PREHISTORIC SETTLEMENT IN THE WESTERN CUMBERLAND PLAIN: RESOURCES, ENVIRONMENT AND TECHNOLOGY.

by

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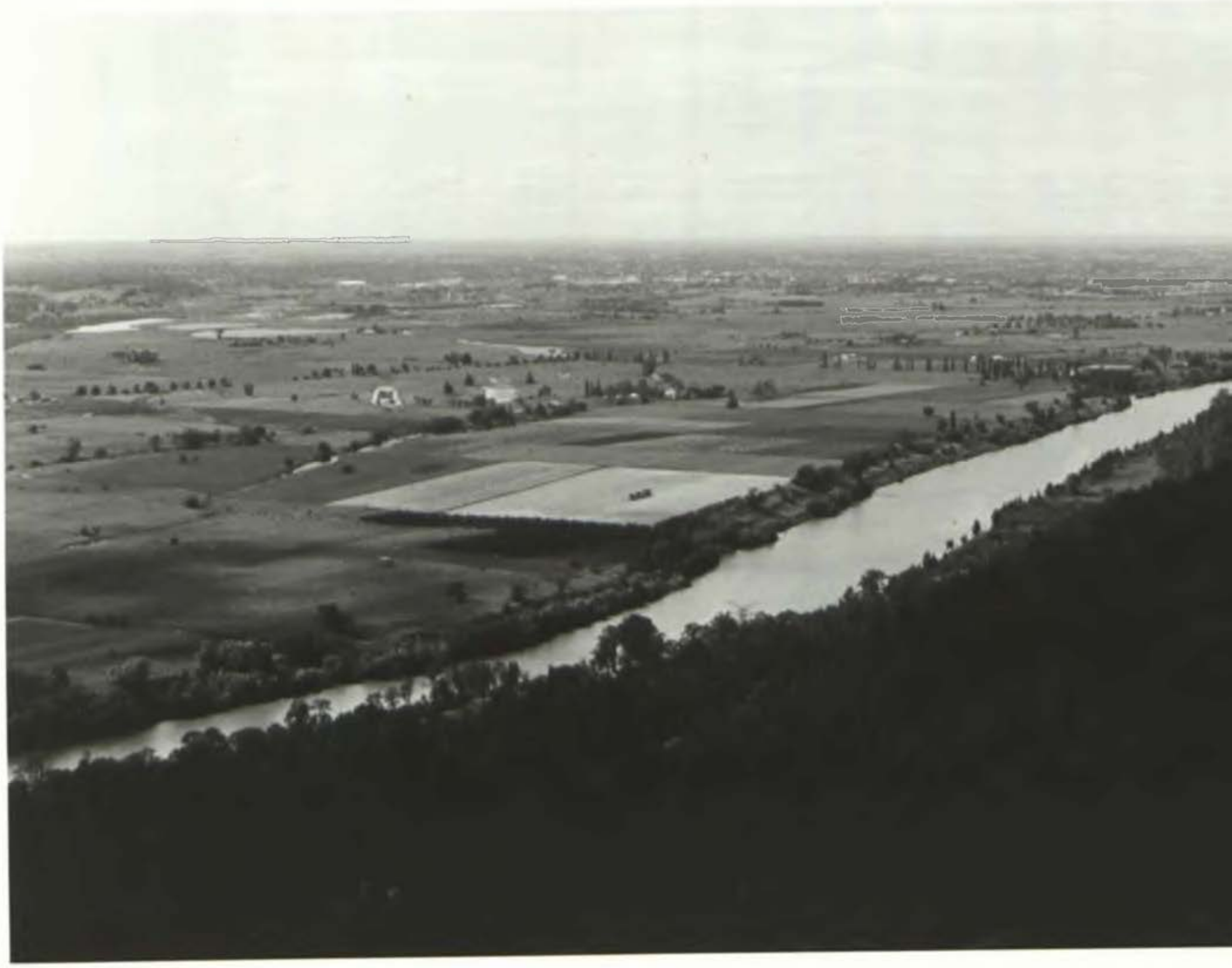
FRONTPIECE. The western Cumberland Plain, viewed across the Nepean River from the Lapstone Monocline.



ABSTRACT

The study of prehistory is subject to the same bias and prejudice as any other scientific discipline. When the rewards are likely to be few and the effort required great, researchers will avoid problem areas in favour of more lucrative fields. One such neglected area of research has been the archaeology of the coastal plains and forests of southeastern Australia, where poor visibility and the diffuse nature of the archaeological record militate against the investment of valuable research time. In the Sydney region, the archaeological data accumulated relate almost exclusively to rock shelter deposits. While such sites do have the potential to provide a great deal of valuable information, they reflect only a fraction of the activities carried out by the prehistoric population. In order to counteract the bias evident in the archaeological investigations, I undertook a systematic archaeological survey of the western Cumberland Plain.

In the early chapters of this thesis, I examine the environmental setting and the resources which were available to Aboriginal people at the time of European settlement in 1788. After evaluating the ethnographic accounts, a clear picture emerges of two major economic systems operating; one based on coastal resources and one reliant on a wider range of locally abundant foods. Associated with this dichotomy were linguistic, technological and social differences suggestive of dense Aboriginal populations exploiting relatively narrow territories.

Archaeological surveys were undertaken, a representative rockshelter site and two open sites were excavated, and, in conjunction with the surface collections of artefacts, it was possible to identify patterns in the archaeological record suggesting that the technological changes evident in the stone tools were a reflection of a changing resource base.

In the final chapters, the factors which have influenced the location of sites and the distribution of artefact types are examined, and a model proposed which accounts for the observed data. The model suggests that macropodids formed a major component of the diet for several thousand years following the introduction of the microlithic industry, but that over the last 2,000 years increasing Aboriginal population has necessitated a diversification into a wider range of resources.

DECLARATION

The work contained in this thesis is the result of my original research except where due acknowledgement is given. It has not been submitted for a higher degree to any other University or Institution.

J. L. Kohen

James Leslie Kohen

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CHAPTER 1

INTRODUCTION

1.1 Background

Historically, archaeology in eastern New South Wales has played a major role in the development of Australian prehistoric research. As early as the 1930's, scientific excavations were being undertaken along the foot of the Blue Mountains to the west of Sydney at Lapstone Creek near Emu Plains (McCarthy, 1934; 1948). On the basis of the results of one of these excavations, a two phase cultural sequence was proposed for eastern New South Wales, later to be extended into a tripartite schema following excavations in the Capertee Valley in the 1960's (McCarthy, 1948; 1964). McCarthy proposed an early *Capertian* phase, followed by a *Bondaian* phase, and terminating with an *Eloueran* phase. While these proposals were fundamental in the interpretation of Australian prehistory, their value was somewhat limited because only excavated rockshelter sites were evaluated. Open sites, briefly mentioned in the earlier paper, were considered as non-stratified, undateable surface scatters, at best peripheral to the interpretation of the excavated sequences, and therefore of little archaeological value.

Although McCarthy had also investigated open sites along the coastal strip, the published accounts were largely confined to the description and classification of the stone artefacts found on these sites (cf. McCarthy, 1943). The problem of bias in archaeological investigations in eastern Australia, with almost all serious research directed towards the excavation of stratified rockshelter occupation sites, was rectified to some extent by the analysis of coastal "surface workshops" (Dickson, 1968). While these studies clearly demonstrated that the same artefact types occurred on open sites as had been found in the rockshelters, no systematic investigations of open sites were carried out at any distance from the coast.

Within the last twenty years, the emphasis in Australian prehistory has shifted from the establishment of regional cultural sequences to questions related to spatial archaeology, man-land interactions and the problem of "intensification", a termed coined to describe the apparent increase in Aboriginal population density during the late Holocene (Lourandos, 1985; Ross, 1985). Along with this approach has come the realisation that open sites form a major and hitherto untapped source of knowledge relating to Aboriginal settlement patterns.

While systematic investigations on open sites in the semi-arid zone in western New South Wales have met with dazzling success, the fundamental problem archaeologists faced over much of southeastern Australia was how to deal with forested areas, where archaeological visibility is minimal. This problem is not exclusive to Australia, but exists world-wide.

The further difficulty which presents itself is intrinsic to most archaeological theory: the basic concept of a site. The perception of archaeological data as a series of discrete clusters across the landscape does not take into account the almost continuous nature of archaeological remains, albeit with marked variations in density. The recent work of Foley (1981a) in Africa and Dunnell and Dancey (1983) in the United States has shown that it is possible to find patterns in non-sites as well as sites. However, both studies were based in semi-arid zones, where surface visibility was good. Such survey methods are generally inappropriate for heavily vegetated localities.

On a local level, a number of questions remained unanswered relating to Aboriginal settlement in the Sydney region. While intensive studies had been carried out on the coast and in the Blue Mountains, the archaeology of the western Cumberland Plain remained an enigma. I therefore planned a study which would enable a fuller comprehension of the prehistory of the western Cumberland Plain. Because the distribution of Aboriginal people across the landscape is integral to understanding the processes which have led to the distribution of evidence in the archaeological record, the ethnographic data from the Sydney area were re-examined in the hope of reconstructing the social and economic patterns evident at the time of European settlement.

1.2. Aims and methods

I undertook a series of archaeological surveys and excavations designed to locate and quantify the observable archaeological data; and for each stone artefact found, a series of attributes were recorded. In addition, environmental data were recorded for every artefact location. A survey was undertaken to locate and identify potentially useful resources, particularly food plants and stone suitable for flaking and grinding. A detailed ethnographic reconstruction was undertaken to ascertain the socio-economic organisation at the time of European settlement and the economy being practised within the study area. These data were analysed and used to produce a reconstruction of prehistoric settlement pattern and land use in the western Cumberland Plain during the late Pleistocene and Holocene.

The specific aims of the project are to establish whether prehistoric sites existed across the Cumberland Plain; to reconstruct the patterns of Aboriginal land use at contact, and project back in time to see if changes have occurred; to devise a mechanism for relating undateable surface scatters of stone artefacts to dateable stratified sequences in the same region; to ascertain the spatial and temporal variability of stone tool types across the Cumberland Plain, and explain that distribution; and to devise a method of survey for use in forested areas which will provide better archaeological visibility and allow the detection of spatial patterning.

CHAPTER 2

CONCEPTUAL FRAMEWORK

2.1 Archaeological background

Most researchers in Australia over the past three decades have adopted one of three approaches to the study of prehistoric Aboriginal society. In the 1950's and early 1960's, a detailed excavation of a single site or small group of related sites was commonly undertaken in order to establish a sequence of stone artefacts. At this time, research aims were primarily related to establishing the antiquity of Aboriginal occupation of the Australian continent and to identifying sequences of stone artefacts which could then be used to build up a chronological framework. There are many published examples adopting this approach, with one or mores sites being excavated in order to identify and quantify the internal temporal variability of the artefact assemblage. Rarely was spatial variability taken into consideration. Excavations such as those by Mulvaney and Joyce (1965) in Queensland, McCarthy (1964) and Tindale (1961) in eastern New South Wales, and Mulvaney et al. (1964) on the Murray River typify this approach.

By the late 1960's the gross temporal variability of stone artefact types had been generally established, and broad geographic surveys covering a range of environments became more common, usually accompanied by sample excavations of selected intensively occupied sites. The questions being asked of the data were related to the mechanisms by which Aborigines had adapted to their environment and to clarifying regional variations between environments. The accumulated data obtained from a number of such excavations could be synthesised into a broad regional framework, and examples of this approach are to be seen in the work of White (1967) in the Northern Territory, McBryde (1974; 1982) in New England and Flood (1980) in the Southern Highlands.

The third approach adopted was to carry out an analysis of a number of sites within a single environmental zone in an attempt to relate hunter-gatherer foraging strategies to the resources at hand. For these researchers, the sites were no longer viewed in isolation, but related to the environment in which they were located. Within this category in New South Wales should be included the work of Lampert (1966; 1971) on the south coast, Megaw (1965; 1966; 1968; 1974) on coastal sites in the Sydney area, Stockton (1970a; 1973a) and Stockton and Holland (1974) in the Blue Mountains, and the work in the far west of the state by research workers from the Australian National University (Bowler et al., 1970; Allen, 1972; Hope, 1981). The approach to all of these projects has been to examine in detail a series of sites within a particular environmental regime and to integrate this information to produce a picture of the prehistoric economy. As a result there is a general acceptance of the existence of a specific "coastal economy", an "uplands economy", and a "riverine economy".

In the last ten years the questions being asked of the archaeological data have become more sophisticated and the research designs more problem-oriented. Specific problems such as late Holocene intensification and population densities (Lourandos, 1977; 1980; Lampert and Hughes, 1974), the timing of the introduction of the microlithic industries of the Australian Small Tool Tradition (Johnson, 1979), pre-microlithic stone industries and how to deal with them (Stockton, 1977a; 1979; Lampert, 1980; 1981), Aboriginal settlement patterns (Hallam, 1979) and to a lesser extent the applicability of ecological models (site catchment analysis, optimal foraging theory, carrying capacity) in determining patterns in prehistoric site location, have been investigated with varying degrees of success.

Intrinsic to all of these studies has been the concept of an archaeological "site", generally implicitly understood to mean a finite scatter of lithic or other material accumulated as the direct result of prehistoric occupation. In the last five years, following on from the re-evaluation of methodology proposed by Binford (1964; 1977) and others under the heading of the *New Archaeology*, a growing number of overseas archaeologists as well as a few within Australia have begun questioning some of the premises upon which many prehistoric studies have been based. The root of this concern lies in the fact that archaeological data are not neatly bundled into "sites", but are spread in non-random patterns across the landscape. As Dunnell and Dancy (1983: 268) suggest: " Much of the difficulty in acquiring regional-scale data may be attributed to two related elements in the traditional fieldwork legacy: (1) the notion of *site* and (2) the excavation technique of data acquisition".

Largely on the grounds of expediency and limitations of time and money, the mechanisms invoked to order the archaeological data are based on two long standing methodological tools: the site survey, and excavation. The survey provides information on the location and excavation potential of dense concentrations of archaeological material, while the excavation of a site or sites is used to elucidate, predict or to confirm some pattern over time. For practical reasons, such excavations are usually restricted to those sites which provide the greatest amount of information with the minimum amount of effort, usually stratified sites such as rock shelters, shell middens and archaeological deposit incorporated in aeolian dunes. Within these three site-types, accumulated debris is more likely to be preserved in a stratified sequence. While it is certainly true that such sites are more likely to produce sound stratification, this approach makes the intrinsic assumption, seldom explicitly stated, that the sites selected for excavation are typical and representative of the range of activities normally carried out by the prehistoric population under investigation. Clearly this is a false assumption, since the majority of activities were carried out in the open, and not necessarily under the conditions suitable for stratigraphic incorporation. If the questions being asked of the data relate solely to areas of concentrated occupation, then excavation of such sites may be adequate.

However, if the pattern of resource utilisation is to be considered, all activity areas need to be examined. While the value of excavation of stratigraphically sound sites is essential for any regional interpretation, it is also necessary to integrate the temporal variability with the spatial patterning. Dancey (1981) clearly defines the problem: "While site survey data are well suited to the problems of organizational and developmental characteristics of human groups, they are inadequate for the investigation of the prehistoric utilisation of the environment as a whole".

An alternative approach is to view archaeological data as a continuum across the landscape, and to view the distribution of artefactual material *between* sites as being as important as the material *within* sites. This approach has been referred to variously as nonsite survey (Dancey, 1981), off-site archaeology (Foley, 1977; 1981a), and siteless survey (Dunnell and Dancey, 1983). In reality these terms are extensions of existing methods for dealing with particular problems related to the varying densities of artefacts across the landscape. Chartkoff (1978) used a method which he called "transect interval sampling" in order to define the extent of an occupation site, and this effectively measured the density of artefacts across the landscape. In this particular example, the aim was to define the boundary of a site rather than to find spatial patterning between sites, but he showed that even in forested environments, methods could be devised which would allow artefact densities to be ascertained.

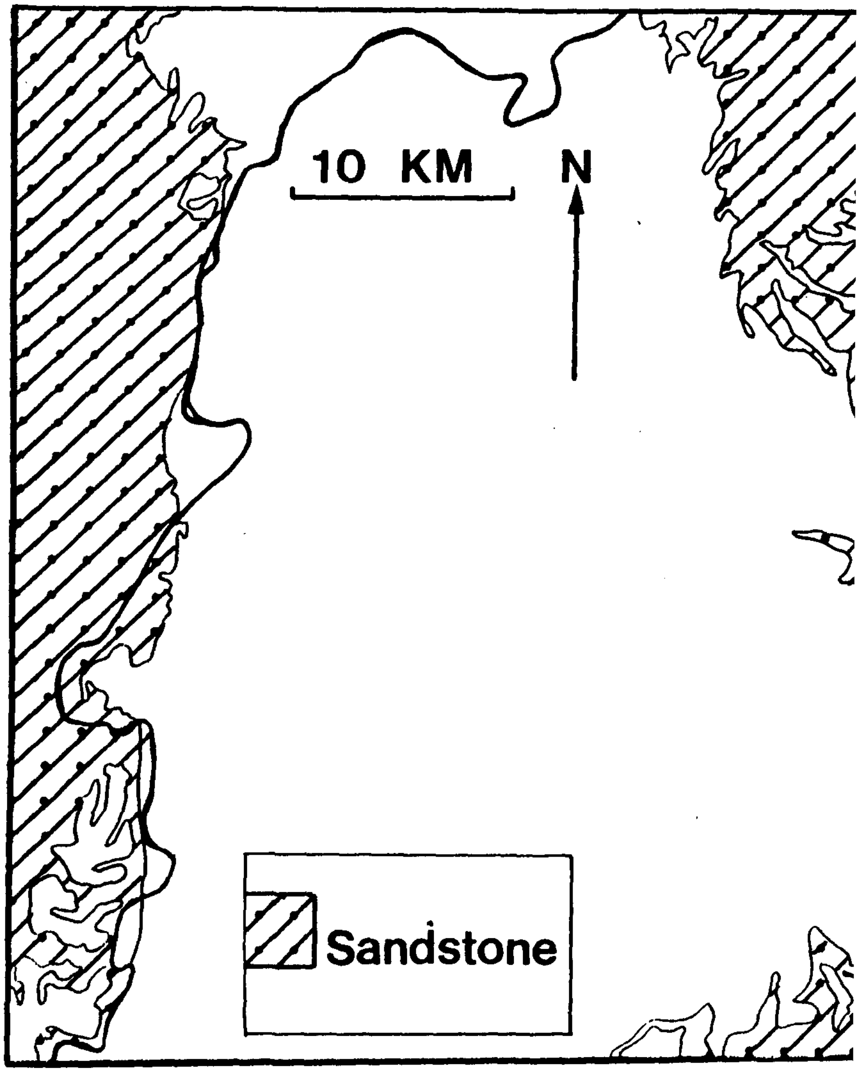
Ideally an archaeological study should combine the best of both approaches: location of sites, excavation of stratified sites, and a closer examination of the low density scatters of artefacts between the sites. In some environmental settings, this does not present a problem. Arid areas like western New South Wales with deflating palaeo-surfaces provide good archaeological visibility, and consequently such areas are relatively easy to survey (Hope, 1981; Anderson et al., 1984). At the other extreme are the dense forests of the east coast where visibility is negligible. Geomorphic processes can therefore play a large role in the visibility of artefacts, and this in turn results in particular environments being more popular with researchers because of the relative ease with with sites can be located.

2.2 Coastal plains in Australian archaeology

One environmental zone which had received little attention is the temperate coastal plain in southeastern Australia. Research carried out on the savanna areas in the tropical north suggest that coastal plains should form an integral part of any regional archaeological assessment (Jones, 1981; 1985; Schrire, 1982). Similarly, in southwestern Australia a significant number of sites are to be found on the coastal plain west of Perth (Anderson, 1984). In southeastern Australia, there are very few places where a broad coastal plain effectively separates the rich resources of the coast from the Great Dividing Range. One such area is to the west of Sydney, where the relatively flat Cumberland Plain consists of soils derived from Wianamatta Shale and alluvial deposits. The geology, in conjunction with a lower rainfall, results in distinctive vegetation associations quite different from those found in the Hawkesbury Sandstone areas along the coast and in the Blue Mountains (see Figure 2.1).

On the plain, archaeological visibility is generally poor; there are no rockshelter sites away from the sandstone, no estuarine resources which could be incorporated into shell middens, and little evidence of aeolian dune formation. In fact, there seemed little likelihood of locating any major stratified open sites. For these reasons, research on the plain had been neglected. This lack of research on coastal plains left many of the problems relating to Aboriginal land use in these areas unanswered. In economic terms, what kind of economy was practised on coastal plains and what resources were used? Poiner (1976) proposed a model for Aboriginal settlement pattern for the coastal strip south of Sydney which suggested that both coastal and hinterland resources were used by the same bands at different times of the year. A major criticism of this model is that the ethnographic data upon which it was based were acquired after the major depopulation which occurred between 1789 and 1791, when a smallpox epidemic ravaged the Aboriginal population in the vicinity of Sydney (Collins, 1798; Kohen, 1985a; in press). The spread of this disease preceded European settlement, and there is every likelihood that the social and economic patterns recorded for Aborigines on the New South Wales south coast were very different from those which existed prior to 1788. In this regard,

FIGURE 2.1. The Sydney region (Lat. 33.52 S, Long. 151.13 E), showing the sandstone boundaries. The western Cumberland Plain is bounded by the Hornsby Plateau in the north, the Blue Mountains in the west, and the Woronora Plateau in the south.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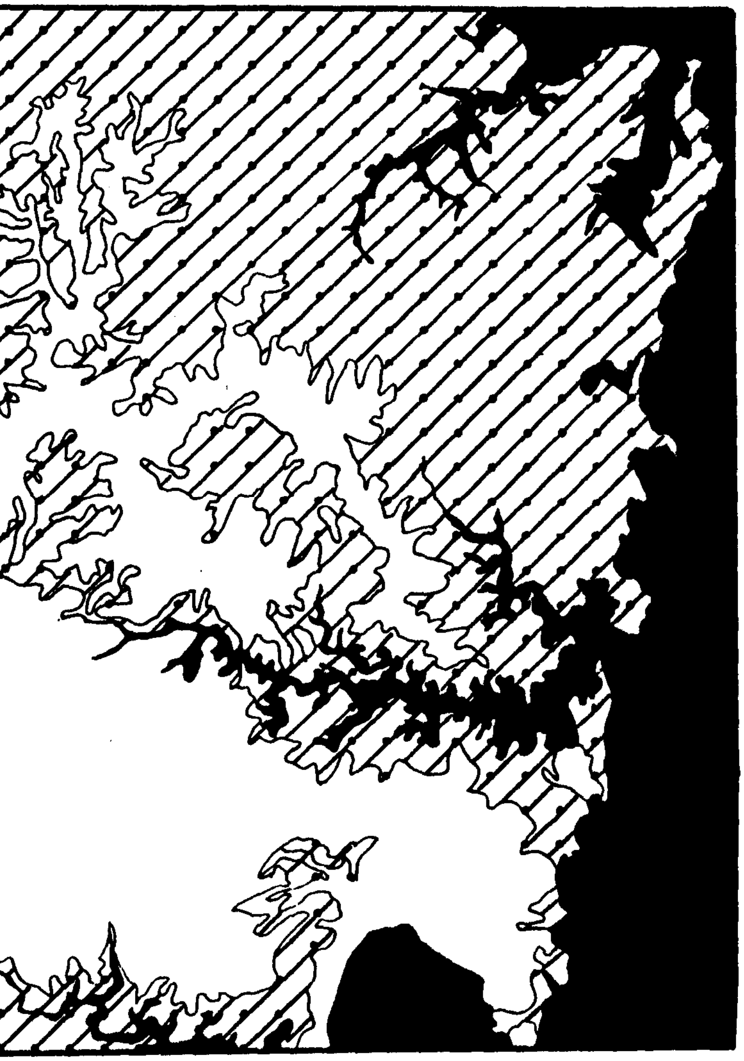


the evidence from the Cumberland Plain is crucial in assessing Poiner's model, for only in the Sydney area is there a substantial body of ethnographic information recorded before European diseases ravaged the Aboriginal population. Are there different foraging strategies employed on the mountains and on the plains, and if so how do they relate spatially and temporally to coastal sites?

2.3 Regional problems

The evidence which leads to possible interpretation of prehistoric change is based largely on the changes in stone toolkits over time. For the Sydney region, the pre-microlithic core tool and scraper stone industries, described under the regional term *Capertian*, present an interesting series of problems. In many rockshelter sites no evidence of this assemblage has been found, while in the sites where it does occur the density of these tools is generally low. This has been interpreted as a reflection of a change from the use of rockshelters as limited activity sites during the *Capertian* to base camps during the *Bondaian* (Stockton, 1981), abandonment of sites under particular climatic conditions (Stockton and Holland, 1974), and as an indication of population increase (Hughes and Lampert, 1982).

While a great deal of research has been carried out on the pre-microlithic assemblages found on open sites in western New South Wales, there has only been a single open site excavated on the east coast of New South Wales which has been securely dated to the Pleistocene (Bowdler, 1970). There are no other recorded open sites which appear to belong to the *Capertian*. This raises a number of questions of great significance to Australian prehistory. Why have no such sites been located on the east coast? Is it because there genuinely are few such sites, and if this is true is it because of low population density, infrequent use of stone tools, poor archaeological visibility or more likely simply the failure to distinguish artefacts belonging to the *Capertian* phase when they are found in surface exposures mixed with later *Bondaian* assemblages? This raises the important problem of how does one recognise a *Capertian* assemblage in an undated surface scatter lacking diagnostic stone tools.

Another major problem which has arisen at least in part because of the concentration of effort on rockshelter sites is the possibility of a hiatus between the early *Capertian* industry and the later *Bondaian*, suggested by Stockton and Holland (1974) but disputed by Johnson (1979). Does such a hiatus exist, and if so is it possible that it is a result of increased sedimentation, rather than decreased occupation? In light of low rates of accumulation in rockshelters and stratigraphic disturbance caused by human occupation, resolution of this issue may have far-reaching consequences. If a similar pattern of artefact deposition was found to occur on open sites, the suggestion that the hiatus, if it in fact exists, was the result of preference for camping in the open rather than in rockshelters would no longer be tenable.

One of the more intriguing problems which has arisen in eastern New South Wales is related to backed blades which occur both in rockshelters and on open sites along the coast. Yet in the Blue Mountains it was suggested that they only occur in rockshelters (Stockton, 1970b). Do backed blades occur on the plain? The concentration of archaeological effort on rockshelter sites has left open many questions about the timing and reason for the loss or decline of backed blades. On the far south coast, it is suggested that the backed blades had been largely replaced by bipolar artefacts around 2000 years ago (Lampert, 1971), while for the Sydney area they continued until the last millennium (Megaw, 1974). In the Blue Mountains, there is evidence to suggest that they were still in use within the last 500 years (Stockton, 1973a; Stockton and Holland, 1974), and possibly continued to be used until contact. Although this apparent contradiction could be due to mixing of archaeological material as a result of human activity within rockshelter sites (cf. Matthews, 1965; Stockton, 1973a; Hughes and Lampert, 1982), the possibility exists that there is a cultural or economic basis for late retention of backed blades in some areas. Again the evidence from the western Cumberland Plain could shed some light on this problem.

Perhaps the most intriguing question which has arisen from the archaeological research carried out in the Sydney region is the observation that within the last millennium along the coast stone tools have been replaced by the use of organic materials such as bone and shell. This trend away from the use of stone requires explanation. In the Hawkesbury Sandstone and along the coast, quartz is the only stone found suitable for producing sharp cutting edges. This is in marked contrast to the Nepean River area at the foot of the Blue Mountains where a wide range of cherts, quartzites and igneous rocks are to be found in the gravel beds, and to the east on the western Cumberland Plain, where silcretes crop out adjacent to the major waterways. What then is the effect of different availability of raw materials on the coast and across the plain? Why is it that the sources of raw materials used in the manufacture of stone artefacts 2,000 years ago along the coast were not exploited in recent times, and why are artefacts manufactured from these materials almost totally absent from the uppermost layers of coastal archaeological sites?

This project set out to answer as many of these questions as possible. The advantages of attempting to answer these questions from archaeological data obtained in the western Cumberland Plain are many. The Sydney area is one of the few places in Australia where a unique combination of factors occurs: 1) A broad coastal plain separates the coast from the Great Dividing Range; 2) a substantial amount of archaeological research has already been carried out along the coast and in the mountains; 3) detailed ethnographic accounts were made prior to and during the time when introduced European diseases first attacked Aborigines; and 4) rapid development threatens to destroy evidence of prehistoric settlement patterns. While the first three points are obvious advantages in a study of the regional prehistory, the threat of destruction may not at first appear to be. In fact, because of impending development, research on the plain has become a higher priority. As a result, funding has become available to carry out this research. The other advantage of imminent destruction of archaeological data arises from the fact that undisturbed forested areas are unlikely to reveal many archaeological sites. Previous work on the New South Wales south coast suggests that disturbances such as logging and initial land clearing can actually enhance the likelihood of locating archaeological sites (Byrne, 1983). In forested areas with vehicle tracks, fire trails and other kinds of disturbance, the disturbance itself can be used to advantage if the initial survey strategy is carefully planned.

2.4 Previous archaeological research

Based on archaeological and ethnographic data, a number of models have been suggested for Aboriginal land use patterns in the Sydney area and the southern coastal part of New South Wales. Ross (1976) suggested that the economic base around Sydney was essentially coastal, and that few if any Aborigines relied on the resources of the Cumberland Plain for any substantial part of the year. This conflicts with the Poiner model of a seasonal resource base, with Aborigines exploiting coastal resources in the summer months and relying on terrestrial resources in the mountain ranges during the winter (Poiner, 1976). Both models can be tested archaeologically and ethnographically. If the model proposed by Ross is correct, then there should be little evidence of occupation across the plain, and the ethnographic data should indicate an absence of Aboriginal bands actually living on the plain. If the Poiner model applies in the Sydney region, the resources being exploited on the plain would be those available during the winter months. If the seasonal distribution of plant and animal resources can be assessed, archaeological sites may be expected to occur in close proximity to those resources which occur in the winter months. Additionally, the ethnographic data should confirm that only the same bands occupied the coast during the summer and the plains and mountains during the winter.

Archaeological knowledge of the western Cumberland Plain, between the estuarine resources of the Parramatta, Georges and Hawkesbury Rivers and the Blue Mountains, was minimal. By the mid 1970s, only a single site had been recorded in the NSW National Parks and Wildlife site register for this area, although a few others on the extreme western edge had been discussed in early publications (McCarthy, 1934; 1948). The Cumberland Plain offerred an area close to Sydney where a number of specific questions relating to Aboriginal land use in southeastern Australia could possibly be answered. Did evidence exist for any intensive use of the resources on the plain, and, if so, could those resources be identified? Was exploitation of the plain a seasonal phenomenon, or was it a year round occupancy? Were the same people exploiting both coastal and hinterland resources (as Poiner's model would suggest), or were different economies being used by different groups? How was the population distributed across the landscape? What brought about the change in the kinds of stone tools used, and the decline in stone on coastal sites in the last two thousand years? How had the settlement patterns changed over time, and what resources were being used? Finally, a re-evaluation of the ethnographic evidence is necessary, particularly in light of the recent suggestion that the initial Aboriginal population throughout Australia in 1788 may well have been substantially greater than previously imagined (Butlin, 1983).

In order to answer these questions, I decided to survey intensively an area at the foot of the Blue Mountains lying between Parramatta and the Lapstone Monocline (Figure 2.2a). The size of the area was determined by a number of factors. First it had to be large enough to allow for a statistically reliable number of sites to be found. Second, it should contain areas representative of all the different microenvironments within the western Cumberland Plain. Thirdly, it should contain an adequate number of areas for which the level of development had not significantly reduced archaeological visibility, and which would provide comparable data. Bearing these factors in mind, an area 30 km by 20 km was selected, extending from the City of Blacktown to the Lower Blue Mountains (Figure 2.2b).

At the western boundary of this study area, the first systematic archaeological investigations in eastern New South Wales took place on the escarpment at the foot of the Blue Mountains in the vicinity of Emu Plains. In 1934, F.D. McCarthy published an account of the excavation of a small rockshelter in a gully "known locally as that of Wallaby Creek", but which was in fact the same gully in which a second rockshelter was later excavated, this shelter being said to occur on Lapstone Creek (F.D. McCarthy, pers. com.). Because this site had been partly dug out by local artefact collectors, the remainder of the deposit was removed in a single day's excavation. It was recognised that the raw materials used for the stone tools came from locally available gravels, including basalt and grey chert. The stone tools excavated included 49 "scrapers" of various kinds, four "asymmetrical crescentic scrapers (of the elouera type)", two ground-edge and one unground pebble axe, a "ground edge skin-dresser", fifty one bondi points, and a hammerstone. All the artefacts recovered were "scatterred throughout the earth, and were not in any particular layer". Fragments of a human skull, a human tooth, a few bird and marsupial bones, and freshwater mussel shells were also recovered (McCarthy, 1934). The location is shown in Figure 2.3.

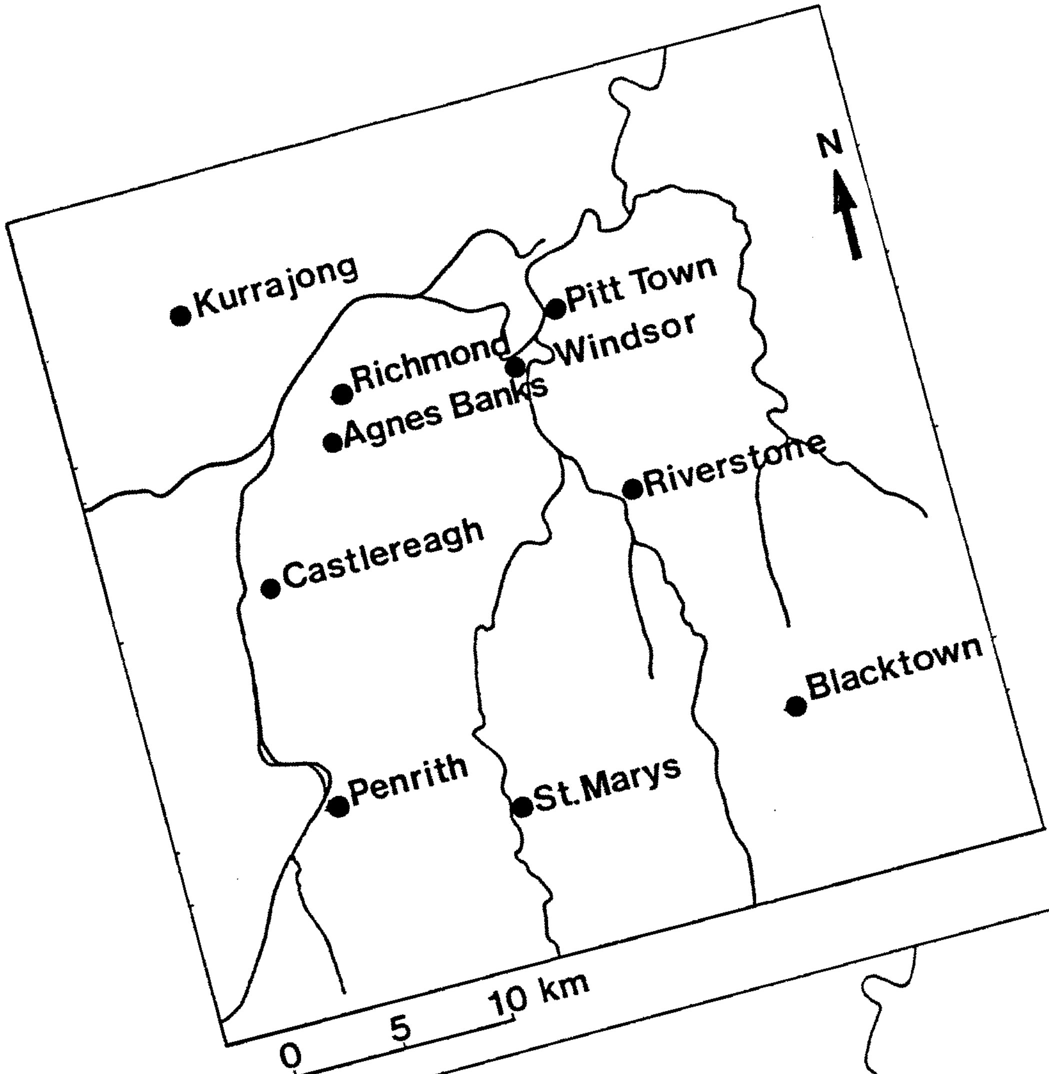
A more important excavation was carried out in December 1936, when the remnants of the deposit in a second shelter close to the lower end of the gully were excavated (McCarthy, 1948; 1978). Again local collectors had disturbed a substantial area within the shelter, and the balance of the deposit was excavated by a party of five including McCarthy and C.C. Towle. The Lapstone Creek excavation provided the first evidence for a fundamental change in the stone tool assemblages in this area at some time in the past. Radiocarbon dates published thirty years after the excavation indicate that the Bondi points first occurred at the site about 3,600 years ago, but dropped out of the local Aboriginal toolkit approximately 2300 years ago, and that later assemblages were dominated by the elouera adze flake. The location of the site is shown in Figure 2.3. On the basis of this excavation, McCarthy proposed a division of the stone tool assemblage into two phases, an earlier *Bondaian* phase dominated by Bondi points, and a later *Eloueran* phase, lacking Bondi points and dominated by elouera adze-flakes. As the result of subsequent excavations in the Capertee Valley (McCarthy, 1964), he added an even earlier phase, the *Capertian*, with the three phases being seen to comprise an *Eastern Regional Sequence*.

Another rockshelter at the foot of the Lapstone Monocline, also shown in Figure 2.3, was excavated by Eugene Stockton on Shaws Creek, approximately 10 km north of McCarthy's sites (Stockton, 1973a). Shaws Creek shelter (KI) was first described by McCarthy (1948: 28) in the following way:

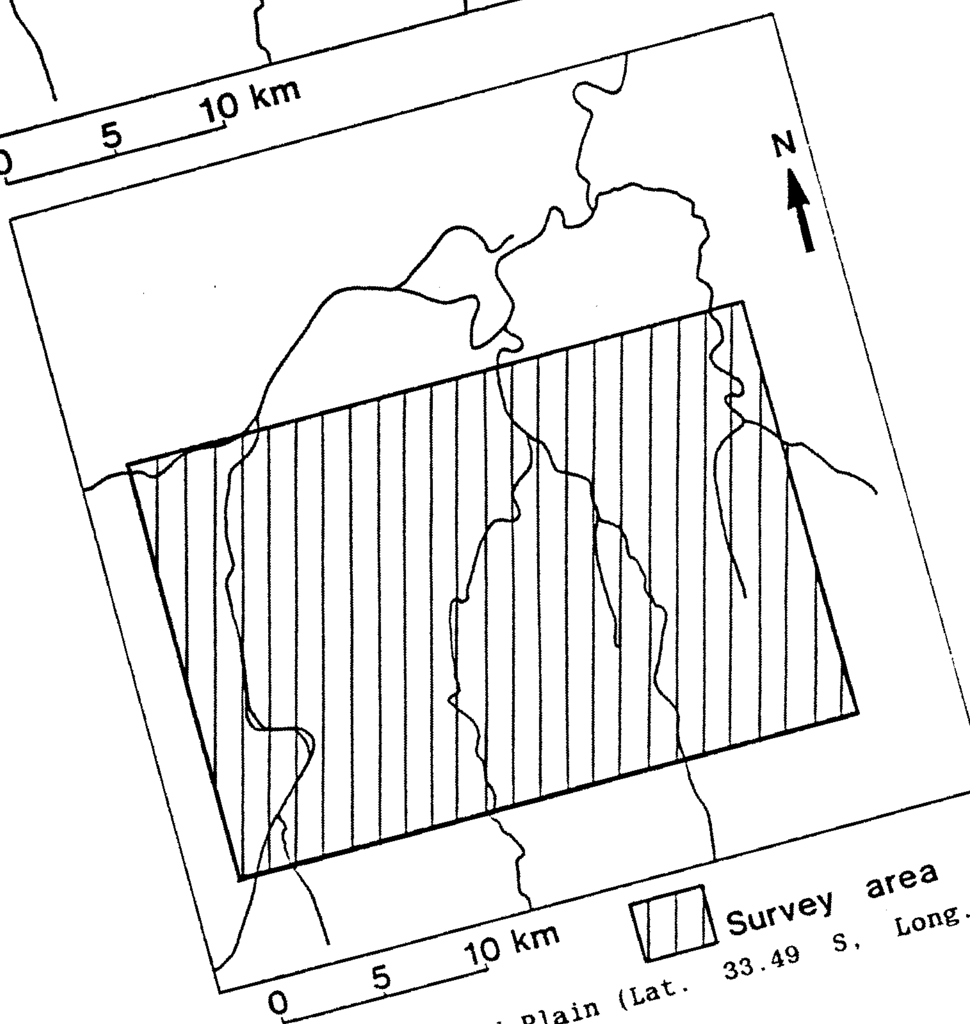
> "the deposit on the floor ... has been dug out by campers. Implements scattered about as a result comprise normal flake and blade scrapers, elouera adze-flakes, and edge-ground pebble axes, but no bondi points have been found to date, so that the site would appear to belong to the Eloueran culture period".

Stockton excavated an area 1m x 1m at this site and first found Bondi points in his Phase II at a depth of between 5 and 15 cm. These continued to a depth of 55 cm. Below this level in Phase VI was a "heavy archaic assemblage, with choppers and serrated flakes" which continued to the base of the excavation at a depth of 80 cm. Although the site was not radiocarbon dated, it appears that a pre-*Bondaian* phase was present at this site, corresponding to McCarthy's *Capertian*.

a

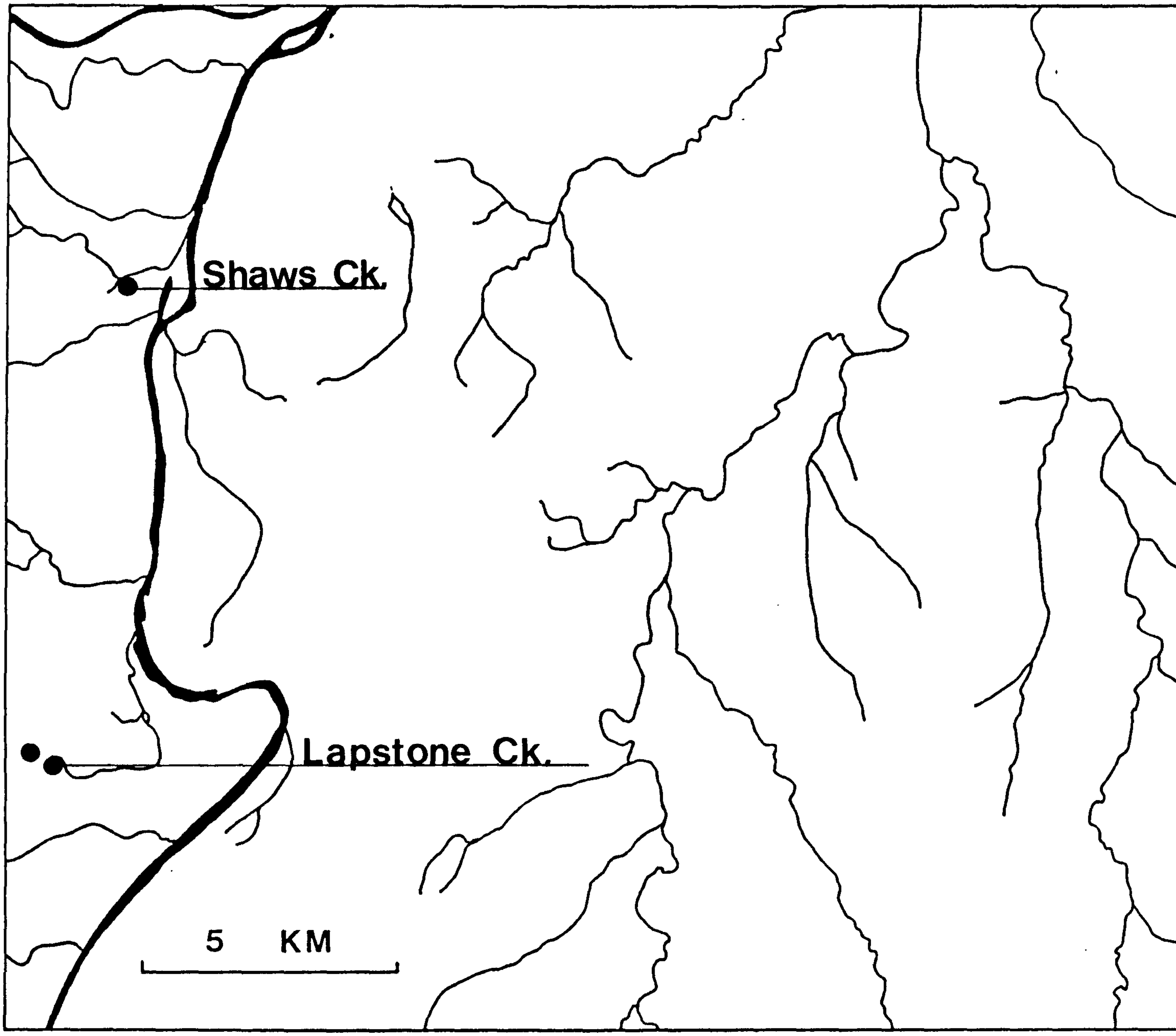


b



URE 2.2. The western Cumberland Plain (Lat. 33.49 S, Long.
149.50 E).
towns.

FIGURE 2.3. Archaeological sites in the study area excavated prior to this study. The two sites on Lapstone Creek were excavated by F. D. McCarthy, while Shaws Creek KI was excavated by E. D. Stockton.



ARCHAEOLOGICAL SITES EXCAVATED BEFORE 1975

The earliest evidence for possible Aboriginal occupation at the foot of the Blue Mountains comes from the gravel beds near Castlereagh, where Stockton found a dozen pebble tools in gravels estimated to be between 15,000 and 30,000 years old (Stockton and Holland, 1974). A uniface pebble tool, with three flakes dislodged by conchoidal fracture in a series along one side, was found near the base of the gravels close to a wood sample dated to 26,700 ± 1700 BP (GaK. 3445).

To the west of the study area, the Blue Mountains had been surveyed by Stockton (1970a; 1970b; 1973b; 1977b), Stockton and Holland (1974) and more recently by Johnson (1979). In addition, Bowdler has reviewed this research (Bowdler, 1981). Stockton proposed a hiatus between the *Capertian* and *Bondaian* phases, but this has been disputed by Johnson. Evidence from a number of sites suggests that there was a period of intensive occupation approximately 12,000 years ago, followed by a decrease in site usage, possibly related to worsening climatic conditions (Stockton and Holland, 1974).

The coastal archaeology of the Sydney district was intensively studied during the 1960s and 1970s, primarily by researchers based at the University of Sydney. Excavations include Royal National Park (Megaw, 1965), Gymea Bay (Megaw and Wright, 1966), Connells Point (Wade, 1967), Kurnell (Megaw, 1967), Audley (Cox, Maynard and Megaw, 1968), Balls Head (Bowdler, 1971), Wattamolla (Megaw and Roberts, 1974), Curracurrang (Glover, 1974), Newport (Tracey, 1974), Yowie Bay

(Poiner, 1974), and Bantry Bay (Ross and Specht, 1976), while extensive surface collections have been carried out by Dickson at Kurnell and Boat Harbour (Dickson, 1968, 1971, 1973, 1977a). Ross (1976) has reviewed the ethnographic data for the coast around Sydney.

The archaeological sequence on the coast is therefore well established, although there has been a distinct bias towards rockshelter sites. There is clear evidence of occupation around 7,500 years ago at the main Curracurrang site, with the initial appearence of backed blades being relatively late, possibly only 2,500 years ago (Megaw, 1974). Similarly, Megaw has suggested that backed blades dropped out of the toolkit within the last 1000 years, in contrast to the suggested 2000 years for this event on the south coast (Lampert, 1971).

These developments have often been interpreted as a shift from a generalised economy to a more specialised economy on the coast, where fishing is seen to have become the economic base. This is reflected in the greater use of shell fishhooks and ground bone barbs for fishing spears, at the expense of stone. The substitution of shell for stone on the coast has been seen as a concentration on immediately local resources. since the Hawkesbury sandstone around Sydney (with the exception of quartz) is almost totally lacking in suitable stone for manufacturing wooden artefacts. The large numbers of stone artefacts characteristic of the *Bondaian* phase suggest that major changes have occurred in settlement patterns or trading patterns over the past millennium.

A number of serious discrepancies occur when the data from the coastal sites and the Blue Mountains are compared. Doubt remains as to the timing of the decline of Bondi points and their subsequent disappearance from the archaeological record, and whether or not this happened synchronously on the coast and in the mountains. The work of McCarthy and Stockton provides a basis for answering these questions, but crucial to this discussion is the evidence from the Cumberland Plain.

2.5 Bias in site selection

One reason why so little research has been undertaken on open sites is that the geomorphic setting is unlikely to yield stratified archaeological remains. In the exceptional circumstances of alluvial deposition or aeolian dune formation, such stratification may well occur, but the shallow soils which cover most of the Cumberland Plain are not conducive to the formation of stratified archaeological sites. Without such stratification, material suitable for radiocarbon dating will not be found intimately associated with the lithic artefacts upon which archaeological sequences are established. In an Australian context, this type of problem has had two important consequences. Firstly archaeological research has been concentrated on specific kinds of sites (rockshelters, coastal middens, Pleistocene and Holocene dunes), a situation bound to result in a distorted picture of the past. Secondly, it is usually difficult to relate surface scatters to dated archaeological sites, except in the broadest terms. In the Sydney region, any site containing backed blades, blade cores, and microlithic debitage can reasonably be assumed to be no older than about 5,000 years, and if it occurs close to the coast probably no younger than 1,000 years. Further refinements of timing of occupation are difficult if not impossible unless a stratified deposit containing charcoal or other dateable material is also present. This lack of precision argues heavily against investing valuable research time and money into investigations of such sites.

In Australia, the emphasis of recent archaeological research has shifted from the earlier preoccupation with establishing regional sequences of artefacts to a closer examination of the variability within the archaeological record, both from the point of view of the taphonomic processes at work and techniques used for the retrieval of archaeological data. The questions asked are more likely to be related to the function of the artefacts in the site and the taphonomic processes associated with them rather than the presence or absence of specific artefact types. Also the site is increasingly being viewed in its environmental context, with the resource base around the site being perceived as of almost equal importance as the artefacts recovered. An extension of this process is the awareness of the value of distributions of all artefacts across the landscape.

The recognition that a coastal plain should be seen as an important component of prehistoric settlement pattern studies has not lessened the problems associated with surface sites. Rather it has meant that new methods and techniques must be employed, and a more rigorous application of statistical and archaeological theory must be applied. Each site or artefact location can be seen to represent combinations of four variables: time, space, activity and taphonomy. In a stratified site, whether open or rockshelter, carbon dating allows the temporal component to be isolated. Careful survey design can partially overcome the problems associated with spatial and taphonomic processes, leaving activity as the remaining variable. In the western Cumberland plain, the open sites generally preserve neither plant nor animal remains. Only the stone artefacts themselves are available to use as indicators of prehistoric activities. When viewed in conjunction with the environmental setting, the patterns in the data may begin to emerge under careful analysis.

