré's Domain assemblages which exhibited attributes indicative of purposeful secondary retouch and/or use-wear, suggesting that the piece had been shaped and/or used to perform some task. These "implements" are virtually the only available clues to what activities, besides stoneworking, took place at the sites from which they were recovered, and they also supply some additional details regarding the nature of the stoneworking process in the region.

Retouch was applied to these implements for two quite distinct

reasons. In most cases, retouch was applied to the working edge of the piece in order to sharpen or to strengthen that edge for use. In a number of instances, however, retouch was applied not to the working edge, but to other margins of the piece, and its purpose appears to have been solely to blunt those margins in order to facilitate hafting or holding of the piece while in use. This latter type of retouch is called "backing" (Crabtree 1972:36).

Consequently, the implements were initially divided into two categories: "edged implements" and "backed implements", depending upon the basic function being served by the retouch upon them. Two implements which were both backed and edged were classified with the edged implements. Those artifacts without retouch, recognized as implements only on the basis of use-wear, were also classified with the edged implements because the use-wear was always on the working edge of the piece. In the sections below, the backed implements which form a coherent whole are dealt with first; and the edged implements, which can be subdivided into several functional types and sub-types, are discussed following that. Table 6.6 provides a summary of these classifications. Tables showing the divisions of the functional classifications into sub-types are presented with the appropriate sections.

Backed Implements:

A total of 84 pieces which had retouch in the form of backing were recovered in the surveys and excavations of Mokaré's Domain. All are quite small, less than 3 cm in length; and have been classified

TABLE 6.6. BASIC CLASSIFICATIONS OF FLAKED STONE IMPLEMENTS

	BACKED	EDGED IMPLEMENTS					
	MICROLITHS	SCRAPING	CUTTING	CHOPPING	PIERCING	MULTI PURPOSE	TOTAL
KH1	6	2	0	0	0	1	9
KH2	19	31	14	1	1	0	66
KP1	1	1	0	0	0	0	2
KP2	1	2	0	0	0	1	4
MC1	2	0	0	0	1	0	3
MP1	0	1	1	0	0	0	2
MP2	5	17	13	2	0	2	39
MS1	1	0	0	0	0	0	1
WR1	0	0	0	0	0	1	1
WR2	0	2	2	0	0	0	4
SURFACE	49	53	24	7	2	6	141
TOTAL	84	109	54	10	4	11	272

as "Backed Microliths".

Small, backed implements such as these are the hallmark of the "Australian Small Tool Tradition" (Gould 1969a, 1973). They have been an object of much study by Australian archaeologists, and are one of the very few distinctive Australian implement types which have a limited temporal distribution so that they can be used to aid in the dating of deposits. They have a broad spatial distribution across the southern two thirds of the continent (Mulvaney 1975:224), and have recently also been reported for some areas of the north (Hiscock and Hughes 1980).

In the Australian Southwest, backed microliths have been recovered from a number of sites and have recently been studied in detail by Pearce (1979). They are discussed at some length here because of their importance to the depopulation argument: first, in providing some temporal control for surface assemblages as was discussed in Chapter 3; and second, as an aid in the dating of some otherwise undatable Southwest excavated sequences which are presented in the next chapter.

Basic Description Of the pieces defined here as backed microliths, 76 are considered to be "whole". They are small flakes or blades. All have one or more of their margins blunted by steep retouch, one sharp unretouched edge, and, generally, a point either at one or both ends. They are normally triangular in cross-section, tapering from the backed edge to the sharp one, but the presence of dorsal ridges sometimes alters this symmetry; and the angle of the

unretouched edge can vary widely - from 17 to 68 degrees. Beyond these commonalities, overall morphology varies considerably (Illustration: Fig. 6.6d, and schematics: Fig. 6.5.).

Sub-Types: Elsewhere in Australia, depending upon the researcher and the source location, a variety of morphological sub-types have been noted (*cf.* McCarthy, Bramell and Noone 1946, Campbell and Edwards 1966, Coutts 1970, Gould 1977b, Bordes, *et.al* 1979, Kamminga 1980, Morwood 1981). However, it has been suggested that these sub-types are of doubtful statistical validity, and that backed microliths instead appear to form "a multidimensional continuum of varying shapes, sizes and patterns of secondary working and utilization," (Glover 1969:36 - see also Dickson 1973, Wieneke and White 1973, Pearce 1977b).

Two of these statistical studies have also noted a strong correlation between the morphology and the petrology of the backed microliths, and suggest that the raw material used may play a determining role in the ultimate shape of the artifact (Dickson 1973:10, Pearce 1979:171). To see if such might be the case with this assemblage, before proceeding with the development of any sub-classification of the backed microliths based on form, two tests were conducted correlating implement petrology with the attributes which seemed most suggestive of their overall morphology: first, with their length-breadth ratios, and second, with the number of retouched "points" these pieces exhibit.

The length-breadth ratio has been suggested by others as

perhaps the best statistical indicator of form for backed microliths (Glover 1967, Lampert 1971b, Pearce 1973; 1977b). In their studies, relative slenderness seems closely linked with McCarthy's major morphological sub-division of the implements into "Bondi Points" and "Geometric Microliths" (McCarthy, Brammel and Noone 1946). Bondi Points generally have a length-breadth ratio of over 1:2.0 and Geometrics most often have one below that. This arbitrary point was chosen to divide the 76 "whole" backed microliths into two groups, and these were correlated with two petrological categories: "quartz" and "other" (Table 6.7a).

There is, however, a more precise way of distinguishing between Bondi Points and Geometric Microliths. The essence of the difference between them is not that one is long and slender and the other is short and squat, but that Bondi points are asymmetric in form and pointed on only one end, while Geometric Microliths are symmetrical in form and pointed on both ends. As a more exact method of determining if any relationship between form and petrology exists in this assemblage, the microliths were divided into two categories based on the number of points they possessed and these were correlated with the same two petrological categories (Table 6.7b).

The Chi Square statistic correlating length-breadth ratio with petrology has a value of only 2.12 and it is not significant at the .10 level (Table 6.7a). It suggests that in this assemblage there is little correlation between the form and the petrology of a backed microlith when measured in this fashion; and it is contrary to the findings of

TABLE 6.7: CHI SQUARE TESTS CORRELATING FORM WITH PETROLOGY FOR BACKED MICROLITHS.

FORMULA (BRUNING AND KINTZ 1977:231)

$$\chi^2 = \frac{N(AD - BC)^2}{(A+B)(C+D)(A+C)(B+D)}$$

WHEN A,B,C,AND D ARE NUMBERS FROM THE CONTINGENCY TABLE →

A	B
C	D

A. CORRELATION OF LENGTH-WIDTH RATIO WITH PETROLOGY.

LENGTH-WIDTH RATIO	PETROLOGY: QUARTZ	PETROLOGY: OTHER	
> 2.0	10	31	41
< 2.0	14	21	35
	24	52	76

$\chi^2 = 2.12$

SIGNIFICANCE < .10

B. CORRELATION OF NUMBER OF POINTS WITH PETROLOGY.

NUMBER OF POINTS	PETROLOGY: QUARTZ	PETROLOGY: OTHER	
1	13	32	45
2	11	20	31
	24	52	76

$\chi^2 = 0.37$

SIGNIFICANCE < .50

the other studies, cited above, where the opposite is the case. Even less relationship is evident in the Chi Square statistic correlating the number of points with the petrology. It has a value only 0.37 and is not even significant at the .50 level (Table 6.7b). It seems apparent that whatever the reason for this dichotomy in backed microlith morphology, in this assemblage it does not result from requirements placed upon the knappers by the nature of their raw materials, and is more likely to source from factors related to differing functions or cultural "styles".

The classification of the backed microliths into morphological sub-types presented below is based initially upon this symmetric-asymmetric dichotomy; and it may be the only "real" division possible for these implements. These two major categories have been further subdivided on the basis of overall morphology and the proportion of the piece which has been backed, but these secondary subdivisions should probably not be taken too seriously. They were developed merely as an aid to description of the implements, and to illustrate a suggestion of one possible cause for much of the variation in backed microlith morphology. It is possible that many of the previously recognized backed microlith sub-types are not the result of either cultural "style" choices or functional necessities, but are merely partially finished pieces, rejects from the reduction sequence between preform blank and finished product which were, for one reason or another, discarded during the manufacturing process as unsuitable for the task for which they were intended.

These descriptive sub-types are shown as idealized schematic diagrams in Figure 6.5, and some descriptive statistics for each group are recorded on Table 6.8. It must be stressed, however, that within the two major groupings, the morphology of these implements really does form a continuum. Exact correspondence by most of the pieces to the idealized schematics should not be expected. The names in quotation marks used in the descriptions are taken from McCarthy, Brammel and Noone (1946:34-43).

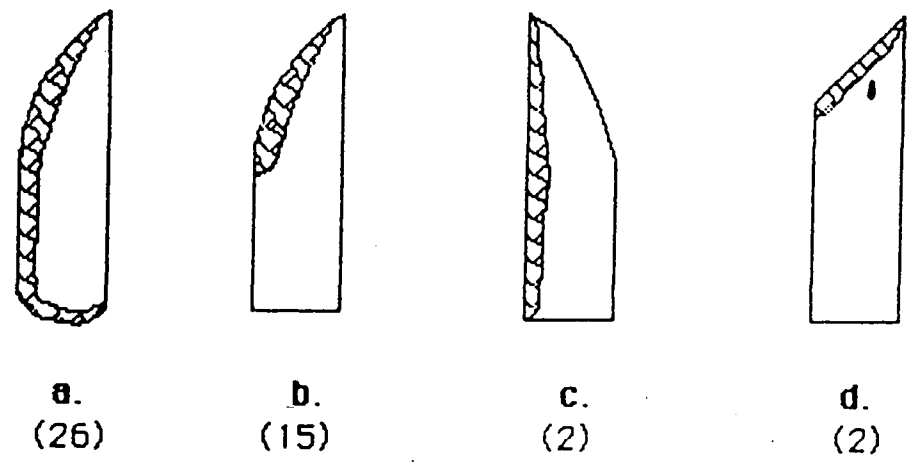
Description of the Implements: Sub-type 1a on Figure 6.5, the "Bondi Points", is the largest single grouping. Ideally it conforms to blade-like specifications, and except for the sharp edge, is backed around the entire margin. Many, however, have a length-breadth ratio of less than 1:2.0 (Table 6.8), and some do not have the butt retouched.

Sub-type 1b is similar except that the margin is only partially backed. If, as is suggested above, many of these implements are incomplete, then these could possibly be rejected early stages of Sub-types 1a, 2a, or 2b.

Sub-types 1c and 1d are residual categories for the asymmetrical points. Sub-type 1c includes two of the three backed microliths where the sharp edge is convex rather than straight. Although the curved edges are sharp, these pieces may be only broken examples of sub-type 1a. Sub-type 1d, the "Woakwine Points" are possibly only unfinished versions of sub-types 2c and 2d.

The great majority of the symmetrical, "Geometric", backed

SUB-TYPE 1: **ASYMMETRIC** (POINTS)



SUB-TYPE 2: **SYMMETRIC** (GEOMETRICS)

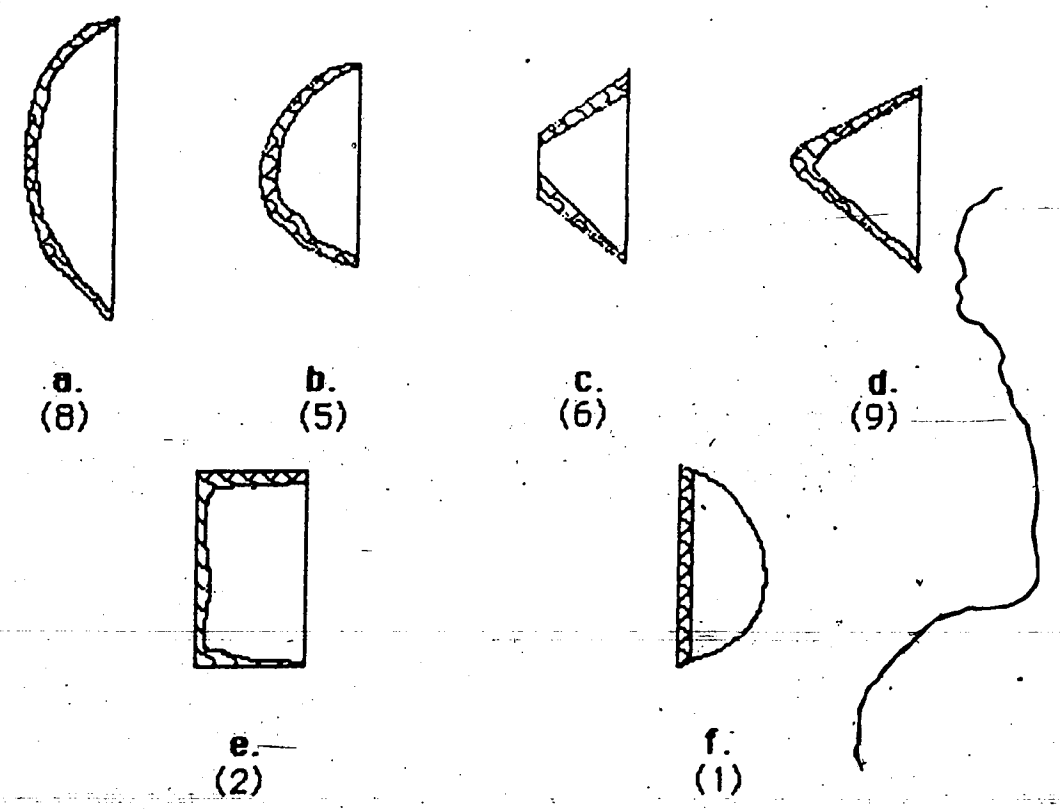


FIG. 6.5: SCHEMATIC REPRESENTATION OF BACKED MICROLITHS

TABLE 6.8: SELECTED DESCRIPTIVE STATISTICS FOR BACKED MICROLITHS.

SUB-TYPE	NO.	LENGTH (mm) RANGE	LENGTH (mm) MEAN	LENGTH (mm) SD	WIDTH (mm) RANGE	WIDTH (mm) MEAN	WIDTH (mm) SD	THICKNESS (mm) RANGE	THICKNESS (mm) MEAN	THICKNESS (mm) SD
1a	26	11-27	17.76	4.40	6-12	8.60	1.68	2-7	4.36	1.29
1b	15	9-27	14.43	4.85	2-11	6.21	2.39	2-7	3.71	1.64
1c	2	16-21	18.50	3.34	6-7	6.50	0.71	3-4	3.50	0.71
1d	2	12-30	21.00	12.73	5-14	10.00	5.66	3-5	4.00	1.41
2a	8	10-24	16.50	4.24	4-9	6.25	1.98	2-5	3.63	1.06
2b	5	11-16	13.60	1.95	8-13	10.00	1.87	3-4	3.40	0.55
2c	6	11-26	17.33	5.86	11-15	13.17	1.60	4-8	5.67	1.60
2d	9	11-19	14.25	2.78	5-12	9.12	2.23	3-6	4.00	0.76
2e	2	14-16	15.00	1.41	8-9	8.50	0.71	4-7	5.50	2.12
2f	1		17.00			7.00			5.00	

CONT.

EDGE LENGTH (mm) RANGE	EDGE LENGTH (mm) MEAN	EDGE LENGTH (mm) SD	EDGE ANGLE (°) RANGE	EDGE ANGLE (°) MEAN	EDGE ANGLE (°) SD	LENGTH-WIDTH RATIO RANGE	LENGTH-WIDTH RATIO MEAN
9-27	16.24	4.34	18-52	31.21	8.12	1.55-3.37	2.07
9-27	14.14	4.64	16-48	36.29	10.20	1.36-5.00	2.32
8-23	15.50	10.61	30-41	35.50	7.78	2.67-3.00	2.85
10-30	20.00	14.14	25-35	30.00	7.07	2.00-2.14	2.10
10-24	16.25	4.46	17-68	38.75	15.80	2.00-3.75	2.64
11-16	13.30	2.28	17-40	30.00	10.27	1.23-1.67	1.36
11-26	17.17	5.71	21-40	30.00	8.07	1.00-1.72	1.32
11-19	14.13	2.85	22-44	33.00	7.05	1.18-2.20	1.56
14-16	15.00	1.41	27-44	35.50	12.02	1.71.77	1.76
	19.00			38.00			2.43

microliths are so similar to one another that the distinctions shown here are probably spurious. There could be little, if any, possible functional or cultural distinctions between them. Sub-types 2a and 2b are both "rounded segments". They were separated into two groups here because of a marked discontinuity between their length-breadth ratios (Table 6.8).

The artifacts in sub-type 2c might be considered "Trapezes", but in no case is the margin parallel to the sharp edge backed (sometimes it is quite uneven), and often the backing does not extend the full length of the end margins. These are possibly pieces rejected on the way to becoming sub-type 2a, 2b or 2d. This latter group contains the "Triangles", but the apex is most often slighty rounded; and any difference between these and sub-type 2b is possibly more in the eyes of the archaeologist than in those of the original knappers. Sub-type 2e contains fully backed rectangular artifacts, a type not mentioned by McCarthy, Brammel and Noon (1946), and sub-type 2f contains the other backed microlith with a convex shaped sharp edge.

Production Techniques: Evidence of the manufacturing techniques employed in making backed microliths is not plentiful in this assemblage. However, if a comment by Dixon (1975) based upon his replicative experiments holds true - that the process simply involves choosing a suitably shaped flake and trimming away the unwanted margin; and if the opportunistic tendencies of Aboriginal stone working also prevail in this quarter, then we should expect that these artifacts might have been produced on flakes resulting from

virtually every stone reduction technique in the Aborigines' stoneworking tradition.

The presence of dorsal ridges on some of these artifacts suggest that they may have been produced on either snapped blade sections (Morewood 1981:19), or on bladelet blanks struck from micro-cores like those previously described. Some may also have been produced on bipolar struck flakes since a few show shattered, severed or sheared bulbs of percussion (Crabtree 1972:42).

The only strong evidence of the process was encountered at the Kojaneerup Springs Road Swamp Site, in the far northeast of Mokaré's Domain, where the majority of the small visible scatter consisted of one spongelite-derived amorphous core (Fig 6.6a) and twenty three pieces struck from that core. Several pieces appear to be missing and the original core cannot be reconstructed, but among the pieces present are three which have been classified as backed microliths: one whole sub-type 1a "Bondi Point" which is fully backed from both faces (Fig. 6.6d); one piece also backed from both faces which was probably a Bondi Point, but which has been transversley snapped 12 mm from the tip (Fig. 6.6b); and one small, crude flake which is partially backed from the dorsal face and is classified as an incomplete sub-type 1b (Fig. 6.6c) None of these pieces fit the negative flake scars left upon the core, but these scars and several of the other flakes from the core suggest that elongate, irregular, but pointed blanks were being produced for subsequent manufacture into backed microliths. This supports a previous suggestion based upon a pilot study that backed microliths from the Australian Southwest,

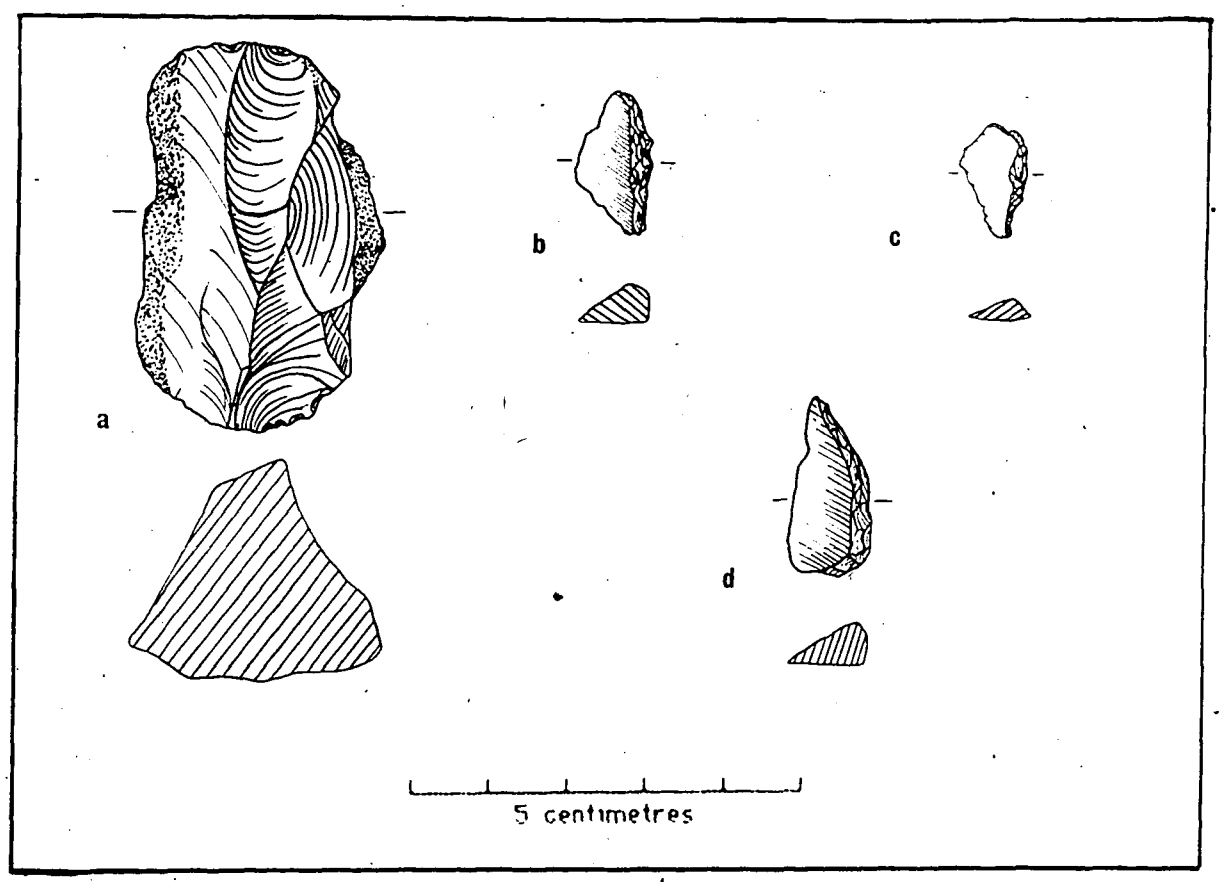


FIGURE 6.6. ARTIFACTS FROM KOJANEERUP SPRINGS ROAD SWAMP SITE.

Figure **a.** is the remains of a spongelite-derived amorphous core, and **b.**, **c.** and **d.** are subsequently backed pieces which were presumably initially struck from that core.

even many of those of blade-like proportions, were actually trimmed down from much wider blanks (Hallam 1984).

Function: Beyond these few details about stone reduction techniques, the backed microliths from Mokaré's Domain provide little information about the activities which took place there in the past. This is because we remain very uncertain about just what these small artifacts were used for. The various attributes suggest many possible uses; and, because they are a truly prehistoric implement, there are no ethnographic observations to serve as models. Speculators have examined a wide variety of possible cutting and piercing functions, but no conclusive evidence has yet been obtained.

Detailed accounts of the history of these speculations can be found in two recent papers concerned with backed microlith function (Kamminga 1980, McBryde 1984). Both of these authors present arguments to support a suggestion that these tools were used as spear barbs. Kamminga conducted micro-wear studies, and argues the spear-barb proposition from negative evidence. That is: since he was unable to find any definite traces of use-wear caused by cutting or other activities on the sharp edges of the microliths, he supports an alternative function which would produce no use-wear striations.

McBryde reviews her previously published materials from Graman Rock Shelter (N.S.W.) where there was a very strong contextual link between kangaroo remains and backed microliths (McBryde 1976:57). She also presents preliminary results from an on-going replicative study in which microliths are hafted as

spear-barbs and the spears thrown in a variety of conditions. She hopes that with enough tests, correlations will be found between the impact damages suffered by these replicates and damage patterns on archaeological backed microliths, but no significant similarities have yet emerged.

Kamminga's study also can be seen to support the proposition mooted above: that many of the artifacts normally designated as backed microliths were never used at all, but were instead discarded by their makers as unsatisfactory during the reduction sequence or immediately after the piece was completed. McBryde (1984) assumed otherwise on the basis that "their production did not pose technical problems for the craftsman", but in her own replicative knapping experiments reported later in the same paper she rejected just over one-third of the backed pieces because they were broken. Her criteria for acceptance of the remainder, although not explicitly stated, was presumably based on whether, as an archaeologist, she considered the piece to be "whole". The formal variation she allowed within this criterion is also unknown, but she probably would have accepted the Bondi from Kojaneerup Springs Road Swamp (Fig. 6.6d) which, although apparently "complete", was probably rejected by its maker.

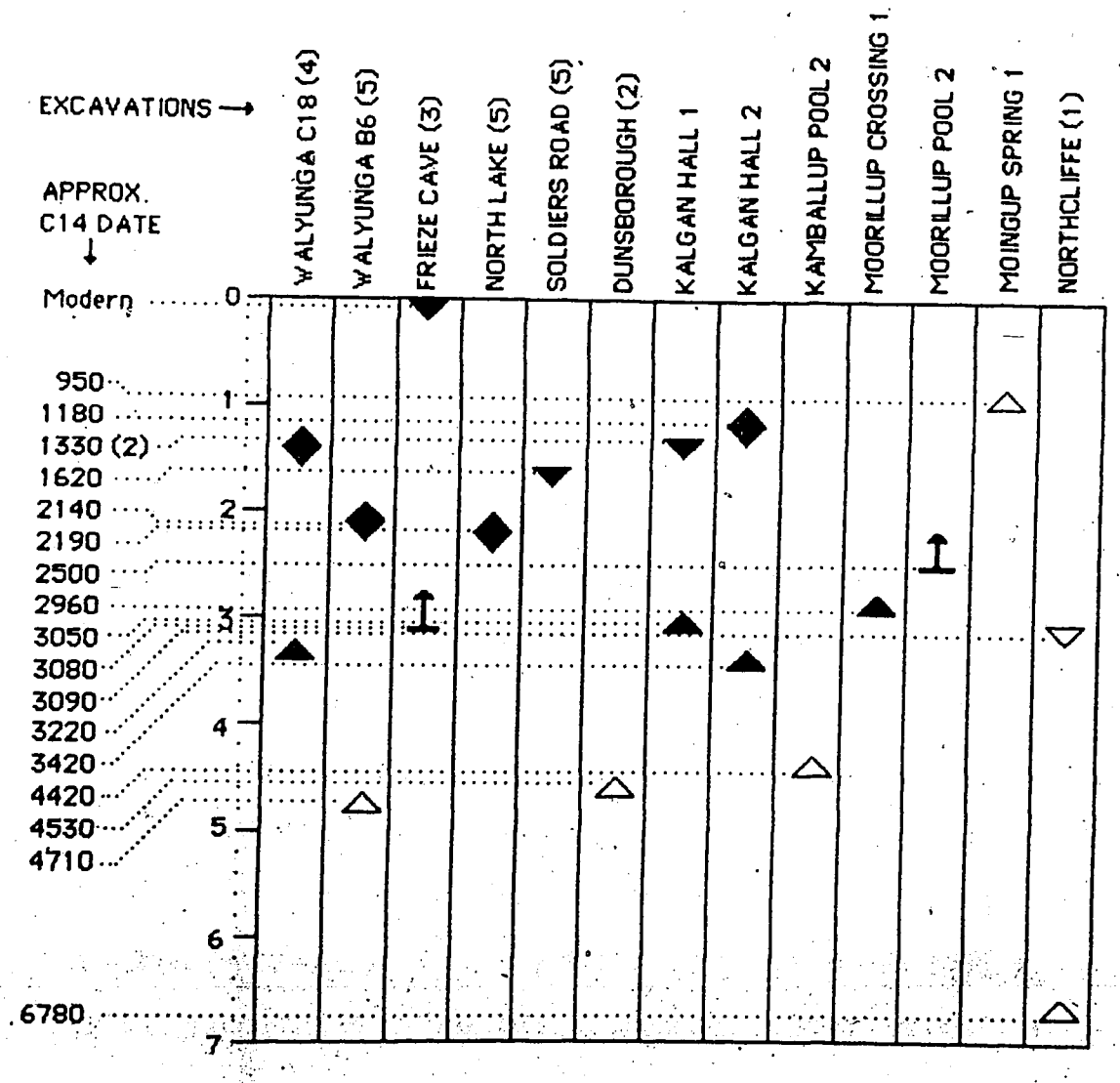
This proposition of 'non-function' is hard to test, and the only course open appears to be the continuation of replicative experiments like McBryde's worthwhile example. Whatever the reality of the situation, the presentation of a convincing case for any given function (or non-function) for artifacts which have neither ethnographic analogues nor recognisable use wear will be very difficult indeed.

Temporal Distribution - A discontinuity in the Artifact Sequence: There are now thirteen trenches in the Australian Southwest containing both backed microliths and radiocarbon dates (Table 6.9), and it seems apparent that they must have been introduced into the region sometime between 3500 and 4500 years ago.

In four trenches with sequences which span the majority of the Holocene, the lowest levels containing backed microliths have been directly dated to between about 3000 and 3500 BP: Walyunga C18 (3220±100 BP - Pearce 1978), Kalgan Hall 1 (3050±110 BP), Kalgan Hall 2 (3420±90 BP), and Moorillup Crossing 1 (2960±260 BP). In three other Holocene trenches, dates from levels below the lowest microliths provide a maximum age for the introduction of these implements as sometime later than about 4500 BP: Walyunga B6 (4710±215 BP - Pearce 1979), Dunsborough (4530±90 BP - Ferguson 1980b), and Kamballup Pool 2 (4420 ±220 BP). Although their use appears to diminish and they drop from some sequences during the second millennium BP, they have been dated to later than 950±90 BP at Moingup Spring, to modern times at Orchestra Shell Cave (Hallam 1972), and are present in undated levels immediately below ground surface at Walyunga B6, Northlake (Pearce 1979), and Dunsborough.

The dates for microliths from the site of Northcliffe (Dortch 1975, Dortch and Gardner 1976) appear to fall outside the pattern established by those in all other sites. At Northcliffe the approximately 30 cm thick microlithic levels are not directly dated;

TABLE 6.9: RADIOCARBON DATES ASSOCIATED WITH BACKED MICROLITHS IN AUSTRALIAN SOUTHWEST EXCAVATIONS.



KEY:

- ▽ CLOSEST DATE ABOVE MICROLITH LEVELS
- ▼ DATE FOR UPPERMOST MICROLITH LEVEL
- ◆ DATE WITHIN MICROLITH LEVELS
- ↥ DATE FOR MICROLITHS AT BOTTOM OF TRENCH
- ▲ DATE FOR LOWERMOST MICROLITH LEVEL
- △ CLOSEST DATE BELOW MICROLITH LEVELS

REFERENCE:

(1) DORTCH 1975
(2) FERGUSON 1980b
(3) HALLAM 1972
(4) PEARCE 1978
(5) PEARCE 1979

but charcoal collected just below the lowest microlith yielded a date of nearly 7000 BP, and charcoal from just above the uppermost microlith produced a date of about 3000 BP. These dates provide maximum time limits for the presence of microliths at the site, but do not necessarily suggest the conclusion of the excavators that the earliest of these implements "is about 6000 years old" (Dortch and Gardner 1976:271). Some of the charcoal for the lower date was collected from up to 13 cm below the lowest microlith (Dortch and Gardner 1976:271); and given the highly variable sedimentation rates in evidence at many Southwest sites, a considerably later date for the introduction of these implements at this site is a strong possibility.

Quininup Brook Site Four provides an example of how variable the sedimentation rates in the otherwise apparently uniform sands of the region can be. There, a level approximately 15 cm thick which built up slowly over 8000 years is directly superimposed by a level about 80 cm thick of identical sands which built up in only about 4000 years (Ferguson 1981). The sedimentation rates at Northcliffe would not have to vary to this extreme for the actual date for the lowest microlith to fit the pattern apparent in the other sites of the region. It would require only an accumulation of 13 cm of sediment in 3000 years followed by an accumulation of 30 cm in 1000 years to bring it into agreement with the 4000 BP date for the introduction of these implements which is suggested here.

Although further investigation at the Northcliffe site is needed to provide a precise date for the introduction of microliths there, there now seems little reason to question the overall pattern of a

beginning of this phase of the Southwest stone tool industry at about 4000 BP. As will be seen, this is the clearest discontinuity within the Southwest artifact sequence. It provides the only strong evidence of non-comparability between artifact densities in the various levels of the excavations. As this event appears to occur at about the same time as the late Holocene increase in artifact numbers in the trenches of Mokaré's Domain, it calls into question whether the increase suggests a corresponding increase in human population numbers or merely reflects more stone working per knapper to satisfy the demand for additional desired end products. Further discussion of this point is provided in the summary at the end of this chapter.

Edged Implements:

The edged implements have been classified into four basic functional types: scraping implements, cutting implements, chopping implements, and piercing implements. Most of these categories have been further sub-divided into morphological sub-types, and since some implements have been used for more than one purpose, a fifth major category, multi-purpose implements, has been used (Table 6.6).

Classification began by comparing all the edged implements against three specific ethnographic models developed through study of the ethnohistorical literature and museum specimens. These models were for the stone components of the basic composite implements used by the Nyungar: the Australian adze - a scraping implement, the *Taap* knife - a cutting implement, and the *Kadja* hatchet - a chopping implement.

Eighty-four of the 188 edged implements compared favourably enough with one or another of these models to be so classified. The remainder, which fit none of the models, were first divided into unifacial and bifacially retouched and/or utilized pieces. The bifacially retouched pieces were classified as either chopping implements or piercing implements on the basis of their overall morphology and edge damage.

The unifacially retouched and/or utilized pieces (the "scrapers" of some archaeologists) for the most part were classified provisionally as either scraping implements or cutting implements using a generalized ethnographic model which ascribes function on the basis of the cross-section angle of the implement's retouched or utilized edge (Ferguson 1980a). Generally, those with relatively high angles, above 60°, were classified as scraping implements; those below as cutting implements.

It must be stressed, as it was in the original study, that function for any given artifact cannot be ascribed on the basis of edge-angle alone. The ranges of possible angles for each of these functions overlap somewhat, and there are other possible functions for which unifacially retouched stone implements might be used. However, as a "rule of thumb", it appears to be a valuable way of provisionally classifying these implements into functional types. This has been borne out repeatedly by independent ethnographic observations, (White 1968b, Gould, Koster and Sontz 1971, Hayden 1979) and is reinforced by the presence on these implements of distinctive types of macroscopic use-wear and modes of retouch

which have been associated with those functions as a result of replicative experiments (Ferguson 1980a, 1982).

For this present study, the author has retreated from the cumbersome and time consuming methods of measuring edge-angles which were used to ensure accurate readings in his previous work. The measurements given below were taken following Wilmsen (1968) using a polar co-ordinate grid and lens stand. The margin of error is estimated to be less than ± 5°.

A few of these unifacial implements possessed two or more retouched and/or utilized edges the angles and use-wear of which suggested that the piece had been used for both scraping and cutting, and these were classified as multi-purpose implements. A few, also, displayed distinctive morphological and use-wear attributes which suggested that in spite of their edge-angles they were either piercing implements (awls) or engraving implements (burins) and were so classified; although all those in the latter category also possessed additional retouched edges and were ultimately classified as multi-purpose implements.

Complete discussions of these functional types and sub-types, the ethnographic models by which they were classified, and descriptions of the implements themselves are presented in the sections which follow.

SCRAPING IMPLEMENTS:

This is the largest functional category of the flaked stone

implements. It includes 109 of the 188 pieces, and over half of these (58) were classified as adze-flakes through the use of an ethnographic model. The remainder are considered to have been hand-held scraping implements and were divided into three sub-categories on the basis of overall morphology. It is suggested that for the most part these were wood-working tools, used to shape the wooden implements that formed the majority of the Nyungar tool kit; although, in some cases, the scraping of other materials, hide and bone, cannot be ruled out.

Adze-Flakes

The Australian "Adze" is a composite implement consisting of a small flake of stone which is end-hafted to a wooden shaft with resin mastic. It has an almost continental wide distribution, noticeably absent, on present information, only in Tasmania and the South-East. Often recorded ethnographically (*e.g.* Spencer and Gillen 1904:636-8, Roth 1904:13-20, Horne and Aiston 1924:101-3, Thomson 1964, Tindale 1965, Gould 1969b:79, Gould, Koster and Sontz 1971, Hayden 1979), it is primarily used as a wood working tool and the shaft is normally held in a two-handed grip to draw the cutting edge of the stone toward the user across the object being shaped. It is a versatile implement, and the working action can vary from short and forceful chopping, gouging or adzing strokes, to even and controlled scraping or planing strokes, depending on the reqirements of the task (Sheridan 1979:11-17).

The type of work to which the implement can be put is apparently conditioned to some extent by the nature of its wooden shaft. For heavy-duty rough-out work the shaft is normally just a simple, sturdy stick; but for lighter finishing and maintenance tasks, the stone is more often fitted to the base of a spear thower. In the ethnohistorical literature of the Australian Southwest, only the latter type of hafting is recorded, and the only use noted is as a light-duty scraping implement for the shaping and maintenance of spears (Hassell 1975:16, King 1827:138, Moore 1884:54, Nind 1831:27, Ogle 1839:57, Roth 1903:68, Salvado 1851:147).

The shape of the hafted stone is altered during the woodworking process. Although it can be quite variable, the adze-flake ideally begins as a discoid or semi-discoid piece with relatively steep retouch around the majority of the margin. With use, the working edge becomes dulled and it is subjected to frequent refurbishing while still in the haft (Hayden 1979:27,56). As a result of this process, the body of the piece is reduced; with the working edge becoming progressively less convex, then relatively straight, and finally concave (Fig. 6.7). At any point in this reduction sequence the user may decide that the edge is no longer suitable for use or resharpening, and either discard the piece or reverse it in its haft so that the exhausted edge is hafted in opposition to the new working edge (Tindale 1965, Gould, Koster and Sontz 1971).

Only two measurable attributes remain relatively static during the use and refurbishing of an adze-flake. These are its thickness and its longest dimension parallel to the working edge. This dimension is

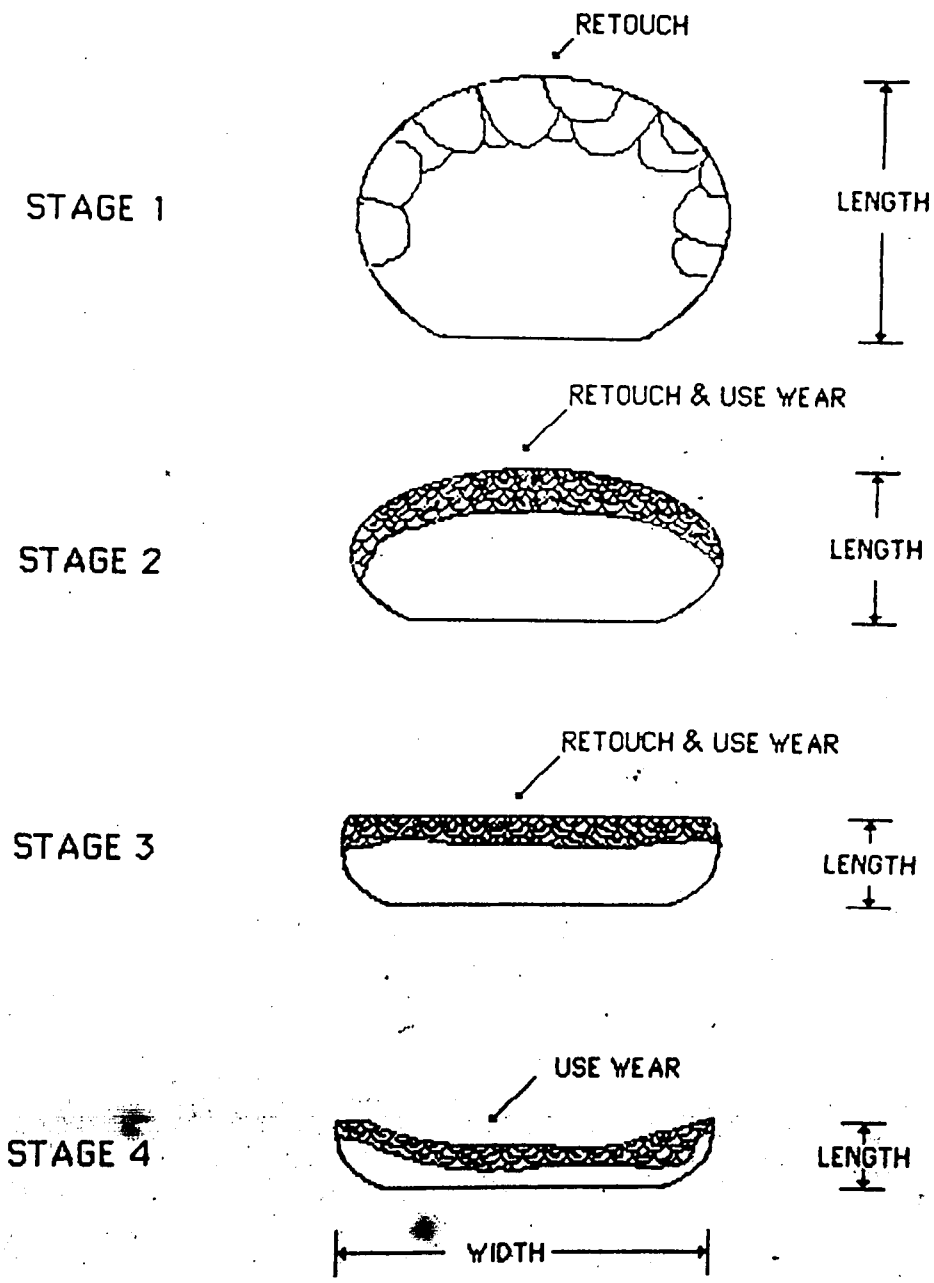


FIGURE 6.7: IDEALISED SCHEMATIC OF STAGES OF ADZE-FLAKE REDUCTION DURING USE.

here called "width" following Gould and Quilter (1972). The length (the longest axis perpendicular to the working edge), the weight, and the length of the working edge will all obviously change with reduction and are of little value as indicators of original size.

Ethnographic adze-flakes can be quite large, at least up to 66 mm wide and 22 mm thick (Lampert 1981:Table 43), but few archaeological adze-flakes approach these dimensions. This probably results from a tendency for archaeologists to classify exceptionally large specimens as hand-held scrapers (Gould 1977b:96). On the other hand, archaeological adze-flakes can be much smaller than their ethnographic counterparts, with measurements as low as as 6 mm wide and 3 mm thick (Gould 1977b:84). This discrepancy possibly results from the small size of the ethnographic sample; but, at least in the Western and Central Deserts, stratified excavations suggest that adze-flakes have tended to become larger over time (Saggers 1982:124). The edge-angles of these hafted scraping implements range from as low as 27 degrees (Gould 1977b:96), but assemblage means cluster around 70 degrees (Lampert 1981:Tables 43,45, Saggers 1982:Tables 1-6).

Model 1: "True" Adze-Flakes: Following Stockton (1982:157), a previously hafted adze-flake found in an archaeological context cannot be *definitely* distinguished from a similar hand-held scraping implement unless:

(1) it has traces of the hafting medium still adhering to it; or,

(2) it is a "slug". A slug is a worked-down adze-flake that has

been discarded because it is no longer suitable for either refurbishing or use. There is, however, no precise definition of just what level of reduction is necessary for an archaeological piece to be so labelled. Most authors apparently consider artifacts approximating Stage II on Figure 6.7 to be slugs (e.g. McCarthy 1976:Fig 12,4-10, White and O'Connell 1982:Fig. 5.15, b-d, Gould 1977b:83-84), but Stockton has cautioned that exceptionally small scrapers can be held in the hand (1982:157); and although unlikely, it is conceivable that many so called slugs could have been reduced in this manner. To avoid confusion, a more restrictive definition of slug is adopted here: a "true" adze-flake slug is a scraping implement which has been worked down so far that it would be physically impossible for the use-wear present on the edge to have occurred while the implement was being held in the hand.

As expected from the porous sands of Mokaré's Domain, no scraping implement in the assemblage bore any traces of resin; however, at least three did satisfy the second criterion in such a manner as to convince the most die-hard sceptic (Fig. 6.9g, h., Fig. 6.10g.) . They confirm the ethnohistorical observations that hafted adze-flakes were in use in the region; imply the presence of other adze-flakes within the assemblage which were rejected as unsuitable either at some earlier stage in the use-refurbishing reduction sequence, or prior to initial hafting; and warrant the development of a less restrictive model which might aid in the identification of these others.

Model 2: "Adze-flakes": Although individual inspection would be neccessary and subsequent reclassification of some pieces expected; based on the qualitative and quantitative information presented in the descriptions of ethnographic adzes above, the term "adze-flake" was provisionally ascribed to any implement which possessed all of the following criteria:

(1) a single convex, straight or concave retouched and/or utilized edge with an angle over 60° covering at least one entire margin of the artifact, or two such edges on opposed margins of the piece.

(2) a maximum width (measured on the axis parallel to the working edge) of 70 mm or less.

(3) a maximum thickness of 25 mm or less.

Fifty implements met all these criteria. With a single exception, each appeared suitable for hafting as an adze flake, and each could easily be matched with one of the four stages of adze reduction shown on the schematic (Fig. 6.7). The exception was a relatively large, odd shaped piece made from a granitic material unlikely to have been suitable for adzing purposes, and this was reclassified as a hand-held scraping implement (Fig. 6.11f). Although the width measurement in the model was set large enough to include the extreme range of adze-flakes recorded ethnographically (Lampert 1981:Table 43); other than this one piece, no implement which met the other two criteria had a width greater than 48 mm. Big, flat,

scraping implements with one or two (opposed) working edges are virtually absent from this assemblage.

Subsequently, nine implements which had edge-angles below 60° were included within the adze-flake classification on the basis of similar overall morphology and/or use-wear. This brought the total number of artifacts so classified to 58. These are described below following a consideration of possible adze-flake sub-types.

Tula and Non-tula adze-flakes: There is considerable confusion in the archaeological literature regarding sub-types of adze-flakes. Even "Tula", the name of the only commonly occurring, well defined and easily recognizable morphological sub-type, is often misused. In the classic sense, the Tula is a discoid or semi-discoid flake which has the working edge trimmed on its distal margin around a prominent bulb of percussion; and where the opposed, relatively large, striking platform meets the bulbar face at an obtuse angle of about 120 degrees (Sheridan 1979:9, McCarthy 1976:31, Mulvaney 1975:77).

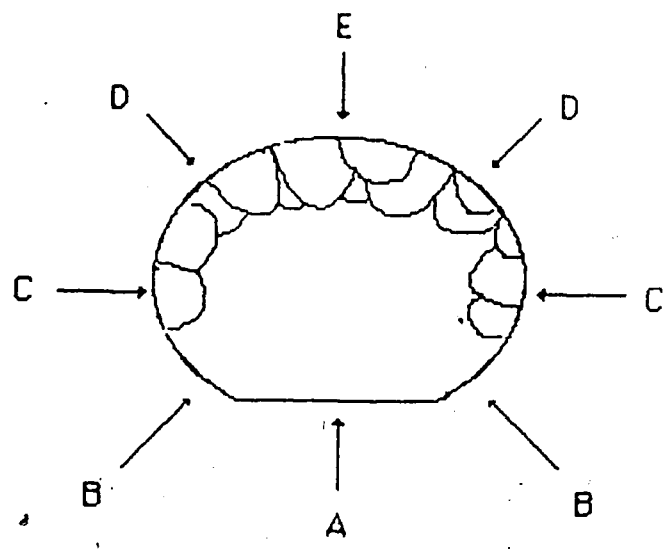
It appears to be a culturally patterned, regional variation centred on the Central Desert where its use has been ethnographically recorded (Spencer and Gillen 1904, Roth 1904, Horne and Aiston 1924), and it is believed to have served primarily for heavy-duty, chopping and adzing work. Although the limits of its distribution are not yet clearly understood, it has recently been suggested on the basis of replicative studies that there is a functional correlation between this adze-flake and the use of *Triodia* (spinifex) resin as a mastic, so

that Tulas will perhaps only occur as a patterned type in areas where this sort of resin is readily available (Sheridan 1979).

Unfortunately, the term has been loosened in some of the literature to denote any adze-flake on which the point of percussion is more-or-less opposed to the working edge (*e.g.* Glover and Lampert 1969:224 - and consequently - Gould 1971; 1973; 1977b, Gould, Koster and Sontz 1971). Glover and Lampert also mistakenly demanded the use of the term "burren" for any adze flake on which the working edge was prepared on a margin more-or-less lateral to the point of percussion (1969:224). This not only loosens a term originally reserved for the relatively rare case where, after an adze-flake has been worked down on two opposed margins, the ends had been sharpened, and the piece rehafted as an engraving tool (McCarthy *et.al.* 1946:30); but the use of the Tula-Burren dichotomy also attempts to establish a false order for the vast majority of Australian adze-flake assemblages where the position of the point of percussion in relation to the working edge is unpatterned and has apparently neither cultural nor functional implications. Such is certainly the case with the adze-flakes from Mokaré's Domain where, when it can be determined, every conceivable orientation of working edge to point of percussion is evident (Table 6.10).

In the first edition of the *Prehistory of Australia*, Mulvaney (1969:73-4) discussed these problems in adze-flake nomenclature, accepted the use of Tula in the classic sense, and established a convention of denoting all others as "non-tula". This has been generally accepted, and would have solved the problem had not two

TABLE 6.10: POSITION OF STRIKING PLATFORM OR FORMER POSITION OF STRIKING PLATFORM ON ADZE-FLAKES RECOVERED FROM MOKARE'S DOMAIN.