If the assemblages in rockshelter sites differ from those on open sites, then it is likely that different activities were taking place on the two site types. This could also be related to seasonal occupation. In the past, the standard method of analysing assemblages has been to compare stone tool types, assuming that tools can be identified (McCarthy, 1948; 1964). This is certainly not always the case, and it is now generally recognised that many apparently unworked flakes have in fact been used as tools. Statistically reliable numbers of tools are not uncommon in late sites but rare in early sites. This is strong motivation to obtain as many data as possible from the totality of the lithic assemblages. All artefacts should be used in such an analysis, not just the formal tools, in order to maximise the information which can be obtained from the evidence available. Regions of high artefact density - the sites - should be used, but a strategy employed which also incorporates the artefacts located between sites if needed. It is just as important to be aware of where artefacts are not located as where they are located. The site or find spot should not be viewed in isolation, but in relation to its environmental setting.

2.6 Aims and methods

In the methodology adopted for this study, I selected an area for investigation which extends from the foot of the Lapstone Monocline east across the Nepean River onto the western Cumberland Plain. A representative rockshelter was excavated, and the assemblage spanning the late Pleistocene and most of the Holocene analysed as the baseline against which open site assemblages could be compared. Archaeological surveys were then undertaken to quantify artefact distributions across the landscape. Detailed analyses were carried out on each stone artefact located, environmental parameters recorded for each artefact location, and the data stored on a microcomputer for rapid analysis and retrieval.

Excavations were carried out on stratified open sites to compare open site assemblages with rock shelter assemblages. These excavations were undertaken so that a chronology could be established for the open site lithic sequence, and the dated sequence could then be compared with the rock shelter sequence.

Environmental surveys were undertaken to identify resource-rich areas within the western Cumberland Plain. Vegetation surveys were conducted, and in association with historical accounts, the vegetable foods available to prehistoric communities were estimated. Historical accounts and other published faunal lists were used to compile a faunal resource list. Surveys were also undertaken to identify potentially useful lithic resources.

The ethnographic data for the Sydney region were examined to identify socio-economic groups which may have utilised the resources within the study area. The economic base of those Aborigines living in the western Cumberland Plain was assessed, and this was related to the location of sites and the lithic assemblages on those sites. Current models of Aboriginal settlement pattern and land use were then tested against the archaeological and ethnographic data, and a sequence proposed for the late Pleistocene and Holocene.

I intend to show that prehistoric sites do indeed exist across the western Cumberland Plain; that major changes in the settlement pattern and mechanisms of resource exploitation have occurred during the Holocene; that the changes in lithic technology associated with these changes are identifiable on open site assemblages; and that unless the distribution of artefacts is examined across the entire study area and not just within excavated sites, it is not possible to interpret these changes correctly. In addition a survey method is suggested for forested areas which may allow a more realistic assessment to be made of the potential archaeological resources within such areas.

The role of the coastal plain in Aboriginal palaeoecology is evaluated, and conclusions drawn relating to the question of "intensification" as it is generally applied to eastern Australia.

CHAPTER 3

ENVIRONMENTAL SETTING AND RESOURCE BASE

3.1 Geology and Topography

The Cumberland Plain is an undulating to flat area of predominantly heavy clay soils supporting grassy woodland and open forest. It is surrounded by steeply dissected sandstone on the north (Hornsby Plateau), west (Blue Mountains) and south (Woronora Plateau), and is central to the Sydney Basin. The geology of the area surveyed is shown in Figure 3.1. The vast majority of the rocks are Triassic in age, although a few post-Triassic igneous intrusions are present, probably of Jurassic and Tertiary age (Branaghan and Packham, 1967; Nashar, 1967). Within the study area, alluvial deposits are associated with the present and former courses of the major waterways (Nepean/Hawkesbury River, South Creek, and Eastern Creek), and a substantial area of Tertiary deposit extends east from the Nepean to St. Marys and Riverstone (Gobert, 1978).

3.2 Soils

Off the sandstone, the soils are of two kinds: clay derived from the underlying Wianamatta shale, and alluvial deposits associated with the Nepean/Hawkesbury River system and its tributaries. Some of the alluvial deposits may have been reworked into aeolian dunes, particularly in the vicinity of Agnes Banks and Pitt Town (Gobert, 1978; Benson, 1981a; Whittle, 1977).

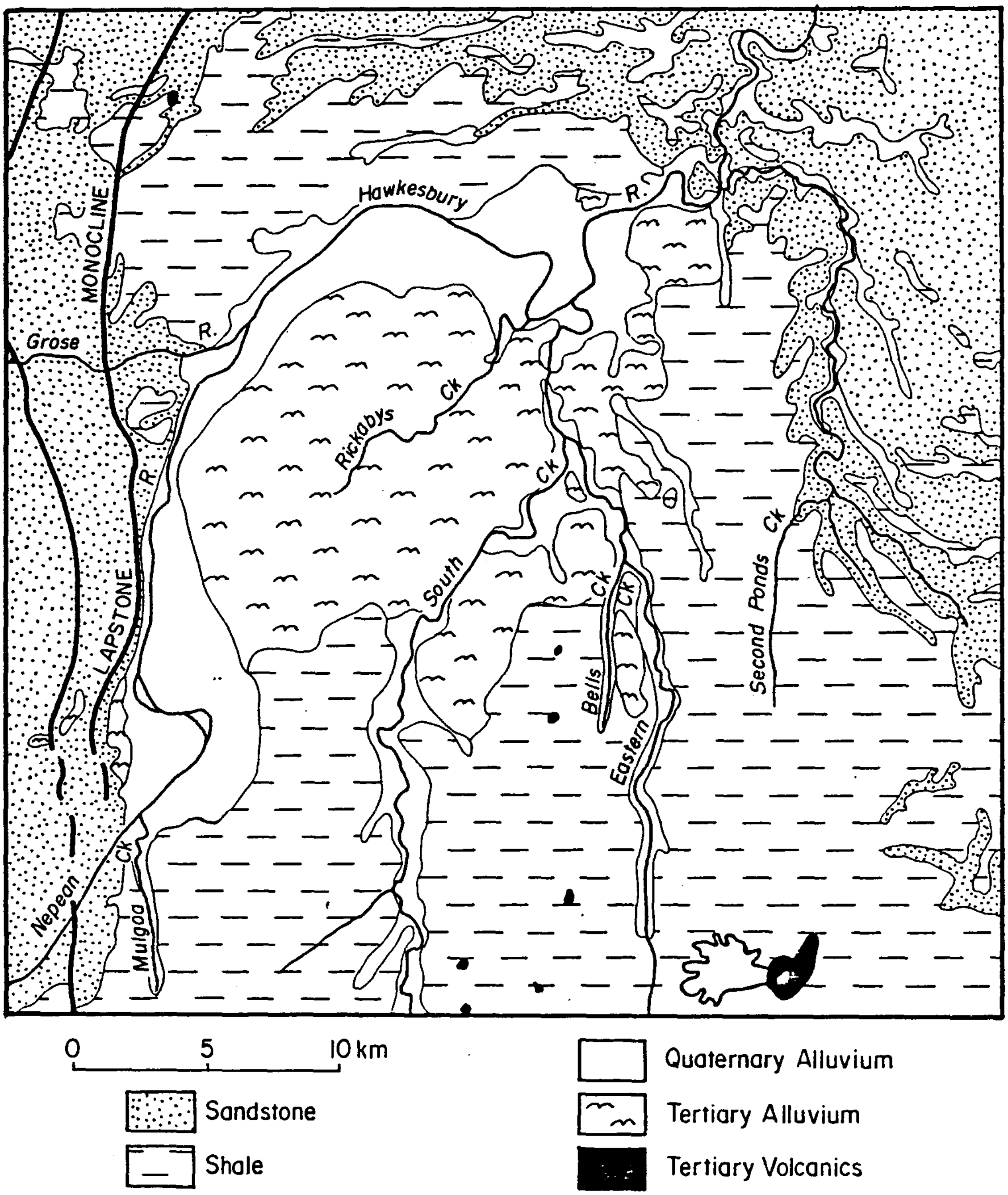


FIGURE 3.1. The western Cumberland Plain: geology.

Soil maps of the major alluvial deposits have been constructed (Walker and Hawkins, 1957), and some detailed descriptions exist for particular areas such as the City of Blacktown (Hannam et al., 1980; Edmond et al., 1980).

3.3 Climate

The annual rainfall pattern varies across the plain, but mostly falls within the range of 700 - 1000 mm compared with just over 1200 mm at Sydney and almost 1500 mm at Bilpin in the Blue Mountains to the west. There is evidence of a rainshadow south of Windsor (where the annual precipitation may be lower than 650 mm), and of a definite dry season (August-September). Peak rainfall is in late summer and early autumn, with spring and early summer relatively dry (Forster et al., 1977). Temperature ranges tend to be more extreme on the plain than on the coast or in the Blue Mountains, with a January mean monthly maximum at Penrith of 30 ^{o} C, and July mean monthly minimum of 3^{o} C.

3.4 Hydrology

The landscape is dominated by the Nepean/Hawkesbury River system, which cuts through the Hawkesbury Sandstone formations of the Blue Mountains before entering the Cumberland Plain at Emu Plains. As the Nepean River, it flows along the foot of the Lapstone Monocline as far as Yarramundi, where it is joined by the Grose River and becomes the Hawkesbury River. The Hawkesbury swings to the northeast away from the Hawkesbury Sandstone, reentering the sandstone near the town of Wilberforce. Between the Grose junction and Wilberforce is a broad floodplain, consisting of both Pleistocene and Holocene silts, sands and gravels.

The Hawkesbury/Nepean system is subject to periodic flooding, although this has been moderated in recent times through damming of the Warragamba River. The greatest recorded flood was in 1867, when the river rose over 20 metres at Windsor (Scholer, 1974).

Three major creeks flow across the study area. Ropes Creek joins with South Creek north of St. Marys, and Eastern Creek flows into South Creek near Vineyard. South Creek then joins the Hawkesbury River at Windsor (see Figure 3.1). These three waterways are also subjected to occasional flooding. Smaller creeks include those which flow into the Nepean from the west (Jamisons Creek, Lapstone Creek, Fitzgeralds Creek, Shaws Creek, Lynches Creek), those which flow from the east (Mulgoa Creek, Peachtree Creek, Cranebrook Creek, Rickabys Creek), and those which enter the Hawkesbury system to the north of the study area (First Ponds Creek, Second Ponds Creek).

3.5 Current Land Use

Present land use in the study area is diverse. Urban development is heavy adjacent to the main roads and railway lines, with large population centres like Penrith and Blacktown falling within the boundaries. The western part of Sydney is one of the most rapidly growing population centres in Australia, and in addition to the housing estates which have been developed within the last ten years, a number of large industrial complexes have also been established.

The western boundary of the study area encompasses part of the Lapstone Monocline immediately west of the Nepean River. North of Emu Plains the area generally has been left undeveloped, although overhead transmission lines run along the foot of the monocline parallel to the river. The firetrails and maintenance trails which serve this area are the only forms of disturbance on the western side of the River between Emu Plains and Castlereagh, but from Castlereagh to Yarramundi are to be found farms, gravel extraction plants, convention centres and houses.

Penrith is located on the eastern bank of the Nepean immediately south of a point where the river swings west towards the foot of the Lapstone Monocline. Between Penrith and Castlereagh, the floodplain consists of a surface layer of sands and silts overlying a gravel layer. This gravel is being commercially extracted, and ultimately it is intended that the holes left after the gravels have been removed will be filled with water diverted from the Nepean River to form a series of large lakes. The archaeological survey undertaken for the Penrith Lakes Scheme Environmental Study forms a component of this study (Kohen, 1984a).

A second extractive industry operates between Castlereagh and Richmond at Agnes Banks. Here a sand deposit, possibly of Pleistocene age, is being removed from an area approximately six kilometres long and three kilometres wide. Because of the unique vegetation growing on this deposit, an area of land has been set aside for a nature reserve.

Between Agnes Banks and South Creek are the only major stands of natural vegetation remaining on the western Cumberland Plain. From South Windsor to Llandilo, a substantially undisturbed open woodland is found growing on sandy soils derived from Tertiary alluvial sediments. Castlereagh State Forest is located in the centre of this area, providing a refuge for a range of animals. The area is criss-crossed with firetrails and other vehicle tracks.

Between South Creek and Eastern Creek, the principal land use is grazing for cattle. Although it has been mostly cleared, some small stands of vegetation remain, particularly along and adjacent to the Plumpton Ridge which runs parallel with and to the north of Richmond Road. To the south between Ropes Creek and Rooty Hill, the massive housing estate covers the suburbs of Dharruk, Emerton, Wilmot, Lethbridge Park, Hassall, Hebersham, Whalan, and Tregear, and further housing developments are planned north as far as Richmond Road. An area planned for an industrial estate near Eastern Creek was also surveyed as part of this study (Kohen, 1985b).

From Eastern Creek to the eastern boundary of the study area, the land uses are diverse. This region includes the urban centre of Blacktown, a major Council reserve along Eastern Creek (Nurragingy Reserve), Prospect Reservoir serving Sydney's water supply, a lawn cemetery, an aerodrome and Naval Training Centre (H.M.A.S. Nirimba), an Overseas Telecommunications Centre, and Parklea Prison. The remaining land is largely cleared paddocks used for grazing or small farms.

The study area has a wide range of land uses, some destructive to Aboriginal sites and others protective. The rate of development made it imperative that an a major study be undertaken to identify potentially significant archaeological sites and areas.

3.6 Original Vegetation

Vegetation associations are largely determined by a combination of rainfall and soil (Benson, 1981b). For the Penrith 1:100000 Vegetation Map (which includes the entire study area), Benson has identified thirteen distinct plant communities, but for the purposes of identifying vegetation groupings useful to Aborigines, the vegetation associations can be broadly grouped into six habitats:

1. Kurrajong and Gullies along the Lapstone Monocline

The combination of shale and heavy rainfall produces a unique combination in the Kurrajong area, where the resulting vegetation contains many rainforest and rainforest-margin species. Because of clearing, only a few pockets remain. Similar vegetation occurs in the some of the steep gullies further south along the Lapstone Monocline.

2. Hawkesbury Sandstone west of the Nepean River

The open-forest growing on Hawkesbury Sandstone at the foot of the Blue Mountains is different from all the other vegetation associations to the east of the river, and is similar in composition to the communities which grow on sandstone along the coast. It is dominated by *Eucalyptus fibrosa*, *E. sclerophylla* and *Angophora bakeri*, with an understorey containing *Dodonea triquetra*, *Bursaria spinosa* and a range of wattles.

3. The Nepean/Hawkesbury River and its Floodplain

At the time of European settlement, the western part of the study area adjacent to the Nepean floodplain supported a tall open-forest dominated by the forest red gum, *Eucalyptus tereticornis*. *Casuarina cunninghamiana* occurred immediately adjacent to the creek banks, and *Phragmites australis* lined the streams. In the more sheltered areas, *Eucalyptus pilularis* was also found in this community, often with the climbers *Geitonoplesium cymosum* and *Eustrephus latifolius*. On less sheltered flats, *Melaleuca linariifolia* and *Astroloma humifusum* formed components of the understorey (Forster et al., 1977). Freshwater swamps, now drained, also existed on the floodplain, and these were dominated by *Eleocharis sphacelata*.

4. <u>The Agnes Banks Sand</u>

Benson (1981a) describes in detail the vegetation association found growing on a white sand deposit at Agnes Banks, approximately five kilometres south of Richmond. This association is dominated by *E. sclerophylla*, *Angophora bakeri*, and a number of tall Banksias (*Banksia* spp.), but includes areas of woodland, low open-woodland and sedgeland.

5. <u>Castlereagh State Forest and Surrounding area</u>

This low rainfall area is predominantly woodland and low-woodland dominated by *E. sclerophylla*, with patches of open-forest dominated by *E. fibrosa*.

6. <u>Wianamatta Shale</u>

Although most of this vegetation association has been cleared, it would appear that the majority of the shale-derived soils supported a woodland vegetation dominated by *Eucalyptus moluccana*, *E. tereticornis*, and *E. crebra*. Along the transition zone between the Wianamatta Shale and Tertiary alluvium, some species overlap.

3.7 Plant Resources

During the time that Aboriginal people have occupied the western Cumberland Plain, the vegetation composition has changed in response to changing climate. Only during the last few thousand years a relatively stable climate (Young, 1986), together with Aboriginal burning practices, has resulted in the development of the vegetation patterns evident in 1788 (Hope, 1983).

Throughout the late Holocene, Aborigines living on the western Cumberland Plain have had a comparatively stable environment in which to pursue their hunting and gathering activities. In order to exploit this area successfully, they used a wide range of plants both for food and to provide them with raw materials necessary for other aspects of their culture. It is therefore important to understand the distribution of the plant resources which were available during the late Holocene, and how they may have been used by Aboriginal people.

In recent years, a growing number of archaeologists and prehistorians have become interested in Aboriginal use of plants (Beaton, 1982; Gott, 1982; 1983; see also Monash University, 1981). Few of these studies have actually carried out vegetation surveys within a defined study area. Concurrently with the archaeological surveys in the western Cumberland Plain, vegetation surveys were carried out in order to identify which potentially useful plants may have occurred in close proximity to the sites (Kohen and Edgecombe, in press). Flowering and fruiting times were also recorded. Both data sets were stored on a microcomputer, allowing for rapid cross-correlation (Kohen, 1984b). This vegetation survey was not intended to be comprehensive, as adequate floral surveys on the Cumberland Plain have already been completed (Beadle et al., 1972; Forster et al., 1977; Benson, 1981a; 1981b). Rather, the information from the surveys has been used to construct a list of *potentially* useful plants. The list was expanded by conducting a literature survey to establish those plants occurring in the Sydney region recorded as having been used by Aboriginal people in southeastern Australia. To this end, "Flora of the Sydney Region" was used as the basic Sydney species list (Beadle et al., 1972).

To confirm that at least some plant foods were actually eaten in the Sydney region, the local ethnographic data were examined in detail. Unfortunately ethnographic accounts around Sydney tend to concentrate on the activities of the men, and because men usually hunted and trapped while women collected vegetable foods, reports on plant gathering are few. This bias in the ethnographic record is one of the reasons why it is necessary to deal primarily with *potential* plant resources rather than resources recorded as actually used. Although some Australia-wide examinations of the relationship between plants and Aborigines have been undertaken (Carr and Carr, 1981), detailed investigations of this kind are rare in southeastern Australia. One notable exception is the salvage ethnographic work undertaken on the Beecroft Peninsula (Lampert and Sanders, 1973). With the knowledge of which plant resources were available to and used by Aborigines in the Sydney region, the relative importance of plants in the diet and culture can be assessed. Consideration of management of plant resources by the use of fire can be viewed in relation to the economy being practised at the time of European settlement of Australia.

Ethnographic accounts of Aborigines in the Sydney region all agree that there were two distinct economies practised; one along the coast and a second inland across the plain. This second economy was that of the "woods tribes". Tench (1793: 230) describes these people in the following way:

> "They (the inland Aborigines) depend but little on fish, as the river yields only mullets, ... their principal support is derived from small animals which they kill, and some roots (a species of wild yam chiefly) which they dig out of the earth."

David Collins (1802: 462) described the vegetable component of the diet of the Sydney Aborigines as consisiting of "a few berries, the yam and fern root, the flowers of the different Banksia, and at times some honey", but added that the inland Aborigines also "make a paste formed of the fern-root and the large and small ant bruised together; in the season they also add the eggs of this insect".

This list does not include the burrawang *Macrozamia communis*, which was recorded by almost all the early observers, and was apparently a major source of carbohydrate when the seeds were available. In addition to the burrawang, a second smaller species of macrozamia (*Macrozamia spiralis*) grows to the east of the Nepean River. Both species are poisonous and required extensive preparation by soaking and pounding before the toxins were removed (Kohen, 1983). One method of preparation states that the women would:

> "gather it when ripe, and would put it to soak in nets made of the fur of opossums. After allowing it to soak for three or four days in rain water, they would bruise it and bake it into cakes fifteen inches in diameter and eat it when hungry" (Edgeworth, 1890: 119).

Backhouse (1843) recounted a slightly different method of preparation.

> "The Blacks place these nuts under stones, at the bottom of the water, in order to extract some noxious principle from them; they are afterwards converted into food. In wet weather, an insipid, jelly like gum, which is wholesome, and not unpalatable, exudes from the plant".

At Wallaga Lake on the far south coast of New South Wales, the women would leave the fruits on the ground until the fleshy pericarp had decomposed before collecting the nuts (T. Thomas, pers. comm.).

Other plant foods could be eaten without such painstaking preparation. However, many of them must have contained toxins, for Watkin Tench (1793: 48) noted that "(they) broil ... their vegetables on a fire, which renders these last an innocent food, though in their raw state many of them are poisonous".

Orchids and lillies with edible tubers were plentiful in the open woodlands to the east of the Nepean River, where Hunter (1793: 104) reported that "the natives here appear to live chiefly on the roots which they dig from the ground", including "the wild yam (found) in considerable quantities, but in general very small". The banks of the Nepean were often submerged by floodwaters, producing a rich soil dominated by tuberous plants. The "yams" were "in greatest plenty on the banks of the river; a little way back they are scarce" (ibid).

Along the coastal strip, Bungwall fern (*Blechnum* sp.) provided a staple (Bancroft, 1895). Other references to "fern root" in the Sydney region are usually not so specific. Common bracken fern, *Pteridium esculentum*, is also known to have been used for food (Backhouse, 1843).

Few accounts of foods along the Nepean River relate to fruits. Governor Phillip (1791) describes a tree growing along the river bank. He says that "... they are about the size of large walnut trees, which they resemble; they shed their leaves and bear a small fruit, which is said to be very wholesome". This is almost certainly a description of white cedar, *Melia azedarach*, but other than a passing reference to a copious yellow fruit adjacent to the Hawkesbury, there does not appear to be any confirmation that the fruits of the white cedar were eaten by Aborigines.

Backhouse (1843) describes a meeting with a party of Aborigines near Goulbourn, where "one of the women was eating raw sow-thistles, as salad, with avidity". At Bargo Brush in October 1836, he reported that "some of the women had considerable quantities of Native Currents, the fruit of *Leptomeria acida* ..".

Backhouse also records a number of other food plants, including *Billardiera scandens*, *Oxalis* spp., Rubus spp., *Sambucus gaudichaudiana*, *Coprosma* spp., Astroloma spp., *Leucopogon* spp., *Solanum laciniatum*, *Exocarpus cupressiformis*, and a range of orchids with tubers (*Gastrodia*, *Pterostylis*, *Caladenia*, *Microtis*, *Prasophyllum*, *Diuris*, and *Thelymitra*). He also discusses at length the preparation of fern root, *Pteridium esculentum*.

Many climbers also have roots or tubers which were eaten. Edgeworth (1890) mentions three plants with roots of tubers consumed by the Aborigines. *Glycine tabacina* has a root which is said to have a liquorice flavour, while Eustrephus *latifolius* and *Geitonoplesium* cymosum were also eaten regularly.

Probably the most interesting account of food plants in the Sydney region comes from William Dawes (1791), who, while recording the vocabulary of the coastal dialect of the Dharug language, suggested that the Aborigines perceived food plants in one of three categories. One group of plants were referred to as ***wigi***, a term which may be loosely translated as "berry". Included in this group were the **tyibung** (Geebung, *Persoonia* spp.), **buruwang** (*Macrozamia* communis), **takuba** (probably *Exocarpus cupressiformis*), ***marrinmara***, ***magara***, **bomula**, ***mirriburu*** (probably ***murri* buru**, literally a large amount of food), and ***tyiwaragang***.

A second class of foods included ***watangal*** (a Banksia), ***ngurumaradyi***, ***wiyigalyang***, **konamea**, ***warata***, **kamarang**, **burudun**, and ***mirrigaylang***. These words are "the names of flowers bearing honey in sufficient quantity to render them notorious to the natives". The only easily translated plant in this list is the waratah, *Telopea speciosissima*, but the others almost certainly include Banksia, Grevillia and Melaleuca species.

The third group contained the foods obtained from under the ground, but no single word was recorded for these foods. However, Goth (1983) records eleven accounts of 'yams' (other than *Microseris scapigera*) of various kinds in Victoria. These are referred to as *darook*, *darrook*, *djarug*, *dyarruk*, *taaruuk*, *taruuk*, *tar-rook*, and *turruc*. There can be little doubt that this word is identical with the name of the tribe of Aborigines living across the western Cumberland Plain, variously recorded as *Dharug*, *Dharuk*, *Daruk*, *Dharoog* and *Dharruk*. This is almost certainly derived from the word for teeth, given as *da-rak* by Dawes for the coastal dialect, and *tarra* for the inland dialect (Kohen, 1984b). Many of the small white tubers do bear some resemblance to teeth. The fact that the Aborigines of the western Cumberland Plain referred to themselves as *Dharug* strongly suggests that they did indeed rely heavily on tuberous plants.

Tables 3.1, 3.2 and 3.3 summarise the food plants which occur in the Sydney area and are also recorded as having been eaten by Aborigines. Some rainforest and rainforest-margin plants have been included, since they may have been present along the rich floodplain or in the steep gullies at the foot of the Lapstone Monocline.

GENUS	SPECIES	HABITAT					
		1	2	3	4	5	6
Acmena	*smithii*	*	*				
Adriana	*glabrata*	*	*				
Alectryon	*subcinereus*	*					
Astroloma	*humifusum*			*	*	*	*
Astroloma	*pinifolium*			*	*	*	*
Billardiera	*scandens*	*	*				
Breynia	*oblongifolia*	*	*	*			
Caprobrotus	*spp*			*			
Cayratia	*clematidea*	*	*				
Cissus	*antarctica*	*	*				
Cissus	*hypoglauca*	*	*				
Citriobatus	*pauciflorus*	*	*	*			
Clerodendrum	*tomentosum*	*					
Conospermum	*longifolium*		*				
Coprosma	*spp*	*					
Diospyros	*australis*	*					
Elaeocarpus	*reticulatus*	*	*	*			
Elaeodendron	*australe*	*					
Endiandra	*spp*	*					
Eupomatia	*laurina*	*	*				
Exocarpus	*cupressiformis*		*	*	*	*	*
Ficus	*coronata*	*	*				
Ficus	*rubiginosa*	*	*				
Hedycarya	*angustifolia*	*					
Jacksonia	*scoparia*		*				
Leptomeria	*acida*		*	*			
Leucopogon	*spp*	*	*	*	*	*	*
Lissanthe	*sapida*		*	*	*		
Lissanthe	*strigosa*		*	*	*	*	*
Melia	*azedarach*		*	*			
Monotoca	*elliptica*		*	*	*		
Monotoca	*scoparia*		*				
Morinda	*jasminoides*	*	*				
Myoporum	*spp*		*	*	*	*	*
Passiflora	*herbertiana*	*					
Persoonia	*spp*		*	*	*	*	*
Planchonella	*australis*	*					
Podocarpus	*elatus*	*	*				
Rapanea	*variabilis*		*	*	*	*	*
Rubus	*hillii*		*	*			
Rubus	*parvifolius*		*				*
Rubus	*rosifolius*		*	*	*		
Sambucus	*australasica*	*					
Sambucus	*gaudichaudiana*		*		*	*	*
Schizomeria	*ovata*	*					
Solanum	*laciniatum*	*					
Solanum	*aviculare*	*					
Styphelia	*spp*		*	*	*	*	
Syzygium	*coolminianum*	*	*				
Syzygium	*paniculatum*	*					

TABLE 3.1. Edible fruits found in the Sydney area. For habitats, refer to the text.

GENUS	SPECIES	PART EATEN
Acianthus	*caudatus*	tuber
Alocasia	*macrorrhizos*	rhizome
Anguillaria	*spp*	tuber
Arthropoidum	*milleflorum*	tuber
Arthropoidum	*minus*	tuber
Blechnum	*spp*	rhizome
Brachychiton	*populneum*	root
Bulbine	*bulbosa*	tuber
Burchardia	*umbellata*	tuber
Caesia	*vitatta*	tuber
Caladenia	*spp*	tuber
Cayratia	*clematidea*	root
Cissus	*antarctica*	tuber
Cissus	*hypoglauca*	tuber
Cryptostylis	*erecta*	tuber
Cymbidium	*spp*	tuber
Davallia	*pyxidata*	roots
Dichopogon	*fimbriatus*	tuber
Dichopogon	*strictus*	tuber
Dioscorea	*transversa*	tuber
Diuris	*spp*	tuber
Elaeocharis	*sphacelata*	tuber
Eustrephus	*latifolius*	tuber
Gastrodia	*spp*	tuber
Geitonoplesium	*cymosum*	tuber
Geranium	*spp*	root
Glycine	*tabacina*	root
Haemodorum	*spp*	tuber
Hardenbergia	*violacea*	roots
Hypoxis	*hygrometrica*	rhizome
Ipomoea	*spp*	tuber
Marsdenia	*spp*	tuber
Microtis	*spp*	tuber
Nymphaea	*spp*	tuber
Parsonsia	*straminea*	root
Patersonia	*spp*	rhizome
Phragmites	*australis*	rhizome
Prasophyllum	*spp*	tuber
Pteridium	*esculentum*	rhizome
Pterostylis	*spp*	tuber
Scirpus	*spp*	rhizome
Thelymitra	*spp*	tuber
Thysanotus	*tuberosis*	tuber
Trachymene	*incisa*	root
Triglochin	*spp*	tuber
Typha	*spp*	roots

TABLE 3.2. Edible roots, tubers and rhizomes found in the Sydney area.

GENUS	SPECIES	PART EATEN
Acacia	*longifolia*	seeds
Banksia	*spp*	nectar
Cryptocarya	*spp*	nuts
Cyathea	*australis*	shoots
Dendrobium	*speciosum*	stem
Doryanthes	*excelsa*	stem
Grevillia	*spp*	nectar
Lambertia	*spp*	nectar
Livistona	*australis*	leaf
Macrozamia	*communis*	seeds
Macrozamia	*spiralis*	seeds
Oxalis	*corniculata*	leaves
Telopea	*speciosissima*	nectar
Xanthorrhoea	*spp*	shoots

TABLE 3.3. Miscellaneous food plants found in the Sydney area.

Several plant foods collected in the study area were submitted to the Human Nutrition Laboratory at the University of Sydney for analysis. The analysis has shown that *Macrozamia communis*, Arthropoidum *milleflorum*, and *Caesia vitatta* all contained carbohydrates which were released much more slowly than European foods (Fitz-Henry and Brand, 1982). *Caesia vittata* also has a high concentration of iron (J. Brand, pers. comm.). One of the fruits common in the Sydney region, *Leptomeria acida*, has been shown to have a particularly high vitamin C content. From a nutritional point of view, the vegetation in the western Cumberland Plain was apparently nutritious and was quite capable of providing the local Aborigines with the basis of a more than adequate diet (see also Cribb and Cribb, 1975).

Many other plants were used by Aborigines. Maiden (1889) lists a large number of plants from which the Aborigines obtained fibre for making string and rope, several of which occur in the

Sydney area. The most important of these belong to the families Sterculiaceae and Malvaceae, and they include *Abutilon oxycapum*, *Hibiscus* spp., *Commersonia fraseri*, *Rulingia pannosa* and both species of *Brachychiton*. *Ficus* spp. also provided fibres, particularly from the roots, while a number of *Pimelia* species also produced fibre of great strength. *Dianella laevis*, *Doryanthes excelsa*, *Lomandra spp.*, *Livistona australis* and *Phragmites communis* were all used to weave baskets. *Melaleuca* spp. provided bark which was "used, amongst other purposes, by the Aboriginal women to wrap their children in" (Maiden, 1889: 627).

Resin was primarily obtained from the Grasstree *Xanthorrhoea resinosa var resinosa*, although other sources were probably also used. Native bees wax, from the hives of the small black bee (*Trigona* spp.), contains a large proportion of *Xanthhorrhoea* resin, and this was also used as an adhesive.

A variety of plants were used to provide wood for the manufacture of wooden artefacts. Eucalypts provided the wood from which was carved the coolomon or dish. Spears were often made from a shaft of *Xanthorrhoea* flower stalk, tipped with a hardwood point. Few wooden artefacts remain in existence from the western Cumberland Plain. Two throwing sticks, found on Werrington House Estate in the 1820's and now housed in Macquarie University Library, were described in the records of the collection as being "made from a wood not known in that district". Indeed, an examination of the throwing sticks by John Ford of the Forestry

Commission of New South Wales confirmed that the wood was particularly dense, and was possibly obtained from an *Acacia* species, although not a local species. The likely source is the Upper Blue Mountains (J. Ford, pers. comm.).

Another major use of plants was as medicines. There are almost no references to specific medicinal plants being used by Aborigines in the Sydney region, but a number of such plants used in other parts of southeastern Australia also occur adjacent to Sydney. A list of the other useful plants is included in Table 3.4.

As can be seen from Table 3.1, the majority of edible fruits occur in or near rainforest and steep gullies. Few edible fruits are to be found in the low rainfall areas in the central part of the western Cumberland Plain. Table 3.5 shows the seasonal availability of some of the important fruits, and it is apparent that most of these fruits are available in the autumn and winter months. However, it is clear from Table 3.2 that tuberous plant foods are found in a wider range of habitats. While species like *Dioscorea transversa*, *Eustrephus latifolius*, and *Marsdenia rostrata* grow in wet areas and along the river bank, lillies and orchids grow in the open woodlands. Swamps and creeks also provide a wide range of similar foods. The ethnographic accounts stress the importance of tuberous plants ("yams") to the Aborigines west of Parramatta.

GENUS	SPECIES	USE
Abutilon	*spp*	fibre
Acacia	*longifolia*	fish poison
Acacia	*spp*	fishgig, woomera
Alocasia	*macrorrhizos*	medicine
Alphitonia	*excelsa*	fish poison
Backhousia	*myrtifolia*	boomerangs
Brachychiton	*populneum*	fibre for nets
Cassytha	*spp*	medicine
Casuarina	*spp*	canoes, shelter
Commersonia	*fraseri*	fibre
Cymbidium	*spp*	medicine
Dianella	*laevis*	baskets
Doryanthes	*excelsa*	spear, baskets
Duboisia	*myoporoides*	produces stupor
Eucalyptus	*agglomerata*	canoes
Eucalyptus	*gummifera*	fishing lines
Eucalyptus	*spp*	shield, coolomon
Eupomatia	*laurina*	fishing lines
Ficus	*coronata*	smoothing weapons
Gnaphalium	*luteo-album*	medicine
Gymnostachys	*anceps*	string
Hibiscus	*spp*	fibre
Imperata	*cylindrica*	dilly bags
Leptospermum	*spp*	used to carry fire
Livistona	*australis*	fishing lines
Livistona	*australis*	shelters
Lomandra	*spp*	dilly bags
Melaleuca	*spp*	shelters, babies
Phragmites	*communis*	baskets
Pimelia	*spp*	fibre
Rulingia	*pannosa*	fibre
Schoenus	*melanostachys*	twine
Smilax	*glyciphylla*	medicine
Stephania	*japonica*	fish poison
Xanthorrhoea	*spp*	spear shaft
Xanthorrhoea	*resinosa*	adhesive (yellow)

TABLE 3.4. Non-food plants used by Aborigines in the Sydney Region.

GENUS	SPECIES	SPRING	SUMMER	AUTUMN	WINTER
Acmena	*smithii*			*	*
Adriana	*glabrata*				
Alectryon	*subcinereus*				
Astroloma	*humifusum*	*	*	*	*
Astroloma	*pinifolium*				
Billardiera	*scandens*			*	*
Breynia	*oblongifolia*	*	*	*	*
Caprobrotus	*spp*		*		
Cayratia	*clematidea*	*	*	*	*
Cissus	*antarctica*			*	
Cissus	*hypoglauca*		*	*	*
Citriobatus	*pauciflorus*	*			*
Clerodendrum	*tomentosum*		*	*	*
Conospermum	*longifolium*		*		
Diospyros	*australis*				
Elaeocarpus	*reticulatus*	*			
Elaeodendron	*australe*				
Endiandra	*laurina*				
Eupomatia	*laurina*			*	
Exocarpus	*cupressiformis*	*	*		*
Ficus	*coronata*	*	*	*	
Ficus	*rubiginosa*		*		
Hedycarya	*angustifolia*				
Leptomeria	*acida*	*			*
Leucopogon	*spp*	*	*	*	
Lissanthe	*sapida*	*			*
Lissanthe	*strigosa*	*			*
Melia	*azedarach*				*
Monotoca	*elliptica*		*		
Monotoca	*scoparia*				
Morinda	*jasminoides*			*	*
Myoporum	*spp*	*		*	*
Passiflora	*herbertiana*			*	
Persoonia	*spp*		*	*	
Planchonella	*australis*	*	*		
Podocarpus	*elatus*			*	
Rubus	*hillii*			*	
Rubus	*parvifolius*	*	*	*	
Rubus	*rosifolius*	*	*	*	*
Sambucus	*australis*				
Schizomeria	*ovata*				
Solanum	*laciniatum*			*	*
Solanum	*aviculare*			*	*
Styphelia	*spp*	*	*		
Syzygium	*coolminianum*		*	*	
Syzygium	*paniculatum*		*	*	

TABLE 3.5. Seasonal availability of some edible fruits in the Sydney area.

The only other detailed archaeological survey close to Sydney which compiled an extensive list of plant resources was undertaken in the Gosford-Wyong region (Vinnicombe, 1980). The results of this vegetation study suggest that the majority of all kinds of plant resources are available in summer, with the least number of species available during the winter months. This apparent anomaly may be due in part to differences in flowering and fruiting times between the coast and the mountains.

One important aspect of Aboriginal economy was the practice of regularly burning the underbrush. Aborigines were still burning large tracts of land at Castlereagh as late as the 1820's (Mansfield, 1822). Phillip (1791) observed "the natives so frequently setting fire to the country, which they do to catch the opossum, flying squirrel, and other animals ...". Although Aboriginal burning may well have been used to catch small game, it may also have played an important role in the regeneration of some useful food plants. Beaton (1982) reported that seed production in *Macrozamia communis* increased significantly after burning, a pattern which is not uncommon in a variety of species.

A regular low intensity burning of the open woodlands across the Cumberland Plain may have maintained an environment particularly suitable for tuber-producing species to the detriment of other species. The biology of plants with fleshy underground storage organs has been examined in detail only for western Australia, but the same principles would apply in other parts of Australia (Pate and Dixon, 1981). The fact that many of the yam beds along the Hawkesbury provided a regular food resource suggests that some care may have been taken to ensure that the resource was renewable. As Hallam states, " Gathering yams (*Dioscorea*) was anything but a random process ... it was certainly not a matter of digging out a root here and there, but of returning regularly to extensively used tracts" (Hallam, 1979: 12). Perhaps the soft sand beside the Nepean and Hawkesbury Rivers was easier to dig with wooden digging sticks than the heavier clay soils further east.

3.8 Faunal Resources

Because of the extensive clearing which has been carried out in the study area over the past two hundred years, many animal species which did occur in 1788 have disappeared altogether, while others now have very retricted distributions. Those species most seriously affected are the large mammals and birds. A small population of wallabies (probably the red-necked wallaby, *Macropus rufogriseus*) remain in and adjacent to Castlereagh State Forest, but they are the only macropod population still extant east of the Nepean River. Emus were common before extensive settlement occurred, but were quickly shot out (Tench, 1793; Collins, 1802; Best, 1843).

Table 3.6 identifies the larger animal species which were probably found on the western Cumberland Plain in 1788 (Marlow, 1958; Davey et al., 1980), and which are recorded as having been hunted by Aborigines (Collins, 1802; Best, 1843; Tench, 1793;

Barallier, 1802). Although some species may have been only seasonally abundant, most would have been available regardless of seasonal conditions, although varying in abundance.

To this list must be added a wide variety of fish, birds, insects and aquatic resources. Freshwater mullet (*Mugil* spp.), bass (*Percalates novemaculeatus*), estuary perch (*Percalates colororum*) and eels (*Anguilla* spp.) were the most important freshwater fish species (although other smaller species were probably exploited as well), while crayfish and freshwater mussels (*Velesunio ambiguus*) were also eaten (Barrallier, 1802). However, additional large species such as freshwater catfish (*Tandanus tandanus*) and Macquarie perch (*Macquaria australasica*) may have been present in the Nepean/Hawkesbury River system in 1788, even though they no longer occur there.

Smaller birds like quail were trapped along the banks of the Nepean (Tench, 1793), and birds eggs were also collected (Barallier, 1802). A wide variety of animal foods were therefore available to the Aborigines who lived in the study area, and most were available throughout the year.

TAXA	GENUS AND SPECIES	COMMON NAME
Monotremes		
	Tachyglossus aculeatus	Echidna
	Ornithorhyncus anatinus	Platypus
Marsupials		
	Megaleia giganteus	Grey kangaroo
	Macropus robustus	Wallaroo
	Macropus rufogriseus	Red-necked wallaby
	Wallabia bicolor	Swamp wallaby
	Petrogale penicillata	Rock wallaby
	Vombatus ursinus	Wombat
	Dasyurus maculatus	Tiger cat
	Phascogale tapoatafa	Phascogale
	Phascolarctos cinereus	Koala
	Schoinobates volans	Greater glider
	Pseudocheirus peregrinus	Ring-tailed possum
	Petaurus australis	Yellow-bellied glider
	Trichosurus vulpeca	Brush-tailed possum
	Permales nasuta	Long-nosed bandicoot
	Isoodon macrourus	Short-nosed bandicoot
Placentals		
	Canis familiaris dingo	Dingo
	Pteropus poliocephalus	Grey-headed bat
	Pteropus scapulatus	Little red fruit bat
	Rattus fuscipes	Southern bush rat
	Rattus assimilis	Bush rat
	Rattus lutreolus	Swamp rat
	Hydromys chrysogaster	Water rat
Reptiles		
	Chelodina longicollis	Long-necked tortoise
	Amphibolurus barbatus	Bearded dragon
	Physignathus leseurii	Water dragon
	Varanus varius	Lace monitor
	Egernia cunninghami	Cunninghams skink
	Morelia spilotes	Diamond python
	Pseudechis prophyriacus	Black snake
Birds		
	Dacelo gigas	Kookaburra
	Pelecanus conspicillatus	Pelican
	Cygnus atratus	Black swan
	Dromaius novaehollandiae	Emu

TABLE 3.6. Some common fauna used for food by Aborigines on the Cumberland Plain in 1788.

3.9 Lithic Resources

The study area is rich in the stone resources utilised by Aborigines. The Hawkesbury Sandstone to the west of the Nepean River contains quartz in the form of isolated pebbles and bands of conglomerate, while the sandstone itself was used for grinding hatchet heads (Dickson, 1981).

The gravel beds associated with the Nepean and Hawkesbury Rivers contain chert, quartz, quartzite, and basalt, all of which were exploited for the manufacture of stone tools (Kohen, 1985a; 1985b). A second gravel unit, the Rickabys Creek Gravel, contains primarily quartzites and sandstones, with some granites and porphyrites (Gobert, 1978). These gravels show intense chemical weathering, suggesting that they are much older than those in the present bed of the Nepean River (Walker and Hawkins, 1957).

The third series of gravels, referred to as the St. Marys Formation (Walker and Hawkins, 1957), is found near St. Marys, Riverstone and Plumpton, is well consolidated, and consists of silcrete, sandstone, shale and ironstone. The silcrete, predominantly red but sometimes yellow, pink and grey, was used extensively across the study area. The ironstone layers also contain nodules of red and yellow iron oxides, which may have been used as ochre for decoration. White ochre is sometimes found in the banks of the creeks which flow through the Wianamatta shale. A diverse range of lithic resources was therefore available to the Aborigines of the western Cumberland Plain.

CHAPTER 4

ETHNOGRAPHY: SOCIAL ORGANISATION AND ECONOMY

4.1 Tribes and Bands

The definition of a "tribe" within traditional Aboriginal society is a difficult problem, for not only is there geographic variability in how Aboriginal people perceive themselves and their relationships to one another, but also the value of defining such a group must come into question. Peterson (1976) believes that "writers who use the term tribe, usually imply that it is a cultural, linguistic and geographic unit", but believes that Stanner's approach, defining the tribe at the level of land ownership as "the sum of its constituent clan estates" has merit (Stanner, 1965). Stanner divides Aboriginal groups into bands and clans, perceiving the former as an economic unit and the latter as a social unit. From the point of view of the prehistorian using ethnographic data to reconstruct Aboriginal land use and settlement patterns, it is generally the band which leaves its imprint on the archaeological record. However, in order to understand the relationships between bands, some appreciation of the complexities of the social system is also necessary. For this reason, the distribution of languages across the landscape is also important. In this context, the term "tribe" is used to define a particular language group in relation to its geographic boundaries.

A number of tribal reconstructions have been suggested for the Sydney region, largely based on ethnographic accounts and linguistic data because local Aboriginal knowledge is fragmented and of limited value. The following spellings have been adopted, and will be used subsequently, except where citing another author: Dharug, Dharawal, Kuringgai, Darkinjung, Gundungurra.

Tindale (1974:193) refers to the Aborigines in the vicinity of the study area as "Daruk", based largely on the late nineteenth century and early 20th century accounts of R.H. Mathews (Mathews, 1896; 1897; 1898; 1900; 1901a; 1901b; 1902) and Mathews and Everitt (1900). Mathews (1901b: 155) states:

> "The Dharruk speaking people adjoined the Thurrawal on the north, extending along the coast to the Hawkesbury River, and inland to what are now Windsor, Penrith, Campbelltown, and intervening towns".

This greatly expands the boundaries over his earlier comments:

> "The Dharook dialect ... was spoken at Campbelltown, Liverpool, Camden, Penrith, and possibly as far east as Sydney." (Mathews and Everitt, 1900: 262).

For the coastal people, Tindale uses the term "Eora", citing many references, most of them based on the vocabularies provided by Collins (1798; 1802) and Hunter (1793). To the southwest were the "Gandangara", to the northwest the "Darkinjang, to the south the "Tharawal", and to the north the "Awabakal", noting that these people were included in the term "Kuringgai" used by Fraser (1892) to denote a wider group.

Capell (1970) provided a reassessment of the traditional view based largely on two manuscripts recovered from the Mitchell

Library in Sydney. One was written by Lancelot Threlkeld in the early 1820's, while the other was a later compilation made by J. F. Mann, undated but certainly made prior to 1912. Mann's informant was "Long Dick, an influential native of the Cammeray tribe - a son of Bungaree and Queen Gooseberry". These two vocabularies, both recording a language spoken on the south side of Broken Bay, led Capell to propose the linguistic name "Kuringgai" for the Aborigines living between Port Jackson and Tuggerah Lake. He states:

> "A language which it is convenient to call Kuringgai was spoken on the north side of Port Jackson, and extended at least to Tuggerah Lakes" (Capell, 1970: 21).

Between Port Jackson and Botany Bay, the language was seen to be a dialect or even sub-dialect of "Dharruk" (also spelled "Dharuk" in the same paper). The status of the "Dharawal" remained largely unchanged, although the status of the "Gweagal" dialect, spoken on the Kurnell peninsula immediately south of Botany Bay, remained in doubt. Recent work suggests that Gweagal in fact may be another dialect of Dharug (P. Newton, pers. comm.). Eades (1976) examined the linguistic evidence to the south of Botany Bay, and accepted the term "Dharawal" for the language spoken between Jervis Bay and Botany Bay. The boundaries she suggests for surrounding languages are not supported by other evidence. It is highly unlikely that the Dharug language extended beyond the Great Dividing Range where the language spoken was clearly Wiradjuri, or to the southwest where the language was Gundungurra.

The basic tribal classification of Capell has been broadly accepted, although Ross (1978) included the Dharug speakers along the coast within the "Guringai" (Kuringgai), apparently on the basis of similarities in economy. A re-evaluation of the linguistic and ethnographic data relating to Sydney Aborigines has confirmed the basic divisions suggested by Capell, although slightly modifying the boundary between the Dharawal and the Dharug (Kohen, 1981a; 1985a). Hill (1892) states:

> "Those on the southern shore of the George's River, across to the coast and the south shore of Botany Bay, spoke a different language to those at Liverpool."

It is clear that Dharug was spoken at Liverpool, for Rowley (1878) entitled his paper "Language of the Aborigines of George's River, Cowpasture and Appin, that is from Botany Bay, 50 miles to the south-west." There is no doubt that this language was Dharug, so it would seem that the George's River formed a natural boundary between the Dharug and Dharawal speakers, in much the same way that Port Jackson and the Lane Cove River formed the boundaries between the Dharug and Kuringgai speakers (Capell, 1970). It is not uncommon to find that natural features mark the boundaries between language/tribal groups (Tindale, 1974; 1976).

Another river, the Hawkesbury, may well have marked the boundary between the Dharug and their neighbours to the northwest, the Darkinjung. Mathews (1897: 1) suggests that:

> "The Darkinjung speaking people ...occupied a considerable range of country ... extending from Wilberforce and Wiseman's Ferry on the Hawkesbury River, to Jerry's Plains and Singleton on the Hunter... On the south they were met by the Gundungurra and Dharruk tribes".

The meaning of these tribal names, if indeed they have meanings, is not clear. Dharug was the word used by Aborigines living along the Hawkesbury River to describe themselves to R.H. Mathews, but it is not translated in his vocabulary or any others purporting to be Dharug (Rowley, 1878; Tuckerman, 1886; Kohen, 1984c). Recorded vocabularies for other surrounding languages also fail to provide clues. However, the staple diet of the Aborigines recorded along the banks of the Hawkesbury River was reported to be "a kind of wild yam" (Hunter, 1793). Gott (1983:17) lists ethnographic references to "yams" in Victoria which were not the daisy yam, *Microseris scapigera*. These include, under the heading "Aboriginal name", **darook**, **darrook**, **djarug**, **dyarruk**, **taaruuk**, **tar-rook** and **turruc**. It seems highly likely that the Dharug took their name from the tuberous plant foods which provided them with a food staple.

The term "Kuringgai" (the word is also spelled "Kuriggai" in the same publication) was coined by Fraser (1892) to describe the "tribe" between Bulli and Port Macquarie. Using R. H. Mathews Dharug grammar, it is clear that "Kuringgai" is the possessive case of the word **kuri** or man, literally "belonging to the men".

The probable language/tribal distribution is shown in Figure 4.1. It is clear that the entire western Cumberland Plain was occupied by Dharug speakers, or in this context by the Dharug Tribe.

The basic economic unit is not the tribe, but the band. In the Sydney region, and indeed over most of Australia, the band was referred to by early ethnographers as "tribe". Because the Sydney area was the location of the first European settlement in Australia, it might be expected that a substantial amount of information would be available on the local Aboriginal bands. To some extent this is true, but particularly for those bands living away from the coast, little contact was made before smallpox ravaged the Aboriginal population between 1789 and 1791. A re-evaluation of all the available ethnographic evidence has produced the distribution of bands shown in Figure 4.2 (Kohen 1985a; in press), and the source of this information is given in Table 4.1, and discussed in greater detail below.

The name of each band was generally taken from the place where the members of the band normally resided. Collins (1798: 453) explained that

> "Each family has a particular place of residence from which is derived its distinguishing name. This is formed by adding the monosyllable 'gal' to the name of the place".

Other terms are commonly found in the names given to bands, including "***ora***" (a place or country), and "***matta***" (a creek or waterway).