A	B	C	D	E	?	Tot.
13	5	16	4	1	19	58

new terms for adze-flake sub-types, "flat-adze" and "micro-adze", been subsequently introduced into the literature. The use of these terms also attempts to establish false order on highly variable assemblages; and, because both of them have been applied to adze-flakes found in and adjacent to the Australian Southwest, they require some comment.

Flat-adzes: The flat-adze was defined by Gould and Quilter (1972) on the basis of metrical comparisons between two small collections of adze-flakes. The first collection, subsequently to be designated as flat-adzes, contained 22 pieces gathered from the surface of several widely scattered sites in the Australian Southwest and adjacent parts of the Western Desert. The second collection contained a mixture of 21 ethnographic and recent archaeological adze-flakes from the interior of the Western Desert near Warburton.

The definition was based upon the observation that the mean values for three important attribute measurements (edge-angle, maximum width, and maximum thickness) were radically lower in the first collection than in the second. However, compared with much larger samples now available for both areas, neither of these collections appears at all representative of its area.

On Table 6.11 the relevant attribute means for these two collections are shown in relation to those from five larger and more coherent samples, including the one from Mokaré's Domain as representative of the Australian Southwest, and one from Puntutjarpa which was obtained from the exact same area of the Western Desert as Gould and Quilter's second collection. Three other large samples

TABLE 6.11: COMPARISON OF MEANS FOR THREE SIGNIFICANT ADZE-FLAKE ATTRIBUTES.

COLLECTION	EDGE-ANGLE NO.	EDGE-ANGLE MEAN	WIDTH (mm) NO.	WIDTH (mm) MEAN	THICKNESS (mm) NO.	THICKNESS (mm) MEAN
"FLAT-ADZES" (SW) [1]	22	46.5°	22	27.0	22	5.4
WEST. DESERT (WA) [1]	26	67.0°	21	43.0	21	14.7
PUNTUTJARPA (WA) [2]	184	68.5°	184	23.4	184	8.4
JAMES RANGE EAST (NT) [2]	253	63.4°	199	32.4	253	9.3
MACDONALD DOWNS (NT) [3]	97	72.4°	97	31.6 [6]	97	13.3 [7]
KANGAROO ISLAND (SA) [4]	90	70.5°	90	31.7 [6]	90	13.0 [7]
MOKARE'S DOMAIN (SW) [5]	62	69.5°	53	24.0	58	7.9
TOTAL	734	66.9°	666	29.2	725	10.0

[1] Gould and Quilter 1972 Figs.4,5,&6.
[2] Data grouped from Tables 1-3, Saggers 1982.
[3] Data grouped from Table 44, Lampert 1981.
[4] Lampert 1981 :Table 44.
[5] See Figure 6.8, this volume.
[6] Width is Termed "length" (Lampert 1981)
[7] Thickness is termed "height" (Lampert 1981)

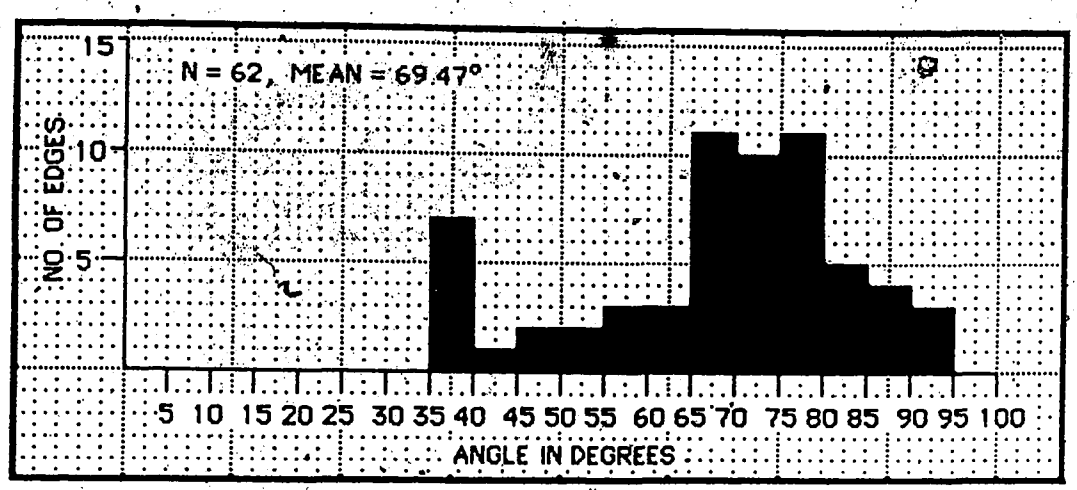


FIGURE 6.8a: DISTRIBUTION GRAPH OF ADZE-FLAKE EDGE-ANGLES.

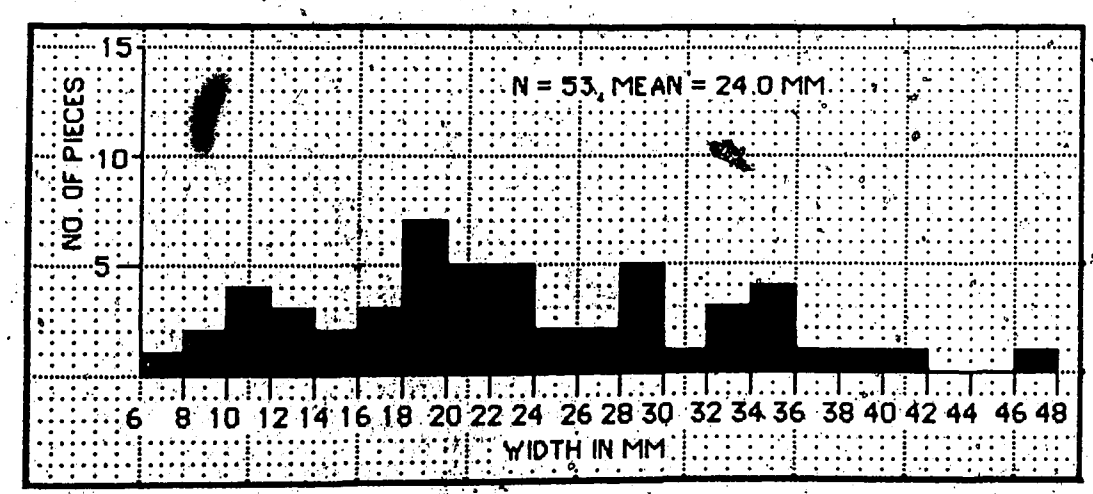


FIGURE 6.8b: DISTRIBUTION GRAPH OF ADZE-FLAKE WIDTHS.

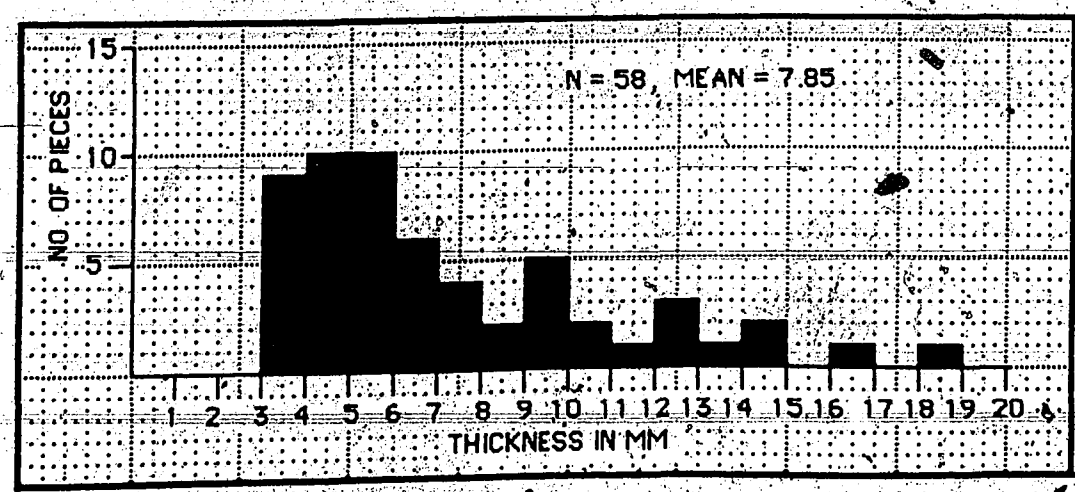


FIGURE 6.8c: DISTRIBUTION GRAPH OF ADZE-FLAKE THICKNESS.

FIGURE 6.8: DISTRIBUTION GRAPHS OF SELECTED MOKARE'S DOMAIN ADZE-FLAKE ATTRIBUTES.

from further east (James Range East and Macdonald Downs from the Northern Territory and Kangaroo Island from South Australia) are included as a basis for wider comparison.

The radically low mean edge-angle of the Flat-adze collection (46.5°) is clearly anomalous; and significantly, the Mokaré's Domain sample mean (69.5°) adheres closely to the norm for all assemblages (66.9°).

The mean width of the flat-adzes (27.0 mm) is close to the average for all assemblages (29.2 mm), and here it is the high mean of Gould and Quilter's second collection (43.0 mm) which is anomalous. The extreme bias of that sample is evident when this mean is compared to the extreme bias of that sample is evident when this mean is compared to the one from nearby Puntutjarpa which is the lowest mean width of all (23.4 mm).

The low mean thickness of the flat-adzes (5.4 mm) and the high mean thickness of the second collection (14.7 mm) are at opposite extremes of the range for all assemblages. Again, it is the second collection which is clearly unrepresentative of its region, as Puntutjarpa (8.4 mm) falls with Mokaré's Domain (7.9 mm) toward the bottom of the range.

The only trend evident on Table 6.11, when the larger samples are compared, is that Western Australian adze-flakes tend to be somewhat smaller, narrower and thinner, than those from further east. To determine whether or not this trend is real will require several more large samples from both regions; but in any case, it is difficult to believe that it could be of much cultural significance.

Even if the samples in Gould and Quilter's study had been representative of their regions, it would still have been incorrect to claim, as they did, a new "class of flaked stone tool from Southwest Australia". Since the ranges of all attribute measurements for the two collections overlap considerably, their categories "adze" and "flat-adze" are not mutually exclusive, and it would be impossible to determine in many cases to which group a given adze-flake should belong.

Micro-adzes. A similar problem exists with the term "micro-adze". As Mulvaney (1960:61) had done previously, Gould originally attached the prefix "micro" to adzes not to denote a distinctive artifact type, but simply to indicate that the adze-flakes in question were relatively smaller than others (Gould 1969c:168-9). In a subsequent publication, he set the division between the two arbitrarily at 25 mm, but reiterated that "there is a continuous distribution in size and weight between micro-adzes and adzes" (Gould 1971:154-6). In the definitive publication of the Puntutjarpa assemblage, however, the term was not only rigidified to denote a sub-type of adze-flake, but the arbitrary dividing point of 25 mm was ignored so that the width ranges of micro-adzes and adzes overlap. The former can now be up to 29 mm in width and the latter as low as 10 mm in width (Gould 1977b: 82-85).

Gould was perhaps led by the small, biased sample collected in his salvage ethnographic research and used in the Gould and Quilter study above, to believe that "real" adzes had to be big; but the

application of the term "micro-adze" appears to be totally subjective. Since it is not even justified by a bimodal distribution in adze widths, it should be discarded. Its use obscures the facts that the size of adze-flakes varies enormously in almost all assemblages, that the width distribution of these implements is apparently always more-or-less continous, and that relatively small adzes are so common that the mean width of no large assemblage yet collected falls above 32 mm (Table 6.11).

Summary. Only the classic Tula can be accepted as a valid adze-flake sub-type. All the rest appear to be simply "adze-flakes". The tula was the first type to be described, but the latter are ubiquitous and far more numerous, so it seems unnecessary in most instances to affix the qualifier "non-tula" to them. In processing the adze-flakes from Mokaré's Domain, each was examined to see if it possessed the qualitative attributes necessary for it to be called a tula, and two such implements were found. These are noted in the descriptions below, but it is not known whether they reflect a conscious cultural choice or are merely products of random opportunistic selection as seems to be the general case in this highly variable assemblage.

Description of the Adze-Flakes.

Due to the absence of sub-types, the adze-flake assemblage from Mokaré's Domain was divided for descriptive purposes into four subjective morphological groupings roughly corresponding to the four

idealized stages of adze reduction shown on Figure 6.7. Each group is summarized below and relevant descriptive statistics for each are presented on Table 6.12.

Group 1: (Fig. 6.9a,b, Fig. 6.10a,b).

There are 21 adze-flakes in this group but three are incomplete fragments. Two whole implements were classed as tulas (Fig. 6.9a, Fig. 6.10b). Some, including one tula (Fig. 6.10b) show considerable use wear. Others, including all the rest shown on the plates, have very little edge damage and may not have been used at all.

Artifacts from this group were found throughout the excavations. One tula (Fig. 6.9a) comes fom Moorillup Pool 2, 54 cm BD, and is dated to about 2500 BP. The other (Fig. 6.10b), from 30 cm DBS in Waychicup River 2, is dated to about 1400 BP.

The oldest of all the Group 1 adze-flakes (Fig. 6.10a) was found broken into three pieces at 145 cm BD in Kalgan Hall 2. It is older than 18,850±370 BP, and estimated from the depth/age graph to be roughly 20,000 years old. This relatively finely retouched and delicate implement was evidently broken at, or just after, the final stage of manufacture and was never used. The three fragments were on approximately the same level; and although they fit perfectly back together, each is a distinctly different colour as a result of variable iron staining.

Group 2: (Fig. 6.9c,d, Fig. 6.10d,c.)

Eighteen of the provisional adze-flakes, including two broken fragments, were placed in this group. Two have opposed working edges, suggesting reversal in the haft. As with Group 1, above, some

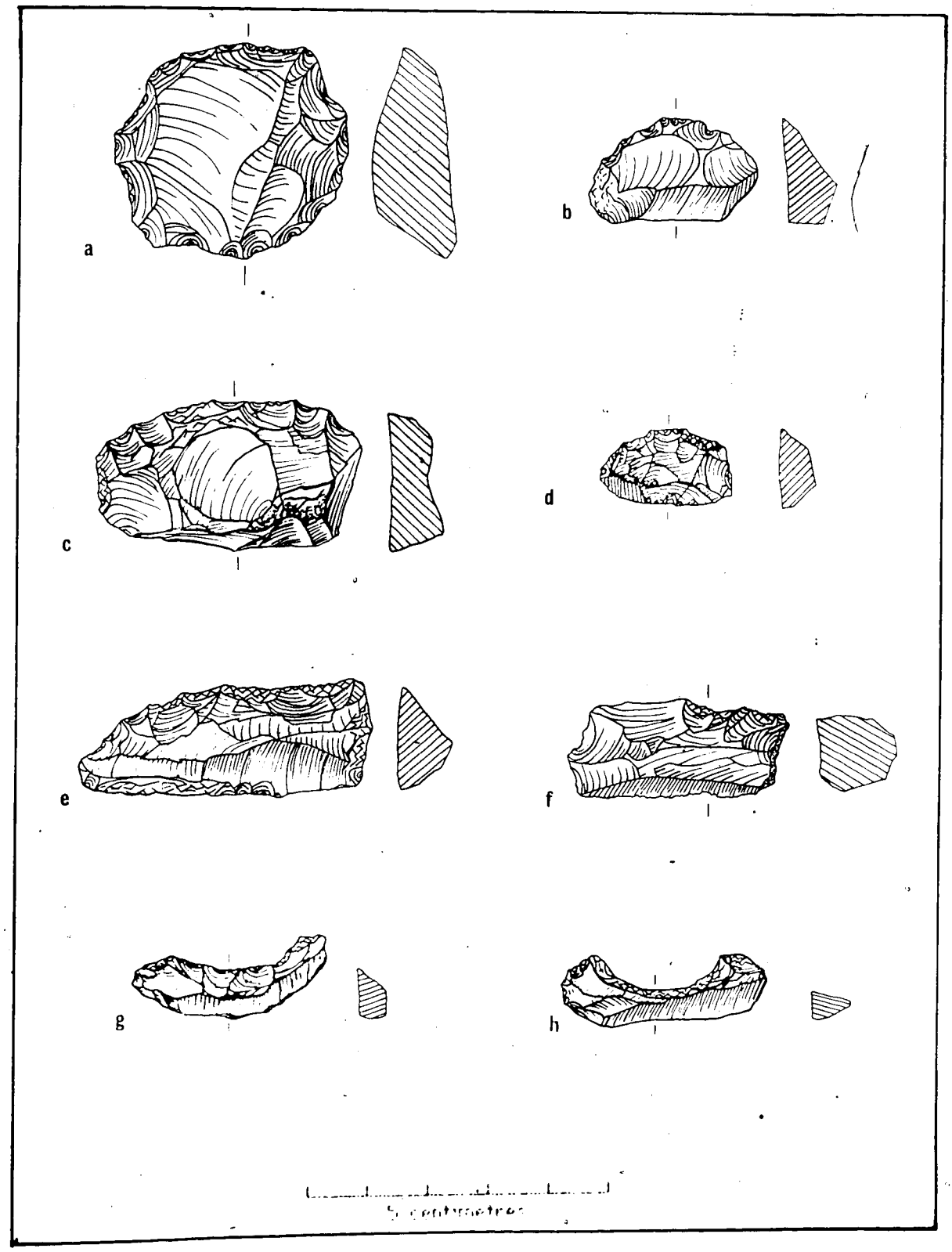


FIGURE 6.9. **ADZE-FLAKES I.**

Figures **a.** and **b.** are classified as sub-type 1; **c.** and **d.** as sub-type 2; **e.** and **f.** as sub-type 3; and **g.** and **h.** as sub-type 4.

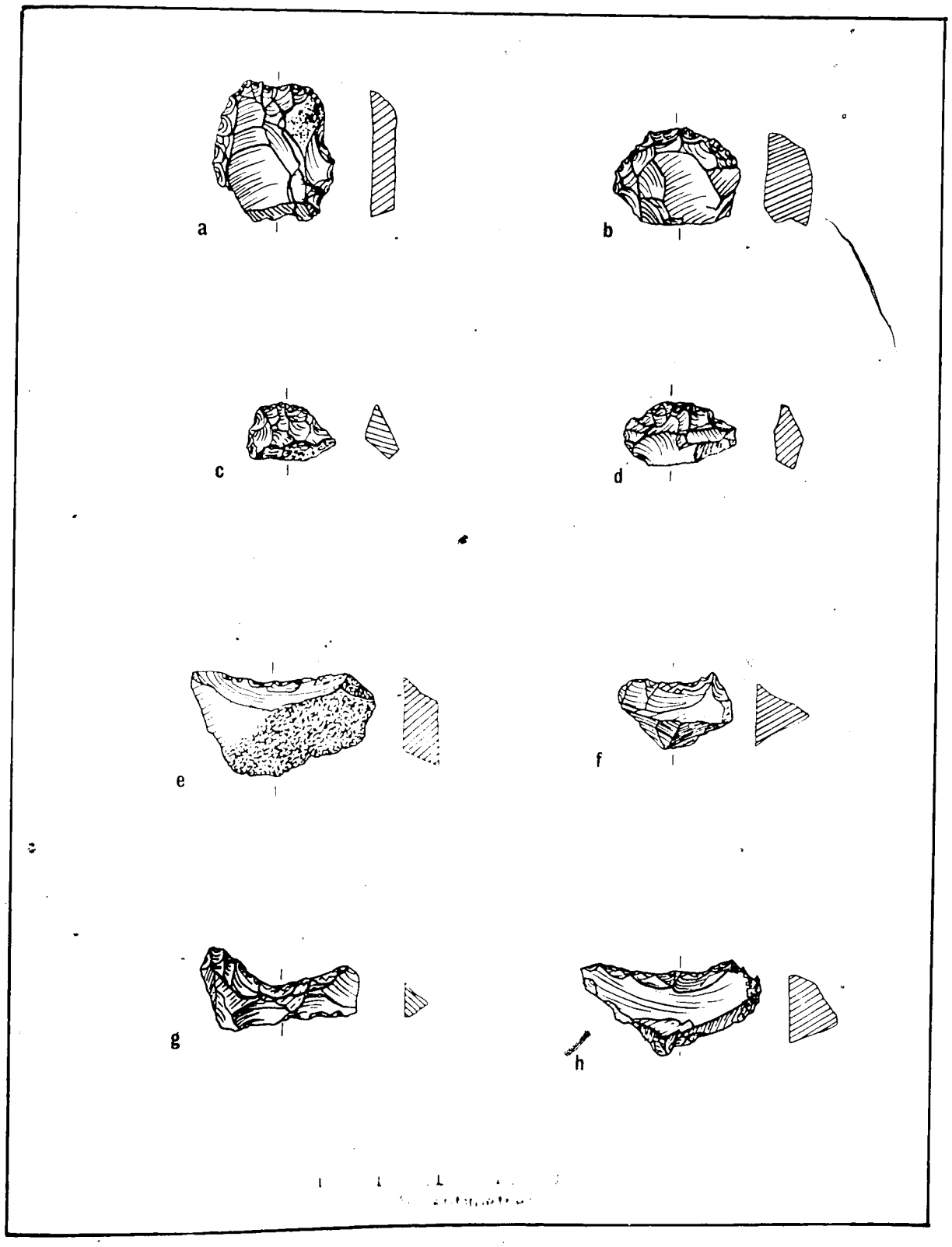


FIGURE 6.10. ADZE-FLAKES II.

Figures **a.** and **b.** are classified as sub-type 1; **c.** and **d.** as sub-type 2; **e.** and **f.** as sub-type 5; and **g** b-type

TABLE 6.12: SELECTED DESCRIPTIVE STATISTICS FOR SCRAPING IMPLEMENTS.

		LENGTH (mm)			WIDTH (mm)			THICKNESS (mm)		
TYPE	NO.	RANGE	MEAN	SD	RANGE	MEAN	SD	RANGE	MEAN	SD
Adze-Flakes										
STG 1	18	12-34	21.11	8.67	9-38	22.11	10.06	4-19	8.94	4.84
STG 2	16	9-35	15.50	6.86	11-42	23.44	9.54	4-14	7.31	2.91
STG 3	14	12-30	16.93	4.94	8-48	25.79	10.42	4-15	7.64	3.48
STG 4	5	12-15	13.20	1.29	24-34	28.60	4.50	4-10	6.20	2.22
Other										
AMORPH	12	23-70	39.18	15.30	20-49	27.64	8.74	8-25	13.18	4.58
CORE	6	25-69	48.17	17.12	17-45	32.83	9.35	17-35	25.17	6.43
NOTCH	5	26-57	39.75	12.84	18-34	27.50	7.19	9-16	13.00	3.16

CONT.

WEIGHT (G)			RETOUCHED EDGE LENGTH (mm)			EDGE ANGLE (°)		
RANGE	MEAN	SD	RANGE	MEAN	SD	RANGE	MEAN	SD
1-18	5.55	5.75	9-76	28.87	16.98	36-90	62.44	16.20
1-17	3.56	5.02	10-42	24.25	9.39	47-86	70.69	12.44
1-8	3.07	2.67	8-30	21.00	6.93	36-80	71.36	11.24
1-3	1.60	0.96	19-28	24.00	2.06	72-93	85.60	9.61
3-58	25.18	9.56	13-43	27.64	9.75	63-84	73.09	6.95
4-122	51.00	41.79	22-99	72.67	37.51	85-94	90.50	3.39
7-20	13.00	3.35	12-36	22.00	10.86	67-88	79.50	9.61

show very little edge-damage, suggesting that they were either never used or that they were discarded soon after refurbishing. Others, including all those illustrated, exhibit very heavy use wear and might be called "slugs" by some authors (e.g. McCarthy 1976:Fig. 13:4,6,7,10).

The oldest of the artifacts in this group (not illustrated) comes from 90 cm B.D. in Kalgan Hall 2 and is estimated to be about 6000 years old from the depth/age graph.

Group 3: (Fig. 6.9e,f, Fig. 6.10e,f.)

Fourteen of the provisional adze-flakes are included in this group. All are whole, and two have opposed working edges (Fig. 6.9e). Seven, including Figure 6.9e & f, and 6.10e, exhibit one or more flake scars from blows which have removed portions of the heavily damaged edges. This accounts for the relatively low edge-angles on some of the artifacts in this group (Table 6.12). Moreover, it gives inferential support to the proposition that these implements were hafted. Attempts to refurbish adze-flakes often result in haft breakage (Hayden 1979:27); and if this were to happen with pieces such as these, they would probably be discarded as too small to be worth the effort of re-hafting.

Even though these more-or-less straight edged pieces are conceivably still large enough to be hand-held, in most cases it is highly unlikely; and it seems legitimate, especially in light of the evidence for partial refurbishing, to nominate them as "probable adze-slugs". They are found throughout the excavations and two were found associated with fairly early dates. One (Fig. 6.9f) was recovered between 80 and 85 cm DBS in Waychinicup River 2, well

below the date of 7430±170 BP, and is estimated from the depth/age graph to be about 12,000 years old. The other (Fig. 6.10e) is somewhat less "probable", but was found at 137cm BD in Kalgan Hall 2 directly associated with the date of 18850±370 BP

Group 4: (Fig. 6.9g, h, Fig. 6.10g, h)

There are only five artifacts in this group, and it is suggested that this category is so much smaller than the others because it is relatively rare that adze-flakes are worked down to this degree. All of them are whole and all show a high degree of use-wear. Three are undoubtedly adze-slugs (Fig. 6.9g, h, Fig.6.10g). The other two, including (Fig. 6.10h.) could conceivably have been hand-held and are considered "probable adze-slugs". One of the former (Fig. 6.9g) is an oddity in that it is fully backed from both sides of the piece. This with Figure 6.10h are the oldest dated artifacts in this group. They were found between 55 and 60 cm BD in Kalgan Hall 2 and dated to about 3000 years ago.

Evaluation of the Model

The model itself supplies no way of guaranteeing that the pieces provisionally categorized as "adze-flakes" were hafted rather than hand-held, but it does enable a demonstration that pieces in all ways similar to ethnographic adze-flakes were being manufactured and used in Mokaré's Domain throughout the over 19,000 years covered by the excavations. Although in the past it was assumed that resin hafting was not developed in Australia until the beginning of the "inventive phase" about 6000 years ago (Mulvaney 1969:107), many

authors, especially in the West, are now claiming adze-flakes for Pleistocene levels in their excavations: Dortch illustrates late Pleistocene adzes from Miriwun in the Kimberleys (1977:121, Fig 7); Schrire (1982) describes "adzes or adze-like scrapers" from level III of Nawamoyn (21,450±380 BP) and level III of Malangangerr (18,000-24,000 BP) in Arnhem Land; and, using a model in most ways similar to this one, Lampert (1981) has identified "scraper/adzes" as old as 16,000 BP from Seton Cave on Kangaroo Island, South Australia. In criticism of Lampert, however, Stockton (1982:157) argued that: "Such small flakes may indeed be adzes, but before generally presuming this function in very old specimens, unambiguous evidence (e.g. associated slugs, traces of resin) will need to be found in widely dispersed contemporaneous assemblages."

For the Australian Southwest and adjacent areas, the data to satisfy Stockton's requirements are being found. In addition to the probable adze-slugs from Waychinicup River and Kalgan Hall described above, three other sites now provide this kind of information. In Devil's Lair there is a retouched quartz flake with traces of what appears to be mastic adhering to it. It is dated to about 25,000 years BP, and from its illustration it would here be classified as a probable adze-slug (Dortch and Merrilees 1973:107-8, Fig. 7c). At Puntutjarpa pieces which Gould calls adze-slugs, but which under the stricter criteria used here would be probable adze-slugs are found throughout the sequence, and one of them is from a level dated to 10,170±230 BP (Gould 1977b:Fig. 82;1). Finally, one "true" adze-slug and one probable adze-slug were found at Quininup Brook in an assemblage dated to

before 6000 BP, and it is highly probable that both came initially from levels dated from about 10,000 BP to about 18,000 BP (Ferguson 1980a:fig. 2, i, j).

While still probably not strong enough to convince the most die-hard skeptic, this evidence suggests that it would be unwise to reject the concept of hafted adze-flakes from the late Pleistocene out of hand. Also worthy of note in this context are the several small "scrapers" from Upper Swan which are dated to about 38,000 BP (Pearce and Barbetti 1981:Plate 1, Fig.2). It may be that the hafting of artifacts is very much older than was previously imagined.

Hand-held scraping implements:

All high-angled pieces not otherwise classified were considered to be scraping implements. There were 51 of them, and presumably, they were held in the hand during use. Two morphological sub-categories which had been observed during the author's previous implement analysis in the Southwest (Ferguson 1980a) were noted. These are here termed "core" scraping implements, and "notched" scraping implements. The remainder, by far the majority, were placed in a generalized category called "amorphous" scraping implements. These are described below and selected descriptive statistics for each sub-classification are presented on Table 6.12.

"Core" scraping implements (Fig. 6.11a, b, c.)

A total of eleven pieces, five whole and six broken fragments, were included in this classification. Presumably, they attained their present morphology through reduction as single platform cores, and

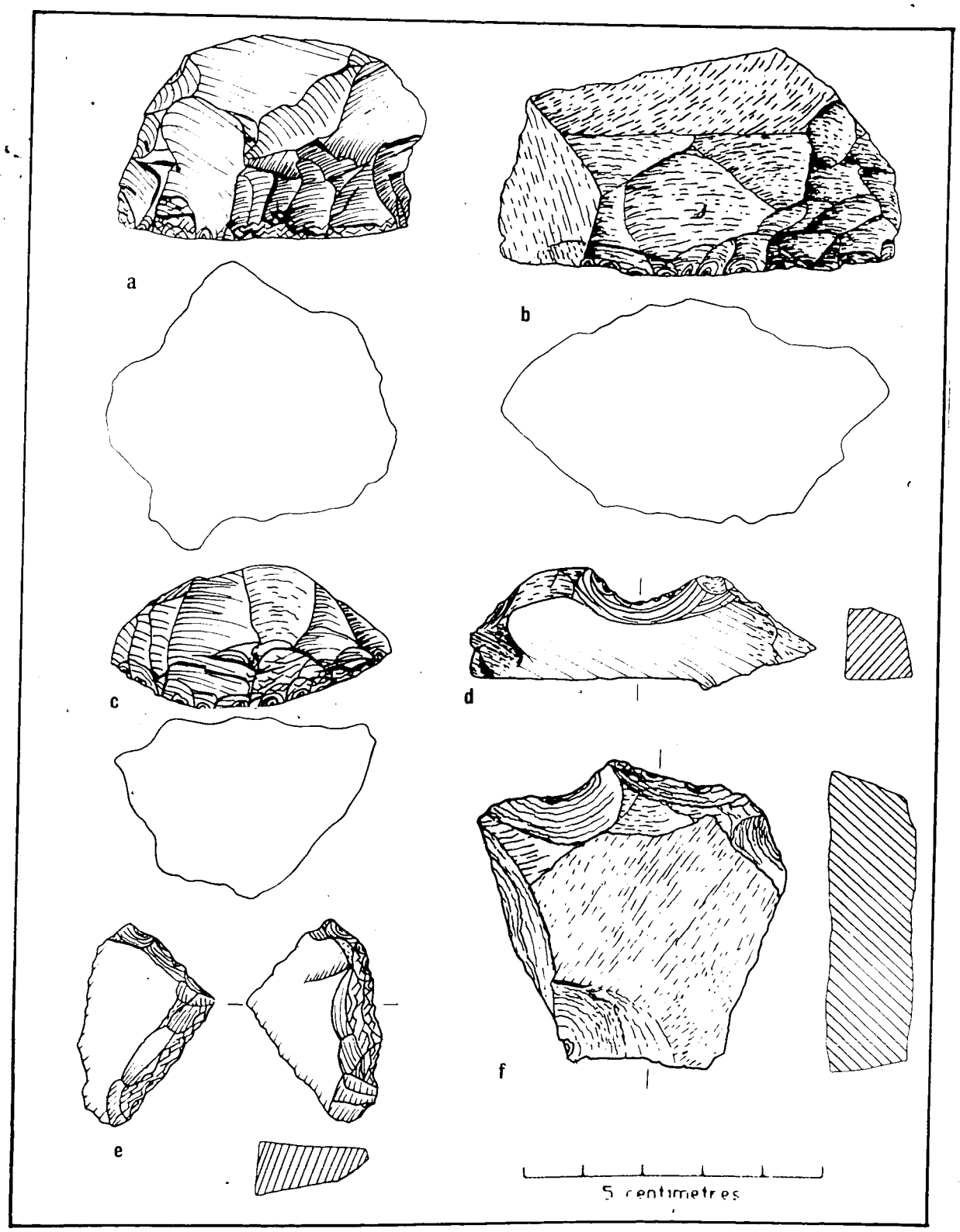


FIGURE 6.11. HAND-HELD SCRAPING IMPLEMENTS.

Figures **a**. **b**. and **c**. are core scraping implements, **d**. is a notched scraping implement, and **e**. and **f**. are amorphous scraping implements.

were then opportunistically used as scraping implements. They all show a large amount of edge damage, but as was discussed above, it is normally extremely difficult to confidently differentiate, even with a microscope, between edge-damage resulting from core preparation or unsuccessful attempts to remove more flakes, and that resulting from use as a scraping implement. Consequently the decision whether any given artifact should be classified as a single platform core or a core scraping implement is a highly subjective one.

Implements of this type appear to be present throughout the sequence. The oldest are two broken fragments (not illustrated), found in Kalgan Hall 2 between 125 and 135 cm BD, and estimated from the depth/age graph to be about 16000 or 17000 years old. A dolerite piece (Fig. 6.11b.) was found in Moorillup Pool 2 and is dated to about 2500 BP. While relatively small by standards elsewhere, it is the largest such implement of any age found in Mokaré's Domain, and bears the closest resemblance to the well known horse-hoof core (McCarthy 1976:20-1).

"Notched" scraping implements: (Fig. 6.11d.)

Five scraping implements were placed in this category. All have only isolated instance of retouch and/or use wear which always takes the form of a concave notch, and all are presumed to be whole. These are equivalent to Bordes' "retouched notches" (1979:43), McCarthy's "concavities" (1976:34), or Gould's "spokeshaves" (1977b:82), and presumably were used for shaping the rounded shafts of wooden implements.

None, however, were found in datable context, and the most

surprising thing is that there are so few of them. At Quininup Brook fully 22 % of all implements were placed in a similar category. Even allowing for slight differences in classification procedures, this dissimilarity in assemblages is quite striking, and as yet no testable suggestion of a possible reason for it is available.

"Amorphous" scraping implements. (Fig. 6.11e, f.)

There are thirty six artifacts in the classification, and they each have from one to three, more-or-less straight, retouched and/or utilized edges. The majority, 25 pieces, are only broken fragments which are often quite small, and consequently provide little information.

Some of the whole pieces are within the general size range of adze-flakes, and, indeed, may have been hafted. They were excluded from that classification for three main reasons: they had more than two working edges or had two adjacent working edges, as in the case of Figure 6.11e which resembles an adze flake in all other ways; they had a working edge which did not cover one entire margin of the implement; or, as in the case of the granitic piece discussed above (Fig. 6.11f.) they just didn't look like an adze-flake. These artifacts are found throughout most layers of the excavations. The oldest (not illustrated) was from 120 cm BD in Kalgan Hall 2, and dated from the depth/age graph to about 15,000 years ago.

CUTTING IMPLEMENTS:

Fifty four of the Mokaré's Domain edged-implements were classified as cutting implements. This is the second largest

functional category, but is probably not truly representative of the amount of stones in the assemblage which were actually used for this purpose. Almost any sharp flake will suffice for most cutting functions. In a study of 22 ethnographic cutting implements from the Western Australian Museum (Ferguson 1980a) 27% showed no retouch. Futher, unlike scraping and chopping, the cutting function normally produces little distinctive macroscopic use-wear; generally only a slight chipping and rounding of the edges. Consequently, unless a cutting implement was retouched or extensively utilized, it would not be recognized as an implement and would be classified as debitage.

Artifacts were placed in this category primarily on the basis of their edge-angle and on the presence of a distinctive form of retouch, "denticulation", which has been linked with the cutting function (Ferguson 1980a). Presumably these implements were used primarily for cutting relatively soft organic matter: flesh, skins, and vegetable materials.

Teep Flakes:

Teep knives are briefly described in Chapter Two. Although these composite implements were the most common type of cutting implement used in the ethnographic present of the Australian Southwest, it was generally assumed that their stone components consisted only of tiny unmodified flakes which are indistiguishable from any other small, sharp-edged flake (Mulvaney 1975:108, McCarthy 1976:36), and there has been no previous attempt to identify them in an archaeological context. One possible reason for this

widely held belief is discussed below; but both a study in which a *Teep* knife was taken apart and the individual flakes analysed (Hayden 1973), and a careful reading of the ethnohistorical record suggest that it is not entirely warranted.

Hayden's study suggests that the necessity of hafting these flakes to provide a relatively sturdy and even cutting edge placed limits on their variability, and demonstrates that *at least some of them* were intentionally modified to fit within these tolerances. With some support for this provided by local ethnohistorical sources, it was decided to attempt to devise a pilot model for archaeological *teep* flakes to test against the implements recovered from Mokaré's Domain.

Additional information which aided in the development of the model was provided by an examination, conducted during the course of this research, of whole or nearly whole *teep* knives held in the collections of the Western Australian Museum and the Australian Institute of Anatomy, Canberra (the latter collection has since been transferred to the Museum of Australia, Canberra). These lines of evidence and the results of the first application of the model are described below. While not entirely satisfactory, they suggest that it may be possible in some cases to identify archaeological *teep* flakes and that further research toward this end is likely to prove productive.

The "Authenticity" of Museum Specimens: One of the major causes of the confusion involving the nature of *teep* flakes is

that many, if not most, of the extant *laap* knives available for prehistorians to examine were never intended to be used. They are, instead, merely "tourist goods", made quickly by the Aborigines for trade with the Europeans. This practice began very early, well before permanent settlement of the region, and at least as early as 1821 when Captain Phillip King made a large collection of implements at King George Sound. King's comments in this regard are worth quoting at length, both as a cautionary tale which should be taken into account when examining any type of museum specimens from any region, and because they bear directly upon the discussions of *laap* flakes and *kadja* stones which follow.

> "...during the day they were basically occupied in manufacturing spears, knives [*laap*], and hammers [*kadja*], for the evening's barter; and when they came in the morning, they generally brought a large collection which their wives had probably made in their absence."(King 1827:132)

> "...he [an Aborigine they called Jack]...laughed heartily whenever a bad and carelessly-made spear was offered to us for sale: for the natives, finding we took everything , were not very particular in the form or manufacture of the articles they brought to us."(King 1827:136)

> "We saw no fizgig, shield, nor boomerang: it is probable that they may have had such weapons, but did not produce them from a dislike at parting with them; but the knives, spears, and hammers, which did not require much labour to manufacture, were always ready for barter, *particularly the first*, but the greater part were, like Peter Pindar's razors, only made for sale." (King

1827:136 - *my emphasis*)

Hayden was aware of this problem, and went to great lengths to demonstrate the quality of the construction in the specimen he destroyed for analysis (1973:117-8). He stressed that the handle was shaped by a stone implement, but this is not very convincing, considering that those collected by King probably were, too; and the fact remains that it is really impossible to be sure in most cases. In analysing the museum pieces for this research, it seemed the only recourse was subjective comparison between them, and three of the seven which I examined do appear much more "functional" than the others.

The specimens shown in Figures 6.12 and 6.13 are those formerly in the Institute of Anatomy. The three on the left (A-TS22, A-TS238, and A-TS239), with their relatively even, straight-sided, and close fitting flakes, appear to be quite serviceable cutting implements. Allowing for the broken teeth, their overall cutting edge is quite sharp and straight. Two of these have extra bits of resin stuck between the teeth for support, and the other has several layers of resin bevelled up around the teeth for the same purpose. This practice is described ethnographically by Jackman (1855:107). All of them also show considerable damage to the cutting edges of the flakes, suggesting that they actually have been used.

Compared with these, the two on the right are not very convincing. A-TS20 is a particularly unconvincing example. Its teeth are made of some totally unserviceable crockery material. All but

FIGURE 6.1 TYPICAL [illegible]

[illegible] implements, while the two on the right are believed to be demonstration copies which were never designed to be used. See Figure 6.13 for enlargement of knife heads.

FIGURE [illegible] ENLARGEMENT OF [illegible] TYPES OF [illegible]

two of them are broken off, the the remaining ones show no use-wear. A-TS237 was also probably made only for the tourist trade. There is no supporting resin around the individual teeth and they are incorrectly aligned so that the cutting edges of several of them run parallel to one another or off at an angle. The edges of these flakes show no damage at all which is especially significant since this implement has been housed with the others and presumably subject to similar handling.

The two specimens I examined from the Western Australian Museum collection (not illustrated) were in a bad state of disrepair. Their resin was disintegrating and there were only three teeth remaining in each one. Although it is difficult to be certain, subjectively they, too, were probably never designed for use, and are more similar to those on the right of Figure 6.13 than those on the left. It is also interesting to note how favourably the three "good" specimens here compare with those illustrated by Mulvaney (1975:89 and McCarthy (1976:31), and which are presumably representative of those upon which they based their conclusions that *loop* knife flakes were unmodified.

Raw Material and Reduction Techiques Quartz appears to have been the preferred materal for *loop* knife blades. Those described by Hayden and all the museum specimens examined by me were made from this material. It is also the raw material most often mentioned in this regard by the ethnohistorical sources (Breton 1833:239, Chauncy 1876:250, Grey 1841:266, Hassell 1975:14, King

1827:140, Moore 1884:69, Parker 1886:337). Other materials were evidently used on occasion, however. McCarthy (1976:36) says that "quarzite, chert and other stones" were sometimes used, and two of the ethnohistorical sources state that "flint" was used (Fremantle 1829-32:27, Jackman 1855:107). It should also be noted that the "quartz" mentioned by Hassell from the area around Jerramungup, less than 100 Km east of Mokaré's Domain, is possibly a spongelite derived material instead. She describes the "quartz" as a special kind which "splits into rather thin flakes and is almost transparent, very like common glass, with a very pale green tint" (1975:15), and several exceptionally thin flakes including one backed microlith made from a spongelite-derived material of this description were recovered in the Moorillup Crossing excavation.

Hayden (1973:22) observed that at least three and possibly all seven of the flakes he analyzed were manufactured by the bi-polar reduction technique, and he stressed the suitability of flakes produced in this manner for use as *leap* knife blades. That this technique was often used is probable. Although it is normally almost impossible to tell with the hafted specimen, Flake No. 1 of WAM 9920 is definitely a result of bipolar reduction and all those on A-TS239 appear to be, as well. There is also one excellent ethnohistoric description of flakes being produced for a *leap* knife in this manner:

> "The stone is a highly vitreous kind of white flint. A mass of this laid upon another mass of the same material, when, with another stone of suitable size, and hardness, it is fractured till a piece is obtained

sufficiently knife-like for the purpose." (Jackman 1955:107)

However, the flakes on A-TS238 were obviously all produced by percussion flaking. These are of high-grade quartz crystal and totally translucent. Percussion rings are visible on all the flakes, and bulbs can clearly be seen on flake numbers 1,2, and 4. Consequently, it seems legitimate to conclude that, although there may have been preference for certain materials, and certain methods of reducing them, like most other aspects of this highly opportunistic technology, any material and any reduction technique which could produce a suitable flake would be employed on occasion.

Shape and Patterns of Modification: Hayden concluded on the basis of his study that: "There seems to have been selection for sharp-edged flakes which also had thick and abrupt to semi-abrupt edges to be inserted into the gum hafting" (1973:124). Of his seven flakes, four had a natural cortex to provide these abrupt edges; on one it was provided by a flat fracture plane; and on two, intentional modification - what is here termed "trimming", was applied to both the back and one end in order to adapt the flake to the necessary shape.

On each of these modified flakes there is a slight crushing at the edges, and tiny flake scars crossing the abrupt margins from both faces. Hayden suggested this was done by placing one face of the flake against an anvil and tapping the end with a "light bi-polar technique" (1973:119-20). There is, however, an alternative method

of trimming provided by the ethnohistory which might produce the same kind of crushing and scars. Chauncy states that the Aborigines "...stick thin splinters of quartz, broken with their teeth to the side of a short stick..." to make a *leap* (1876:250). It may be that the ends of Hayden's flakes have been "nibbled" off.

Rather than nibbling, however, Chauncy may have been observing Aborigines "snapping" flakes with their teeth. Hassell writes that: "Each piece of quartz was made straight as possible and fitted as closely together as they can make it" (1975:15). On A-TS238 where the percussion struck flakes are very straight and close together, it appears that snapping may have been the method of modification; at least some of the flakes are mounted with the striking platform providing one abrupt end margin and what looks to be a clean break forming the other. Of course, there are several ways to snap a flake, and it need not necessarily be done with the teeth.

Examination of the museum specimens has revealed yet another form of modification not noted by Hayden or others. This is modification done to sharpen the cutting edge, not to blunt the hafting margins. On A-TS239 flake numbers 5 and 6 have definitely been retouched. Number 5 is the clearest example; it has been subjected to at least six blows which produce shallow, narrow and relatively even, invasive flake scars on the A face. There are also two similar scars on one end of the B face. Number 6, which is quite a small flake, has two relatively wide retouching scars , each covering one half of the A face.

There are five other flakes which also have scars that may have

resulted from attempts to sharpen the cutting edge. On A-TS238, flake number 1 has a small uneven series of seven invasive flake scars on the A face. This could be light retouch, but the scars are very small and it might merely be the result of use damage. Flake numbers 3 and 6 on the same implement each have a single large flake scar invading one face for a considerable distance. In both these cases the removal of the flake resulted in a much sharper edge, but it is impossible to tell whether this was done intentionally. On A-TS22 flake numbers 1 and 3 show similar damage. The dorsal end of flake 1 has been broken off, but there are two scars invading the B face. On flake 3 there is one large scar on the A face.

In summary, it appears that a usable *Iaap* flake ideally had one sharp cutting margin and three abrupt and relatively even ones to aid in secure hafting. It also seems clear that if a flake did not naturally possess these attributes, the manufacturer might modify any one or all of the margins to provide them.

Size. Totally accurate and complete measurements of size attributes are available only for the seven flakes described in Hayden's study. He lists their lengths (axis parallel to the cutting edge) as ranging from 10.1 to 18.5 mm, and I have taken their widths (axis perpendicular to the cutting edge) and thickness from his drawings. The former ranges from 7 to 10 mm, and the latter from 2.5 to 5.5 mm (Table 6.13).

For the flakes still embedded in the resin of the museum specimens, only the lengths can be estimated with any degree of

TABLE 6.13: DIMENSIONS OF ETHNOGRAPHIC *TAAP* FLAKES.

ETHNO *TAAP*	FLAKE POSITION† (measurements in mm)											
	1	2	3	4	5	6	7	8	9	10	11	12
HAYDEN (1973)												
LENGTH	18.5	10.1	13.2	12.3	16.1	14.8	15.6					
WIDTH	7.5	10.0	7.5	10.0	9.0	7.0	8.0					
THICKNESS	5.5	4.5	3.5	4.0	2.5	4.0	3.0					
Lengths:												
*A-TS 20	12.0	9.0	13.0	13.0	11.0	13.0	17.0	12.0				
A-TS 22	10.0	10.0	8.5	7.5	10.0	7.0	6.0	6.0				
*A-TS 237				7.0								10.0
A-TS 238	13.0	11.0	10.0	9.0	9.0	5.0						
A-TS 239	13.0	12.0	12.0	10.0	10.0	8.0						
*WAM 9920	17.0	11.0	8.0									
*WAM 11463	22.0	18.0	20.0									

†Flakes are numbered from the gummed end of the stick.
*These implements are very probably "demonstration" copies which were never designed to be used.

accuracy. The lengths for the 36 flakes I measured are listed on Table 6.13 . Although probably fairly correct, these should be treated as minimums since the flakes are not always very closely spaced and some protrusions undoubtedly exist under the resin covering. These flakes range from 5 to 22 mm in length, the mean for all 43 flakes is 11.94 mm. Width and thickness for the museum specimens are not listed on the table since they are practically impossible to measure without X-ray techniques, but 8 mm of flake protrudes from the resin on A-TS238, number 1. As there appears to be room for another 5 to 7 mm within the resin, this flake could be up to 15 mm wide. The thickest flake above the resin was A-TS239, number 1, at 5mm; and since all these flakes appear to taper with the widest part being covered, this must be considered an absolute minimal thickness.

The Model. Based upon the information detailed in the above sections, implements in the Mokaré's Domain assemblage which meet the following criteria are provisionally considered to be taap flakes:

(1) In size they must be no larger than 25 mm long, 15 mm wide, and 10 mm thick.

(2) They must possess one relatively straight and sharp, low-angled cutting edge which exhibits either sharpening retouch, evidence of use wear, or both.

(3) The three remaining margins of the flake will ideally be relatively even and abrupt; either naturally, or from some form of modification which makes them so.

Since this model is applied only to artifacts already classified

as "implements", the retouch or use wear requirement of criterion 2 will be automatically satisfied. Doubtless, the vast majority of *laap* flakes within the assemblage will have been previously classified as "chips" or "flakes", by-products of the stone reduction process, because they possess neither retouch nor use-wear sufficiently extensive to be recognized as such without microscopic examination.

Description of the Implements (Fig. 6.14 a-f). Eighteen artifacts which were deemed to sufficiently satisfy the requirements of the model were identified among the implements from Mokaré's Domain. Seven were of quartz, ten of spongelite derived materials, and one of possibly spongelite-derived material. Three, including Figure 6.14a were definitely produced by bi-polar reduction, and three, including Figure 6.14b were definitely detached from a core by percussion flaking. For the others, there is no way of determining how they were initially produced. All were within the stipulated size range, and only one (Fig. 6.14c) approached the upper limits of this range in all three dimensions (see Table 6.14).

All had a single relatively sharp cutting-edge which except in two cases, had an edge-angle of less than 55 degrees. The remaining two had extensive edge damage which resulted in angles of between 70 and 80 degrees. All had damage on the cutting edge which was interpreted as use-wear; and twelve, including Figure 6.14a, c, d, & e, had retouched cutting edges. In five cases, including Figure 6.14e, this retouch took the form of "denticulation" in which a series of tiny protrusions, or "teeth", were left on the edge. Denticulation of this

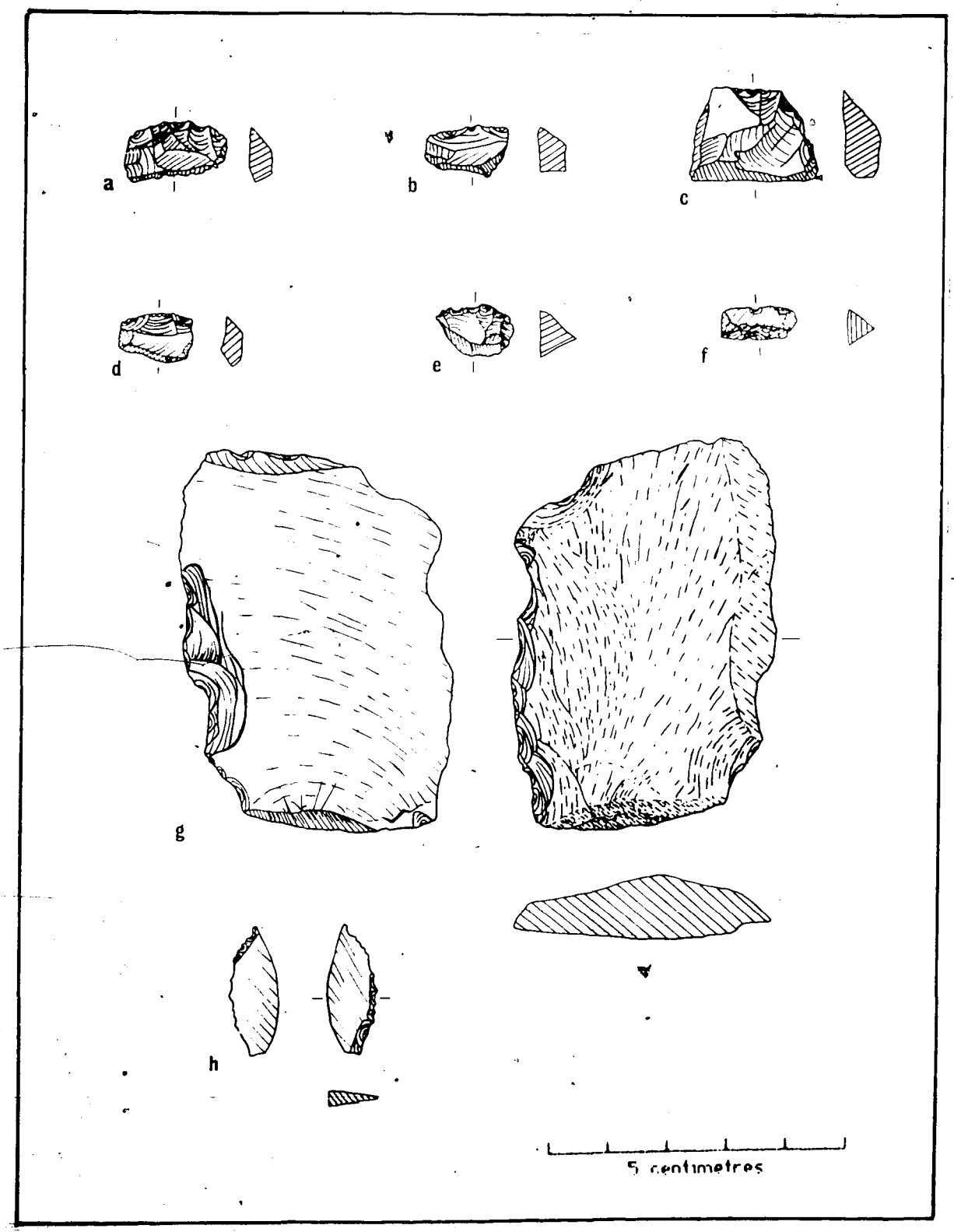


FIGURE 6.14. CUTTING IMPLEMENTS.

Figures **a.** through **f.** are provisionally classified as *Taap* flakes, and **g.** and **h.** as hand-held cutting implements.

TABLE 6.14: SELECTED DESCRIPTIVE STATISTICS FOR CUTTING IMPLEMENTS.

		LENGTH (mm)			WIDTH (mm)			THICKNESS (mm)		
TYPE	NO.	RANGE	MEAN	SD	RANGE	MEAN	SD	RANGE	MEAN	SD
TAAP FLAKE	18	12-24	16.33	5.22	5-15	10.21	3.07	3-9	5.20	1.74
HAND-HELD	18	19-63	30.45	12.43	8-44	21.34	8.55	3-22	8.32	3.65

CONT.

	WEIGHT (G)			RETOUCHED EDGE LENGTH (mm)			EDGE ANGLE (°)		
	RANGE	MEAN	SD	RANGE	MEAN	SD	RANGE	MEAN	SD
	1-2	1.07	0.25	8-20	13.27	3.53	28-78	42.00	16.32
	1-41	6.28	8.69	13-50	24.34	9.22	28-55	40.14	8.47

type is a form of retouch normally associated only with cutting implements (Ferguson 1980a).

Fifteen of these implements including all those illustrated, had abrupt, semi-abrupt, or partially abrupt margins on the back and both ends of the flake. One was abrupt on the back and one side, another only on the two sides, and the last only on the back. These three were accepted because they fit the model in all other ways, and because not all Hayden's flakes matched the perfect ideal.

The forty abrupt margins were achieved in five different ways: eight were striking platforms, either bi-polar (Fig. 6.14a - both ends) or percussion (Fig. 6.14b - right end); twelve were smooth and featureless fracture planes (Fig 6.14a - back, Fig. 6.14b - back, Fig. 6.14 e - right end); ten appear to have been snapped (Fig. 6.14d & f - right end, Fig. 6.14b left end); one was cortex (Fig. 6.14e - back); one was a combination of cortex and trimming (not illustrated); and eighteen are interpreted as having been trimmed (Fig. 6.14d & e - left end, Fig. 6.14b - back, Fig. 6.14c - both ends, Fig. 6.14f - back & left end).

The trimming varied widely in elaboration, from one or two, possibly unintentional flake scars (Fig. 6.14b - back), through light bi-polar working such as described by Hayden (Fig. 6.14c - left end), to extensive facetting (Fig. 6.14c - right end, Fig. 6.14f - back). The term "trimming" was adopted to distinguish this rather haphazard sort of retouch from formal backing. Although Hayden (1973:124) is correct in noting that it served basically the same purpose, there is a definite qualitative difference which cannot be denied.

Of all these implements, only the back of Figure 6.14f comes even close to what most prehistorians would recognize as backing, and even here there is a difference. On this implement there seems to have been a conscious effort to only flatten the back without rounding the margins where the back meets the faces of the flake. This difference is slight, and perhaps this piece should have been included with the backed implements. It was classified here on the basis of overall morphology and damage to the cutting edge.

Dating and evaluation of the Model: The primary reason Hayden tried to stress the similarity between the trimming done to *loop* flakes and proper backing, was that he was seeking support for a concept, also discussed by Mulvaney (1975:108-9, 236), that *loop* flakes were a degenerate substitute for the more elaborate backed microliths which supposedly preceded them. This concept is not supported by the dating for the provisional *loop* flakes, because both they and the backed microliths have a similar antiquity.

Fifteen of the eighteen provisional *loop* flakes are found in a datable context. Six were recovered from Moorillup Pool Trenches 1 and 2 and are consequently dated to the middle of the third millennium BP. One was found in Waychinicup River 2 in association with the date of 1390±70 BP. The remaining eight were found throughout the upper levels of Kalgan Hall 2 from just below the surface to a depth of 60 cm BD, and cover a time span from about 3000 to 1000 BP

The model provides no way of determining with certainty whether these flakes were actually hafted into the resin of a *loop*

knife. Those with retouch were obviously intended for use and the evidence for use-wear suggests that all of them actually were used. It is possible that many may be only the broken bits of larger implements which have been scuffed around to produce what I have interpreted as trimming scars, but in some cases this simply is not so.

Figure 6.14a is an obviously whole, 17 mm long by 10 mm wide, bi-polar flake with low angled sharpening retouch along one margin. Figure 6.14e is a 12 mm long by 9mm wide flake with a carefully denticulated cutting edge, cortex for a back margin, one end carefully trimmed, and the other end a smooth fracture plane. It is conceivable that both of these could have been held in the hand; but, especially in the latter case, it is highly unlikely. These two, at least, were probably designed purposefully for hafting, and I would suggest that they would have beep practically useless for most tasks unless they were hafted in a series with similar flakes. There are three others that are whole, retouched flakes, but these are larger, and less likely to require hafting. The rest may, indeed, be just bits broken from larger implements.

The apparent non-random temporal distribution, however, also suggests that this may not be the case. In Kalgan Hall 2, for instance, if the provisional *loop* flakes were simply a result of accidental breakages, it could be expected that somewhat over a third of them would be found below the levels dated to 3000 BP. None are; and, although the total number of *loop* flakes identified is too small for this argument to be statistically convincing, their distribution

suggests a course of further research which might aid in determining the validity of this classification.

It was mentioned above that the majority of *loop* flakes would probably not have been initially recognized as implements because they would have neither edge retouch nor extensive use-wear; and, consequently, would have been classified simply as flakes or chips. Those classifications could be re-examined and the pieces which satisfied the *loop* flake model in all other ways could be identified. Undoubtedly, some flakes which were only accidentally similar to *loop* flakes would be included, but if the vast majority of those which met the criteria were restricted to the upper levels of the tranches, then inferential support would be given to the model.

Hand-held Cutting Implements:

All implements with exclusively low-angled working edges not classified elsewhere are included in this category. There are 30 of them, twelve of which are broken fragments. Selected specimens are illustrated on Figures 6.14 and 15, and descriptive statistics for the 18 complete pieces are shown on Table 6.14.

The size and form of these implements vary enormously. Apparently, any piece upon which a suitable edge could be manufactured might be employed for cutting. The largest piece collected was Figure 6.14g and the smallest was Figure 6.14h. This latter piece falls within the size range of the *loop* flakes, and does have a naturally abrupt back. It was excluded from the category because the ends are not abrubt and the working edge has a convex

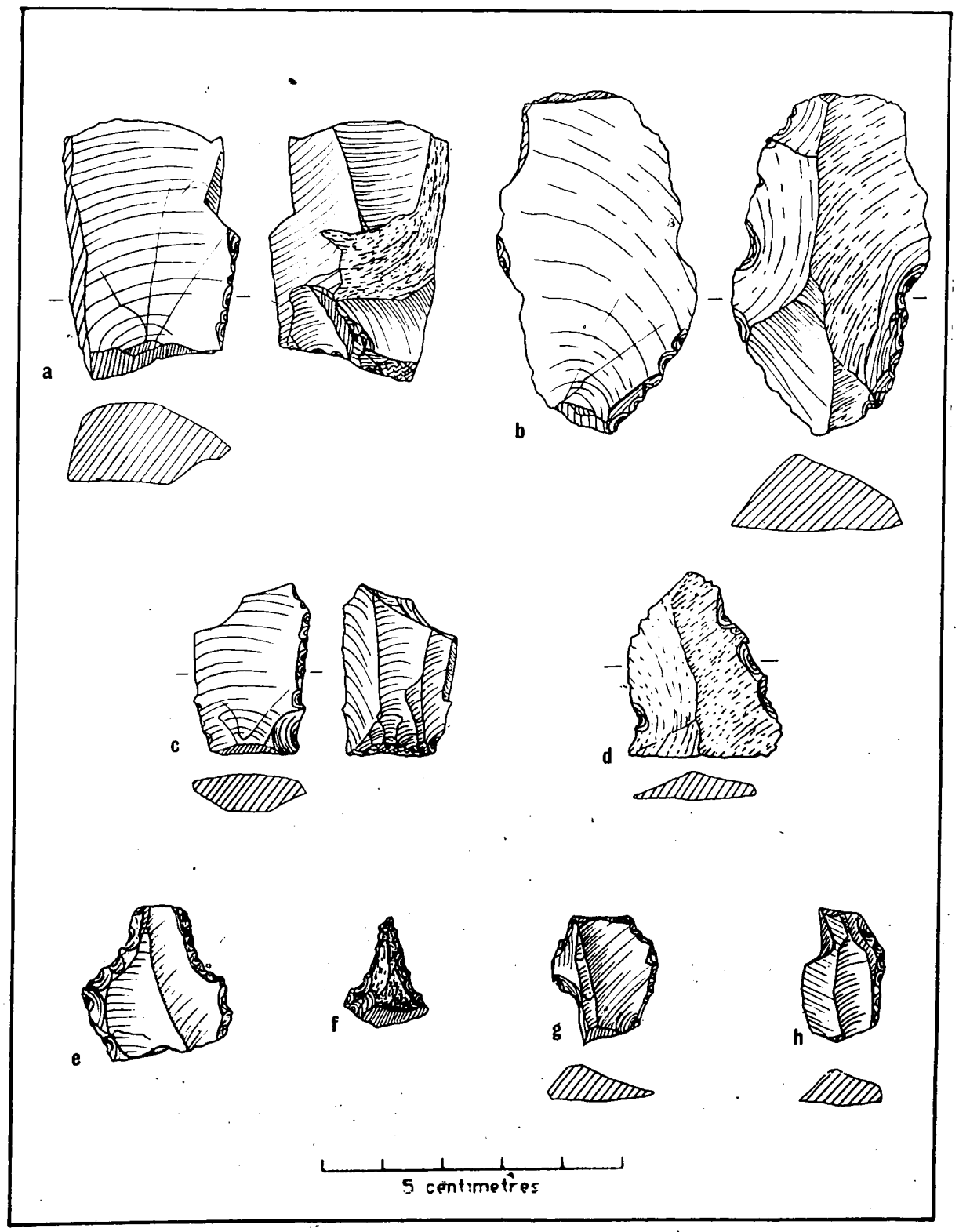


FIGURE 6.15. CUTTING, PIERCING, AND MULTI-PURPOSE IMPLEMENTS.
Figures **a**. through **d**. are hand-held cutting implements, **e**. and **f**. are piercing implements, and **g**. and **h**. are multi-purpose implements.

shape. Three of the pieces, including Figure 6.15c were made on consciously designed blades. All are broken fragments, but they provide the only evidence for large blade production in the assemblage. The two of these which were found in datable context suggest that this stone working technique may have been confined to about the last 2500 years.

Seven of the pieces have two working edges and one has three. With only one exception, all these edges are retouched, and in eleven instances this retouch takes the form described above as denticulation (Fig. 6.14 g, h, Fig. 6.15a, d). In some cases the denticulation results in regular, even-spaced teeth protruding from the edge (Fig. 6.14h), on others it is apparently quite haphazard (Fig. 6.14g), and spacing varies from two to seven teeth per 10 mm.

Use wear is minimal on most pieces, generally confined to minor chipping and a slight rounding of the edge. There is, however, one form of edge damage which reoccurs several times. This is a break running parallel to the working edge which removes a narrow portion of it (Fig. 6.15a, b, and c). This type of fracturing was also noted on a few of the provisional taap flakes, and on flakes No. 3 of A-TS 238 and No. 1 of A-TS22. It perhaps results from situations where the cutting edge is tightly held by the material being cut and the user moves the implement laterally (Keeley 1980:25).

Implements of this category are found in most levels of the excavations. The youngest is Figure 6.15c, found just below the surface of Kalgan Hall 2. The oldest is Figure 6.14d, found at 130 cm BD in that excavation and dated to approximately 17,000 BP on the

basis of the depth/age graph.

CHOPPING IMPLEMENTS:

There are ten implements in this category. All are relatively large, and all but one possess bi-facial retouch to the working edge. The majority of these appear to have been designed to be side hafted to a shaft for use in a manner similar to the European axe or hatchet. Only two are large enough to have received their extensive and distinctive use-wear while being held in the hand. From the use wear, all these were probably used for chopping wood, but other functions (dismembering carcasses, as weapons, etc.) are possible.

Kodja Stones:

As with *leap* flakes, developing a model to identify archaeological *kodja* stones is hampered by the dubious nature of many of the surviving museum specimens. A major study of Museum *kodja* by Tindale (1950) did attempt to distinguish "true" and "original" specimens from "degenerate" and "demonstration" pieces, but it was severely criticized for doing so (Davidson and McCarthy 1957:413-6, Massola 1960). Apparently, many archaeologists accept all forms, including a great number whose stone components are simply lumps of soft, unworked granite, as equally valid; and therefore assume that these pieces would be archaeologically unrecognizable (*e.g.* Mitchell 1949:78, Mulvaney 1975:108-9).

However, in light of the lengthy quotes from King on "tourist" goods cited above, and the functional requirements of a *kodja* as

documented in the ethnohistorical sources of the region, it is argued here that Tindale's attempted distinctions are generally valid. King collected 40 *kodja* at King George Sound, but their quality was evidently so poor that he was even unaware that their primary function was as a chopping implement. He refers to them as "hammers", stipulates that they possess "no sharpened edge", and suggests that they are "only used for the purpose of breaking open shell-fish, killing seals and other animals by striking them on the head" (King 1827:139).

In the remainder of the ethnohistorical literature, including all sources from King George Sound, it is stressed that at least one stone of a *kodja* is sharp; that it served as an "axe" or a "hatchet" as well as a hammer. Further, it is described most often as having been used primarily for chopping foot holds and holes into trees as the Aborigines went in search of possum (*e.g.* Backhouse 1843:546, Breton 1833:239, Browne 1856a:271, Chauncy 1876:249-50, FitzRoy 1839:626, Haddleton 1952:103, Hammond 1933:237-8, Hassell 1975:14-5, Jackman 1855:108, Knight, et. al 1886:335, Moore 1884:38, Nind 1831:27, Ogle 1839:57, Parker 1886:338, Roth 1903:68, Salvado 1851:148). Details of these descriptions are provided where applicable below. Important here is the fact that the traditional *kodja* is an efficient chopping implement which "cleaves the gnarliest wood known to the Australian forests, not excepting the hard-grained mahogany" (Jackman 1855:108), and a great number of the museum specimens would be incapable of cleaving much of anything.

The model developed below is based upon the ethnohistorical references, and those museum specimens which were determined to be "true" *kodjo* from a subjective evaluation of whether or not they would make a reasonably efficient chopping implement. For the most part, the museum pieces have not been personally examined, but are described and illustrated in the literature. In the Institute of Anatomy, Canberra, however, were three *kodjo* which were examined in the course of this research. A-TA25 was formerly in the S.R. Mitchell collection and has been described by Massola (1960:90). Its stones are of unretouched, poor quality granite-gneiss, and it probably is a "demonstration" or tourist piece. The other two have been transferred from the Blackmore Museum. A-TA658, which has soft granite stones, definitely is a "demonstration" piece because it has a note attached saying: "made by the natives for sale." A-TA 657, however, is an excellent specimen with extensive retouch and use wear. It is illustrated on Figure 6.16. and described in detail below.

The archaeological literature of the Southwest already records at least 16 chopping implements, eight of which have been nominated, usually only tentatively, as *kodjo* stones. Since their size range is enormous, it seems unlikely that they all should be grouped in the same implement classification, and they were ignored in the development of the model. They were, however, considered in light of the information supplied by the application of the model to the Mokaré's Domain implements, the results of this consideration are reported in the final discussion.

Raw Material: It seems clear that the most desirable stone for *kadja* heads was of a relatively fine-grained, tough material. It needed to be capable of holding its edge while its user hung ten metres in the air and chopped a hole through a well seasoned eucalypt limb; and, therefore, basic igneous rocks which possess this quality were most often used.

Only five of the ethnohistorical sources mention the type of stone used; disregarding Jackman's usual "flint" (1855:108), and the "sharp flinty stone" of Knight *et.al* (1886:329). Moore (1884:38) and Chauncy (1876:249-50) describe it as "whinstone" (dolerite or basalt trap). Chauncy writes that it occurs in veins running NE-SW in the Darling range; and I take that to mean the dolerite which is common in the region, although there is some basalt known further south in the Bunbury area. Salvado calls it a "hard grey granite" and says it is found well inland from the coast (1851:148). This is also probably dolerite, as is Haddleton's "very hard granite rock" which would crack and "come off in big shales" when doused with cold water after heating in a fire (1952:103). Hammond's "very dark grey, almost blue" stone which is "very hard to break" (1933:37-8) definitely is dolerite, since the primary quarry source mentioned by him was investigated in the course of this research (see this chapter, above).

The museum specimens reinforce this concept that a tough, fine-grained basic igneous rock was the most desirable. A-TA657 is made from dolerite, and the literature appears to support an overwhelming choice for this type of stone. In two papers by Tindale (1950:267-9. 1951), he mentions the type of stone for ten of the 22

specimens he accepted as "true" *kadja*: seven are of fine-grained igneous materials, and the others are one each of quartz, quarzite and granite. Davidson and McCarthy (1957:41-2) describe four *kadja* from the Australian Museum, Sydney, two of which (E5983 and H367) appear from their descriptions to be "true" specimens. They are made, respectively, of "dark greenish black stone, probably igneous in origin" and "almost black indurated ferrugeneous sedimentary stone". Massola (1960) presents 23 *kadja* from the National Museum of Victoria, Melbourne, and private collections; and, although his descriptions are generally not detailed enough for a decision on whether the specimens are "true" or not, the three he stipulates were either well used or retouched (837, 35648, and one from the Smith collection) are all made from fine-grained igneous rock.

Shape and size: All "true" *kadja* chopping stones reported have a convex working edge, but the overall shape of the stone is very difficult to model. It cannot be seen on the museum specimens and the ethnohistory is generally silent on the subject. Hammond says the stone was chosen for size and shape as well as sharpness of edge, but does not elaborate (1933:37). Haddleton provides the only details when he writes that after final reduction, "This piece would be in the shape of an axe head about one inch (25 mm) thick, tapering off to a sharper edge" (1952:103).

Whatever their shape, *kadja* stones are relatively small for chopping implements. Most researchers do not provide very detailed measurements for the *kadja* stones they discuss, but those available

for "true" specimens are collected on Table 6.15. There are 14 measurements for length, which is the longest chord visible across the arc of the sharp edge. They range from 38 to 70 mm, with a mean of 51.7 mm. These measurements are probably fairly accurate, but they do not allow for any odd protrusions which may be hidden within the resin. Ride found a similar length range of 35 to 70 mm for the 29 *kodja* stones in the Western Australin Museum, Perth, which he measured, although he did not distinguish "true" from "demonstration" specimens (1958:172). Because the majority of the stones are covered with resin, width and thickness are seldom provided. Those on Table 6.15 should be considered bare minimums and are included only to give a rough approximation.

Retouch. Both the ethnohistorical sources and the "true" *kodja* in museum collections testify to the fact that the chopping edges of kodja stones were purposefully shaped. Hammond (1933:37) says they were "spalled to get a good edge", and Chauncy (1876:249-50) says they were "chipped to an edge", implying some sort of percussion retouch was carried out. Examination of the museum specimens suggests that this minimally took the form of unifacial removal of relatively large invasive flakes; but several have been bifacially flaked in this manner, and a few apparently have also been subsequently worked by smaller, secondary flaking along the edge to remove irregularities or repair damaged edges (Tindale 1950; 1951, Davidson and McCarthy 1957, Massola 1960).

The chopping stone in A-TA657 can be used as an example. It

TABLE 6.15: AVAILABLE MEASUREMENTS FOR "AUTHENTIC" ETHNOGRAPHIC *KODJA* STONES.

MUSEUM	ACC.NO.	STONE	LENGTH*	WIDTH*	THICKNESS*
FRANKFURT[1]	9741	1	45	--	20
		2	45	--	30
WEST.AUST.[1]	E39	1	50	--	--
		2	60	--	--
LEIDEN[1]	588/2	1	--	--	35
		2	--	--	15
S.AUST.[1]	A15245	1	50	--	--
		2	55	--	--
BISHOP[1]	1922	1	45	--	--
		2	50	--	--
BISHOP[1]	unknown	1	70	--	--
		2	60	--	--
EXETER[2]	unknown	1	38	45	--
AUSTRALIAN[3]	H367	1	44	35	25
AUSTRALIAN[3]	E5983	1	50	--	23
INST. OF ANAT.	A-TA657	1	62	--	>25
MEAN			52		

*ALL MEASUREMENTS IN MILLIMETRES

[1]TINDALE 1950
[2]TINDALE 1951
[3]DAVIDSON & McCARTHY 1957

appears to be a large flake, and is similar to the unifacially flaked *kodjo* stones illustrated by Tindale (1950:fig. 1-10; 1951:fig. 1-4). Relatively large and shallow flake scars invade the dorsal face from the edge on the upper two thirds of the piece (oriented as in Fig. 6.16). On the lower third, attempts to dislodge flakes of this type were unsuccessful. They resulted in hinge fractures, and, after repeated blows, in a step-flaked type of retouch. The bulbar face is slightly convex. It shows only two, relatively small flake scars near the upper end of the edge, and the otherwise straight edge is consequently sinuous in this area. The angle of the working edge is 55 degrees.

The ethnohistorical literature also reports another type of edge preparation: three sources describe the edges of *kodjo* stones as being "ground" (Haddleton 1952:103, Parker 1886:337, Roth 1903:66). Ground edges have not been noted on any of the museum specimens; but since these three reports come from widely scattered areas of the region, and Haddleton's description is quite detailed, it seems reasonable to postulate that, at least on occasion, edge grinding of *kodjo* stones was undertaken.

Use-wear. Many of the museum specimens which display purposeful edge shaping are also described as having edge damage and/or use polish (Tindale 1950, 1951, Davidson and McCarthy 1957). A-TA657 is an example of some of the forms this use wear may take. The upper two thirds of the edge is slightly blunted and rounded, and there are minute hinge fractures on both faces extending back from the edge. The lower third of the edge shows very little of this type of

edge damage and remains very sharp. The distribution of use-polish on the faces of the flake follows a similar pattern. It is most pronounced on the upper parts, and especially on the dorsal face where the ridges between the relatively large flake scars are smoothed and glossy. This differential wear suggests that the *kodjo* was habitually swung in such a manner that only the upper portion of the edge bit into the material being chopped.

The Model: The ethnohistorical literature and the museum specimens could not provide sufficient information to accurately predict the overall morphology of a *kodjo* chopping stone. They did, however, supply enough detail to develop the guidelines listed below which place limits on the variations possible. In applying this pilot model to the implements from Mokaré's Domain, it was hoped that a study of the pieces which satisfied its criteria might reveal other attributes they held in common and thereby enable greater refinement. Such appears to have been the case, as is discussed in the following section on description of the implements.

(1) The chopping stone of a *kodjo* will be made of a tough, relatively fine-grained material.

(2) It must have a convex working edge, and be relatively small with a length (longest chord of the working edge) between 35 and 70 mm. It's width (longest axis perpendicular to that chord) will probably also lie approximately within these dimensions, and its maximum thickness will probably not be less than about 15 mm.

(3) The working edge will show some form of purposeful

shaping, and, if used, it should have the distinctive bifacial use-wear patterns described above.

Description of the Implements: Seven artifacts satisfied the criteria of the model and descriptive measurements are shown for each of them on Table 6.16. Two dolerite pieces, exhibit evidence of bifacial shaping and use to the extent that there can be little doubt that they were designed and used as chopping implements (Fig. 6.17a & b). Three others, one of a very fine grained quartzite (Fig. 6.18a), and two of different types of tough and indurated, possibly spongelite-derived, sandstone-like material (Fig.6 18b, Fig. 6.19); are somewhat less regular in form, but are also considered to be "probable" *kodja* stones. The remaining two, both of quartz, display most of the characteristics evident on the other pieces, but because large portions of their edges have been broken off, it is difficult to be as confident of their function. They are considered to be only "possible" *kodja* stones.

All these pieces, including those not illustrated, share an important attribute not predicted by the model. In each case the margin of the stone opposed to the sharp, convex edge is abruptly truncated, either naturally or from purposeful flake removal, providing a relatively broad, flat base to set into the resin. This has been previously suggested as a possible aspect of *kodja* stone morphology by Ride (1958:172).

All the stones are secondarily flaked, and this seems to have been undertaken in two different but complimentary modes. On four

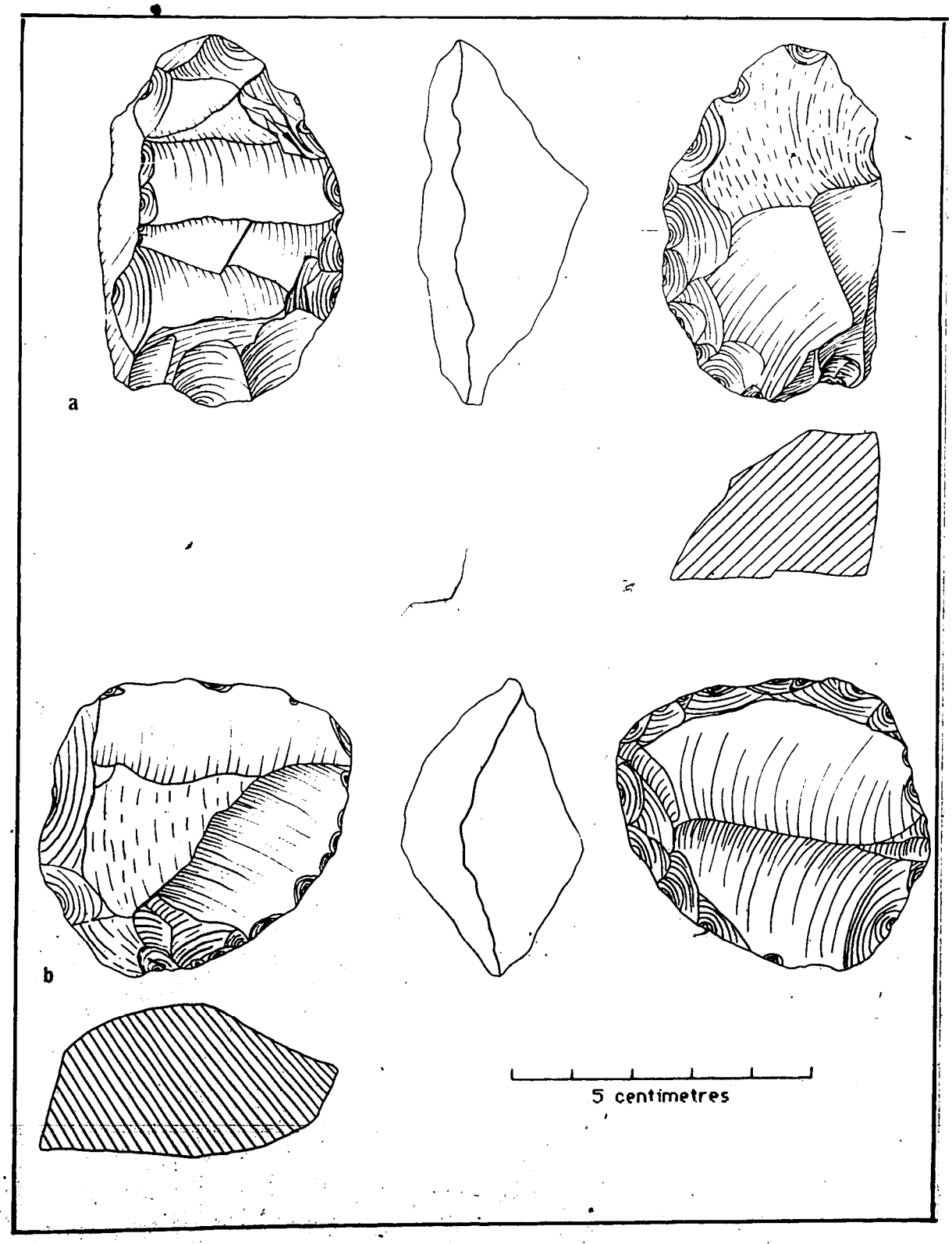


FIGURE 6.17. *KODJA* STONES I.

The two dolerite *kodja* stones. Figure a. is from the Elizabeth Street site on the northwest shore of Oyster Harbour, and b. is from the Lower Hay River site.

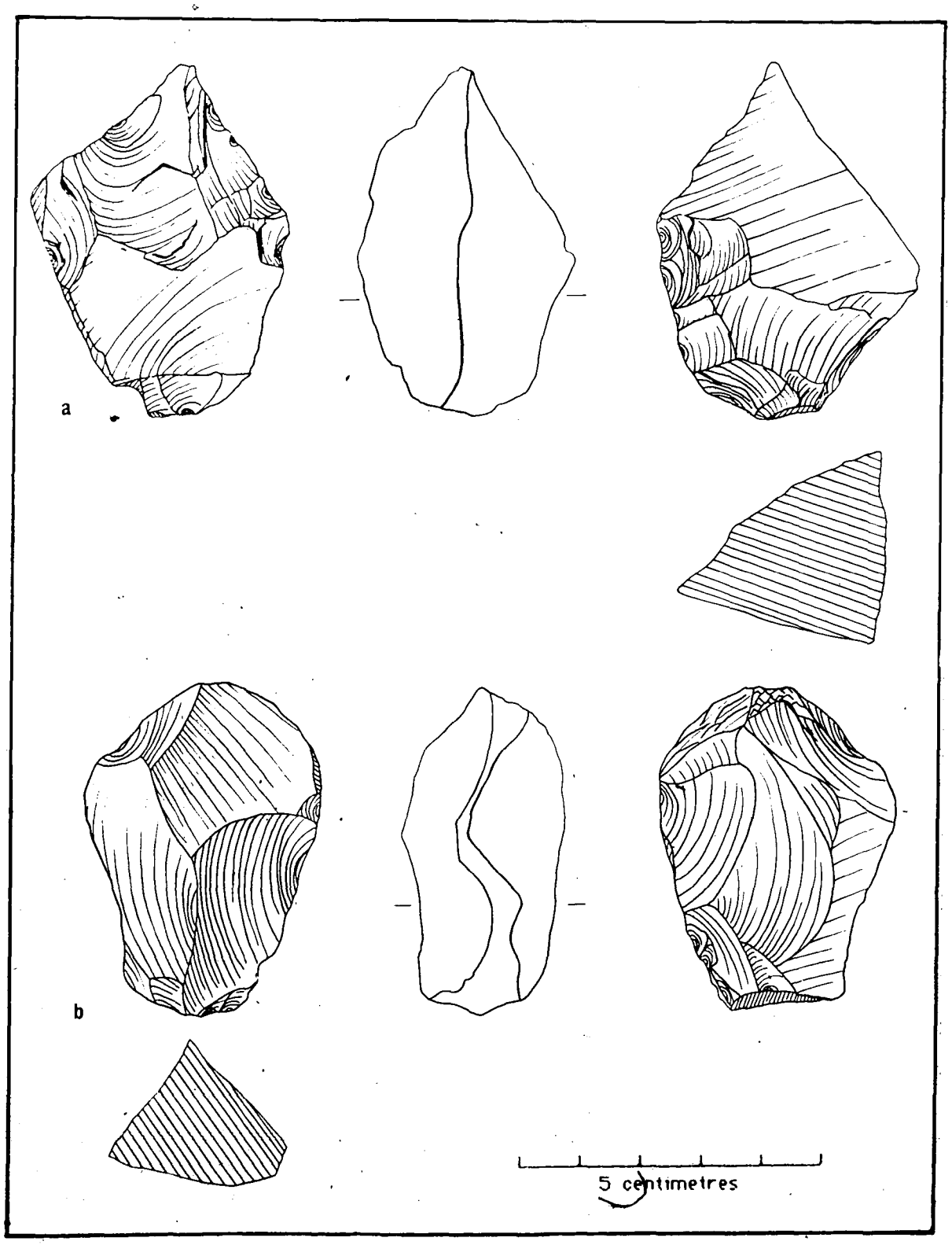


FIGURE 6.18. *KODJA* STONES II.

Figure **a.** is from the Mindijup Spring site on the eastern bank of the Kalgan River approximately five kilometres north of Kalgan Hall, and **b.** is from the Poison Point Dolerite Chipping Station at Wilson's Inlet, but it is not made of dolerite.

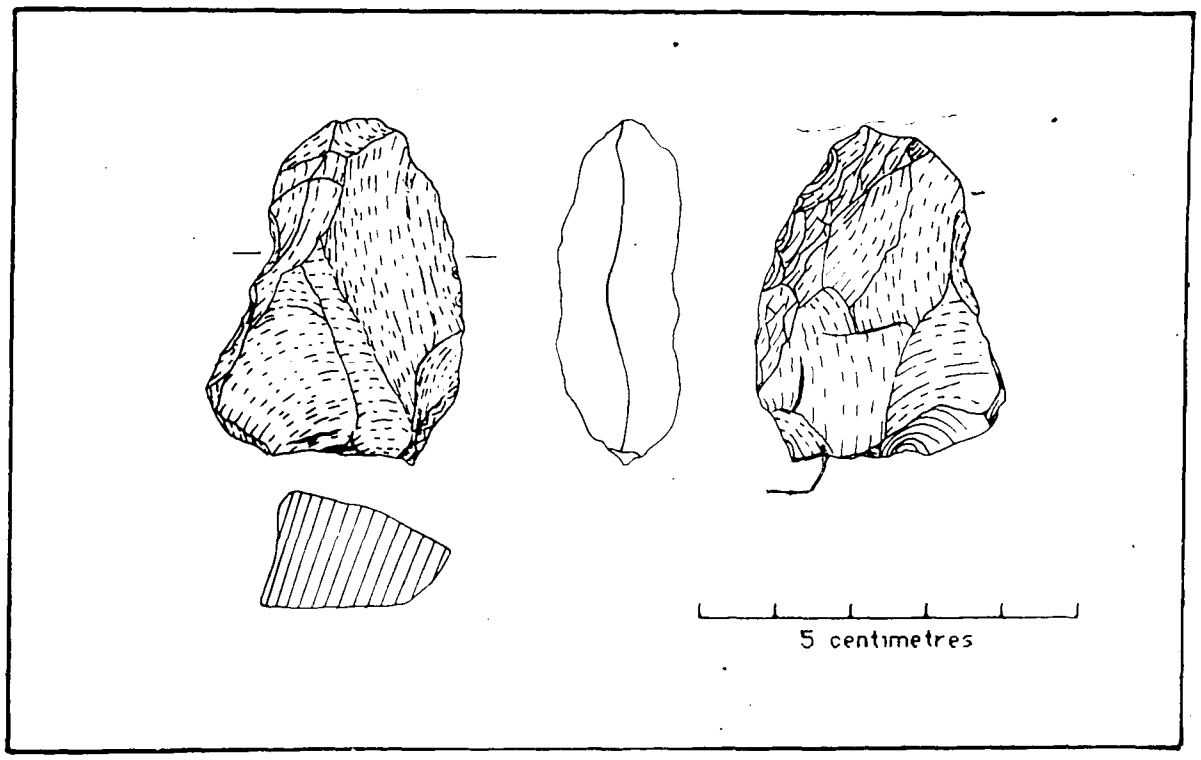


FIGURE 6.19. ***KODJA*** **STONES III.**

This implement was found in the Moorillup Pool Trench 2 excavation and is dated at about 2500 BP.

TABLE 6.16: DESCRIPTIVE MEASUREMENTS FOR CHOPPING IMPLEMENTS.

A. *Kodja*

WAM Acc. No.	SITE	FIG.	LENGTH	WIDTH	THICKNESS	WEIGHT	EDGE LENGTH	EDGE ANGLE
X126.01	POISON POINT CS.	6.18b	54mm	33mm	27mm	50g	79mm	67°
X138.01	LOWER HAY	6.17b	64	49	29	83	98	62
X196.01	MINDIJUP SPRING	6.18a	57	43	35	55	67	64
X525.01	MOORILLUP POOL	6.19	46	36	18	24	48	64
X963.01	ELIZABETH STREET	6.17a	58	36	30	63	85	55
X978.02*	WOOGENILLUP		67	53	25	97	67	70
X1401.02*	KALGAN HALL		52	50	26	104	60	70
	MEAN		59.6	46.2	29.0	80.4	67.3	64.6
	STANDARD DEV.		5.49	6.76	3.94	21.14	8.2	14.29

*Possible *Kodja*

B. Other Probably Hafted Chopping Implements

X978.01	WOOGENILLUP	6.23	67	111	43	346		50
X979.01	MADDEN	6.22	89	89	20	215		76

C. Probably Hand-Held Chopping Implement

X272.01	MOORILLUP POOL		58	102	38	233		50

pieces thinning flakes were removed from both faces using the base as a striking platform (Fig. 6.17a, b, Fig. 6.18a, b). These blows seem to have been designed to provide a relatively even taper from the base to the sharp edge. In addition, all seven implements have some form of secondary working which was directed from the sharp margins. The most extensive preparation has been given to the piece shown in Figure 6.17a which has relatively neat bifacial retouch over the entire length of the edge. On most others retouch is primarily unifacial with only isolated instances of bifacial trimming (Fig. 6.17b, Fig. 6.18a, Fig. 6.19).

The piece shown in Figure 6.18b differs from the others somewhat in that rather large flakes have been detached from the sharp edge, invading both faces for a considerable distance. The majority of the edge itself has been broken off, and the blunted remains are considerably battered, so that it is no longer suitable for use. This artifact was the only piece of non-dolerite materal found at the Poison Point Chipping station, and its presence there may reinforce the ethnohistorical information noted above that this location was a site of *kadja* manufacture and repair.

All five of the *kadja* stones illustrated show patterns of use wear similar to those described for the museum specimen A-TA657. All have minute hinge fractures just below the edge on both faces, and all have portions of their edge slightly blunted and rounded. This is more exaggerated on the sandstone pieces (Fig. 6.18b, Fig. 6.19) where the edges are best described as "crushed". Use-polish is clearly visible on the flake scar ridges and edges of four pieces (Fig.

6.17a & b, Fig. 6.18a & b), and, as with the museum specimen, this polish is differentially distributed on each piece so that it is more pronounced at one end of the edge than at the other. On three pieces these ridges are blackened as well as smoothed (Fig. 6.17b, Fig 6.18a & b).

Dating and Discussion Previously, because there has been no general agreement on what an achaeological *kadja* stone was supposed to look like, speculation as to its antiquity has produced a variety of suggestions. Crawford (1981:16), who accepted only an incompletely described "possible" *kadja* stone excavated from Walyunga with a date of about 1300 BP (Pearce 1978:6), assumed that the implement type was probably of "no great antiquity". Hallam (1981:54) argued for an age greater than 6000 BP since she accepted the Dunsborough Biface (Glover, Dortch and Balme 1978) as a *kadja* stone, and that implement is made of a material similar to the fossiliferous chert which is believed to have been quarried during periods of low sea-level from now submerged supply sources on the continental shelf. Tindale (1950,1951) considered the *kadja* to be very old, equivalent in date to the Karton industries of South Australia, on the basis of what he interpreted as similarity of form.

The use of the model described above has provided at least five and possibly seven implements which agree in detail with the attributes observed on ethnographic specimens. These stones all possess, in addition, a similar, unpredicted pattern of overall morphology which probably renders them more suitable for hafting,

and it seems reasonable to suggest that they are *kadja* stones of the type in use during the ethnographic present. Only two were found in a datable context. The piece shown in Figure 6.19 was recovered from 63 cm BD in Moorillup Pool 2 and is dated to about 2500 BP. The other piece, which is not illustrated and only possibly a *kadja* stone, is from 63 cm BD in Kalgan Hall 2 and dated to approximately 3000 BP. This suggests that *kadja* of the modern form have at least a few thousand years of antiquity in the region, but the sample is small and a greater age is certainly possible.

In the hope that a larger sample might clarify the situation somewhat, the model, augmented with the information on overall morphology supplied by its first application, was applied to the 16 previously recorded chopping implements from the region (Table 6.17). Of the 16, only 15 had been described in enough detail, and ten of those fell well outside the acceptable size range. This group, which includes the Dunsborough Implement, should probably not be considered as possible *kadja* stones.

Of those five within the size range, only one, a piece from Rushy Pool, near Narrogin, agrees in all detail with those from Mokaré's Domain. Its shape is very similar, and, from Noone's illustration (1943:Fig. 28), it appears that it has the large thinning flakes struck from both faces using the base as a striking platform. Three others, described by Akerman (1973: fig, 1c,2a,b) also agree in size and basic shape. All have an abruptly truncated base and taper to a prepared, convex edge, but they are all edge-ground to some extent. However, in light of the three ethnohistorical sources which mention

TABLE 6.17 PREVIOUSLY REPORTED SOUTHWEST ARCHAEOLOGICAL CHOPPING IMPLEMENTS

WAM Acc.No.	APPELLATION	LOCATION	MATERIAL	LENGTH	WIDTH	THICK-NESS	RE-TOUCH	TRUNC BASE	*KOOJA* ?
E596	AXEHEAD[1] POS.*KOOJA*[2]	CHIDLOWS WELL	INDURATED SHALE	82	82	20	GRND	YES	NO
10492	AXE BLADE[1] POS.*KOOJA*[2]	LAKE MAGENTA	INDURATED SANDSTONE	74	60	22	GRND	YES	POS.
10063	AXEHEAD[1] POS.*KOOJA*[2]	DINNIUP	DIORITE	60	90	28	FLKD& GRND	YES	NO
10067	*KOOJA*[1&2]	NARROGIN	GREYWACKE	56	50	30	FLKD	YES	YES
12206	POS. *KOOJA*[2]	WALYUNGA	INDURATED SHALE	86	90	28	FLKD	YES	NO
121731	AXE[2]	WALYUNGA	INDURATED SHALE	65	106	41	GRND	NO	NO
9545	AXEHEAD[2]	WOOROLOO	DIORITE	63	147	28	GRND	NO	NO
12166	AXEHEAD[2]	DENMARK	QUARZITE	71	107	25	GRND	NO	NO
12727	AXEHEAD[2]	WALYUNGA	QUARZITE	66	88	unk.	FLKD	NO	NO
unknown	AXE[3]	WALYUNGA	INDURATED SHALE	94	130	29	FLKD& GRND	NO	NO
unknown	AXE[3]	WALYUNGA	DOLERITE	101	130	46	FLKD& GRND	YES	NO
unknown	POS.*KOOJA*[3]	BULLSBROOK	DOLORITE	66	54	14	FLKD& GRND	YES	YES
unknown	AXEHEAD[3]	KOJONUP	unknown	58	34	18	GRND	YES	YES
unknown	AXEHEAD[3]	MT. BARKER	GREYWACKE	72	54	28	FLKD& GRND	YES	YES
unknown	BIFACE[4] *KOOJA*[5]	DUNS-BOROUGH	CHERT	106	83	46	FLKD	YES	NO
unknown	POS.*KOOJA*[6]	WALYUNGA	QUARTZ	unk.	76	unk	FLKD	unk.	?

[1]Noone (1943)
[2]Ride (1958)
[3]Akerman (1973)
[4]Glover, Dortch & Balme (1978)
[5]Hallam (1981)
[6]Pearce (1978)

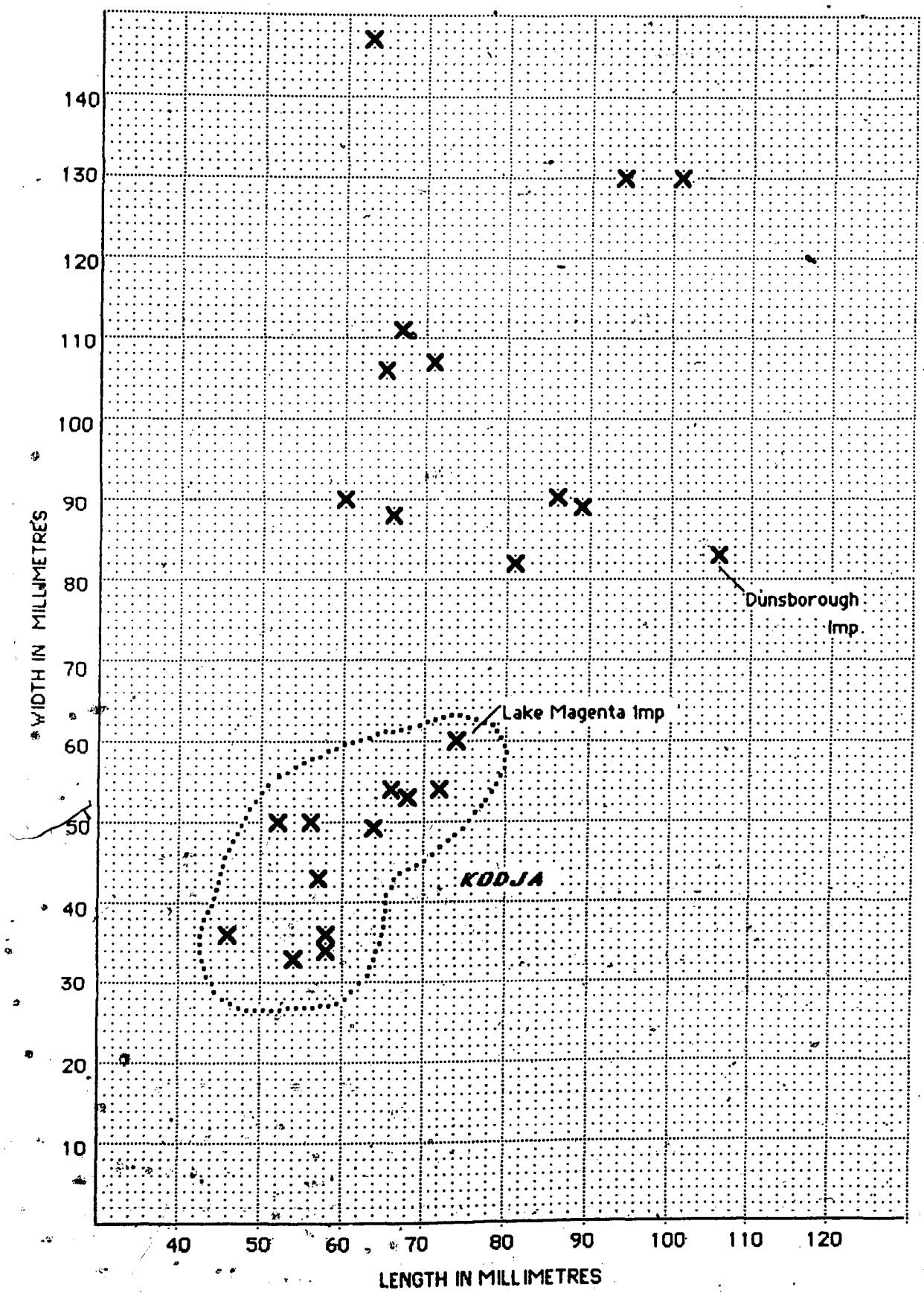


FIGURE 6.20: GRAPH OF LENGTHS AND WIDTHS OF CHOPPING IMPLEMENTS LISTED ON TABLES 6.16a & b, and 6.17.