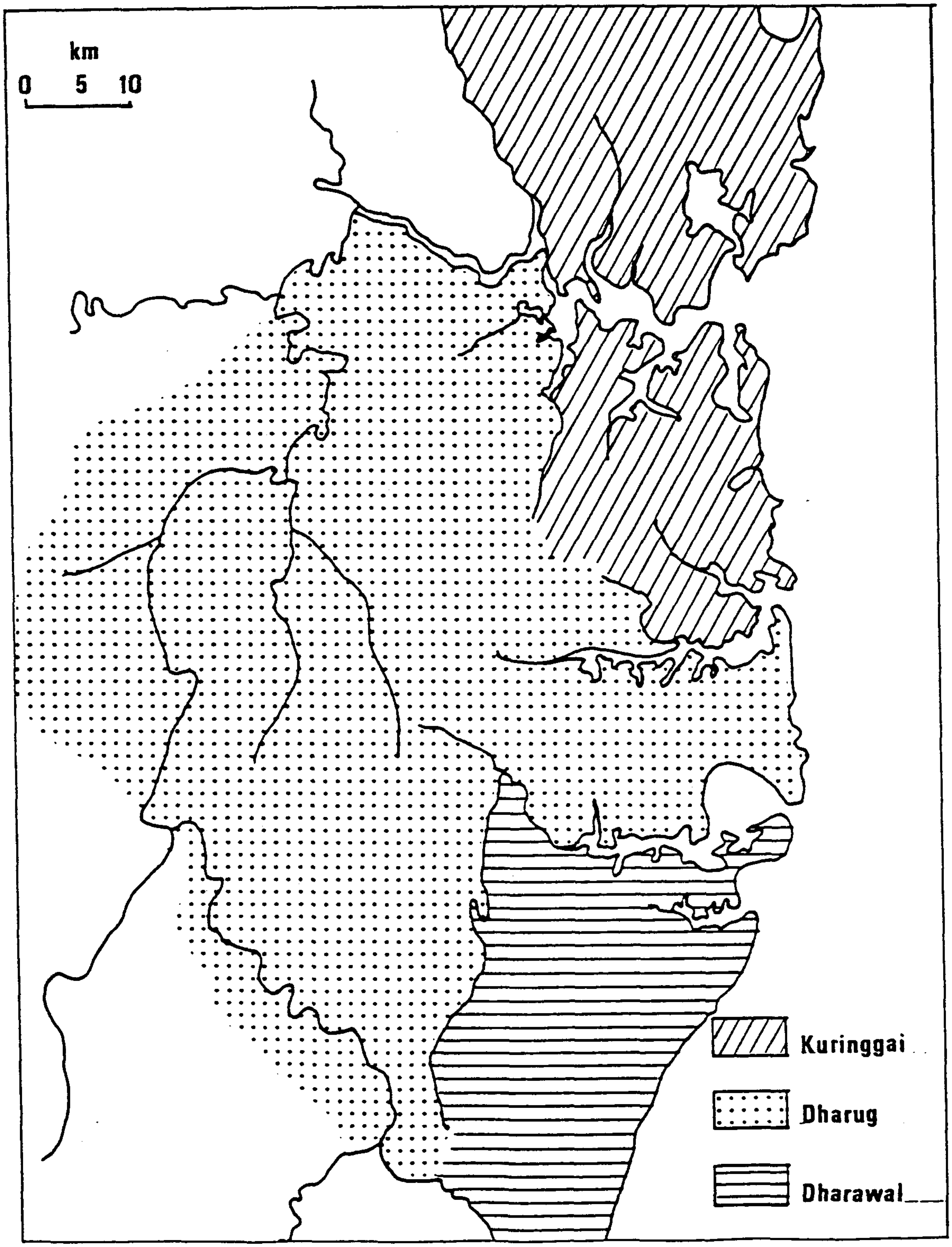
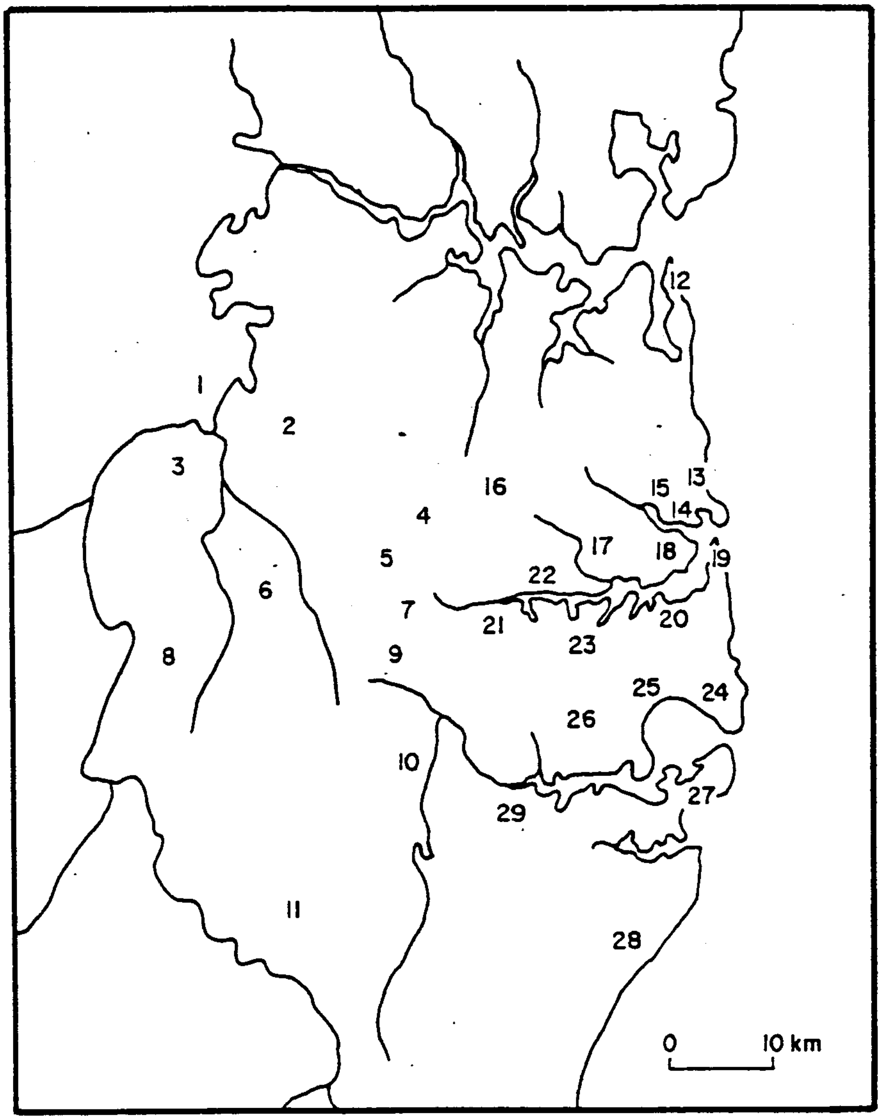


FIGURE 4.1. Aboriginal linguistic/tribal groups of the Sydney area in 1788.



1	KURRAJONG	11	MURINGONG	21	BURRAMATTAGAL
2	CATTAI	12	CARIGAL	22	WALLUMATTAGAL
3	BOOROOBERONGAL	13	CANNALGAL	23	WANGAL
4	BIDJIGAL	14	BOROGEGAL	24	MURU-ORA-DIAL
5	TOOGAGAL	15	KAYIMAI	25	KAMEYGAL
6	GOMERRIGAL	16	TERRAMERRAGAL	26	BEDIAGAL
7	CANNEMEGAL	17	CAMMERAIGAL	27	GWEAGAL
8	MULGOA	18	GORUALGAL	28	TAGARY
9	BOOL-BAIN-ORA	19	BIRRABIRRAGAL	29	NORONGERRAGAL
10	CABROGAL	20	CADIGAL		

FIGURE 4.2. Aboriginal bands/clans of the Sydney area in 1788.

NAME		LOCATION	SOURCE
Bediagal	Bejigal	Botany Bay	D,H,C
Bidjigal		Castle Hill	H
Birra birragal		Sydney Harbour	D
Bool-bain-ora		Parramatta area	D
Booramedigal	Burramattagal	Parramatta	D,H
Borogegal.yuruey (yurey)		Bradleys Head	D,H
Burubirangal	Buruberongal Booroobirrongal	Richmond	D,H
Cadigal		Sydney Cove	D,H
Cahbrogal		Cabramatta	C
Cammeragal	Cammeraigal	Cammeray	D,H,C
Cannemegal	Cannabaigal?	West of Parramatta (10 mins walk)	D
Carrugal	Carigal Carregal	Broken Bay	D,H,C
Gomerigal-tongarra		South Creek?	D,H
Goorungurregal	Gundungurragal	Lower Blue Mtns?	D
Gorualgal		Fig Tree Point	D
Gweagal		South of Botany Bay	D,H,C
Kameygal		North of Botany Bay	D
Kay-yee-my		Manly	H,C
Murro-ore-dial		Maroubra	D
Norongerragal		South of Georges R.	D
Ory-ang-soora		?	D
Tarramerragal		Turramurra	D
Toogagal	Tugagal	Toongabbie	D,C
Wandeandegal		?	D
Walumedegal	Wallumettagal	Ryde	D,H,C
Wongal	Wangal	South Parramata R.	D,H,C

Key to Sources: D, William Dawes; H, John Hunter; C, David Collins.

TABLE 4.1. Aboriginal bands of the Sydney region in 1788.

Bediagal

The Bediagal were mentioned by a number of writers, and they were certainly located along the headwaters of Botany Bay west towards the George's River. Collins includes them in his list of "woods tribes", and notes that they barbed their spears with stone rather than the shell which was normal for coastal people. Dawes groups them together with the Tugagal as the "Bediagal.Tugagal.Tugara", probably a more general term for the "woods tribes", but specified that the Bediagal lived at "Arrowanelly", the "island at the flats" near Rose Hill. Hunter (1793) referred to them as "Bejigal". The Bediagal are almost certainly included in those later referred to as the Botany Bay Tribe (Walker, 1821). Thornton (1899:211) referred to the Aborigines living in a particular direction from Parramatta as Bedia Mangora. Although the "***Bedia***" and "***ora***" are of Dharug origin, it seems his informants were speaking a form of pidgin, with the term "man" being English. Similarly, when referring to the Aborigines who lived in the opposite direction, the name he was given was Bulladeerz-Yallaway, which can be translated as ***Bulla*** (Dharug), two; deerz (English), days; ***yalla*** (Dharug), walk; away (English), away.

Bidjigal

The Bidjigal were referred to by Hunter (1793) when he was travelling northwest from Rose Hill (Parramatta) in April 1791, accompanied by two coastal Aborigines. When asked the name of the Aborigines who lived in that particular area (in the vicinity of the present town of Castle Hill), they replied that "this part of the country was inhabited by the *Bidjigals*, but that most of the tribe were dead of the small-pox". While it may well be that the Bidjigal from Castle Hill are the same as the *Bediagal* from the headwaters of the George's River, since no other name has been recorded for the people living in the area immediately northwest of Parramatta it has been retained.

Birra Birragal

Birra Birragal was the "tribe" to which the Aboriginal woman ***Gony-ar-a*** belonged, according to Dawes (1791). The word ***Birra birra*** is used to describe a "rock in the harbour", while Larmer (1832) says that ***burra bre*** was the name for Middle Harbour. The Birra Birragal would appear to be a coastal band living in Port Jackson close to Sydney.

Bool-bain-ora

Dawes is the only one of the diarists to record this name. "Bool-bain" is described as being west of Parramatta.

Borogegal.yuruey

Included in Dawes' list, the suffix "**yuruey**" (= ***E-ora-i***) refers to the fact that these people lived near the coast. Larmer (1832) states that the name for Bradley's Head in Sydney Harbour was "Borogegy", strongly suggesting that these people lived on the north side of Port Jackson.

Burramattagal

Although Hunter refers to this band as the Boora-me-digal, it is apparent that this word is identical with the place name Parramatta (literally eel creek).

Buruberongal

Dawes refers to these people as "Burubirangal", and indicates that they are not "coasters". An alternative spelling was "Booroobirrongal" (Collins, 1802). These people lived on the Hawkesbury River near Richmond, and are among Collins' "woods tribes".

Cammeraigal

Most of the early accounts mention the Cammeraigal, or Cameragal, who lived on the north side of Sydney Harbour near the present suburb of Cammeray.

Cannemaigal

Dawes states that these people lived west of Parramatta. This name is possibly synonymous with "Cannabaigal" referred to by Barallier (1802) when he travelled southwest from Parramatta.

Cadigal

Dawes, Hunter, Tench and Collins all indicate that the Cadigal occupied a territory around the settlement at Port Jackson.

Cahbrogal

Collins states that "there is a tribe of natives dwelling inland, who, from the circumstance of their eating these loathsome worms (cobra grubs, an estuarine mollusc), are named Cah-bro-gal". Dawes indicates that ***Carrar-matta*** (Cabramatta) was close to Parramatta, and there is no doubt that the territory of these people was near the present towns of Cabramatta and Liverpool. They were later to be referred to as the Liverpool Tribe or the Cabramatta Tribe. A drawing in the Dickson Library in Sydney, and dating from the 1840's, shows the Cabramatta Tribe with an envoy from the Hawkesbury (Phelps, 1843?).

Carigal

Dawes, Hunter and Collins all refer to these people, with Carrugal and Carregal as alternate spellings. Larmer (1832) states that the name of West Head was "Gurugal". Hunter Stated that they were "at or near Broken Bay", so it is clear that the Carigal were from West Head and Broken Bay.

Cannalgal

Dawes mentions both males and females from this "tribe", and gives the word "***canna***" as the term for the Manly area along the coast. Hill (1892) also states that "***cannae***" was the name for Manly.

Gomerigal-tongarra

Dawes lists the Gomerigal-tongarra, the suffix indicating that these people were one of the "woods tribes". They are also referred to as coming from "inland parts" (Collins, 1798). Although no exact location is given by Dawes, they must have lived beyond Prospect, since he named all the bands living that far west. The most likely location seems to be around South Creek, and the Gomerigal were probably the South Creek Tribe (Walker, 1821).

Goorungurragal

Goorungurragal were included in Dawes' list of tribes. No location was given, but it may be that the word is the same as the term Gundungurra, the linguistic group living in the Blue Mountains and southwest of the Nepean River.

Gorualgal

Another band mentioned by Dawes. Thornton (1899) uses the term "***cooroowal***" for Figtree Point in Middle Harbour, so it is likely that the Gorualgal were a Kuringgai band from the north side of Sydney Harbour.

Gweagal

Dawes uses the term Gwiagal, but there is no doubt that the Gweagal were the band living on the south side of Botany Bay adjacent to Cook's landing place at Kurnell.

Kameygal

Dawes is quite specific, stating that ***Kamey*** was the name for Botany Bay, and the Kameygal therefore lived at Botany Bay. This confirms the presence of at least two bands adjacent to Botany

Bay, the Kameygal presumably near the coast and the Bediagal from the headwaters.

Kay-yee-my

According to Hunter, Kay-yee-my was the name of the area and the people where Governor Phillip was speared in September 1790. This was at Collins Cove adjacent to Manly Cove on the north side of Port Jackson. Dawes refers to ***Ky-yee-my*** as Manly Cove, and Thornton (1899) calls "Kayjamee .... Collins Flat, Manly".

Murro-ore-dial

Dawes mentions the Murro-ore-dial, but does not give a location for them. The "***dial***" termination is an alternative for "***gal***" which signifies the male members of a band. ***Murro-ore*** is almost certainly the same as ***Merooberah***, translated by Thornton (1899) as "a pretty sandy beach south of Kooja (Coogee). The beach was named after the tribe which inhabited that particular place." The word **muru** or **mer**oo means a pathway, and in this case it refers to the pathway which linked Port Jackson to Botany Bay.

Norongerragal

Hunter and Dawes both mention the Norongerragal, but neither one gives any location. Hill (1892) states that the area on the south side of the George's River was known as "***nunnungurrung***", and allowing for differences in spelling it is highly likely that "***nunnungurung***" and "***norongerra***" are the same word. This suggests that the Norongerragal were probably Dharawal speakers, since Hill states that the people in this area spoke "a different language from those at Liverpool" (who spoke Dharug).

Ory-ang-soora

This band was recorded by Dawes, but no location was given.

Tarramerragal

Dawes uses various spellings of this band, including ***Tarramarragal*** and ***Darramurragal***. It is almost certainly the area now known as Turramurra he refers to, although he states that they were a "tribe near Wanne", or Parramatta. An anonymous word list published in 1908 states that the name for the Lane Cove River was "***Turrumburra***", so the Lane Cove River may have been the southern boundary of this band.

Toogagal

Collins and Dawes speak of the Toogagal as one of the "woods tribes". The word "***tooga***", "***tuga***", or "***toonga***" is recorded variously as meaning thick brush near a waterway. The only use of this term in a place name was for Toongabbie, to the west of Parramatta. This fits with the description of them a a "woods tribe", since Toongabbie Creek is a tributary of the Parramatta River.

Wandeandegal

This group is recorded by Dawes, but no location was given. The word **wan** means west, **yan** means to walk, so it is likely that this band (*wan-(d)-yan-de-gal*) occupied a territory west of Parramatta.

Wallumattagal

Dawes, Hunter and Collins all mention this band, and there is no doubt that they lived along the north shore of the Parramatta River in the vicinity of Ryde.

Wangal

A band mentioned by Dawes, Hunter, Tench and Collins, who lived on the south side of the Parramatta River.

It is clear that there were a large number of bands both along the coast and across the plain. By identifying the core territories of these bands, it is apparent that there could be no great population movements away from the coast west towards the mountains, for a dense Aboriginal population already occupied the western Cumberland Plain.

4.2 Population densities

The number of Aborigines in each band was widely estimated to be about fifty people. This figure can be taken as a basis for estimating population densities across the Cumberland plain, for there is little doubt that whenever a "tribe" is mentioned by the early ethnographers, they are in fact referring to a band. Collins (1802: 453) states:

" Each family has a particular place of residence from which is derived its distinguishing name. This is formed by adding the monosyllable 'gal' to the name of the place; thus the southern shore of Botany Bay is called Gwea, and the people who inhabit it style themselves Gwea-gal. Those who live on the north shore of Port Jackson are called Cam-mer-ray-gal, that part of the harbour being distinguished from the others by the name of Cam-mer-ray".

At least along the coast, some bands probably lived at one campsite for some months of each year, and regularly returned there. In 1788, for example, Tench (1793: 52) recorded:

"On the northwest arm of Botany Bay stands a village, which contains more than a dozen houses, and perhaps five times that number of people".

A similar village was described eighteen years earlier when the Endeavour crew made the first contact with Aborigines on the southern shore of Botany Bay, at Kurnell. Banks (1770) recorded "We came to anchor abreast of a small village consisting of six or eight houses" At a later time he noted that "we saw many Indian houses and places where they had slept upon the grass without the least shelter". Although these "villages" were primarily found along the coast, as late as 1816, a village containing 70 huts was observed in the vicinity of Bents Basin on the banks of the Nepean River (Macquarie, 1816). The term "village" suggests that some sites were occupied for perhaps several weeks or even months. Certainly the rich resources of the coast were capable of supporting a small group living at one place, at least during the warmer parts of the year. The evidence from the Sydney area is important in this regard, because it is the only place where detailed observations were made before

European diseases severely reduced the population. It is quite likely that all later accounts are reporting an Aboriginal way of life drastically different from the pre-contact culture.

The number of bands in Port Jackson can be estimated from two pieces of information. Sixty seven canoes were counted in the harbour on a single day, and because "each tribe has six, eight or ten canoes", there were between seven and eleven bands living in the immediate vicinity of Port Jackson, a value which corresponds well with the nine Dharug and Kuringgai bands recorded by name (Kohen and Lampert, in press).

Similar numbers were to be found at Botany Bay, where the Aborigines were "tolerably numerous as we advanced up the river (Georges River)", and at Broken Bay, where "the Indians who live on its banks are numerous" (Tench, 1793). Near the entrance to Botany Bay forty nine canoes were counted, and on the following day a party of two hundred and twelve armed men was observed. Certainly Governor Phillip was surprised at the density of settlement, for he wrote " The Natives ... are far more numerous than I expected to find them ...". (Stockdale, 1789).

Several indications are given that the coastal people had smaller territories and were more localised that the bands living inland across the plain. Caley (1809) says that "The water natives are more confined to one place of abode (than the inland or Bush natives)". This has often been cited as evidence for low population densities across the plain (Ross, 1976), but it seems more likely that there was an extremely dense population living along the coast. Certainly for ceremonial gatherings, there were still hundreds of people attending such activities well into the 1820's. Hassall (1902), referring to the year 1826, recounts that "At Denbigh [near Camden], during this early period, the blacks were very numerous. One evening I witnessed a coroboree in which over four hundred of them took part". One of the first estimates of Aboriginal population in the Sydney region concluded that there were around 1500 people living along the coast between Broken Bay and Botany Bay (Stockdale, 1789).

The reason many Aboriginal population estimates for the Sydney region are so low is that a smallpox epidemic ravaged the population within the first few years of European settlement. Hunter (1793) refers to " ... smallpox, which swept off hundreds of the natives in the winter of 1788". The Cadigal band, which occupied a territory in the immediate vicinity of the settlement, was reduced from about 50 in 1788 to three in 1790. Smallpox spread so rapidly that by the time the first European expeditions reached the Nepean River, only fifty kilometres west of Port Jackson, many Aborigines there had already died. When the explorers enquired about the people who lived between Parramatta and the Nepean River, they were told that "this part of the country was inhabited by the Bidjigals, but that most of the tribe were dead of the smallpox" (Hunter, 1793: 340). The epidemic seems to have spread rapidly throughout Australia, for Angas (1847) reported:

> "In the year 1789, the aboriginal tribes of New South Wales were visited with the smallpox ... It was this epidemic of which the natives of South Australia speak: they say that it came down the Murray from the country far to the eastward, and almost depopulated the banks of the river for more than a thousand miles".

The death rate around Sydney was so great that traditional burial customs were discontinued, and bodies were found floating in the harbour and lying in rockshelters. One consequence of the high death toll was a major social reorganisation, with remnants of bands combining to form new groups. These groups were subsequently referred to by such titles as the "Botany Bay Tribe", the "Kissing Point Tribe", and the "Broken Bay Tribe".

In 1788, there were at least seven and possibly eight Dharug speaking bands adjacent to to coast. The Kuringgai were also coastal people, and at least six bands lived in the area bounded by Port Jackson, Broken Bay and the Lane Cove River. This agrees well with the original estimate of 1500 people for the coastal strip.

Because there was severe depopulation across the plain before direct European contact, it is necessary to base population estimates on the number of bands who are recorded as having occupied the area. Even allowing for massive depopulation and social re-organisation, there should still be later evidence confirming the existence of a substantial population, and indeed European records dating from the period between 1820 and 1850 show that there were many bands still surviving as social entities during this period. William Walker, the first missionary to the Aborigines, recorded in 1821 the existence of the Kissing Point, Windsor, Hawkesbury, South Creek, Mulgoa, Liverpool, Botany Bay, Cow Pastures, Five Islands, (Illawarra) and Broken Bay "tribes". At least six of these bands, (Windsor, Hawkesbury, South Creek, Mulgoa, Liverpool and Cow Pastures) came from the western Cumberland Plain. Macquarie (1816) also mentions "tribes" from Portland Head, Caddie (probably Walker's Windsor Tribe), and Prospect. Of these the "Prospect Tribe" should certainly be added to the list of Cumberland Plain bands.

The 1828 Census shows that there were bands still living at Parramatta, Richmond, Liverpool, Mulgoa, Burragorang, Cowpastures, Nepean, Portland Head, and First Branch between Parramatta and the Blue Mountains, but indicated that all the Aborigines from Airds had diappeared. The "Returns of Natives 1834-1843" (Anon., 1834-43) provides information on names, numbers, "tribe", and location, and confirms the presence of several hundred Aborigines well into the 1840's. "Tribes" recorded include South Creek, Windsor, Nepean, Cattai Creek (Caddie Ck.), Richmond, Kurrajong, Prospect (Weymaly) Breakfast Creek (Warrawarry), Georges River (Liverpool), and Cowpastures (Muringong).

The bands of Dharug found on the western Cumberland Plain beyond Parramatta are summarised in Table 4.2. The bands listed are those whose existence can be confirmed by later accounts, and should be viewed as an absolute minimum. On the basis of the ethnographic data, a minimum of between 500 and 1000 Aborigines permanently occupied the western Cumberland Plain.

EUROPEAN NAME	**DHARUG NAME**	**LOCATION**
Prospect Tribe	Weymaly	Prospect
Liverpool Tribe	Cabrogal	Liverpool
South Creek Tribe	Gomerrigal?	South Creek
None	Bidjigal	Castle Hill
Windsor Tribe	Caddi	Windsor
Hawkesbury Tribe	Boorooberongal	Richmond
Nepean Tribe	Mulgoa	Penrith
?	Tugagal	Toongabbie
Kurrajong Tribe	Kurrajong	North Richmond
Cowpastures Tribe	Muringong	Camden

Table 4.2. Dharug bands from the western Cumberland Plain.

4.3 Economic Base

The divisions between "coasters", "woods tribes" and "mountaineers" were noted by several observers along the south coast of New South Wales (Howitt, 1904). In the Sydney region, the "coasters" and "woods tribes" were sub-groups of the Dharug. Further inland, the Gundungurra people inhabited the Blue Mountains and the plains southwest of the Nepean River (Mathews, 1901a).

Unlike the coastal bands, who were primarily dependent on fish and shellfish, the Aborigines who lived between Parramatta and the Blue Mountains were more dependent on small animals and plant foods, although freshwater mullet and eels were seasonally available.

> "They (the inland Aborigines) depend but little on fish, as the river yields only mullets, ... their principal support is derived from small animals which they kill, and some roots (a species of wild yam chiefly) which they dig out of the earth." (Tench, 1793: 230).

They were described as "climbers of trees, and men who live by hunting" by the coastal Aborigines, for they would "ascend the tallest trees after the opossum and the flying squirrel" (Hunter, 1793). Honey from native bees was also collected from the treetops (Collins, 1802).

At least three bands, the Bidjigal, the Cabrogal and the Cattai also had access to the estuarine resources of the Georges River and the Hawkesbury River, but the Toogagal, Boorooberongal, Gomerigal, Cannemegal, the Boolbain-ora, the Muringong and the Mulgoa people relied entirely on terrestrial and freshwater foods.

The diet of the inland groups was varied, and included fruits and berries, yams of various kinds, fern root, nectar from *Banksia* flowers, ants and the eggs of ants (Collins, 1802: 462).

The importance of the burrawang (*Macrozamia* spp.), "yams", and other plant foods in the diet has already been discussed.

While the women and children gathered yams, roots, fruits and small game which provided the staple diet, the men hunted. Traps and snares were set for quail and possums, while pitfall traps were dug for other small mammals (Tench, 1793; Collins, 1798). Along the rivers and creeks fish traps were constructed, and in these mullet and bass could be speared easily with a multipronged fishing spear similar to that used on the coast. Eels were an important part of the diet particularly during the month of April. Collins (1802: 462) reported that the Aborigines

> " resort at a certain season of the year to the lagoons where they subsist on eels which they procure by laying hollow pieces of timber into the water into which the eels creep, and are easily taken".

Other animals speared in the rivers and lagoons included the platypus. Collins (1804: 232) records that

> "The natives sit upon the banks with small wooden spears, and watch them every time they rise to the surface, till they get a proper opportunity of striking them. This they do with much dexterity and frequently succeed in catching them this way".

Yabbies, freshwater mussels, tortoises and water birds were also collected. The importance of aquatic resources to the Aborigines who lived on the plain is significant. Hassall (1902), recalling South Creek in the early 1830's, says "We always caught a number of fine large mullet".

Although kangaroos were hunted on the plain, the importance of kangaroo hunting was more likely to have been as a social function than to provide a dietary staple. The method of catching kangaroos, observed by both Barallier (1802) and Caley (1804), required the attendance of a large gathering of men. Caley calls it a "Walbunga ... catching kangaroos by setting the place on fire and by placing themselves in the direction the animal is forced to pass and by throwing spears at it as it passes along." Barallier (1802: 751) confirms that the Aborigines caught kangaroos with a great deal of difficulty.

> " They usually feed upon opossums and squirrels, which are abundant in that country, and also upon kangaroo-rat and kangaroo, but they can only catch this last one with the greatest trouble, and they are obliged to unite in great numbers to hunt it."

Probably the most important source of protein was the possum. Although kangaroos and wallabies were undoubtedly prized, possums were both abundant and readily available. Kangaroos were not a significant component of the diet, although they "ate it (kangaroo) whenever they were fortunate enough to kill one of these animals" (ibid).

The stone tool technology of the area reflected the relative importance of possums and other tree dwelling animals in the diet. The dominant stone tool was the edge-ground hatchet, used to cut toe-holds in trees to facilitate climbing to catch the animal, and also for enlarging the base of a hollow tree so that a fire could be lit to drive the possum from its nest. Tree climbing may also have been necessary to capture the large bats which "are very fat, and are reckoned by the natives excellent food" (Tench, 1793). Other food was obtained from trees, for Barallier (1802: 755) mentions insect larvae as being popular.

> "Besides lizards and other animals, grubs are eaten by the natives, but it is more particularly those which are found in the trunks of trees they look for. For this purpose they always carry with them a switch about twelve inches long and of the thickness of a fowl's feather, which they stick into their hair above the ear".

Movement along the river was by well-established paths beside the banks, and by bark canoes identical to those used on the coast. Although Hunter (1793) described the canoes as "nothing more than a large piece of bark tied up at both ends with vines", they seem to have been well suited to the slow-moving waters of the Nepean River and South Creek. Bark from nearby trees was also used to make bark huts, the only form of protection available to people who lived away from the rockshelters of the sandstone country. They consisted of

> "a piece of the bark of a tree, bent in the middle and set upon the ends, with a piece set up against that end on which the wind blows. This hut serves them for a habitation, and will contain a whole family" (Hunter, 1793: 42).

Fire was an important tool to the people living in the country between Parramatta and the Blue Mountains, so much so that the band living southwest of Parramatta and Prospect was known as the Cannemegal (belonging to fire). Fire was used to maintain grassland and open woodland environments thus ensuring an abundant supply of tuberous plants like lillies and orchids which flourish there. It was also used during kangaroo hunts. A large circle was formed around a mob of kangaroos, with each man standing about thirty metres from his neighbour. The grass was then set on fire, and the kangaroos were speared as they tried to escape (Barallier, 1802).

Possums also were captured through the use of fire. As described by Hunter (1793: 43), two or more people were involved.

> "One man climbs even the tallest tree with much ease, by means of notches at convenient distances, that are made with a stone hatchet, when he has arrived at the top, or where there may be an outlet for the animal, he sits there with a club or stick in his hand, while another person below applies a fire to the lower opening, and fills the hollow of the tree with smoak; this obliges the animal to attempt to make its escape, either upwards or downwards, but whichever way it goes, it is almost certain of death, for they very seldom escape. In this manner they employ themselves, and get a livelihood in the woods."

4.4 Stone tools.

Clearly the economy of the Aborigines living across the study area at the time of European settlement was based on a wide variety of resources which required a narrow range of stone tool "types". Only five stone tool "types" are clearly distinguished in the ethnographic accounts.

(a) Stone hatchets

The edge-ground hatchet is distinctive, and there is little doubt that the major source of basalt pebbles used to manufacture the hatchets was the gravels beds of the Nepean and Hawkesbury. The description of a coastal Dharug travelling to the foot of the mountains in order to obtain hatchet blanks suggests that direct access may have been allowed for at least some coastal people. However, trade is a more likely process for dispersal of this resource.

(b) Stone wedges

Bradley (1792) refers to another tool type made from basalt. He states:

> "They (the Aborigines) use a wedge of the same kind of stone (as the hatchet), with a junk of wood for a mallet or maul. These tools appear all to be used in providing the canoe and shields from the trees, with with such wretched implements is a great work of labour; they cut the bark round to the length they want and enter the wedges, leaving it in that state for some time before they take it off altogether".

While it is possible that this description refers to ground basalt pebbles which have not been hafted into a handle, it is also possible that uniface pebble tools, so common in the stone tool collections from the Nepean River area, were used as wedges for removing bark from *Casuarina* for the manufacture of canoes (Kohen, 1984b).

(c) Stone adzes

The third tool type described is the adze flake, hafted onto the end of the spearthrower and used in the manufacture of other wooden implements. There is little doubt that the elouera adze flake was used in this way, but a range of small adze flakes, scrapers and utilised flakes could have served a similar function.

(d) Stone knives and planes

The fourth type is the hand held stone used for sharpening spears and cutting. Again a range of scrapers and utilised flakes could be representatives of this functional tool class. It might be expected that these tools would be of larger size for ease of holding (Mulvaney, 1975), and perhaps could be subdivided into two classes, steep-edged tools for scraping and sharp-edged tools for cutting (see Ferguson, 1980).

(*e*) Stone barbs

Finally, untrimmed stone flakes were used to barb some hunting spears, and the "death spear" of the New South Wales south coast appears to fit this description (Lampert, 1971). Lampert (ibid) has suggested that untrimmed flakes replaced backed blades as barbs on compound spears, and if this is the case the backed blades would fit into this functional class of artefacts. Untrimmed flakes used to barb spears are not distinguishable from debitage unless they retain traces of the hafting material.

The discard rates of these five broad classes of tools will vary, as will the nature of the sites where they will be found. On large intensively occupied campsites, the full range of these artefact types might be expected to be found. Hatchets were curated tools, and in general would therefore be rare in archaeological assemblages. They are likely to be found discarded on major campsites or in isolation. Specialised adze flakes would probably need to be replaced at frequent intervals (Gould, 1980; Hayden, 1979), and are therefore likely to be more common than hatchets. Their presence on a site would indicate woodworking activities, as would the presence of large scrapers and utilised flakes. Since untrimmed flakes to be used as spear barbs are not distinguishable from debitage, any site where debitage occurs could conceivably have been associated with barbing spears for hunting. Only if backed blades are accepted as functioning as barbs is it possible to identify a site where hunting-related activities may have occurred.

Very few data are available on the discard rates of stone tools in eastern Australia. Within the study area, only one archaeological site had been excavated and radiocarbon dated prior to this study: Lapstone Creek (McCarthy, 1948). At this site, elouera adze flakes were the dominant tool type in the upper unit, a unit which is considered to have spanned almost two thousand years. A total of 73 elouera were identified in an area of approximately 50% of the rockshelter. This suggests that around 146 elouera were discarded in this site over 2,000 years, a mean discard rate of 1 elouera every fourteen years. Yet this site has by far the greatest density of elouera adze flakes of any excavated site in eastern Australia. The limited value of these kind of data can be seen from the fact that Hayden (1979) reported the use of up to 16 functional adze flakes (albeit not all of them identifiable as such) in the manufacture of a single wooden artefact in Central Australia.

The ethnographic data suggest some tentative relationships between stone artefact types and specific activities. In order to quantify these relationships and interpret changes in patterns of resource exploitation, the distribution of artefact types across the landscape must be characterised, and this could only be achieved by carrying out extensive archaeological surveys.

CHAPTER 5

SURVEY METHODOLOGY

5.1 Site survival and archaeological visibility

A number of serious problems became apparent when a survey strategy was being devised for the western Cumberland Plain. Schiffer et al. (1978) define an archaeological survey as "the application of a set of techniques for varying the discovery probabilities of archaeological materials in order to estimate parameters of the regional archaeological record", and further define the regional archaeological record " ... as a more or less continuous distribution of artefacts over the land surface with highly variable density characteristics". High density scatters, or "sites", while providing substantial amounts of information, in isolation clearly do not provide the "parameters of the regional archaeological record". Low density artefact scatters must also be viewed as an integral part of the archaeological record. Therefore in order to survey an area like the western Cumberland Plain, it is necessary to identify the "parameters of the archaeological record" which are appropriate in order to determine changing settlement patterns, population densities and economic strategies. The identification of such parameters is not easy when there is an almost total absence of knowledge relating to the archaeological record within the study area.

Most archaeologists working in Australia perceive the surface survey as a mechanism for locating dense artefact scatters suitable for excavation. While this method is valid if the questions being asked relate to processes which have occurred within a single site or a series of sites, it is not suitable if data are being sought to explain regional processes involving land use, settlement pattern, ecological adaptations or resource utilisation (Dunnell and Dancey, 1983). Under these circumstances, a substantial amount of information can be obtained from the distribution of artefacts across the landscape without necessarily resorting to the destructive process of excavation.

One major criticism which can be made of surface survey without excavation is the fact that significant mixing or disturbance of archaeological material can occur on surface sites, restricting the amount of data obtainable. Recent studies have shown that geomorphic processes can and do cause serious disturbance at some open sites (e.g. Cahen and Moeyersons, 1977), but it has equally been shown that mixing occurs in some rockshelter sites, particularly in sandstone rockshelters (Matthews, 1965; Stockton, 1973a; Hughes and Lampert, 1977). The key to this problem is understanding the taphonomic processes which have led to the formation of the archaeological record present at the site, regardless of whether the site is a surface scatter, a stratified open deposit or a rockshelter deposit.

It is possible to identify a number of variables which contribute to archaeological visibility. These include the original size of the "site", disturbance of the deposit, vegetation cover and post-depositional regime. A single artefact is less likely to be located than a "site" containing several hundred stone flakes. Similarly, if artefacts have been spread over a wide area then a "site" is more likely to be located than if the artefacts are tightly clustered. If a "site" has been covered by alluvial deposits, and remains buried under any depth of sediment, it will not be located. Similarly, if a "site" occurs in a densely wooded or forested environment, the likelihood of seeing artefacts on the surface is greatly diminished. Another related factor is that older sites are more likely to have been subjected to post-depositional disturbance in the form of erosion by water or bioturbation. Some of these considerations have been examined by Sullivan (1983) in relation to archaeological surveys within Australia. Because of the total lack of knowledge relating to the distribution of artefacts across the landscape, and in order to overcome the problems discussed above, a survey strategy was required which *minimised* the effects of these variables.

5.2 Site definition

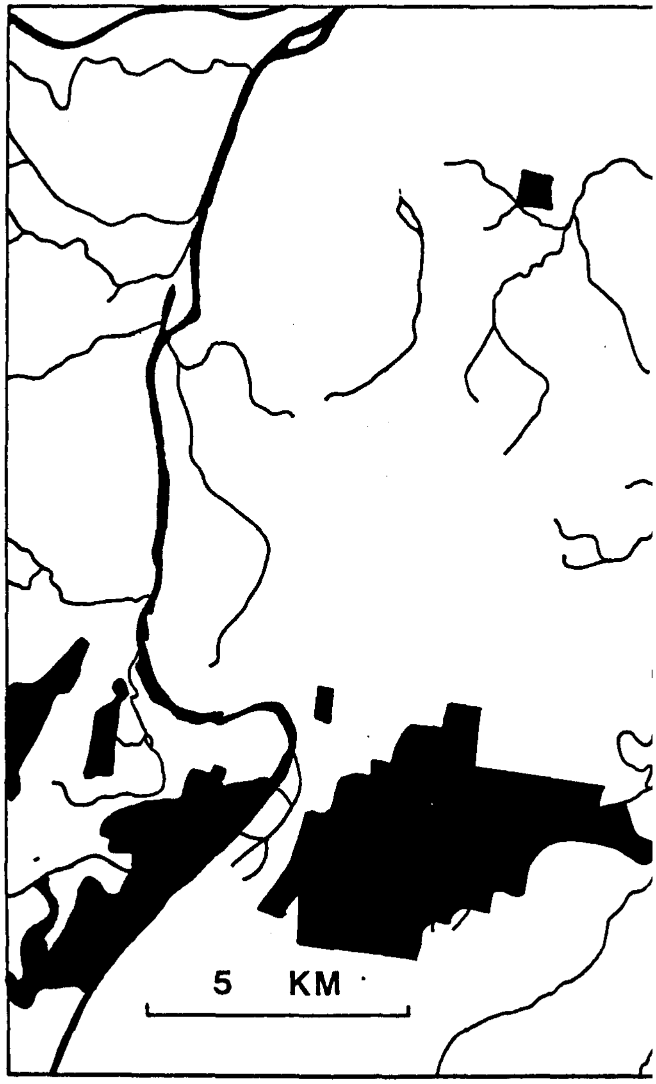
I decided to use the broadest definition possible for an archaeological site. A site is defined as any evidence of prehistoric occupation at a particular location. In this study, this ranged from a single stone artefact or manuport, grinding groove, art site, or scarred tree to large scatters of stone and post-European artefacts numbering thousands of pieces. In practice, over ninety five percent of the sites discovered consisted solely of stone artefacts. If two artefacts were separated by more than 100 metres, they were designated as two distinct sites. Where artefacts were scattered continuously over several hundred meters, but distinct variations in density were apparent, each cluster was given a separate site code. For example at Second Ponds Creek, the traditional notion of a spatially bound site becomes meaningless, since artefacts are distributed along the creek banks for over 1 kilometre (Kohen, 1984d).

5.3 Survey sampling method

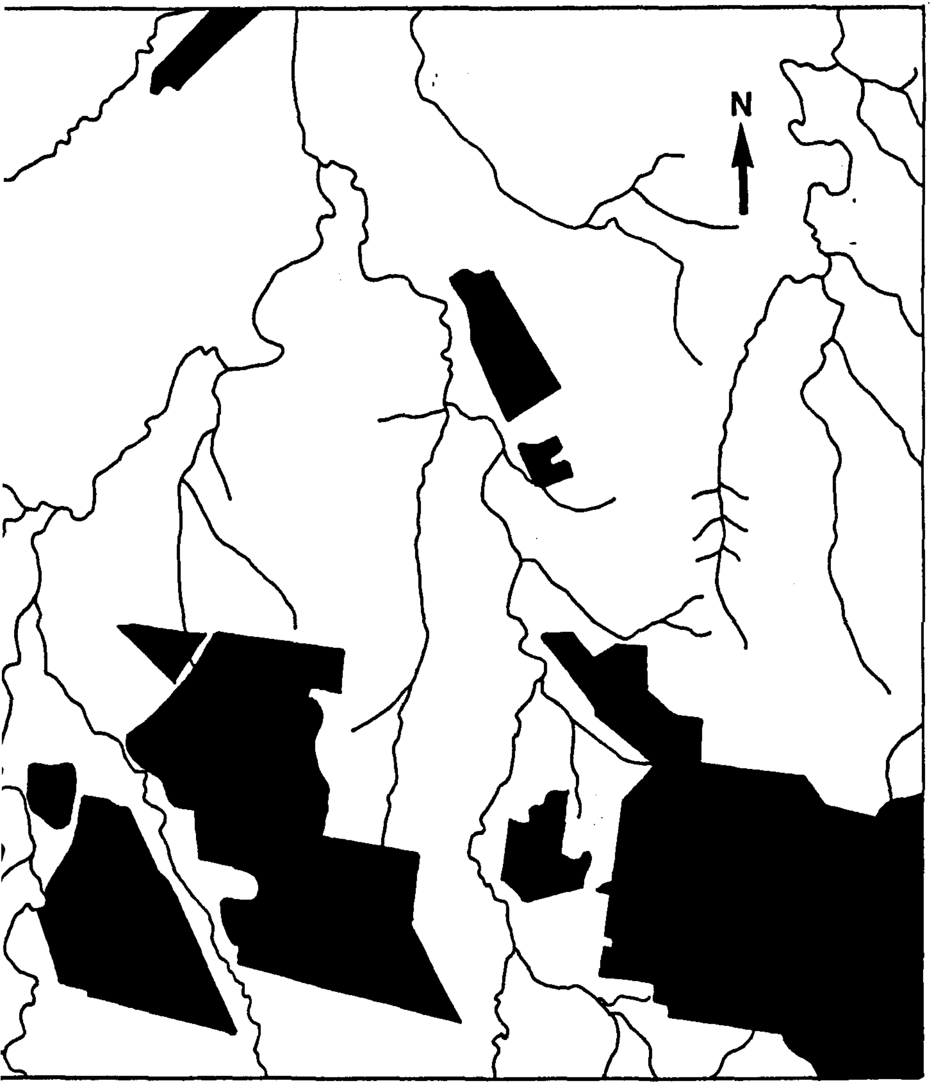
The study area of 600 square kilometres was too large to carry out a complete survey. Indeed, such a survey would be impractical and impossible because of the density of housing in some areas. For this reason, those areas grossly disturbed by high density housing or industry were excluded from consideration. These areas are shown in Figure 5.1. Providing an adequate number of sites could be located, the pattern of site location outside the developed areas should give a statistically reliable sample to generalise over the entire area.

The next problem to be overcome was how the remaining area should be sampled. Consideration was given to using random sampling techniques, dividing the remaining relatively undisturbed areas into 1 km squares and sampling a random selection. The drawback with this method is that the major

FIGURE 5.1. The survey area: areas excluded from intensive survey because of high density housing and development.



AREAS EXCLUDED FROM



SURVEYS BECAUSE OF DEVELOPMENT

environmental zones are not equally distributed across the landscape. Indeed some smaller zones, such as the Agnes Banks sand, were so small that it was unlikely to be sampled at all, since it occupied less than 2 percent of the remaining area. Yet it represents a unique combination of soil and vegetation associated with a geological event which may be Pleistocene in age, possibly containing evidence of early sites. I decided therefore to divide the study area into a number of environmental zones, and then sample from within each of the zones. The zones so determined were:

1. Alluvial deposits on Emu Plains,
2. Lapstone Monocline and associated Hawkesbury Sandstone region west of the Nepean River,
3. Nepean river and floodplain on the eastern side of the river,
4. Agnes Banks sand,
5. Open woodland on tertiary alluvium (Castlereagh State Forest),
6. Woodland and forest on Wiannamatta shale.

The identification of these six zones provided a mechanism for representation on the basis of geology, geomorphology, vegetation and rainfall, which included all of the major environments available to Aborigines over at least the late Holocene.

Within these six zones, one might expect to find varying degrees of exposure of artefacts. As previously outlined, forested areas are less likely to produce sites than eroded surfaces. In order to minimise this problem, I devised a sampling strategy based on the system of tracks and firetrails which criss-cross most of these areas. By using a firetrail or vehicle track as a transect, and accepting that visibility along such a transect would be considerably greater than along a transect of similar dimensions covered with vegetation, it would be possible to obtain a better picture of the distribution and nature of sites in each area. It would also be possible, on the basis of the percentage of each area surveyed, to estimate the minimum number of sites and the minimum number of artefacts present within each zone. These estimates could then be extrapolated to those areas which were not surveyed. While this method would only provide approximate site and artefact densities, it would give a much more accurate estimate than any method based purely on random sampling or equidistant uniform transects.

The concept of using disturbances such as fire trails or tracks in archaeological survey is a well established technique, although it is seldom explicitly identified. Wright (1983) lists a number of locations where artefacts may be found in vegetated landscapes, including " ... places where the surface soil has become scoured by runnels of water flowing in cattle or vehicle tracks ... road or rail cuttings ... (and) ploughed paddocks". He sums up by stating that " The essential principle, in looking for surface artefacts, is to look for natural disturbances of the soil".

Obviously a random sampling method has much to recommend it. However, where such methods are inappropriate, sampling techniques adapted from the field of ecology may prove to be the most effective in obtaining the required data with the greatest efficiency. Two such methods are the use of quadrats and transects (see Wright, 1983). Theoretically, within each area surveyed, transects should be walked at equidistant intervals. For this study, the interval used was 200 metres, and the transect width was standardised to 5 metres. Transects across an area in one direction would result in 5/200 of the area being sampled, that is 2.5%. By using transects in two directions, north-south and east-west, a total of 5% of the surveyed area would be sampled (actually slightly less because of overlap, but the difference is not significant overall).

If tracks and firetrails were regularly spaced at intervals of 200 metres across the landscape, such a system would provide an excellent mechanism for overcoming the problem of site visibility. In practice, such tracks are irregular, and seldom conform to the ideal. However, in many cases the tracks do run subparallel to each other, and at intervals ranging from 100 to 400 metres. Wherever a track existed within 50 metres of the appropriate ideal transect, the firetrail was used as the transect. Where no firetrail or track existed in the appropriate location, a 5 metre wide transect was undertaken through the vegetation. This method had the following advantages:

1. It increased the likelihood of locating artefacts,
2. It provided a uniform percentage of each zone surveyed (5%),
3. It significantly speeded up the process of surveying.

It had the following disadvantages:

1. Not all transects within a zone had equal probability of locating artefacts,
2. The degree of disturbance was greater on the tracks than off the tracks. For instance, it is much more likely that artefacts on a track will have been broken on or after exposure rather than before deposition.

The first problem is acceptable, as long as it is realised that the number of sites/artefacts found represent *minimum* numbers. The quantitative data will be related to the nature of the assemblages found within the survey area, and not the absolute number of artefacts or sites across the survey area. Using this method to survey such a diverse range of environments, subjected to a wide variety of land uses over the past 200 years, also leads to a degree of bias. However I would contend that all archaeological surveys in similar forested or woodland environments must contend with precisely the same problem of varying degrees of visibility, although it is seldom identified as a consideration in research design.

The second problem, post-depositional breakages, is a serious one, but the effects can be minimised by close examination of all broken artefacts. In some instances, recent breaks can be detected by the presence of a fresh surface lacking patination, and in many cases conjoins can be formed. Roper (1976) found that even activities as destructive of sites as ploughing produced lateral displacement of artefacts over distances of less than five metres, while Redman and Watson (1970) used surface density data obtained from ploughed mounds to identify temporal and spatial patterning.

The statistical reliability of data obtained using the proposed survey method must be questioned. Within each survey area, the number of sites or artefacts located will be a function not only of the number of sites and artefacts actually present, but also of the degree of exposure. The lack of statistical precision apparent in the method must be weighed against the amount of data which would be obtained using statistically valid random sampling methods. As Hole (1980) points out: "the adherence to rigorous statistical protocol has resulted in methodology which is inflexible to a wide variety of circumstances, unmanageable in the presence of the unexpected, and insensitive to any but the most obvious of structure. The only instances in which such research designs can be effective are those in which they are not needed". For the western Cumberland Plain, some statistical precision must be sacrificed in order to obtain enough data to interpret the archaeological record.

5.4 Testing the method

In order to test the relatively greater rate of visibility on a track compared to off a track, experiments were carried out over a range of different environments. The point of these experiments was intuitively trivial; that the archaeological visibility would be significantly better on an exposed surface than off one, but it was important at least to attempt to quantify this fact.

A site complex at Black's Falls (BF/-), on the western bank of the Nepean River, was chosen for the first test. A firetrail was located on which artefacts were exposed. The firetrail had been originally created by a bulldozer clearing a path sub-parallel to the river at a distance of approximately 400 metres from it. The underlying rock was Hawkesbury Sandstone. Two parallel transects were examined, the first consisting of a 200 metre length along the firetrail, while the second ran parallel to it and five metres to the east. The results are shown in Figure 5.2. A total of exactly 200 stone artefacts were located over the 200 metre transect, giving an average density of 0.2 artefacts per square metre (200 artefacts in an area 200 metres long and five metres wide). The second transect, immediately to the east in an undisturbed section of the forest, produced a single chert flake. There is no reason to suspect that the two areas should have any significantly different artefact concentrations. However, in this case, the likelihood of locating artefacts was increased by a factor of 200 because of the increased visibility on the track. Although some conjoins and freshly broken surfaces were located, the frequency was low enough to suggest that post-depositional breakage of artefacts was a minor consideration when compared with the increased archaeological visibility on the track.