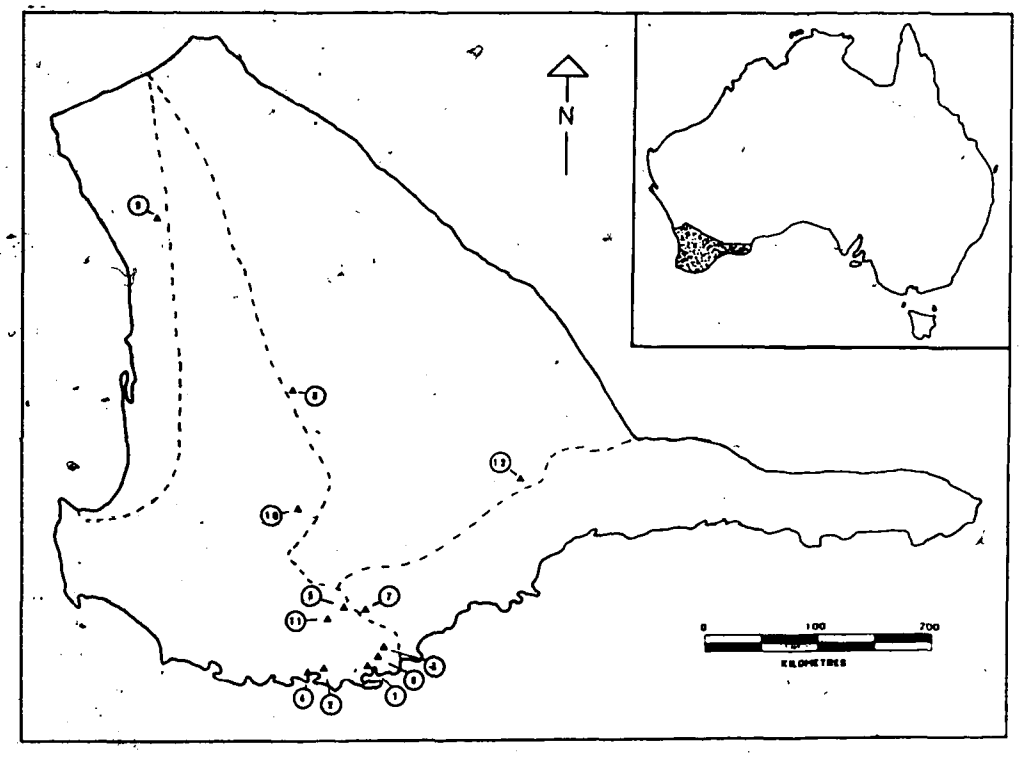


FIGURE 6.21. ARCHAEOLOGICAL *KODJA*-STONE DISTRIBUTION MAP: The map shows the find locations of those artifacts listed on Tables 6.16 and 6.17 as *kodja*-stones or possible *kodja*-stones. An asterisk beside the name in the list below indicates that piece is only a possible *kodja*-stone.

1. Elizabeth St., Lower King. **2.** Lower Hay River. **3.** Mindijup Spring. **4.** Poison Point, Wilsons Inlet. **5.** Moorillup Pool. **6.** Kalgan Hall*. **7.** Woogenillup Pool*. **8.** Rushy Pool, Narrogin. **9.** Bullsbrook. **10.** Lynford Hill Farm, Kojonup. **11.** Kiriwara Farm, Mt. Barker. **12.** Lake Magenta*.

edge-grinding in this context, it seems reasonable that these, too, should be considered as "probable" *kadja* stones.

The final piece, which comes from Lake Magenta, (Noone 1943:fig 30, Ride 1958: fig 5), is an oddity. It is a fully ground rectangular piece, and its edge is only very sightly convex. However, it does have a truncated base, and although its length is slightly outside the model's requirements, its measurements cluster with those of the *kadja* (Fig 6.20), so it has been tentatively included as a "possible" *kadja*.

The acceptance of these five pieces brings the total number of *kadja* identified by the model in the region to nine, and possibly twelve. Unfortunately, all the additional examples are surface finds, so it must be concluded that on present evidence that there is no indication of *kadja* in the archaeological record before the third millennium BP. It is now possible, however, to begin to create the distribution map which will, hopefully, one day provide a form of archaeological confirmation for the ethnohistorical model of the extent of the Nyungar culture (Fig. 6.21).

Other, Probably Hafted, Chopping implements:

There are two chopping implements whose size measurements fell among those of the non-*kadja* when graphed on Figure 6.20. Their descriptive measurements are shown on Table. 6.16. The first of these (Fig. 6.22) is undoubtedly designed to be hafted. It is made on a tabular piece of dolerite and has full bifacial retouch over three-quarters of its ovate margins. The base is partially truncated

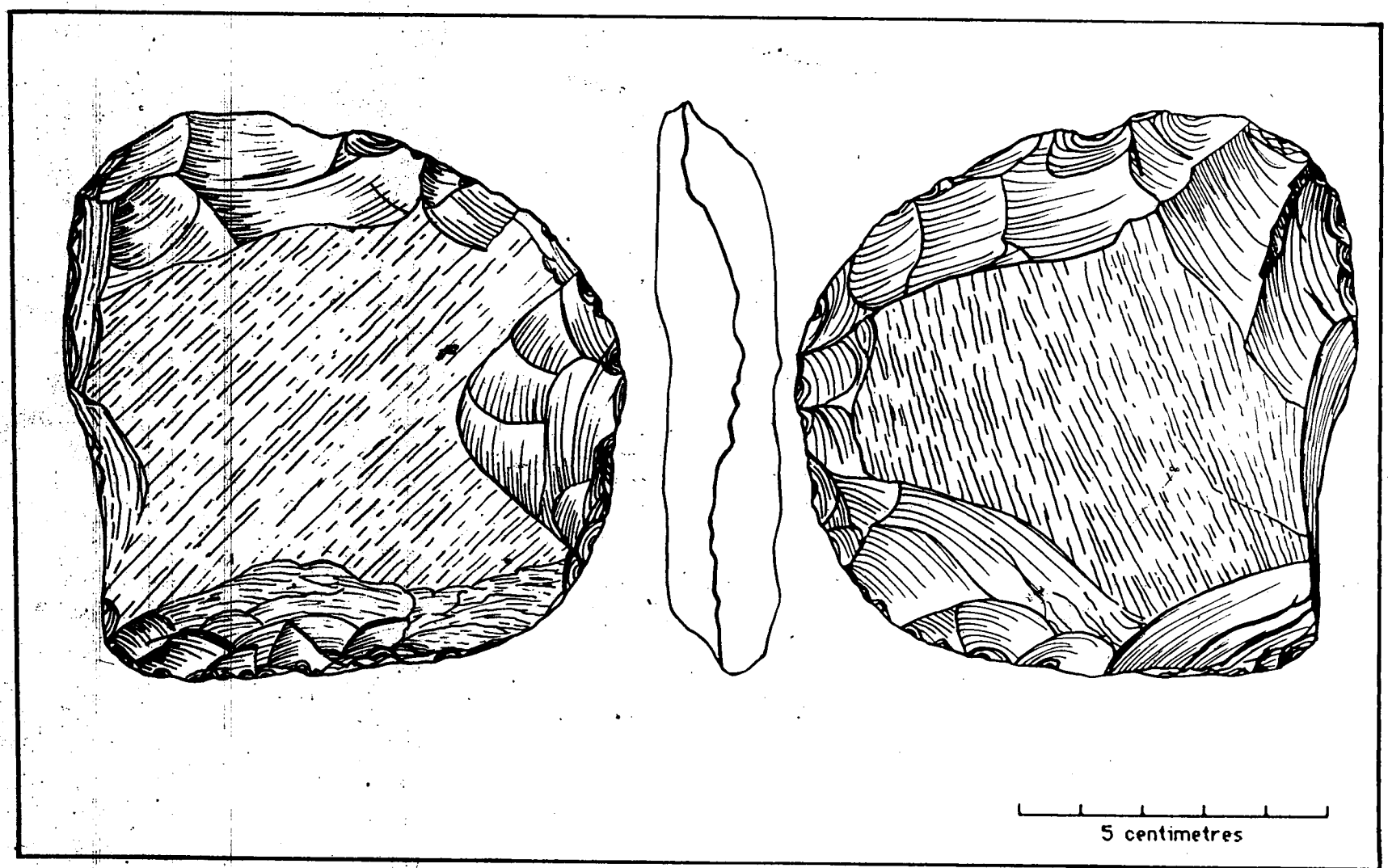


FIGURE 6.22. THE MADDON AXE.

This is a non-*kudja*, probably hafted chopping implement from the Maddon site on the Kalgan River approximately two kilometres above Kalgan Hall.

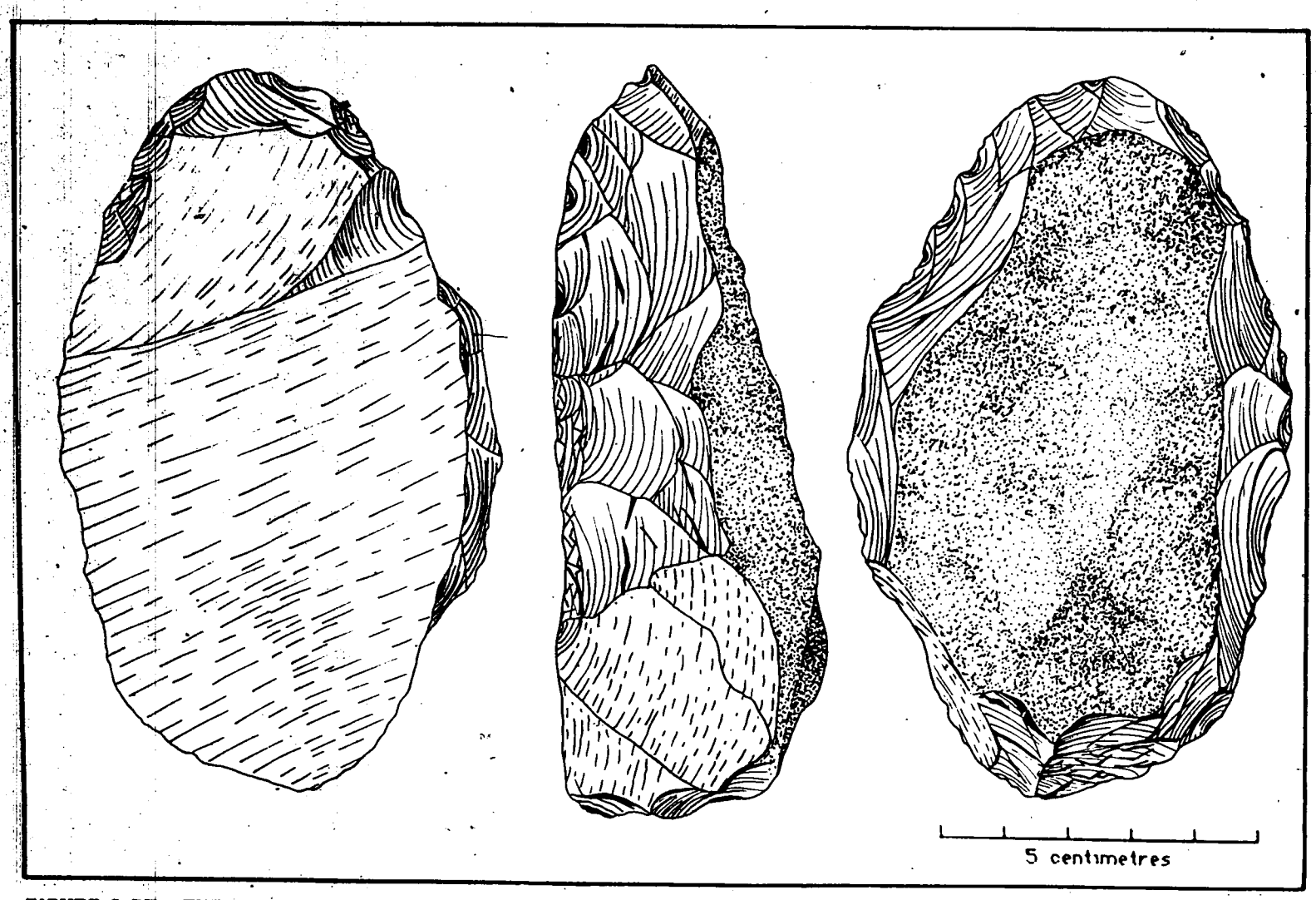


FIGURE 6.23. THE PROBABLY HAFTED CHOPPING IMPLEMENT FROM WOOGENILLUP.

by what appears to be purposeful removal of a large flake, and use-wear is similar to that described for the *kodja*: rounded edges, tiny hinge fractures, and use-polish extending well into the basins of the negative flake scars.

The other piece (Fig. 6.23) is less certainly designed for hafting and could have served as a hand-held chopping implement. It is made on a dolerite split-cobble, has cortex on its dorsal surface, and is unifacially retouched around the majority of its margin. Bifacial retouch is limited to an approximately 70 cm arc around the point. The cortex covered base is naturally blunt, and the well pronounced use-wear is similar to that described for the *kodja*.

Discussion. The non-*kodja* chopping implements of the Southwest have no local ethnographic analogue, yet are as numerous as *kodja* in the archaeological record. Since all of them, including these two, are surface finds, their place in the archaeological sequence is conjectural. They may precede the *kodja* in time as is perhaps implied by the petrology of the Dunsborough implement (Glover, Dortch & Balme 1978) which suggests its manufacture prior to the earliest currently known date for *kodja*.

On the other hand, about two thirds of the non-*kodja* are edge-ground, and this technique is generally assumed to be a very late introduction into the region (Ride 1958, Akerman 1973). This would suggest that even if the non-*kodja* have considerable antiquity, they may have continued to be used concurrently with the *kodja* up to the recent past. There is no solid evidence that edge-grinding was only

recently introduced, however. It has been practiced in other parts of Australia for at least 20,000 years (Schrire 1982), and it is just as likely that this technique was used as an alternative method of edge preparation by the prehistoric inhabitants of the region for a considerable period.

The method by which they were hafted is also a problem. About two thirds of them have truncated bases; and these, as Ride (1958) suggests, may have been hafted in a fashion similar to the *kodja*. This does not account for the remainder, however, and whether or not *kodja*-like hafting could cope with the amount of stress likely to be placed upon it, if stones of this size were used, is a question which probably requires controlled replicative experiments.

• Probably hand-held chopping implement:

Only one probably hand-held chopping implement was identified. It is made of relatively course-grained granite-gneiss and is of similar dimensions to the piece illustrated in Figure 6.22 (see Table 6.16). On one end of this artifact, one or two fairly large flakes have been struck from each face leaving a relatively sharp edge. This edge shows evidence of considerable use and is extensively crushed.

POSSIBLE PIERCING IMPLEMENTS:

Five implements were recovered whose designed morphology and subsequent use-wear suggest that they may have been used to bore holes in softwood, bone or hide. They are similar in appearance to the implements called "piercers" or "drills" by McCarthy (1976:38).

Each possesses a pointed extremity which has been produced by purposefully chipping away the stone to either side of it. The piece shown in Figure 6.15e is the only one which shows no use-wear. Possibly, the necessary sharpened tip was broken off during manufacture. The rest more closely resemble Figure 6.15f in that they have bi-facial use-wear along both sides of the extremity. The descriptive measurements for these implements are shown on Table 6.18a.

Whatever their actual function, artifacts of this type were apparently in use throughout the Holocene. The piece shown in Figure 6.15f comes from 40 cm BD in Kalgan Hall 2 and is dated about 2000 BP; and another piece (not illustrated) was found at 60 cm DBS in Moorillup Crossing 1, just below a date of 7700±200 BP.

MULTI-PURPOSE IMPLEMENTS:

The descriptive measurements for this classification are shown on Table 6.18b It includes the ten artifacts whose attributes suggest that they may have been used for more than one function. Six are flakes which have two opposed working edges: one with high-angled scraping retouch and/or use-wear, and one with low-angled cutting retouch and/or use-wear. Another piece is a fire-shattered fragment of a quartzite grind-stone which has two edges retouched: one is steep and convex, and the other is straight with low-angled denticulation. The three remaining pieces all have one retouched and/or utilized working edge and what appears to be a burin spall removed from one or more ends of the opposite margin.

TABLE 6.18: SELECTED DESCRIPTIVE STATISTICS FOR PIERCING AND MULTI-PURPOSE IMPLEMENTS.

A. PIERCING IMPLEMENTS

	LENGTH (mm)		WIDTH (mm)		THICKNESS (mm)		WEIGHT (g)		RETOUCHED EDGE-LENGTH (mm)		EDGE-ANGLE (°)	
NO.	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN
4	18-24	22.0	15-24	17.5	4-21	9.0	1-5	2.25	12-19	15.75	66-94	78.75

B. MULTIPURPOSE IMPLEMENTS

		LENGTH (mm)		WIDTH (mm)		THICKNESS (mm)		WEIGHT (g)	
TYPE	NO.	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN
SCRAPING & CUTTING	3	32-52	41.33	23-30	27.00	7-10	9.00	6-15	9.00
SCRAPING, CUTTING & GRINDING	1	73		40		25		70	
ENGRAVING & SCRAPING OR CUTTING	3	21-31	24.67	14-23	18.33	7-11	8.33	2-8	4.33

Two of this last group are from dated excavations. The piece illustrated in Figure 6.15.g was found in Kalgan Hall 2 directly over a date of 3420±90 BP; and Figure 6.15h, from Moorillup Pool 2, is approximately 2500 years old.

The "multi-purpose" classification was used previously in the analysis of the artifacts from the Quininup Brook Site Complex (Ferguson 1980a) to cope with a large number of implements which had both high-angle and low-angle working edges on the same piece. It was suggested in that study that most of these pieces probably gained their multiple use patterns from a prehistoric practice of picking up previously discarded implements and reworking them for a new task. If this is so, then the practice was not as frequent in Mokaré's Domain. Pieces of this type comprise only .04 % of the implements, whereas they account for over 15% at Quininup Brook.

This is possibly best explained by a difference of good raw material in the two research areas. Adequate stone is readily available throughout Mokaré's Domain, but the fossiliferous chert preferred for implements at Quininup Brook had to be imported, perhaps from quite some distance (Ferguson 1980b). In such circumstances, re-use of material would likely be considerably more common.

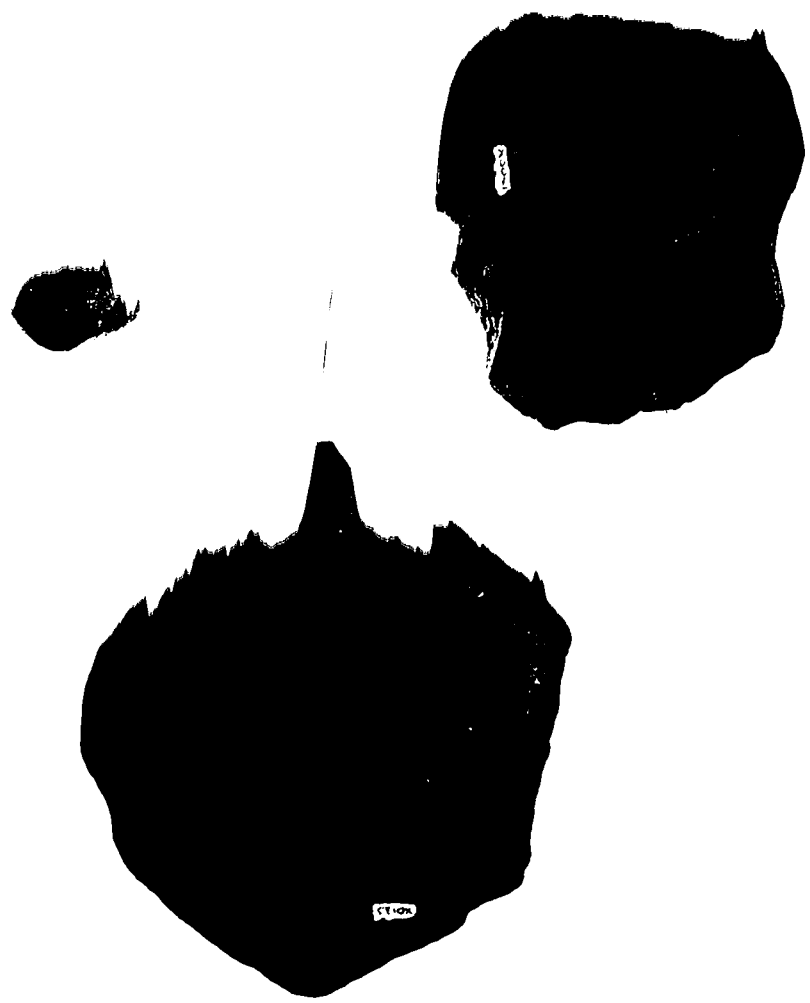
GROUND AND PECKED STONE:

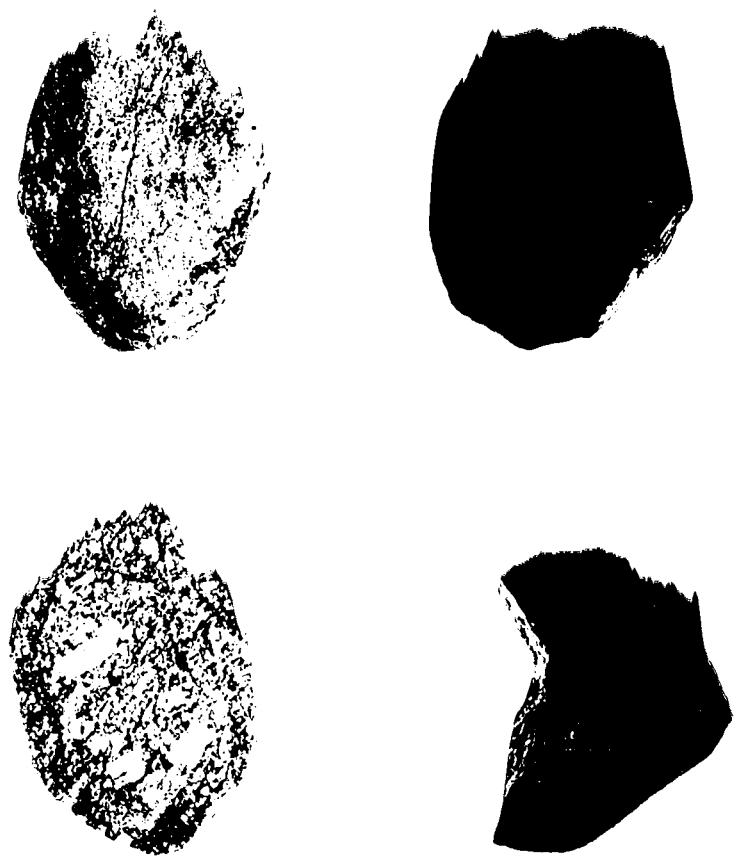
The ground and pecked stone implements were not included in the artifact sequence level counts of the Mokaré's Domain excavations which are used in the examination of the mid-Holocene depopulation

hypothesis. They were excluded because there are so few of them, especially in stratigraphic contexts, and because they are so varied that comparison seems unwarranted. They have not been subjected to any detailed analysis, and the description and discussion which follows is only a tentative beginning to what will necessarily need to become a major area of study in its own right.

Only nine whole and eleven broken implements were recovered which show evidence of stone grinding and/or pecking. The size of the whole pieces varies enormously: from 3450 grams (Fig. 6.24a) to 50 grams (Fig. 6.26c). These appear to represent a wide variety of activities; but at this stage of understanding, all "functional" interpretations remain only speculative.

The majority are probably "basal grindstones" as they have smooth and shallow concavities which have been abraded on one or more of their broad surfaces (Fig. 6.24a; Fig. 6.25a, b & c; Fig. 6.26b & d). Others, although similar in over-all morphology, are probably best considered as "anvil stones" because they have relatively rough, pecked depressions, rather than smooth, ground ones (Fig. 6.24b, Fig. 6.25d). On both sides of the piece shown in Figure 6.25d this pecking is concentrated to such an extent that small "dimples" are pecked into each surface. Pecked dimples are common on the grindstones of the Southwest (Ferguson 1981:624), and on the implements from Mokaré's Domain such features are not restricted only to basal "anvils", but are also found on smaller "upper" grindstones such as that shown in Figure 6.25c. The rounded, upper grindstones also vary greatly in size (*c.f.* Fig. 6.24c, Fig 6.26a), and some have battered margins which





suggest additional use as hammerstones. Some of the smaller, basal grindstones and anvils were also apparently used as upper grindstones because some of their narrow margins have been ground flat (Fig. 6.25a & d).

In Chapter 2 the functions of grindstones as listed in the ethnohistorical literature were discussed. This included the preparation of various vegetable products (seeds, leaves, roots, vines, etc.) for food, and the grinding of ochre for decoration. Many of these archaeological artifacts just described may have gained their characteristic attributes from being used for these purposes. In this Chapter on stone working, the use of anvil stones for bi-polar reduction and the ethnohistorical practice of edge-grinding chopping implements were discussed. These activities, too, may have produced some of the attributes noted here. There are, however, two implements in the assemblage which have attributes suggesting a possible function not previously considered. These are small, thin disks of relatively soft, fine-grained sandstone-like material which have been ground very smooth (Fig. 6.26c), and may have been used as "sanding blocks" for smoothing wooden or bone implements.

No attempt to test any of these functional hypotheses was undertaken, and all remain speculative. Whatever is the case, in Kalgan Hall Trench 2 materials with attributes suggesting grinding were found associated with dates from each of the three time periods used in the analysis of the flaked stone, indicating a long continuity of the practice. The oldest of these implements are the two fragments of a basal grindstone shown in Figure 6.26d. They were

found in direct association with the date of 18,850±370 BP.

DISCUSSION - CONTINUITY AND FUNCTION OF THE FLAKED STONE ASSEMBLAGE:

The discussion which follows assumes first, as was argued in Chapter 5, that the artifact density sequences are representative of the sites from which they were recovered; and, second, as is discussed in detail in the next Chapter, that the sites themselves are representative of the greater region. It attempts to determine from an examination of the stone artifacts described above whether or not any evidence exists to suggest that the dramatic decline in artifact numbers during the mid-Holocene was not a direct result of fewer people being present in the region to make and use these artifacts.

Throughout this Chapter stress has been placed on determining whether or not there was continuity in the various aspects of stone working technology. Any change in these aspects over time could result in different amounts of stone residue being produced from otherwise comparable activities, and thereby render the equation of artifact numbers with population suspect. This investigation has experienced a major limitation because there are so few artifacts dated to the mid-Holocene period, that it is difficult to conclude much of anything about them. However, given this limitation, several points have been established.

The nature and proportions of the raw material used has been investigated, and it has been found that although each site appears to have its own special mix of raw materials, this mix has remained

basically unchanged in all three time periods (Fig. 6.2). The evidence for reduction patterns has also been investigated and only two minor anomalies to a picture of overall continuity were noted: the introduction of a small amount of blade-production technology in the period beginning about 4000 BP (Table 6.5), and an inexplicable decline in the percentage of cores and flaked fragments at about the same time.

In the study of the implements, however, greater discrepancies between the various levels occur. It has already been stressed that the sudden introduction of the backed microliths at about 4000 BP indicates one notable discontinuity (Table 6.9), and others exist. Table 6.19 shows the presence or absence of all the various implement types in each of the three time periods. As can be seen, there is still evidence for a high degree of continuity. Most of the types listed are found in at least Periods I and III where samples are large enough to provide adequate representation; but, along with the microliths, two important ethnographically recorded implements, the *leap* and the *kadja*, appear to be confined to the late Holocene period.

The dating on these two implements is not very secure. Only one, possibly two, *kadja* have been identified in a datable context anywhere in the region; and it could not be argued with confidence that unidentified *leap* flakes from earlier periods are not present in the Mokare's Domain assemblage. That the backed microliths are an anomaly, however, does appear certain; and if the dating for these other two as presented here is confirmed, then there appears to be three major additions to the Nyungar tool kit during the late Holocene.

TABLE 6.19. CONTINUITY OF IMPLEMENT TYPES OVER TIME.

The presence of an implement type in the Mokaré's Domain assemblages is indicated by an **X** in the appropriate location. Implement types not found during a given period in the Mokaré's Domain assemblages, but known elsewhere in the Australian Southwest for that period are indicated with a **K**, and a superscript number to indicate one of the locations at which it has been found.

	BACKED MICRO-LITH	ADZE FLK	CORE SCRP. IMP.	NOTCH SCRP. IMP.	AMORPH SCRP. IMP.	*TAAP* FLK	HAND-HELD CUT.IMP	*KOOJA* STONE	PIERC-ING IMP.	MULTI-PURP. IMP.	GRIND* STONE
PERIOD III	X	X	X	K^1	X	X	X	X	X	X	X
PERIOD II		X			X						X
PERIOD I		X	X	K^2	X		X		X	K^2	X

1. Northcliffe (Dortch & Gardner 1976)
2. Quininup Brook (Ferguson 1981)

*Ground and Pecked stone not included in level counts.

On current evidence, this is the only significant discontinuity in the sequence, and it does not affect the basic premise of the thesis: that the artifact density sequences of the region can be legitimately interpreted to suggest a depopulation of the region in the early to mid-Holocene. It calls into question whether or not the region was so significantly repopulated at about 4000 BP, but there is no evidence for change of any kind in the source materials, reduction techniques or desired end-products of the stone working process prior to that time.

Comparison of other aspects of stone implements between the various levels would be desirable to confirm the continuity argument, but the small sample size precludes this. It had been originally planned, for instance, to investigate not just the presence or absence of implement types in each period, but any trends toward alteration in size of the implements within each type as well. Such a study must be done on a site by site basis because of the undeniable influence of raw material on this factor; and, allowing for the high variablity in size attributes which can be expected from such a highly opportunistic technology at any given time, quite large numbers would be required before any confidence could be granted to that study.

No site in Mokare's Domain contained enough artifacts of any given implement type for this to be done. Only with the debitage was it possible to investigate trends toward changing size attributes. This was done by comparing the proportions of chips to flakes (Fig. 6.4), and it reinforced the continuity argument since those minor trends which appear at the various sites do not form a coherent

regional pattern.

A high degree of continuity exists in all aspects of the stone working technology for the period before about 4000 BP, and yet, in the early to mid-Holocene, each site which covers this period experiences a dramatic drop in artifacts per millennium. This could only result from two circumstances: either there were less people present to require and make stone implements, or there was a massive decline in the amount of stone implements that each person used. Given the nature of the artifacts and their functional role in the society, the latter possibility seems highly unlikely.

As was suggested in Chapter 1 and at the beginning of this Chapter, those activities which are represented by the artifacts, especially stoneworking and woodworking, must be seen as basic "cultural core" activities. Together, they provided the essential extractive implements with which the prehistoric inhabitants maintained their livlihood. Without them, or some suitable substitute for them, it is difficult to imagine how a pre-metallurgical society could sustain itself within its environment. In general, evidence which suggests a decline in the amount of these activities can logically be taken to suggest a corresponding decline in all other activities as well.

Only if another type of raw material was substituted for stone in the cultural core activities of the Southwest during the mid-Holocene can the decline in artifact numbers be explained without reference to falling human population numbers. Although

unlikely, this possibility cannot be entirely discounted. In the ethnohistorical literature both shell (Roth 1903:68) and kangaroo incisors (Hassell 1975:16, Salvado 1851:147) are noted as having been substituted on occasion for the stone adze-flake on the end of spear throwers; and it is certainly possible that these materials could have served as substitutes for many of the other cultural core functions normally fulfilled by stone.

These materials are perishable and do not survive in the preservation conditions of most Southwest sites, but the prehistoric use of kangaroo incisors has been argued on the basis that there are proportionately fewer of them than there should be among the faunal remains in the late Pleistocene levels of Devil's Lair cave (Balme 1979). A few shells, although no implements, are also present at that site (Dortch 1979a). Accepting Balme's argument, these materials were, however, being used in conjunction with large amounts of stone in both the late Pleistocene and the late Holocene; and it must be emphasised that no incisor or shell artifacts have been found dated to the mid-Holocene anywhere in the region.

Additionally, shell would have had to have been imported quite some distance to most sites; and, as was discussed in Chapter 2, during the mid-Holocene the encroaching forests would have severely reduced the kangaroo population of the region. A relatively sudden and near total switch during the mid-Holocene to a reliance upon materials with such limited natural distributions is not logically consistent with the basic opportunistic nature of prehistoric implement manufacture in the region. Both before and after this

period the prehistoric inhabitants relied to a large extent on whichever suitable raw material was closest to hand for the production of their cultural core implements.

This remains a remote possibility. However, until quantities of incisor or shell implements dated to this period are discovered, it seems reasonable to conclude that it is highly unlikely, and to accept that the drop in artifacts probably reflects a depopulation of the region.

The interpretation of the sudden rise in artifact numbers at about 4000 BP is somewhat more difficult. The introduction of new types and reduction patterns at about the same time casts doubt on any attempt to equate absolute artifact densities from the late Holocene with those from earlier periods. As was implied above, the increase at this time might reflect merely a trend to more stone working per person rather than an increase in population. However, the increase in artifacts at this time is very large, over 7700 % from 5000 to 3000 BP in Kalgan Hall Trench 2, and it seems improbable that what appear to be relatively minor changes to the overall continuity of the stone working technology could account for all of it.

Only one new reduction pattern is introduced, designed blade production; and from the evidence it was not practiced especially extensively. Even assuming the dating of the *kadja* and the *laap* is correct, there is still probably only one implement type which can really be seen as a "true" addition to the tool kit, the microliths. The known functions of the *kadja* and the *laap* are so basic to the

cultural core activities that it seems logical that they are replacements for other implements rather than true additions.

This cannot be demonstrated in any convincing way. An examination of the Kalgan Hall assemblage did suggest that there are proportionally almost five times as many hand-held cutting implements in the late Pleistocene levels than in the late Holocene levels; but as the data sample used in this comparison is so small (3 hand-held cutting implements from 1296 artifacts in Period I, compared with 3 from 5215 in Period III), it is only barely worthy of note. Admittedly, manufacture of a *leap* could require more stone working than manufacture of a hand-held cutting implement; but, without replicative experiments, just how much more is questionable.

As is discussed in the next chapter, the dramatic increase in artifact numbers which is found in all the trans-Holocene sequences (except Moorillup Crossing where the rise is small but evidence suggests that the focus of occupation moved to another part of the site), occurs simultaneously with the occupation for the first time of many new sites within the region. Kamballup Pool in Mokaré's domain [illegible]ne of these.

These new sites are separate evidence for increasing population at this time, and it would seem that the dramatic increase in stone artifacts probably does suggest a substantial increase in population. It must be stressed, however, that the amount of this "repopulation" cannot be determined by comparison with the previous levels because of the changes in the technology; and that any acceptance of the repopulation hypothesis, must be only provisional.

CHAPTER 7

CONCLUSION: THE MID-HOLOCENE DEPOPULATION OF THE AUSTRALIAN SOUTHWEST

In the preceding chapters, this study has moved progressively from the general to the particular investigating the possibility that there was a mid-Holocene depopulation of the Australian Southwest. This final chapter returns to the macro-area to compare the sites of Mokaré's Domain with other Australian Southwest excavations.

The archaeology in Mokaré's Domain has provided strong support for the depopulation argument. Through the use of age/depth graphs and millennial density models, which are reproduced below for easier comparison, it was shown that three of the five sites excavated experience dramatic drops in artifact numbers during the mid-Holocene: Kalgan Hall (Fig. 7.1), Moorillup Crossing (Fig. 7.2), and Waychinicup River (Fig. 7.3). As was argued in the last chapter, unless the prehistoric inhabitants suddenly substituted some other material for stone, this suggests an equally dramatic decline in the amount of essential, life giving, human activity in the region.

The other two sites which were excavated do not provide any direct evidence for a mid-Holocene depopulation; but, because they exhibit evidence for only late Holocene occupation, they do not dispute the possibility that such a depopulation occurred. Kamballup Pool (Fig 7.4) appears to have been frequented from about 4000 BP onward; and Moingup Spring, which has not been modelled, has occupation restricted to the last millennium BP

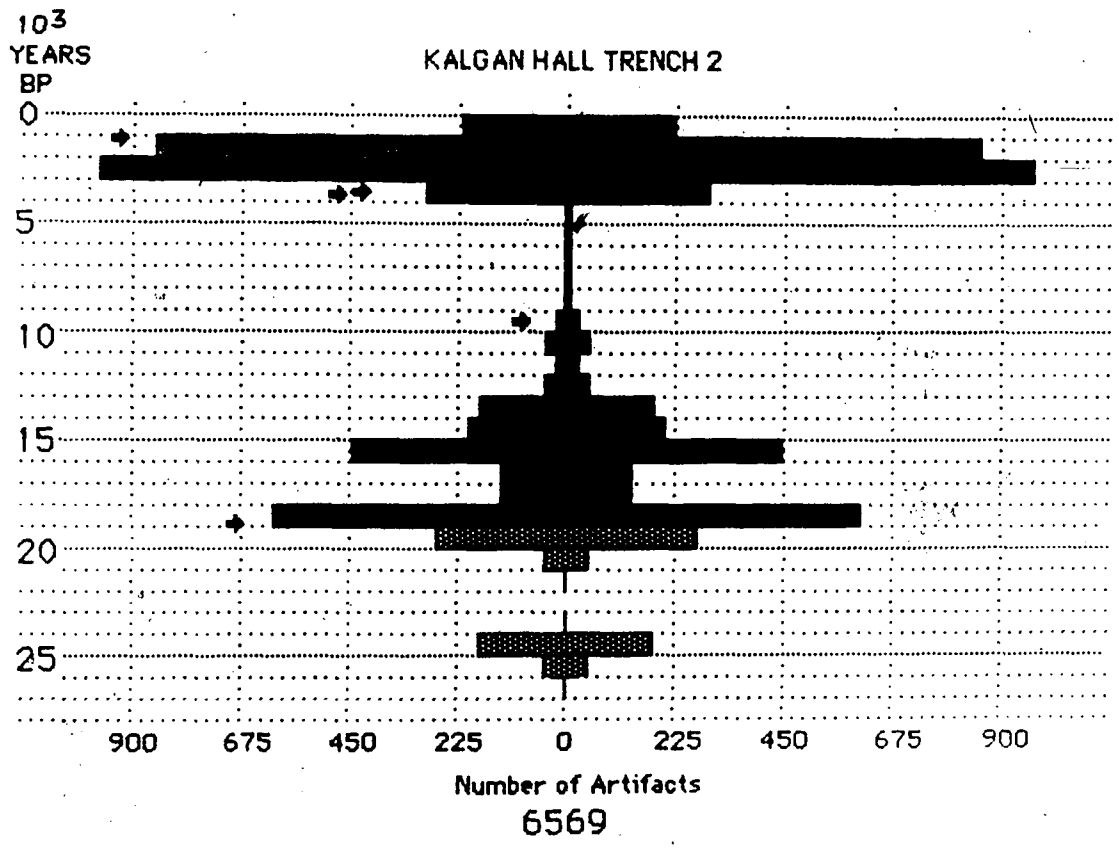


Figure 7.1. Millennial Density Model for Kalgan Hall Trench 2:

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Fig. 5.10).

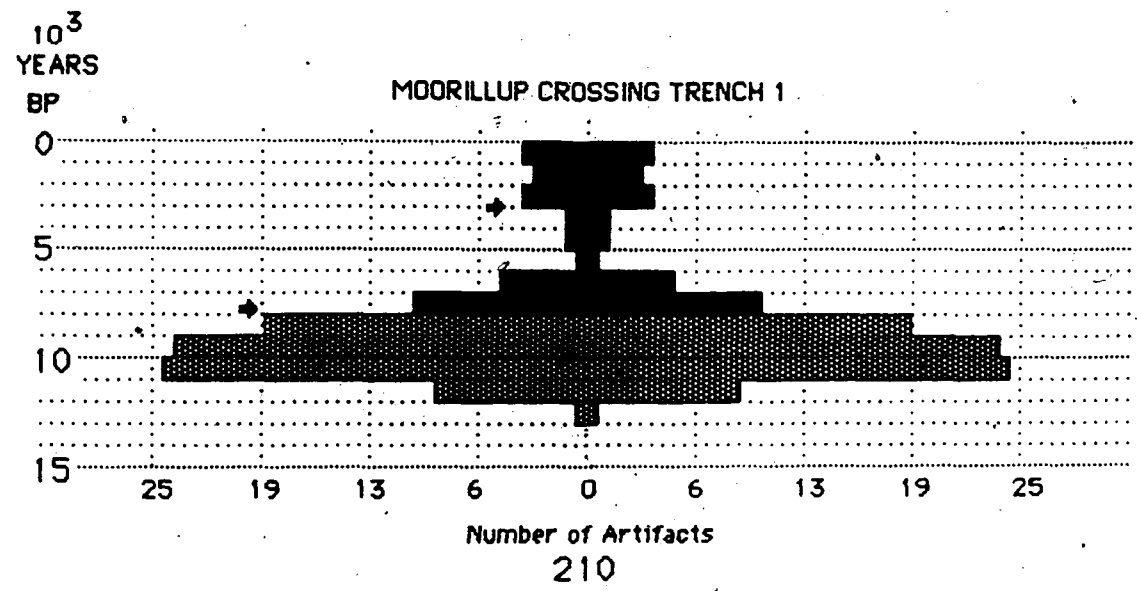


Figure 7.2: Millennial Density Model for Moorillup Crossing Trench 1. Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Fig. 5.26).

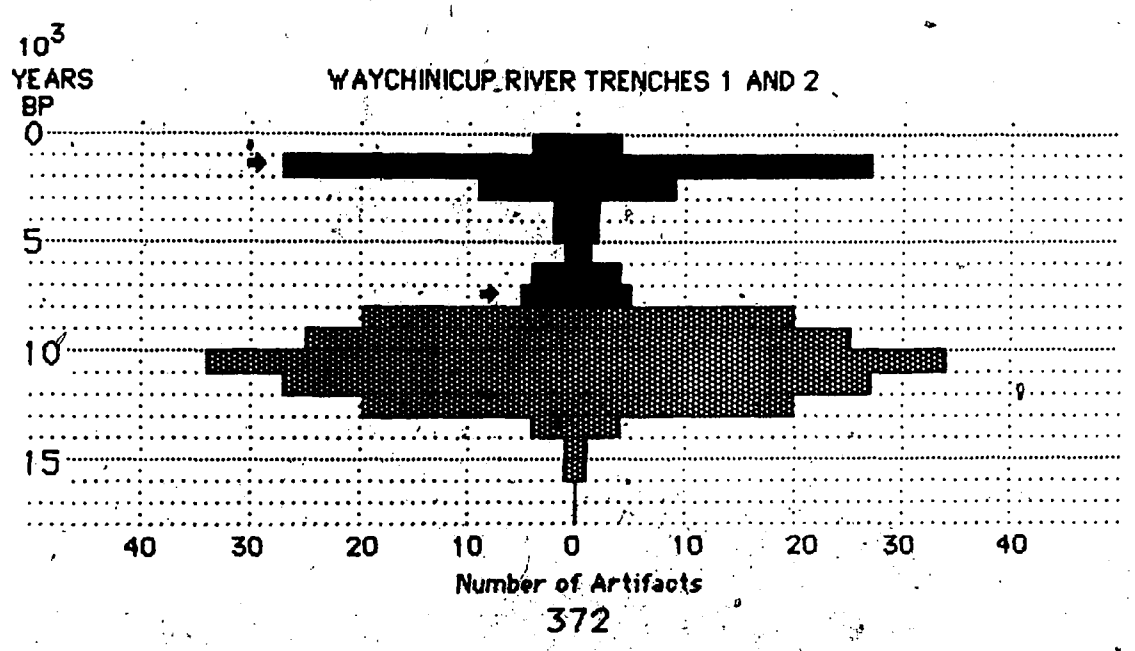


Figure 7.3: Millennial Density Model for Waychinicup River Trench 1 & 2

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Fig. 5.30).

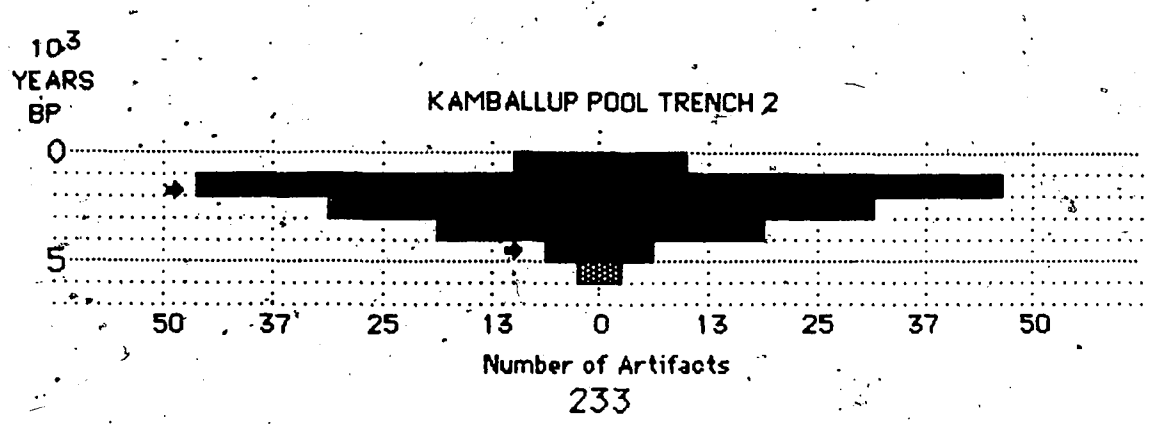


Figure 7.4: Millennial Density Model for Kamballup Pool Trench 2.

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Fig. 5.34).

The sites of Mokaré's Domain have also provided details regarding the timing of depopulation in the Southern Jarrah Forest and adjacent woodlands which tentatively support the cultural ecology model upon which the prediction of a mid-Holocene depopulation was originally based. It appears to have begun sometime before 10,000 BP in the currently forested areas around Kalgan Hall; and somewhat later, around seven or eight thousand BP, in today's woodland areas where Moorillup Crossing and Waychinicup River are located. In all areas, including the scrubland surrounding Kamballup Pool, it appears to have ended at about the same time: between three and four thousand years ago.

Other Southwest Excavations:

There are seventeen dated archaeological sites in the Australian Southwest besides those already reported from Mokaré's Domain. They are listed on Table 7.1, and shown on the location map, Figure 7.5. Each of these sites should provide an individual test of the mid-Holocene depopulation hypothesis; and together, if those tests are generally positive, they may provide further information as to whether the depopulation progressed from forest to woodland and from south to north as should be the case if the cultural ecology model is correct.

There are nine sites which have sequences extending through the crucial early and mid-Holocene millennia (Table 7.1), and each of these is discussed individually below. The remaining eight sites, two with sequences restricted to the late-Pleistocene and six covering

TABLE 7.1 DATED ARCHAEOLOGICAL SITES OF THE AUSTRALIAN SOUTHWEST

SITE NAME	LOC.NO (FIG.7.5)	DATE OF EXCAVATION	SEQUENCE DATED FROM-TO yrs BP	PRIMARY REFERENCE
UPPER SWAN BRIDGE	10	1978,1981	>39,000-<35,100	Pearce and Barbetti 1981
DEVIL'S LAIR	2	1971-1977	~33,000-6,490	Dortch 1979
HELENA RIVER	7	1982-1983	29,400-Present	Schwede 1983
KALGAN HALL	18	1978,1981	>18,850-Present	This volume
QUININUP BROOK	3	1977	>18,500-~6000	Ferguson 1981
ARUMVALE	1	1976,1977	18,450-Present	Dortch and Macarthur n.d
CHEETUP ROCKSHELTER	9	1979,1981	13,245-Present	M.Smith 1982
MINIM COVE	11	1975	? - >9930	Clarke and Dortch 1977
WALYUNGA	6	1975	>8000-Present	Pearce 1978
MOORILLUP CROSSING	19	1980	>7700-Present	This volume
WAYCHINICUP RIVER	20	1981	>7430-Present	This volume
DUNSBOROUGH	4	1977	>7145-Present	Ferguson 1980b
NORTHCLIFFE SILCRETE QUARRY	5	1973-1974	>6780->3080	Dortch 1975
REFINERY SITE R4B	8	1979	>5810-Present	Pearce 1982
KAMBALLUP POOL	21	1979	>4420-Present	This volume
ORCHESTRA SHELL CAVE	13	1970	3310-Present	Hallam 1974b
CAVE 5-BOULDER HILL	14	1979	3230-Present	Pearce 1982
FRIEZE CAVE	12	1970	3090-Present	Hallam 1972
NORTHLAKE	16	1975	>2190-Present	Pearce 1979
SOLDIERS ROAD	15	1975	>1620-Present	Pearce 1979
MOINGUP SPRING	22	1980	950-Present	This volume
MALIMUP SHELL MIDDEN	17	1976	200	Dortch 1984a

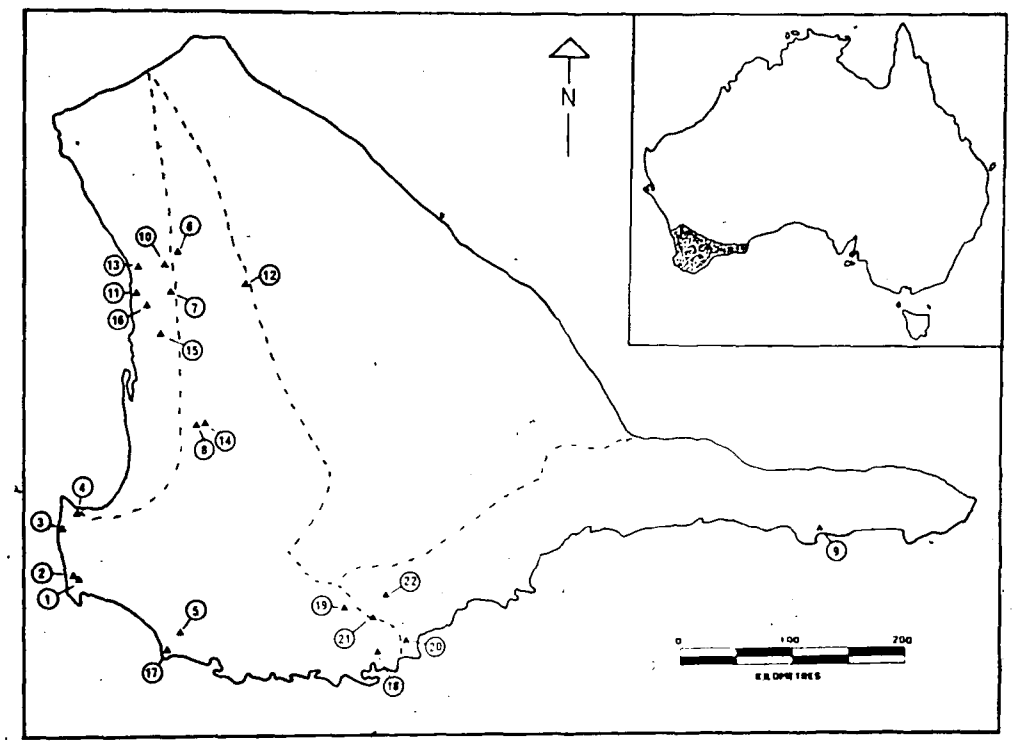


FIGURE 7.5: DATED ARCHAEOLOGICAL EXCAVATIONS IN THE AUSTRALIAN SOUTHWEST.

The map shows the sites discussed in the chapter:
1. Arumvale. **2**. Devil's Lair. **3**. Quininup Brook **4**. Dunsborough. **5**. Northcliffe Silcrete Quarry. **6**. Walyunga. **7**. Helena River. **8**. Refinery Site R4B. **9**. Cheetup Rockshelter **10**. Upper Swan Bridge. **11**. Minim Cove. **12**. Frieze Cave. **13**. Orchestra Shell Cave. **14**. Cave 5-Boulder Hill. **15**. Soldiers Road. **16**. Northlake. **17**. Malimup Shell Midden. **18**. Kalgan Hall. **19**. Moorillup Crossing. **20**. Waychinicup River. **21**. Kamballup Pool. **22**. Moingup Spring.

only the late-Holocene, are also briefly described. Although these sites cannot be used as direct tests of the mid-Holocene depopulation hypothesis, as a group they provide inferential support for it because of their total lack of artifacts dated to that period.

Early and Mid-Holocene Sequences:

If there really was a mid-Holocene depopulation of the region, then it can be predicted that each site with a sequence covering the early and mid-Holocene period should experience a sharp decline in the number of artifact finds per millennium sometime from about the terminal Pleistocene, onward. Further, in sites where the sequence continues on into the late Holocene, this depressed rate of finds should be maintained until the period when the backed microliths are introduced into the regional assemblage.

Tests of this prediction require that a millennial density model comparable to those provided for the Mokaré's Domain sites be constructed for each of the excavations in question. This is not always easy. Different types of stratigraphy, different excavation techniques, and different ways of publishing data, all tend to push the methodology to its limits; and slightly different methods were necessarily used in constructing some of the age/depth graphs. Additionally, many of the sites do not have enough radiocarbon determinations to enable their density sequences to be discussed with confindence.

In one case, Cheetup Cave, the problems of constructing a graph were insurmountable, and none is provided. For all others, a

reasonable comparablility has been achieved. Where possible, additional temporal control has been provided by using less precise, "provisional" dating procedures.

Where no radiocarbon dates were available for layers containing backed microliths, the lowest-most backed microlith was set at 4000 BP based on the argument detailed in the last chapter. In one case, that of the Quininup Brook site, geomorphological argument was used to set the date of a buried soil horizon.

The millennial density models of the other Australian Southwest sites are not always as reliable as those from Mokaré's Domain. In total, however, those models which are the most reliable are those which most clearly suggest a mid-Holocene depopulation. Most of the others, if they do not support the argument, do not dispute it; and in the one case where the model initially suggests disagreement, a sound explanation is available.

The millennial density models are presented with the discussions of the individual sites, below. The age/depth graphs (or substitutes for them), upon which the models were based, form Appendix A of this thesis.

Of the eight late Pleistocene and early Holocene sites which could be modelled, five are in the southern forests and woodlands, and three are in the north of the region. Four of the southern sites are grouped reasonably close together along the Leeuwin-Naturaliste Ridge. These will be examined first because their proximity to one another enables them to be compared closely for the timing of the

depopulation.

Arumvale (Fig. 7.5-No.1): Arumvale is the most southerly of four sites which are located along the Leeuwin-Naturaliste Ridge. It is in Karri Forest, only a kilometre south of the well known site of Devil's Lair. To date, only the maximum age (Dortch 1979:276) and a description of the surrounding environment (Dortch 1977:127) have been published, but the excavator, Mr. C.E. Dortch, has graciously allowed me to use the working tables and diagrams from his forthcoming detailed publication (Dortch and McArthur *n.d.*) to construct the millennial density model.

The model (Fig. 7.6) was constructed for Trench 2, the only dated trench, from a depth/age graph (see Appendix A.1). Primary temporal control is provided by two radiocarbon determinations: one between 18 and 19 thousand BP, and one between 9 and 10 thousand BP. A third, provisional, controlling date is provided by setting the bottom of the microlithic layers at 4000 BP. In this, and all other models where provisional dating is used, the locations of the provisional dates are shown using arrows which have not been filled in solid like those of the radiocarbon determinations.

This sequence (Fig. 7.6) appears to provide fair support for the mid-Holocene depopulation argument. There is an 82% drop in the rate of artifact finds per millennium at around 10,000 BP, or before; and this is well controlled by radiocarbon dates. The lack of sound dates in the upper part of the sequence precludes certainty in the duration of the depressed rate, but it appears to continue until the time when

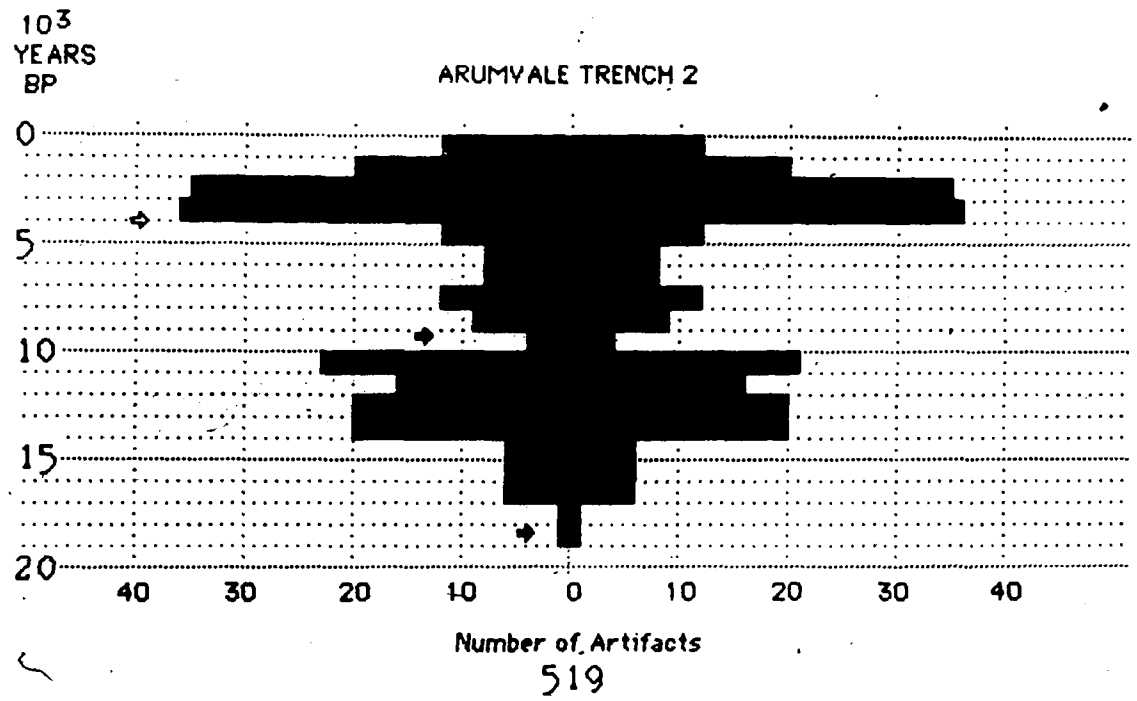


FIGURE 7.6 : MILLENNIAL DENSITY MODEL FOR ARUMVALE TRENCH 2.

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A.1).

the backed microliths are introduced into the sequence, set here at 4000 BP. If this model is to be believed, the find rate then increases by almost 300% over the highest for the mid-Holocene millennia.

The mid-Holocene levels at Arumvale do not appear as devoid of artifacts as those of the Mokaré's Domain sites. Although the initial decline is sudden and striking, the find rate appears to recover to about 50% of that of the pre-10,000 BP period almost immediately. This may suggest that the depopulation was not as severe at this west coast site as it was in Mokaré's Domain; but another explanation is available. There is good evidence of a major change in the stone reduction process, occuring in the mid-Holocene, and affecting only the west coast sites. This change is discussed in detail in conjunction with the Dunsborough site, below.

Whatever the severity of the depopulation, Arumvale suggests that it did happen. Moreover, the sequence also appears to demonstrate a timing for the depopulation similar to that found in Mokaré's Domain. The lowest layer of the depopulated period is securely dated, and suggests that in this southern forest site, as in Kalgan Hall, the depopulation begins relatively early, sometime before 10,000 BP.

Devil's Lair (Fig. 7.5-No.2): Devil's Lair is a site in a limestone cave surrounded by Karri Forest on the Leeuwin-Naturaliste Ridge. It is one of the two sites in the region which, after considerable occupation in the late Pleistocene, were totally abandoned in the early Holocene, and it therefore strongly supports the concept of a

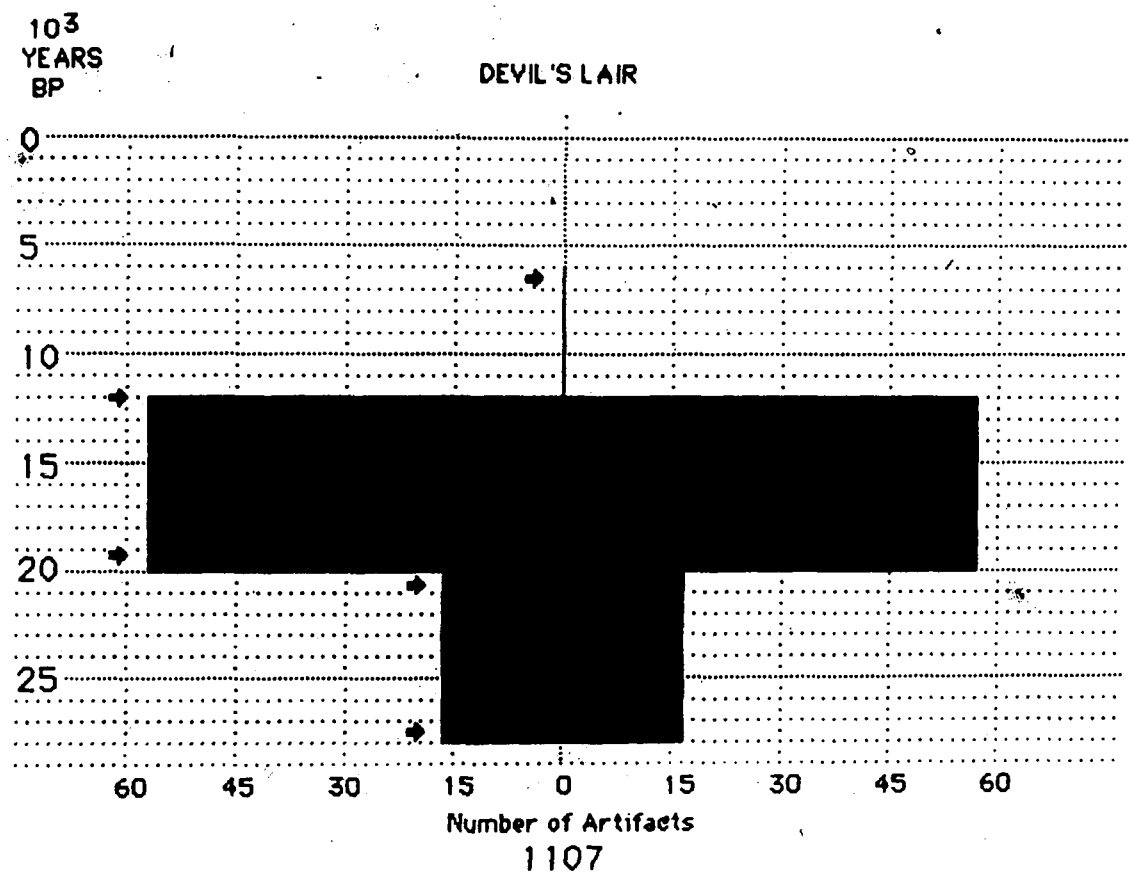


FIGURE 7.7: MILLENNIAL DENSITY MODEL FOR DEVIL'S LAIR.

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A.2).

mid Holocene depopulation. The site was continuously excavated between 1971 and 1977, and has already been the source of over 20 publications (Dortch 1984b and references). Unfortunately, none yet give an overall tally of artifact finds by depth, and it has been necessary to rely once again on the good graces of Mr. C.E. Dortch for his working tables in order to construct the millennial density model. To maintain comparability with the other sites examined, only stone artifacts were included in the totals.

The sediments in the cave are a well stratified sequence of often very thin bands of limestone interspersed with equally thin bands of sand and charcoal. These strata dip unevenly, and there are numerous lenses and pit and hearth features. Since the excavation progressed by natural layers, totalling the artifacts by depth below datum is both difficult and inaccurate, and this millennial density model (Fig. 7.7) was not constructed from an age/depth graph as were all the others. Instead, all artifacts found in strata between the radiocarbon determinations were added together and divided by the number of millennia represented. This results in the loss of detail on minor fluctuations in density between the radiocarbon dates, but is accurate enough for the purposes of this study since none of the levels cover the mid-Holocene period in question. Further details on the construction of the model are presented in Appendix A.2.

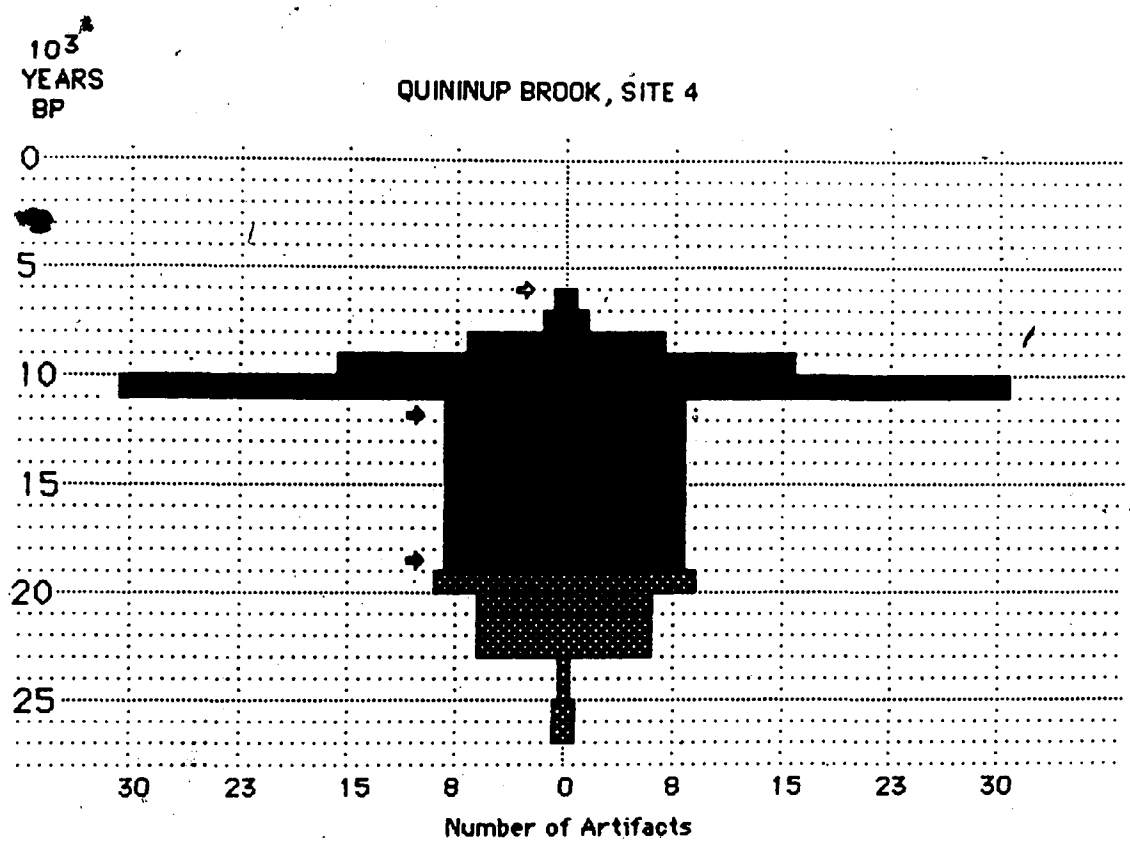
Artifacts are found in lower levels, but the excavators believe that these rolled in from outside, and that occupation of the cave itself began about 27,000 BP (Dortch 1979:266). It continued until

just before 6000 BP, but was most intensive between about 20,000 and 12,000 BP. Between then and the time the site was abandoned, only a few isolated artifacts were found, suggesting that in a similar fashion to other southern forest sites, depopulation began here prior to 10,000 BP.

Quininup Brook (Fig. 7.5-No. 3): The abandonment of Quininup Brook in the early Holocene (Ferguson 1981) is the incident which provoked this study, and the site is discussed in more detail in Chapter 1. It is located on the Leeuwin-Naturaliste Ridge, about 40 kilometres north of Arumvale and Devil's Lair. It is directly on the present coastline, and surrounded by *Acacia* dominated open heath. The adjacent inland region is dominated by Jarrah-Marri low open forest which is less dense than the Karri forest further south

As with Waychinicup River, two trenches were combined in the construction of the millennial density model (Fig. 7.8), but virtually identical radiocarbon dates in similar stratigraphic contexts render the practice less questionable in this case. The provisional controlling date at 6000 BP is the approximate time when calcareous sand dunes associated with the modern shoreline would have begun to form. These sands overlie a well developed humic horizon of the artifact bearing siliceous sands (See Ferguson 1981 for discussion).

Also, because the great majority of the artifacts were concentrated in a single narrow horizon that spanned several millennia it was decided to partially employ the technique used at Devil's Lair, and combine and average all finds between 19 and 11



307

FIGURE 7.8: MILLENNIAL DENSITY MODEL FOR QUININUP BROOK, SITE 4.

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A.3).

thousand years BP (see Appendix A.3).

The model (Fig. 7.8) suggests the major occupation of the site took place in the late-Pleistocene, similar in time to Devil's Lair and the lower concentration at Arumvale, but that the depopulation may have occured slightly later. At about 9000 BP the find rate is about the average for the late Pleistocene levels; but from then onward it progressively declines until total abandonment just before the provisional date of 6000 BP.

Dunsborough (Fig. 7.5-No.4): The Dunsborough site is located about 20 kilometres north of Quininup Brook, on the southern shore of Geographe Bay. It is in a woodland area, very near where the Swan Coastal Plain and the Leeuwin-Naturaliste Ridge adjoin one another. This model is the only one which appears to contradict the suggestion of a mid-Holocene depopulation, but as was stated above, there is a ready explanation for this irregularity.

On the face of it, the Dunsborough model (Fig. 7.9) suggests that the site was occupied since the terminal Pleistocene, with relatively greater intensity between eight and seven thousand BP than before. Just after the radiocarbon determination at about seven thousand BP, as might be expected from a southern woodland site on the basis of the study in Mokaré's Domain, there is a sharp drop in the number of artifacts found. Unexpectedly, however, after an interval of only one thousand years, artifact numbers again increase dramatically and remain almost constant until about three thousand BP when the most

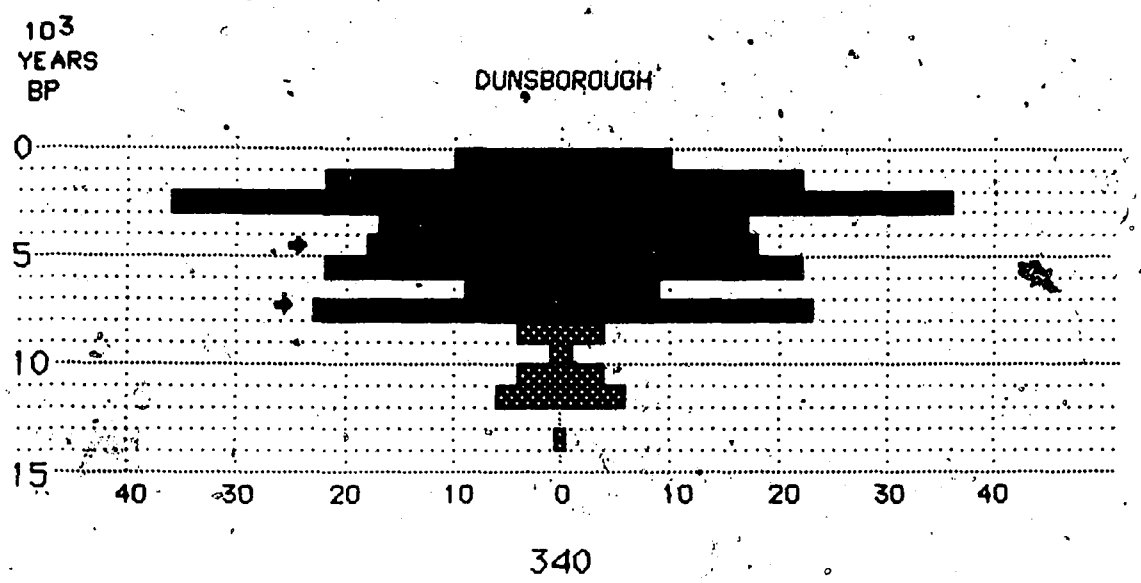


FIGURE 7.9: MILLENNIAL DENSITY MODEL FOR DUNSBOROUGH.

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A.4)

intensive period of site occupation begins.

The answer to this apparent anomaly probably lies in a sudden and radical change in the type of raw material used to make artifacts at this site which took place at about 6000 BP (Ferguson 1980b:Fig.3). Before this date, about 90% of the artifacts were made from a distinctive form of fossiliferous chert whose source is believed to have been at quarries on the now submerged coastal plain (Glover 1975). After 6000 BP, when the sea had reached its present level and the chert was no longer available, the inhabitants of the Dunsborough site made almost all of their artifacts from vein quartz. These two materials have distinctly different fracturing properties: the chert breaks with an even conchoidal fracture, while the quartz has a tendency to shatter into many small fragments, and it seems likely that equal amounts of stone knapping activity would produce a far greater amount of debris from the latter than from the former.

This means that similar numbers of artifacts found above and below 6000 BP do not represent similar amounts of human activity, and consequently the two portions cannot be directly compared. Each of these portions of the sequence taken separately, however, does provide a reasonable approximation of the expected pattern: there is a 68% drop in artifact numbers at about 7000 BP, and there is an increase of over 100% at about 3000 BP.

The sudden disappearance of the fossiliferous chert should affect most of the west coast sites, and this may be the reason that the mid-Holocene find rate did not remain as depressed as expected at the Arumvale site (Fig. 7.6). A cursory glance at Dortch's unpublished

tables suggests large amounts of this material in the lower levels - although probably a smaller proportion than at Dunsborough, and a reliance upon quartz in the upper levels. If this is the case, then the recovery of the find-rate at Arumvale, which was projected to have occurred at about 9000 BP, possibly did not occur until 6000 BP

Northcliffe (Fig. 7.5-No. 5): The silcrete quarry-factory at Northcliffe (Dortch 1975, Dortch and Gardner 1976) is the last of the southern sites which could be modelled. It is in a Karri forest area about halfway between Mokaré's Domain and the Leeuwin-Naturaliste Ridge. It appears to have been occupied throughout most of the Holocene, on the basis of the age/depth graph (Appendix A.5). It has two radiocarbon determinations: one at 3080±75 BP, and one at 6780±120 BP. As with Arumvale, the lowest microlith has been set provisionally at 4000 BP to provide greater control.

The resulting millennial density model (Fig. 7.10) suggests that from the beginning of the Holocene to about 4000 BP there was only very infrequent occupation on the site. During this period, in fact, the site may not have been used primarily as a quarry-factory since almost 17% of these 78 early artifacts are made from exotic stone (quartz and chert). After the beginning of the microlithic period and until the site's apparent abandonment after about 3000 BP, however, it appears to have been used for little else. Only 1% of the artifacts are of exotic material, and there are masses of debris suggesting intensive working of the nearby silcrete outcrop. Over 2500 silcrete artifacts were taken from this level, and the authors admit they made

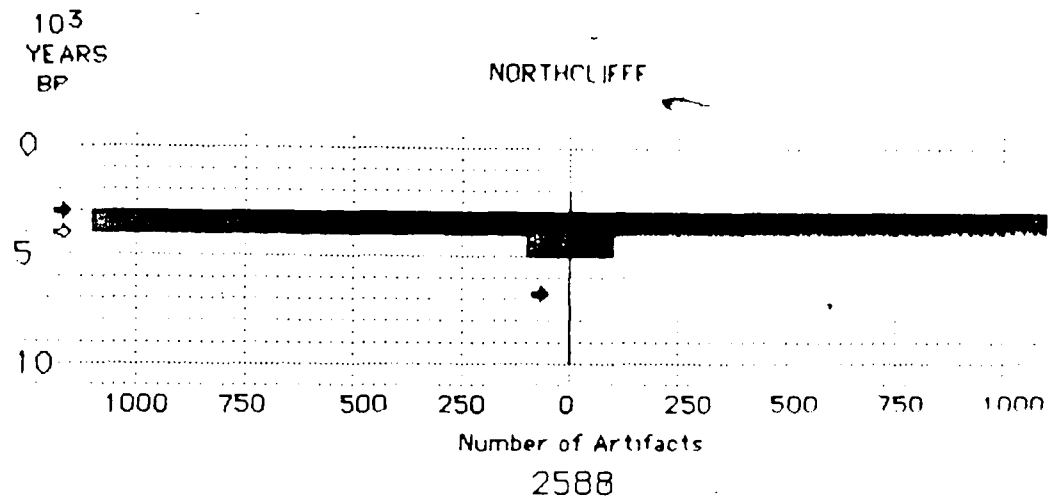


FIGURE 7.10: MILLENNIAL DENSITY MODEL FOR NORTHCLIFFE SILCRETE QUARRY

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A.5).

no attempt to recover all the chips.

Northcliffe is an odd site. It is the only quarry site included in the sample, and the sedimentation build-up over time appears to have been extremely variable. Roughly three thousand years seem to be represented by the 13 centimetres of deposit between the lowest radiocarbon date and the beginning of the microlithic period, and the subsequent one thousand years appears to be spread through about 40 cm of sediment which accumulated during the period of intensive quarrying. Both types of accumulation have well controlled precedents in other Southwest sites: the slow rate at Quininup Brook, and the fast rate at Moorillup Pool; but here they seem to be immediately superimposed.

The Northcliffe sequence gives no direct support to a concept of a mid-Holocene depopulation of the region, but it does not preclude the possibility. Given the far southern Karri forest location of the site, such a depopulation might be expected to have occurred earlier than any of the levels occupied at this site. Consequently, about all that can be said is that, if a depopulation did occur, it ended about four thousand BP.

Walyunga (Fig. 7.5-No.6): Walyunga is located on the banks of the Swan River about 250 kilometres NNE of Dunsborough. This is a Northern Jarrah Forest area, but the site lies in a steep-sided woodland valley where the Swan cuts down through the Darling Scarp before meandering across the Coastal Plain. Walyunga is a large site, and like Kalgan Hall, can be seen as a central node in the prehistoric

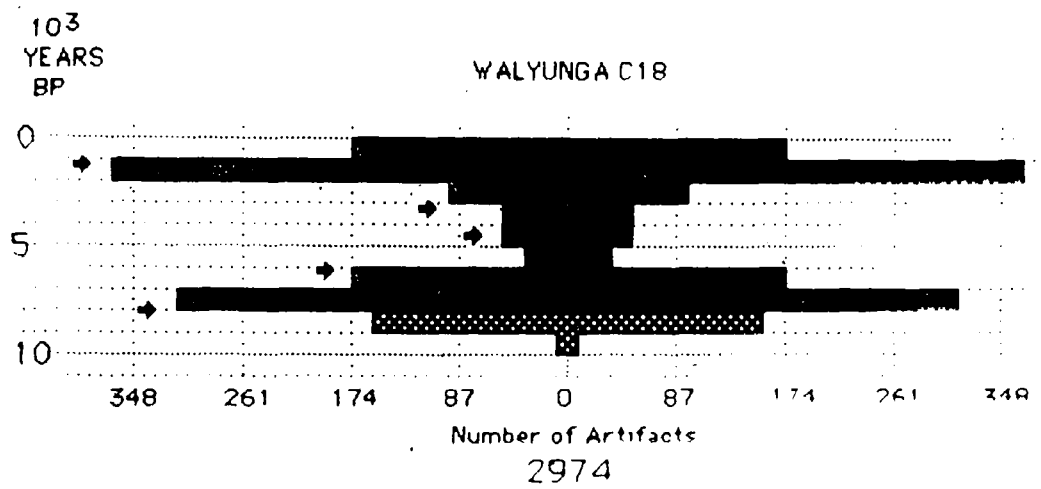


FIGURE 7.11 : MILLENNIAL DENSITY MODEL FOR WALYUNGA TRENCH C18.

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A.6).

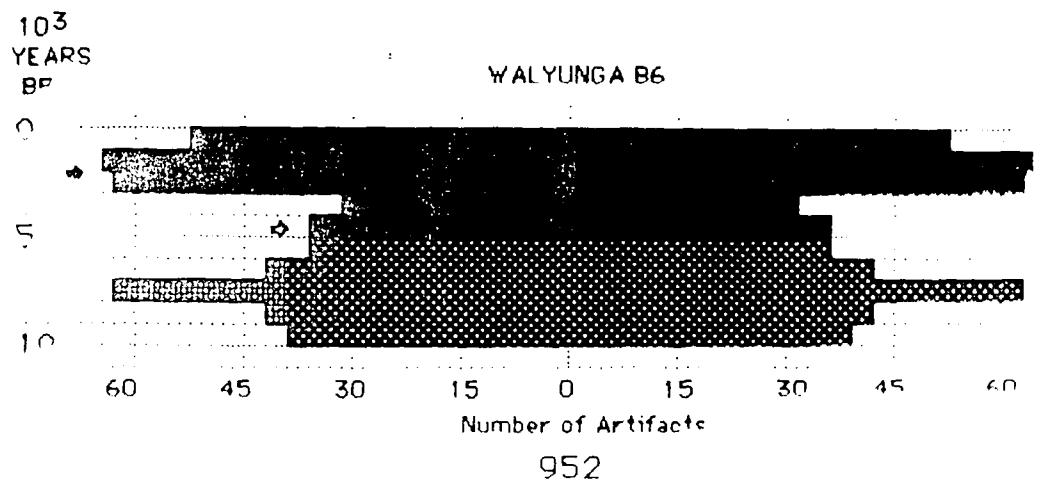


FIGURE 7.12: MILLENNIAL DENSITY MODEL FOR WALYUNGA TRENCH B6

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A.7).

exploitation network It lies near the junction of the main north-south trackway along the base of the Scarp and the main east west trackway which followed the River (see Chapter 1)

The main trench (C18) excavated at the site (Pearce 1979) has five radiocarbon determinations, and provides probably the best controlled sequence in the region (Fig 7 11) It has the expected upper and lower concentrations of artifacts, and clearly supports the concept of a mid-Holocene depopulation There is an 82% drop in the rate of artifact finds at about 6000 BP, and, although it climbs slightly, the rate remains depressed until about 2000 BP when it increases dramatically by over 300%

Walyunga provides the only good evidence for the timing of the depopulation in the north. It appears to have begun later than in the south, at about 6000 BP, and this is as it should be if the cultural ecology model is correct. It also appears to have ended later than in all the southern sites, at about 2000 BP. This is unexpected, but the sequence of the second dated trench at Walyunga, B6, (Pearce 1979) suggests that it may be a result of sample bias.

Trench B6 is approximately 20 metres distant from Trench C18. The lower portions of its sequence (Fig. 7.12) are not controlled, and the depressed rate of artifact finds during the mid Holocene does not appear to be as striking as in the main excavation. It does, however, have a basically similar density sequence configuration, suggesting that the main trench is generally representative of occupation on the site over time. The only qualification to this is in the timing of the end of the depopulation period. The upper portion of this sequence is

reasonably well controlled, and there appears to be a 100% increase in artifact find rate at about 3000 BP. This suggests that the anomalous late end to the depopulation period apparent in Trench C18 is not a site wide phenomenon, but that at Walyunga, too, the depopulation of the region ended between three and four thousand BP.

Helena River (Fig. 7.5 No. 7): The Helena River is one of the main tributaries of the Swan, and the site is on the Swan Coastal Plain about 20 kilometres south of Walyunga. Major excavations are currently being conducted here by Madge Schwede, and the bulk of the data is still being analyzed. The information discussed here is taken from a preliminary report (Schwede 1983) and is only concerned with the test trenches. No totals of artifact finds by depth are available, but a graph showing the density of artifacts per cubic metre of excavation (Schwede 1983:Fig. 6) has been converted into density sequence graphs reasonably compatible with those presented for the other Southwest sites (see Appendix A.8 for details).

Test Pit 1 is the only excavation with more than a single radiocarbon date. Its sequence (Fig. 7.13) suggests that the site was frequented since about thirty thousand BP, but artifact finds are very rare (approximately 4 per cubic metre of sediment) until about ten thousand BP. Above this finds increase slightly (to about 20 per cubic metre). There is a slight drop in numbers between about five and six thousand BP, and then a dramatic increase, with the vast bulk of the artifacts (up to 580 per cubic metre) being found after about 4000 BP.

Alone this trench supplies only the slightest support for the

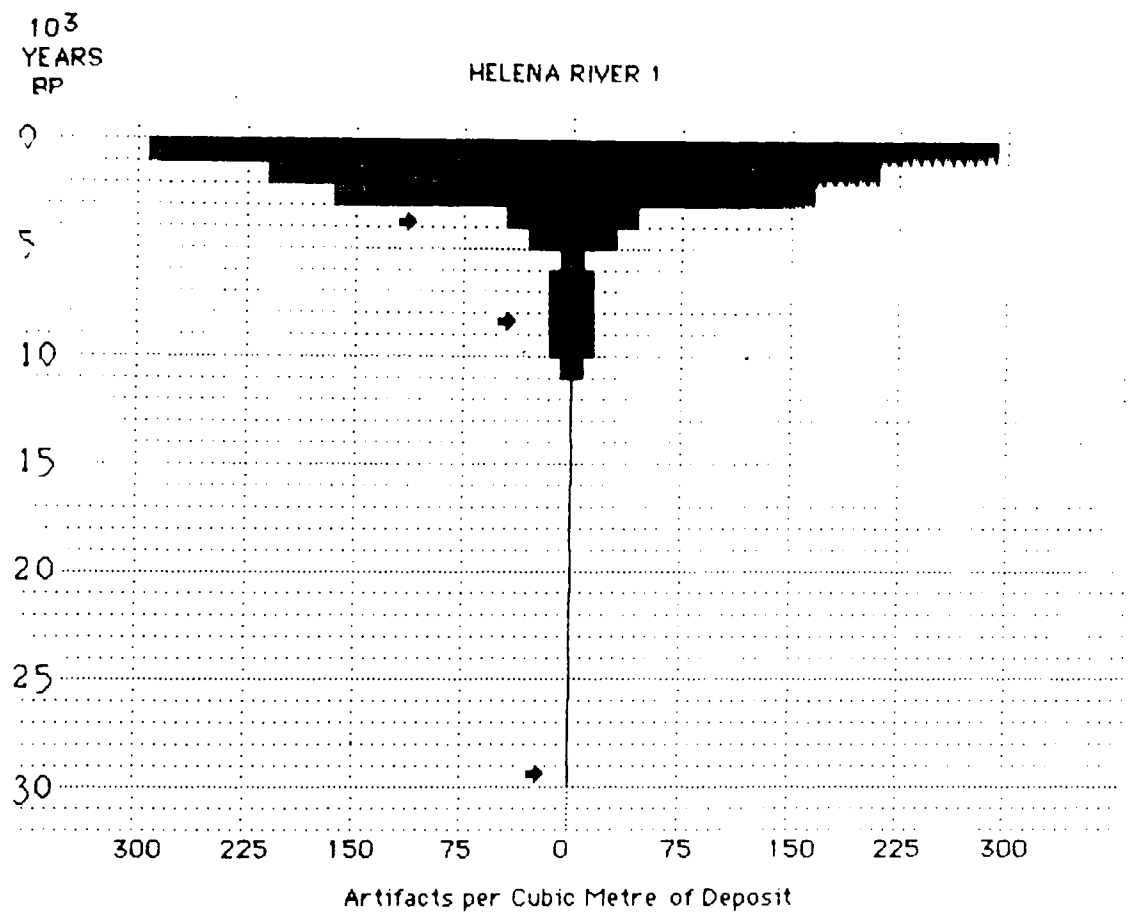


FIGURE 7.13: MILLENNIAL DENSITY MODEL FOR HELENA RIVER TRENCH 1.

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. Although this model provides comparable information, it was based on density of artifacts per cubic metre of deposit rather than actual artifact counts. See Appendix A.8.

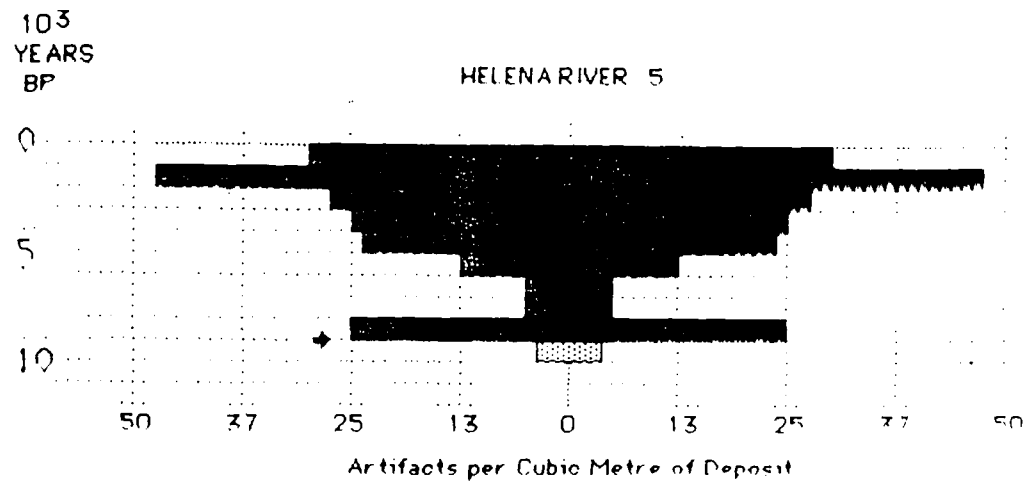


FIGURE 7.14 : MILLENNIAL DENSITY MODEL FOR HELENA RIVER TRENCH 5

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average.
Although this model provides comparable information, it was based on density of artifacts per cubic metre of deposit rather than actual artifact counts. See Appendix A.9.

mid-Holocene depopulation hypothesis, but the only other dated trench for which density figures are presented Test Pit 5 suggests that it may not be entirely representative of the site Test Pit 5 (Fig 7.14) has only a single radiocarbon determination at about 9000 BP and its upper levels are not controlled It does, however, suggest that on this site, too, there may have been a period of relatively intensive occupation in the early Holocene followed by a period of depopulation

The Helena River site remains, at this early date, somewhat problematic. About all that can be said is that it supplies some tentative data to support the concept of a mid-Holocene depopulation, but this is by no means clear, and certainly no details on the timing of this event are available other than a suggestion from Trench Pit 1 that, if it did happen, it must have ended between about 3000 and 4000 BP. Hopefully, the research now being conducted will shed further light on this matter.

R4B (Fig. 7.5-No. 8): R4B (Pearce 1982) is located in the Northern Jarrah forest near the town of Collie. It is the last of the early and mid-Holocene sequences which could be modelled (Fig. 7.15). It is based on an extremely small sample of artifacts and very poorly controlled. This makes any interpretation difficult and of limited value. There appears to be the usual upper and lower concentrations of artifacts separated by a period of relatively fewer finds; but the timing of this period seems much shorter and out of phase with the other sites of the region. Before any faith can be placed in either the existence of a mid-Holocene depopulation or the length of its duration

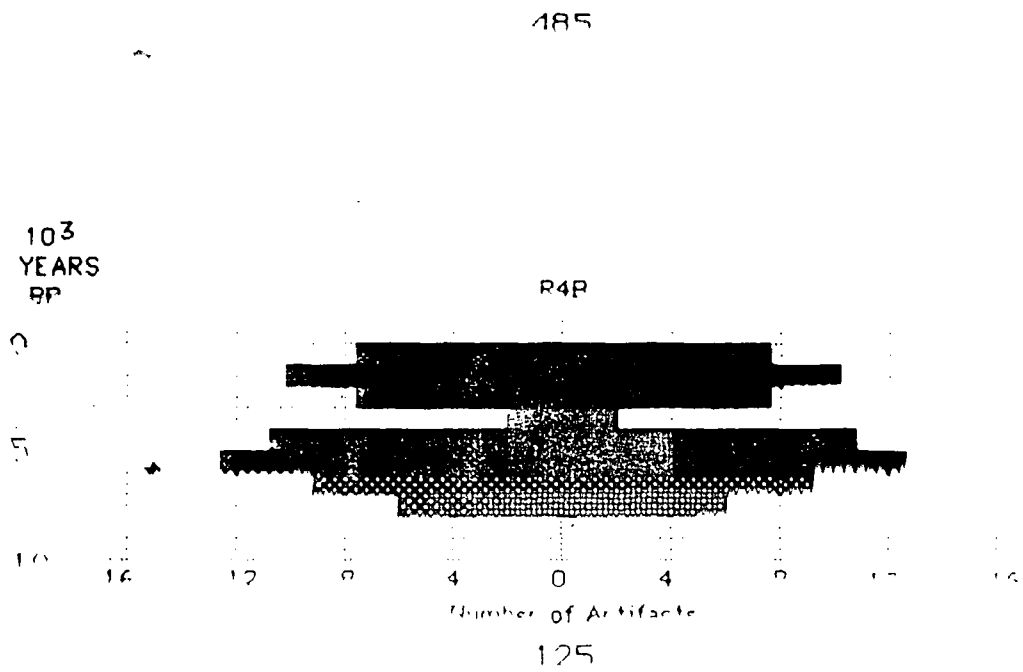


FIGURE 7.15: MILLENNIAL DENSITY MODEL FOR REFINERY SITE R4B

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A 10).

at this site, a larger and better controlled sample will be necessary

Cheetup (Fig. 7.5-No. 9): Cheetup (Smith 1982) is a cave site located near Esperance on the Eyre South Coast. It has an archaeological deposit which dates from the late Pleistocene to the near present, but based on current information it cannot be graphed as a test of the mid-Holocene depopulation hypothesis. The artifact finds by depth have not been published; but even if they were, it is doubtful whether such a graph could be constructed. The deposit is extremely shallow and made up almost entirely of hearths, ash, plant remains, and other residues of human activity. A date of about 400 BP is stratified only about fifteen centimetres above a date of about 13,000 BP, according to the published section; and in such circumstances it is improbable that the refinement necessary for a meaningful density model could be attained.

LATE PLEISTOCENE SEQUENCES

There are two sites in the Southwest which have sequences restricted to the late Pleistocene period. The oldest, and most well known is the Upper Swan site (Pearce and Barbetti 1981). It is located on the Swan Coastal Plain (Fig 7.5-No. 10) and all the artifacts are found in layers dating to before about 35,000 BP.

The second of these sites, Minim Cove (Clark and Dortch 1977), is located near the mouth of the Swan River (Fig 7.5-No. 11). It consists of only 16 artifacts found well below a date of about 10,000

BP. These sites are not directly relevant to the mid-Holocene depopulation argument, and have not been modelled.

LATE HOLOCENE SEQUENCES

The six sites with sequences restricted to the late Holocene are relevant to the mid-Holocene depopulation hypothesis in that they might support the suggested timing for the end of it. If the majority of them, like Kamballup Pool (Fig. 7.4), appear to begin about three or four thousand years BP, it would reinforce the assumption that the striking increase in artifact numbers which most of the early and mid-Holocene sequences experience at this time does not result simply from a change in stone working technology. An increase in the number of sites occupied per millennium is often assumed to suggest an increase in the relative density of a region's population (Flood 1980, Bowdler 1981, Ross 1981, Hughes and Lampert 1982, Lourandos 1983).

There are three of these sites which, from radiocarbon dates in their lowest levels, appear to have definitely been established at about this time: Frieze Cave, in woodlands on the eastern edge of the Northern Jarrah forest (Fig. 7.5-No. 12), at 3090±240 BP (Hallam 1972); Orchestra Shell Cave, on the Swan Coastal Plain (Fig. 7.5-No. 13), at 3310±150 BP (Hallam 1974b); and Cave 5-Boulder Hill, in the Northern Jarrah forest (Fig. 7.5-No. 14), at 3230±170 BP (Pearce 1982). Their support for the argument is unquestionable and they have not been graphed.

Two other sites, Soldiers Road (Fig. 7.5-No. 15) and Northlake

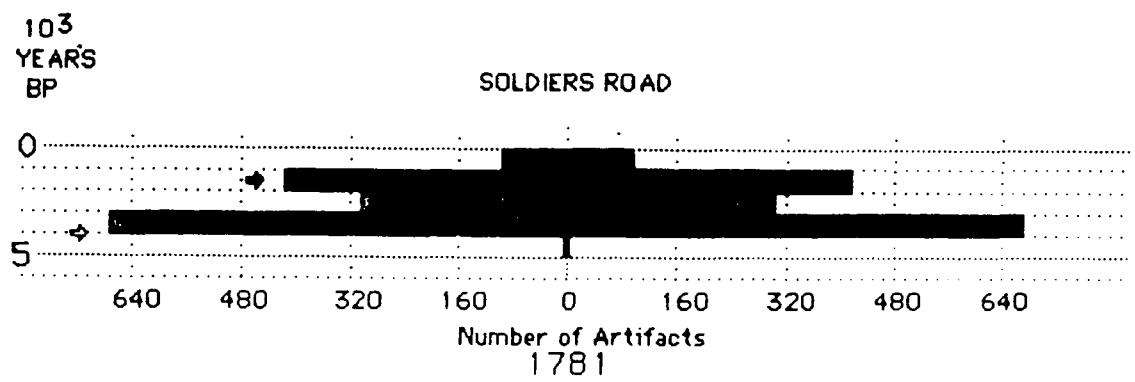


FIGURE 7.16: MILLENNIAL DENSITY MODEL FOR SOLDIERS ROAD.