In order to confirm that the vehicle track method was applicable in other environmental zones, a similar experiment was conducted at a site within the alluvial deposits on the eastern side of the Nepean River at a site complex adjacent to Smiths Road, Castlereagh (PL/7). At this site, a vehicle track, running east-west, extended over the crest of a sandy ridge, and artefacts were exposed on the track. Two hundred metre transects were established, one centred on the track and the other immediately to the south of it. The results are shown in Figure 5.2. A total of 578 artefacts were located, and only three were found off the track, again suggesting that the vehicle track had increased visibility by a factor of approximately 200. In this instance, there is no reason to suspect that the concentration should vary significantly for any reason other than differing visibility caused by exposure.

The same kind of result was observed within the Wiannamatta Shale zone, where disturbance of a different kind produced a transect denuded of vegetation. Along Second Ponds Creek (SPC/-), high salinity has caused the destruction of the grass cover along both banks of the creek for a distance of over one kilometre. Within the exposed areas, over a 200 metre transect, 468 artefacts were found, while within the uneroded grasscovered bank, only 3 were recorded (see Figure 5.2).

The contention that the method would increase the likelihood of finding artefacts was confirmed, and the likelihood would appear to be increased by a factor of almost 200.

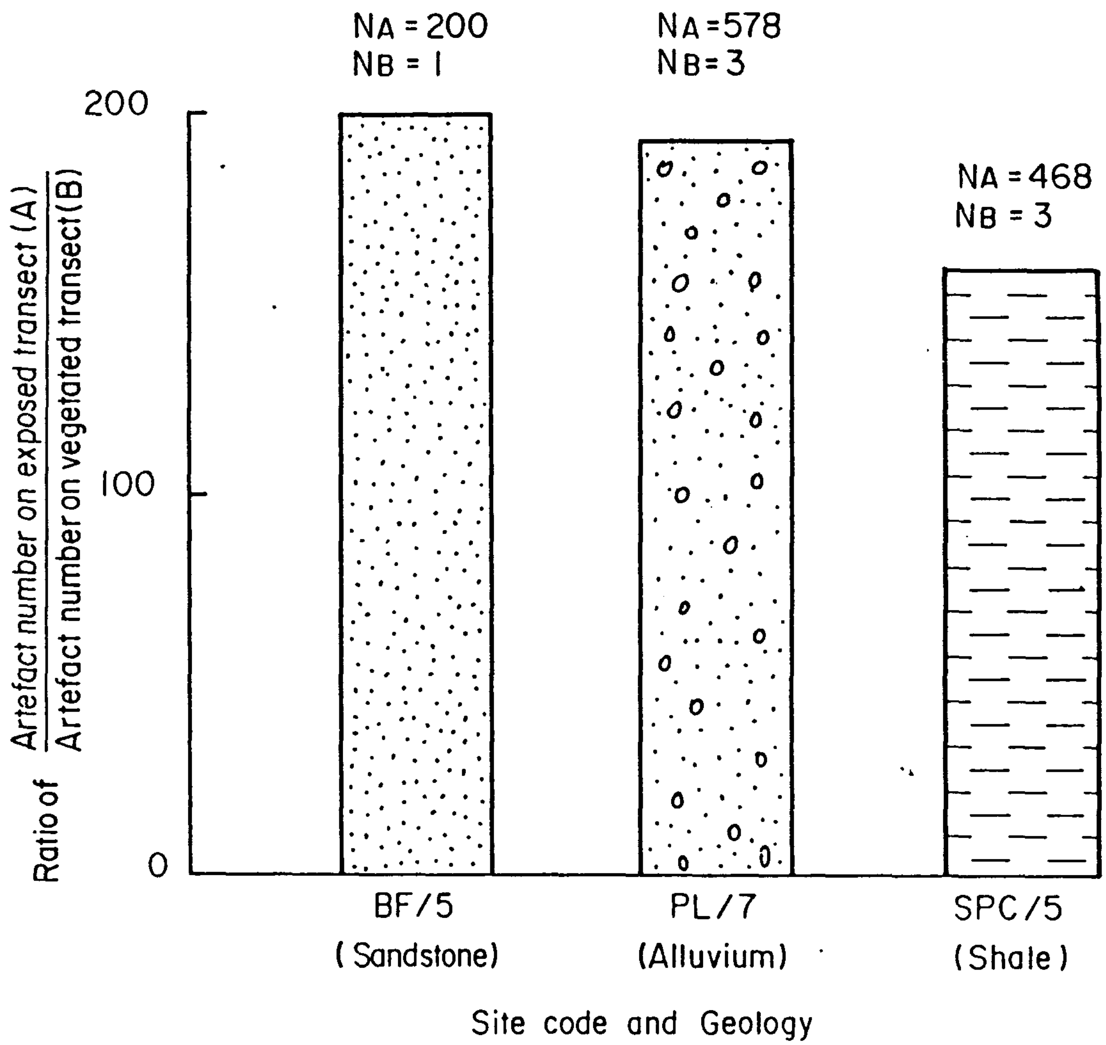


FIGURE 5.2. Ratio of artefacts found on disturbed transects to those found on undisturbed transects.

5.5 Data recording procedures for stone artefacts

Data recording sheets were prepared and used for coding a number of attributes for each stone artefact found (see appendix 1). The following attributes were noted on each artefact located:

Raw material:

Raw material was divided into one of six categories; chert (C), silcrete (S), quartz (Q), quartzite (Qz), basalt (B), and other (O). The first five raw materials are all found within the study area, and were known to have been utilised by Aborigines. The category "other" includes silicified wood, sandstone and other rare or exotic raw materials.

Modification:

Artefacts were classified as unmodified, modified by normal flaking, or modified by bipolar flaking. Unmodified objects or manuports could include such things as chert pebbles and block-fractured silcrete. The category "modified by normal flaking" includes cores and core tools, flakes, blades, and broken flaked fragments. Bipolar artefacts were distinguished by the presence of crushing or scaling on at least two opposing ends.

Type:

Each artefact was placed into one of five broad types. These were pebble, lump, core, flake, flake fragment. A "lump" is defined as a piece of stone which has been produced by natural fracture along planes of weakness in the original raw material. This category includes block-fractured silcrete and slabs of laminated chert.

Backing (if present):

Backed blades were divided into the categories Bondi point, geometric microlith, elouera, or miscellaneous backed flake.

Retouch (if present):

If an artefact showed signs of use as a tool, the modification was defined as utilisation, retouch, grinding, polish, or hammer/anvil use. In some cases, a single artefact might exhibit a combination of these traits.

Location of retouch/usewear (if present):

The location of the modification from use was categorised as distal, lateral, proximal, or ventral. Some artefacts showed signs of use on more than one edge, so multiple location of retouch/usewear was not uncommom.

Number of retouched/utilised edges:

The number of retouched or utilised edges was recorded.

Number of platforms on cores:

The number of striking platforms present on each core was recorded.

Dimensions:

The maximum length, width, and thickness were measured to the nearest millimetre with vernier calipers, and the weight measured to the nearest gram with a spring balance for artefacts up to 50 g and a laboratory balance for those above 50 g.

Dimensions of striking platform:

Wherever possible, the maximum width and maximum thickness of the striking platform was measured to the nearest millimetre for flakes, and the dimensions of the striking platform measured for cores. Where multiple striking platforms were present, a representative platform was measured.

Amount of cortex:

To determine the relationship between the degree of reduction and the distance from the source of raw material, the amount of cortex remaining on each artefact was quantified. The categories used were no cortex, <20% cortex, 20-50% cortex, and >50% cortex.

Edge angle:

Because of the probable relationship between the edge angle of a tool and its function (Ferguson, 1980), edge angles were classified as either sharp (<60 degrees), or steep (>60 degrees).

Comment:

A general description, classification (steep scraper, blade core, burin, debitage, etc) and artefact number were recorded.

This system of artefact classification was adopted after long deliberation. The typology adopted for the Shaws Creek KII excavation included all of these categories and two other additional parameters (shape of edge, dorsal trimmed flake butts). However these traits were found to be of limited value when assessing surface assemblages, so they were not used for subsequent analyses.

Any researcher will measure attributes which he or she considers significant in terms of the aims of the particular piece of research. If the reduction sequence of an artefact assemblage is being studied, a wide range of metrical data is likely to be considered necessary. If, on the other hand, the research is centred on usewear, microscopic examination and quantification of edge damage will be paramount. The aims of this study relate to technological change and resource availability, patterns of land use and site selection. For these reasons, the classification system adopted allows for rapid yet detailed analysis of a diverse range of artefact types.

A further consideration was whether or not the need existed to collect the artefacts located during the surveys for laboratory analysis, or whether they could be classified and left in the field. Because the collection of artefacts is considered effectively to destroy much of the information contained in a site, it is generally appropriate to leave artefacts *in situ* whenever possible. However, four factors influenced my decision to collect all artefacts located during these surveys. They were:

1) The total absence of archaeological material from the western Cumberland Plain in any scientific repository,

2) The need to weigh larger tools, and examine others microscopically for usewear,

3) The fact that the majority of the artefacts located came from disturbed environments, and

4) The relatively small proportion of the artefacts within the study area which would be collected.

5.6 Data recording procedures for site location analysis

Each site was allocated a site code and number, and environmental data were recorded on a site form (see appendix 1). The following information was recorded on the site data sheet:

Map reference:

The New South Wales State Mapping Authority Penrith 1:100,000 sheet was used as the base map for all surveys. The coordinates of each site were recorded for the Penrith 1:100000 and the appropriate 1:25,000 scale map.

Site name:

Each site was given a site code consisting of two or three letters to identify the survey area (e.g. BF for Blacks Falls, EC for Eastern Creek), followed by a slash and a number (BF/1, BF/2). Up to 32 sites were recorded for a single survey area.

Site type:

Each site was classified into one or more of the following types- Isolated find, surface scatter, exposed section, rockshelter, grinding grooves, engravings, and other (to be specified).

Site location:

The location of a site in relation to geomorphic and topographic features was recorded. The locations used were steep slope, river bed, river terrace, alluvial flat, levee, creek bank, hill slope, rockshelter, below ridgetop, ridgetop, and flat plain.

Soil type:

Soil type was recorded, and the following classifications used: aeolian sand, alluvial sand, sandy loam, clay loam, clay, other (to be specified).

Sub-soil:

The sub-soil was identified as sandstone, shale, alluvium, igneous or other (to be specified).

Geomorphology:

Any rock deposits at the site were recorded as Nepean gravels, quartzite gravels, silcrete gravels, silcrete outcrops, laterite, or other (to be specified).

Degree of disturbance:

Some quantification was required for the degree of disturbance leading to the exposure of the site. The following classifications were used: totally disturbed, 50-90% disturbed, 10-50% disturbed, disturbed by track only, or no disturbance.

Nature of disturbance:

The nature of the disturbance was specified as water, vehicles, bulldozing, animals, none, or other (to be specified).

Vegetation:

The nature of the existing vegetation at the site was recorded. Categories were cleared, woodland, open forest, closed forest, wet sclerophyll forest, or swamp.

Plant foods within 100 metres:

The genus and species of any known food plant exploited by Aborigines in eastern Australia found within 100 metres of a sites was recorded, and the date noted.

Distance to water:

The distance to water was measured from a 1:25000 map. Water sources were identified as seasonal creek, permanent creek, Nepean/Hawkesbury River, and swamp or lagoon.

Height above surrounding area:

The height of the site above the surrounding terrain was estimated from contour maps, and recorded as a height in metres.

Rainfall isohyet:

The present average annual rainfall was estimated for the site from rainfall data (Forster et al., 1977), and classified as 500-600 mm, 600-700 mm, 700-800 mm, 800-900 mm, 900-1000 mm, 1000-1100 mm, 1100-1200 mm, and greater than 1200 mm per annum.

Dominant raw material:

A preliminary impression of the dominant lithic raw material in use at the site was recorded, and the choices were chert, silcrete, quartz, basalt, and quartzite. Other raw materials present were also recorded.

Surface collection:

The nature of the surface collection carried out on the site was recorded. Choices were none, partial, total (by grid), and total (non-grid).

Depth of disturbance:

The maximum depth of disturbance at the site was recorded in centimetres.

Area of surface collection:

The area of the site over which the surface collection was conducted was recorded in square metres.

Distance from chert/basalt source:

The distance from a source of chert and basalt in the Nepean/Hawkesbury gravels was recorded to the nearest kilometre.

Distance from silcrete source:

The distance from a source of silcrete was recorded to the nearest kilometre.

Distance from sandstone:

The distance from a source of Hawkesbury sandstone was recorded to the nearest kilometre.

Associated fauna:

Any fauna which was seen in the vicinity of the site which may have been exploited as a food by the Aborigines was noted.

Comments:

Any other important or notable features or characteristics of the site or its environment were recorded.

Map/diagram:

A diagram was drawn recording the general physical appearance of the site, and photographs were taken for all sites other than isolated finds.

The choice of parameters to be measured or recorded was influenced by the fact that the survey was designed to locate sites which would generally be disturbed in some way. I felt it necessary to attempt to quantify and identify the nature of this disturbance, since it was a distinct possibility that the archaeological visibility was determined not by the density of artefacts present but by the erosional processes which had operated at the site.

Other parameters recorded were chosen for more obvious reasons. The selection of a campsite is expected to be influenced by factors like distance from water, height above the surrounding area, distance from useful resources, and nature of the soil. Sullivan (1976) attempted to quantify these factors for coastal sites in south-eastern New South Wales, while Flood (1980) identified factors considered responsible for the location of campsites in the Southern Upland region of New South Wales.

The value of such information has been expanded by the use of techniques like site catchment analysis, which aims to investigate the "relationships between technology and those natural resources lying within economic range of individual sites" (Vita-Finzi and Higgs, 1970: 5). Although there has been interest expressed from some Australian archaeologists regarding the potential of site catchment analysis (Davidson, 1981), detailed accounts of the successful use of the method are rare in Australian literature. One recent attempt to use site catchment analysis in north Queensland has confirmed that the method has potential when used in conjunction with traditional excavation techniques (Birkett, 1985). Outside Australia, a number of other approaches to palaeoeconomic reconstruction have been used with varying degrees of success (e.g. Foley, 1981b; Bintliff, 1981).

5.7 Computer storage of data

The data were stored on a microcomputer using the commercially available dBase II database. This was selected in preference to other archaeological database management systems (Johnson, 1979) because of the flexibility of the system. A not insignificant consideration was also that this software package is CP/M compatible, and was available for use with the microcomputers at Macquarie University.

Data were entered into the customised dBase files and stored on 13 cm floppy disks, with backup copies regularly made. The data could be used in conjunction with statistical packages available for the microcomputers, or could be transferred to the University Vax computer for more sophisticated data analysis.

5.8 Excavation techniques

In order to identify the temporal variability in the archaeological assemblages located within the study area, it was necessary to carry out at least some excavations. Without excavation, radiocarbon dating is generally not possible. With the characterisation of temporal variation in the stone tool kit, it may be possible to identify spatial variability.

Because the vast majority of sites within the study area were expected to be open sites, and because the density of artefactual material is generally greatest within rockshelter sites, it was recognised that the excavation of a representative rockshelter within the study area, ideally showing evidence of occupation extending over a long time span, could provide a baseline study against which the open site assemblages could be compared.

The two rockshelter sites which had been excavated within the study area, Lapstone Creek (McCarthy, 1948) and Shaws Creek KI (Stockton, 1973a) each had major problems which weighed heavily against using the excavated assemblages from these sites as the baseline study.

Lapstone Creek had been excavated during the 1930's, and the excavation techniques employed were inappropriate for the detailed analysis I required (see McCarthy, 1978). In addition, only two radiocarbon dates were available for the site, and at least one of these dates is inconsistent with other dated assemblages in eastern Australia. The date of 2300 ± 100 yrs BP (ANU-11) for the last Bondi points at this site is considerably earlier than other sites in the Sydney area.

Shaws Creek KI certainly appeared to have had a long period of occupation for the excavated assemblages included both *Capertian* and *Bondaian* cultural material, but no radiocarbon dates were available for the site. In addition, the loose sandy sediment within the shelter was shown to be susceptible to vertical displacement of artefacts (Stockton, 1973a), and the topmost units were probably disturbed (McCarthy, 1948).

A second rockshelter site was located on Shaws Creek approximately 500 metres downstream from the site excavated by Stockton. It was a much larger shelter, had a floor capped with hard laminated Nepean flood silts, contained a sandstone slab with rows of grinding grooves extending below the surface, and had flaked stone present in the dripline. A broken edge-ground hatchet head was found on the floor of the shelter, suggesting that no major disturbance or prior collecting had occurred. For these reasons, the site, Shaws Creek KII, was excavated in the hope that it could provide a dated sequence against which the open site assemblages could be compared (Kohen et al., 1981; 1984).

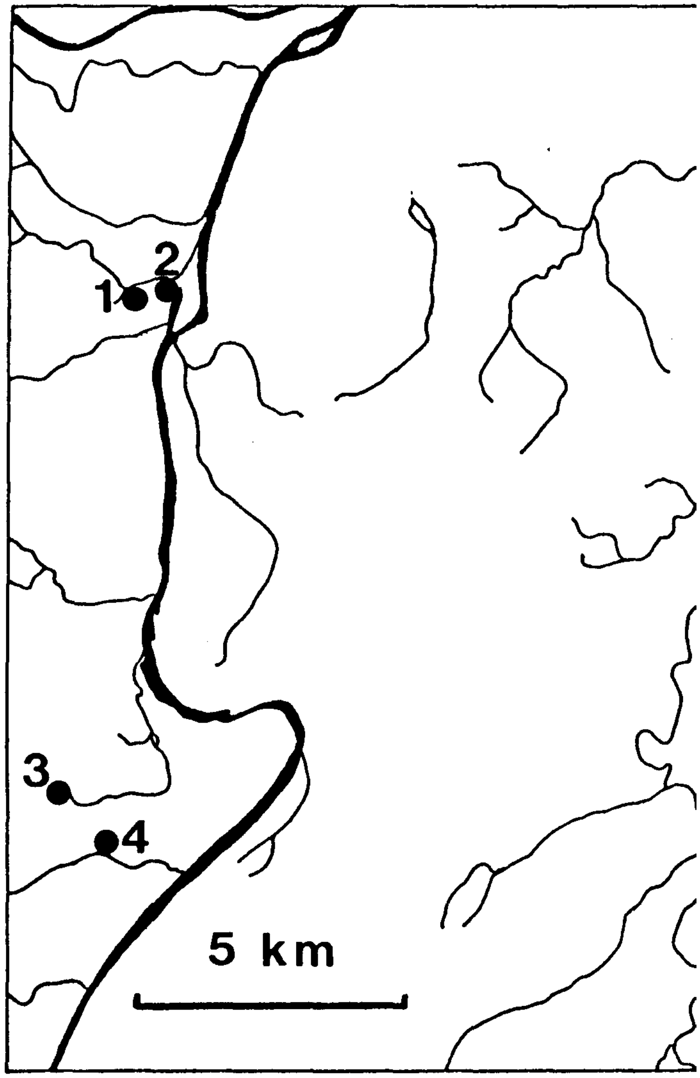
It was also seen as necessary to excavate at least one open site in order to detect any variations which may exist between rockshelter site and open site assemblages. No open site had been excavated within the study area. In fact few non-coastal open sites had been excavated in eastern Australia. The Emu Plains area approximately 10 km south of Shaws Creek, also on the western side of the Nepean River, was identified by McCarthy as having several "surface workshops" where edge-ground hatchets and uniface pebble tools were manufactured. One such workshop fell near the southwestern corner of the study area adjacent to Jamisons Creek, only one kilometre south of Lapstone Creek. When this area was surveyed, a major open campsite was located on a sandy terrace overlooking Jamisons Creek. The site had been disturbed by trail bikes, and several hundred stone artefacts, including edge-ground hatchet heads and backed blades, were exposed over an area approximately fourty metres long and fifteen metres wide. The geomorphology of the site was similar to an open site on Lapstone Creek, where artefacts had been exposed in a section extending down for a depth of up to 1 metre (Kohen, 1978). The Jamisons Creek open site (JC/1) was therefore excavated in the hope that the surface density of artefacts reflected the density below the surface, and that charcoal would be available for radiocarbon dating (Kohen, 1979; 1981b).

Because of the nature of the soils on the eastern side of the river, few sites were located which had excavation potential. In light of the variability in the proportions of raw materials used across the study area, I thought it necessary to excavate a site on which silcrete was the dominant raw material. The only site located which appeared to have a high density of surface artefacts associated with any significant depth of deposit was on Second Ponds Creek at Quakers Hill. The site SPC/5 was selected for excavation, and in the event this choice was justified (Kohen, 1984d).

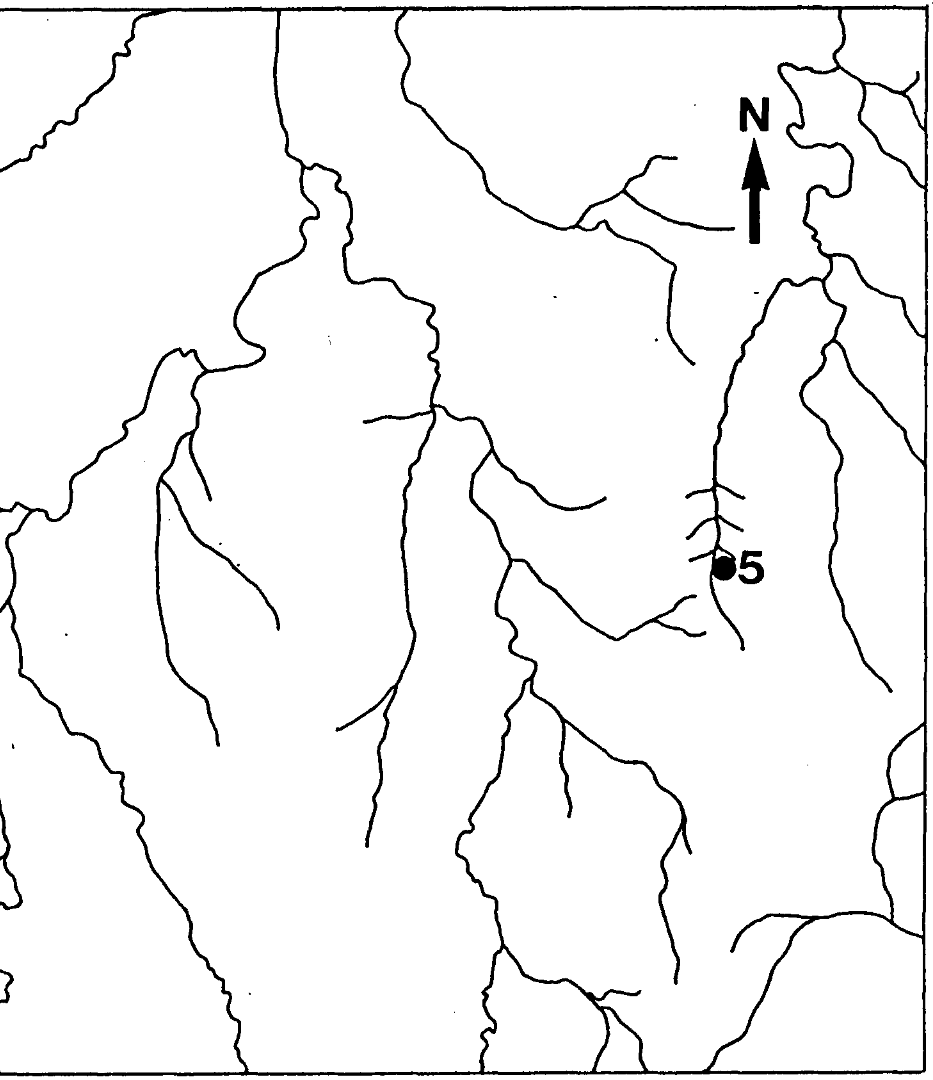
The location of the three sites excavated for this study and the two sites earlier excavated is shown in Figure 5.3.

FIGURE 5.3. Western Cumberland Plain: location of excavated sites in the study area.

1. Shaws Creek KI rock shelter
2. Shaws Creek KII rock shelter
3. Lapstone Creek rock shelter
4. Jamisons Creek open site
5. Second Ponds Creek open site



Excavated sites in



the study area

CHAPTER 6

SHAWS CREEK KII ROCKSHELTER SITE[1]

6.1 Historical background

The excavations undertaken by McCarthy (1948) and Stockton (1973a) established the range of artefact types which were likely to be found on the western edge of the study area at the foot of the Blue Mountains, and the temporal sequence in which they occur. Later excavations in eastern N.S.W. confirmed the main lines of this sequence (Lampert, 1971; McBryde, 1974; Moore, 1970; 1981; Megaw, 1974) but with certain refinements: For instance, the "fabricator", rather than the elouera, was seen to be more typical of the terminal phase, and the *Bondaian* was considered to have begun in the sixth millennium B.P.

For the Blue Mountains and piedmont zone, Stockton and Holland (1974) had shown:

(a) human occupation stretching well back into the Upper Pleistocene, perhaps as early as 28,000 BP (Nepean quarries);

(b) confirmation of the *Capertian-Bondaian* sequence, though characterised not only by the traditional cultural markers of stone tools but also by assemblage wide traits;

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1. *The excavation and analysis of the Shaw's Creek KII site was a cooperative project. The geomorphological analysis was undertaken by M.A.J. Williams, the stone tool analysis was carried out jointly by E.D. Stockton and the author, while the faunal analysis, environmental assessment and co-ordination for publication were undertaken by the author.*

(c) in addition to these two industries, recognised as predominating in true flake tools, the presence of assemblages of more massive tools on open sites;

(d) the possibility of a hiatus in occupation between the *Capertian* and the *Bondaian*;

(e) the dating of the *Bondaian* from the 4th millennium BP;

(f) the tripartite subdivision of the *Bondaian*, the latest phase of which corresponds with McCarthy's *Eloueran* but yielding cultural markers of the *Bondaian* in reduced numbers possibly up to European contact (but with more "fabricators", eloueras and edge-ground hatchets);

(g) climatic fluctuations in the Blue Mountains similar to those prevailing in S.E. Australia in the last 30,000 years, with local erosion more active in the first than in the second half of this time and pronounced aridity at about 12,000 B.P.

The excavation of Shaws Creek shelter one (KI) drew attention to disturbance of stratified deposits during occupation (Stockton, 1973a), which led to a review of earlier dates for the beginning of the *Bondaian* obtained from sites with similar sandy conditions, in which small backed blades tend to be forced down to lower levels (Stockton, 1977b). A fourth millennium BP date for the beginning of the *Bondaian* in this area was confirmed by the publication of McCarthy's and Megaw's dates and by Johnson's assessment of all the relevant data (1979). Johnson doubted the reality of the hiatus between the *Capertian* and the *Bondaian*. A tripartite division of the Small Tool Tradition has been favoured by Flood in the Southern Highlands (1980) and by Attenbrow at Mangrove Creek, west of Gosford (1981), with the terminal phase exhibiting regional differences in its tool components. The preliminary surveys on the western Cumberland Plain revealed a large number of open sites and silcrete quarries which appear to belong to the latest phase of the *Bondaian* (Kohen, 1980).

6.2 Aims

Despite this level of archaeological activity, the understanding of the technological sequence in the Sydney region remained sketchy both in specific detail and in overall characterisation. In order to establish a technological and chronological sequence which could be used as a basis for evaluating the open site assemblages across the Cumberland Plain, a thorough review seemed desirable and this called for excavation of a site which ideally enjoyed sound stratification, long and continuous occupation and high artifact yields. KI, though exemplifying problems of occupational disturbance, had a heavy concentration of artefacts ($6{,}000/m^3$), perhaps related to its favourable ecological setting and proximity to suitable and varied tool-making stone in the Nepean gravels. KII, only 500 m downstream, promised the advantages of KI, without its disadvantages, and in the event proved the ideal sought.

The excavation aimed to reach a fuller comprehension of the successive stratified assemblages, of the changes between them, of their respective time spans, of their relationship to open-sited assemblages, and of their environmental context. The results of the excavation have previously been published (Kohen <u>et al.</u>, 1981; 1984).

6.3 **Physical setting**

Before assessing the archaeological evidence, it is appropriate to focus on the physiographic setting, for it is apparent that the location of the site at the ecotone between plain and plateau accounts for its attraction to prehistoric hunter-gatherers.

The sandstone rock-shelter of KII is situated on the right bank of Shaws Creek some 700 metres from its junction with the Nepean River and only 14 metres above sea level (Figure 6.1). The shelter is 30 metres long, 4 metres wide and 2.5 metres high (Figure 6.2 and Plate 1), making it the largest rock-shelter between Emu Plains and Castlereagh. It commands a view north over the alluvial fan built up by Shaws Creek on emerging from the uplands, and is now occasionally submerged during major Nepean floods.

Shaws Creek drains a rugged sandstone catchment 11 km^2 in area, with over 350 metres of local relief. It is a mountain stream with a bed-load of quartz sand and sandstone fragments. The KII cave sediments reflect the interplay through time of Shaws Creek and the Nepean River.

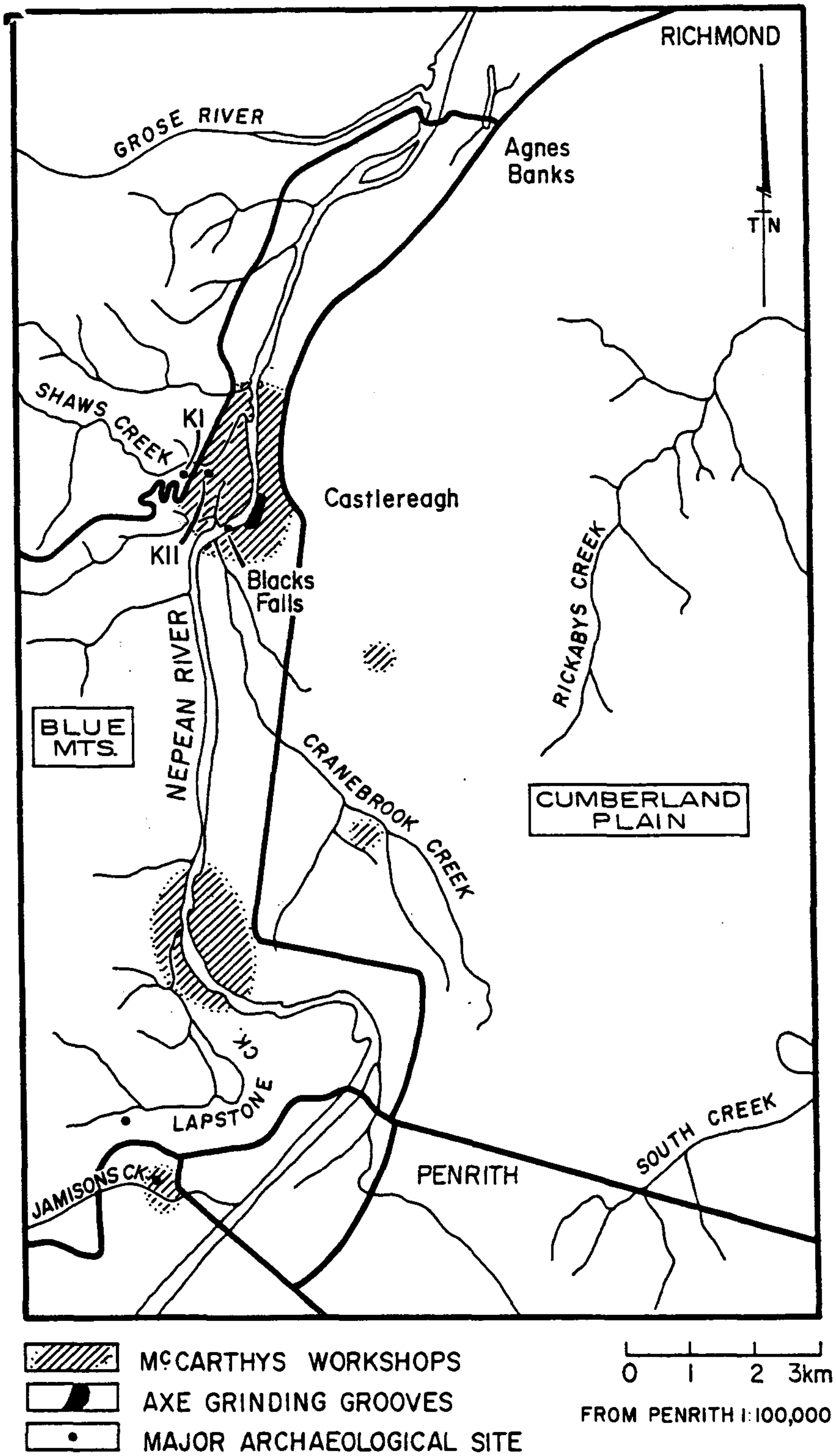
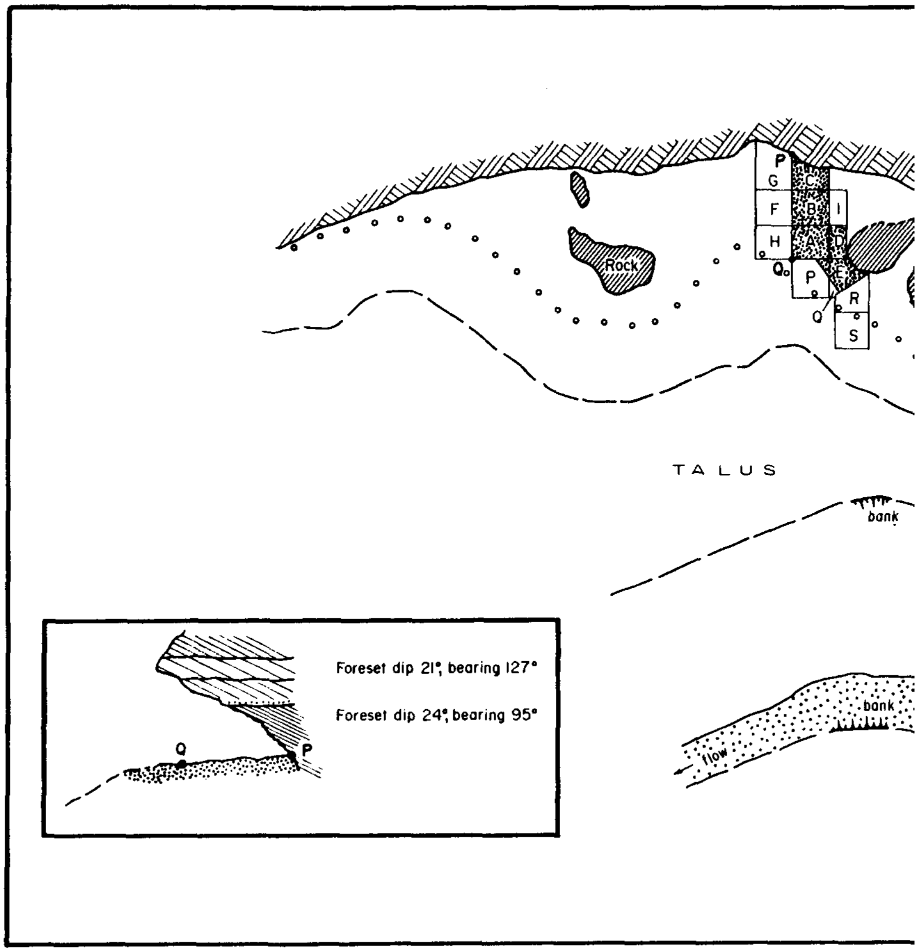
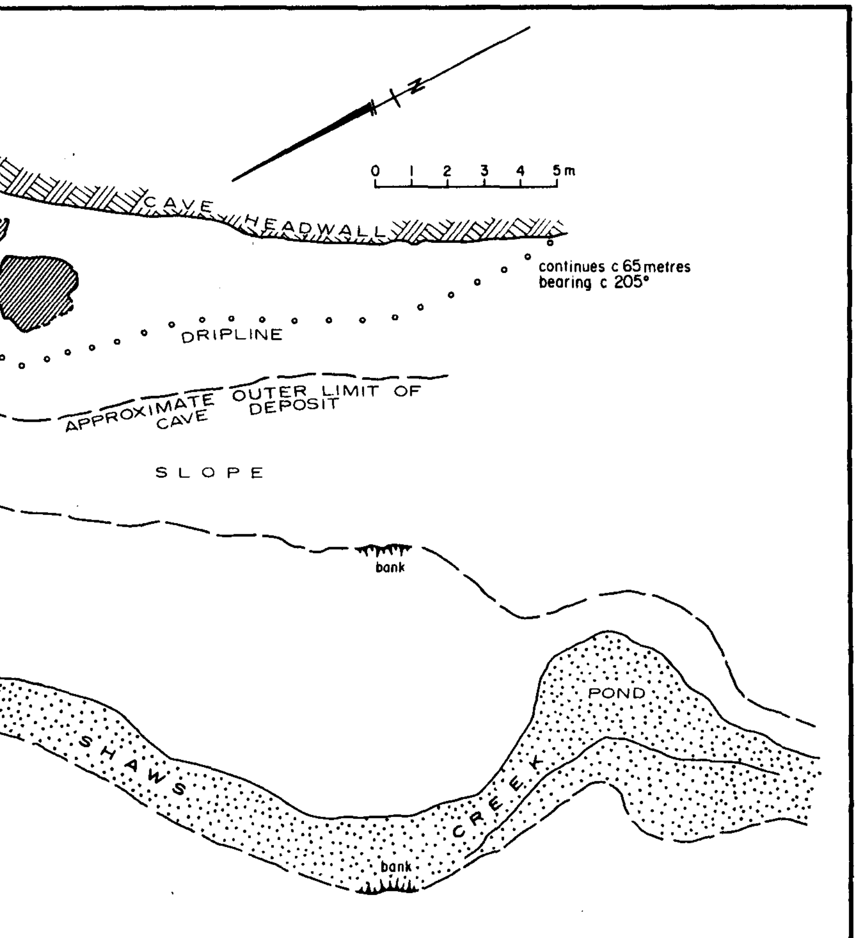


FIGURE 6.1. Archaeological sites in the vicinity of KII. Roads marked in heavy black line.

FIGURE 6.2. Plan and section of rockshelter KII. Letters indicate excavated squares.



P
G
F
H
C
B
A
I
D
E
Q
P
R
S
Rock
TALUS
bank
Foreset dip 21°, bearing 127°
Foreset dip 24°, bearing 95°
Q
P
bank
flow


N
0 1 2 3 4 5m
CAVE HEADWALL
continues c 65 metres bearing c 205°
DRIPLINE
APPROXIMATE OUTER LIMIT OF CAVE DEPOSIT
SLOPE
bank
POND
SHAWS CREEK
bank

Both waterways are prone to sudden, severe floods, not always concurrent. The impact of such floods upon the shelter differs. Nepean floods of the past 30 years and more have left silt drapes on the rock face several meters above the cave roof. Despite its low elevation, the shelter is protected from Nepean flood scour by a low sandstone spur which runs at right angles to the flow path of the main river. The upstream face of the spur is now concealed beneath the alluvium of the 15-metre Nepean terrace. KII thus lies in a protected flood backwater of the Nepean, and so will tend to receive backswamp silts and clays from that river during the waning stages of each major flood. At the present state of entrenchment, Shaws Creek does not appear to contribute to the accumulation of deposit within the shelter. However, as excavation revealed, the deposit consists not only of fallen blocks of sandstone and Nepean flood silts but also of local alluvial sands. The depositional sequence at KII thus reflects the interplay of a number of influences.

6.4 Ecological setting

The shelter is located near the junction of three major ecosystems. To the west, the narrow wooded valleys of the dissected sandstone plateau support a diverse fauna and flora. The woodland is dominated by *Eucalyptus fibrosa*, *E. sclerophylla* and *Angophora bakeri*; the most common understorey plants are *Dodonea triquetra*, *Bursaria spinosa* and a variety of wattles. Within a kilometre of the shelter there are several edible plant species, including patches of the burrawang, *Macrozamia communis*, the seeds of which were prepared and eaten by the Aborigines in the Sydney area (Worgan, 1788). Plants with edible fruits include *Billardiera scandens*, *Lissanthe sapida*, *Exocarpus cupressiformis*, and the geebung, *Persoonia linearis*. The wet sclerophyll vegetation along the creek includes the Lilly Pilly, *Acmena smithii*, native grape, *Cissus hypoglauca*, and a variety of species with edible tubers including *Eustrephus latifolius*, *Marsdenia* spp., and *Arthropoidum milleflorum*. The pencil yam, *Dioscorea transversa*, was found actually growing within the shelter. Yams were reported as a major food source in the Hawkesbury and Nepean River area at the time of white settlement (Tench, 1793). It should be remembered that many plants with edible tubers were commonly called "yam" at this time.

To the east, the Nepean River and its associated swamps and lagoons offer a seasonal abundance of aquatic resources. Beyond the river, remnants of the forests which grew on the Nepean flood plain adjoin extensive woodlands characteristic of the clay soils developed on the shales of the western Cumberland Plain.

It is obvious that juxtaposition of river, plain and plateau, by providing an abundance and variety of plant and animal resources, would offer a very favourable environment for a band of hunter-gatherers. There are additional advantages, with a convenient supply of chert and basalt pebbles in the bed of the river for making stone tools, and suitable sandstone outcrops for grinding stone hatchet heads (Dickson, 1980). These resources remained available until the recent past. By the early part of the nineteenth century, most of the floodplain had been cleared for farming, although Aborigines remained in the area until at least the 1820's, when they were seen setting fire to the underbrush between Castlereagh and Richmond (Mansfield, 1822).

The immediate vicinity of the site has been cleared for grazing, and no longer reflects the pre-European situation. The nutrient rich talus slope in front of the shelter is covered with the exotic lantana, *Lantana camara*, which has protected the site from recent intrusion and disturbance. Along the creek, the wattles *Acacia decurrens* and *A. parramattensis* are now plentiful, with an understorey of bracken fern, *Pteridium esculentum*.

The fauna in the area is diverse. In the river fish are plentiful, particularly during the summer months. They include the freshwater mullet, *Trachystoma petardi*, the bass, *Percalates novemaculeatus*, and eels, *Anguilla spp*. Crayfish and freshwater mussels are also present, and platypus, although now rare, were once common and hunted by the Aborigines (Collins, 1802). A wide variety of bird species frequents the river and lagoons, including ducks, egrets, swans and occasionally pelicans. Emus were found in the area, and quail were caught in traps (Tench, 1793). The woodlands east of the river supported populations of grey kangaroo, *Macropus giganteus*, until early this century, while the swamp wallaby *M. bicolor* and the red-necked wallaby, *M. rufogriseus*, still occur in the Lower Blue Mountains. Possums, gliders, bandicoots and a variety of small mammals are found nearby, while large goannas and snakes are still frequently encountered.

The January mean maximum temperature is 30 degrees C, with temperatures in excess of 40 degrees C not uncommon. In July, the mean monthly minimum is around 3 degrees C, with frequent sub-zero temperatures and frosts. Although the rainfall varies from 900-1000 mm per annum, it is highly irregular, sometimes producing extensive flooding.

6.5 Excavation

The rockshelter showed every indication of being a rich site even before the excavations were begun. A broken edge ground hatchet lay on the surface, and the major rockfall at the northern end of the shelter revealed several rows of grooves, some extending below ground level. Part of the same slab has a flat polished surface, quite distinct from the grooves but certainly an artefact, of unknown function. On the opposite bank of the creek, a little upstream, are two circular mounds of earth, again certainly of human and not recent origin, which may be burials. Cox (1880) describes edge ground axes being found in burial mounds in this area.

Figure 6.3 shows the location and order of excavation. The first metre square, A, was put down in December 1979 to probe the underlying stratigraphy. On removal of a veneer of flood silt, the excavation proceeded by 5 to 10 cm horizontal spits (depending on stratigraphy encountered). The trench was extended to the headwall (squares B and C) by depositional strata, at times subdivided into artificial spits of varying depth. At the base of A and B, a cleft was found in the lower of two major rockfalls. It contained a high concentration of artefact material resulting from tool production/use on the rockfall surface. To capitalize on this, squares D and E branched off from the axis of the main trench. In May 1980, the original trench was extended sideways (squares F,G,H,I) by 50 cm squares, excavated in highly controlled, shallow spits, principally dictated by stratigraphic changes. This helped to identify various kinds of stratigraphic disturbance. The deposit towards the front was recognised to be subject to disturbance from dripline and faunal activity, but P,Q,R, and S were excavated to clarify the extent and sequence of the minor rockfalls and to extend the excavation of the cleft, which was found to be free of the disturbance apparent in the upper levels.

The excavated material was dry-and wet-sieved through a 5 mm mesh, and all artefacts, manuports, bone, shell and ochre were retained. Charcoal samples were collected from secure contexts, and those submitted which promised to help reconstruct a framework of technological and geomorphic changes on the site (Table 6.1). Suitable samples could not be found within the cleft and no attempt has been made to project back the chronology on supposed rates of deposition, since in the confined conditions of the cleft such rates could not be presumed comparable with those for the rest of the deposit.

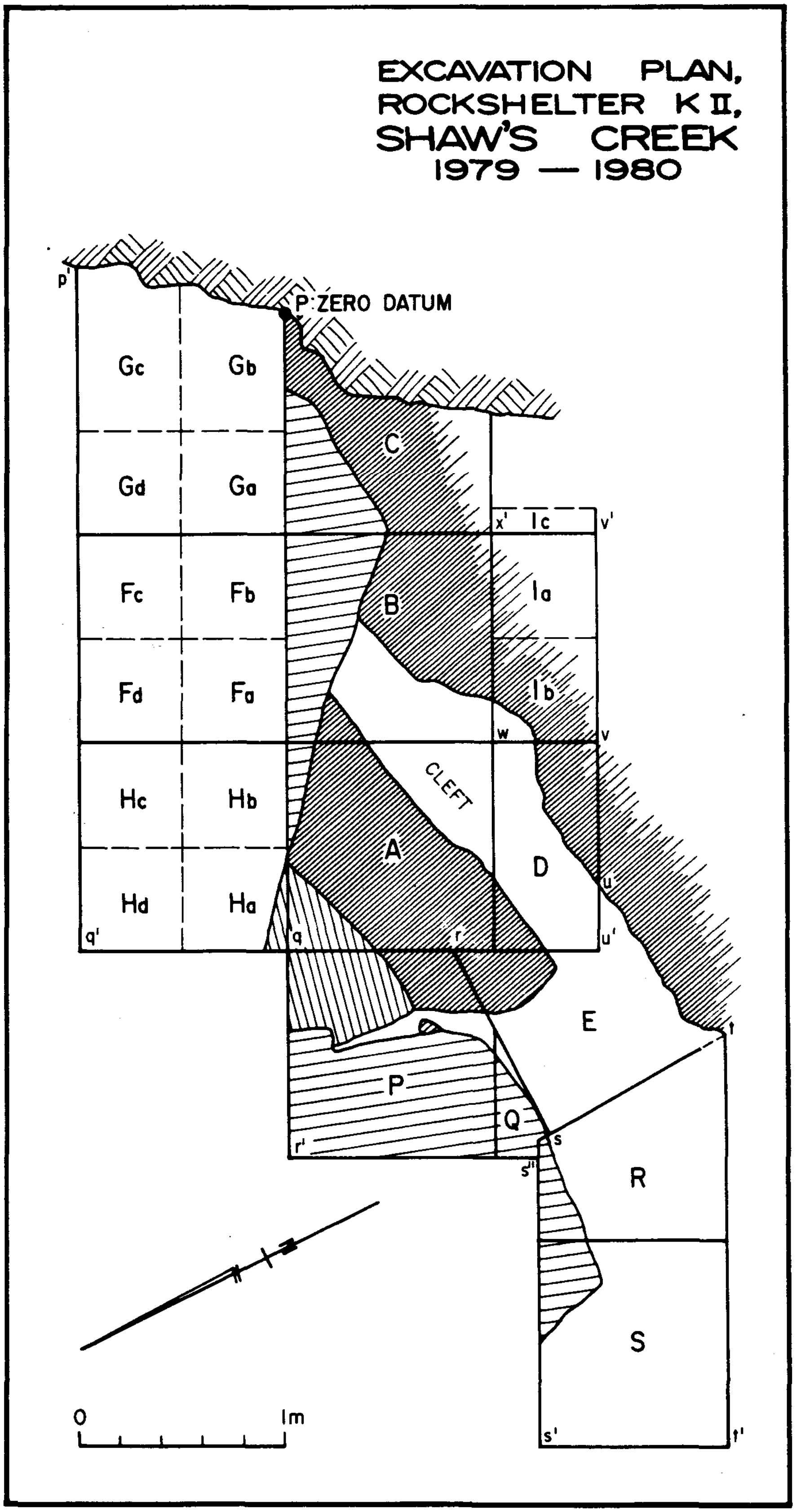


FIGURE 6.3. Site KII: excavation plan, showing rockfalls (diagonally hatched) and central cleft. Cave headwall shown by cross-hatching.

Sample	Spit No.	Depth (cm)	Strat. Unit	Phase	Year BP
Beta-1209	A11	71	4	V	12980 ± 480
SUA-1398	Gc5	31	4	IV	7860 ± 220
Beta-1211	C8	38	4		4140 ± 180
Beta-1210	B5	31	5	III	2235 ± 120
Beta-1213	B3	23	6 (base)	II	1840 ± 70
Beta-1212	C1	5	6		1790 ± 115
SUA-1307	A3	24	6	II	1580 ± 190
SUA-1393	Da2	11	cut and fill		1240 ± 90

Table 6.1. Radiocarbon dates from KII.

Unit	Square	Taxa	Item
6	B	(?)*Petrogale penicillata*	Molar
6	I	(?)*Petrogale penicillata*	Partial molar
6	G	(?)*Macropus giganteus*	Partial molar
6	F	Fam. *Macropodidae*	Molar
6	F	Fam. *Macropodidae*	Molar
6	G	*Sus scrofa*	Molar
6	S	*Sus scrofa*	Four molars
6	D	Class *Aves*	Bone fragment
6	Several	*Velesunio ambiguus*	Shell fragments
5	F	(?)*Macropus dorsalis*	Two partial molars
5	Several	*Velesunio ambiguus*	Shell fragments
4	B	Fam. *Macropodidae*	Phalanx

Table 6.2. Identifiable animal taxa at KII.

6.6 Stratigraphy

Williams (Kohen et al, 1981; 1984) has described the six main stratigraphic units (Figure 6.4). They are numbered consecutively from the base up, consistent with international stratigraphic practice, a procedure given archaeological endorsement by Butzer (1982) and Kiernan et al., (1983). Cultural phases are denoted by Roman numerals, starting with the youngest.