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A.11).

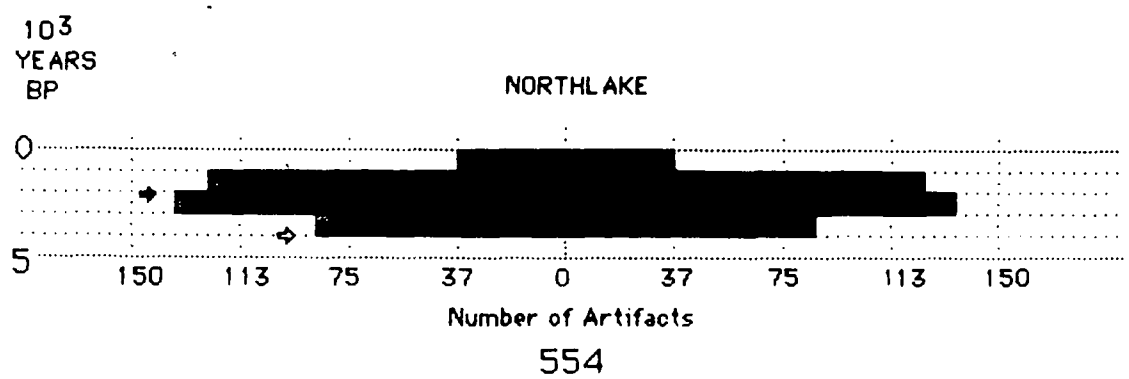


FIGURE 7.17 : MILLENNIAL DENSITY MODEL FOR NORTHLAKE.

Details of the construction of these models are presented in Chapter 5. The solid black arrows indicate the temporal position of controlling radiocarbon determinations, and the arrows-in-outline on some models indicate the temporal position of "provisional" controlling dates established by other dating techniques. The lighter shaded millennia toward the bottom of the model indicate that portion of the sequence is below the lowest controlling date where the sedimentation rate is based on the trench average. The scale at the bottom of the model provides a rough indication of the number of artifacts in each millennium, but several of the sequences have been multiplied by a constant to compensate for variations in the size of the excavation. The actual number of artifacts recovered from the excavation is shown in larger print at bottom centre, and for the actual number of artifacts in each millennium see the age/depth graph (Appendix A.12).

(Fig. 7.5-No. 16), both swamp-side sites on the Swan Coastal Plain (Pearce 1979), have also been interpreted as giving support to the argument, but their temporal control is not as good. These have been modelled (Figs. 7.16 and 7.17), and although they seem to have been established at about 4000 BP, the lowest levels were set at that date because they contained backed microliths. They could not have been established any earlier, but a slightly later date is possible in both cases.

The final dated Southwest site, Malimup (Fig. 7.5-No. 17), is on the south coast near Northcliffe. It was, on the basis of a radiocarbon date of "less than 200 C-14 years BP" (Dortch 1980a), only occupied during the last millennium. Like Moingup Spring, it has not been modelled.

The Mid-Holocene Depopulation: A Summary of the Evidence.

With the addition of three sites which were first reported in this thesis, there are twelve sites in the Australian Southwest with artifact sequences covering at least the early and mid-Holocene periods. One , Cheetup Cave, could not be examined; leaving eleven. Of these, five have millennial density models made without the use of provisional dating methods which suggest a dramatic drop in artifact numbers during the mid-Holocene: Kalgan Hall (Fig. 7.1), Moorillup Crossing (Fig. 7.2), Waychiniup River (Fig. 7.3), Devil's Lair (Fig. 7.7), and Walyunga (Fig. 7.11). Two others, Arumvale (Fig. 7.6) and Quininup Brook (Fig. 7.8), provide similar evidence if provisional dates are allowed. The average drop in the find rate for these seven sites is

roughly 85%.

The remaining four sites are somewhat problematic. Two, Helena River (Fig. 7.13 & 7.14) and R4B (Fig. 7.15), seem to hint of a mid-Holocene drop in artifact numbers, but have small artifact samples and poor temporal control. A third, Northcliffe (Fig. 7.10), shows no sign of a drop in artifact numbers during the mid-Holocene; but the amounts of artifacts dated to this period are very small, and the site's location in the far southern forest suggests that the sequence may not extend back to the period when the decline would have occurred.

Only one site, Dunsborough (Fig. 7.9), has a millennial density model which suggests relatively large numbers of artifacts in the mid-Holocene, but a near total change in the raw material from which the artifacts were made suggests that any comparison between the late Pleistocene and mid-Holocene levels is of dubious validity. Examination of the two periods separately seems to hint that a reduction in the amount of stone working activity also may have occurred here, but this site should be disregarded until such time as replicative experiments can be conducted to thoroughly examine the ramifications of the raw material change.

In Chapter 6 it was argued that this drop in artifact numbers suggests a corresponding drop in the amount of human activity on the basis that the artifacts were essential components of the prehistoric society's cultural core and that sufficient continuity in the stoneworking process exists to legitimise comparison of the relevant

late Pleistocene through mid-Holocene levels. This was qualified only by the highly unlikely possibility that some other raw material could have been substituted for stone.

The artifacts of the other Southwest sites have not been subjected to the same kind of scrutiny as those from the sites in Mokaré's Domain, but the tables and illustrations presented in the publications suggest that a basic similarity exists With the exception of those from the quarrying phase at the Northcliffe site, these artifacts probably represent essentially the same types of activities as those from Mokaré's Domain. If this is so, then most of the relevant Southwest excavations strongly suggest that the sites they represent were depopulated during the mid-Holocene; and all those which do not suggest this, do not dispute it.

As was discussed in Chapter 4, it seems unlikely that this evidence for the depopulation of individual sites only suggests a change in local settlement pattern. Every dated excavation in the entire region known to the author has been examined. The sample now includes several cave and lake or swamp side sites, as well as additional riverine sites; and more sites have been included with multiple excavations to support site-wide representivity of the sample sequences. It is hard to imagine any form of settlement pattern that would go entirely unrepresented in the sample.

The dearth of artifacts in the mid-Holocene layers of sites like Kalgan Hall and Walyunga, which would have been geographically optimal nodes in the exploitation network of any mobile foraging

society, is especially noteworthy in this context. Unless a society was almost entirely sedentary, it is unlikely that these sites would remain unfrequented

A change in settlement pattern in the Australian Southwest during the mid-Holocene remains a possibility, but on the basis of present evidence it is a very slim one Pending presentation of well controlled excavations which suggest otherwise, it seems reasonable to dismiss it, and conclude that the region-wide drop in artifact finds during the mid-Holocene suggests a comparable region-wide drop in human population The main question now is why this depopulation occurred.

The Reason for the Mid-Holocene Depopulation:

As was discussed in Chapter 1, hints that there may have been a depopulation of at least parts of the Australian Southwest were provided by excavations at Walyunga and Quininup Brook in the late 1970's, and the two researchers who conducted those excavations suggested totally opposite versions of a climatic change model as the possible cause of this depopulation (Pearce 1978, Ferguson 1981).

Pearce took an orthodox Australian view of the more water, the better. Supported primarily by a study of mid-Holocene shell deposits in the Swan which suggests a lower discharge for the river (Kendrick 1977), he proposed that the mid-Holocene was a time of great aridity and the depopulation resulted from the stress of drought.

Ferguson presented the outline of the Southwest-specific cultural ecology model which was developed in Chapter 2 of this

thesis. With the backing of the majority of the region's palaeoenvironmental research, he suggested that during the mid-Holocene there was a dramatic increase in rainfall resulting in an equally dramatic spread of the densely forested areas; and that the depopulation resulted from the deterioration of the Aborigines' preferred open woodland habitat.

The evidence from which this second model was initially developed has so far received only limited additional support from this thesis. The results of the Road Survey reported in Chapter 3 suggest some archaeological support for a woodland focus of prehistoric occupation during the present climatic regime; but no new palaeoenvironmental data has been presented, and no noteworthy additions to the ethnohistorical sources suggesting a woodland adaptation have been found. Other possible causes besides climatic change also need to be considered. The mid-Holocene depopulation now seems established, but why it happened remains unexplained.

However, if climatic change is responsible for this event, it seems unlikely on the basis of the evidence presented by the total sample of archaeological excavations that the change involved was one that resulted in a severe shortage of water. Figure 7.18 suggests that sites located in the areas of the Southwest most likely to be affected by such a shortage, those in the drier portions of the region, are the last ones to experience depopulation. The depopulation appears to have progressed from the wetter areas to the drier areas, and from south to north.

Although, the millennial density models are somewhat crude

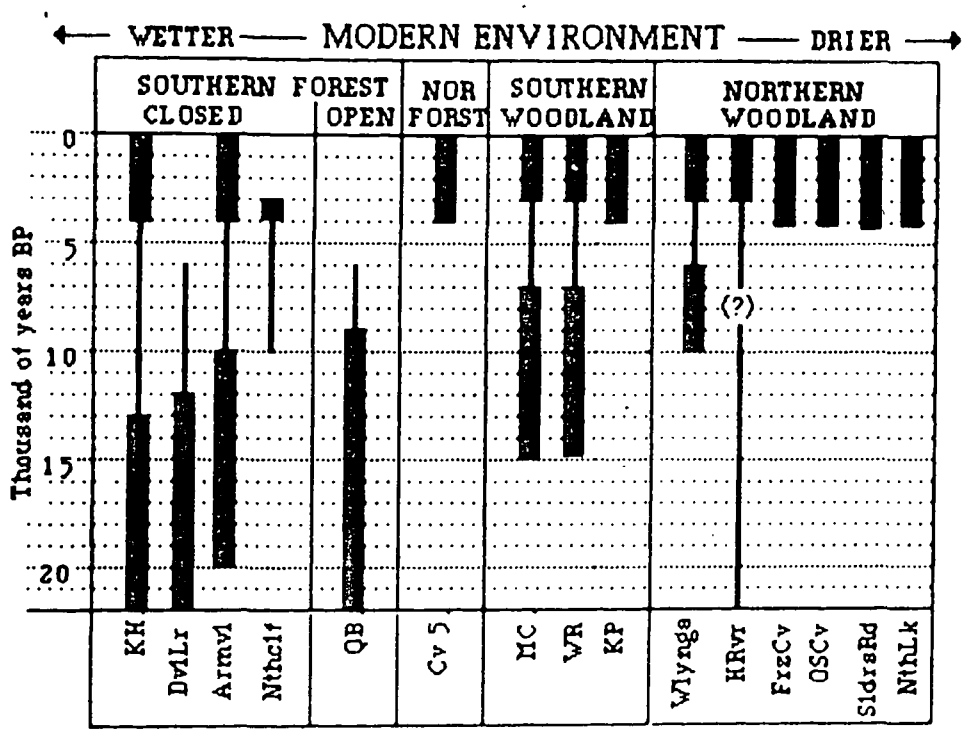


FIGURE 7.18 : SUMMARY OF AUSTRALIAN SOUTHWEST MILLENNIAL DENSITY MODELS :

The table shows the sites for which reasonably reliable information was provided in the text. Periods from which relatively high densities of artifacts were recovered are shown with thick lines, and periods with relatively low densities of artifacts are shown with thin lines.

for this degree of refinement, and the sample is very small; the pattern is consistent. Moorillup Crossing and Waychinicup River in the woodlands are depopulated well after nearby Kalgan Hall in the forests. Quininup Brook in the open forest is depopulated after nearby Arumvale and Devil's Lair in the closed forest If the sudden decrease at about 7000 BP in the chert layers at Dunsborough could be allowed, it would both confirm this date as a probable one for depopulation of the southern woodlands, and support the south-to-north trend toward later dates along the Leeuwin-Naturaliste ridge. There is only one well controlled, relevant trench in the north of the region, Walyunga C18, but it appears to be depopulated later than all the southern sites.

Many more excavations will be needed before complete confidence can be given to these trends, but if the evidence suggests environmental pressure, it suggests environmental pressure applied to the wetter areas of the region first. Whatever the ultimate worth of the two competing climatic change models, the one which suggests an arid-phase in the mid-Holocene cannot explain this.

There are several other possible causes for the depopulation besides climate induced vegetation change which probably cannot be ruled out completely; but all that have been suggested to me, like epidemics and increased warfare, contain an inherent element of catastrophism within them. They do not account for the between four and six thousand year span apparently involved in this depopulation.

This appears to have been no sudden catastrophe. Depopulation

began at the far southern sites prior to 10,000 BP, and it appears to have taken at least four thousand years to spread to the northern sites only about 350 kilometres away Possibly the only response required was a less than 90 metre annual northward relocation in the focus of group exploitation. It could be questioned whether anyone in a society which kept no written records would even be aware that a shift was occurring.

Slow moving environmental stress seems most consistent with the evidence. Coupled with the postulated spread of the forests is a better documented form of environmental stress which also contributed to the reduction of habitable space in the region during the early Holocene. From about 18,000 to about 6000 BP period, sea level was rising as a result of world-wide eustatic changes. This alone must have enforced a pattern of relocation to the east and north upon the coastward Aboriginal populations in the Australian Southwest.

That this pattern appears to have been maintained in areas not directly affected by the rising sea seems better explained by the cultural ecology model developed in this Thesis than by any other currently available for consideration. It is assumed that this slow movement of exploitation focus continued out of the region, into areas of the adjacent desert which probably would have been made more productive by the increased rainfall of the period. It is possible that human population of the Southwest just dwindled away with a slowly increasing death rate, a slowly decreasing birth rate, or both; but this seems less likely because the population would not have been

an isolate.

A Late Holocene Repopulation of the Australian Southwest

For at least two thousand years, from about six thousand BP to about four thousand BP, the entire Southwest region appears to have supported only a very small fraction of its previous population. During, or even shortly before this time, however, the increasing rainfall of the early and mid-Holocene period reached its maximum and began to decline; and the dense forests began to retreat toward their present boundaries.

It was expected at the beginning of this research that the repopulation of the region would follow a similar pattern to the depopulation, and slowly follow the retreating forests southward; but it does not appear to do so. Throughout the region, at every site with a sequence continuing from the middle to late Holocene there seems to be a sudden and dramatic increase in the artifact find-rate between about three and four thousand years ago.

Equating this sudden upsurge in artifact numbers directly with increasing population is complicated by a partial change in stone working technology; but there is concurrently a sixty percent increase in the number of sites occupied in the region, and this strongly supports the suggestion that there was a large population increase at this time (see Fig. 7.14).

The degree of suddenness involved cannot be determined with devices as crude as the millennial density models. On the basis of the

evidence presented here it may have taken as much as a millennium or only a few years. In either situation, however, it certainly seems sudden when compared with the slowness of the depopulation; and the cultural ecology model for the Southwest has difficulty explaining it. More likely the cause lies outside the region. This appears to have been a relatively rapid movement of population, a conscious migration.

This suggestion of a major migration is of significance to the study of Australian prehistory in general, because concurrent with the rise in artifact numbers in the region is the first appearance of backed microliths. It may be that a "migrating populations" hypothesis can offer the best explanation for the apparent rapid spread of these implements across the continent at this time.

This will need to be tested for each region of the continent separately. However, at first glance, this new evidence suggests that in the Southwest, at least, the introduction of backed microliths into an archaeological sequence means the appearance of new people, not just new ideas.

Who these new people may have been and where they may have come from is, of course, speculative; but the basic underlying similarity of the stone technology of this period with that of the late Pleistocene Southwest suggests that they were Australians, sharing a cultural heritage with the former inhabitants of the region. It also seems reasonable to suggest from the hints that the *leap* knife and *kadja* hatchet were either introduced or locally developed about this

time, that they were the direct ancestors of the historic Nyungar.

Only two main routes for an inward migration are possible. Either they came overland out of the adjacent desert regions, or they came by boat along the coast or coasts. Both the nature of the environment and the basic dry-land orientation of the historic Nyungar seem to argue for the former.

This migration would have taken place during the present environmental regime, and Tindale (1974:75) has noted that there is a total absence of floatable wood from which to manufacture rafts or boats along the nearly 2000 km. western coast from Broome in the Kimberleys to the northern boundary of the Australian Southwest. A similar argument is also probably valid for the nearly 1200 km southern coast from the Spencer Gulf in South Australia to the eastern boundary of the Australian Southwest. In any case, a southern coastal migration would have had to progress along the shores of the Great Australian Bight where, for hundreds of kilometres, limestone cliffs drop straight into the tempestuous Southern Ocean from the barren Nullarbor Plain.

There is abundant wood from which to make boats or rafts in the Southwest, but there is no evidence that the historic Nyungar ever did so. They generally avoided walking into the water above their knees, and they ignored the rich shoreline and estuary shell-bed resources which were extensively exploited by other coastal Aborigines around Australia (Dortch, Kendrick and Morse 1984). It is possible that this is a radical local adaptation by coastal migrants who, after a harrowing journey, firmly turned their backs on the sea;

but it seems unlikely.

More likely the ancestors of the Nyungar were desert people who, in migrating into the relative abundance of the Southwest, conservatively maintained their basic adaptations toward the types of resources they already understood. What motivated them to begin their migration in the first place, however, is less certain.

Climatic change resulting in pressure from a deteriorating environment in the desert regions seems to be the best explanation at this point. Given the fragile nature of desert eco-systems this kind of pressure can arise fairly quickly, and the shift need not be a gradual reversal of the slow process of relocation which seems to have occurred in the Southwest during the early Holocene. Meggitt (1962:24-7) describes one such instance in historical times when "from 1924 to 1929 Central Australia suffered the most severe drought in its history." During this time most of the Walbiri and adjacent peoples left the desert to settle at stations and missions on its periphery, and many of those who did not leave died of starvation. A short-term climatic event such as this could have easily triggered the apparently sudden repopulation of the Southwest.

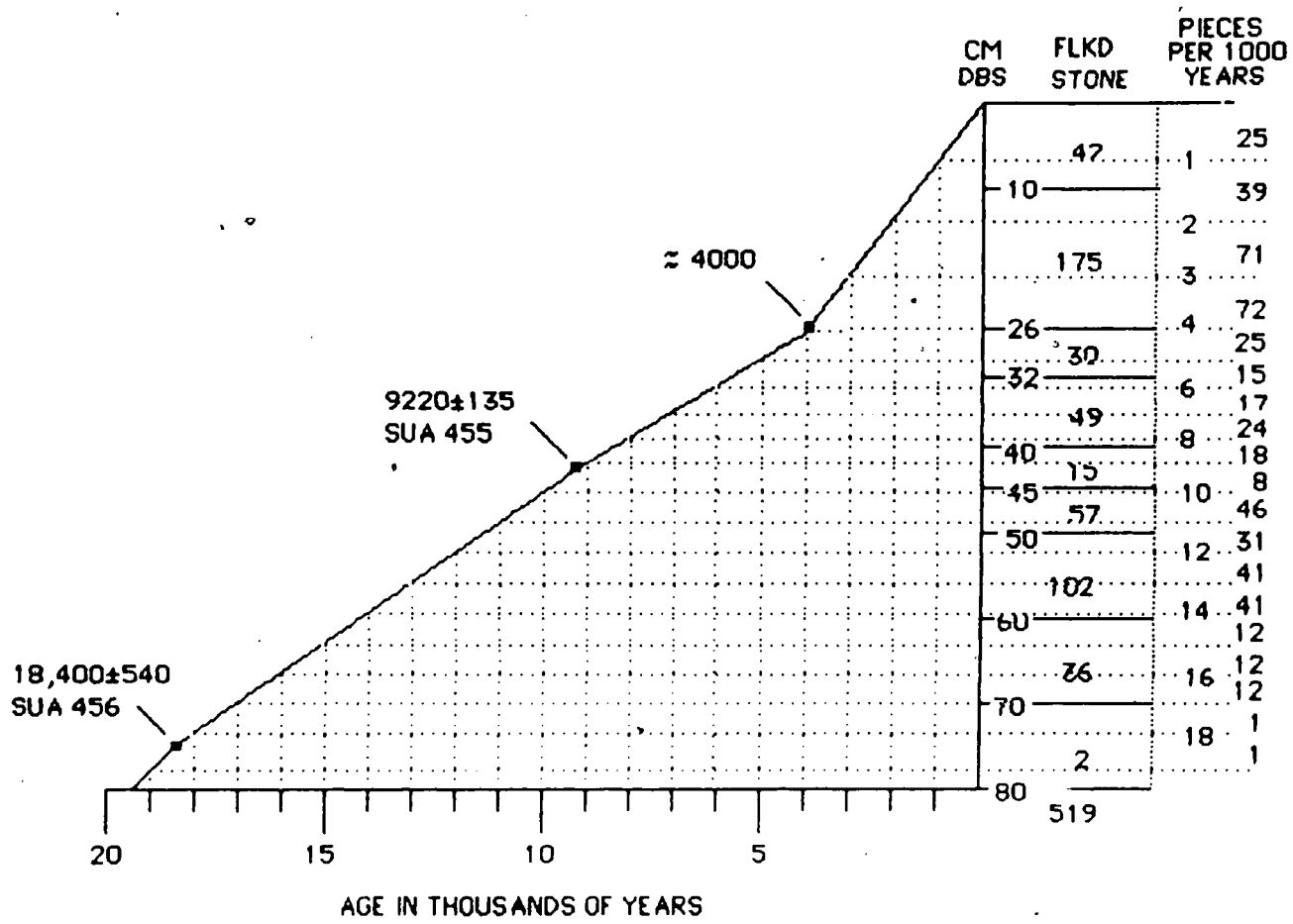
However, because of the association of backed microliths with this migration, it would probably be unwise to completely disregard other possible causes for its occurrence. The ultimate origin of the backed microlith phenomenon in Australia is unknown. It may have come from India via Indonesia, as has long been postulated (e.g. McCarthy 1977), or it may have been independently developed in southeast Australia (Pearce 1974). Whatever the case, because the

spread of backed microliths is associated with a migration in this case, it may be associated with migrations in others; and possibly the desert ancestors of the Nyungar were being pressured by other populations from the east and/or north. Possibly there was a much more turbulent social atmosphere in late Holocene Australia than has previously been generally assumed.

Regrettably, investigation of these intriguing possibilities necessarily carries well beyond the boundaries of the Australian Southwest. This thesis has achieved its objective in having demonstrated the likelihood of a mid-Holocene depopulation of the region, and in having reinforced the cultural ecology model which predicted it.

APPENDIX A

AGE/DEPTH GRAPHS



APPENDIX A.1 : AGE/DEPTH GRAPH FOR ARUMVALE TRENCH 2

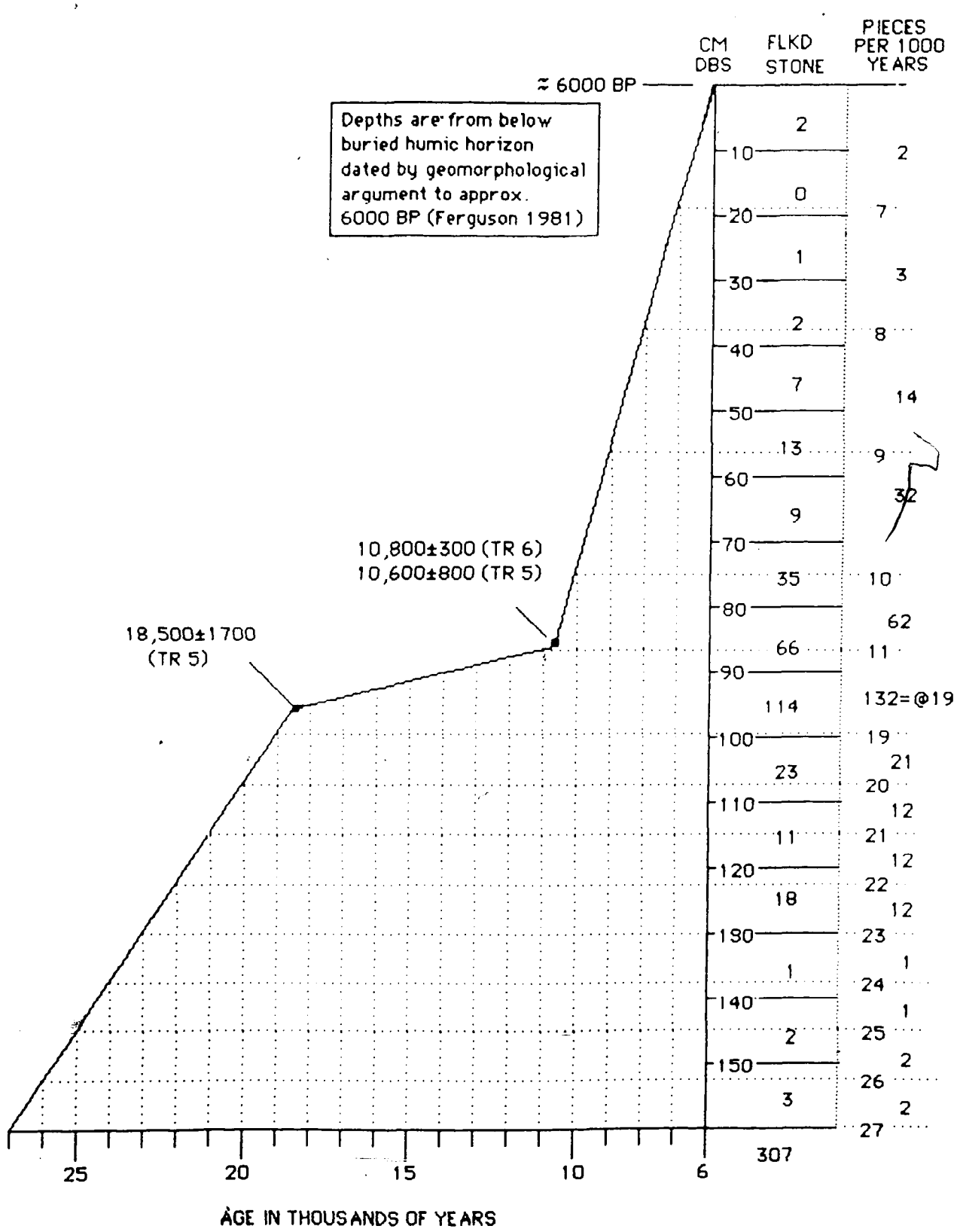
Taken from the working tables of C.E. Dortch, excavator. The approximately 4000 BP date was set at the bottom of the spit which contains all but one of the backed microliths in this and other trenches. A single backed microlith shown on the working tables to have been found in Trench 2 associated with the 9220 BP date has been ignored. On the basis of the information presented in Chapter 6 of this Thesis it is improbable that this is a "true" backed microlith in primary depositional position. It is most likely either a piece which only accidentally resembles a backed microlith; or is a backed microlith which, through some sort of subsurface disturbance, has been shifted approximately 20 cm downward in the sands of this site. Hopefully, the forthcoming publication of this site (Dortch & McArthur n.d) will provide clarification.

APPENDIX A.2: EXPLANATION OF THE CONSTRUCTION OF THE DEVIL'S LAIR MILLENNIAL DENSITY MODEL.

The data to construct the model (Fig. 7.7) were taken from the working tables of Mr. C.E. Dortch, excavator. Section diagrams showing strata nomenclature and depth below datum are presented in Dortch (1984) and elsewhere. The model is based on the stone artifacts from Trenches 5, 7, 8, 9 and 10. Because of irregular stratigraphy no age/depth graph was attempted. Instead the total artifacts recovered between dated strata were averaged for the number of millennia involved in the following manner:

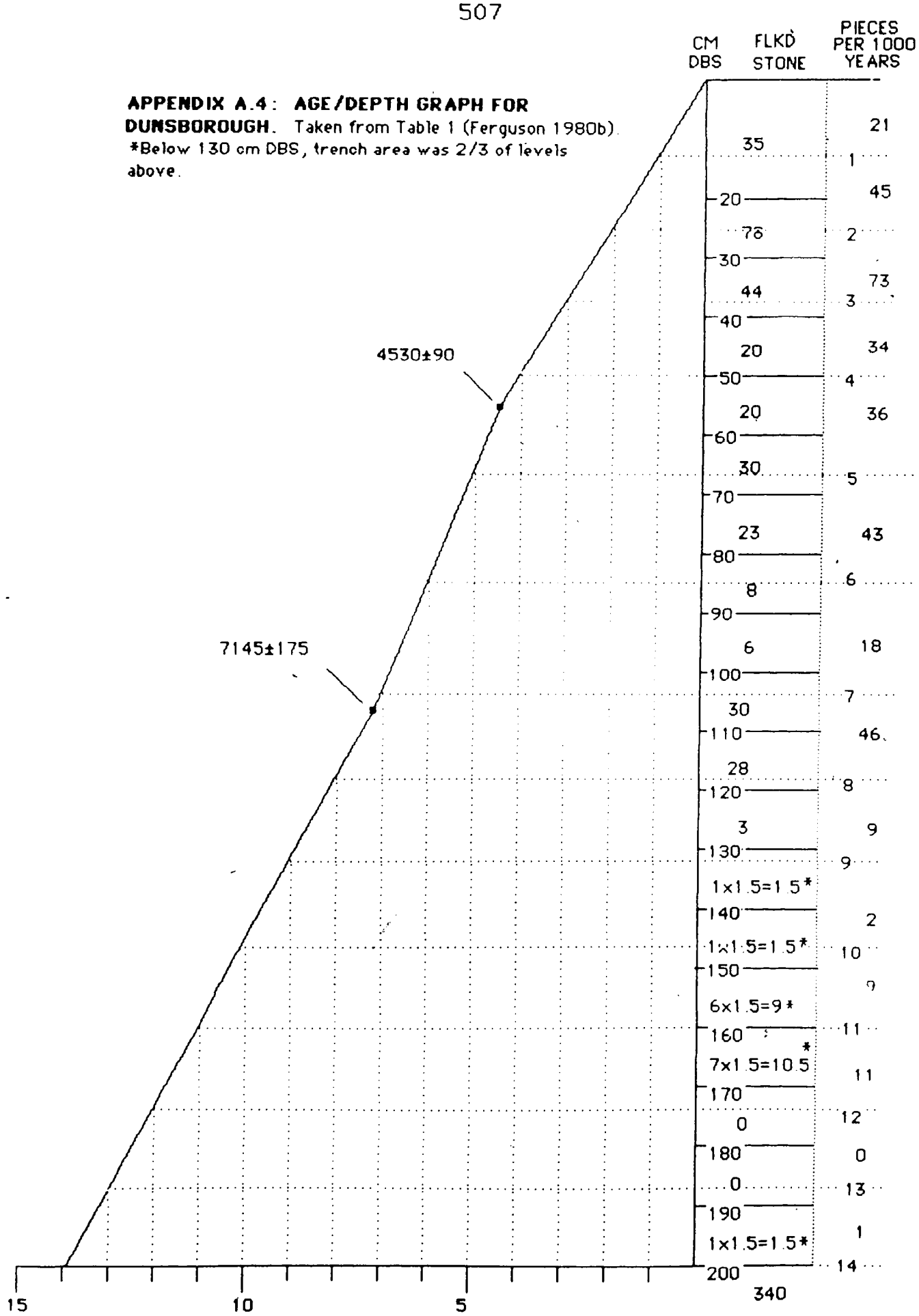
LEVEL	DATE	TRENCH	ARTIFACTS	TOTAL	SIZE ADJUSTMENT*	ARTIFACTS PER MILLENNIUM
G -	6490±13					
		7	4	4		APPROX. .66
I						
K -	12,050±140					
		5	52			
		7	345			
		8	280			
		9	186			
		10	60			
				923		APPROX. 115
9 -	19,250±900					
10 -	20,40±100					
		5	4			
		7	22			
		8	83			
		9	58			
		10	13			
				180	× 1.5 = 270	APPROX. 34
28 -	27,700±700					

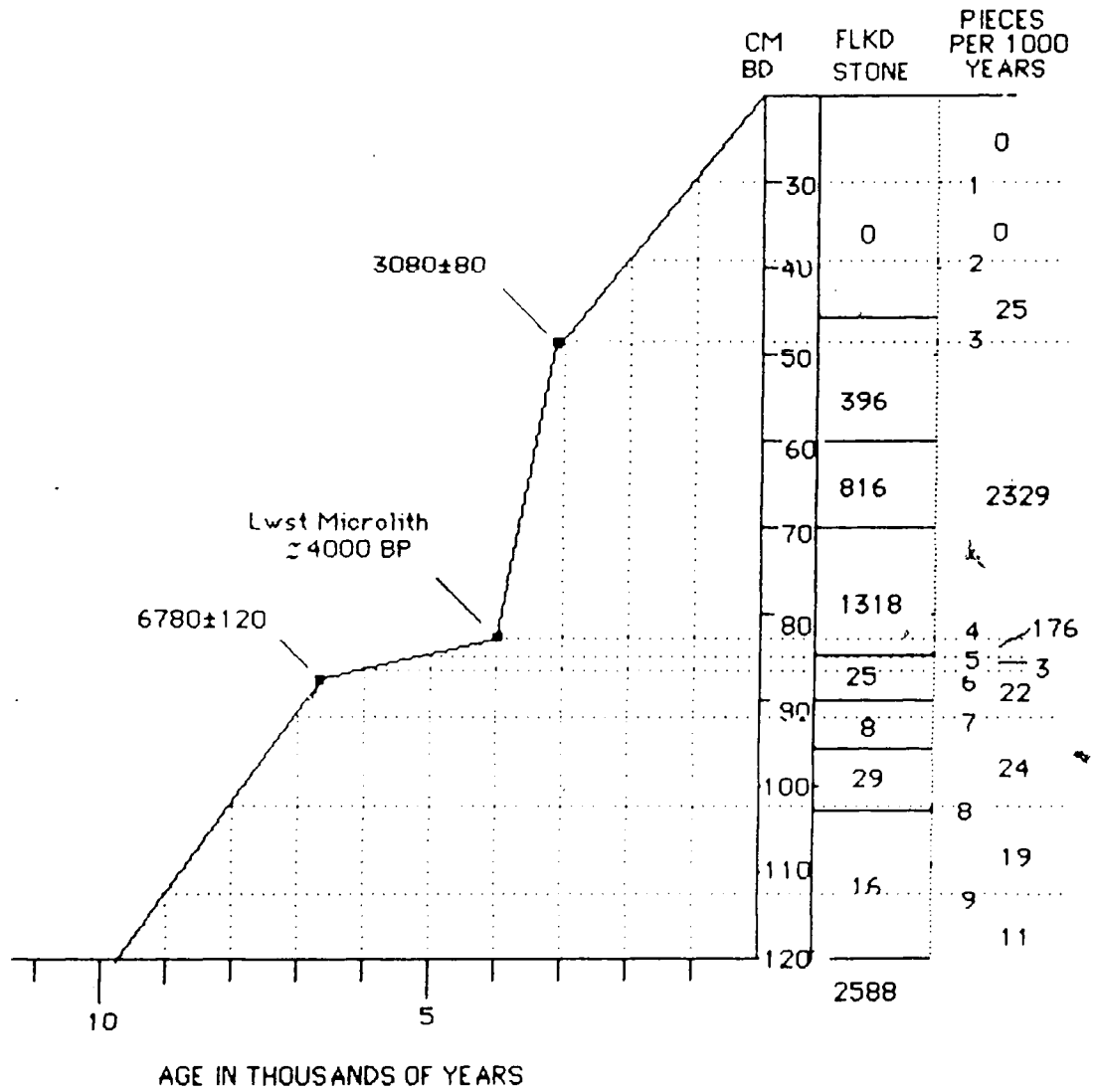
* Trenches 5, 7a and 7b only go through layer 10. Trenches 9 and 10 begin at layer M. It is difficult to figure the cubic area of the trenches excavated precisely, but an arbitrary multiplier of 1.5 for the layers 10 through 28 total should create a reasonably accurate equivalent to the layers K through 9 total.



APPENDIX A.3: AGE/DEPTH GRAPH FOR QUININUP BROOK, SITE 4.
The graph was taken from Table 1 (Ferguson 1981), and combines Trenches 5 & 6.

APPENDIX A.4: AGE/DEPTH GRAPH FOR DUNSBOROUGH. Taken from Table 1 (Ferguson 1980b). *Below 130 cm DBS, trench area was 2/3 of levels above.

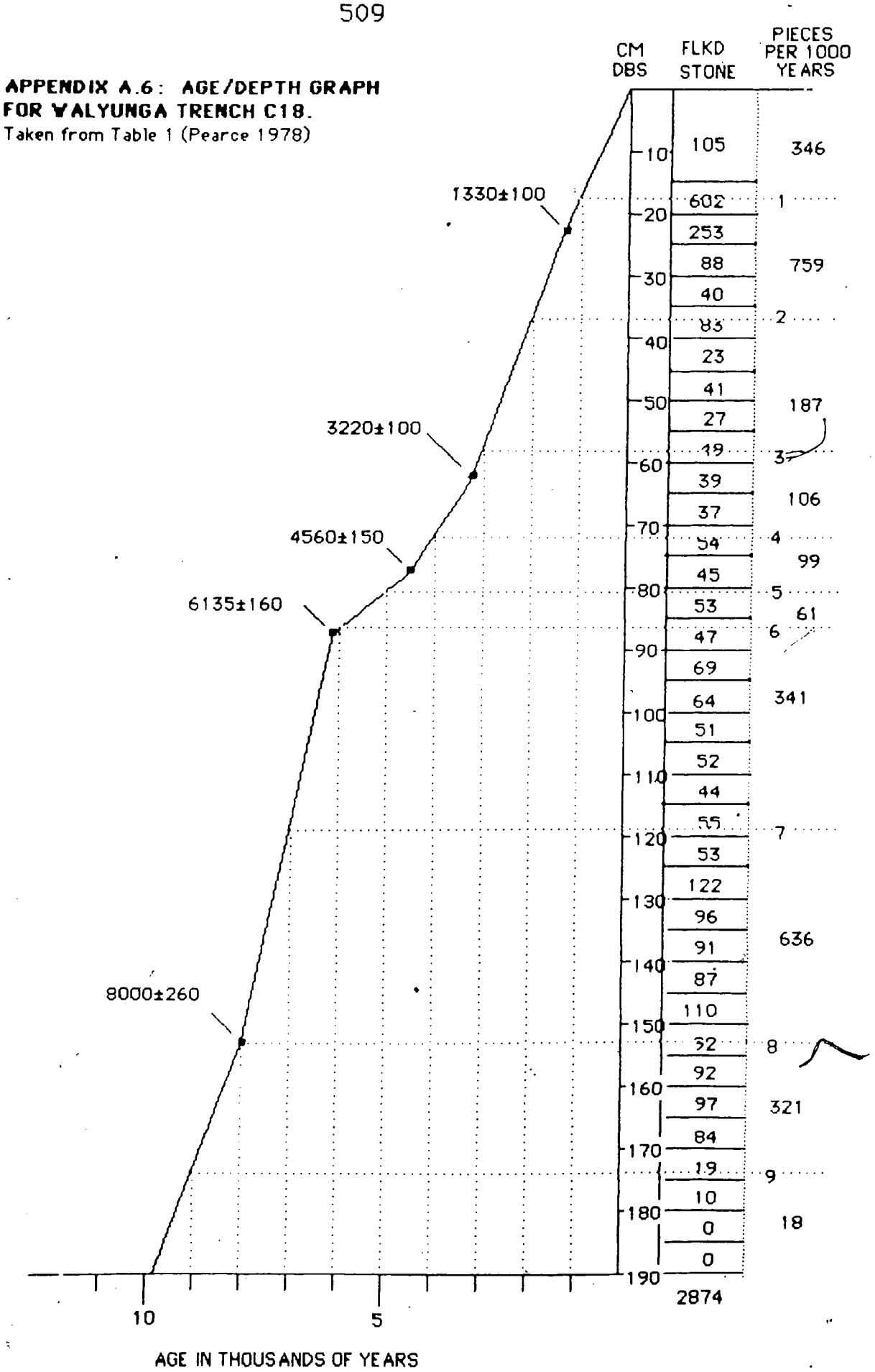


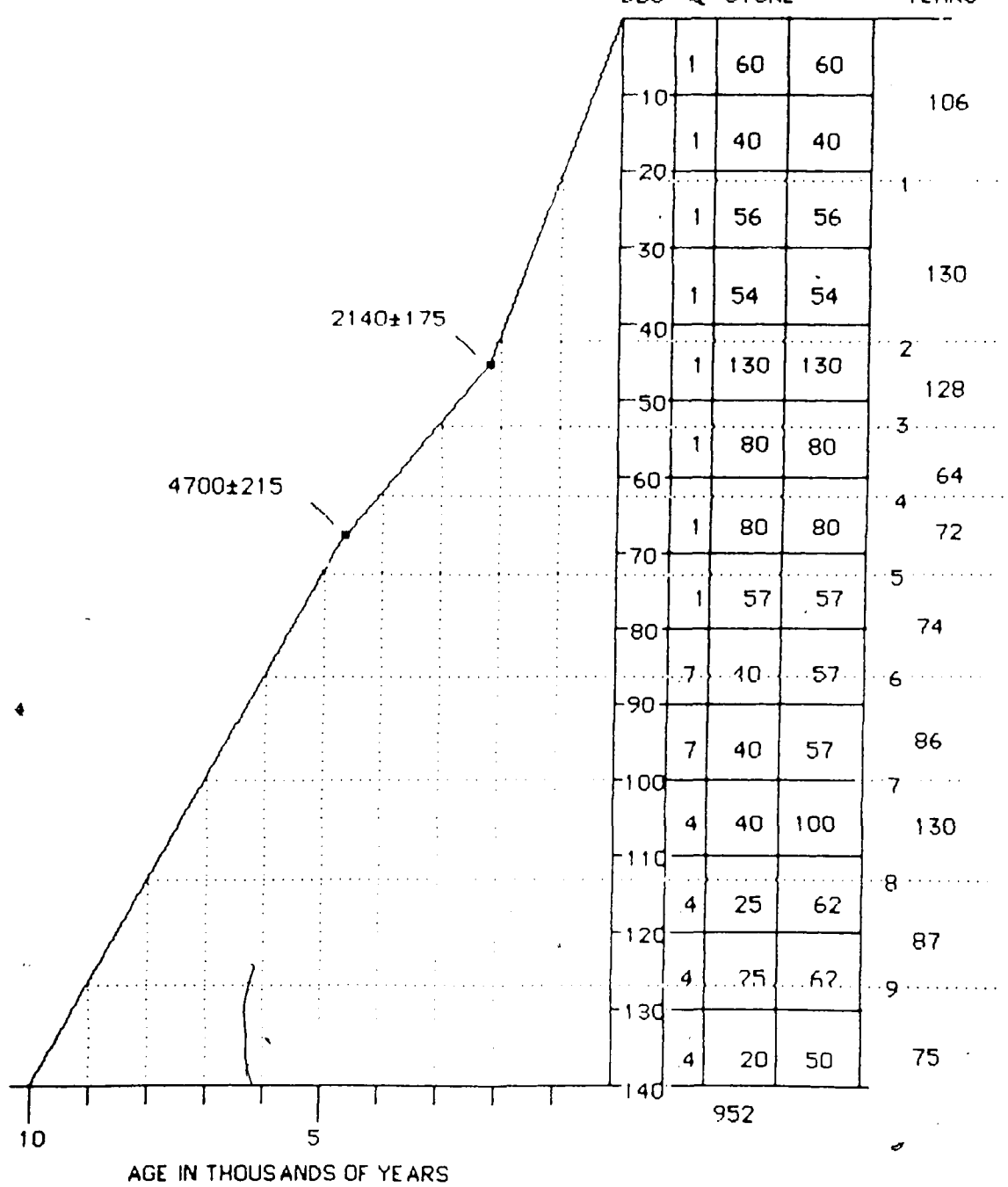


APPENDIX A.5: AGE/DEPTH GRAPH FOR NORTHCLIFFE SILCRETE QUARRY.

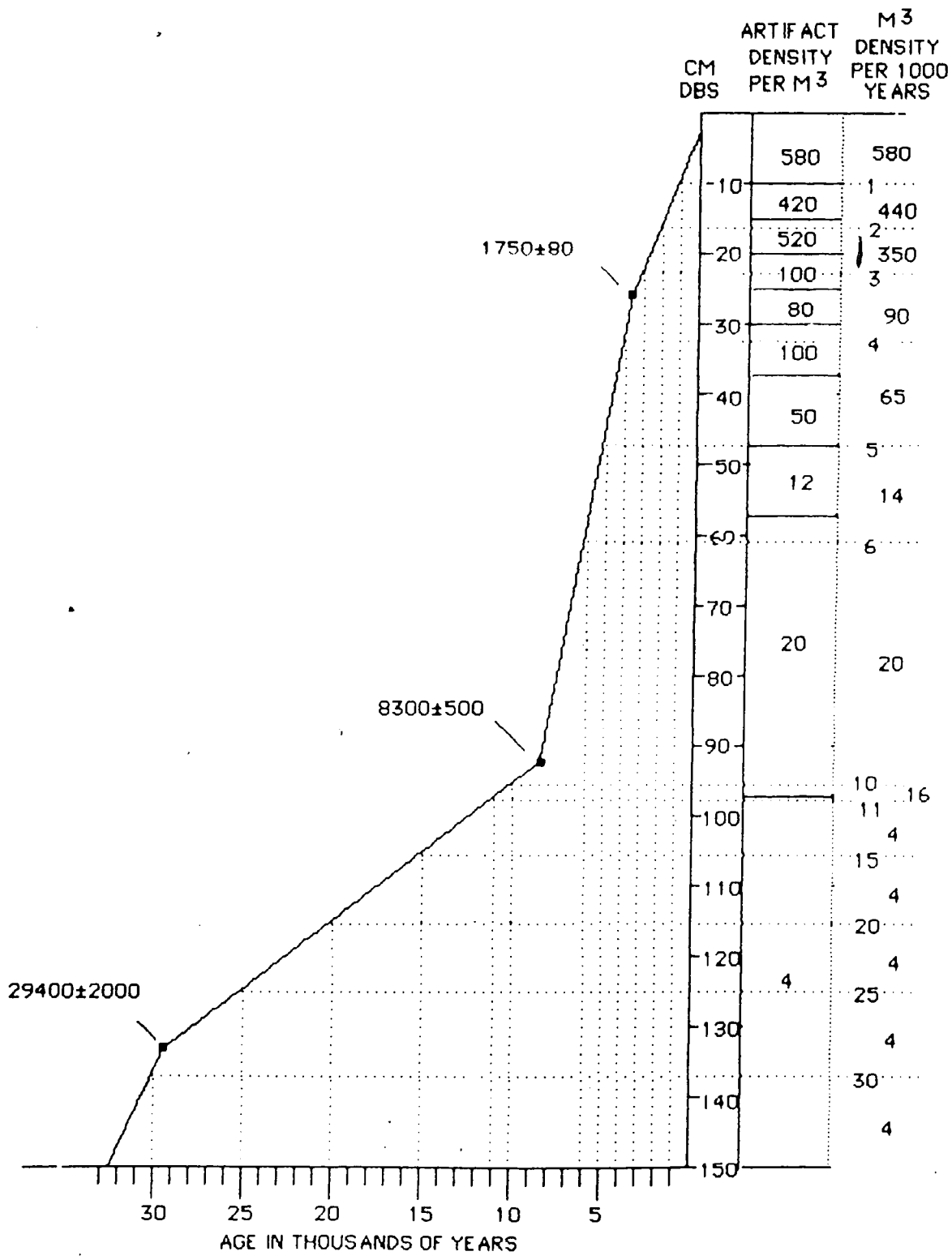
Taken from Table 1(Dortch and Gardner 1976) Artifact numbers for high density levels are minimums because excavators did not attempt to recover all the chips.

APPENDIX A.6: AGE/DEPTH GRAPH FOR WALYUNGA TRENCH C18.
Taken from Table 1 (Pearce 1978)

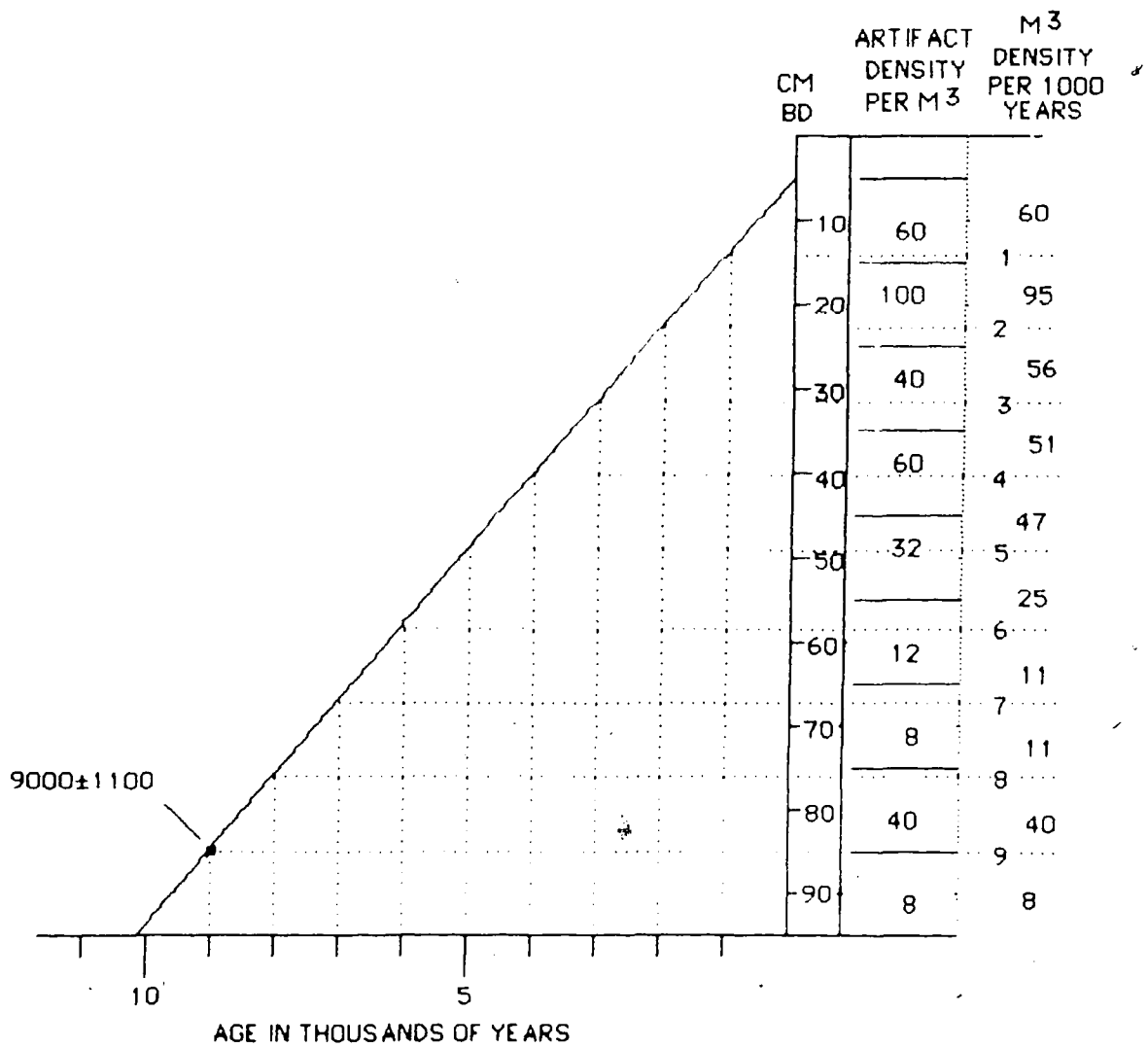




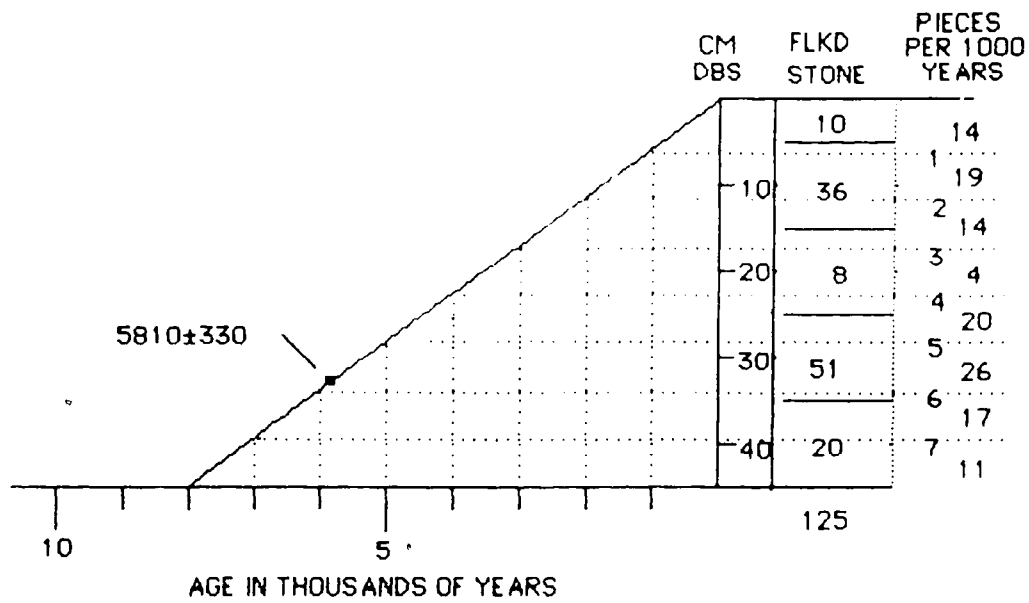
APPENDIX A.7: AGE/DEPTH GRAPH FOR WALYUNGA TRENCH B6.
Taken from Table 8 (Pearce 1979). To compensate for changing area of excavation, level totals have been multiplied by one over the area excavated.



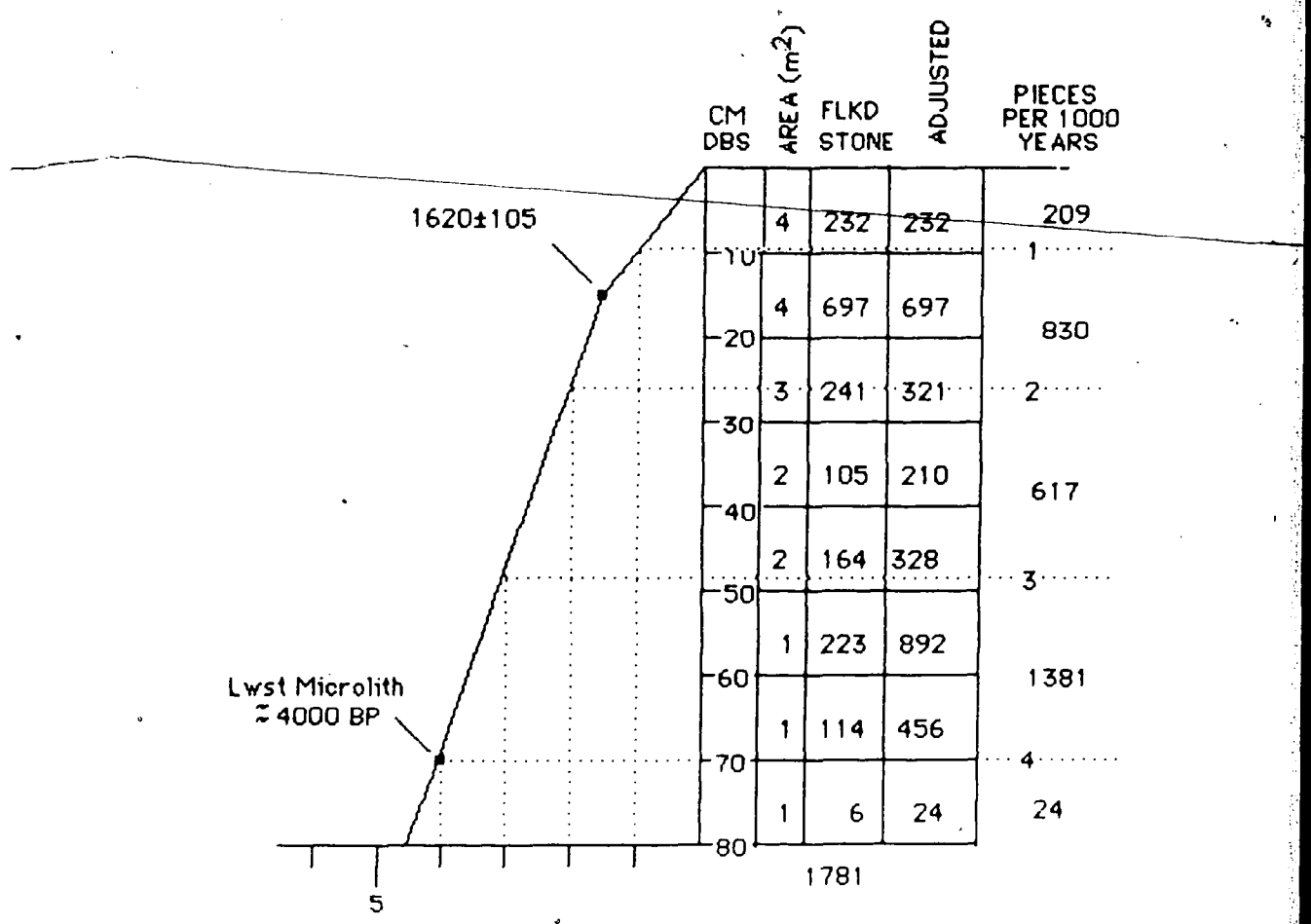
APPENDIX A.8: AGE/DEPTH GRAPH FOR HELENA RIVER 1.
Taken from Fig. 6 (Schwede 1983) which reports changes in artifact density per cubic metre with depth. Where more than one density rate is included in a single millennium, a proportional average of those rateswas determined.



APPENDIX A.9: AGE/DEPTH GRAPH FOR HELENA RIVER TRENCH 5.
Taken from Fig. 6 (Schwede 1983) which reports changes in artifact density per cubic metre with depth. Where more than one density rate is included in a single millennium, a proportional average of those rates was determined.

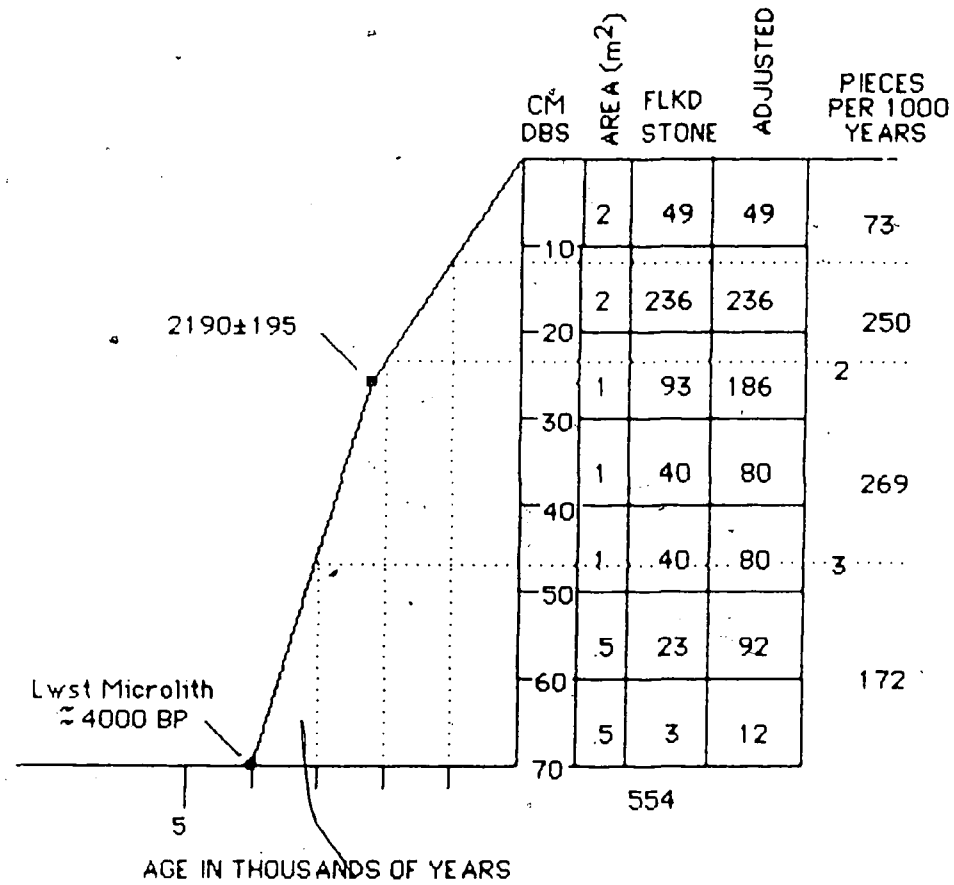


APPENDIX A.10: AGE/DEPTH GRAPH FOR REFINERY SITE R4B.
Taken from Table 1 (Pearce 1982).



APPENDIX A.11: AGE/DEPTH GRAPH FOR SOLDIERS ROAD.

Taken from Table 4 (Pearce 1979). To compensate for changing area of excavation, level totals have been multiplied by four over the area excavated.



APPENDIX A.12 : AGE/DEPTH GRAPH FOR NORTHLAKE.

Taken from Table 3 (Pearce 1979). To compensate for changing area of excavation, level totals have been multiplied by two over the area excavated.

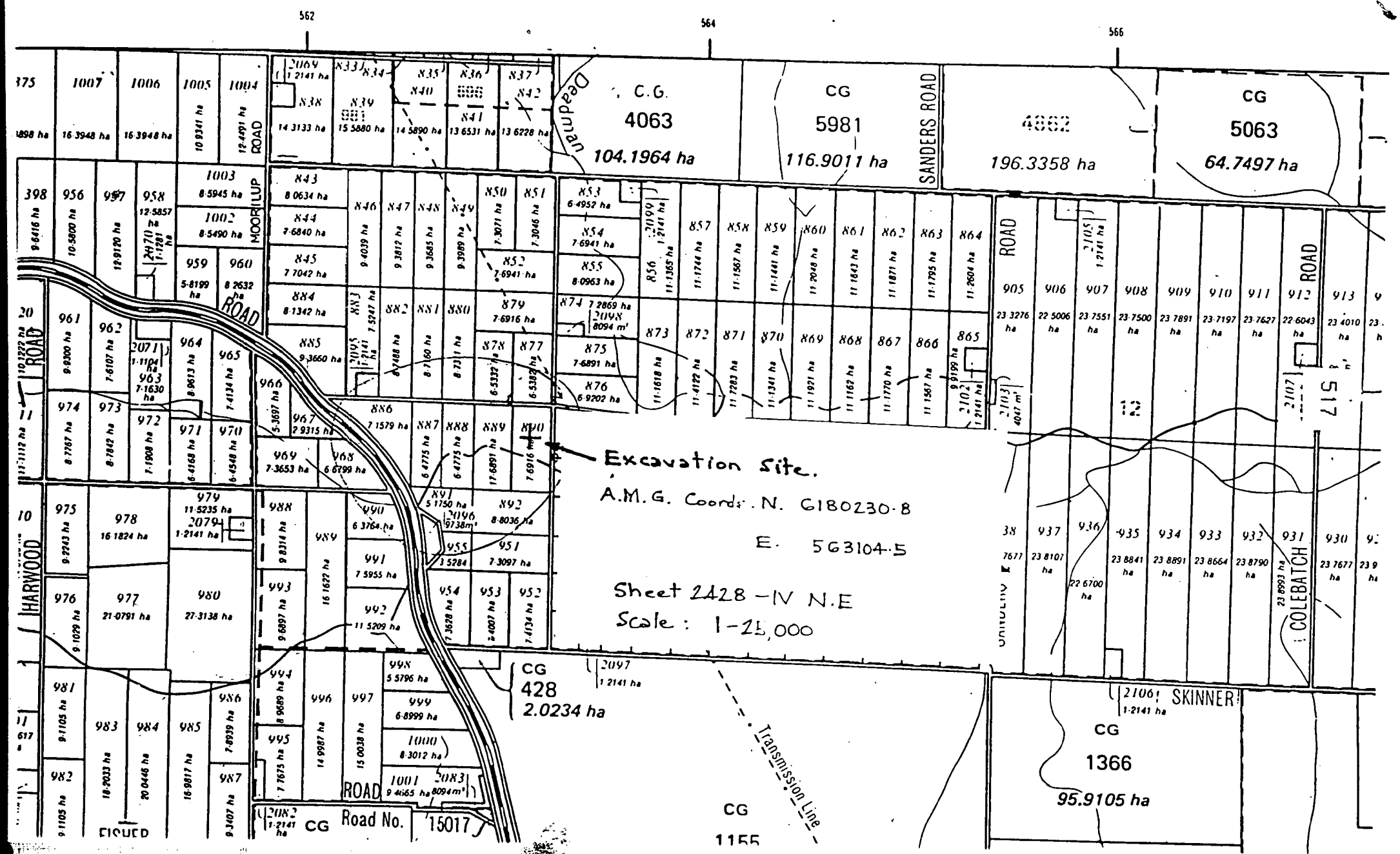
APPENDIX B

MISCELLANEOUS PAPERS

1. Surveyed location of NE Corner, Moorillup Pool Trench 2A on copy of Plantagenet Shire Plat.

MOUNT BARKER N.E.

WESTERN AUSTRALIA



APPENDIX C

SITE GAZETTEER

MOKARE'S DOMAIN SITE GAZETTEER

This gazetteer contains an alphabetical listing of the sites of Mokaré's Domain and eight vegetation-system maps with border grids so that those sites can be easily located for a more complete understanding of the text. To use it, find the name of the site in the list, and note the grid co-ordinates following the name. The bold-face numeral is the number of the map, and the plain numbers are the vertical and horizontal gridlines which are closest to the site on that map.

On the maps the grid is in kilometre increments, and the heavy black lines are the routes of the road survey. Sites found during the road survey are shown as solid triangles, and sites found by other methods are shown as hollow triangles. The inset shows the division of Mokaré's Domain into vegetation systems after Beard (1979b).

LIST OF MAPS:

ALPHABETICAL LISTING OF SITES:

Akora **4** 77 60
Apex Park **3** 78 76
Appledeen **4** 85 61
Arizona Pool **8** 82 77
Armstrong-Takenup **4** 89 57

Bench Mark 9 **3** 76 24
Bennett Road **4** 89 52
Bloxidge Road **7** 06 66
Blue Lake Road **2** 40 52
Bolitho Road **1** 52 24

Boonawarup Creek **8** 83 83
Borderline Swamp **8** 27 79
Bradstock Hills **7** 26 57
Burnside Ford **5** 72 81
Bushby Road **3** 86 33

Catalina Road **3** 81 28
Century **7** 20 68
Cherryup Dolerite Quarry **1** 39 29
Cheyne Road Swamp **6** 18 47
Chillinup-Palmdale Swamp **7** 00 76
Chillinup Road **7** 07 76
Church Lane **4** 90 38
Corimup Road East **6** 07 51
Cozy Corner **1** 59 21
Crockerup Road **4** 62 72
Cupup Creek **1** 45 22
Curricup Fish Traps I **1** 42 25
Curricup Fish Traps II **1** 42 25
Currinup **1** 56 20
Cuthbert Dunes **3** 72 25

Deadman Gully **5** 63 80
Deep Creek **4** 92 44
Dempster Road **6** 96 34
Deneryl Swamp **8** 26 81
Drawbin Road **7** 16 62

East Hunwick **3** 61 32
East Sisters Swamp **6** 11 49
Elizabeth Street **3** 86 31

Fish Track Swamp **6** 03 44

Gaalgegup Creek **5** 85 71
Gardner Lake **6** 06 31
Gibralter Creek **4** 78 65
Gold Holes **8** 98 88
Golf Links Road **4** 63 64

Lake Barnes **4** 60 56
Lake Chillinup **7** 98 76
Lake Morandee **4** 84 52
Lake Pleasant View **6** 08 45
Lake Powell **1** 68 25
Lalley's Orchard **5** 59 81
Lang Park **3** 85 29
Ledge Beach Road **6** 89 26
Little Chorkerup **3** 68 44
Little Grove **1** 80 17
Little Kyewong **6** 09 47
Lower Hay **2** 43 32
Lower King Ford **3** 86 33

Madden **4** 91 44
Manypeaks Homestead **6** 08 37
Manyswamps **7** 10 59
Marbellup Brook **1** 66 28
Marbellup Road North **3** 64 35
Millanup Creek **4** 82 60
Millbrook Downs **3** 74 40
Mindijup **6** 96 52
Mindyegillup Creek **5** 79 71
Mitchell River **2** 37 45
Moats Lake **6** 00 32
Modiarup Road **6** 91 60
Moorillup Crossing **5** 63 80
Moorillup Pool **5** 63 80
Morandee Road West **4** 80 52
Mgrrialup Creek **4** 88 60
Mullarup Creek **6** 94 61
Munaleen **4** 78 49

Napier Crossing **4** 84 45
Nioka **7** 24 49
Noorubup-McCrea Creeks **6** 08 64
Noorubup Pool **6** 07 65
Normans Beach Road **6** 09 36
Normans Estuary **6** 10 35

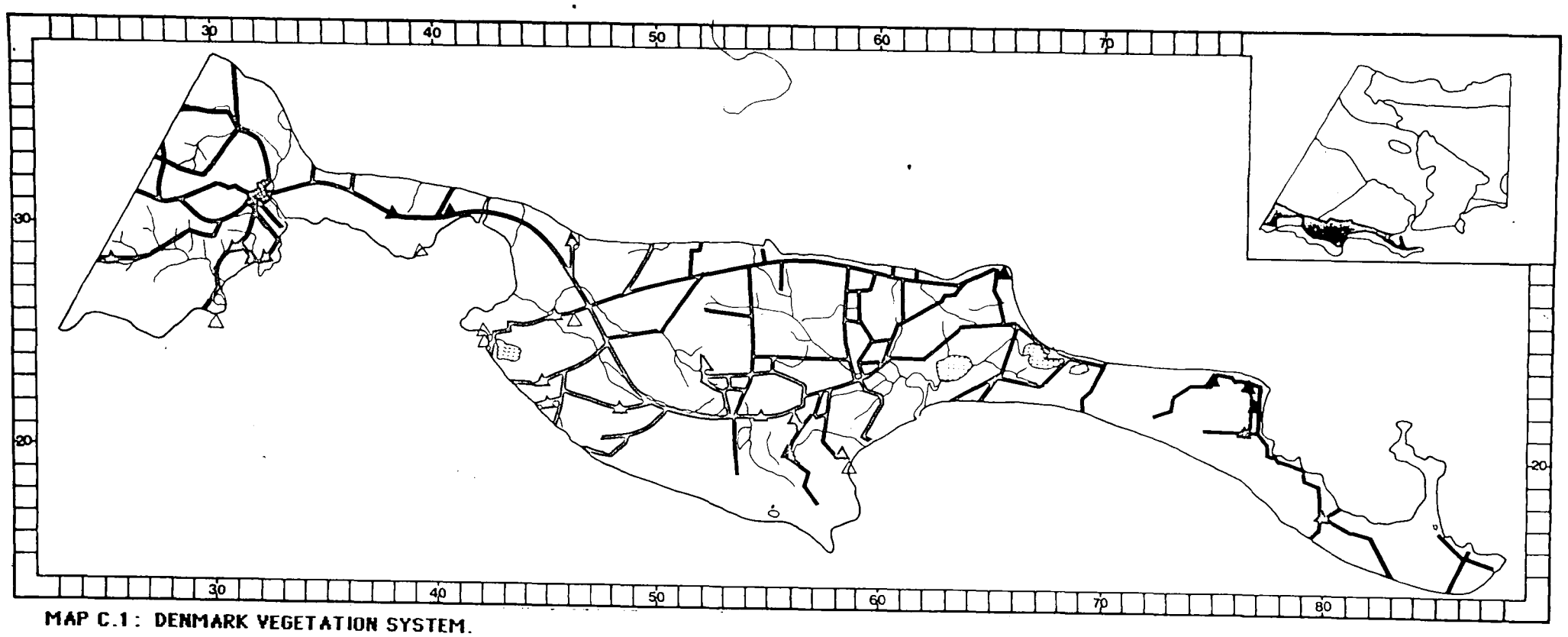
Number One Swamp **6** 10 55

Ocean Beach Road **1** 31 29
Old Barrack Spring **4** 62 65
O'Malley's Swamp **3** 65 39
Ongerup Lagoon **4** 51 63
Oyster Harbour Fish Traps **4** 86 32

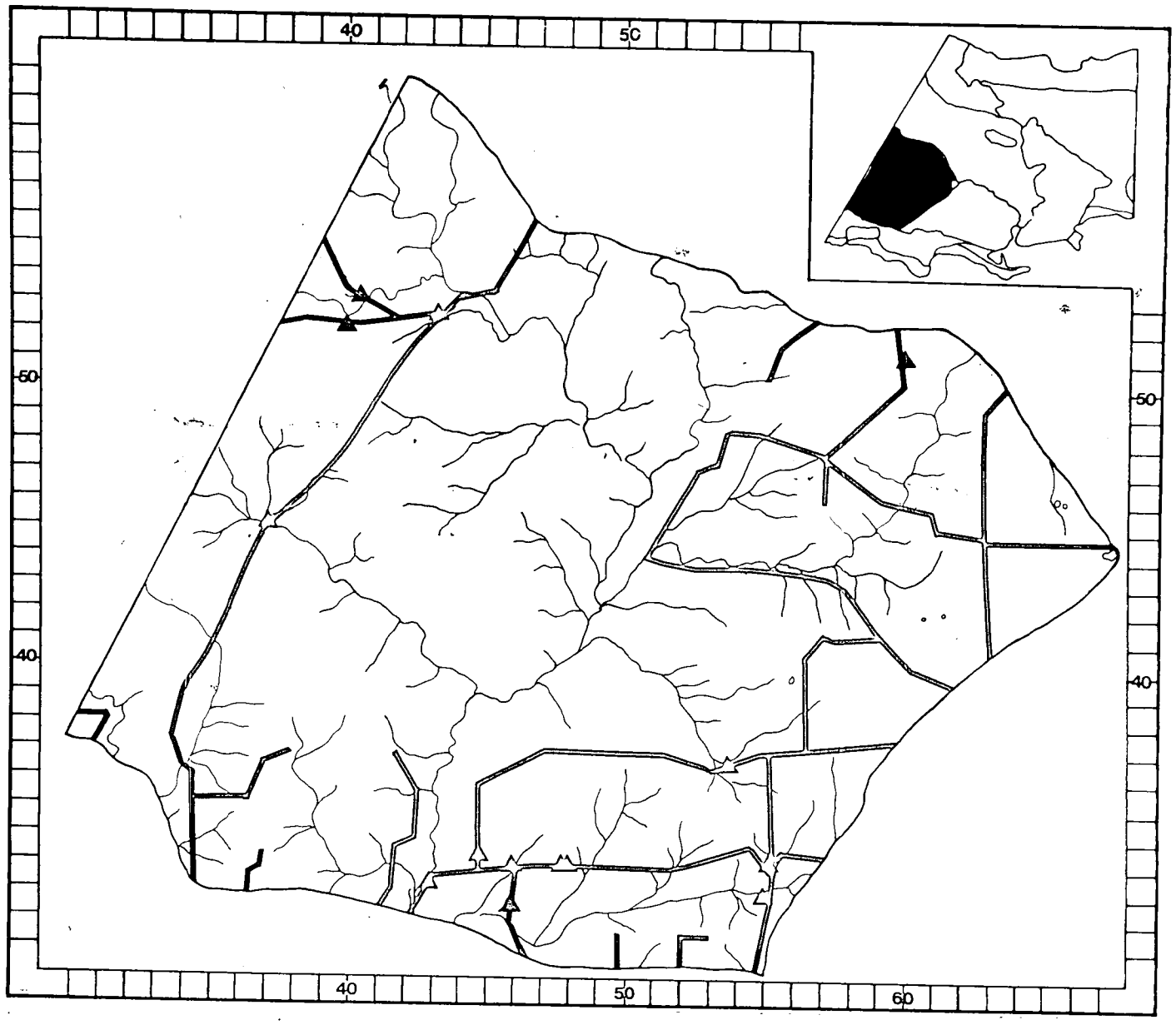
Palmdale Swamp **6** 01 51
Parker Brook **3** 77 31
Perallup Gully **5** 59 77
Pfeiffer Road **7** 10 66
Piggot-Martin Road **1** 48 22
Poison Point Dolerite Quarry **1** 32 28
Port Harding Dunes **1** 58 20
Possum Tree 1 **5** 62 81
Possum Tree 2 **5** 58 81
Possum Tree 3 **5** 58 82
Princess Avenue Dunes **1** 77 21
Pwakkenbak SE **4** 62 63

Red Hen Junction **2** 55 33
Redmond Creek **2** 45 33
Redmond Road West **2** 54 37
Roberts Road Dunes **1** 77 23
Rudyard Farm **1** 38 31
Ruin Creek **4** 81 56

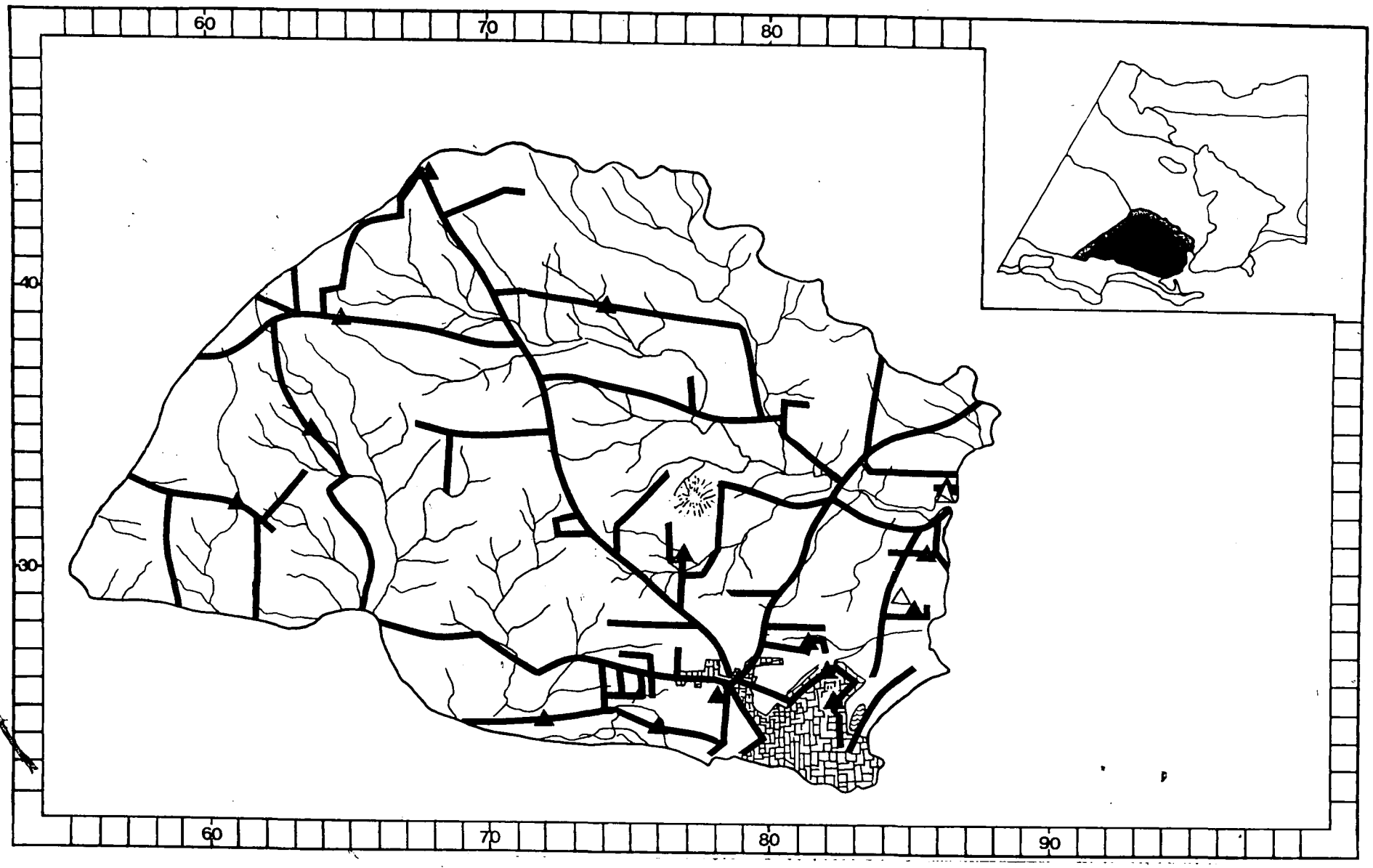
Saide Road **1** 45 22
Sanders-Deadman Swamp **5** 64 80
Sand Patch Road **1** 75 23
Second Pool **7** 89 75
Seven Mile Swamp **6** 99 46
Sheep Wash Creek **2** 43 52
Sleeman River **2** 46 32
Sleeman Road **1** 46 30
Sleeman Road Lake **2** 60 51
Smokers Road **4** 60 63
South Skye **6** 01 56



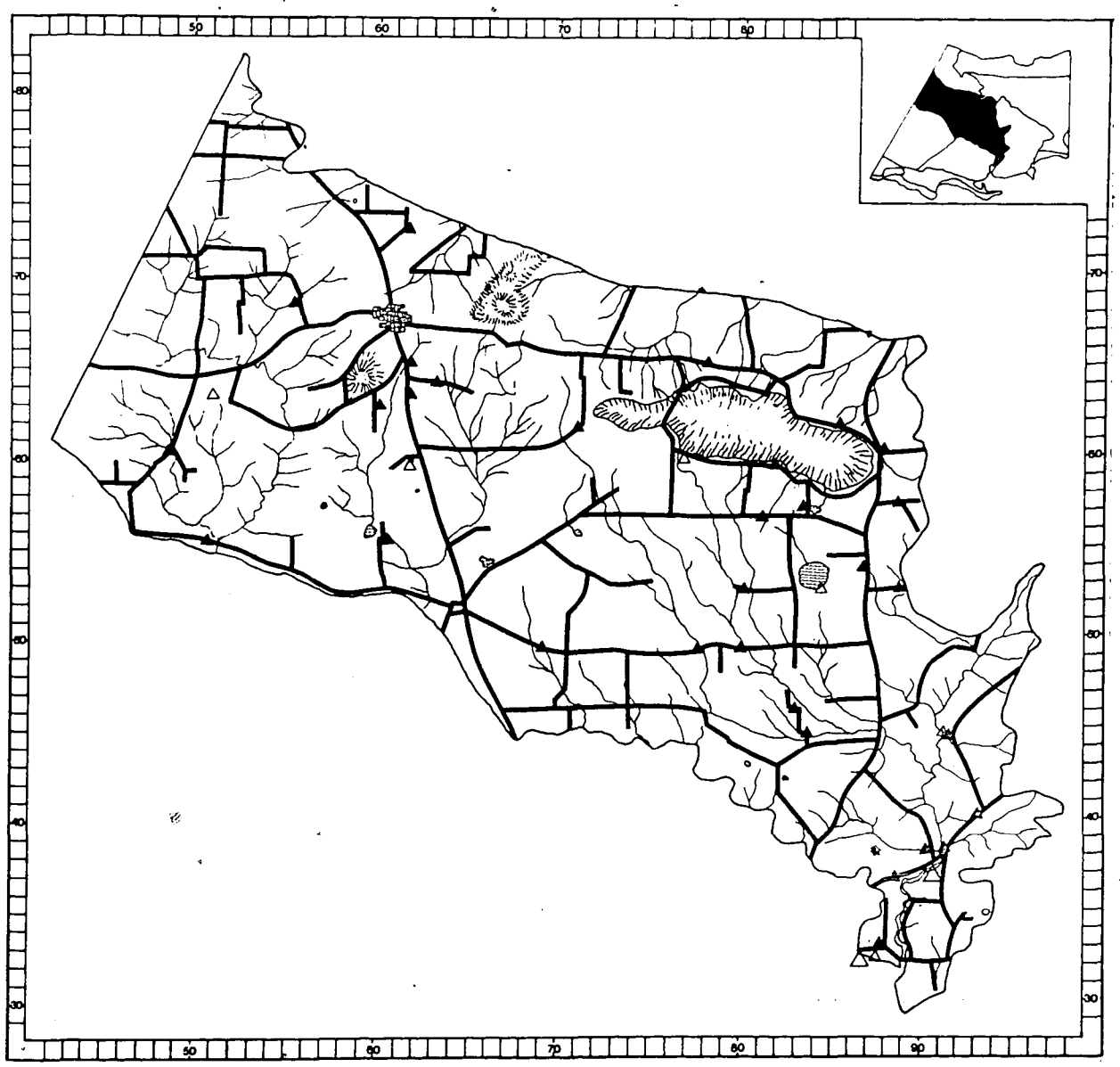
MAP C.1 : DENMARK VEGETATION SYSTEM.



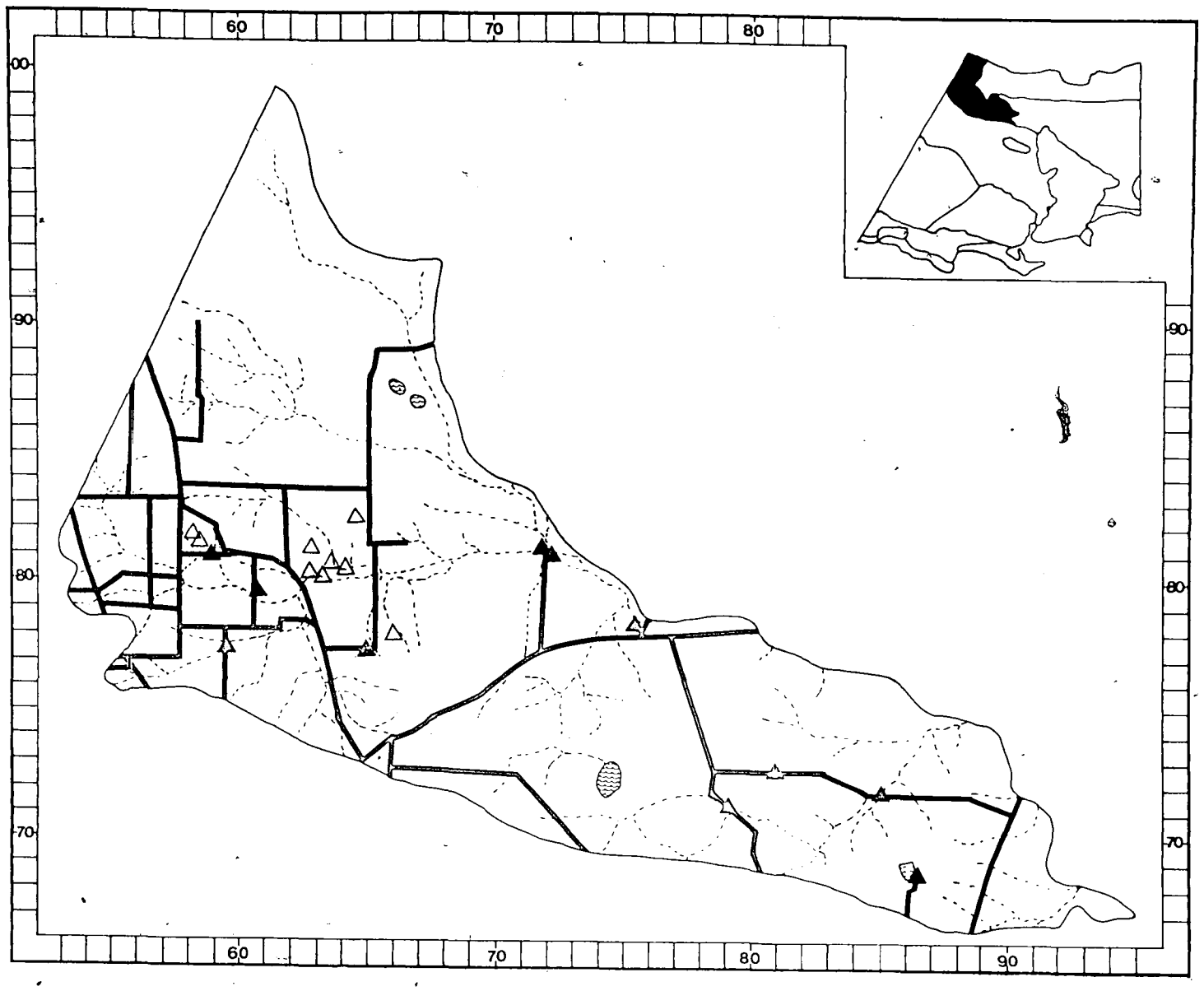
MAP C.2: HAY VEGETATION SYSTEM.



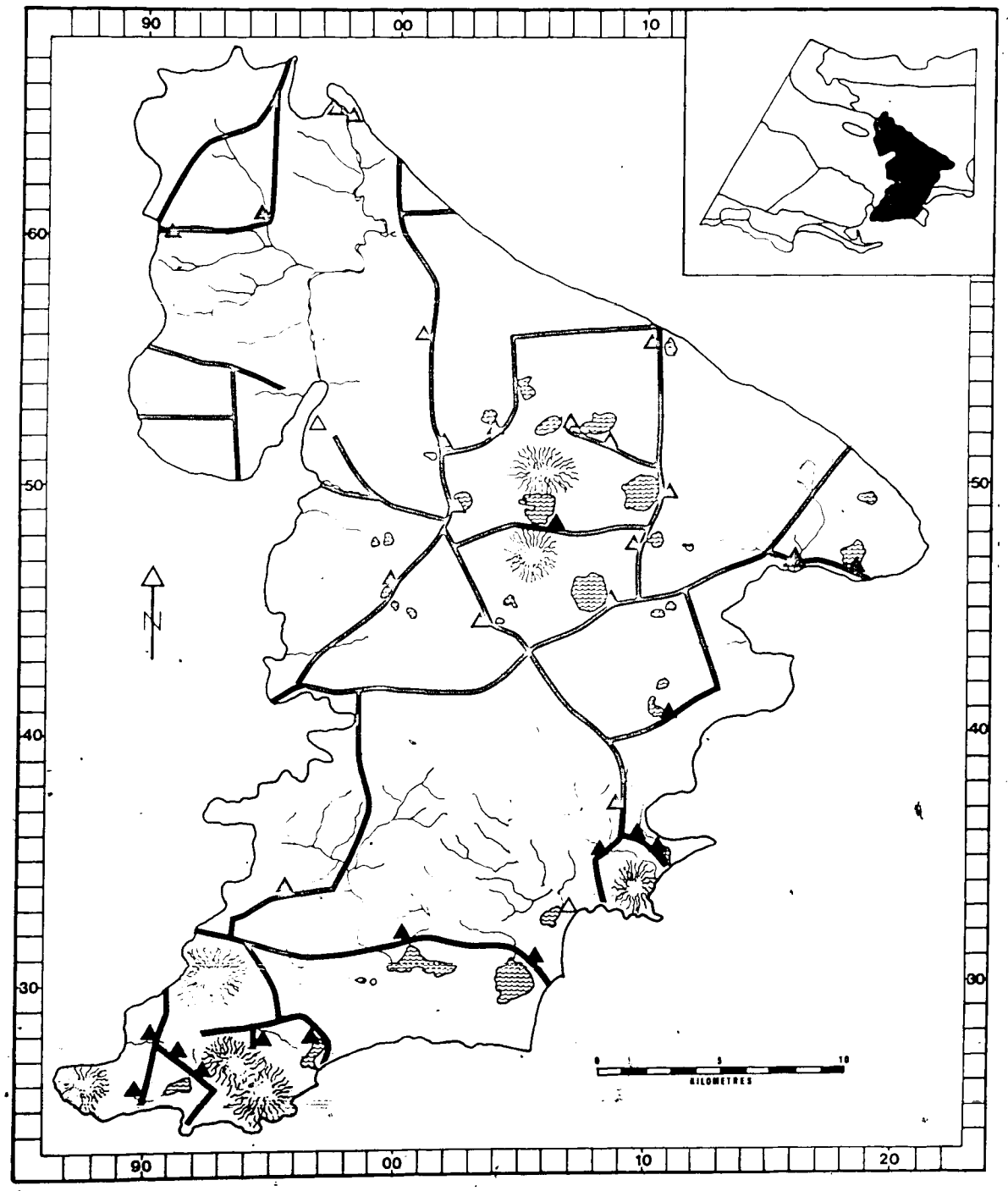
MAP C.3: ALBANY VEGETATION SYSTEM.



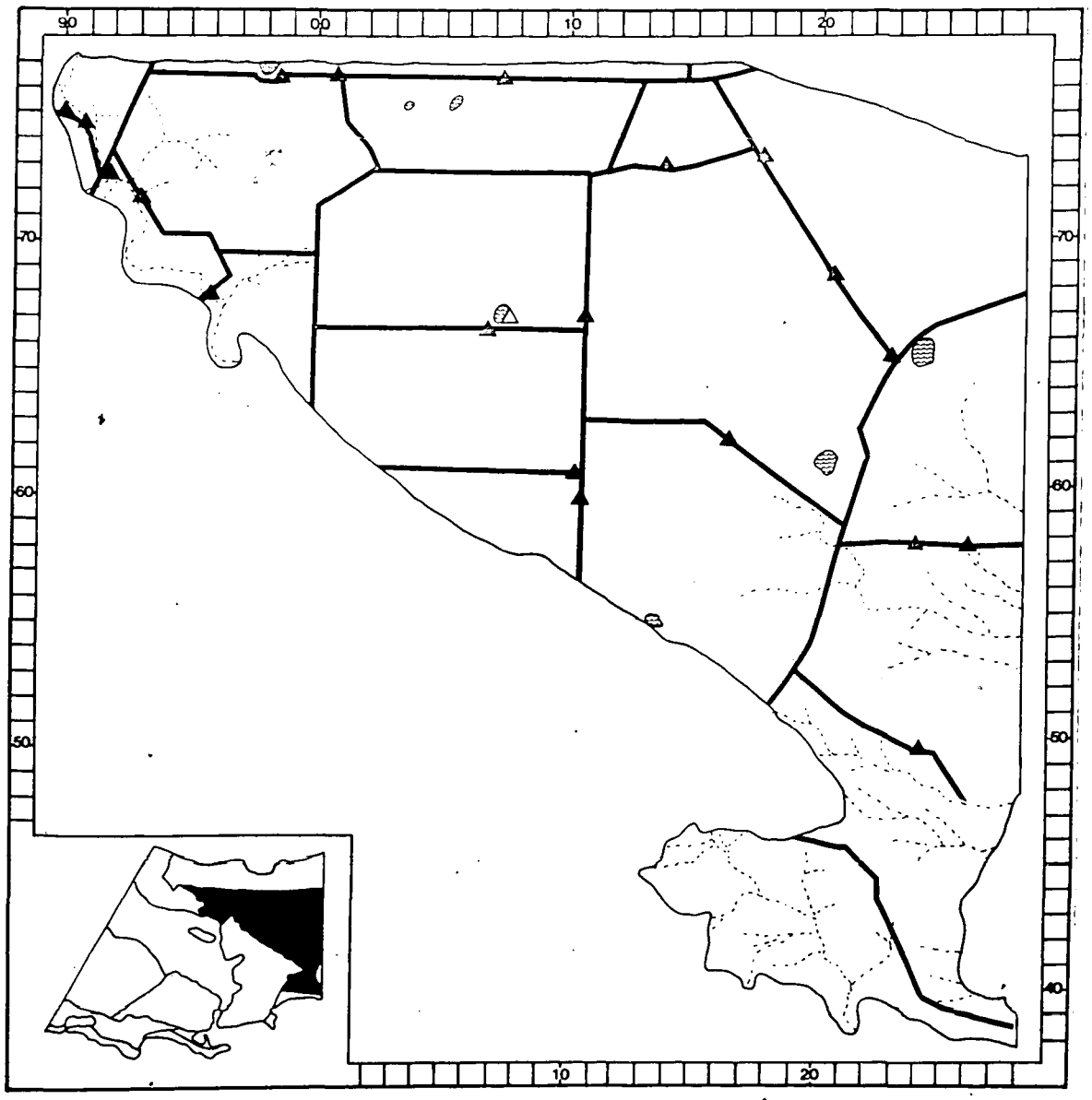
MAP C.4: MARRICUP VEGETATION SYSTEM.



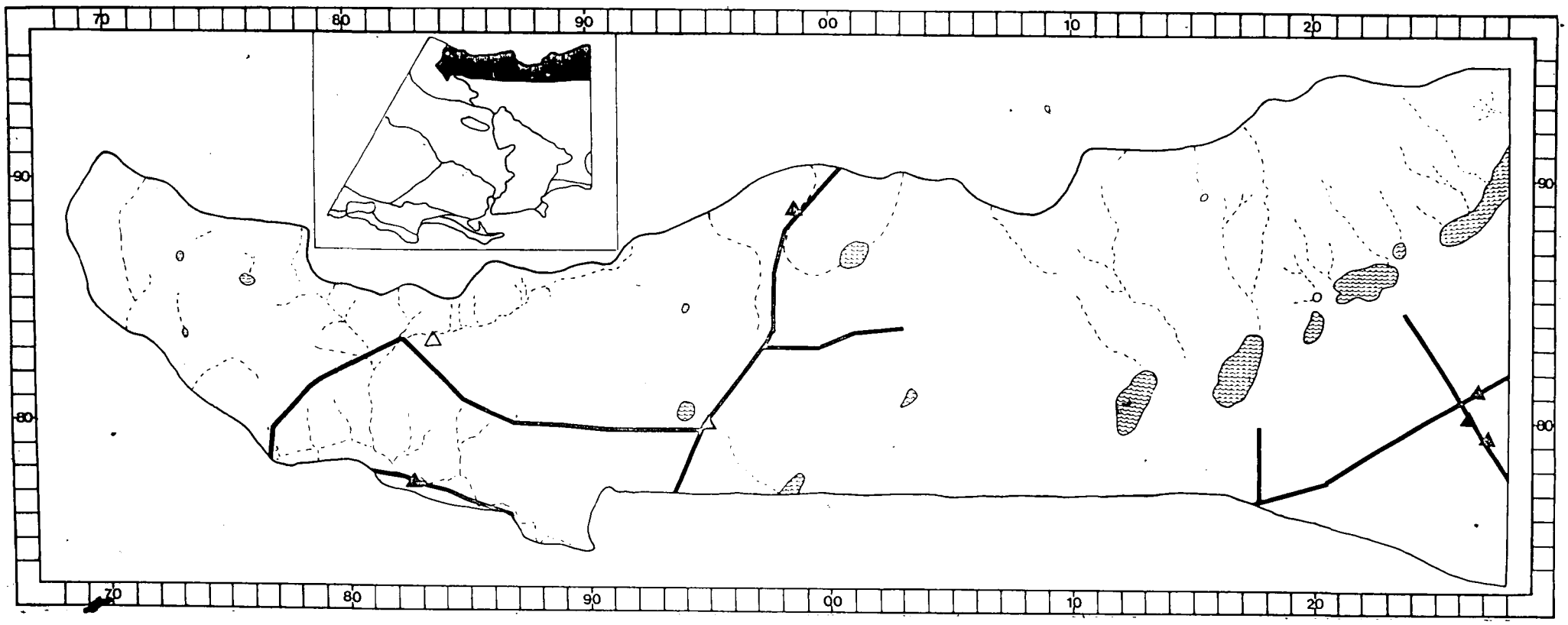
MAP C.5: KENDENUP VEGETATION SYSTEM.