The three oldest units fill the lower half of a fissure which runs roughly east-west through the lower of two major rockfalls exposed during the excavation. Unit 1 is a hard, mottled olive and grey clay-cemented sand interspersed with fragments of weathered sandstone. Unit 2 above it is a loose yellow-brown gravelly quartz sand comparable to the modern bedload of Shaws Creek. The gravel fraction comprises rounded quartz pebbles and rolled sandstone clasts. Unit 3 is similar to the basal unit 1 except that it is brown. In thin section it appears weakly bedded and is seen to contain microscopic wood fragments (Dr. Paul Goldberg, pers. comm.). Sandstone clasts are embedded within the deposit, which may reflect entrainment of local sandstone fragments by turbid Nepean floodwaters. All three units are of Pleistocene age, and are older than charcoal sample Beta-1209 collected near the base of unit 4 and dated to 12,980 ± 480 BP. Unit 4 is a loose fluviatile yellow quartz sand (4s) with gravel lenses (4g). The sand is well sorted; the sandstone and quartz gravel is rolled and also well sorted. As with unit 2, this unit reflects episodic accumulation of bedload sands and gravels from Shaws Creek. Two further charcoal samples collected from near the middle and top of unit 4 indicate intermittent deposition over a span of time perhaps longer in duration than the entire Holocene (Figure 6.4). Sample SUA-1398 (7,860 ± 220 BP) overlies the upper of the two major rockfalls exposed in section, as does sample Beta-1211 (4,140 ± 180 BP).

Collapse of the two large rockfalls from the roof of the sandstone shelter may have been effected during exceptional floods from Shaws Creek and/or the Nepean. Such collapse was not a frequent event, as the lower rockfall is older than 12,980 BP, and the upper is older than 7,860 BP.

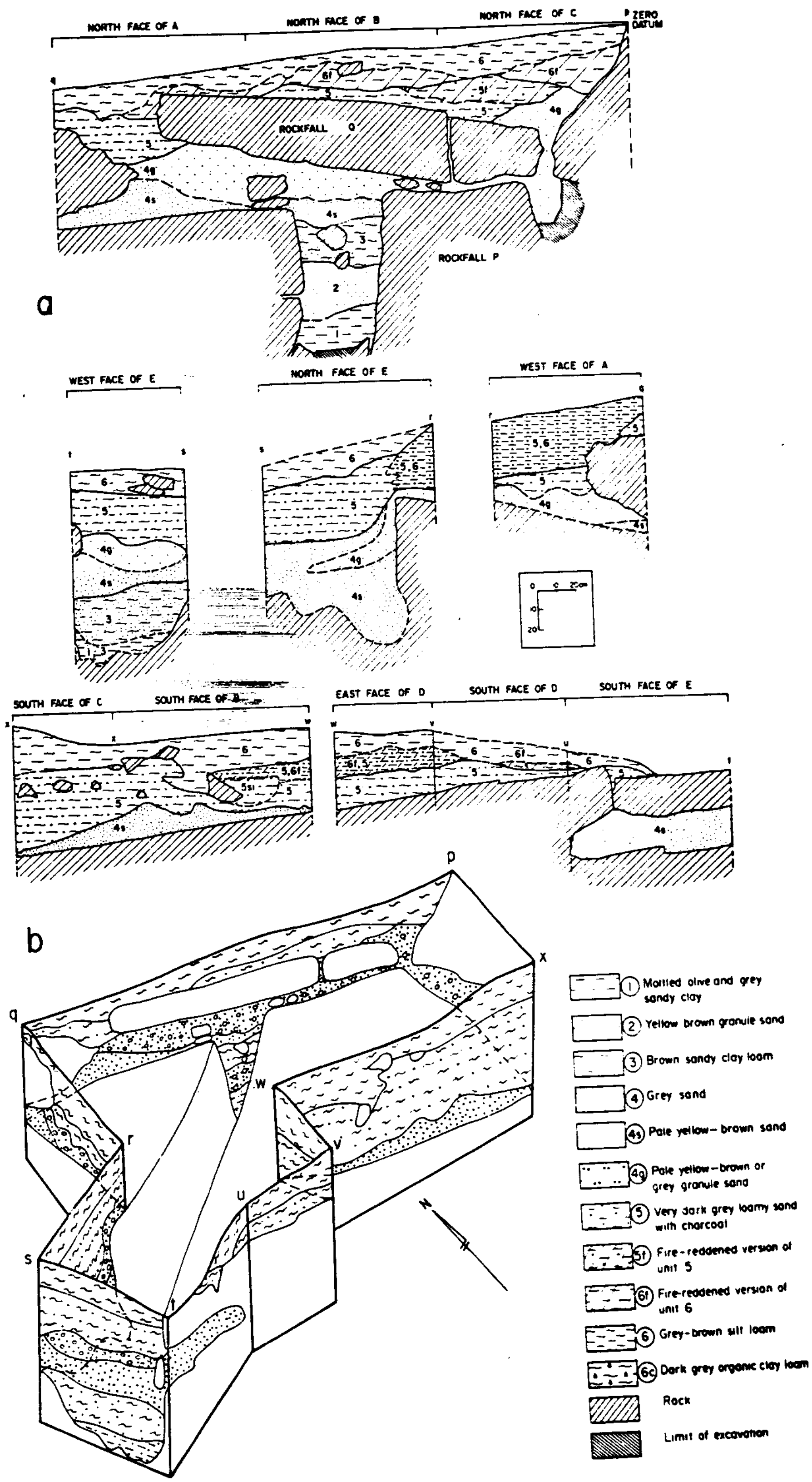
Units 5 and 6 both show considerable signs of human activity in the form of hearths, and in this respect differ from the four underlying units, which, apart from the rockfalls, are largely of fluviatile origin. Unit 5 is a dark grey brown clayey sand with abundant charcoal, and is locally silty (5 si) or fire-reddened (5f). In colour, texture and mineralogy it closely resembles Nepean flood deposits exposed in the banks of that river and in tributary channels, including Shaws Creek. In terms of age, it is younger than 4,140 BP, contains charcoal dated to 2,235 ± 120 BP (Beta-1210), and predates sample Beta-1213 collected from the base of unit 6, dated to 1,840 ± 70 BP.

Unit 6 is a grey-brown silt loam, locally fire-reddened (6f), capped by up to 4 cm of recent flood silts. This unit thickens beyond the dripline into a dark organic loam over a

FIGURE 6.4. a: Stratigraphic sections of December 1979 excavations at KII;

b: Block diagram of December 1979 excavations at KII.

(Stratigraphic description by M.A.J. Williams in Kohen *et al.*, 1981; 1984).

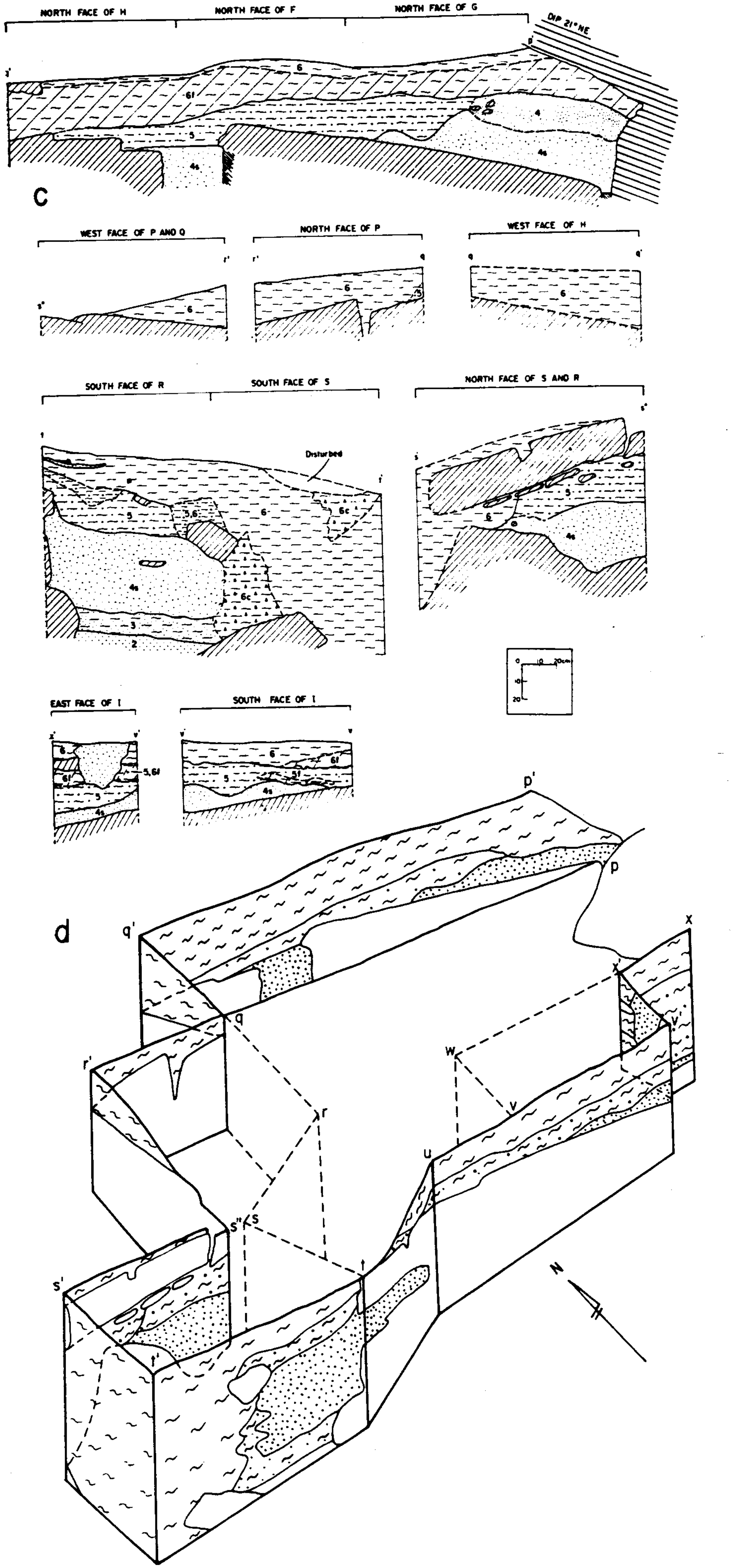


a
NORTH FACE OF A
NORTH FACE OF B
NORTH FACE OF C
ZERO DATUM
ROCKFALL Q
ROCKFALL P
WEST FACE OF E
NORTH FACE OF E
WEST FACE OF A
SOUTH FACE OF C
SOUTH FACE OF B
EAST FACE OF D
SOUTH FACE OF D
SOUTH FACE OF E
b
1 Mottled olive and grey sandy clay
2 Yellow brown granule sand
3 Brown sandy clay loam
4 Grey sand
4s Pale yellow-brown sand
4g Pale yellow-brown or grey granule sand
5 Very dark grey loamy sand with charcoal
5f Fire-reddened version of unit 5
6f Fire-reddened version of unit 6
6 Grey-brown silt loam
6c Dark grey organic clay loam
Rock
Limit of excavation

FIGURE 6.4 c: Stratigraphic sections of May 1980 excavtions at KII;

d: Block diagram of May 1980 excavations at KII.

(Stratigraphic description by M.A.J. Williams in Kohen _et al._, 1981; 1984).



NORTH FACE OF H
NORTH FACE OF F
NORTH FACE OF G
DIP 21° NE
c
WEST FACE OF P AND Q
NORTH FACE OF P
WEST FACE OF H
SOUTH FACE OF R
SOUTH FACE OF S
NORTH FACE OF S AND R
Disturbed
EAST FACE OF I
SOUTH FACE OF I
d
N

metre thick. Human and other biological activity have destroyed most of the original laminar stratification, but the abundance and freshness of the hornblende and biotite within this unit are consistent with relatively recent accretion from Nepean flood deposits (Dr Paul Goldberg, pers. comm.). In addition to Beta-1213, two charcoal samples within this unit have yielded ages of 1790 ± 115 BP (Beta-1212) and 1580 ± 190 BP (SUA-1307).

A single flood probably from Shaws Creek scoured a channel near the back of the shelter which, in the south face of square I, was 25 cm wide and 25 cm deep, leaving a channel-fill deposit of yellow sand which was clearly visible in excavated section (Figure 6.4). Charcoal from this cut-and-fill structure is dated to 1240 ± 90 BP (SUA-1393), and like unit 6 is capped by the recent flood silts. Since charcoal fragments carried by sandbed streams may be up to 1600 years older than the sands in which they occur (Blong and Gillespie, 1978), the channel could well be younger than 1240 BP.

6.7 Faunal analysis

The acid nature of the Hawkesbury sandstone soils frequently means that in occupation sites other than shell middens, bone is not well preserved. In the case of the upper two units at this site, where the deposit is largely flood silts, bone is relatively common. Although over 600 bone fragments were recovered, very few were suitable for identification. However, the majority of the fragments appeared to belong to large animals, with small mammal and bird bone being rare. This may be due in part to the more rapid breakdown and dissolution of the smaller bones, but the almost total lack of fragments and teeth belonging to small species strongly suggests that macropods were by far the most important component of the faunal assemblage. Since much of the bone was burnt, it seems that most of the fauna was associated with Aboriginal activity and not the result of the use of the shelter by non-human carnivores. Macropods would therefore appear to have been an important source of protein in the diet (also reflected in the fact that kangaroos are a recurring motif of local rock engravings). With one exception (a macropod phalanx), all post-cranial remains were shattered, suggesting that the bone was intentionally broken prior to deposition, perhaps to extract the marrow. Well preserved bone was restricted to units 5 and 6, with a few poorly preserved fragments near the top of unit 4.

After preliminary sorting, the teeth were sent to Dr Michael Archer of the Zoology Department, University of New South Wales, for further identification. The analysis of the fauna is summarised in Table 6.2. From the rear of the shelter in square G came the molar of a pig, *Sus scrofa*, which was apparently incorporated in the deposit since European settlement began in 1788. At the base of unit 6 in square S, outside the dripline in an area greatly disturbed by rabbit and insect burrows, came four more pig molars, all well preserved. The other teeth recovered were all macropodid, some of which could be identified below family level. Unfortunately, species level identification was not possible. Of the three tentatively identified species present, only *Macropus giganteus* has been recorded alive from this area. The nearest record of the Black Striped Wallaby is north of Lithgow in the Blue Mountains (Marlow, 1958: 102-3), while the closest natural populations of rock wallabies are on the north side of the Hawkesbury River (Leong Lim, pers. comm.). The tentative identifications cannot be used for extending the range of these species, but the possibility that their distributions had altered prior to white settlement cannot be discounted. In any event, it appears that macropods found in a number of different environments were being exploited for food.

Fragments of freshwater mussel shell were plentiful throughout units 5 and 6. These were almost certainly the species still found in the area, *Velesunio ambiguus*. The greatest concentrations of both shell and bone occurred at the base of unit 6 in the squares at the rear of the shelter, while square S, outside the dripline, produced few fragments. Such distribution may indicate that the rear is the area least subject to post-depositional degradation from moisture (Hughes, 1977), and/or the preferred locus for the dumping of food refuse.

6.8 Stone tool analysis

The classification of the lithic assemblage was undertaken by Kohen and Stockton (Kohen et al., 1981; 1984). The results of the analysis of the stone artefacts are summarised in Tables 6.3, 6.4 and 6.5.

(a) Phasing

Technologically there was a clear contrast between the artefact assemblage in the upper two stratigraphic units and that of the lower four. To highlight the trends within the two and the changes between them, each was further subdivided into three phases on the basis of the change in size and density of material, artefact types, lithic preference and methods of manufacture. Further criteria were the need for a statistically reliable sample within each phase, exclusion of all squares showing stratigraphic disturbance, and good correlation with stratigraphic units identified on geomorphic grounds (Figures 6.4).

Phase I = upper Unit 6 (< c.1500 BP)

Phase II = 5/6 transition (c. 1500-2000 BP)

Phase III = lower Unit 5 (2000 - 4000 BP)

Phase IV = Unit 4, upper half (> 4000 BP)

Phase V = Unit 4, lower half, and Unit 3 (c. 13,000 BP)

Phase VI = Units 2 and 1 (> 13,000 BP)

It must be emphasised that the tripartite subdivisions are not claimed to represent cultural entities but to illustrate cultural trends within such entities. The decision to phase the sequence on assemblage traits and sample size, rather than on purely stratigraphic units, was justified on the grounds that a purely stratigraphic phasing

(i) would have masked important trends such as the peaking of the backed tool technology at the transition between stratigraphic units 5 and 6 (cf. later discussion);

(ii) would have resulted in one phase, in unit 4, covering a time span of almost 10,000 years, out of all proportion comparatively with the succeeding phase;

(iii) would have relegated to phases in the lower three units sample sizes too small to be statistically reliable.

Detailed study of the tool sequence was restricted in the upper two soil units to squares A, B and F; squares H, P, Q and R were excluded by dripline activity; S by plant and animal activity; G, C, I, D, and E by cut-and-fill; G and C also by successive hearths, with associated scooping and piling of earth towards the rear (Stockton, 1980). The above restrictions did not apply to the lower four depositional units, confined as they were between rockfalls, and material from all squares was used.

(b) Classification

For ease of comparison with recent excavations in nearby areas, the system followed is a modification of that used for the Blue Mountains (Stockton and Holland, 1974; Stockton, 1977c) and Mangrove Creek (Attenbrow, 1981). The system moves away from reliance on recognisable tool types, especially cultural markers (which may be few, even absent, in small samples of the appropriate period), and pays more attention to characteristics of the assemblage as a whole. In describing the assemblage-wide traits of each successive stratified assemblage, account is taken of the following kinds of data:

(i) the mean weight of flakes;

(ii) the percentage in the whole assemblage of each raw material and each artefact form (cores, tools, debitage);

(iii) the percentage in the toolkit of each tool type, especially of each group of tool types (e.g. backed tools, pebble/core/thick flake tools, described below);

(iv) the proportion of each type of retouch in the total of retouched edges;

(v) the incidence of different flaking techniques.

Where such indices show long-term, regular trends through a sequence they may indicate cultural developments through time, especially if similar results are registered in other excavated sequences. The method has potential for comparing stratified assemblages, both diachronously and synchronously, in particular where diagnostic artefacts are absent. One aim of the excavation was to test the method in a continuous, well-controlled sequence in an artefact-rich deposit close to abundant and varied raw material, and to provide figures which might be compared with other excavated sequences.

Table 6.3 lists the tools in the major tool groups; pebble tools, amorphous core/flake tools, back-blunted flake tools. The first and last of these hardly require explanation. The second (often labelled "scrapers" in Australia) demands more detailed attention, both because as a group it is numerically the most important tool, and because it has occasioned more problems in classification. The term "amorphous" applies to those tools which show use/retouch only at the working edge and do not exhibit a consistent combination of traits. They appear to have been ad hoc implements in which the stone as found, or the casual result of primary flaking (whether cores or flakes), have been used with little or no modification where edges have proved convenient for immediate work, such as cutting, chopping, scraping, planing, shaving and sawing. Because these amorphous tools by definition do not consistently combine traits (e.g., sometimes thin flakes have steep retouch and thick flakes have sharp retouch), and frequently show multiple use, it was decided to list them not hierarchically as discrete tools, but by their traits (artefact form, edge angle, shape and angle of retouch, again noting through time the varying proportions of each (Table 6.4).

As to artefact form, the core component of this amorphous group needs no explanation. The flake component has been divided into thin (edge-trimmed) flake tools and thick flake tools, following the distinction first recognised by McCarthy ("normal flakes and blades" and "blocks", 1967) and pursued in the Blue Mountains and Mangrove Creek reports. For the purpose of this analysis the division was made by visual inspection between:

(i) flat, thin-sectioned flakes with sharp edges showing evidence of use or deliberate retouch; and

(ii) thicker, chunky flakes, more irregular in size, usually with steep retouch on a steep edge and approximating to core tools.

Attenbrow (1981) notes that the former, through time, tended to become standardised in shape and size, which suggests a certain deliberation and control in manufacture which is certainly not the case with thick flake tools. Her third category of "steep edged scrapers" corresponds to some of the more chunky flake tools at Shaws Creek. Table 6.3 also lists among amorphous core/flake tools "dorsal-trimmed flake butts", a provisional designation for rejuvenation flakes bearing signs of prior knapping or steep retouch from the butt over the dorsal surface. Where use/retouch is certain the flake is presumed to have been removed from a chunky steep-edged tool.

Table 6.3 also regroups the material in the pebble and amorphous groups (which are common to all assemblages, old and new) into two new categories which vary proportionally to a significant degree through time and so provide useful indices for comparing older and younger assemblages, irrespective of diagnostic tools. It is based on the classic distinction between a true (i.e. thin) flake tool and a core tool, including pebble tools and thick flake tools. In the regrouping, the amorphous *thin flake tools* have been designated *edge-trimmed flake tools*, and the rest *pebble/core/thick flake tools*. Even on cursory inspection of an assemblage, the two categories stand apart quite distinctly in size and typology. This bimodalism, in what are probably *ad hoc* maintenance tools, may be related to different modes of handling, whether in the whole hand or at fingertip (Stockton, 1977a), and the varying proportions between the two through time may have cultural implications in the gradual shift from hand-held tool to finger-held and hafted tools. Whatever the basis for the difference, the smaller and larger series of amorphous tools vary significantly in their respective proportions of the tool kit through time. A review of well-dated assemblages in South-East Australia has shown a decline through time of the combined pebble/core/thick flake tools as a percentage of the toolkit ("p/c/tf index" for short), concomitantly with an increase in edge-trimmed flake tools (Stockton, 1977c; 1979).

Table 6.4 contains an analysis of the working edges of the amorphous core/ flake tools, and records not only edge profiles, which undergo proportional variation through time, but also edge angle, before and after retouch, in view of the current interest in its relationship to function (for a discussion and references see Ferguson, 1980). Following Ferguson, the working edges are divided into steep and sharp, with the boundary set at 60 degrees, roughly separating edges more suited to scraping from edges more suited to cutting. However, natural sharp edges could be, and were, also used for scraping. Despite the occasional occurrence of sharp edges on concave and convex margins, such tools are presumed to have been used at right angles to their plane, for scraping and shaving. For straight margins (i.e., ones which also permit use along the axis of their plane), scraping and planing can be suspected where the angle of retouch/use is steep, cutting and shaving where sharp. Steep retouch on a straight margin can occur on steep edges as step flaking, and on sharp margins as abrupt (with facets running between the two surfaces) or minute (with tiny abrupt facets on the tip of the edge, perhaps the result of incipient use). Denticulation, whether due to use or deliberate retouch, can be related to cutting and sawing. Denticulates are subdivided into serrated and dentated according to whether they have coarse irregularly spaced teeth, or fine regularly spaced teeth (Stockton, 1977c).

Manufacturing data in Table 6.5 refers to artefacts indicative of specialised flaking techniques, irrespective of their being tools or waste. Blades and pointed flakes are long thin flakes with parallel or convergent margins. Faceted butts indicate core preparation. Redirecting flakes and dorsal-trimmed flake butts are forms of rejuvenation. Under burin spalling are included what are technically burins, without suggesting that this was an intended tool type as in the Old World; at least one example of burin use was suspected from microscopic examination (R. Fullager, pers. comm.). Ground fragments probably derive from edge-ground hatchets. Bipolar/scalar pieces, formerly "fabricators", are the result of bipolar reduction of a core.

Phases	I	II	III	IV	V	VI
Total worked stone	2369	2737	1239	460	550	432
Cores	12	14	3	26	31	18
Tools	62	95	43	44	62	73
Pebble Tools						
Choppers	-	1	1	-	2	1
Hammerstones	-	-	-	2	3	3
Anvils	-	-	-	1	2	1
Total	-	1	1	3	7	5
Amorphous Core/Flake tools						
Cores	1	2	1	6	12	3
Thick flakes	12	20	5	9	17	41
Dorsal-trimmed butts	7	11	9	16	12	8
Thin flakes	31	35	17	10	14	16
Total	51	68	32	41	55	68
Back blunted tools						
Bondi points	7	18	4	-	-	-
Geometric microliths	2	3	3	-	-	-
Eloueras	1	3	2	-	-	-
Backed fragments	1	2	1	-	-	-
Total	11	26	10	-	-	-
P/c/tf Index						
P/c/tf/tools	13	23	7	18	36	49
Edge-trimed flake tools	31	35	17	10	14	16
P/c/tf Index (%)	21	24	16	41	58	67

Table 6.3. Technological sequence at KII. In phases I-III stone from squares A, B and F only is used. For a discussion of the "p/c/tf index", refer to the text.

(c) Stone tool sequence

Phases VI-IV

The assemblages represented in the lower three phases, spanning more than 9,000 years, are in general homogeneous. However, at the very base of Phase VI, cemented in a dense sandy clay were 55 artefacts which, although aggregated here to Phase VI for the sake of numbers, differ from the material in the rest of Phase VI and of the succeeding phases (cf. figures below) in having a higher mean weight (7.2 g), a larger proportion of retouched stone (42%) and a higher p/c/tf index (83%). The toolkit, lacking pebble tools, comprises a high proportion of thick flakes (61%), with half the retouched edges being less than 60 degrees. There was a remarkable incidence of fine invasive retouch, of a kind not found in the overlying material. Whether a real technological difference exists at this level cannot be asserted with confidence, until further excavation yields a larger sample.

Apart from this basal element, Phase VI is apparently continuous with Phases V and IV. Distinctive features and trends through time include the following:

(a) mean weight of flakes declines from 6.4 g to 5.3 g (Figure 6.5a);

(b) chert declines from 67% to 54%, with quartz averaging 19% (Figure 6.6a);

(c) cores average a stable 5% of the total assemblage ;

(d) tools decline from 17% to 10% of the whole assemblage ;

(e) the p/c/tf index declines slightly from 67% to 41% (Figure 6.5b);

(f) the percentage of thick flake tools in the toolkit declines (56%-27%-20%) ;

(g) the incidence of multiple-edged pieces is indicated by a ratio of retouched edges to retouched stones of 3:2 ;

(h) among the retouched edges there is registered an increasing proportion of steep edges (47% to 72%) and of concave margins (16% to 34%), a decreasing proportion of convex margins (16% to 7%) and of denticulates (29% to 17%), with straight margins stable at 39%.

It must be stressed that the assemblage shows no recurring patterns in the toolkit by which it might be characterised: it can only be described as amorphous and ad hoc, with a retouch which is incidental (see Figure 6.5c), i.e., where a convenient edge has been slightly modified for or by use (cf. Stockton, 1977a). The definable tool types are not diagnostic. These include hammerstones, anvilstones, uniface and biface choppers, and bipolar/scalar pieces. Three "thumbnail scrapers" occurred in Phases VI and V, but in the table they are not distinguished from longer bodied pieces with similar working edge in the general category of discoid margins. The uniface split pebble tool (sumatralith), though absent in this excavation, was present at the base of KI and may have been part of the toolkit.

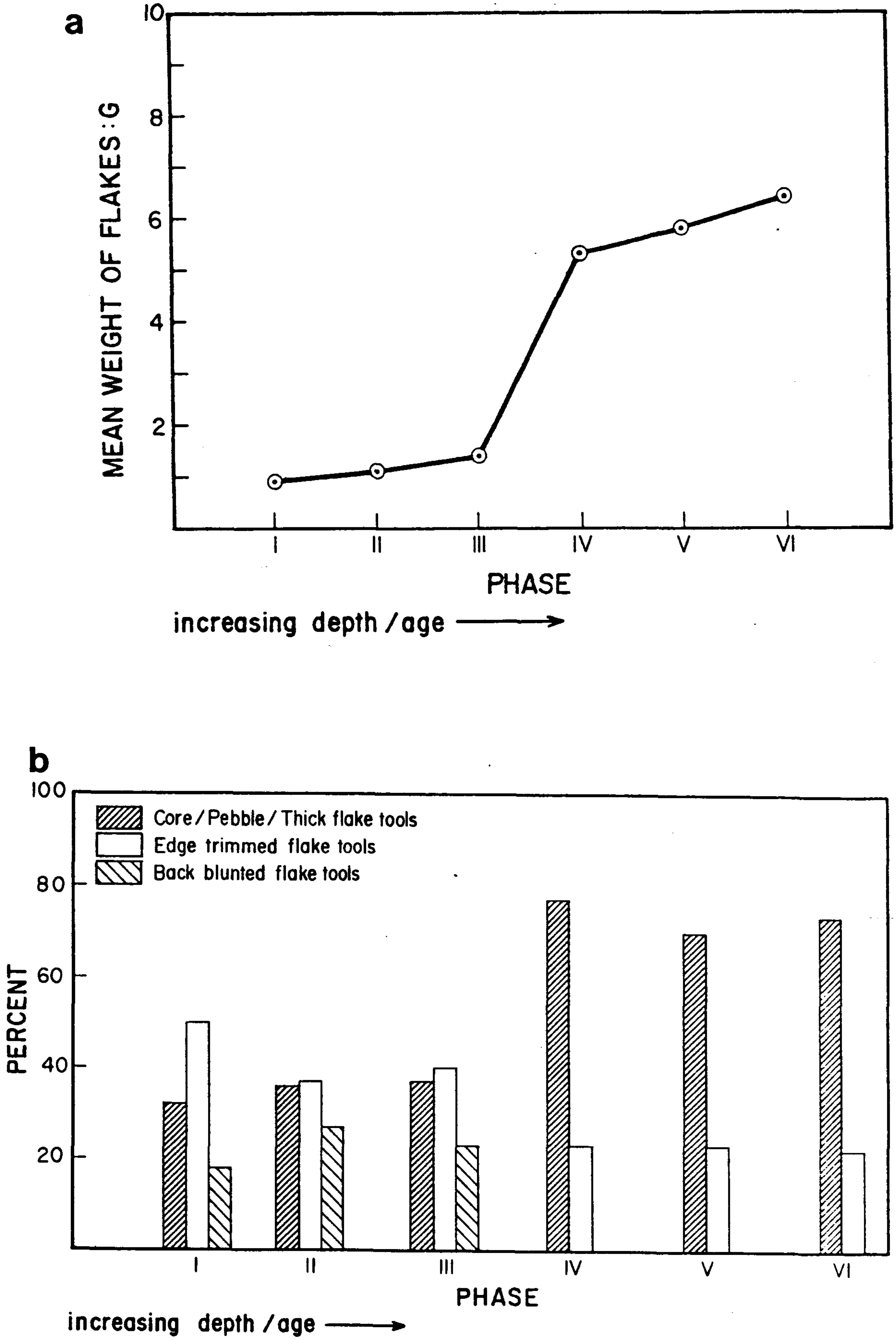


FIGURE 6.5 a: Mean weight of flakes (g) in Phases I to VI;

b: Proportions of major tool groups in Phases I to VI.

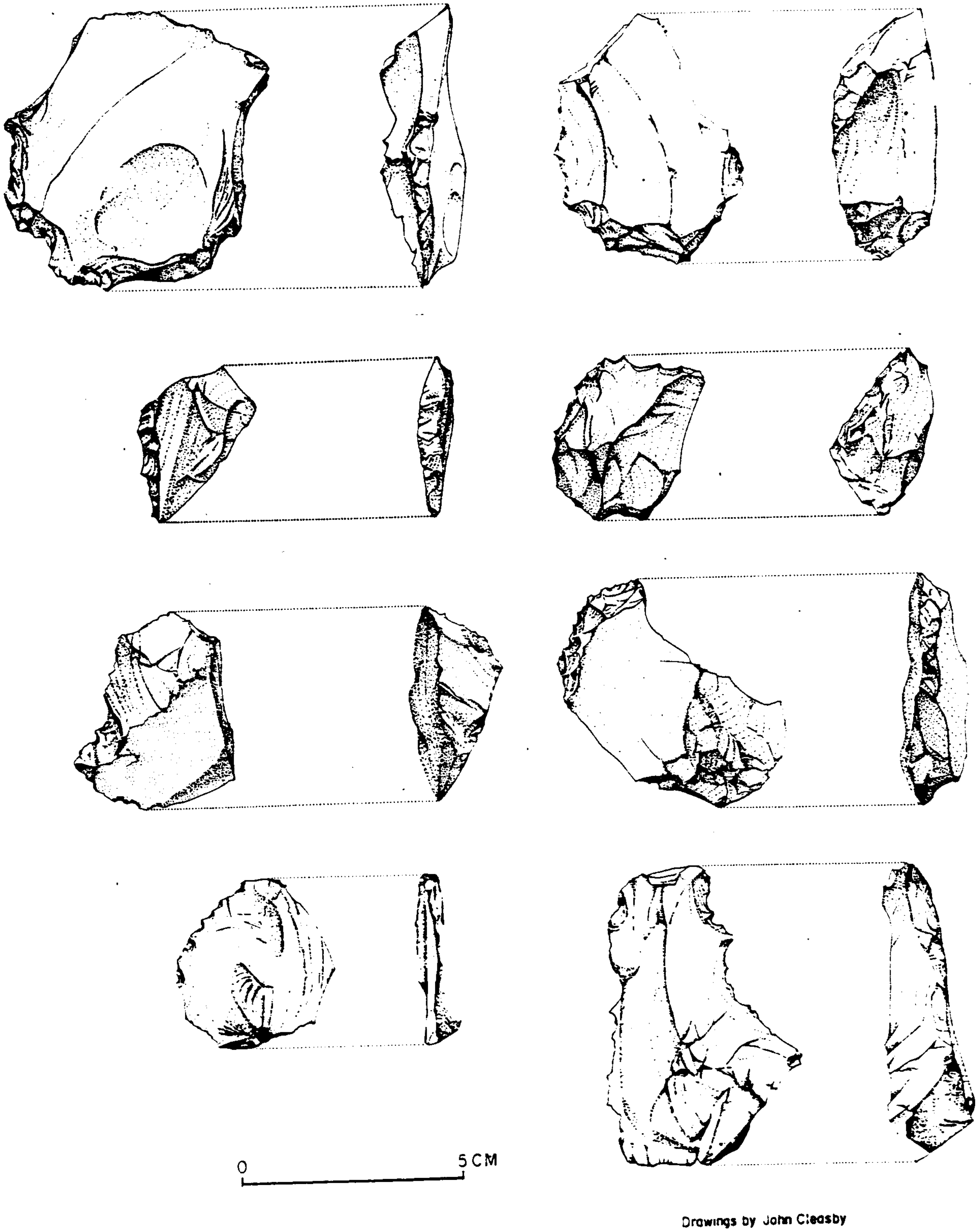


FIGURE 6.5c. Selected thick flake scrapers from the lowest two stratigraphic levels at Shaws Creek.

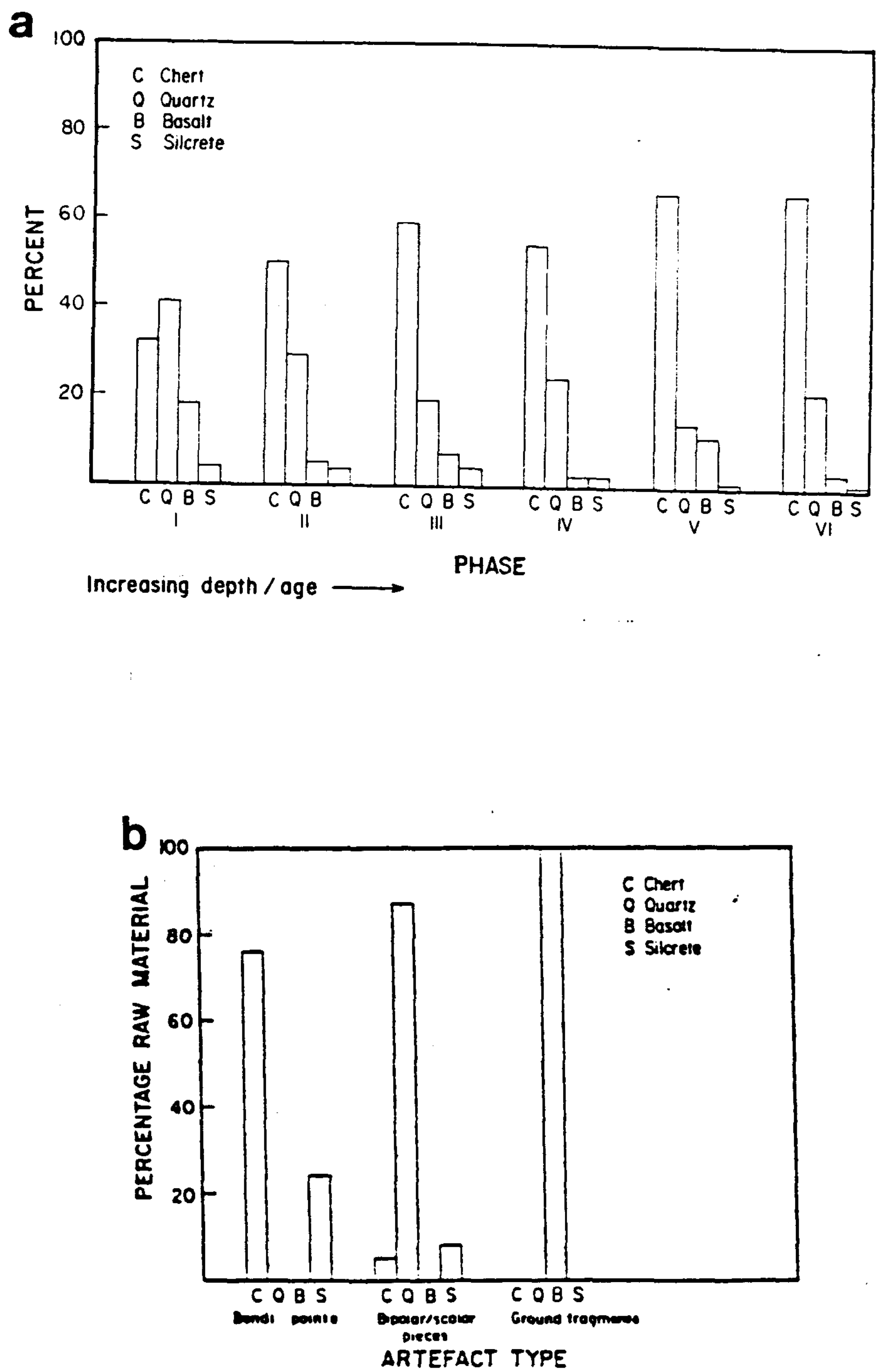


FIGURE 6.6 a: Proportions of dominant raw materials in Phases I to VI;

b: Raw materials used for selected artefacts in Phases I to III.

Phases	I	II	III	IV	V	VI
No. of core/flake tools	51	68	32	41	55	68
No. retouched edges	53	69	37	57	83	96
No. retouched edges/tool	1.0	1.0	1.2	1.4	1.5	1.4
Edge angle before retouch						
Steep (> 60 deg.)	21	30	21	43	56	44
Sharp (< 60 deg.)	32	39	16	14	27	52
Shape of retouched edge						
Straight margin	31	40	15	23	30	38
Concave/notch	9	16	16	20	23	15
Convex: discoid	5	2	2	-	8	4
: nosed	2	3	1	4	8	11
Denticulate: serrated	2	3	2	7	8	12
: dentated	4	5	1	3	6	16
Retouch, straight margins						
Steep on steep	7	8	2	14	14	9
Abrupt on sharp	6	6	2	1	5	8
Minute on sharp	11	16	10	2	7	14
Sharp on sharp	7	10	1	6	4	7

Table 6.4. Amorphous core/flake tools. In phases I-III, stone from squares A, B and F only is used.

Phases	I	II	III	IV	V	VI
Ground fragments	11	2	1	-	-	-
Blades	3	16	10	-	-	-
Pointed flakes	2	6	3	2	-	-
Facetted butts	3	11	2	1	-	-
Redirecting flakes	1	1	1	1	1	-
Burin spalling	-	1	-	1	1	1
Dorsal-trimmed butts	17	25	18	9	11	11
Bipolar/scalar pieces	74	54	16	6	1	1

Table 6.5. Manufacturing data. In phases I-III, stone from squares A, B and F only is used.

Phases III-I

Noteworthy in the upper phases of KII are the introduction and decline of geometric microliths and backed tools generally (including Bondi points and eloueras), signs of the growing use of edge ground axes and the increasing predominance of bipolar/ scalar pieces (Table 6.3). The tool types noted in the lower three phases continue in the upper three, but they are accompanied by marked quantitative changes in some assemblage-wide traits at the transition, followed by more gradual changes thereafter. The features noted in Phases VI-IV show the following trends through Phases III-I:

(a) the chert component declines from 59% to 32%, concomitantly with rises in quartz (19% to 41%), silcrete (averaging 4%) and basalt (7% to 18%), associated respectively with bipolar/scalar pieces, backed tools and edge ground axes (Figure 6.6b);

(b) mean weight of flakes drops to 1.4 g, thereafter declining to 0.9 g ;

(c) cores average 0.5% of the whole assemblage ;

(d) tools decline from 3.5% to 2.5% as a proportion of the whole assemblage ;

(e) the p/c/tf index after a drop from 41% to 16%, stabilises to just over 20%, while edge-trimmed flake tools rise from 40% to 50% ;

(f) the bulk of the amorphous core/flake tools show retouch on a single edge ;

(g) retouched edges of the amorphous core/flake tools show an increase in straight margins (41% to 57%), a decrease in steep edges (59% to 39%) and in concave margins (43% to 17%), with denticulates and convex margins averaging each about 10%.

The homogeneity of the upper three phases is demonstrated by the fact that, after the notable changes between Phases IV and III, the trends in values for the diagnostic artefacts and for the eight features listed above continue without aberration. The one exception to this linear development is the backed tool component, which rises from 23% of the toolkit to 27%, falling away to 18% in the terminal phase. It is worth noting that Bondi points and geometric microliths occur up to the topmost sealed level (spit 2), but do not occur in spit 1 over most of the site.

In anticipation of discussion to follow, the industry revealed in Phases III-I can be described as *Bondaian*.

The new technology is seen to encompass not only new tool types and some variation in those continuing from the earlier phases, but also refinements in flaking techniques. Greater control over flaking is indicated by core preparation in the form of faceted butts and by the incidence of blades and pointed flakes, i.e., long, thin flakes with parallel or convergent margins. The association of faceted butts and blades is shown by their vertical and horizontal distribution (Tables 6.3 and 6.4) and by the fact that the two traits are combined in 25 instances, out of a total of 52 facetted butts and 97 blades. Serial production of blades is evident with 44 out of the 97 bearing blade scars on their dorsal surface; 10 out of the 57 pointed flakes have pointed scars.

(d) Artefact densities

A notable contrast between the lower three phases and the upper three is the relative concentration of artefacts in the deposit, expressed as the number per cubic metre (Table 6.7). A generally low density is registered over the whole excavation for phases VI to IV, but where it is more closely monitored in square A, values are seen to drop sharply in lower Phase V and in upper Phase IV. It cannot be excluded that these are due to conditions peculiar to the site or to this part of the deposit. However, the low concentration at the end of Phase IV may correspond with the occupation hiatus claimed before the introduction of microlithic industries on many highland sites (Stockton and Holland, 1974; Bowdler, 1981; but contested by Johnson, 1979), and with the two phases of low density occupation at Loggers Shelter after 11,000 BP (Attenbrow, 1981).

The amount of worked stone increases enormously in the upper three phases, with the peak concentration being recorded in Phase II.

(e) Dating of the Major Transition

The transition between Phases IV and III can be firmly dated as no earlier than the 4th millennium BP, since the top of stratigraphic unit 4, bearing the Phase IV assemblage, is dated to 4,140 ± 180 BP. Figure 6.4a shows that a rock fell on stratigraphic unit 4 at an angle, later allowing some of unit 5 to slip under its projecting end. However, within squares A, B and C, a breakaway from the rockfall was found to lie, sloping towards the front, across almost the whole of the three squares, effectively sealing unit 5 from unit 4. Hence there is no fear that the respective materials have been mixed through occupational disturbance (Stockton, 1980), and the date provides a firm maximum age for the succeeding Phase III.

(f) Horizontal Variation in the *Bondaian*.

A number of squares were not used in the sequential analysis because of signs of stratigraphic disturbance. However these squares were disturbed only through the upper two units, i.e., in the *Bondaian* levels, and, while not useful for demonstrating changes within the *Bondaian*, they did offer further information about the *Bondaian* in general. For example, tool types not registered in the *Bondaian* phases of the sequence (Table 6.3) but appearing in other parts of the deposit included 3 hammerstones, 2 anvil stones, a pick (in the dripline) and a complete edge-ground axe head (outside the dripline).

The yields from these squares also showed variation in the distribution of artefact types across the deposit. To demonstrate this variation, the excavated squares were grouped into four zones:

(a) against the rear wall: squares C and G

(b) the central area: squares A, B, F (as used in the sequence, plus) D, E, I

(c) straddling the dripline: H, P, Q, R

(d) outside the dripline: S

The artefact count in each of the four zones is set out in Table 6.6. That Table, and Figure 6.7 in more detail, show that

1. the mean weight of flakes is higher towards the rear.
2. the density of worked stone per unit volume is much higher at the dripline, and to a lesser degree in the adjacent zones.

Other variations appear in the incidence of each artefact type in each zone when translated from the raw figures of Table 6.6 to a proportion (a) of the whole assemblage or (for tools) of the whole toolkit within the zone (b) of the total number of each artefact type across the four zones.

These additional variations show that:

3. back-blunted flake tools and bipolar/scalar pieces are more numerous in the dripline and outside zones;
4. blades, pointed flakes and faceted butts are slightly more in evidence in the dripline zone
5. cores, dorsal-trimmed flake butts and amorphous core/flake tools are more numerous in the central and rear zones.

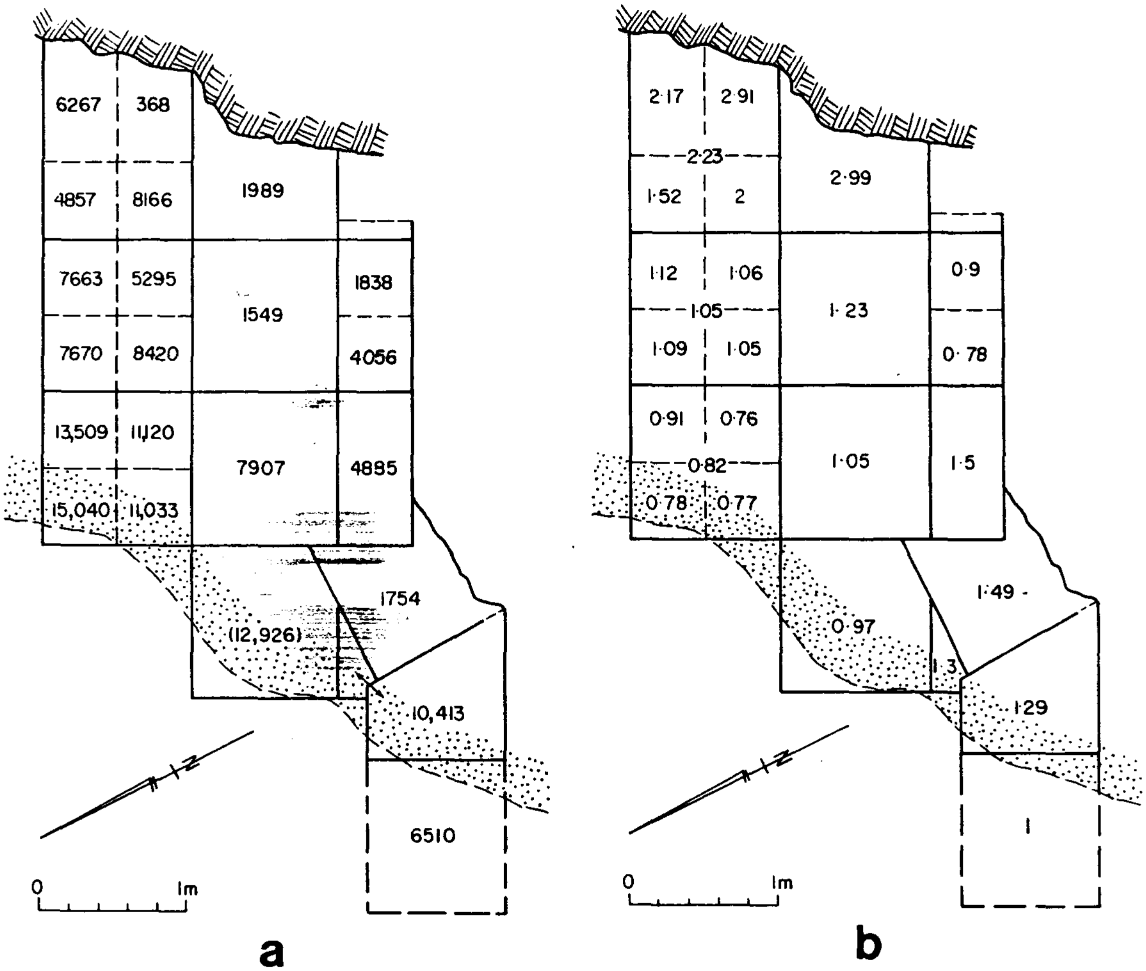


FIGURE 6.7 a: Spatial variation in artefact concentration at KII (number of artefacts/cubic metre);

b: Spatial variation in mean artefact weight at KII (g).

Location	Outside	Dripline	Central	Rear	Total
Squares	S	HPQR	ABDEFI	CG	
Total worked stone	5857	7890	8240	2508	24495
Mean wt. of flakes (g)	1.0	1.03	1.12	2.45	1.19
Concentration (no./m3)	6508	12926	4938	3668	-
Cores	25	34	41	26	126
Blade Cores	8	11	3	2	24
Blades	16	41	33	7	97
Pointed Flakes	9	23	19	6	57
Facetted Butts	8	18	17	4	47
Dorsal-trimmed Butts	11	38	75	24	148
Ground Fragments	4	9	17	3	33
Bipolar/scalar Pieces	230	255	194	35	714
Pebble tools	4	7	2	1	14
Amorph. core/flake tools	87	145	182	83	497
Back-blunted flake tools	65	86	59	6	216
Total Tools	156	238	243	90	727

Table 6.6. Horizontal variation in the site in Phases I-III.

6.9 Ochre

Ochre was sporadic throughout the upper four phases. Given that powdered ochre is practically irrecoverable by normal excavation methods and that quantity rather than number of pieces is a more meaningful measure of pigments, 5 g of ochre were found in the final *Capertian* phase and 22 g in the *Bondaian* phases.

Unit	Phase	Squares A,B and F	Square A only		Date
		No/m^3	No/m^3	Depth(cm)	Yr B.P.
6	I	5743	2240	0-5	
			8420	5-15	
5/6	II	7820	9533	15-30	c.1700
5	III	3177	6242	30-45	c.2200
4	IV	110	60	45-60	c.4100
			160	60-70	c.7900
3	V	1000	5529	70-85	c.13000
			60	85-105	
2	VI	865	910	105-125	
1			607	125-150	

Table 6.7. Concentration of worked stone in undisturbed squares.

6.10 Bone implements

There is some evidence for bone working at the site, even though most of the bone is badly degraded. A fragment of mammal bone 2.3 cm long and 1 cm wide has two distinct overlapping cuts producing a point at one end. A second rectangular fragment 1.4 cm x 0.8 cm has a series of scars creating a thick, flat margin opposite a naturally sharp edge, reminiscent of a back- blunted stone microlith. Other pointed fragments may be either worked or natural. One recurring form was a burin-like point on small bone fragments, at least one of which showed signs of use. A similar form has been described from the Upper Hunter Valley (Moore, 1970: Pl.13). Although many fragments have a glossy appearence, none appears to have been ground.

6.11 Backed blades and bipolars

Although square S was highly disturbed by biogenic processes, it did contain large numbers of those artefact types dominant towards the front of the shelter, particularly backed blades and quartz bipolars. The thirteen spits excavated in square S contained no fewer than 230 bipolar pieces and 36 bondi points. In view of the proposition that bipolars may have replaced Bondi points as barbs on hunting spears (Lampert, 1971), the relationship between the two artefacts types with depth was investigated. The results are shown in Table 6.8.