MAP C.6: EAST KALGAN VEGETATION SYSTEM.



MAP C.7: CAPE RICHE VEGETATION SYSTEM.



MAP C.8: QUALUP VEGETATION SYSTEM.

BIBLIOGRAPHY

BIBLIOGRAPHY

AKERMAN, K.
1973 Further evidence of the manufacture and use of ground edged axes in South Western Australia. *Western Australian Naturalist* **12**:107-11.

AMERICAN GEOLOGICAL INSTITUTE
1976 *Dictionary of Geological Terms.* (Revised Edition New York: Anchor Press.

Anonymous
1833 Report of an Excursion in a Whale Boat, from six Miles to the eastward of Ramé Point to Six Miles to the N.W. of Point d'Entrecasteaux, and from thence to the Murray River by Land. In J. Cross (ed.) *Journals of Several Expeditions made in Western Australia....* London: J. Cross. pp.114-131.

APPLEYARD, R.T. and MANFORD, T
1979 *The Beginning.* Perth: University of Western Australia Press.

ATLAS OF AUSTRALIAN RESOURCES
1967 Surface water resources. Canberra: Department of National Development, Geographic Section.

BACKHOUSE, J.
1843 *A Narrative of a Visit to the Australian Colonies.* London: Hamilton, Adams and Co.

BALME, J.
1979 Artificial bias in a sample of kangaroo incisors from Devil's Lair, Western Australia. *Records of the Western Australian Museum* **7**:111-6.

BALME, J., MERRILEES, D. and PORTER, J.K.
1978 Late Quaternary mammal remains, spanning about 30,000 years from excavation in Devil's Lair, Western Australia. *Journal of the Royal Society of Western Australia* **61**:33-65.

BANNISTER, T.
1833 A Report of Captain Bannister's Journey to King George's Sound, over Land. In J. Cross (ed.) *Journals of Several Expeditions made in Western Australia....* London: J. Cross. pp.98-109.

BARKER, C.
1830-31 Journal of Captain C. Barker. ms. N.S.W. Archives.

BAUDIN, N.
1800-04 *The Journal of Post Captain Nicolas Baudin.* C. Cornell (Trans.) 1974. Adelaide: Libraries Board of South Australia.

BAYNES, A., MERRILEES, D. and PORTER, J.K.
1975 Mammal remains from the upper levels of a late Pleistocene deposit in Devil's Lair, W.A. *Journal of the Royal Society of Western Australia* **58**:97-126.

BEARD, J.S.

1979a Phytogeographic Regions. In J. Gentilli (ed.) *Western Landscapes*. Perth: UWA Press. pp. 107-21.

1979b *Vegetation Survey of Western Australia: The vegetation of the Albany & Mt. Barker Areas, W.A. Map and explanatory memoir* Perth: Vegmap Publications.

1979c *Vegetation Survey of Western Australia: The vegetation of the Perth area, W.A. Map and explanatory memoir*. Perth: Vegmap Publications.

BERNDT, R.M.

1959 The concept of 'the tribe' in the Western Desert of Australia. *Oceania* **30**:81-107.

1973 Aborigines of southwestern Australia: The past and the present. *Journal of the Royal Society of Western Australia* **56**:50-55.

1979a Aborigines of the South-west. In R.M & C.H. Berndt (eds.) *Aborigines of the West*. Perth: UWA Press. pp. 81-9.

1979b Traditional Aboriginal life in Western Australia: as it was and is. In R.M. & C.H. Berndt (eds.) *Aborigines of the West*. Perth: UWA Press. pp. 3-27.

BETTENAY, E. and POUTSMA, T.

1962 *Soils of the North Manypeaks area, W.A.* C.S.I.R.O. Divisional Report 15/62, Adelaide.

BINFORD, L.R.

1964 A Consideration of Archaeological Research Design. Collected in L.R. Binford (ed.) *An Archaeological Perspective* (1972) New York: Seminar Press. pp. 135-62.

BOEHM, E.W. and PYM, L.W.

1950 *The Denbarker Reconnaissance*. C.S.I.R.O. Division of Soils. Divisional Report 7/50.

BORDES, F.

1979 *Typologie du Paleolithique*. Paris: Editions du Centre National de la Recherche Scientifique.

BORDES, F. and CRABTREE, D.

1968 The Corbiac Blade Technique and Other Experiments. *Tebiwa* **12**:1-21.

BORDES, F., DORTCH, C., RAYNAL, J-P and THIBAULT, C.

1979 *The 1978 season of the Franco-Australian Quaternary Project in the Murchison Basin, Western Australia*. Perth: Western Australian Museum.

BOWDLER, S.

1981 Hunters in the Highlands: Aboriginal Adaptations in the Eastern Australian Uplands. *Archaeology in Oceania* **16**:99-111.

BOWLER, J.M.
1973 Clay dunes: their occurrence, formation and environmental significance. *Earth Science Reviews* **9**:315-38.
1976 Aridity in Australia: Age, Origins and Expression in Aeolian Landforms and Sediments. *Earth Science Reviews* **12**:279-310.

BRETON, W.H.
1833 *Excursions in New South Wales, Western Australia and Van Dieman's Land, During the years 1830, 1831, and 1833.* London: Richard Bently.

BRITISH MUSEUM PUBLICATIONS
1968 *Flint Implements.* London.

BROWNE, J.
1856a The Aborigines of Australia. *Canadian Journal of Industry, Science and Art* **1**:251-71.
1856b The Aborigines of Australia. *The Nautical Magazine and Naval Chronicle*: 485-93, 534-43.
1956c Die einebornen Australiens ihre sitten und gebrouch. *Peterman's Mitteilungen* **2**:443-54.

BRÜNING, J.L. and KINTZ, B.L.
1977 *Computational Handbook of Satistics.* Glenview, Ill.: Scott, Foresman.

BUSSELL, J.
1833 Mr. Bussell's Journal of an Expedition to the River Vasse. In J. Cross (ed.) *Journals of Several Expeditions Made in Western Australia....* London: J. Cross. pp.. 186-203.

BUTZER, K.W.
1972 *Environment and Archaeology.* Chicago: Aldine.

BYRNE, D.
1980 Dynamics of Dispersion: The Place of Silcrete in Archaeological Assemblages from the Lower Murchison, Western Australia. *Archaeology and Physical Anthropology in Oceania* 15:110-9.

CAMPBELL, T.D. and EDWARDS, R.
1966 Stone Implements. In B.C. Cotton (ed) *Aboriginal Man in South and Central Australia.* Adelaide.

CHAPMAN, B.
1979 *The Colonial Eye.* Perth: Art Gallery of Western Australia.

CHANG, K.C.
1972 *Settlement Patterns in Archaeology.* Addison Wesley Modular Publication 24.

CHAPPELL, J. and THOM, B.G.
1977 Sea levels and coasts. In J. Allen, J. Golson and R. Jones (eds.) *Sunda and Sahul*. London: Academic Press. pp. 257-92.

CHAUNCY, P.
1876 Notes and Anecdotes of the Aborigines of Australia. Appendix A to R. Brough Smythe, *The Aborigines of Victoria*. Melbourne: Government Printer. Vol. 2, pp. 222-84.

CHERRY, J.F. and SHENNON, S.
1978 Sampling Cultural Systems: Some Perspectives on the Application of Probabilistic Regional Survey in Britain. In J.F. Cherry, C.Gamble, and S. Shennon (eds) *Sampling in Contemporary British Archaeology*. Oxford: BAR British Series 50. pp. 17-48.

CHRISTENSEN, P.E. and KIMBER, P.C.
1975 Effect of Prescribed Burning on the Flora and Fauna of South-West Australian Forests. *Proceedings of the Ecological Society of Australia* 9:85-106.

CHURCHILL, D.M.
1968 The Distribution and Prehistory of *Eucalyptus diversicolor* F. Muell., *E. marginata* Donn Ex Sm., and *E. calophylla* R. Br. in relation to Rainfall. *Australian Journal of Botany* **16**:125-51.

CLARK, W.N.
1840 Letter to *Perth Inquirer*. 4-11-1840.
1841a Letter to the editor. *Perth Inquirer*, 17-11-1841, p. 3.
1841b Journal on an Expedition to Nornalup or the Deep River of the sealers ... *Perth Inquirer* 25-8-1841, 1-9-1841.
1841c Journal of a Second Expedition to Westward of King Georges Sound.... *Perth Inquirer* 29-9-1841, 6-10-1841, 13-10-1841, 20-10-1841.
1842 An Inquiry respecting the Aboriginals of South-Western Australia. *Perth Inquirer*, 16-2-1842, 23-2-1842, 2-3-1842.

CLARKE, J
1983 An Aboriginal engraving site in the south-west of Western Australia. *Records of the Western Australian Museum* **11**:63-7

CLARKE, J and DORTCH, C.E
1977 A 10,000 year BP radiocarbon date for archaeological finds within a soil of the Spearwood Dune System, Mosman Park, W.A. *Search* 8:36-8.

CLARKE, D.L.
1977 Spatial Information in Archaeology. In D.L. Clarke (ed.) *Spatial Archaeology*. London: Academic Press. pp. 1-32.

COCKBAIN, A.E.
1968 The Stratigraphy of the Plantagenet Group, Western Australia. In *Geological Survey of Western Australia Annual Report 1967*. Perth. pp. 61-3.

COLLIE, A.

1832 Letter to Governor Stirling. In *Swan River Papers, Vol. 9.* pp. 110-21. Battye Library Acc. 58.

1833a Account of an Excursion to the North of King Georges Sound, between the 26th of April and the 4th of May 1831, by Al. Collie, Surgeon. In J. Cross (ed.) *Journals of Several Expeditions made in Western Australia....* London: J. Cross. pp. 32-54.

1933b Account of a short Excursion from Albany up French River by A. Collie. In J. Cross (ed.) *Journals of Several Expeditions Made in Western Australia....* London: J. Cross. pp. 168-77.

1834 Anecdotes and Remarks Relative to the Aborigines at King George's Sound. (pub. anonymously) In *Perth Gazette*, 5-7-1834, 12-7-1834, 26-7-1834, 9-8-1834, 16-8-1834.

COUTTS, P.J.F.

1967 Coastal dunes and field archaeology in S.E. Australia. *Archaeology and Physical Anthropology in Oceania* 2:28-34.

1970 *The Archaeology of Wilson's Promontory.* Canberra. A.I.A.S.

CRABTREE, D.E.

1972 *An Introduction to Flintworking.* Occasional Papers of the Idaho State University Museum, No. 28.

CRAWFORD, I.M.

1981 Aboriginal cultures in Western Australia. In C.T. Stannage (ed.) *A New History of Western Australia.* Perth: UWA Press. pp.3-34.

CROSS, J. (ed.)

1833 *Journals of Several Expeditions made in Western Australia, During the Years 1829, 1830, 1831, and 1832; under the Sanction of the Governor, Sir James Stirling, Containing the Latest Authentic Information Relative to that Country, Accompanied by a Map.* London: J. Cross

DALE, R.

1833 Mr. Dale's Journal of an Expedition from King George's Sound to the Korkyennenuft Range of Mountains. In J. Cross (ed.) *Journals of Several Expeditions made in Western Australia....* London: J. Cross. pp. 161-5.

DANCEY, W.S.

1981 *Archaeological Field Methods: an introduction.* Minneapolis: Burgess.

DARWIN, C.R.

1831-36 *Charles Darwin's Diary of the Voyage of H.M.S. "Beagle".* N. Barlow (ed.) 1933. Cambridge: CUP.

DAVIDSON, D.S. and McCARTHY, F.D.

1957 The distribution and chronology of some important types of stone implements in Western Australia. *Anthropos* **52**:390-458.

DICKSON, F.P.
1973 Backed Blades and Points. *Mankind* **9**:7-14.
1975 Bondi Points. *Mankind* **10**:45-6.

DIELS, L.
1906 *Die Pflanzenwelt von West-Australien südlich des Wendekreises*. Vol. 7 of *Vegetation der Erde*. Leipzig: Englemann.

DIX, W.C. and MEAGHER, S.J.
1976 Fish traps in the South-West of Western Australia. *Records of the Western Australian Museum* **4**:171-88.

DORTCH, C.E.
1975 Geometric microliths from a dated archaeological deposit near Northcliffe, Western Australia. *Journal of the Royal Society of Western Australia* **58**:59-63.
1976 Two engraved stone plaques of late Pleistocene age from Devil's Lair, Western Australia. *Archaeology and Physical Anthropology in Oceania* **11**:32-44.
1977 Early and late stone industrial phases in Western Australia. In R.V.S. Wright (ed.) *Stone Tools as Cultural Markers*. Canberra: A.I.A.S. pp.104-32.
1979 Devil's Lair, an example of prolonged cave use in south-western Australia. *World Archaeology* **10**:258-79.
1980a Are there Aboriginal shell middens in south-western Australia? *AIAS Newsletter* **NS 14**:26-30.
1980b A possible pendant of Marl from Devil's Lair, Western Australia. *Records of the Western Austrlian Museum* **8**:401-3.
1984a The Malimup middens: evidence for mollusc eating in prehistoric southwestern Australia. In V.N. Misra and P.S. Bellwood (eds.) *Recent Advances in Indo-Pacific Prehistory*. New Dehli: Oxford and IBH. pp. 251-6.
1984b *Devil's Lair, a study in prehistory*. Perth: Western Australian Museum.

DORTCH, C.E. and GARDNER, G.
1976 Archaeological investigation in the Northcliffe district, Western Australia. *Records of the Western Australian Museum*. **4**:257-94.

DORTCH, C.E., KENDRICK, G.W. and MORSE, K.
1984 Aboriginal mollusc exploitation in southwestern Australia. *Archaeology in Oceania* **19**:81-104.

DORTCH, C.E. and McARTHUR, W. M.
n.d Archeological and Geomorphological Investigations at Arumvale, Western Australia. (*in preparation*).

DORTCH, C.E. and MERRILEES, D. ∞
1973 Human Occupation of Devil's Lair, Western Australia during the Pleistocene. *Archaeology and Physical Anthropology in Oceania* **8**:89-115.

DOUGLAS, W.H.
1968 *The Aboriginal languages of the South-west of Australia*. Australian Aboriginal Studies no. 14. Linguistic Series No. 4. Canberra: A.I.A.S.
1973 The language of southwestern Australia. *Journal of the Royal Society of*

Western Australia **56**:48-50.

1976 *The Aboriginal Languages of the South-West of Australia* (2nd ed.). Canberra: A.I.A.S.

DRIVER, H.E.

1961 *Indians of North America*. Chicago: University of Chicago Press.

DUMONT D'URVILLE, M.J.

1830 *Voyage de la Corvette l'Astrolabe....* (15 vols. and Atlas 7 vols.) Paris: L'Imprimerie Imperiale.

ELKIN, A.P.

1970 The Aborigines of Australia: 'one in thought, word and deed". In S.A. Würm and D.C. Laycock (eds.) *Pacific linguistic studies in honour of Arthur Capell*. Canberra: ANU Press. pp. 697-716.

ERICKSON, R.

1978 *The Dempsters*. Perth: U.W.A. Press

ERSKIN, A

1833 Journal of Lieut. Ad. Erskin, 63rd Regiment, travelling from Perth to the eastward, over Darling's Range, in the month of September, 1830. In J. Cross (ed.) *Journals of Several Expeditions made in Western Australia....* London: J. Cross. pp. 92-7.

FIRE, J.E.

1845 *Journals of Expeditions of Discovery into Central Australia and Overland from Adelaide to King Georges Sound in the Years 1840-1*. (2 vols.). London: T. and W. Boone.

FERGUSON, W.C.

1977 Report of Preliminary Archaeological Investigations at the Quininup Brook Site Complex, Western Australia. Unpublished BA Honours Thesis, University of Western Australia.

1980a Edge-angle classification of the Quininup Brook implements: testing the ethnographic analogy. *Archaeology and Physical Anthropology in Oceania* **15**:56-72.

1980b Fossiliferous chert in southwestern Australia after the Holocene transgression: a behavioural Hypothesis. *The Artefact* **5**:155-69.

1981 Archaeological investigations at the Quininup Brook site complex, Western Australia. *Records of the Western Australian Museum* **8**:609-37.

1982 A different angle. *Australian Archaeology* **15**:113-5.

n.d. Mokaré's Domain. In D.J. Mulvaney and J.P. White (eds.) *Australians to 1788*, Vol. 1 of *A Bicentennial History of Australia*. Forthcoming.

FITZ-ROY, R.

1839. *Voyages of the Adventure and Beagle*. (3 Vos.) London: Henry Coleburn.

FLANNERY, K.V.

1968 Archaeological Systems Theory and Early Mesoamerica. In B. Meggers (ed.) *Anthropological Archaeology in the Americas*. Washington D.C.:

Anthropological Society of Washington.
1976 The Trouble with Regional Sampling. In K.V. Flannery (ed.) *The Early Mesoamerican Village*. New York: Academic Press. pp. 159-60.

FLENNIKEN, J.J. and WHITE, J.P.
1985 Australian Flaked Stone Tools: A Technological Perspective. *Records of the Australian Museum* **36**:131-51.

FLINDERS, M.
1814 *A Voyage to Terra Australia*... (2 Vols.) London: G. and W. Nicol.

FLOOD, J.
1980 *The Moth Hunters*. Canberra: Australian Institute of Aboriginal Studies.
1983 *Archaeology of the Dreamtime*. Sydney: Collins.

FREMANTLE, C.H.
1829-32 *Diary and Letters of Admiral Sir C.H. Fremantle, G.C.B. Relating to the Founding of the Colony of Western Australia, 1829*. Lord Cottesloe (ed.) 1928. Printed for Private Circulation.

GARDNER, C.A.
1942. The vegetation of Western Australia with special reference to climate and soils. *Journal of the Royal Society of Western Australia* **28**:11-67.

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
1975 *Geology of Western Australia*. Geological Survey of Western Australia, Mem. 2.

GLOVER, I.C.
1967 Stone implements from Millstream Station, Western Australia: Newall's Collection re-analysed. *Mankind* **6**:415-25.
1969 The use of factoranalysis for the discovery of artefact types. *Mankind* **7**:36-51.

GLOVER, I.C. and LAMPERT, R.J.
1969 Puntutjarpa rockshelter excavations by R.A.Gould: A critical review. *Archaeology and Physical Anthropology in Oceania* **4**:222-8.

GLOVER, J.E.
1975 Aboriginal chert artefacts probably from quarries on the continental shelf, W.A. *Search* **6**:392-4.

GLOVER, J.E., DORTCH, C.E. and BALME, B.E.
1978 The Dunsborough implement: an Aboriginal biface from southwestern Australia. *Journal of the Royal Society of Western Australia* **60**:41-7.

GLOVER, R.
1979 *Plantagenet 'Rich and Beautiful*....' Perth: University of Western Australia Press.

GOODYEAR, A.C.
1977 Research Design in Highway Archaeology: An Example from South Carolina. In M.B. Schiffer and G.J. Gumerman (eds.) *Conservation Archaeology*. New York:

Academic Press. pp. 157-65.

GOULD, R.A.
1969a Puntutjarpa rockshelter: a reply to Messrs. Glover and Lampert. *Archaeology and Physical Anthropology in Oceania* **4**:229-37.
1969b *Yiwara: foragers of the Australian Desert*. New York: Charles Scribners and Sons.
1969c A preliminary report on excavations at Puntutjarpa rockshelter, near the Warburton Ranges, Western Australia. *Archaeology and Physical Anthropology in Oceania* **3**:161-85,
1971 The archaeologist as ethnographer: A case from the Western Desert of Australia. *World Archaeology* **3**:143-77.
1973 *Australian Archaeology in Ecological and Ethnographic Perspective*. Warner Modular Publications, Module 7.
1977a Some Current Problems in Ethnoarchaeology. In D. Ingersoll, J.E. Yellen, and W. Macdonald (eds.) *Experimental Archaeology*. New York: Columbia University Press.
1977b Puntutjarpa Rockshelter and the Australian Desert Culture. *Anthropological Papers of the American Museum of Natural History* **54**:Part 1.
1980 *Living Archaeology*. Cambridge: Cambridge University Press.

GOULD, R.A., KOSTER, D.A. and SONTZ, A.H.L.
1971 The lithic assemblage of the Western Desert Aborigines of Australia. *American Antiquity* **36**:149-69.

GOULD, R.A. and QUILTER, J.
1972 Flat Adzes - a class of flaked stone tool from southwest Australia. *American Museum Novitates* **2502**.

GREEN, N.
1979 *Nyungar - The People*. Perth: Creative Research.
1981 Aborigines and white settlers in the nineteenth century. In C.T. Stannage (ed.) *A New History of Western Australia*. Perth: University of Western Australia Press. pp.72-123.
1983 King George Sound: The Friendly Frontier. In M. Smith (ed.) *Archaeology at ANZAAS 1983*. Perth: Western Australian Museum. pp. 68-75.

GREY, G.
1841 *Journals of Two Expeditions of Discovery in North-West and Western Australia*. (2 Vols.). London: T. and W. Boone.

GUMERMAN, G.J.
1973 The Reconciliation of Theory and Method in Archaeology. In C.L. Redman (ed.) *Research and Theory in Current Archaeology*. New York: John Wiley & Sons. pp. 287-300.

HADDLETON, J.F.
1952 *Katanning Pioneer*. Perth: Paterson Brokensha.

HALLAM, S.J.
1971 Roof Markings in the Orchestra Shell Cave, Wanneroo, near Perth, Western

Australia. *Mankind* **8**:90-103.

1972 An archaeological survey of the Perth area, W.A.: a progress report on art & artifacts, dates & demography. *AIAS Newsletter* **3/5**:11-19.

1974a Excavations in the Orchestra Shell Cave, Wanneroo, Western Australia. Part 1: The ethnographic and environmental background. *Archaeology and Physical Anthropology in Oceania* **9**:66-84.

1974b Excavations in the Orchestra Shell Cave, Wanneroo, Western Australia. Part II: Archaeology. *Archaeology and Physical Anthropology in Oceania* **9**:134-55.

1975 *Fire and Hearth*. Canberra: A.I.A.S.

1978 Population and resource usage on the Western littoral. *Memoirs of the Victorian Archaeological Survey* **2**:16-36.

1981 The first Western Australians. In C.T.Stannage (ed.) *A New History of Western Australia*. Perth: UWA Press. pp.35-71.

1983 A View from the other side: or 'I Met a Man Who Wasn't There'. In M. Smith (ed.) *Archaeology at ANZAAS 1983*. Perth: Western Australian Museum. pp.95-121.

1984 Microlithic industries in Western Australia - some aspects. In V.N. Misra and P.S. Bellwood (eds.) *Recent Advances in Indo-Pacific Prehistory*. New Dehli: Oxford and IBH. pp. 219-29.

HAMMOND, J.E.

1933 *Winjan's People*. Perth: Imperial Printing.

1936 *Western pioneers: the battle well fought*; ed. by O. K. Battye. Perth Imperial Printing.

HARRIS, D.R.

1969 Agricultural systems, ecosystems and the origins of agriculture. In P.J. Ucko and G.W. Dimbleby (eds.) *The Domestication and Exploitation of Plants and Animals*. London: Duckworth. pp. 3-15.

HARRIS, M.

1968 *The Rise of Anthropological Theory*. New York: Crowell.

HASSELL, E.

1975 *My Dusky Friends*. Perth: C.W. Hassell.

HASSELL, E. and DAVIDSON, D.S.

1936 Notes on the Ethnology of the Wheelman Tribe of South-western Australia. *Anthropos* **31**:679-711.

HAWKES, C.F.C.

1954 Archaeological Theory and Method: some suggestions from the Old World. *American Anthropologist* **56**:155-68.

HAYDEN, B.

1973 Analysis of a *Tasp* composite knife. *Archaeology and Physical Anthropology in Oceania* **8**:116-26.

1977 Stone tool function in the Western Desert. In R.V.S. Wright (ed.) *Stone Tools as Cultural Markers*. Canberra: Australian Institute of Aboriginal Studies. pp.178-88.

1979 *Palaeolithic Reflections*. Canberra: Australian Institute of Aboriginal Studies.

HIRSCHBERG, K-J. B.
1976 *Geology and Hydrology of the Albany-Mount Barker Area.* Geological Survey of Western Australia Record 1976/14

HISCOCK, P.
1981 Comments on the use of chipped stone artifacts as a measure of intensity of site usage. *Australian Archaeology* **13**:30-4

HISCOCK, P. and HUGHES, P.J.
1980 Backed blades in northern Australia: Evidence from northwest Queensland. *Australian Archaeology* **10**:86-95.

HOLE, B.L.
1980 Sampling Archaeology: A Critique. *Annual Review of Anthropology.* **9**:217-34.

HORNE, G. and AISTON, G.
1924 *Savage Life in Central Australia.* London: Macmillan.

HUGHES, P.J. and LAMPERT, R.J.
1982 Prehistoric population change in southern Coastal New South Wales. In S. Bowdler (ed.) *Coastal Archaeology in Eastern Australia.* Canberra: ANU. pp. 16-28.

IRWIN, F.C.
1835 *The State and Position of Western Australia, commonly called the Swan River Settlement.* London: Simpkin, Marshall, and Co.

JACKMAN, W.
1855 *The Australian Captive.* New York: Miller, Orton and Mulligan.

JOHNSTONE, M.H., LOWRY, D.C. and QUILTY, P.G.
1973 The Geology of southwestern Australia--a review. *Journal of the Royal Society of Western Australia* **56**:5-15.

JONES, R.
1968 The geographical background to the arrival of man in Australia and Tasmania. *Archaeology and Physical Anthropology in Oceania* **3**:186-215.
1971 Rocky Cape and the Problem of the Tasmanians. Unpublished Ph.D. Thesis, University of Sydney.
1973 Emerging Picture of Pleistocene Australia, *Nature* **246**:278-81.

JUDGE, J.W., EBERT, J.I. and HITCHCOCK, R.K.
1975 Sampling in Regional Archaeological Survey. In J.W. Mueller (ed.) *Sampling in Archaeology.* Tucson: University of Arizona Press. pp. 82-123.

KAMMINGA, J.
1980 A functional investigation of Australian microliths. *The Artefact* **5**:1-18.

KEELEY, L.H.
1980 *Experimental Determination of Stone Tool Uses.* Chicago. University of Chicago Press.

KENDRICK, G.W.
1977 Middle Holocene marine molluscs from near Guildford, Western Australia and evidence for climatic change. *Journal of the Royal Society of Western Australia* **60**:49-60.

KERSHAW, A.P.
1981 Quaternary vegetation and environments. In A. Keast (ed.) *Ecological Biogeography of Australia*. The Hague: W. Junk. pp. 82-101.

KING, P.P.
1827 *Narrative of a Survey of the Intertropical and Western Coasts of Australia*... (2 vols.). London: John Murray.

KNIGHT, W.E., ARMSTRONG, C.F. and GILCHRIST, J.
1886 Perth, Western Australia. In E.M. Curr (ed.) *The Australian Race*. Melbourne: John Ferres. Vol. 1, pp. 328-335.

KROEBER, A.L.
1939 Cultural and natural areas of native North America. *University of California publications in American archaeology and ethnology* **48**:1-242.

LAMPERT, R.J.
1966 An excavation at Durras North, N.S.W. *Archaeology and Physical Anthropology in Oceania* **1**:84-118.
1971a Coastal Aborigines of Southeastern Australia. In D.J. Mulvaney and J. Golson (eds.) *Aboriginal Man and Environment in Australia*. Canberra: ANU Press.
1971b *Burrill Lake and Currarong*. Terra Australis 1. Canberra: ANU.
1981 *The Great Kartan Mystery*. Terra Australis 5. Canberra. ANU.

LAWRENCE, R.
1969 *Aboriginal Habitat and Economy*. Occasional Paper no. 6. Department of Geography, S.G.S., The ANU.

LEE, R.B.
1979 *The !Kung San: Men, Women, and Work in a Foraging Society*. Cambridge: Cambridge University Press.

LE SOUEF, S.
1980 Social Organisation and Territoriality among the Aborigines of King George Sound. Unpublished BA Honours Thesis. University of Western Australia.

LOCKYER, E.
1827 Journal of Major Lockyer. In *Historical Records of Australia* Series III, Vol. VI. pp. 460-505.

LONERAGAN, O.W. and LONERAGAN, J.F.
1964 Ashbed and Nutrients in the Growth of Seedlings of Karri (*Eucalyptus diversicolour* F.v. M.). *Journal of the Royal Society of Western Australia* **47**:75-80.

LOURANDOS, H.
1983 Intensification: a late Pleistocene-Holocene archaeological sequence from Southwestern Victoria. *Archaeology in Oceania* **18**:81-97.

LYON, R.M.
1833 A Glance at the Manners and Language of the Aboriginal inhabitants of Western Australia; with a short vocabulary. Collected in N. Green (ed.) *Nyungar - The People*. (1979). Perth: Creative Research. pp. 148-80.

McARTHUR, W.M. and BETTENAY, E.
1960 *The development and distribution of the soils of the Swan coastal plain, Western Australia*. Melbourne: CSIRO Soil Publication No. 16.

McARTHUR, W.M. and CLIFTON, A.L.
1975 *Forestry and agriculture in relation to soils in the Pemberton area of Western Australia*. Melbourne: CSIRO Soils and Land Use Series No. 54.

McBRYDE, I.
1962 Archaeological field survey work in northern New South Wales. *Oceania* **33**:12-7.
1974 *Aboriginal Prehistory in New England*. Sydney: University of Sydney Press.
1976 Subsistence Patterns in New England Prehistory. *University of Queensland Occasional Papers in Anthropology* **6**:48-68.
1979 Ethnohistory in an Australian Context: Independent Discipline or Convenient Data Quarry. *Aboriginal History* **3**:128-51.
1984 Backed blade industries from the Graman rock shelters, New South Wales: Some evidence on function. In V.N. Misra and P.S. Bellwood (eds.) *Recent Advances in Indo-Pacific Prehistory*. New Dehli: Oxford and IBH. pp. 231-49.

McCARTHY, F.D.
1970 *Aboriginal Antiquities in Australia: their nature and preservation*. Canberra: A.I.A.S.
1976 *Australian Aboriginal Stone Implements*. (2nd edition - revised). Sydney: The Australian Museum Trust.
1977 The use of stone tools to map patterns of diffusion. In R.V.S. Wright (ed.) *Stone Tools as Cultural Markers*. Canberra: Australian Institute of Aboriginal Studies. pp. 251-62.

McCARTHY, F.D., BRAMELL, E. and NOONE, H.V.V.
1946 The Stone Implements of Australia. *Memoirs of the Australian Museum* **9**.

MARCHANT, N.G.
1973 Species diversity in the southwestern flora. *Journal of the Royal Society of Western Australia* **56**:23-30.

MARTIN, H.A.
1973 Palynology and historical ecology of some cave excavations in the Australian Nullarbor. *Australian Journal of Botany* **21**:283-316.

MASSOLA, A.
1960 On the Western Australian *Kodja*. *Proceedings of the Royal Society of Victoria* **72**:87-92.

MATSON, R.G. and LIPE, W.D.
1975 Regional Sampling: A Case Study of Cedar Mesa, Utah. In J.W. Mueller (ed.) *Sampling in Archaeology*. Tucson: University of Arizona Press. pp. 124-43.

MEAGHER, S.J.
1974 The food resources of the Aborigines of the south-west of Western Australia. *Records of the Western Australian Museum* **3**:14-65.

MEAGHER, S.J. and RIDE, W.D.L.
1979 Use of natural resources by the Aborigines of south-western Australia. In R.M. and C.H. Berndt (eds.) *Aborigines of the West*. Perth: UWA Press. pp. 66-80.

MEGGITT, M.J.
1962 *Desert People*. Sydney: Angus and Robertson.
1964 Aboriginal food-gatherers of tropical Australia. In *The Ecology of Man in the Tropical Environment*. Morges: IUCN (Publ. Ser. 4). pp. 30-7.

MERCER, F.R.
n.d. *Amazing Career - the story of Western Australia's first Surveyor General*. Perth: Paterson Brokensha Pty. Ltd.

MERRILEES, D.
1979a The prehistoric environment in Western Australia. *Journal of the Royal Society of Western Australia* **62**:109-28.
1979b Prehistoric rock wallabies (Marsupialia, Macropodidae, *Petrogale*) in the far south west of Western Australia. *Journal of the Royal Society of Western Australia* **61**:73-96.

MITCHELL, S.R.
1949 *Stone Age Craftsmen*. Melbourne: Tait.

MONCRIEFF, J.S.
1977 *Outline of the Geology and Groundwater Prospects in the Stirling Range Area*. Geological Survey of Western Australia Record 1977/8.

MOORE, G.F.
1884 A descriptive vocabulary of the language in common use amongst the Aborigines of Western Australia. Addendum to *Diary of Ten Years Eventful Life of an Early Settler in Western Australia*. London: M. Walbrook.

MORSE, K.
1982 Middle Head: A Prehistoric Aboriginal Shell Midden on the Southwestern Australian Coast. *Australian Archaeology* **15**:1-7.
1984 First Record of Painted Aboriginal Rock Art in a South-Western Australian Limestone Cave. *Records of the Western Australian Museum* **11**:197-9.

MORWOOD, M.J.
1981 Archaeology of the central Queensland highlands: The stone component. *Archaeology in Oceania* **16**:1-52.

MUELLER, J.W.
1974 The Use of Sampling in Archaeological Survey. *Memoirs, Society for American Archaeology*. No. 28.
1975 *Sampling in Archaeology*. Tucson: University of Arizona Press.

MULVANEY, D.J.
1960 Archaeological excavations at Fromm's Landing on the lower Murray River, South Australia. *Proceedings of the Royal Society of Victoria* **72**:53-85.
1969 *The Prehistory of Australia*. New York: Frederick A. Praeger.
1975 *The Prehistory of Australia* (Revised). Ringwood (Vic.): Penguin.
1978 Australia Before the Europeans. Institute of Archaeology *Bulletin* No 15. pp. 35-47.
1981 What future for our past? *Australian Archaeology* 13:16-27.

NIND, S.
1831 Description of the natives of King George's Sound (Swan River Colony) and the adjoining country. *Journal of the Royal Geographical Society* **1**:21-51.

NOONE, H.V.V.
1943 Some Aboriginal stone implements of Western Australia. *Records of the South Australian Museum* **7**:271-80.

O'CONNELL, A.M., GROVE, T.S. and DIMMOCK, G.M.
1978 Nutrients in the litter on Jarrah forest soils. *Australian Journal of Ecology* **3**:253-60.

OGLE, N.
1839 *The Colony of Western Australia: a manual for emigrants...* London: James Frazer.

ORLOVE, B.S.
1980 Ecological Anthropology. In B.J. Siegel, A.R. Beals, and S.A. Tyler (eds.) *Annual Review of Anthropology Volume 9*. Palo Alto: Annual Reviews Inc. pp. 235-73.

PARKER, E.R.
1886 York District: Whadjoak Tribe. In E.M. Curr (ed.) *The Australian Race*. Melbourne: John Ferres.. Vol. 1, pp. 336-42.

PEARCE, R.H.
1973 Uniformity of the Australian backed blade tradition. *Mankind* **9**:89-95.
1974 Spatial and Temporal Distribution of Australian Backed Blades. *Mankind* 9:300-9.
1977a Relationship of chert artefacts at Walyunga in southwest Australia to Holocene sea levels. *Search* **8**:375-7.
1977b Investigations of backed blade problems by statistical specification of distinctive features. In R.V.S. Wright (ed.) Stone Tools As Cultural Markers. Canberra: Australian Institute of Aboriginal Studies. pp. 282-7.
1978 Changes in artefact assemblages during the last 8000 years at Walyunga, Western Australia. *Journal of the Royal Society of Western Australia* **61**:1-10.
1979 Analysis of Some Western Australian Small Tool Assemblages. Unpublished MA Thesis, University of Western Australia.
1982 Archaeological Sites in the Jarrah Forest, Southwest Australia. *Australian*

Archaeology **14**:18-24.

PEARCE, R.H. and BARBETTI, M.
1981 A 38,000-year-old archaeological site at Upper Swan, Western Australia. *Archaeology in Oceania* **16**:173-78.

PERON, F. and FREYCINET, L, de
1807 *Voyage de découvertes aux Terres Australes*. (4 Vols. and Atlas). Paris: L'Imprimerie Imperiale.

PETERSON, N.
1973 Campsite Location amongst Australian Hunter-Gatherers: Archaeological and Ethnographic Evidence for a Key Determinant. *Archaeology and Physical Anthropology in Oceania* **8**:173-93.
1975 Hunter-Gatherer Territoriality: The perspective from Australia. *American Anthropologist* **77**:53-68.
1976 The natural and cultural areas of Aboriginal Australia. In. N. Peterson (ed.) *Tribes and Boundaries in Australia*. Canberra: A.I.A.S. pp. 50-71.

PICKERING, M.
1982 A 1500 Kilometre by 30 Meter Transect Survey of Western Australia. Paper presented at 52nd ANZAAS Conference, Section 25A, 11 May 1982. Macquarie University.

PLOG, S.
1976 Relative Efficiencies of Sampling Techniques for Archaeological Surveys. In K.V. Flannery (ed.) *The Early Mesoamerican Village*. New York: Academic Press. pp. 136-58.

PLOMLEY, N.J.B. (ed.)
1966 *Friendly Mission: The Tasmanian Journals and Papers of George Augustus Robinson, 1829-1836)*. Hobart: Tasmania Historical Research Association.

PORTER, J.K.
1979 Vertebrate remains from a stratified Holocene deposit in Skull Cave, Western Australia and a review of their significance. *Journal of the Royal Society of Western Australia* **61**:109-117.

PRETTY, G.L. *et. al.*
1977 *Ngaiawang Folk Province: Preliminary Inventory of the Cultural Landscape*. National Folk Province Study Paper No. 10. Adelaide: South Australian Museum.

RADCLIFFE-BROWNE, A.R.
1930a Former numbers and distribution of Australian Aborigines. *Australia, Official Year Book* **23**:687-96,
1930b The social organization of Australian Tribes. *Oceania* **1**.

RENFREW, C.
1973 Monuments, mobilization and social organization in neolithic Wessex. In C. Renfrew (ed.) *The Explanation of Culture Change*. London: Duckworth. pp.539-58.

RIDE, W.D.L.
1958 The Edge-ground Axes of South-western Australia. *Western Australian Naturalist* **6**:162-79.

ROE, J.S.
1831 *To the Northward and Westward of King Georges Sound*, Excerpt from Roe's Field Book 2A. MS in Battye Library, Perth.
1852 Report of an expedition under the Surveyor-General, Mr. J.S. Roe to the South-Eastward of Perth in Western Australia, between the months of September, 1848, and February 1849. *Royal Geographical Society Journal* **22**:1-57.

ROGNON, P. and WILLIAMS, M. A. J.
1977 Late Quaternary climatic changes in Australia and North Africa, a preliminary interpretation. *Palaeogeography, Palaeoclimatology, Palaeoecology* **21**:285-327.

ROSS, A.
1981 Holocene environments and prehistoric site patterning in the Victorian Mallee. *Archaeology in Oceania* **16**:145-55.

ROSSITER, R.C. and OZANNE, P.G.
1970 South-western temperate forests, woodlands, and heaths. In R.M. Moore (ed.) *Australian Grasslands*. Canberra: ANU Press. pp. 199-218.

ROTH, W.E.
1903 Notes of savage life in the early days of West Australian settlement. *Proceedings of the Royal Society of Queensland* 17:45-69.
1904 Domestic implements, arts and manufactures. *North Queesland Ethnography Bulletin* **4**.

ROUSE, I.
1972 *Settlement Patterns in Archaeology*. Warner Modular Publication 3.

ROWE, F.W.
1979 Kendenup. In R. Glover (ed.) *Plantagenet Rich and Beautiful...*. Perth: UWA Press. pp. 109-67.

RULE, A.
1967 *Forests of Australia*. Sydney: Angus and Robertson.

SAGGERS, S.
1982 Comparative analysis of adzes from Puntutjarpa rockshelter and the James Range East site complex, Australia. *Archaeology in Oceania* **17**:122-6.

SALVADO, R.
1951 *The Salvado Memoirs*. E.J. Stormon (ed. & transl.) 1977. Perth: UWA Press.

SATTERTHWAIT, L.D.
1980 Aboriginal Australia: The simplest technologies? *Archaeology and Physical Anthropology in Oceania* **15**:153-6.

SCHIFFER, M.B., SULLIVAN, A.P. and KLINGER, T.C.
1978 The design of archaeological surveys. *World Archaeology* **10**:1-28.

SCHRIRE, C.
1982 *The Alligator Rivers*. Terra Australis 7. Canberra: ANU.

SCHWEDE, M
1983 Supertrench - Phase 2, A Report on Excavation Results. In M. Smith (ed.) *Archaeology at ANZAAS 1983*. Perth: Western Australian Museum pp. 53-62.

SEMENOV, S.A.
1964 *Prehistoric Technology*. New York: Barnes and Noble.

SHARP, L.
1952 Steel Axes for Stone Age Australians. Collected in Y.A. Cohen (ed.) *Man in Adaptation: The Cultural Present*, (1974). Chicago: Aldine. pp. 116-27.

SHAWCROSS, F.W. and KAYE, M.
1980 Australian Archaeology: Implications of Interdisciplinary Research. *Interdisciplinary Science Reviews* **5**:112-26.

SHEA, S.E., HATCH, A.B., HAVEL, J.J. and RITSON, P.
1975 The effect of changes in forest structure and composition on water quality and yield from the Northern Jarrah forest *Proceedings of the Ecological Society of Australia* **9**:58-73.

SHERIDAN, G.
1979 Tulas and Triodia. Unpublished M.A.Q. Thesis. Dept. of Prehistory and Anthropology, The Australian National University.

SLEEMAN, G.
1828-29 Letters of Lt. George Sleeman to Colonial Secretary Macleay. *Historical Records of Australia, Series III, Vol. VI*. pp. 522-44

SMITH, M.
1982 Late Pleistocene Zamia Exploitation in Southern Western Australia. *Archaeology in Oceania* **17**:117-21.

SMITH, R.
1950a *The East Narrikup Soil Survey, Western Australia*. C.S.I.R.O. Division of Soils, Divisional Report 2/50.
1950b *Reconnaissance Soil Surveys in the South and South East Stirling Areas*. C.S.I.R.O. Division of Soils. Divisional Report 8/1950.

SPENCER, W.B. and GILLEN, F.J.
1904 *The Northern Tribes of Central Australia*. London: Macmillan.

STANNER, W.E.H.
1965 Aboriginal territorial organization: estate, range, domain and regime. *Oceania* **36**:1-26.

STEPHENS, R.
1961 Three Black Brothers. *Journal of the Western Australian Historical Society* **5**:65-82.

STEWARD, J.H.
1942 The Direct Historical Approach to Archaeology. *American Antiquity* 7:337-43.
1955 *Theory of Cultural Change: the methodology of multilinear evolution*. Chicago: University of Illinois Press.

STIRLING, J.
1827 Letter to Governor Darling. *Historical Records of Australia*, Series 3, Vol 6. 1923:551-84.

STOCKTON, E.D.
1971 Investigations at Santa Teresa, Cental Australia. *Archaeology and Physical Anthropology in Oceania* **6**:44-61.
1982 Comment. The Great Kartan Mystery. *Archaeology in Oceania* **17**:157.

STOKES, J.L.
1846 *Discoveries in Australia*... (2 Vols.). London: T. and W. Boone.

STRAWBRIDGE, L.A.
1982 Disturbance Processes and Survey Techniques: Their Effect on Site Samples and Data. Unpublished BA Honours Thesis. University of Western Australia.

STREHLOW, T.G.H.
1965 Culture, Social Structure, and Environment in Aboriginal Central Australia. In R.M and C.H. Berndt (eds.) *Aboriginal Man in Australia*. Sydney: Angus and Robertson. pp.121-45.

SURVEYOR GENERAL'S OFFICE, PERTH.
1830 Government Notice relative to Port Leschenault. In J. Cross (ed.) *Journals of Several Expeditions Made in Western Australia*.... London: J. Cross. pp.80-8.

TEAKLE, L.J.H.
1953 *Soil Survey of the Many Peaks District, Albany Road Board, Western Australia*. Western Australian Department of Agriculture Leaflet No. 2070.

THOM, B.G. and CHAPPELL, J.
1975 Holocene sea levels relative to Australia. *Search* **6**:90-3.

THOMSON, D.F.
1939 The Seasonal Factor in Human Culture. *Proceedings of the Prehistoric Society* **10**:209-21.
1964 Some wood and stone implements of the Bindibu tribe of Central Western Australia. *Proceedings of the Prehistoric Society* **30**:400-22.

TINDALE, N.B.
1940 Distribution of Australian aboriginal tribes: a field survey. *Transactions of the Royal Society of South Australia* **64**:140-231.

1950 Palaeolithic *Kodj* Axe of the Aborigines and its Distribution in Australia. *Records of the South Australian Museum* **9**:257-73.

1951 Palaeolithic *Kodj* Axe of the Aborigines - Further notes. *Records of the South Australian Museum* **9**:371-4.

1965 Stone implement making among the Nakako, Ngadadjara and Pitjandjara of the Great Western Desert. *Records of the South Australian Museum* **15**:131-64.

1974 *Aboriginal Tribes of Australia*. Berkeley: U. of California Press.

1976 Some ecological bases for Australian tribal boundaries. In N. Peterson (ed.) *Tribes and Boundaries in Australia*. Canberra: A.I.A.S. pp. 12-29.

TRIGGER, B.G.

1970 Settlement Patterns in Archaeology. In B.M. Fagan (ed.) *Introductory Readings in Archaeology*. Boston: Little, Brown. pp. 237-62.

TRUBOWITS, N.L.

1977 Archaeological Research Design for the Genesee Expressway. In M.B. Schiffer and G.J. Gumerman (eds.) *Conservation Archaeology*. New York: Academic Press. pp. 145-9.

VANCOUVER, G.

1801 *A Voyage of Discovery to the North Pacific and Round the World...* (6 Vols.). London: Robinson and Edwards.

VITA-FINZI, C. and HIGGS, E.S.

1970 Prehistoric economy in the Mount Carmel area of Palestine: site catchment analysis. *Proceedings of the Prehistoric Society* **36**:1-37.

WACE, N. and LOVETT, B.

1973 *Yankee Maritime Activities and the Early History of Australia*. Research School of Pacific Studies Aids to Research Series, No. A/2. Canberra, Australian National University.

WAKEFIELD, J.

1827-28 Letters to Colonial Secretary Macleay. In *Historical Records of Australia. Series III, Vol. VI*. pp. 506-21.

WEST, D.A.P.

1976 *The Settlement on the Sound*. Perth: Western Australian Museum.

WESTERN AUSTRALIAN YEAR BOOK

1980 Perth: Australian Bureau of Statistics.

WHITE, C.

1967 Plateau and plain: prehistoric investigations in Arnhem Land. Unpublished Ph.D. Thesis, Australian National University.

1971 Man and Environment in Northwest Arnhem Land. In. D.J. Mulvaney and J. Golson (eds.) *Aboriginal Man and Environment in Australia*. Canberra: ANU Press. pp. 141-57.

WHITE, J.P.

1968a Fabricators, outils ecailles or scaler cores? *Mankind* **6**:658-66.

1968b Ston Naip Bilong Tumbuna: the living stone age in New Guinea. In D. De Sonneville Bordes (ed.) *La Préhistoire: Problèmes et Tendances*. Paris: Centre National de la Recherche Scientifique. pp 511-6.

WHITE, J.P and O'CONNELL, J.F.
1982 *A Prehistory of Australia, New Guinea and Sahul*. Academic Press: Sydney.

WIENEKE, C. and WHITE, J.P.
1973 Backed blades: Another view. *Mankind* **9**:35-8.

WILLEY, G.R.
1966 *An Introduction to American Archaeology, Volume One: North and Middle America*. Englewood Cliffs (N.J.): Prentice-Hall.

WILMSEN, E.N.
1968 Lithic Analysis in Paleoanthropology. *Science* **161**:982-7.

WILSON, T.B.
1833 Extract of a Letter received from Dr. T.B. Wilson, R.N. dated King George's Sound, 15th December 1829. In J. Cross (ed.) *Journals of Several Expeditions made in Western Australia....* London: J. Cross. pp. 14-26.
1835 *Narrative of a Voyage Round the World....* London: Sherwood, Gilber & Piper.

WOODS, P.J. and SEARLE, D.J.
1983 Radiocarbon Dating and Holocen History of the Becher/Rockingham Beach Ridge Plain, West Coast, Western Australia. *Search* **14**:44-6.

WOODWARD, H. B.
1900 *Zoo-geographical provisional sketch map of Western Australia*. Perth: Government Photolithographer.

WURM, S.A.
1972 *Languages of Australia and Tasmania*. The Hague: Mouton.

WYRWOLL, K-H
1977 Late Qaternary events in Western Australia. *Search* **8**:32-4.
1979 Late Quaternary climates of Western Australia: evidence and mechanisms. *Journal of the Royal Society of Western Australia* **62**:129-42.

WYRWOLL, K-H. and MILTON, D.
1976 Widespread late Quaternary aridity in Western Australia. *Nature* 264:429-30.