SPIT	DEPTH (CM)	BIPOLAR PIECES	BONDI POINTS
1	0 - 5	3	0
2	5 - 10	33	4
3	10 - 15	44	8
4	15 - 20	34	7
5	20 - 25	29	4
6	25 - 30	19	1
7	30 - 35	17	5
8	35 - 40	15	2
9	40 - 45	12	2
10	45 - 50	11	0
11	50 - 55	10	2
12	55 - 60	2	1
13	60 - 65	1	0
TOTAL		230	36

Table 6.8. Distribution of bipolar pieces and Bondi points in square S.

The two distributions were correlated and the correlation co-efficient was found to be 0.88. This was significant at the 5% level, suggesting that the two artefact types vary together in frequency. A regression analysis was also carried out, and more than 75% of the variation in Bondi points could be explained by the variation in bipolar pieces (R^2 = 78.1%). At least within square S the bipolar pieces and Bondi points clearly occur together, and there is no evidence to suggest that bipolars replaced Bondi points during the period of occupancy of this site. The significant changes in raw materials registered in the top levels over the remainder of the site are best explained as a *relative* increase in bipolars following the demise of the Bondi points.

6.12 Discussion

(a) Geomorphology and late Quaternary Environments

At the present stage of excavation, the earliest known event concurrent with human occupation, at a date yet to be determined, was the lower of the two major rockfalls (Figure 6.4). Within the cleft, formed by the splitting of the rockfall, were fluviatile sands that had chiefly been laid down by Shaws Creek during the terminal Pleistocene, together with chert artefacts which had probably been produced on the rock surface and had slipped into the fissure. Deposition of local fluviatile sands and gravels, with sparse occupation, continued above the surface of this rockfall from at least 13000 BP. A second major rockfall came to rest at a tilt on the shelter floor at some time prior to about 8000 BP, and later part of this rockfall broke off, effectively sealing off the final deposition of unit 4 sands and gravel in squares A, B and C towards 4000 BP. There followed a period of more intense occupation, culminating at about 2000 BP, together with the deposition of sediments increasingly derived from Nepean floods. The top 2-4 cm of the deposit is a veneer of finely laminated post-occupation flood silts. During excavation, we saw that heavy rain could cause limited scouring, but this was partly due to the removal of the lantana shield and the inevitable disturbance of the shelter floor.

The excavated material allows a further inference about the past riverine environment. The variation through time of raw material used for tool-making (Figure 6.6) shows chert predominating in the earlier phases and declining towards the later, as the use of igneous and metamorphic rocks increased. The chert or silicified tuff is derived from the Burragorang Claystone at the headwaters of the Grose and is available as pebbles in the river bed as far as its junction with the Nepean 6 km downstream of KII, while other rocks (apart from silcrete which crops out several kilometres east of the river) are representative of the nearby Nepean gravels of welded tuff, granite, basalt and quartzite. The increasing use in the upper phases of immediately local stone, if not culturally determined (Attenbrow, 1981), might be best explained by progressive exposure of the Nepean gravels following Holocene entrenchment of the river through the clayey sands which mantle the gravels (Williams, 1982).

The gross stratigraphy of the shelter is consistent with changes in the erosional and depositional regime of Shaws Creek.

For example, the sands and gravels of unit 4 are draped over the outer edge of the lower rockfall, and none of the four lower units extend beyond the cave to the same extent as the two upper units (Figure 6.4). A possible inference is that the creek was somewhat closer to the cave during the time the lower units were laid down, and has moved laterally away from the cave during the last 4000 years, cutting into its former floodplain as it migrated.

As Williams (in Kohen et al., 1984) has pointed out, it has not been possible to ascertain whether the shelter was occupied during the last glacial maximum (25000-17000 BP), when southeastern Australia was drier and up to 8 degrees cooler than today. Deglaciation was well under way, sea level was rising rapidly, and temperatures were increasing by 13000 BP, when the fluviatile sands near the base of unit 4 were accumulating within the shelter. The rapid deglaciation between 10000 and 8000-6000 BP (Kerr, 1983) would probably be reflected in a warmer, wetter climate in SE Australia (see maps 4 and 5 in Chappell and Grindrod, 1983, CLIMANZ Vol. 2). Pollen and lake level evidence from SE Australia suggests that after about 4000-5000 BP the climate has become somewhat cooler and drier than during the early Holocene (Galloway and Kemp, 1981). However, it is likely that there were arid phases even during the relatively moist early Holocene, all of which would have required a degree of adaptive flexibility among the prehistoric inhabitants of the region.

(b) Fauna

Although the faunal evidence from the site is sparse, it appears that macropods formed a substantial proportion of the meat diet at least around 2000-1500 BP, and that freshwater mussels and birds were also being eaten. The presence of pig teeth may be associated with Aboriginal occupation of the site after contact, but unfortunately there is no way to confirm this. The abundant plant foods in the area were undoubtedly exploited, but no direct evidence of plant utilisation was obtained from the excavation.

(c) Stone Tool Sequence

The presence at the base of the excavation has been noted of an assemblage typified by thick amorphous flakes with fine retouch on sharp edges. The small sample size makes it difficult to evaluate these artefacts, particularly as no similar assemblage has been reported from elsewhere in eastern Australia.

Succeeding this is a long-lasting homogeneous industry, which, because it comes up to the threshold of an industry which includes microlithic technology, can be safely labelled by the regional cultural term *Capertian*. This industry has been notoriously difficult to define or characterise, due both to the amorphous nature of the tool kit and to low artefact yields in excavation. Previously it has been equated with pre- microlithic flake industries elsewhere in South-East Australia (Stockton, 1977a; 1979). At Shaws Creek core tools account for only 13% of the toolkit, although a proportion of the dorsal-trimmed flake butts showing signs of use may have come from core tools. Flake tools therefore predominate, and of these thick flake tools outnumber thin flakes. At Loggers, thick flake tools constitute a constant proportion, about 20% of the toolkit in both *Bondaian* and *Capertian* (Attenbrow, 1981: 69), which was also generally true of the corresponding phases I-IV at KII, but in the older phases V to VI they occur in greatly increasing proportions. The p/c/tf index for the KII Capertian is comparable with other eastern Australian sites (Stockton, 1979): 50%, 58%, 68% for Phases IV, V, VI respectively. There is expected to be some variation between contemporary assemblages in artefact type and size, reflecting the degree of on-site reduction, itself influenced by type, size, abundance and proximity of accessible raw material (Stockton and Holland, 1974: 57-8). In this case the Grose River, if not nearer sources, provided a relatively close, plentiful supply of large chert pebbles, which may have resulted at KII in assemblages of comparatively large artefacts. The effect of source material apart, this industry can be characterised as one in which the casual products of previous knapping (itself unrelated to eventual use except to reduce a stone to manageable size) have been used with little or no modification where edges have proved convenient for immediate work.

The upper three phases are again homogeneous, with a wide range of traits common throughout and linear trends between the phases, hence justifying a single designation, the regional *Bondaian*. The changes within the *Bondaian* sequence further render it amenable to a tripartite subdivision, as was proposed and on the same criteria, for the Blue Mountains (Stockton and Holland, 1974: 55-9) and neighbouring highlands (for recent discussion see Flood, 1980: 200-54; Attenbrow, 1981: 144-53).

The Early *Bondaian* Phase witnessed the introduction of changes noted for Phase III. Although it is true, as generally claimed, that the tool kit simply saw the addition of new items to a continuing suite of "scrapers", it should be noted that it is not simply a matter of addition of new items but a comprehensive change affecting both the continuing tool component and the whole assemblage, in some respects rather dramatically (e.g. density, flake size, flaking techniques, raw material, incidence of waste material), and that these changes were not temporary aberrations but the beginning of trends which continued through the succeeding sequence. This phase begins after 4000 BP and has a time span which includes the date 2235 ± 180 BP.

The Middle *Bondaian* Phase corresponds to Phase II, although it is premature to assert its exact time boundaries (if such exist) or to claim that they necessarily coincide with those proposed for the adjoining highlands. The time span includes the dates 1840 ± 70 BP and 1580 ± 190 BP. This industrial phase marked the apogee of the new technology (e.g., backed tools, controlled flake production), the full range of typically *Bondaian* tools (including those in ascendancy in the following phase) and the peak concentration of artefacts per unit volume of deposit.

The Late *Bondaian* Phase continued the trends apparent in the preceding phases, justifying its designation as part of that technological continuum. It was characterised by the decrease in the production of blades and backed tools and by the noticeable relative increase in the production of bipolar/scalar pieces and of edge-ground axes. This was associated with a greater preference for quartz and basalt, at the expense of chert (see Figure 6.6). Edge-trimmed flake tools continued to predominate over pebble/core/thick flake tools, constituting half of the tool kit. The concentration of artefacts fell from the peak registered in the previous phase, and artefact size tended to diminish. The time span of this terminal phase at KII cannot be securely determined.

The question arises of the relationship between the *Bondaian* phases at KII and the *Bondaian-Eloueran* sequence at Lapstone Creek (McCarthy, 1948: 19), only ten km to the south in a similar piedmont location. McCarthy's *Eloueran*, characterised by (a) the lack of Bondi points or any form of geometric microlith, and (b) the exclusive presence of edge-ground tools, is not paralleled at Shaws Creek. The Lapstone Creek dates of 3650 ± 100 and 2300 ± 100 BP, from ash-rich samples originally collected for pollen analysis and published thirty years later (Polach et al., 1967: 20), sandwich the *Bondaian-Eloueran* transition there, suggesting that McCarthy's *Eloueran* has a time span corresponding not only to the Late *Bondaian* at KII, but also to the Middle *Bondaian* (i.e. when the distinctive features of the *Bondaian* were most prominent). In view of the stratigraphic problems at Lapstone

Creek, it seems unwise to press the differences further or to try to resolve them. The late survival of even narrowly defined *Bondaian* traits in the Blue Mountains, Hunter River, New England Tableland (and now Loggers Shelter), by contrast to coastal and southern sites, has been well documented (cf. Stockton and Holland, 1974). Three Blue Mountains sites revealed recognisably Late *Bondaian* levels, each providing stratigraphically sound dates between 1000 and 500 BP, overlain by further Late *Bondaian* levels presumably reaching into the recent past. Until further determination is possible, the Late *Bondaian* may be taken as ranging over the last millennium, and the status of McCarthy's *Eloueran* remains in doubt. The latter may well be an assemblage unique to a relatively narrow ecological zone, and therefore not directly comparable to either highland assemblages or coastal sites, or a specific activity site of unknown function during the latest phase of occupation.

The previous Blue Mountains excavations had sought unsuccessfully to find the temporal relationship of Large Tool assemblages to the *Capertian-Bondaian* sequence (Stockton and Holland, 1974), for they were found on the surface of open sites but not in excavated rockshelter deposits (cf. McCarthy, 1948; Stockton, 1981; Lampert, 1981; Moore, 1981). The excavated sequence at KII is of a succession of flake industries, with no direct evidence of a "core-tool and scraper tradition" or Large Tool industry sequentially related to the flake industries. What, if anything, preceeded the *Capertian* on this site is uncertain. The immediate environs of the shelter abound in open sites with predominantly large tools (edge-ground hatchets, bulga knives, choppers, steep-edged scrapers made on pebbles, uniface pebble tools) such as were described by McCarthy (1948: 23-6) and confirmed by subsequent surveys, although sites with backed blades do also occur. It seems likely that many of these surface scatters are of recent origin, on the following grounds:

(a) these artefacts are found at or near the surface in areas (among others) subject to recent flood deposition;

(b) the river pebbles, other than chert, supplying the raw material for their manufacture may have been exposed only during the Holocene;

(c) there appears to be a typological homogeneity in this suite of tools with overlapping between edge-grinding on pebbles (with or without prior knapping), re-use of edge-ground tools as pebble choppers and the occurrence of use polish on pebble tools;

(d) within the excavated sequence ground fragments occur only in the *Bondaian* phases, predominantly in the latest.

As was shown for the coast (Stockton, 1982), it appears that the regional microlithic industry also had a Large Tool facies, represented not so much at base camps as at open, task specific sites near suitable sources of raw material. This does not exclude the possibility of a similar concurrence of Large Tool assemblages with older flake industries, as well as a greater antiquity (Stockton and Holland, 1974).

(d) Horizontal Variation

Assemblage variations across the site during the *Bondaian* have two important implications. The first concerns the sequence. If it had been based on excavation at the dripline the results would have been drawn from larger assemblage totals with smaller mean weights, biased in favour of some artefacts (backed tools, bipolars, blades, faceted butts) at the expense of others (cores, dorsal-trimmed flake butts, amorphous core/flake tools); the reverse would have been the case in a sequence based on the rear, with the *Bondaian* there hardly recognisable. The central squares, as it happened, were the more representative of the whole, although some large tools not represented there in the *Bondaian* occurred elsewhere in the deposit. Synchronous variation across the deposit at KII has obvious bearing in general on excavation strategies and inter-site comparisons (cf. Morwood, 1981).

The second implication is that horizontal variations, such as recorded here and elsewhere (Attenbrow, 1981; Morwood, 1981; Rosenfeld, 1981), may contribute to viewing the campsite as an artefact in its own right (Stockton, 1981). Differences occur between sites. For example, Loggers Shelter appears to reverse the clustering of cores and small tools, while at Early Man Shelter artefacts tend to accumulate against the rear wall (Rosenfeld, 1981). Such differences may need to take account of the unique physiognomy of each site, which can be regarded as the raw material determining the use and modification of the site-artefact (cf. Morwood, 1981: 41).

At KII there is a contrast between the outer zones and the inner zones. The inner zones, central and rear, are characterised not only by assemblage traits noted above, but also by the noticeable discoloration of the deposit which shows that hearths were preferentially placed to the rear of the shelter extending into the central zone. The practical consideration for the rear placement of the hearth may have been not only that the fire thereby afforded greater protection, but also that a fire in that position causes smoke to rise against the rock ceiling clearing away insects without irritating occupants. The archaeological condition of the central and rear zones at KII fits Hayden's (1979) ethnographic model of a recent open campsite: small fires as the focus of general activities such as the maintainance of wooden implements, the preparation of food, and resting, with an artefact association of amorphous ad hoc tools (even his adzes, though hafted, lacked consistent pattern in their stone form). The slightly lower densities of worked stone in the intermediate squares (B, Gd, Fb, see Figure 6.7) together with higher densities and mean weights against the sloping rear wall (where clumps of cores and large stones were revealed in excavation), may indicate the clearance of obstacles for resting. The outer zones show an emphasis towards making small tools and, to a lesser degree, on more sophisticated flaking techniques.

6.14 Conclusion

Once incidences of depositional disturbances had been identified, the sound stratigraphy at Shaws Creek (KII) resulting from different flood regimes and two massive rockfalls, permitted a more comprehensive understanding of change both in the environment and in lithic technology at the foot of the Blue Mountains. The stratigraphic advantages and high artefact yields further allowed a fuller testing of artefact analysis which had already been tried on smaller Blue Mountains sites and at Mangrove Creek. This method attempts to compare respective whole assemblages, noting not only the occurrence of recognised artefact types, but also assemblage-wide traits in their relative variation through time. The result was a more detailed characterisation of the sequence of flake industries, *Capertian* and *Bondaian*, on a base camp in this piedmont region. The *Bondaian*, with minor variation through time and space on the site, was revealed to extend from < 4000 BP to the recent past, while the *Capertian*, hardly changing through time, was shown to stretch back into the past much further than previously reported, and well beyond 13,000 BP. The Large Tool ("Core Tool and Scraper") Tradition was not represented in diachronous sequence with these successive flake industries, but was apparently synchronous at least with the *Bondaian* (though possibly with the *Capertian* as well) on nearby task-specific sites, satellite to the base camp. The results are in broad agreement with the findings of previous investigations in the Blue Mountains and at Mangrove Creek, and may well be more widely applicable.

The geographic location of KII at the foot of the Blue Mountains makes it particularly significant in determining the spatial and temporal relationships between the surrounding montane, plain and riverine sites. Detailed analysis of an assemblage spanning more than 13,000 years provides a baseline for further studies on settlement pattern, resource utilisation and lithic technology, particularly in relation to variations between rockshelter assemblages and those found on open sites to the east along the Nepean River and across the Cumberland Plain.

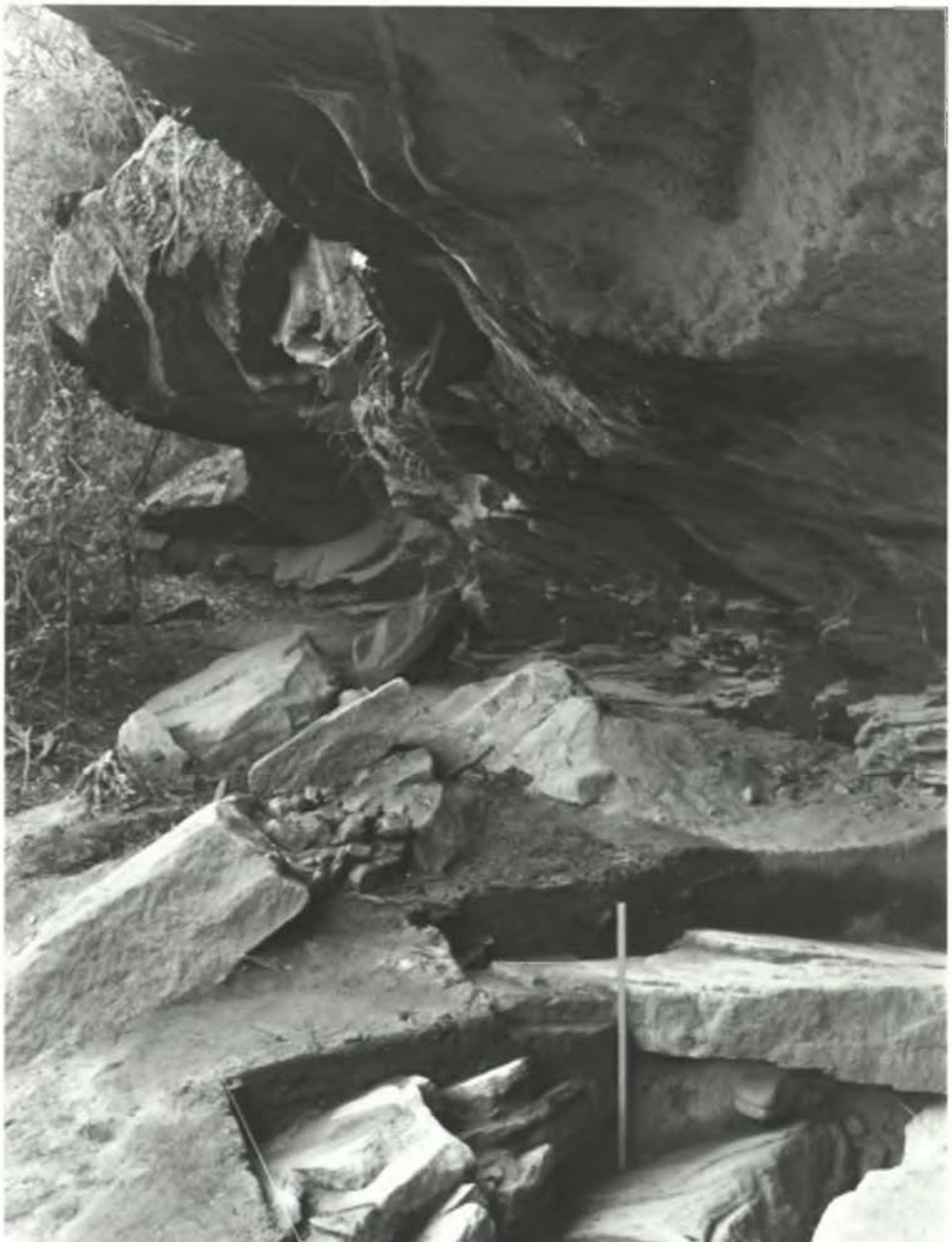
As Kohen, Stockton and Williams have emphasised (Kohen et al., 1984), among the issues relating to early Aboriginal settlement of the Blue Mountains is the apparent hiatus between an early phase of relatively sparse occupation and a later phase of seemingly more intense settlement associated with a radical change in stone tool technology and other aspects of material culture. On present evidence, the occupational hiatus evident in many, but not all (Johnson, 1979), Blue Mountains rock shelters, pre-dates the *Bondaian* technological phase, characterised by a stone tool assemblage which includes Bondi points, geometric microliths, thumbnail scrapers, bipolar pieces, elouera and edge-ground axes. The hiatus, if real, and not merely a function of basal compaction or of accelerated sedimentation rates, prompts several questions which deserve explicit consideration.

Were the shelters not occupied immediately prior to the advent of the Small Tool Tradition for the good and sufficient reason that all year settlement on open sites was at that time more attractive? Reciprocally, was the apparent intensification of occupation in excavated shelters after 4000 BP an artefact of people abandoning open sites for at least part of the year? Or was there indeed a population increase, accentuating demographic pressure, precipitating more intense use of hitherto neglected plant and animal resources, perhaps necessitating a change in material culture to cope with new gathering, hunting or food preparation practices?

Was the increasing use of edge-ground hatchets and quartz which accompanied the decline of backed blades in the most recent phase of the *Bondaian* a reflection of economic specialisation or diversification, and if so what factors led to this change?

One obvious way of attempting to answer these questions is to excavate one or more stratified open sites in an environmental setting similar to Shaws Creek KII, in order to compare the changes in stone tool kits, lithic technology and raw materials over time. With these aims in mind, excavations and surface collections were carried out on a number of sites at Emu Plains.

Plate 1. Shaw's Creek rockshelter: a general view of the completed excavation facing north (scale is 1 metre).



CHAPTER 7

EMU PLAINS OPEN SITES

7.1. Introduction

The results of the Shaws Creek KII excavations clearly demonstrated that stratified rockshelter sites extending back into the Pleistocene exist along the Blue Mountains escarpment. The total absence of a characteristic Core Tool and Scraper industry in the rockshelter assemblages in an area which is characterised by open sites dominated by pebble tools (McCarthy, 1948) and apparently lacking Bondi points (McCarthy, 1948; Stockton, 1970a) requires explanation. In the hope of shedding some light on this problem, the first area surveyed for open sites was Emu Plains, where a large site had been located immediately east of McCarthy's Lapstone Creek site (Kohen, 1978).

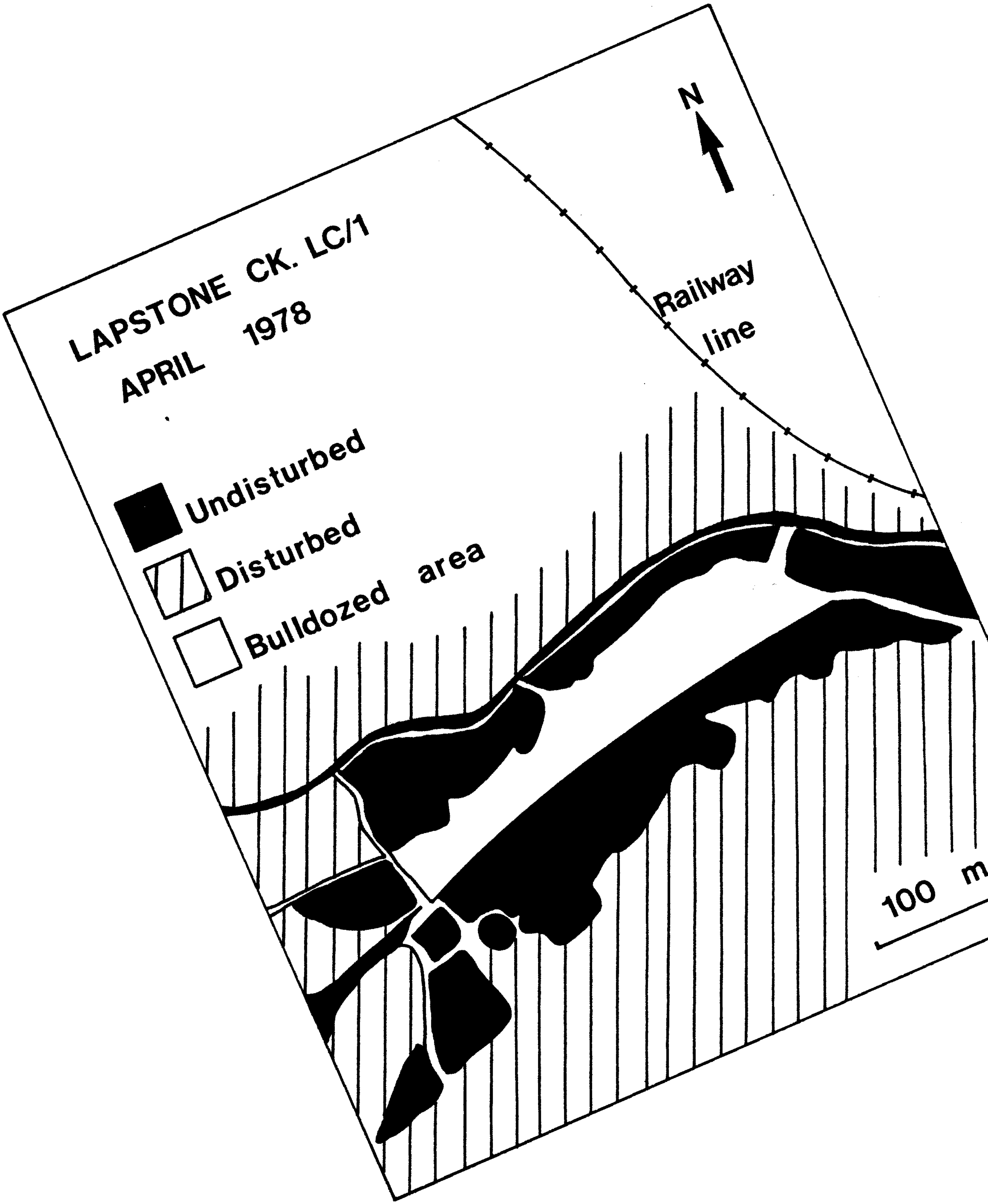
7.2 Lapstone Creek open site

Lapstone Creek emerges from the sandstone escarpment and flows initially east for more than a kilometre before swinging north to meet the Nepean River. A scatter of artefacts was located on the south bank of Lapstone Creek, four hundred metres east of McCarthy's rock shelter site. The open site, coded LC/1, was situated between the railway line and the Great Western Highway, and had been subjected to a substantial amount of disturbance. The area had been used as an unofficial garbage dump, and domestic rubbish, industrial wastes and car bodies were spread over an area extending for almost 200 metres along the creek (Figure 7.1 and Plate 2). Stone artefacts were also visible over the entire area, although concentrated at the eastern end of the site.

In his discussion of the area, McCarthy mentions that a workshop for the production of edge-ground hatchets and pebble tools had been identified on both sides of Lapstone Creek. It was soon apparent that the industry represented at this site consisted primarily of chert flakes and blades. A surface collection was carried out and the surrounding area examined for other traces of Aboriginal activity. To the south of the site, where the original railway line had run, a pebble hammerstone and a broken edge-ground hatchet head were recovered. Nearby, two large eucalypt trees showed symmetrical scarring where bark had been removed. To the west of the site, a series of tracks extended into the bush in the general direction of the rockshelter. Stone artefacts were found along the tracks, including a finely worked elouera showing extensive edge damage.

Glass and ceramic artefacts dating from the first half of the nineteenth century were also observed on these tracks, and a closer inspection of the main site revealed that the same materials were present, although mixed with other more recent glass and ceramic shards. Some of the thick black glass showed evidence of edge damage consistent with use as scrapers. The base of one bottle had a pontil mark indicating that it had been manufactured prior to 1840 (Hutchison, 1978). The ceramic material was compared with early collections held by the Museum of Applied Arts and Sciences in Sydney. The majority of the identifiable crockery was underglazed blue printed earthenware, or "Staffordshire Blue". Two common motifs were the willow pattern and a seaweed design, both of which were in use during the period 1820-1840. Five necks of earthenware bottles were also found, but no bases were found which may have assisted in identification. The glass and ceramic remains are detailed in Table 7.1.

Beside one of the tracks, along with a small cluster of black bottle glass fragments and stone flakes, was a pressed metal belt buckle. The two figures on the buckle were wearing costumes consistent with the period 1835-1850, and the following inscription was present: "Band of Hope. Peace. Temperance. Touch not. Taste not. Handle not." The Band of Hope movement was a temperance organisation founded in England in 1832, from where it spread to Australia by 1835 (Temperance Alliance of New South Wales, pers. comm.). Aborigines were certainly still living in a semi-traditional lifestyle on Emu Plains as late as 1836, when Charles Darwin met a party of 20 people armed with spears and other weapons (Darwin, 1845). The Sydney Aborigines were quick to adopt alcohol from Europeans, and there are many descriptions and illustrations of Aborigines drinking spirits from the black glass bottles (e.g. Earle, 1830). It would appear that Aborigines were using the site on Lapstone Creek until at least the 1830's, and may have been visited by members of the Band of Hope movement.



e Creek open site LC/1: plan of

MATERIAL	NO. OF FRAGMENTS	POSSIBLE RETOUCH/USE
Crockery	86	1
Earthenware bottle	35	3
Clear glass	50	8
Black/dark green glass	43	8
Blue glass	6	1
TOTAL	220	21

Table 7.1 Post-European finds at Lapstone Creek open site.

Organic remains on the site were few, but a collection of all bone and shell was carried out. The results are summarised in Table 7.2. It seems likely that all of the vertebrate remains post-date Aboriginal occupation of the site. The mollusc remains were found on four separate parts of the site, so although they may have arrived at the site with recent garbage the possibility that they were brought to the site by Aborigines cannot be completely discounted.

TAXA	ITEM
Mollusca	
Saccostrea commercialis (rock oyster)	3 valves
Turbo torquata (turban shell)	inner coil
Vertebrata	
Chelodina longicollis (tortoise)	femur, shell
Bird?	bone fragments
Oryctolagus cuniculius (rabbit)	femur, pelvis
Canis familiaris (dog)	tibia
Ovis aries (sheep)	3 cervical vertebrae

Table 7.2. Identifiable taxa from Lapstone Creek open site.

Before the surface collections were completed, earthmoving equipment began to level the area for a housing estate. The topsoil containing the stone assemblage was almost totally removed. In the process, a near-vertical section was cut through the terrace on which the site was located, destroying the site but providing an opportunity to examine the stratigraphy of the area. The archaeological material was restricted to a unit of undifferentiated grey sand up to a metre thick. Below the sand was a massive indurated clay-sand which lensed into a deposit of quartzite gravels at the western end of the site. The gravels are known to be of Tertiary age, suggesting that the lower unit may also be of considerable antiquity.

A period of heavy rain prompted re-inspection of the section to see if any artefacts had eroded out of the deposit. Indeed, a number of artefacts were found exposed by the rain, and three were located *in situ*. They were a chert flake with evidence of retouch on the distal end found just below the surface, a chert Bondi point at a depth of 20 cm, and a laterally trimmed basalt uniface pebble tool at a depth of 80 cm. The artefacts which had eroded from the section were collected separately, and labelled LC/1B, the original collection being labelled LC/1A. Since the artefacts in the LC/1B collection came from the deposit below the original surface, it must be assumed on stratigraphic grounds that in general they are older, although some artefacts recovered will undoubtably have come from the deposit close to the surface (including two of the artefacts found *in situ*).

The cores and stone tools recovered in the two collections are shown in Table 7.3, and the raw material components of the debitage shown in Table 7.4. The differences between the two collections are immediately apparent. Whereas the LC/1A collection consisted of a high proportion of debitage, the LC/1B collection had a high percentage of worked stone tools, with a large component of uniface pebble tools made from basalt pebbles and amorphous thick flake scrapers made from chert. The heavy patination on the chert also suggested a greater antiquity than the earlier collection, which showed little discoloration. The relative proportions of cores, tools and debitage is shown in Figure 7.2.

The Pebble/Core/Thick Flake tool index was calculated for the two collections separately and also for the combined site (Table 7.5). The initial surface collection had a p/c/tf index of 28%, while the LC/1B assemblage had a value of 86%. The combined site had a value of 55%.

The results of these two collections clearly demonstrate the importance of exposure in assessing the relative age of a site. If the evaluation of the site had been based on the initial surface collection alone, the site would have appeared to belong to the *Bondaian* period with occupation continuing until at least the 1830's. Had the site been assessed entirely on the collection made after the disturbance, it probably would have been identified as belonging primarily to the *Capertian* industry because of the dominance of pebble and thick flake tools. Because both assemblages were recorded, it is clear that occupation of the Lapstone Creek site began prior to the beginning of the *Bondaian* (*circa* 4000 BP) and continued until the early part of the nineteenth century. It is also clear that the density of worked stone in the earlier *Capertian* industry was significantly lower than the more recent *Bondaian* industry.

ARTEFACT TYPE	LC/1A	LC/1B	TOTAL
Pebble and Core Tools			
Uniface Pebble Tool	-	7	7
Biface Pebble Tool	1	1	2
Edge-ground Tool	1	2	3
Hammer/anvil	12	4	16
Coretool	-	5	5
Backed Tools			
Bondi Point	3	1	4
Geom. microlith	2	-	2
Elouera	5	-	5
Normal Flake Tools			
Utilised	6	4	10
Sharp retouch	18	1	19
Steep retouch	7	1	8
Thumbnail	-	-	-
Thick Flake Tools			
Utilised	-	4	4
Sharp retouch	2	5	7
Steep retouch	-	15	15
Core	12	6	18
Bipolar/scalar piece	8	1	9
TOTAL	77	57	134

Table 7.3. Diagnostic stone artefacts from the Lapstone Creek open site. LC/1A is the original surface collection, while LC/1B is the industry found after the topsoil had been removed.

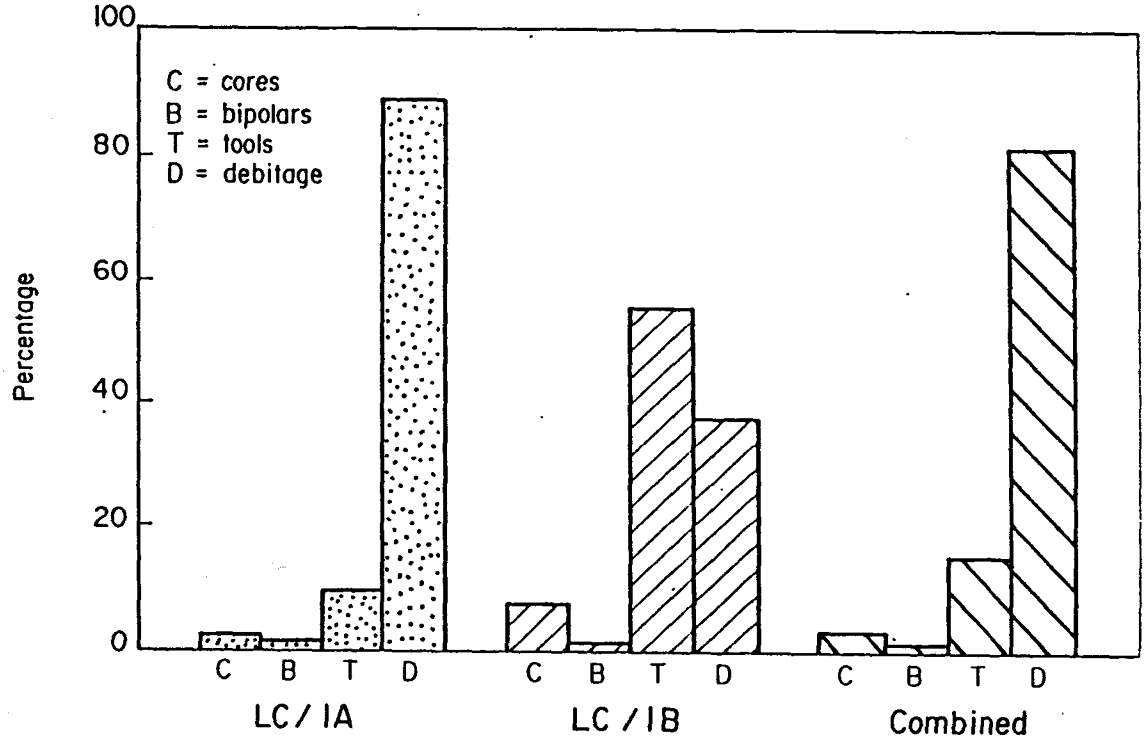


FIGURE 7.2. Lapstone Creek open site LC/1: relative proportions of cores, tools and debitage in the two collections.

RAW MATERIAL	LC/1A	LB/1B	TOTAL
Chert	386	30	416
Silcrete	34	1	35
Quartz	89	1	90
Quartzite	2	-	2
Basalt	13	2	15
Other	1	1	2
Total	525	35	560

Table 7.4. Raw materials found in the debitage at the Lapstone Creek open site.

COLLECTION	P/C/TF TOOLS	TOTAL TOOLS	P/C/TF INDEX (%)
LC/1A	16	57	28%
LC/1B	43	50	86%
Combined	59	107	55%

Table 7.5. Calculation of Pebble/Core/Thick flake tool index for the Lapstone Creek open site.

7.3 Jamisons Creek site complex

A second area on Emu Plains had been identified by McCarthy as a surface workshop, and this extended across both sides of Jamisons Creek, a waterway of similar dimensions to Lapstone Creek. Jamisons Creek flows from the escarpment through Knapsack Gully approximately one kilometre south of Lapstone Creek. In the area of McCarthy's workshop, the southern bank of the creek had been totally disturbed by the building of a golf course. The northern side of the creek had also been subjected to development in the form of a football field. However, three areas were located where artefacts were exposed (Figure 7.3a). The first and most extensive scatter was located on a terrace overlooking a backwater of the creek, and 100 metres north of the present course of the creek (JC/1). Sometime in the past, a meander had incised into the terrace producing a steep drop of 5 metres from the top of the terrace to the base. The alluvial flats between the base of the terrace and the creek had been drained and partly filled during the construction of the football field, resulting in the formation of a small swamp. Before the drainage modifications took place, the swamp probably extended along the base of the terrace for a distance of several hundred metres.

Between the swamp and the present course of the creek, a second lower terrace had formed (JC/1LT). Stone artefacts were found eroding from the edge of this terrace beside the swamp. A large hole ten metres in diameter had been formed where topsoil had been removed, and artefacts were also found in and around this hole.

One hundred and twenty metres east of site JC/1, the terrace sloped gradually down to the level of the football field. Where a batter had been constructed between the field and the terrace, artefacts were again exposed. This scatter was coded JC/1E.

In early 1984, a major sporting complex was initiated in the vicinity of the site complex. The disturbance exposed additional artefacts in the three designated sites, and also showed that a low density scatter existed over the entire complex. One

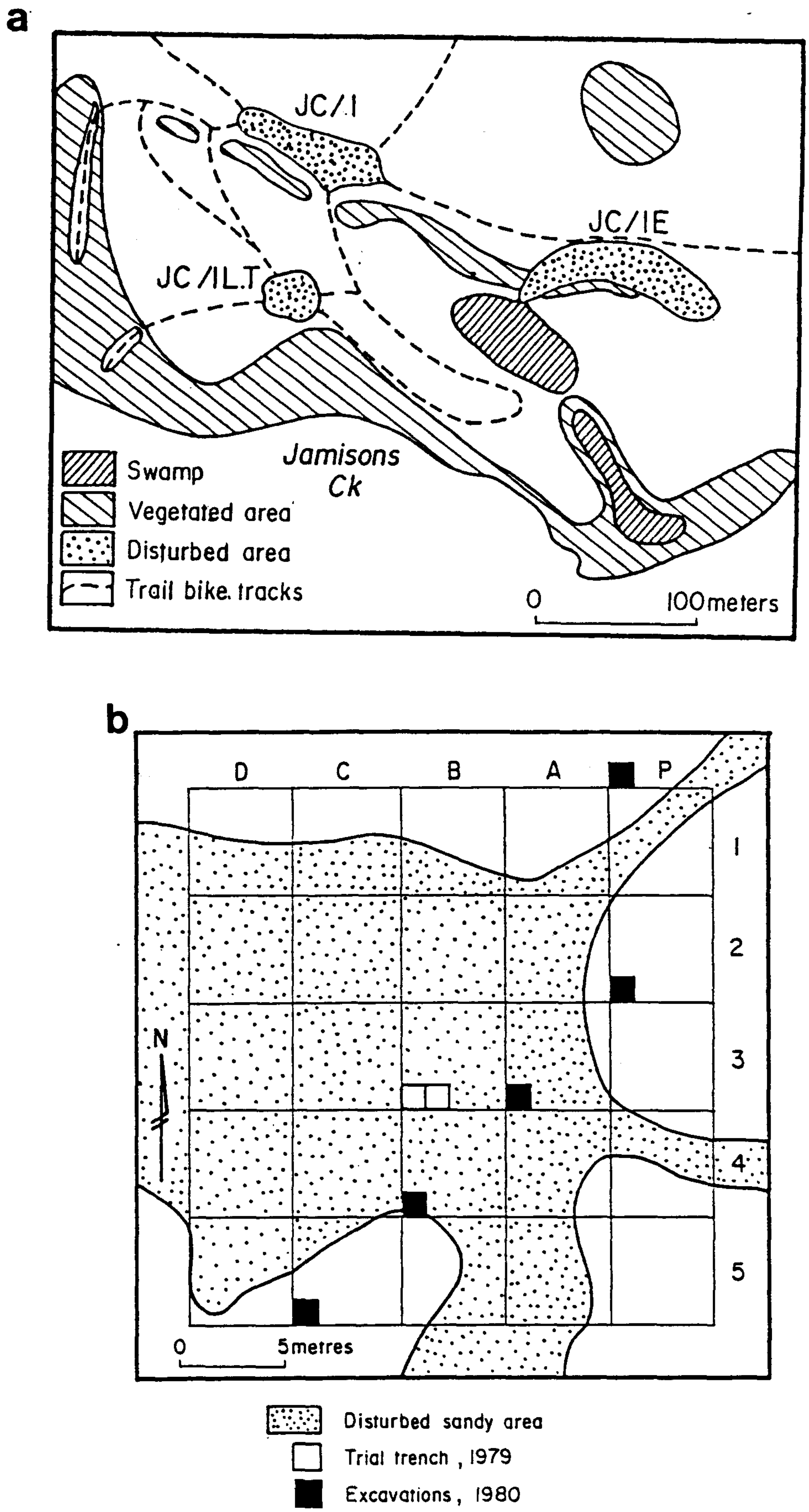


FIGURE 7.3. a: Jamisons Creek site complex JC/-: plan of sites.

b: Jamisons Creek site JC/1: grid for surface collections and location of excavated squares.

See Figure 5.3 for location in study area.

additional discrete concentration of artefacts was identified. This was located on the extreme eastern edge of the lower terrace between the football field and the creek, and was coded JC/1LTE (Kohen, 1984e).

7.4. Jamisons Creek surface collections

By far the greatest concentration of artefacts was observed on site JC/1 (see Plate 3). The region around the top of the terrace had been cleared for grazing prior to 1825 (Steege, 1974), but other than some fencing there was no evidence to suggest that any other developments had taken place. The terrace consisted of sand originally of fluviatile origin, parts of which were redeposited ~~due to~~ wind action. The majority of the terrace was well grassed, but at the crest of a low ridge a series of tracks had been produced by trailbikes. The top of the ridge was grossly disturbed, and over an area approximately 30 metres long and 20 metres wide, the grass cover had been destroyed. With the grass cover removed, the predominantly westerly winds had blown the sand east across the site, and it was being redeposited at the eastern end of the site. The degree of disturbance was apparent, as up to 15 cm of deposit had been removed from the centre of the deflated area.

The deflated area was gridded with a 5 metre grid. Each 5 metre square was represented by a grid letter and a number (see Figure 7.3b), with square A1 being in the northeastern corner of the site. Sites JC/1E, JC/1LT, and JC/1LTE , consisting of lower density scatters over smaller areas, and did not require gridding or systematic collection.

It soon became apparent that the same range of glass and ceramic materials which were present on Lapstone Creek open site were also present on three of the four designated sites. Only JC/1LTE consisted entirely of stone artefacts. I decided that all European artefacts not obviously of recent origin would also be collected.

An initial collection was carried out on site JC/1, but because additional artefacts were continually being exposed, particularly on site JC/1, several collections were made and the results combined. Results of these collections are shown in Tables 7.6 and 7.7.

It is possible that surface collections may have been carried out on this site during the 1920's, since Turner (1934) records the collection of "pygmy implements" (microliths) from "middens" at Emu Plains, although no exact location was given.

ARTEFACT TYPE	JC/1	JC/1E	JC/1LT	JC/1LTE
Pebble and Core Tools				
Uniface pebble tool	13	-	-	2
Biface pebble tool	2	-	-	-
Edge-ground tool	13	-	-	-
Hammer/anvil	31	1	2	-
Core tool	71	4	1	4
Backed Tools				
Bondi point	319	11	-	-
Geom. microlith	25	1	-	-
Elouera	31	5	-	-
Backed piece	34	1	-	-
Normal Flake Tools				
Utilised	323	17	7	-
Sharp retouch	55	7	3	-
Steep retouch	89	4	6	-
Thumbnail	9	-	-	-
Thick Flake Tools				
Utilised	22	1	1	2
Sharp retouch	12	1	-	3
Steep retouch	4	1	2	5
Core	95	2	7	1
Bipolar/scalar pieces	206	12	5	-
Debitage				
Chert	6060	229	98	7
Silcrete	608	31	3	1
Quartz	766	31	19	3
Quartzite	280	9	7	-
Basalt	210	2	5	1
Other	33	-	-	-
Miscellaneous				
Ochre	46	-	-	-
TOTAL	9357	370	166	29

Table 7.6 Stone artefacts recovered from surface collections on Jamisons Creek sites.

ARTEFACT TYPE	JC/1	JC/1E	JC/1LT	JC/1LTE
Post-contact artefacts				
Glass	442	188	61	-
Ceramic	841	28	106	-
Metal	140	-	3	-
Clay pipe fragment	3	-	2	-
Organic artefacts				
Bone fragments	120	7	11	-
Shell	9	-	8	-
TOTAL	1555	223	191	-

Table 7.7. Non-lithic artefacts recovered from Jamisons Creek sites.

The density of stone artefacts on site JC/1 is $12/m^2$, with 9357 artefacts being recovered from an area of 775 square metres. One reason why this value is so high is because the site represents accumulation of up to 15 centimetres of deflated deposit. This density compares favourably with deflated open sites in arid zones (Bonhomme, 1983). The concentration of artefacts suggests that the the site was used as a base camp during the *Bondaian*, with the large numbers of backed blades present refuting the earlier suggestion that Bondi points may be restricted to rockshelters in the Blue Mountains area (Stockton, 1970a).

Two characteristics of the assemblage distinguish it from the Shaws Creek site. They are:

1) the presence of large numbers of uniface pebble tools, and

2) the high proportion of core tools.

The uniface pebble tools on the site are typical of those found on open sites throughout the area (McCarthy, 1948), confirming that this tool type is widespread on open sites including those occupied during the *Bondaian*.

The core tools found on JC/1 are not similar to those found in the *Capertian* industries of either Shaws Creek KII or Lapstone Creek LC/1B. Almost all of the cores from which the core tools were made are small, and clearly the result of intentional production of small flakes and blades. Many of them are actually blade cores, and few show any patination as was apparent on chert artefacts from early assemblages. The secondary use of such a substantial proportion of cores as tools is not documented for any eastern Australian site. The phenomenon cannot be explained by lack of suitable raw materials, for the gravels in the Nepean River within two kilometres of the site contain abundant chert pebbles.

The criteria by which the cores have been classified as tools were re-evaluated to see if in fact the edge damage was not produced as the result of use of the core as a tool. The presence of small flake scars along one or more edges (not necessarily a platform edge) was the basis for this classification. While it may be that the tiny flakes scars which I have interpreted as retouch or utilisation were produced by removal of striking platform edges on some of the cores, many show use on a lateral edge rather than on a striking platform edge.

A second possibility is that cores were discarded and re-used at a later date. In view of the sandy nature of the site, it seems likely that discarded artefacts would have been readily available for re-use. While the degree of weathering is slight on most of these core tools, on several the apparent retouch/usewear does appear to be more recent than the original flake scars. The most likely explanation would seem to be that casual use of previously discarded cores (and presumably other stone artefacts) was a common practice on this site.

The p/c/tf index was calculated for the four surface assemblages at Jamisons Creek (see Table 7.8). The two larger sites, JC/1 and JC/1E, both have low values (16% and 15%). The two sites on the lower terrace, JC/1LT and JC/1LTE, contained only 24 and 16 stone tools respectively, and this was too low to be statistically significant. However, the calculation was made for comparison. It is of interest to note that all 16 of the stone tools from JC/1LTE were pebble tools, core tools or thick flake tools, giving a theoretical p/c/tf index of 100%!

SITE	P/C/TF TOOLS	TOTAL TOOLS	P/C/TF INDEX (%)
JC/1	168	1073	16%
JC/1E	8	54	15%
JC/1LT	8	24	33%
JC/1LTE	16	16	100%

Table 7.8. Calculation of the Pebble/Core/Thick flake tool index for the Jamisons Creek sites.

In order to quantify the relationships between the Jamisons Creek assemblages and those at Lapstone Creek, a correlation co-efficient matrix was generated based on the relative numbers of tool types present in the assemblages. The results are shown in Table 7.9.

	JC/1	JC/1E	JC/1LT	LC/1A
JC/1E	.919			
JC/1LT	.570	.664		
LC/1A	.414	.465	.831	
LC/1B	.181	.214	.253	.131

Table 7.9. Correlation co-efficient matrix for stone tool assemblages from open sites on Emu Plains.

A high correlation is apparent between the two Jamisons Creek sites located on the upper terrace, indicating that they were probably used contemporaneously. The assemblage on the lower terrace is not highly correlated with either of the two sites on the upper terrace, but a moderate correlation does exist between the assemblage on the lower terrace at Jamisons Creek (JC/1LT) and the surface assemblage at Lapstone Creek (LC/1A).

The LC/1B collection shows no significant correlation with the LC/1A collection or any of the three larger sites on Jamisons Creek. However, the industry at JC/1LTE appears very similar in composition and tool types to the earlier Lapstone Creek assemblage, although the numbers are too small for a reliable statistical assessment to be made.

The proportions of the post-contact glass and ceramics materials on the three Jamison Creek sites also varied. A correlation co-efficient matrix was again generated using the numbers of each type of coloured glass (black, blue, green, clear) and ceramic type (Staffordshire Blue, Plain, or coloured). The results are shown in Table 7.10.

	JC/1	JC/1E
JC/1E	.165	
JC/1LT	.999	.214

Table 7.10. Correlation co-efficient matrix for post-European materials on Jamisons Creek sites.

The results show a high correlation between the range and proportions of raw materials on the two sites JC/1 and JC/1LT, with no significant correlation between these sites and JC/1E. This suggests that the taphonomic processes leading to the presence of the post-contact artefacts on two of the sites were the same, but were different on JC/1E. JC/1E had a much higher proportion of black bottle glass fragments, and few ceramic shards. This may mean that while the two sites with the wide range of glass and ceramic types represented general camping areas, the JC/1E site may have been a "specific activity site" during the early nineteenth century, the activity being the consumption of the spirits contained in the black glass bottles!

A total of five clay pipe stem and bowl fragments were recovered from the JC/1 and JC/1LT sites. One stem fragment contained the inscription "McDouga.." on one side and "Cutty " on the other. This is undoubtedly from a pipe manufactured in Scotland by Duncan McDougall ("Cutty" pipes were short Scottish pipes), and was probably manufactured after 1847 (Dane and Morrison, 1979).

Two types of organic materials were located on the high terrace: shell and bone. The identifiable taxa are listed in Table 7.11. A single valve of the Sydney Cockle *Anadara trapezia*, an estuarine mollusc, has edge damage consistent with use as a tool. A valve of another estuarine shell, the Sydney Rock Oyster *Saccostrea commercialis*, was also found at the site.

TAXA	ITEM	POSSIBLE USE
Mollusca		
Anadara trapezia	1 valve	Tool
Saccostrea commercialis	1 valve	Food
Velesunio ambiguus	8 fragments	Food
Mammalia		
Bos taurus	2 right scapula	Food
?	long bone fragments	Food

Table 7.11. Identifiable animal taxa from Jamisons Creek JC/1.

7.5 Jamisons Creek JC/1 excavations

The high density of material on the surface of the main site on the upper terrace suggested that excavation would be productive. It would allow a better understanding of the stratigraphy of the site and the sequence of stone tools, could provide material for radiocarbon dating, and would demonstrate whether the *Capertian* industry was also present.

A test excavation was carried out in the most badly disturbed part of the site, in the southwestern corner of square B3. Two squares, each 1 metre square, were excavated to a depth of 50 cm below the surface. Square B3a was excavated in the extreme southwestern corner, and B3b was an easterly extension of it. Subsequently, 1 metre x 1 metre squares were excavated at five locations across the site. The locations of these squares were selected so as to provide the greatest amount of information on the stratigraphy of the site. An additional 5 metre wide grid was added to the eastern end of the site, and this was labelled P. The excavated squares were in the southwestern corners of the 5 x 5 metre grid squares P, P2, A3, B4, and C5 (see Figure 7.3b).

Excavation method

Each square was excavated initially in 5 cm spits unless the stratigraphy suggested otherwise. In some of the lower levels, where the density of stone was particularly low, this was increased to 10 cm spits. Excavated material was seived through a 5 mm mesh, and all artefactual material and manuports bagged for later analysis. Sediment samples were taken from each stratigraphic unit in every square, and charcoal samples were collected wherever possible. The depth of excavation varied from square to square, due to the fact that the relative depth of the stratigraphic units also varied. Square P2a was excavated to a depth of 110 cm, squares Pa and A3a to 100 cm, square B4a to 60 cm, and square C5a to 70 cm. The two test squares B3a and B3b were excavated to a depth of 50 cm.

Stratigraphy

Three stratigraphic units were present in squares Pa, P2a, B4a and C5a. The two top units were absent from A2a, B3a and B3b. A fourth unit was present across the site, and was identified by boring auger holes ~~into~~ the lowest excavated spit of each square when the excavation was completed. Stratigraphic units are numbered from the top unit down. The stratigraphy is shown in Figure 7.4a.

(1) Unit 1

Unit 1 consisted of loose, yellow aeolian sand. It ranged in depth to a maximum of 10 cm, and represents the wind-blown sand accumulation since the site first suffered disturbance from trail bikes (probably in the early 1970's according to local residents). Over most of the site it had been stabilised by a thick matting of couch grass. It contained recent European material including plastic and glass, and displaced prehistoric items.

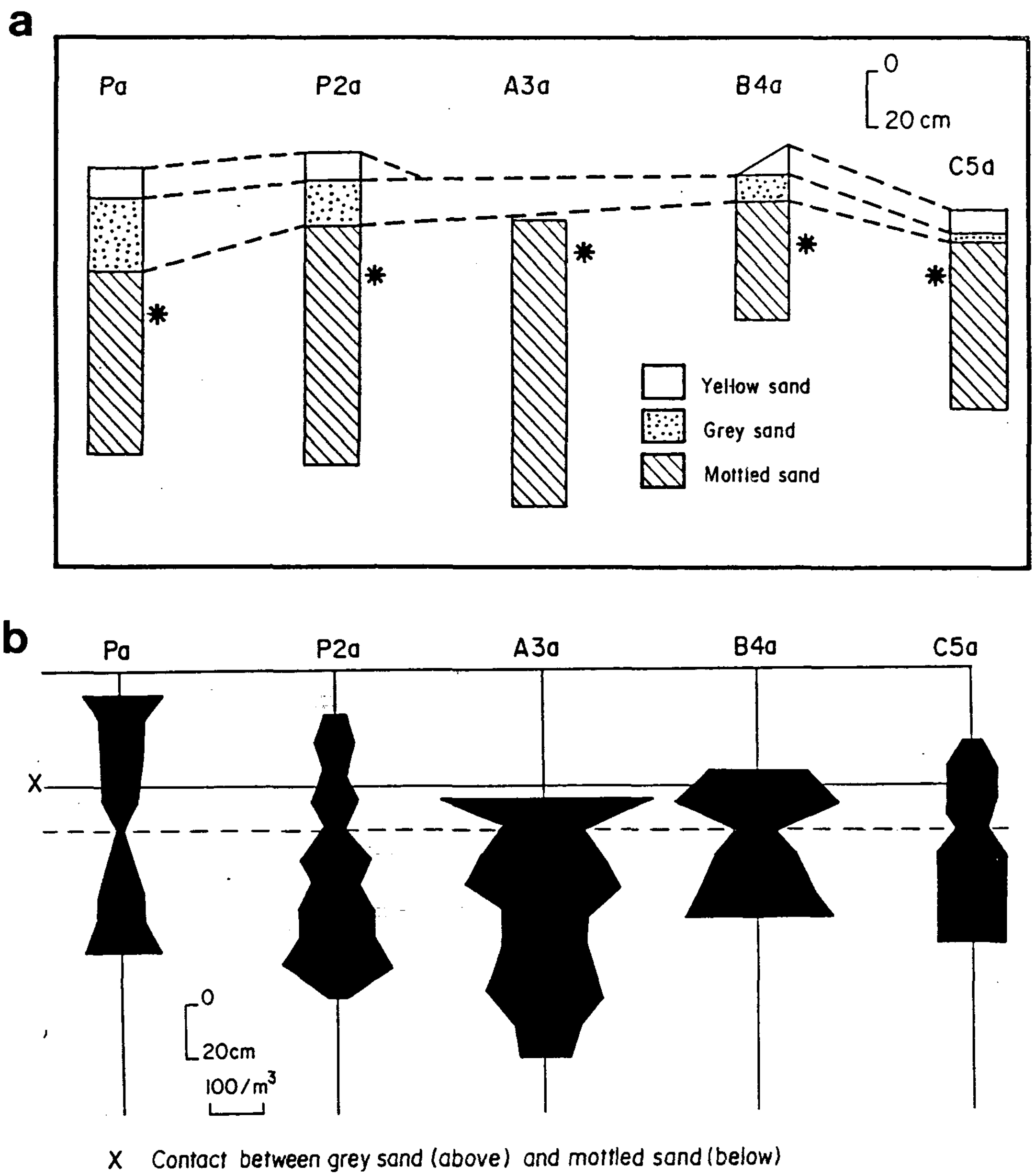


FIGURE 7.4. Jamisons Creek site JC/1

a: stratigraphic sections. Low artefact density layer is shown by an asterisk (*).

b: vertically re-aligned at the contact between the grey sand and the mottled sand, showing changes in artefact density with depth in excavated squares. Dashed line shows the low density level which occurs prior to 4000 BP.

(2) Unit 2

Unit 2 consisted of a grey sand, which ranged in depth from 30 cm in square Pa to a thin band only a few centimetres deep in C5a. It was slightly more compacted than unit 1, and contained glass and ceramics as well as some flaked stone. Most of the European material appears to date from the first half of the nineteenth century (Staffordshire blue ceramics and black bottle glass), so this unit probably represents aeolian accumulation since the land was first cleared *circa* 1815 (Steege, 1974).

(3) Unit 3

This unit consisted of a highly mottled sand, more compacted than units 1 and 2, with evidence of iron being leached down towards the base of the unit. The mottling was produced by iron accumulation, small animal burrows (less than 1 cm diameter) infilled with white, grey and yellow coloured sand), and abundant charcoal. No European artefacts were found within this unit, but flaked stone continues to the base of all the excavated squares, and from the evidence of the auger samples and observations off the main site, stone is present down to the contact with the lowest unit. The unit varies in depth from 100 cm to approximately 140 cm.

(4) Unit 4.

The basal unit found right across the site and extending over most of Emu Plains is the massive indurated clay-sand previously identified at Lapstone Creek. Although this unit was not reached during the excavations, it was detected in auger samples and was exposed in an eroded section at JC/1E. It is apparently archaeologically sterile, although a single chert pebble with three conchoidal fractures was found eroding from this unit east of the main site complex.

Units 3 and 4 are widespread across Emu Plains, while units 1 and 2 are peculiar to the Jamisons Creek site. There is little doubt that unit 3 corresponds to the upper artefact-bearing sand unit identified on the Lapstone Creek open site.

Three radiocarbon dates were obtained from the site complex, and these are shown in Table 7.12. A discrete hearth was located in spit 2 of square B3b, and this provided a date of *circa* 4000 years BP. Above this level, backed blades and edge-ground fragments were found, but none were found below this level within this square. In square A3a at a depth of 90 cm, a change occurred in the nature of the sediments, with a darker charcoal-rich infill, tentatively identified as an animal burrow, being present in the northwest corner of the square. A backed fragment was found within this unit, and as no other backed artefacts had been found at any great depth in any other square, a charcoal sample was collected and submitted for dating. The date of *circa* 1600 BP confirmed that the darker sediment was intrusive into the older deposit.

Charcoal was almost totally absent from the lower units of the excavated squares, and an adequate sample could not be obtained for a radiocarbon age determination. However, an eroded terrace immediately below site JC/1E clearly showed the contact between unit 3 and unit 4. A large block of charcoal was located at the base of unit 3 immediately above the contact with unit 4, and this was submitted for dating. The resulting date of 7000 years BP is consistent with the archaeological evidence from the remainder of the site complex, and also with other carbon dates for similar deposits in the general area. Stockton and Holland (1974) recorded a date of 8820 ± 120 BP (SUA-223) from the base of a clay and sand deposit above the gravel beds a few kilometres to the north of the site on the Nepean River.

Sample	Square	Spit	Depth (cm)	Unit	Years BP
SUA-1232	A3a	12	90*	3	1590 ± 130
SUA-1231	B3b	2	10	3	3980 ± 140
SUA-1233	JC/1E	-	surface	3 (base)	7010 ± 110

* Sample collected from intrusive unit containing a backed blade.

Table 7.12. Radiocarbon dates from Jamisons Creek complex.

Excavated assemblage

A total of 867 stone artefacts were recovered from 5.3 cubic metres of excavated deposit. The assemblage has been divided into two phases, designated by Roman numerals, the younger being Phase I and the older Phase II. Phase I corresponds with the displaced prehistoric items in stratigraphic units 1 and 2 in addition to the upper part of stratigraphic unit 3. A marked level of low artefact density occurred approximately 20 cm below the contact between stratigraphic units 2 and 3, although this level varied slightly in depth from square to square. It is indicated by an asterisk (*) in Figure 7.4a. This low density level was apparent in all squares excavated, and occurred 5 cm below the charcoal sample dated to 3980 ± 140 BP in square B3b. Phase I includes the material in unit 3 above the low density level, while Phase II contains the material from the low density level (and including it) to the base of the excavations. The change in artefact density with depth in the squares other than the test squares B3a and B3b is shown in Figure 7.4b.

The stone tools and diagnostic artefacts recovered from the excavations are shown in Table 7.13, while the proportions of different raw materials in the debitage are shown in Figure 7.5.

Phase I, containing Bondi points, edge-ground artefacts, bipolar pieces and normal flake tools, clearly belongs to the *Bondaian*, and extends over the last 4000 years. Phase II, lacking backed artefacts and edge-ground tools, and having a significant proportion of thick flake tools, would appear to belong to the *Capertian* industry. On this site the assemblage represents the period between 7000 and 4000 BP. The absence of pebble tools in Phase II is probably a reflection of the low density of artefacts. The numbers of artefacts are too low for the p/c/tf index to be calculated. However it should be noted that three of the five amorphous flake tools in Phase II were made on thick flakes, while all ten flake tools in Phase I were made on normal thin flakes or blades.

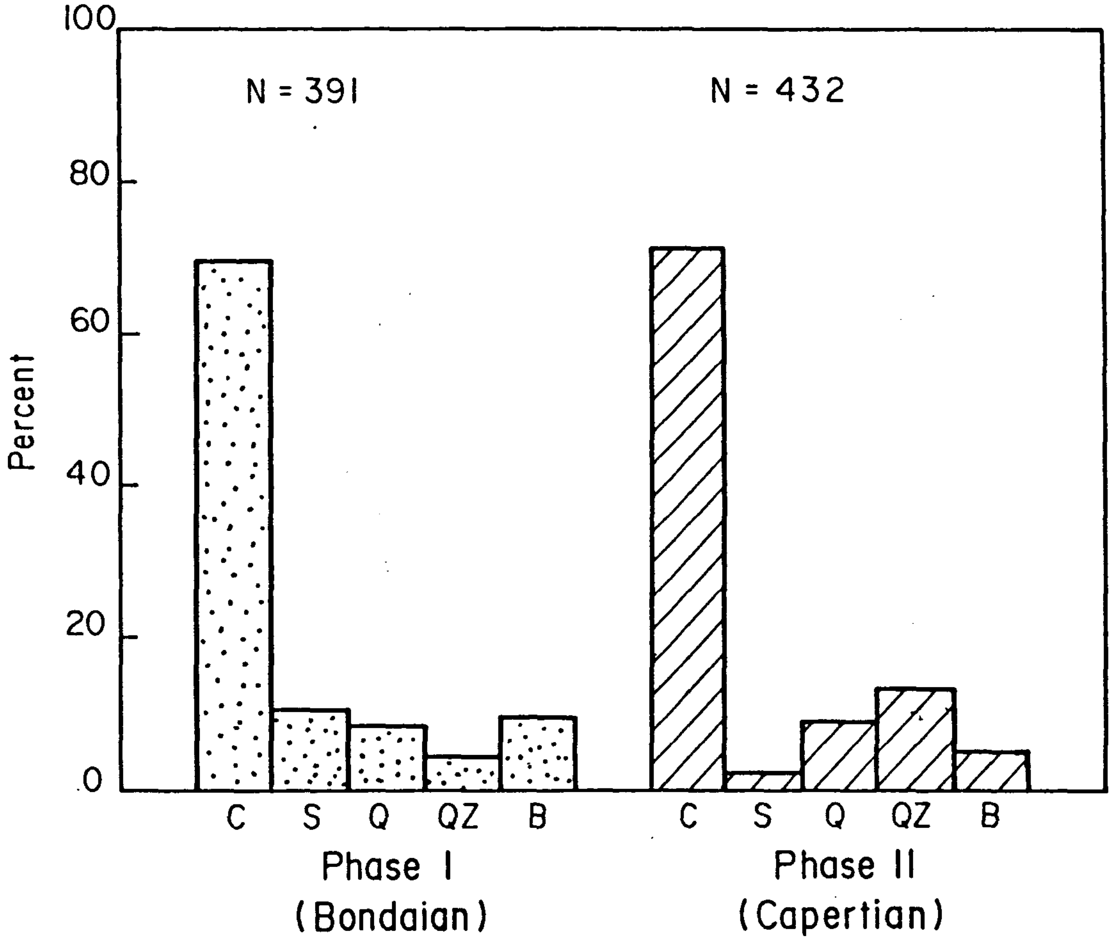


FIGURE 7.5. Jamisons Creek site JC/1: proportions of raw materials in the debitage recovered from the excavation.

ARTEFACT TYPE	PHASE I	II	TOTAL
Pebble and Core Tools			
Uniface Pebble Tool	-	-	-
Biface Pebble Tool	-	-	-
Edge-ground Tool	2	-	2
Hammer/anvil	-	3	3
Core Tool	-	-	-
Backed Tools			
Bondi point	3	-	3
Geom. microlith	-	-	-
Elouera	-	-	-
Backed piece	-	1*	-
Normal Flake Tools			
Utilised	-	2	2
Sharp retouch	4	-	4
Steep retouch	2	-	2
Thumbnail	1	-	1
Thick Flake Tools			
Utilised	-	2	2
Sharp retouch	-	1	1
Steep retouch	-	-	-
Core	2	1	3
Bipolar/scalar piece	2	-	2
TOTAL	16	10	26

* Located within intrusive deposit.

Table 7.13. Diagnostic stone artefacts from the excavated deposits at JC/1.

Figure 7.5 shows that the proportion of the various raw materials recovered from the excavations varies slightly in that there is a lower percentage of silcrete and a higher proportion of quartzite in Phase II compared with Phase I.

7.6 Jamisons Creek Lower Terrace (JC/1LT) excavation

In view of the apparent differences between the surface assemblage on the upper and lower terraces, a 1 metre x 1 metre test square was excavated into the deposit on the lower terrace immediately adjacent to site JC/1LT (Kohen, 1984e). The results of the excavation are shown in Table 7.14.

SPIT DEPTH (CM)	1 0-2	2 2-10	3 10-20	4 20-30	5 30-40	6 40-50	7 50-60
Brown glass	6	-	1	-	-	-	-
Ceramics	3	-	-	-	-	-	-
Rubber	1	-	-	-	-	-	-
Green glass	-	1	-	-	-	-	-
Matchstick	-	1	-	-	-	-	-
Chert deb.	-	-	5	4	1	3	2
Quartz deb.	-	-	2	-	-	-	-
Quartz core	-	-	-	-	1	-	-
Silcr deb.	-	-	-	-	1	-	-
Ironstone	-	-	-	-	4	-	1
Sandstone	-	-	-	-	-	-	1

TABLE 7.14. Excavation of a 1m x 1m test square on site JC/1LT.

Stratigraphy

Spit 1: 0-2 cm. Loose grey sand, bonded by couch grass roots, and containing European items.

Spit 2: 2-10 cm. Compact grey silty sand containing scattered charcoal, similar to unit two on the upper terrace, and containing European items, but lacking stone artefacts.

Spit 3: 10-20 cm. Grey/brown sandy loam, with grey and cream mottling, containing charcoal and similar to unit 3 deposit on upper terrace. Stone artefacts were present.

Spit 4. 20-30 cm. Same material as spit 3.

Spit 5. 30-40 cm. Similar to spits 3 and 4, but slightly softer to trowel and lighter in colour.

Spit 6. 40-50 cm. Continuation of the same mottled sand, but becoming slightly more yellow at depth.

Spit 7. 50-60 cm. Identical to the deposit in spit 6.

Clearly the top ten centimetres of the deposit is of post-European origin, while the lower deposit pre-dates European settlement. This is the same as on the upper terrace, where the same grey sand covered the artefact-bearing deposit.

The relatively low density *in situ* (21 artefacts in 0.5 cubic metres of artefact-bearing deposit) is significantly less than the density on the upper terrace. Since no diagnostic artefacts were recovered, no direct comparisons can be made with the upper terrace excavation. It is clear that the same geomorphic processes in operation on the upper terrace also functioned on the lower terrace.

7.7 Evaluation of Emu Plains sites

The stone assemblages at the Emu Plains sites may best be explained as follows:

Occupation of both the Lapstone Creek site and the Jamisons Creek site complex began prior to the introduction of the Small Tool Tradition, sometime before 4000 years ago and not earlier than

7000 years ago. This does not preclude earlier Aboriginal occupation on other parts of Emu Plains. In fact the evidence from Shaws Creek confirms that Aborigines were certainly living in the general vicinity well before this time. The stone toolkit in use is recognisable as *Capertian*, although a pebble tool component also appears to have been present. The industry is dominated by thick flake steep scrapers and utilised flakes.

Sometime shortly before 4000 BP, the density of artefacts per unit volume on the Jamisons Creek JC/1 site declines markedly. This phenomenon was identified across the entire site in all squares excavated. It parallels the finding at Shaws Creek KII rock shelter and other sites reported by Stockton and Holland (1974). The confirmation that a hiatus or low-density layer exists at both open and rockshelter sites during the period *circa* 5000-4000 BP weighs heavily against Johnson's arguments that no hiatus or low density layer exists (Johnson, 1979). If no geomorphic process can be identified which would cause a marked increase in the rate of accumulation of deposits on both open sites and in rockshelters during the mid-Holocene, then serious consideration must be given to the alternative proposition, namely, that there was a general reduction in the frequency of site usage (possibly because of low population density) rather than a preference for one site type or the other. Certainly the presence of a low density layer on a major open site precludes the possibility that the cause of this anomaly was a shift in settlement pattern from rockshelters to open sites.

The *Capertian* industry identified on the Lapstone Creek site contained end and side trimmed uniface pebble tools. Similar artefacts were found within the surface collections at Jamisons Creek, but not within the excavated sequence. It is apparent that the primary reason so many pebble tools were identified at Lapstone Creek is the degree of disturbance at that site.

Sometime after 4000 BP and probably before 3500 BP (on the evidence from Lapstone Creek rockshelter), artefacts belonging to the *Bondaian* industry (Bondi points and elouera) were being manufactured and used on both rockshelter sites and open sites close to the major creeks. Some areas like JC/1LTE may have been abandoned for purely local reasons, perhaps because of a change in the course of Jamisons Creek. The amount of worked stone discarded on the major sites increased enormously. While this is partly attributable to the major technological change resulting in more and smaller artefacts being produced, it may also indicate that perhaps occupation was concentrated on fewer sites which were used more frequently (perhaps year-round occupation). Edge-ground tools first appear between 4000 BP and 2250 BP (from the evidence at Shaws Creek).

The weight of the evidence from the open sites suggests that uniface pebble tools continued to be used on open sites probably up until the time of European settlement (Flood, 1980). No direct evidence regarding the demise of the Bondi points was forthcoming, but the changes in the proportions of raw materials observed in Shaws Creek rockshelter were also observed at

Jamisons Creek.

Occupation of Lapstone Creek open site and Jamisons Creek JC/1 open site continued until well into the nineteenth century, possibly until the late 1840's.

Plate 2. Lapstone Creek open site, before major disturbance.

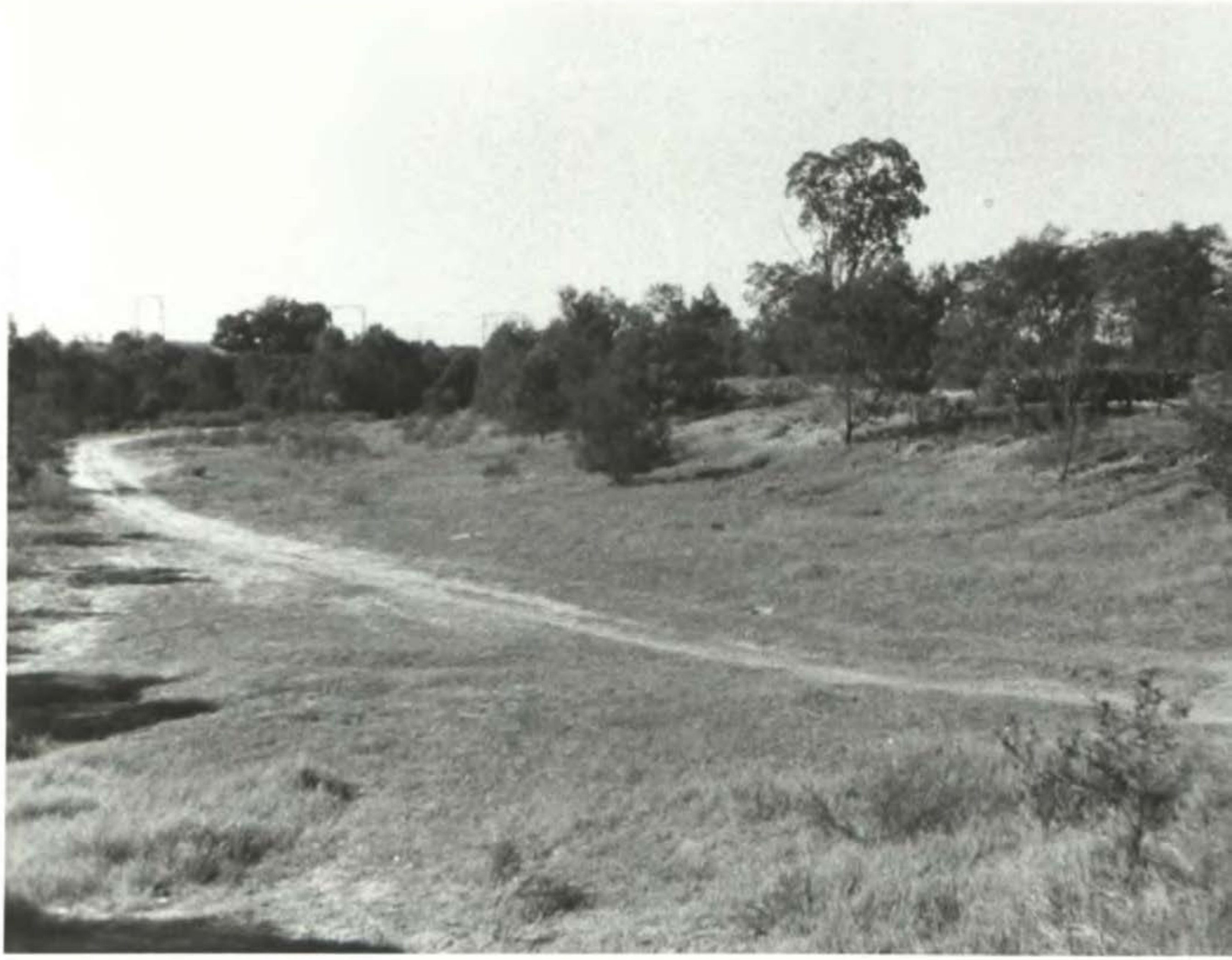


Plate 3. Jamisons Creek open site during excavation (facing south).

CHAPTER 8

SECOND PONDS CREEK SITE COMPLEX

8.1. Introduction

The results of the excavations along the Nepean River confirmed the basic sequence of artefacts and the changes in raw materials over time, narrowed down the dates at which these changes occurred, and provided a range of parameters against which assemblages on open sites could be compared. It was highly desirable to carry out controlled excavations of sites in environmental zones other than those associated with a riverine environment, but in view of the nature of the soils it seemed unlikely that any major stratified open site suitable for excavation would be found.

The last major zone I surveyed was at the eastern end of the study area within a geological unit dominated by Wianamatta Shale. The clay soils are usually thin, and unlikely to contain many stratified sites. However, it was the very nature of the shale deposits which led to the discovery of a complex of sites extending for a distance of over 1 kilometre along Second Ponds Creek (see Figure 8.1). Since the shales were originally deposited in an estuarine environment, the ground water is saline. This has resulted in several of the smaller creeks having high salt levels. Such a situation exists along Second Ponds Creek at Quakers Hill, where the saline soil and groundwater have combined to destroy the vegetation cover near both banks of the creek over a distance of several kilometres, resulting in severe erosion along both banks.

The region surveyed consists of land which has been predominantly cleared, and it is at present used for grazing cattle and horses. The area was part of Hambledon Park, and from the early 1820's until the 1940's it was used for grazing sheep. The few remaining uncleared parts of the valley through which Second Ponds Creek flows consist of scattered stands of *Eucalyptus* spp. along the valley sides, and stands of *Casuarina* and *Melaleuca* along the valley floor. At the time the valley was surveyed, it was covered by grass up to a metre tall, making visibility extremely poor. However, the high salinity has resulted in substantial amounts of localised erosion along the banks of the creek and its tributary streams. Erosion scars extend back from the creek for distances up to 100 metres, but over most of the length surveyed the disturbance was between five and ten metres wide. An attempt to prevent further erosion had been made by the New South Wales Soil Conservation Service, who had bulldozed two large mounds of earth parallel to both sides of the creek to prevent or at least minimise runoff of saline groundwater. This proved unsuccessful, and the erosion continues.

At the lower or northern end of the valley, a dam was built across the creek. This led to an accumulation of silt up to a metre thick near the dam wall. At the time the site was first visited, the dam had been breached and the creek was flowing without obstruction.

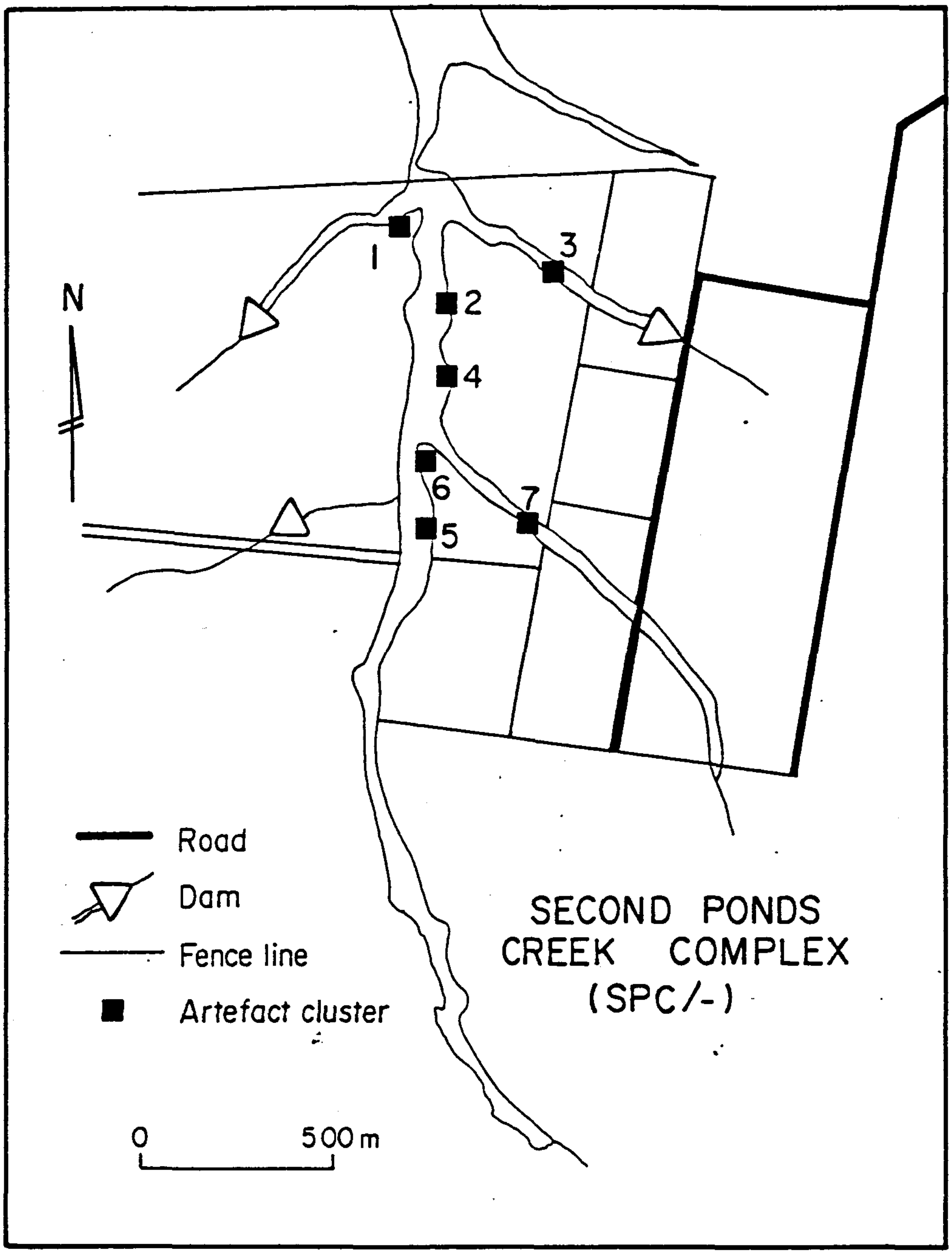


FIGURE 8.1. Second Ponds Creek site complex: plan of artefact concentrations (1-6) and isolated find (7). See Figure 5.3 for location in the study area.

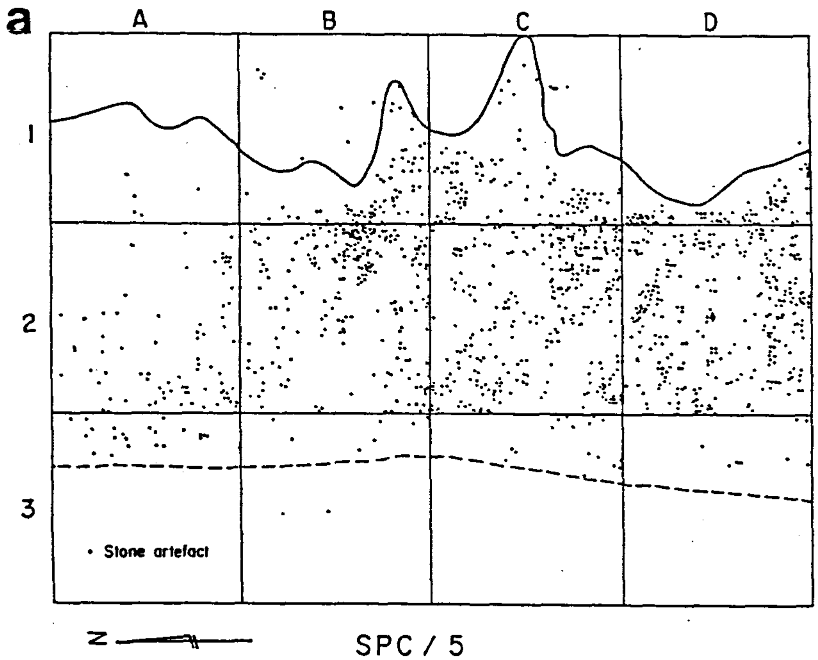
The sediment adjacent to the creek consists of a mixture of clays and silts formed both *in situ* and by alluvial deposition along the creek. There is also some evidence of colluvial activity, with silts being washed down the hillslopes into the creek. The eroding surfaces along the creek consisted of a yellow clay, with a few localised patches of grey clay. Dark organic layers were also present, and this has been interpreted as evidence for the existence of extensive *Melaleuca* swamps in the valley at some time in the past (Peter Mitchell, pers. comm.). Along the banks of the creek, deposits of silt were observed. In some cases the deposits of silt were obviously the result of sediment accumulation as a result of the building of the dam, but further upstream the silt appeared to be an *in situ* deposit averaging 30-40 cm in depth.

8.2 Artefact concentrations

The first visit to the valley confirmed that Second Ponds Creek was rich in archaeological material. Stone flakes were observed wherever the ground surface had been disturbed or deflated, including the bulldozed areas, mounds and the dam wall. Artefacts extended along both banks of the creek for a distance of over a kilometre. Literally thousands of artefacts were obvious on the surface, and also eroding from the silt upstream from the dam.

A survey of the valley using the 200 metre transect method was carried out, but it was soon apparent that artefacts were only visible where the grass cover had been removed. The distribution of stone on the ground suggested that the entire area within 50 metres either side of the creek for a distance of over 1 kilometre could justifiably be designated as a single site, since at no point was there more than 50 metres between two artefacts. However, it was also observed that there were areas of much greater concentration separated by low density scatters, so the high density areas were each allocated a site number (SPC/1-6). Six such areas were recognised; five along the creek and one in a localised erosion scar approximately 200 metres east of the creek. An isolated find was also located (SPC/7). No artefacts were found on the western side of the creek at a distance of more than 100 metres, and this was almost certainly because of the poor visibility rather than any genuine absence of artefacts. The distribution of the designated sites is shown in Figure 8.1.

The greatest surface density of artefacts was adjacent to a *Casuarina* tree 100 metres north of a fence line which runs across the valley 1 kilometre south of the disused dam. A datum was established at the base of the tree, and the concentration was coded SPC/5 (see Plate 4). A five metre grid was established on the eastern bank of the creek south of the datum, and a total of twelve five metre x five metre squares were subjected to surface collection. The position of each stone artefact within each square was plotted, and the position of diagnostic stone tools noted. Figures 8.2a and 8.2b show the distribution of all artefacts and some of the diagnostic tool types across the grid.



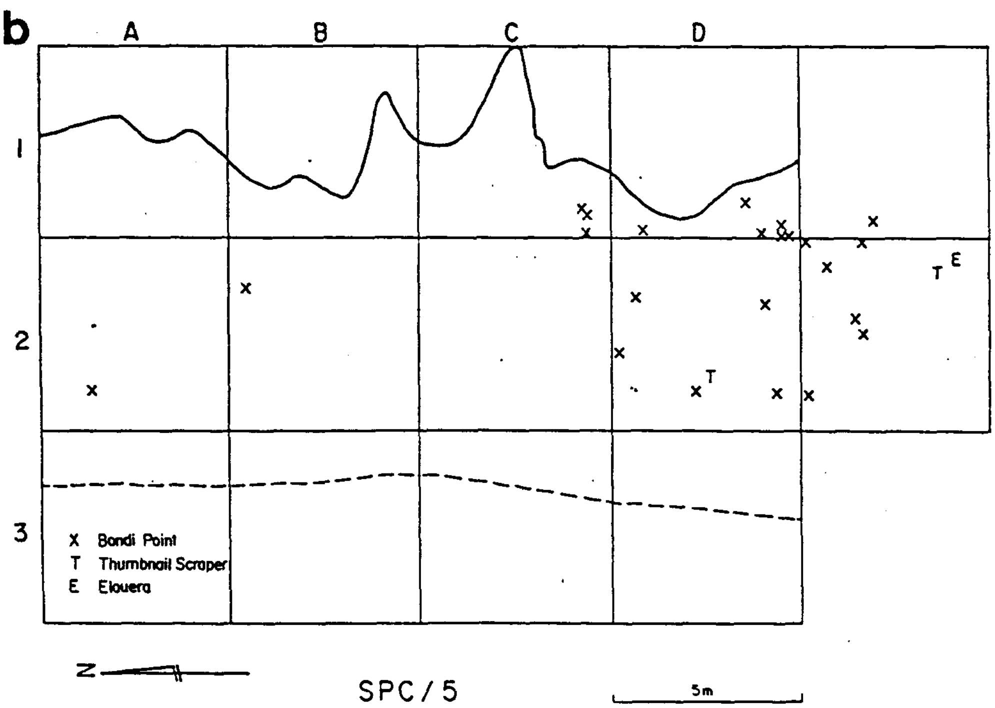


FIGURE 8.2. Second Ponds Creek 5 SPC/5

a: distribution of all stone artefacts over the area gridded for surface collection.

b: distribution of Bondi points, thumbnail scrapers and elouera within the surface collection and in adjoining squares.

The density of worked stone varied considerably across the grid. Maximum average density over any one square was 12 artefacts per square metre (in an area of 25 square metres). Over 1000 artefacts were collected in an area of 300 square metres. Diagnostic artefacts collected from the grid included Bondi points, geometric microliths, and thumbnail scrapers. The distribution of Bondi points was clearly non-randon, and exhibited marked clustering around square D2. Twenty one out of 28 Bondi points were found within this square or less then 2 metres from it (see Figure 8.2b).

Smaller systematic collections were taken at the other concentrations, but in each case the density of artefacts was much lower, averaging 1-2 per square metre. Systematic collections were made at SPC/1 and SPC/2 (near the dam wall), SPC/3 (in an erosion gully east of the creek), SPC/4 (500 metres north of the fence line), and at SPC/6 (a distinct cluster of flake tools and cores 120 metres north of SPC/5). SPC/7 was an isolated find in an erosion scar near the fence line to the east of the creek. Of all the sites located during the surveys, the quantity and density of stone material on this complex was second only to Jamisons Creek. The stone tools recovered from the sites are shown in Table 8.1, indicating that the complex contains almost the full range of tool types recorded for the Cumberland Plain, including edge-ground hatchet heads, Bondi points, geometric microliths, elouera adze flakes, bipolar pieces, and a wide array of amorphous flake tools. Although none was identified in the collections, a uniface pebble tool was found between two of the concentrations. The p/c/tf index was calculated for SPC/5 and for the combined complex. These results are shown in Table 8.2.

ARTEFACT TYPE	SPC/1	SPC/2	SPC/3	SPC/4	SPC/5	SPC/6
Pebble and Core Tools						
Uniface pebble tool	-	-	-	-	-	-
Biface pebble tool	-	1	-	-	-	-
Edge-ground Tool	-	-	1	-	-	-
Hammer/anvil	-	-	-	-	-	-
Core tool	5	-	-	1	4	-
Backed Tools						
Bondi point	-	-	-	1	28	1
Geom. microlith	-	-	-	-	1	-
Elouera	1	-	-	1	-	-
Backed piece	-	-	-	-	-	-
Normal Flake Tools						
Utilised	4	2	1	-	16	1
Sharp retouch	4	1	-	1	7	1
Steep retouch	3	2	-	1	11	2
Thumbnail	-	-	-	-	2	-
Thick Flake Tools						
Utilised	1	-	-	-	2	-
Sharp retouch	-	2	-	1	5	1
Steep retouch	1	1	-	-	2	4
Core	10	1	1	5	47	7
Bipolar/scalar piece	1	2	-	-	12	1
TOTAL	30	12	3	11	137	18

Table 8.1. Diagnostic stone artefacts from Second Ponds Creek concentrations.

COLLECTION	P/C/TF TOOLS	TOTAL TOOLS	P/C/TF INDEX (%)
SPC/5	13	78	17%
Combined SPC/-	32	124	26%

Table 8.2 Calculation of the Pebble/Core/Thick flake tool index for Second Ponds Creek surface collections.

Raw materials

The dominant raw material at the complex was silcrete, almost certainly obtained from the silcrete outcrops along the Plumpton Ridge adjacent to Eastern Creek 3 km to the west. Silicified wood from the same source was also present, but in small concentrations. Although the nearest source of chert was the gravel beds of the Nepean River some 20 km away, it proved to be the second most common raw material. Quartz and basalt debitage was located, and a few fragments of quartzite. The quartz is obtainable from conglomerate bands in the Hawkesbury Sandstone 3 km to the east, while the nearest source of quartzite would appear to be the Rickabys Creek gravels west of South Creek (Gobert, 1978). The proportions of raw materials in the debitage are shown in Table 8.3.

RAW MATERIAL	SPC/1	SPC/2	SPC/3	SPC/4	SPC/5	SPC/6	TOTAL
Chert	28	12	1	4	149	27	221
Silcrete	120	31	4	25	783	70	1033
Quartz	15	5	-	-	69	5	94
Quartzite	-	2	-	-	6	-	8
Basalt	-	-	-	2	8	1	11
Other *	1	1	-	1	17	3	23
TOTAL	164	51	5	32	1032	106	1390

* All silicified wood on these sites.

Table 8.3. Raw materials found in the debitage at the Second Ponds Creek concentrations.

The results of the surface collections show clearly that the assemblage on SPC/5 is typically *Bondaian*, with only edge-ground tools missing from the toolkit. Although no edge-ground tools were recorded within the surface collection grid, two complete hatchet heads and other ground fragments were located within 50 metres of the site. The p/c/tf index of 17% compares well with the Jamisons Creek upper terrace sites (15% and 16%) and the *Bondaian* units of Shaws Creek KII (21%, 24% and 16%). Although the numbers of tools are too small for direct comparison, the SPC/6 cluster has a p/c/tf index of 50%.

The major difference lies in the proportions of raw materials, with silcrete replacing chert as the dominant material within the debitage. There are significantly lower values for basalt and quartzite, but this is probably related to the distance from these raw materials.

8.3 Inter-cluster patterning

Because of the degree of deflation along the creek, the site complex provided a unique opportunity to examine the patterning of artefacts between the clusters. To achieve this aim, two transects were surveyed along the east and west banks of the creek between SPC/5 and SPC/4 over a distance of 400 metres. The cluster SPC/6 occurs within the transect on the eastern bank of the creek. The data collection unit was a strip 5 metres wide back from the edge of the creek and 1 metre long parallel with the creek (i.e. an area of 5 m^2). For subsequent analysis, the data were grouped into larger analysis units, 5 metres wide and 20 metres long (100 m^2) for artefact density analysis, and 5 metres wide and 100 metres long (500 m^2) for raw material analysis. Each stone artefact within the transect was inspected, and its location, raw material and artefact type recorded. It was then replaced in its original position. The results of these analyses are shown in Figures 8.3, 8.4 and 8.5.

Density analysis

From Figure 8.3a, it can be seen that the density of stone in the first twenty metres north of the datum on the east bank is $1.6/m^2$, a reflection of the proximity to the artefact cluster SPC/5. The density drops markedly to a $0.04/m^2$ between 60 and 80 metres, increases to $0.8/m^2$ at SPC/6, drops steeply to less than $0.2/m^2$, and remains around this level until it begins to increase again approaching cluster SPC/4. Figure 8.3b shows that this pattern is not repeated on the western bank of the creek, where there is a much more gradual transition between the two clusters. The stone tool assemblage at SPC/6 consists of a high proportion of thick flake tools and cores, suggesting either a specific activity area peripheral to the major site at SPC/5 and contemporaneous with it, or a site which is temporally distinct from SPC/5 and reflects an earlier (or later) stone tool assemblage.

In order to clarify the situation, the changes in raw materials along the two transects were examined. Figure 8.4a shows the relative proportions of the various raw materials along the two transects. A clear pattern emerges, with the percentage of silcrete being significantly higher near the two major clusters SPC/5 and SPC/4, but falling to less than 50% between the clusters. On the east bank the trend is most pronounced, with the silcrete level dropping to 35% between 200 and 300 metres north of the datum. Because the absolute number of artefacts is significantly lower between the clusters, the absolute number of flakes of chert and silcrete were compared along the transects. The results are shown in Figure 8.4b. The trend observed in the proportion of silcrete is even more pronounced when the absolute numbers of artefacts are examined. It is apparent that the reduction in the percentage of silcrete is a result of three factors:

(1) a marked decrease in the number of silcrete flakes between the clusters,

(2) a significant increase in the amount of chert between 100 and 200 metres along the east bank transect (corresponding with the high p/c/tf index of SPC/6), and between 0 and 100 metres along the west bank,

(3) other than at the two locations identified, the absolute amount of chert remains relatively constant along both banks, averaging around 20 flakes per 500 m^2.

This strongly suggests that the clusters reflect increasing activity involving silcrete rather than chert, although the absolute amount of chert does increase within the clusters. The obvious interpretation is that, since most of the silcrete found at the clusters consists of debitage, the activity being carried out is the reduction of stone. The temporal relationship between the discard of the chert between the clusters and the reduction of the silcrete within the clusters is therefore of prime importance.

Since the SPC/6 cluster contained a high proportion of flake and thick flake tools, the relative importance of these components in the between-cluster assemblages is of significance. Similarly, if the changes in the amount of debitage is directly related to the clusters, does the pattern of distribution of cores follow the same distribution? Another tool type with a distinctly non-random distribution across the site was the Bondi point. Since this is the classic diagnostic artefact for *Bondaian* assemblages, the distribution patterm may be used as a guide for separating the inter- and intra-site patterning. Figure 8.5 shows the relative importance of each artefact type as a percentage of the entire assemblage (including debitage).

Cores would appear to be evenly represented along the west bank where they average about 10% of the assemblage. On the east bank, they are low in the first 100 metres north of the datum, but average between 5% and 10% over the rest of the transect.

Flake and blade tools are significantly more important between the clusters than within the clusters. On the west bank between 200 and 300 metres north of the datum, flake tools represent 25% of the total assemblage. This supports the contention that stone reduction is not taking place to any great extent between the clusters, but that tools are being used and discarded in these areas.

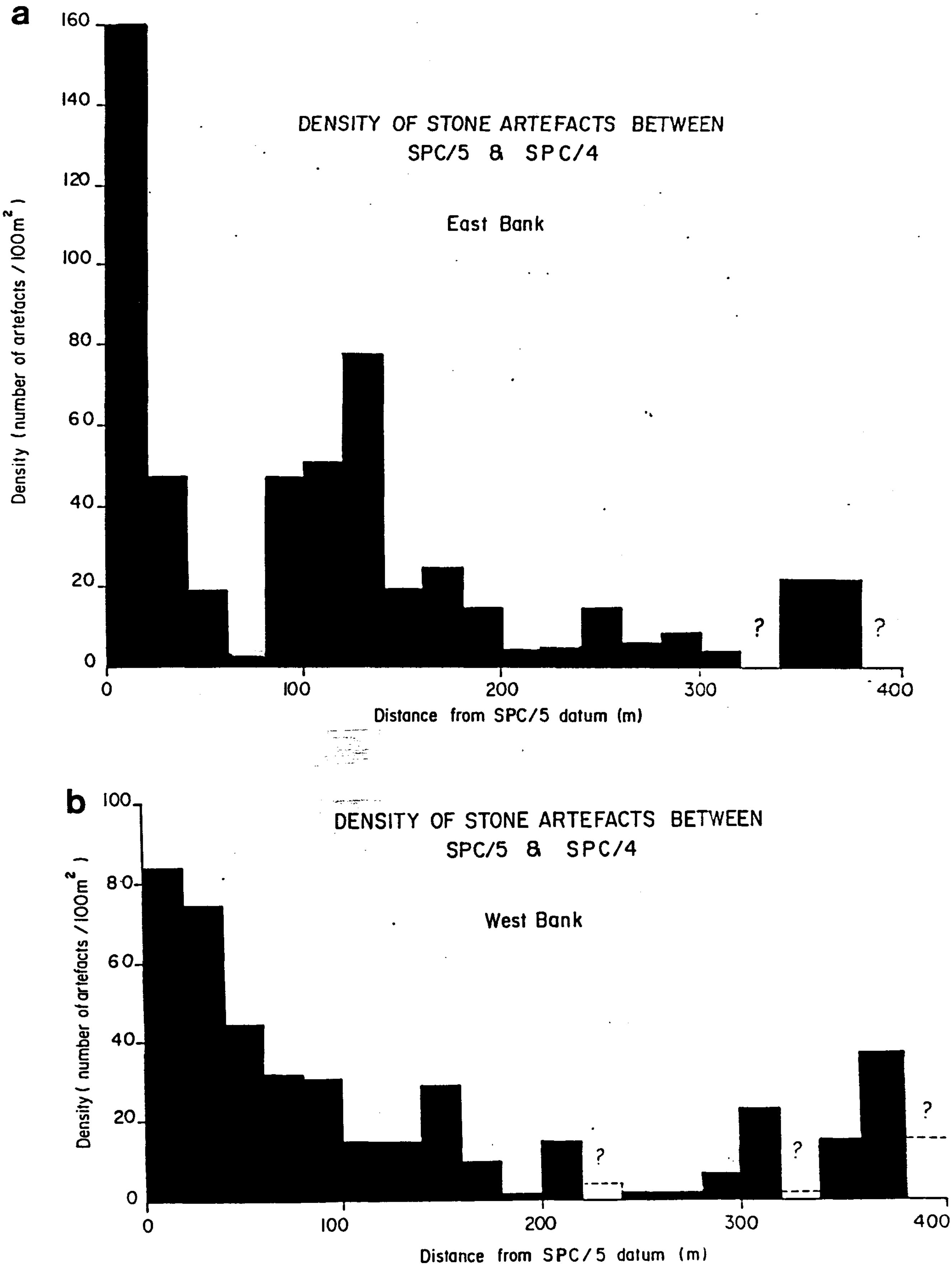
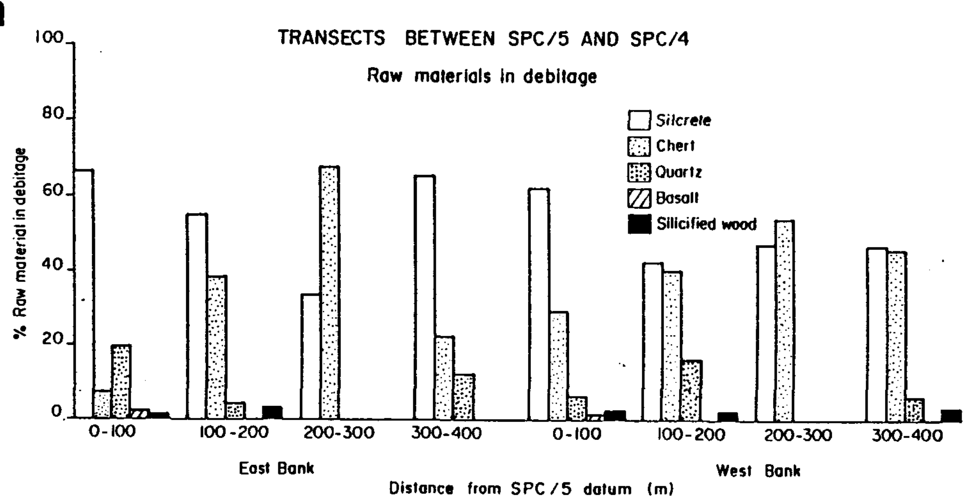


FIGURE 8.3 Second Ponds Creek site complex: density

a: density of artefacts along the eastern bank between SPC/5 and SPC/4.

b: density of artefacts along the western bank between SPC/5 and SPC/4.

a



b

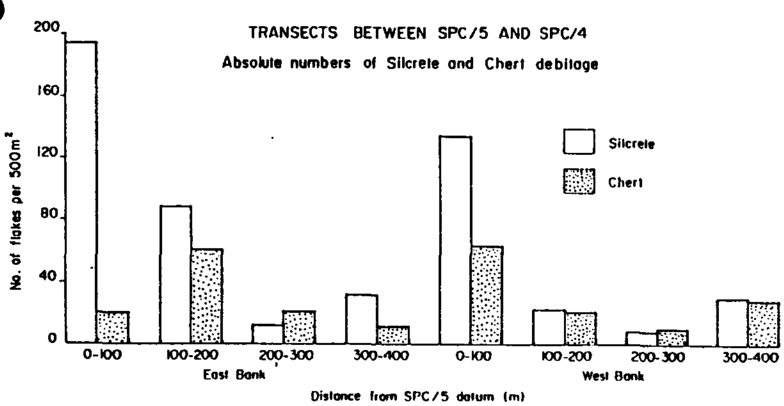


FIGURE 8.4. Second Ponds Creek complex: debitage

a: proportions of raw materials in the debitage between sites SPC/5 and SPC/4.

b: absolute numbers of silcrete and chert debitage between sites SPC/5 and SPC/4.

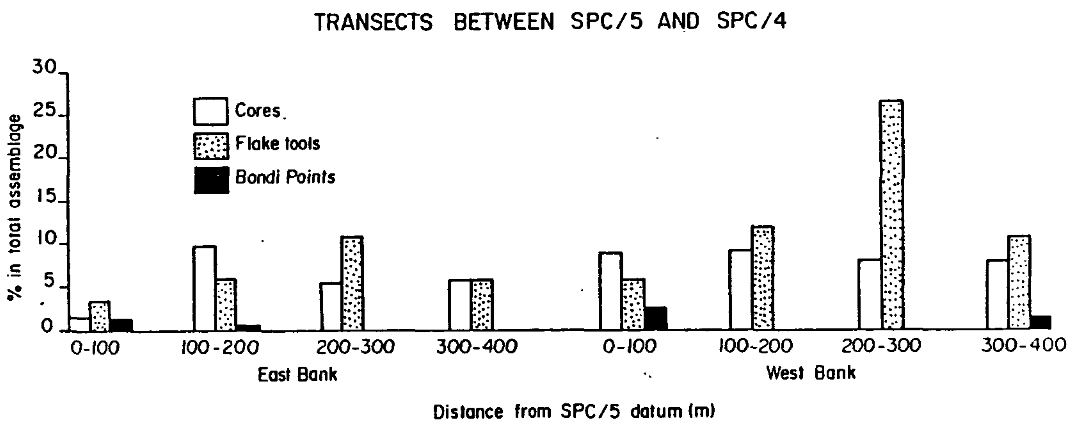


FIGURE 8.5. Second Ponds Creek complex: proportions of cores, flake tools and Bondi points between sites SPC/5 and SPC/4.

Bondi points again show a narrow distribution, nowhere exceeding more than 3% of the total stone assemblage. On the east bank, only a single Bondi point was found more than 35 metres away from site SPC/5. On the west bank, the Bondi points were not found between 100 metres and 300 metres from the datum, but did occur as the major concentrations were approached. Because of the low frequency of Bondi points overall, their absence from the low density areas cannot be used to specify or limit any temporal range.

8.4. Excavation of SPC/5

Excavations were carried out on site SPC/5 with the following aims:

(1) to ascertain whether the site was a thin surface scatter or whether artefacts were buried at depth,

(2) in order better to understand the geomorphic processes operating on this site,

(3) to determine whether stratification occurred within the deposits, and if so did it correlate with changes in the stone tool assemblage,

(4) to obtain charcoal for radiocarbon dating.

All excavated material was seived through 5 mm mesh, the final fraction being wet seived. All stone artefacts were retained for later analysis, and sediment samples taken from each spit. Charcoal was obtained wherever possible for radiocarbon dating. Three squares 1 metre x 1 metre were excavated in different parts of the site. The location of the excavated squares is shown in Figure 8.6.

<u>Square A</u>

The first square excavated was designated square A. It was located in the southwest corner of square A in the 5 metre grid, 5 metres east of the creek bank and twelve metres from the present course of the creek. The surface consisted of the yellow clay so common over the site, with all of the silt having been eroded from the surface. Excavation was carried out in 5 cm spits, since no distinct changes in stratigraphy were evident. Artefacts were retricted to the surface and the top 1 cm of the deposit. Excavation continued to spit 4 (20 cm) over the entire square, and two further spits 30 cm x 30 cm were excavated in the southwest corner. The only observable change in the deposit was a slight increase in mottling with depth caused by the presence of patches of grey clay. The stratigraphy is shown in Figure 8.7a.

<u>Square B1</u>

The second square excavated was B1, in the southwest corner of square B1 in the 5 metre grid. It was selected for excavation because of the greater density of surface artefacts, and because there appeared to be a band of silt *in situ* sandwiched between two layers of the yellow clay. An erosion scar ran through the northern part of the square, exposing the yellow clay beneath the surface layer of silt. On the southern surface of the square, the clay appeared to cover the silt. The excavation of Spit 1 began by removing the top layer of clay until the silt was reached on the southern edge of the square. This top layer of clay was found to reach a maximum depth of 4.5 cm at the eastern edge of the square. Spit 2 followed the sloping level of contact between the top clay level and the silt. As the silt ranged in thickness from approximately 3 cm in the southwest corner to a maximum of 10 cm in the northwestern corner, it was excavated as a single unit, and excavated down to the sloping contact with the clay below. Part of the silt unit in the western part of the square was covered with a residual capping of clay, and the silt below this clay was removed as spit 2a. Spit 3 and Spit 4 were each 5 cm deep, and excavated into the clay below the silt. Both the clay above the silt and the clay below the silt were sterile, and all the artefacts recovered from the excavation came from the silt unit (Spit 2). The stratigraphy of Square B1 is shown in Figure 8.7b.

<u>Square C1</u>

In order to obtain a larger sample of stone and in the hope of finding a charcoal sample suitable for dating, square C1 was excavated in the southwest corner of square C1 in the five metre grid. The square appeared to contain a considerable depth of undisturbed silt, and the surface was covered with a matting of grass. It was also adjacent to the area where Bondi points had been located during the surface collections.

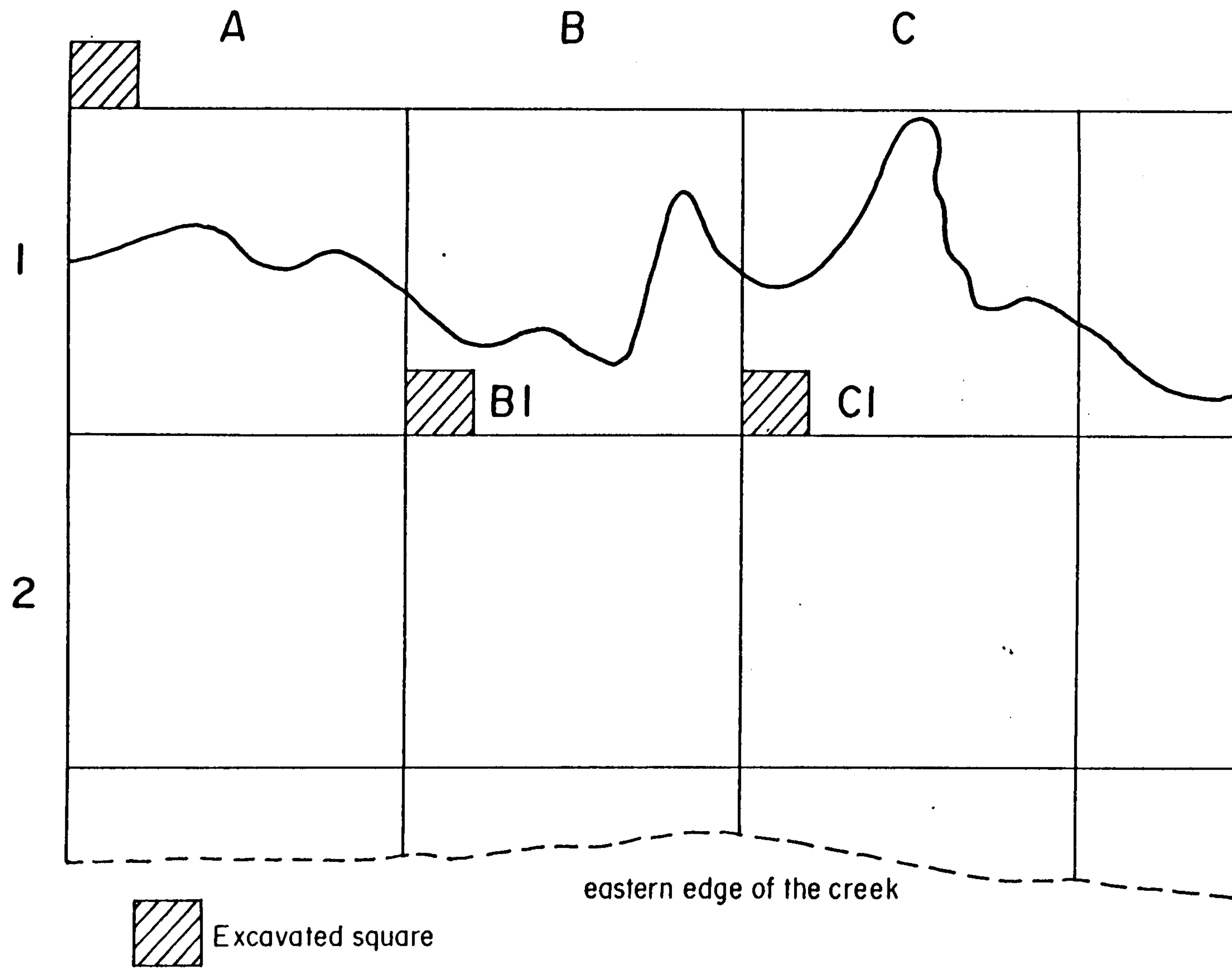
A steep erosion channel was present in the western half of the square, so the square was excavated in four separate 50 cm x

50 cm areas for tighter horizontal control. Excavation began with Spit 1 in the eastern side of the square, and the clay was reached only a few centimetres below the surface, but dropped off steeply towards the west (in the direction of the creek) where it reached a maximum depth of 30 cm below the surface. A series of 5 cm spits (spits 1-6) were removed, taken parallel with the original surface. Spit 7 continued to the contact with the clay. In the event this proved to be a wise decision, for the contact between the silt and the clay at the base of the silt unit was almost parallel to the original surface. Over two hundred stone artefacts were recovered from this square, including blade cores and backed blades. Charcoal was plentiful throughout the deposit, and a sample was collected from the southeast corner of spit 6 to be submitted for radiocarbon dating. The stratigraphy of square C1 is shown in Figure 8.7c.

Analysis

The stone artefact assemblage from the SPC/5 excavations are summarised in Tables 8.4 and 8.5. Excluding the surface finds, which were almost certainly eroded out from other parts of the site, the diagnostic artefacts from the excavated deposits are few. Of significance is the fact that artefact types normally associated with the typical *Bondaian* industry were retricted to spits 4-7. No blade cores, Bondi points or other microlithic forms were identified in spits 1-3.

FIGURE 8.6. Second Ponds Creek 5 SPC/5: plan of excavated squares.



A
B
C
1
2
B1
C1
eastern edge of the creek
Excavated square

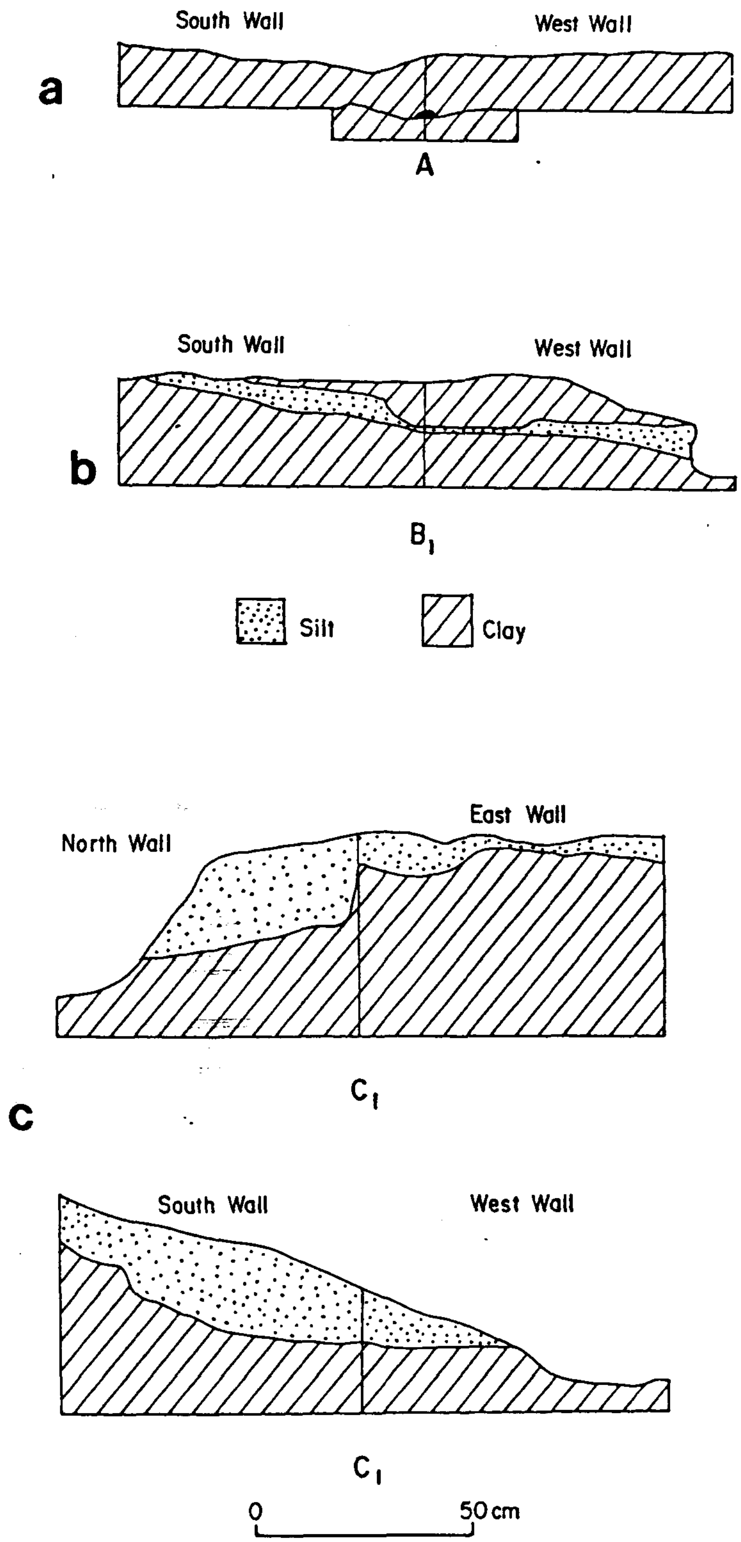


FIGURE 8.7. Site SPC/5: excavation

a: Stratigraphic sections of square A;

b: stratigraphic sections of square B1;

c: stratigraphic sections of square C1.

ARTEFACT TYPE	SQUARE B	SQUARE C SPIT NO. SURF	1	2	3	4	5	6	7	TOTAL
Core	1	-	-	-	1	-	-	-	-	2
Blade Core	1	-	-	-	-	1	-	1	1	4
Bondi Point	-	-	-	-	-	-	1	-	1	2
Utilised flake	-	-	-	-	-	1	-	-	-	1
Sharp retouch	-	1	-	-	-	-	-	-	-	1
TOTAL	2	1	-	-	1	2	1	1	2	10

Table 8.4. Diagnostic stone artefacts from the SPC/5 excavations.

RAW MATERIAL	SQ.A	SQ.B	SQUARE C SPIT NO. SURF	1	2	3	4	5	6	7	TOTAL
Chert	1	7	-	3	4	2	5	3	1	1	27
Silcrete	2	39	1	13	25	16	29	31	11	18	185
Quartz	-	10	1	3	2	4	7	10	3	4	44
Quartzite	-	1	-	-	-	-	-	-	-	-	1
Basalt	-	1	-	-	-	-	-	-	-	-	1
Other *	-	2	1	-	-	1	2	5	1	-	12
TOTAL	3	59	3	19	31	22	43	49	16	23	270

* At this site all of the "other" material was silicified wood.

Table 8.5. Raw materials found in the debitage of the SPC/5 excavations.

The numbers of tools recovered during excavation is too small to draw many conclusions about the most recent industry at the site, but in view of the paucity of backed blades in the surface collection away from the deep deposits adjacent to square C, it seems likely that backed blades and microblade technology were absent during the most recent phase of occupation.

8.5. Discussion

The radiocarbon date obtained from spit 6 would appear to date a microblade industry on the site. The resulting date was 650 ± 100 yrs BP (SUA-2239), surprisingly late considering the fact that Bondi points are all but absent from coastal sites by *circa* 1000 years BP (Megaw, 1974). However, the late retention of backed blades in some non-coastal environments in eastern New South Wales is not uncommon (Moore, 1970; Stockton and Holland, 1974; McBryde, 1974; Flood, 1980). The assemblage excavated at SPC/5 must then be interpreted as belonging to the Late *Bondaian*, extending from sometime earlier than around 650 BP until probably the time of European contact. Unlike the Emu Plains sites, there is no evidence for occupation after European settlement of Australia. Perhaps this might be explained by the ethnographic accounts from this general area which indicate that smallpox drastically reduced the population prior to 1790 A.D.

The similarities between the surface assemblages on SPC/5 and the Jamisons Creek sites greatly outweigh the differences. However, some important differences do exist. The most obvious is undoubtedly the dominance of silcrete over chert as the most important raw material. This indicates that resources available in the immediate vicinity were used rather than cherts from the Nepean River, although chert, quartz, basalt and to a lesser extent quartzite were all present.

The frequency of uniface pebble tools is markedly different, with only a single pebble tool coming from the Second Ponds Creek complex. A detailed inspection of this artefact suggests that it is probably made from a discarded edge-ground hatchet head. This suggests that the presence of this tool type on a particular site may be correlated with the distance from a source of the raw material (in this case basalt pebbles). It is a truism that one does not find pebble tools if there are no pebbles. However, edge-ground hatchet heads were present in the site complex, and are not uncommon throughout the study area. Perhaps the uniface pebble tools were used for specific functions or activities not carried out at Second Ponds Creek. One such possible activity is the removing of bark from trees for canoes (Kohen, 1984b).

Another major difference is the paucity of bipolar/scalar pieces within the Second Ponds Creek complex. While this artefact type numbered in the hundreds at both Shaws Creek and Jamisons Creek, there were only 12 on SPC/5 and 16 overall. The correlation between quartz and bipolars was well established at both Nepean River sites, so it might be expected that the amount of quartz present on the Second Ponds Creek assemblages would be significantly lower. This is not the case when compared with the Jamisons Creek assemblage, although at around 7% it is substantially lower than the Late *Bondaian* at Shaws Creek. The dearth of bipolars cannot be explained on the grounds of low availability of raw materials, particularly since quartz is locally available within a few kilometres. Again it appears that whatever function bipolars served along the foot of the Blue

Mountains, they were not required at Second Ponds Creek. Alternatively, perhaps another artefact type substituted for the flakes which resulted from the bipolar reduction of quartz. If, as has been suggested, bipolar reduction was employed to produce small flakes for barbing spears (Lampert, 1971), the ethnographic data suggest that at least some death spears of the woods tribes were barbed with "red stone" (Hunter, 1793), and it seems almost certain that this stone was the local silcrete.

The varying percentages of specific artefact types between the dense artefact clusters suggest that the clusters represent stone reduction sites superimposed upon a background of discarded artefacts associated with a narrow range of activities. The increased importance of flake and blade tools indicates that woodworking may have occurred along the entire length of the creek. On the other hand, Bondi points are limited in their distribution to a few of the major clusters. Such variations may be due to temporal variability or the existence of specific activity areas using or manufacturing backed blades.

The assemblage at cluster SPC/6 deserves special mention. Although it contains far fewer artefacts than SPC/5, it is notable for the higher concentration of chert (25%) and the presence of four steeply retouched thick flake scrapers, all made of chert. The general pattern repeated on SPC/5 is that steep thick flake scrapers are almost exclusively made from chert. Either the characteristics of the raw material are particularly suited to the task requiring a steep thick flake scraper (presumably some kind of woodworking), or the chert tools may be associated with an earlier phase of occupation. Certainly the thick flake scrapers from SPC/6 would not look out of place amongst the *Capertian* assemblages of Shaws Creek or Lapstone Creek open site. The p/c/tf index of 50% also corresponds well with the 9000-4000 BP phase at Shaws Creek KII. However, the numbers of tools are again too few to make valid statistical comparisons. Since one of the characteristics of *Capertian* assemblages is small numbers of artefacts, the problem is likely to be encountered elsewhere.

The geomorphic evidence from the site presents additional evidence for a major change in the environment around the site probably within the last millennium. The formation of the silt, whether by alluvial or colluvial deposition, is indicative of increased removal of silt from the surrounding valley. The first evidence of Aboriginal activity along the creek corresponds with the deposition of the silt. The nature of the contact between the silt and the underlying clay suggests that an erosion phase preceded the deposition of the silt. Other valley fills in the Sydney area have been dated to the late Holocene (Hickin and Page, 1971), and it has been suggested that this late Holocene alluviation may be associated with increased Aboriginal burning (Hughes and Sullivan, 1981). If this is the case, the intensive use of the resources of Second Ponds Creek may be a relatively recent event. However, this does not preclude the possibility of an earlier occupancy of low intensity, having little impact on the depositional regime along the creek.

Plate 4. Second Ponds Creek site complex, adjacent to site SPC/5, facing south.

CHAPTER 9

OPEN SITE SURVEY RESULTS

9.1 Introduction

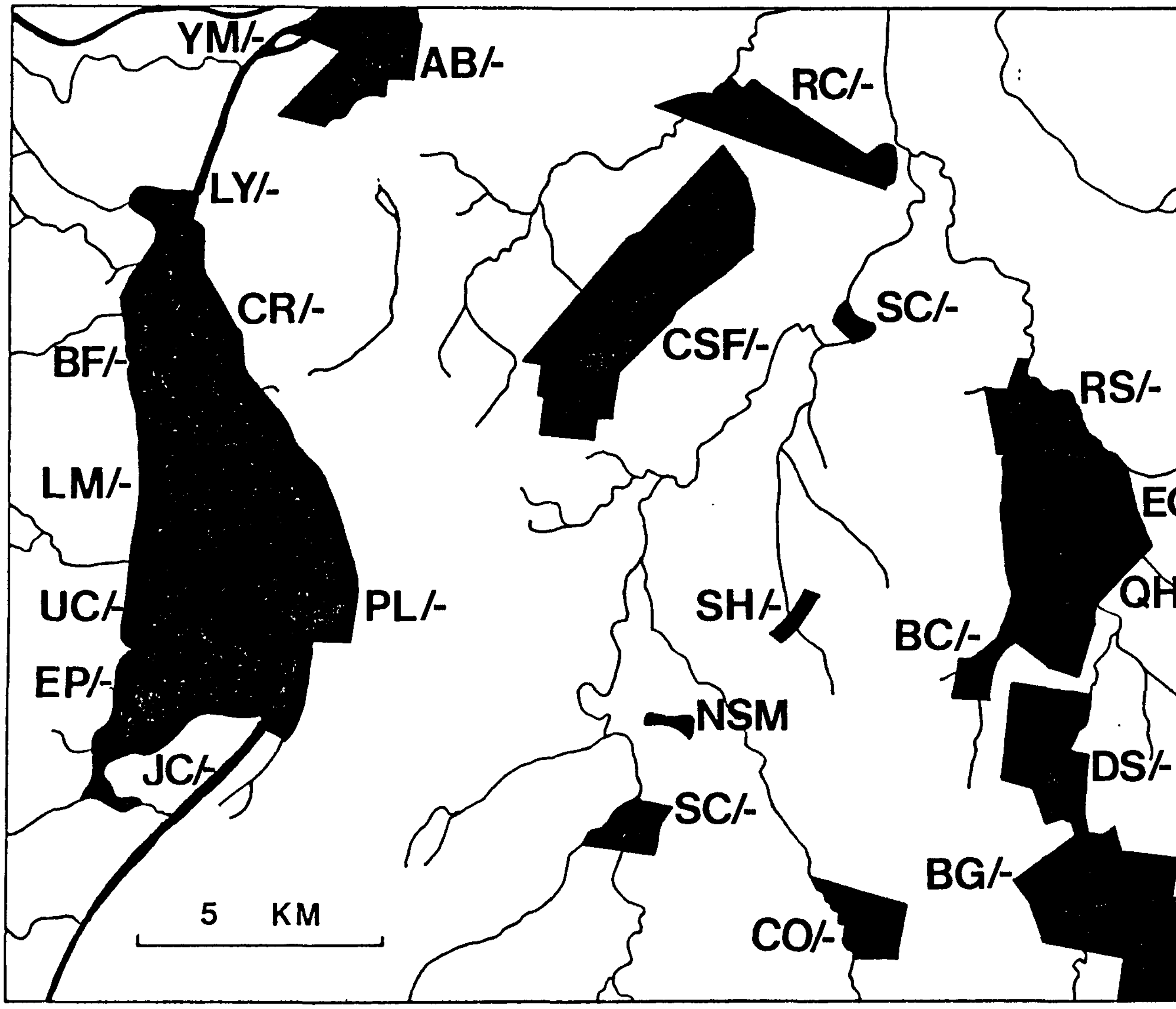
In addition to the sites and site complexes already discussed, the archaeological surveys produced another 209 locations where at least one stone artefact was found. For the sake of clarity, in future each of these locations shall be referred to as a "site". The locations of the areas surveyed are shown in Figure 9.1, and they were chosen after inspection of geological, vegetation and current land use maps of the study area. In addition, two aerial surveys were conducted from a light plane to identify potentially productive areas. Those localities finally chosen were selected because of their comparability and lack of major disturbance. For convenience, the artefact locations have been clustered into eight geographic groups.

Because artefacts are more likely to be exposed in some environments than others, quantitative data on site density or artefact density is almost meaningless. However, it is valid to consider the sites located as representing the range of variation likely to be found within each survey area.

9.2 Emu Plains Survey

In addition to the Jamisons Creek complex and the Lapstone Creek open site, five additional sites were located during the

FIGURE 9.1. The study area: location of intensive surveys.



LOCATION OF ARCHAEOLOGICAL SURVEYS

Emu Plains survey. These are shown in Figure 9.2a.

Jamisons Creek Site 2 (JC/2)

A small scatter was located on the north bank of Jamisons Creek downstream from the main site complex, and consisted of a few stone flakes and post-European materials.

Emu Plains (EP/-)

The low rise which links the western ends of the Lapstone Creek and Jamisons Creek sites was found to contain three artefact scatters. Although stone was present at these three sites, the majority of the material was of European origin, and dated to the mid-nineteenth century. From the nature of the glass and ceramic material present, and confirmation by local residents, the rise was the location for the campsite used by workers building the railway line over the Blue Mountains in the 1850's and 1860's. It would appear that the majority of the European materials post-date Aboriginal use of the sites.

An additional site was located on the western bank of the Nepean within the extensive gravel beds. The artefacts found were almost entirely pebble tools, consistent with McCarthy's (1948) description of the gravel beds as "surface workshops" for the production of pebble tools and hatchets. It is highly likely that this particular area has been subjected to intensive surface collection during the 1920's and 1930's, judging from the numbers of pebble tools labelled "Emu Plains" in the Australian Museum Collection and the many private collections within the area.

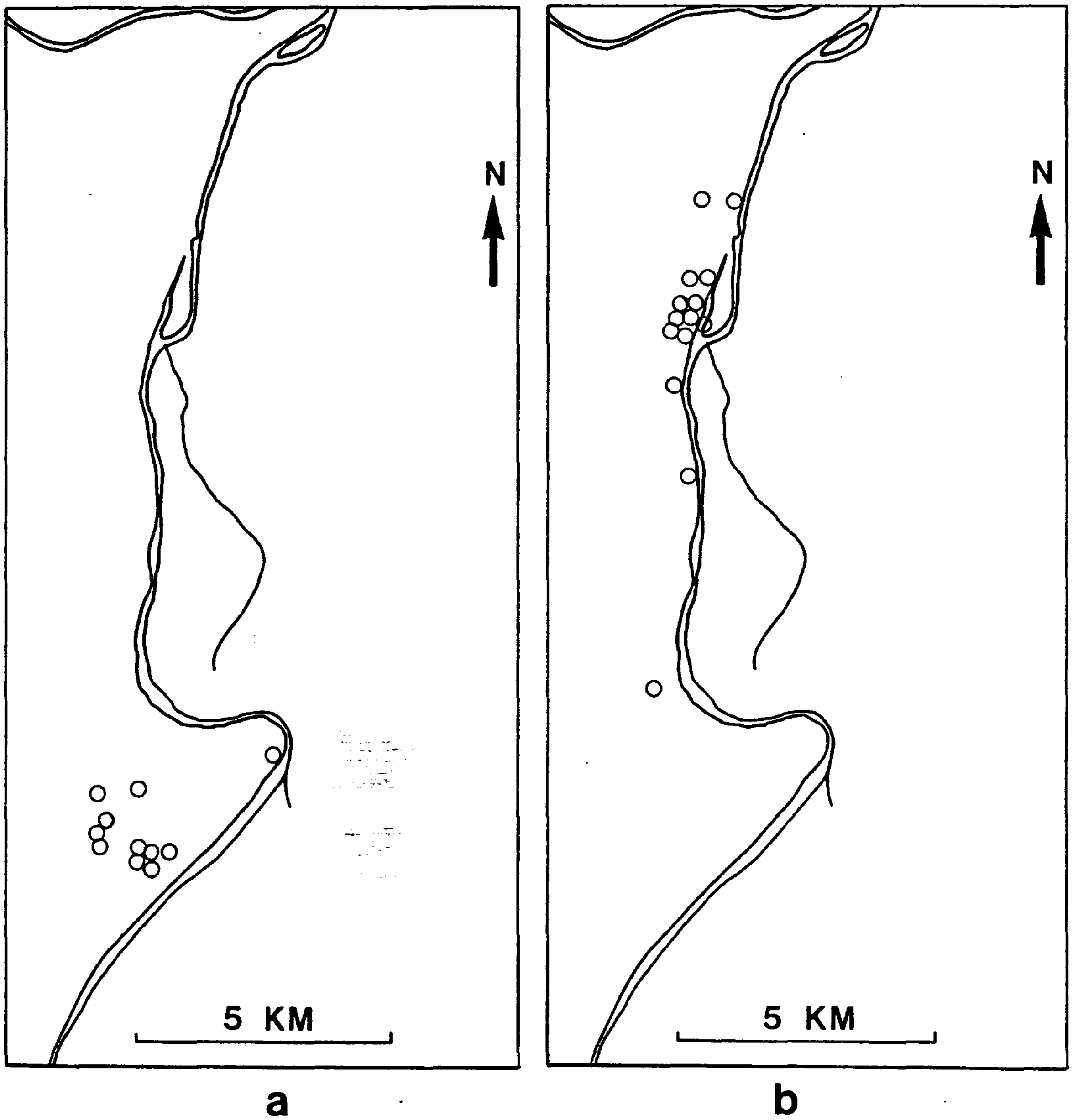


FIGURE 9.2. a: Emu Plains survey, location of sites.

b: Western bank of the Nepean River survey: location of sites.

9.3 Western bank of the Nepean River

The second area surveyed extended from the northern edge of Emu Plains along the foot of the Lapstone Monocline for a distance of ten kilometres. The steep sandstone country was heavily vegetated, resulting in particularly poor archaeological visibility. Using the standard survey methods, the firetrails and overhead transmission line service tracks were used as transects to conduct the surveys, with additional transects being surveyed through the vegetated zones wherever possible. The location of the sites is shown in Figure 9.2b.

Lapstone Monocline (LM/-)

This survey followed the firetrail which runs along the base of the Lapstone Monocline, within a few hundred metres of the Nepean River. Artefacts were rare from Emu Plains to Castlereagh, with only two isolated finds of edge-ground hatchet heads being located (LM/1 and LM/2) and a single quartz bipolar on the floor of the hand stencil art site (LM/3) described by McCarthy (1948). The paucity of finds is probably related to the low visibility, although there were several places where visibility was comparable to other survey areas which did contains substantial numbers of artefacts (e.g. Castlereagh State Forest).

Fire Trail (FT/-)

As the Castlereagh gravel beds were approached, two small artefact scatters were located on the fire trail which extends from the Springwood Road to the Nepean River. FT/1 contained a basalt uniface pebble tool and chert flakes, while FT/2 included a broken edge-ground hatchet head amongst a thin scatter of chert flakes.

Blacks Falls (BF/-)

A major site complex was located on the westen bank of the river overlooking Blacks Falls, so named because Aborigines were known to frequent this locality during the early nineteenth century. The "falls" is a gradual drop associated with a narrowing of the river where a remnant sandstone spur runs parallel with the eastern bank, one of the few places where sandstone is found on the eastern side of the Nepean/Hawkesbury between Emu Plains and Sackville. Blacks Falls marks the southern edge of the Castlereagh gravel beds. McCarthy (1948) reported the existence of a possible fishtrap at this location.

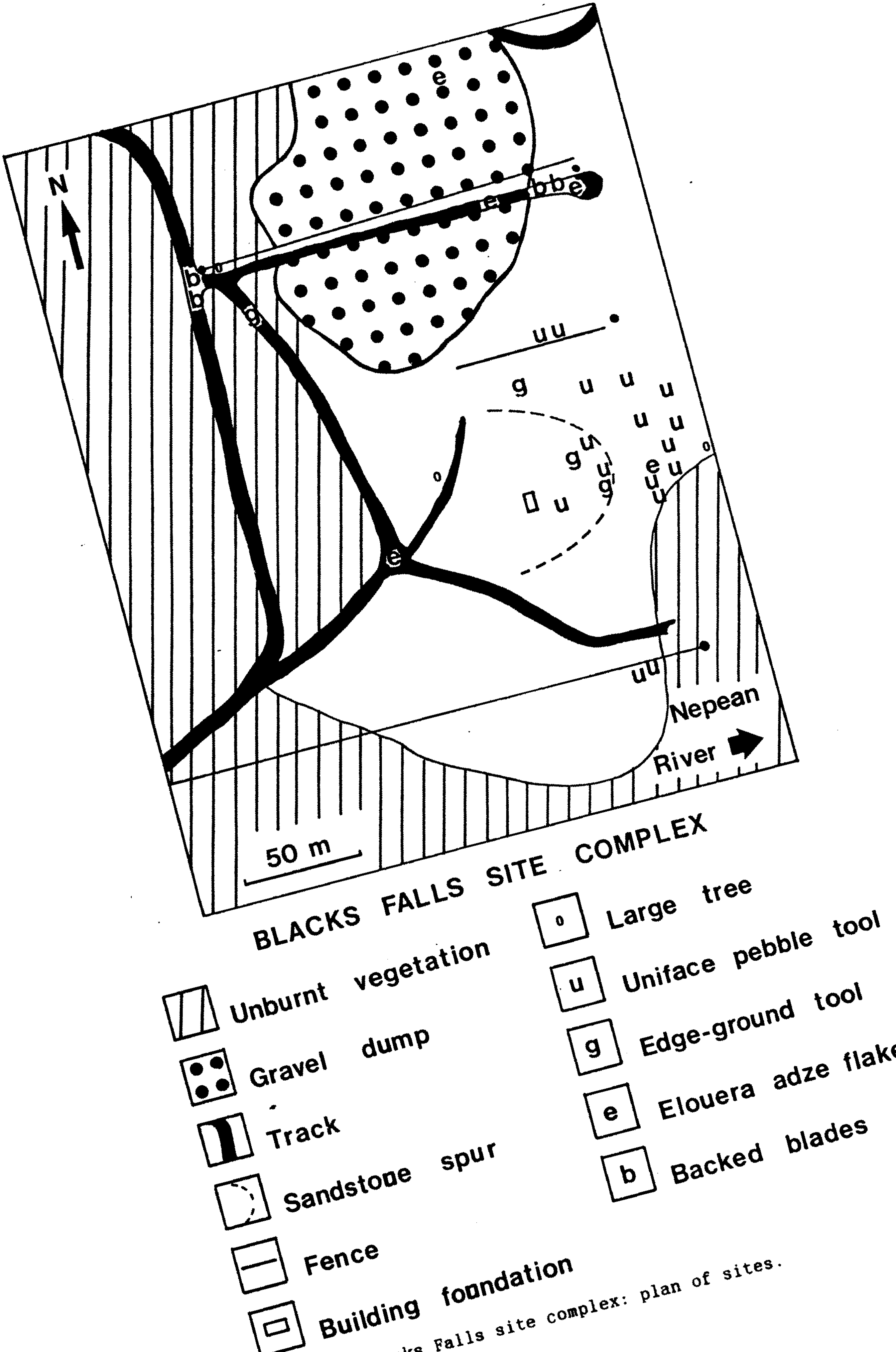
The Blacks Falls complex is a series of artefact scatters from the west bank of the Nepean up the slope to the foot of the escarpment, and extending over an area 300m x 300m. Individual scatters (coded BF/1-6) were collected separately, and within BF/1 two discrete clusters were also collected (BF/1A and BF/1B) (see Figure 9.3). A major activity on this site appears to have been the collection of basalt pebbles from the gravel beds at the foot of the river terrace for manufacture into uniface pebble tools and edge-ground hatchet heads, born out by the large numbers of basalt pebbles, pebble tools and flakes in the assemblage. The location of diagnostic implements was recorded, with backed blades being particularly rare (only five recovered).

There is some disturbance over the northern part of the site in the form of a gravel dump which obscures the ground to a depth of 1m in places. The area is partly cleared, and there are a number of firetrails in the immediate vicinity. One of these firetrails was gridded and systematic collections carried out to determine relative artefact concentrations on and off the exposed surface (BF/5). In addition, collections were carried out at six monthly intervals to measure the rate of artefact exposure. Initially 200 artefacts were collected over a 200 metre transect, followed by 52 more at the second collection and 190 at the third. This suggests that the rate of exposure is very great on these firetrails, and that the density of stone near the soil surface is high.

The area around sites KI and KII (KI/A, KII/A)

Collections were made on tracks and exposed areas around the two previously recorded rockshelter sites on Shaws Creek, KI and KII (coded KI/A and KII/A). The nature of the assemblages varied considerably.

KI rockshelter is located under a flat expanse of sandstone upon which are located a series of engravings. The motifs include a male and a female kangaroo and a series of engraved kangaroo tracks leading west across the rock (McCarthy, 1948). A fire trail and access tracks extend into the Blue Mountains to the south of the site, and a second track leads to the north from the first, finishing in a clearing beside Shaws Creek. The trails and a foot track leading from the shelter to the creek were found to



lacks Falls site complex: plan of sites.

have a considerable density of artefacts exposed on the surface. The assemblages included the full range of *Bondaian* artefacts (Bondi points, geometric microliths, elouera, quartz bipolars, thumbnail scrapers, edge-ground tools and amorphous flake tools).

Contrasting this assemblage, the artefacts found on the northern side of Shaws Creek within 200 metres of KII were predominantly uniface pebble tools, although chert cores and flakes were found on the surface above the shelter on the south side of the creek.

Lynchs Creek (LY/-)

Two sites were located on Lynchs Creek (LY/1, LY/2). One site was exposed on a foot track on the north side of the creek within a hundred metres of a single grinding groove. The only diagnostic artefact was an elouera. The second site was exposed on a rise within the grounds of "Yarrawood" conference centre, and included an edge-ground hatchet head and a heavily used chert elouera with extensive use-polish.

9.4. Collections on the Eastern Side of the Nepean River

This survey extended from Penrith north as far as Castlereagh, and from the bank of the Nepean east as far as and including the crest of the Cranebrook Escarpment. The surveyed area is intended for the proposed Penrith Lakes Development (Kohen, 1984a). The location of the sites is shown in Figure 9.4a.

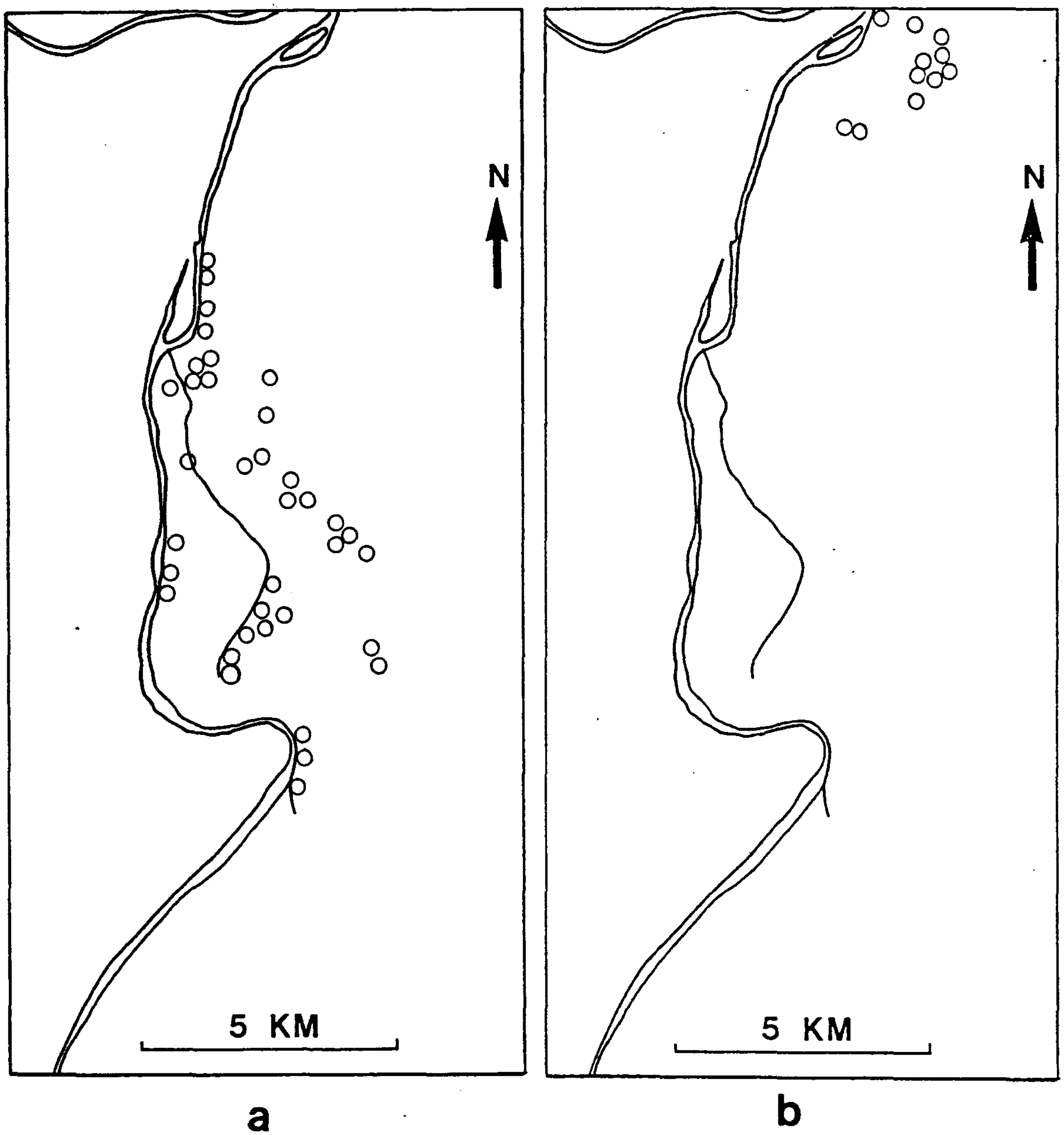


FIGURE 9.4. a: Eastern side of the Nepean River survey, location of sites.

b: Agnes Banks survey, location of sites.

Penrith (P/-)

A site was located eroding from the top one metre of the terrace formed by Peach Tree Creek immediately east of the Penrith weir. The only unusual artefact recovered was a finely made edge-trimmed point.

Castlereagh Sites (CR/-, CS/- and UC/-)

Five sites were located during a survey of the eastern bank of the Nepean River associated with the Castlereagh gravels. They are Castlereagh (CR/1-3), Castlereagh South (CS/1), and Upper Castlereagh (UC/1). Two of the sites (CR/1 and CS/1) are actually located on the gravel beds, and contain assemblages dominated by uniface pebble tools, pebble cores, thick flakes and edge-ground hatchet heads. The Upper Castlereagh site is located on the terrace overlooking the gravels, and includes a wider range of debitage than those on the gravels.

The other two sites are exposed by road cuttings. Smith Street at Castlereagh cuts through an old levee bank three hundred metres east of the river. Artefacts were found eroding from both sides of the road cutting over a distance of one hundred metres (CR/2). At the western end of Devlin Lane, on the terrace overlooking site CR/1, road-widening exposed an assemblage consisting primarily of flaked chert, although it included uniface pebble tools and backed blades (CR/3).

Penrith Lakes and Cranebrook Creek (PL/-, CC/-).

A total of 29 sites were located during this survey (PL/1-28, CC/1), ranging in size from isolated finds to extensive artefact scatters. Only 28 sites are included in the analysis, for one site (PL/27) was destroyed by housing development before a collection of the assemblage could be undertaken. Major sites were restricted to terraces and ridgetops, with three sites (PL/2, PL/7 and PL/26) each containing several hundred artefacts. Other sites were located close to Cranebrook Creek, which flows in a northwesterly direction across the floodplain.

The most unusual site was PL/25, where between 500 and 1000 grinding grooves were located on a sandstone outcrop beside the river two hundred metres north of Blacks Falls (McCarthy, 1948). An edge-ground hatchet, a bifacially flaked basalt pebble (hatchet blank?), a uniface pebble tool and a hammerstone were found at the rear of the outcrop or on the slope immediately above it.

A number of these sites contained shell, none of which was local. Two estuarine species, *Anadara trapezia* (Sydney cockle) and *Saccostrea commercialis* (Sydney Rock Oyster) were identified.

9.5 Agnes Banks

In view of the unusual geomorphic history of the Agnes Banks area with its Pleistocene aeolian deposits (Whittle, 1977;

Gobert, 1978), surveys were undertaken in selected areas extending east from the river (Kohen, 1984f). The location of the 11 sites located is shown in Figure 9.4b.

Yarramundi (YM/-)

Two sites were located between the river and Castlereagh Road. The gravel beds in the river adjacent to the Yarramundi Bridge contained pebble tools, cores and a hammerstone (YM/1), while the terrace on the eastern side of Yarramundi lagoon, exposed by a road cutting, also contained abundant flaked stone (YM/2). Within two metres of the eastern side of Castlereagh Road a complete edge-ground hatchet head was found lying on the surface. It appears that the road has actually cut through a major site, and only the remnants are now visible.

Agnes Banks (AB/-)

The Agnes Banks sand deposit was one area which certainly required survey. The sand units have been tentatively identified as Pliocene or Pleistocene in age (Whittle, 1977), the vegetation has been shown to be unique within the western Cumberland Plain (Benson, 1981a), and no archaeological sites were known from the area. The archaeological survey was carried out in two areas using the standard two hundred metre transect method. The environments within the survey areas range from dense vegetation to a sand mining stockpile. Most of the survey region consisted of cleared but not grossly disturbed land.

Stone artifacts were found at 9 locations during the survey, coded AB/1-9. Most of the finds were in isolation, including one steeply worked uniface pebble tool. The only substantial site was AB/5, located in an area which had been subjected to stockpiling and removal of sand. The majority of the artefacts were located on a vehicle track around the base of one such stockpile of soil. Because of the severe disturbance, these artefacts were collected together. Removal of sand adjacent to the stockpile had led to new erosion surfaces being formed. A total of 18 artefacts were collected separately from these freshly exposed surfaces, and labelled as AB/5A.

The dominant raw material at all sites was chert, the closest source being the gravel beds in the Nepean River approximately two kilometres to the west. The only unusual tools were four thick flake "scrapers" from AB/5A with invasive retouch on a sharp edge. Blade technology was evident only in a single silcrete blade fragment. The initial impression was that AB/5 was probably a late Holocene site, but the more detailed analysis of the collected artifacts suggests that an earlier occupation phase is also represented. The artifacts collected in the newly exposed areas (labelled AB/5A) consist largely of thick chert flakes and hammerstones. The high proportion of chert, high proportion of tools, high mean weight of flakes, almost total absence of blade technology, and fine invasive retouch on sharp edges of thick flakes all correspond to the patterns found in pre-*Bondaian* artefact assemblages in nearby Shaws Creek, where the assemblages are dated from before 13,000 BP to about 4000 BP when the

Bondaian industry becomes established. It seems likely therefore that at least part of the assemblage at AB/5 dates to a period prior to 4000 BP, but the site probably continued to be used after the microblade technology became established. There is certainly some mixing of materials after deflation and exposure.

The geomorphology of the sites at Agnes Banks is not well understood, but a late Pleistocene or early Holocene age for the near-surface sediments is indicated. This is consistent with the proposed interpretation of the sites.

9.6 Castlereagh State Forest and South Windsor

The unique combination of open woodland growing on Tertiary alluvium offered another range of resources which may have been exploited by the Aborigines. Surveys were therefore undertaken in and adjacent to Castlereagh State Forest. Sites located during these surveys are coded CSF/- (Castlereagh State Forest), RC/- (Rickabys Creek), or DH/- (Dharruk Training Institution).

Castlereagh State Forest (CSF/-)

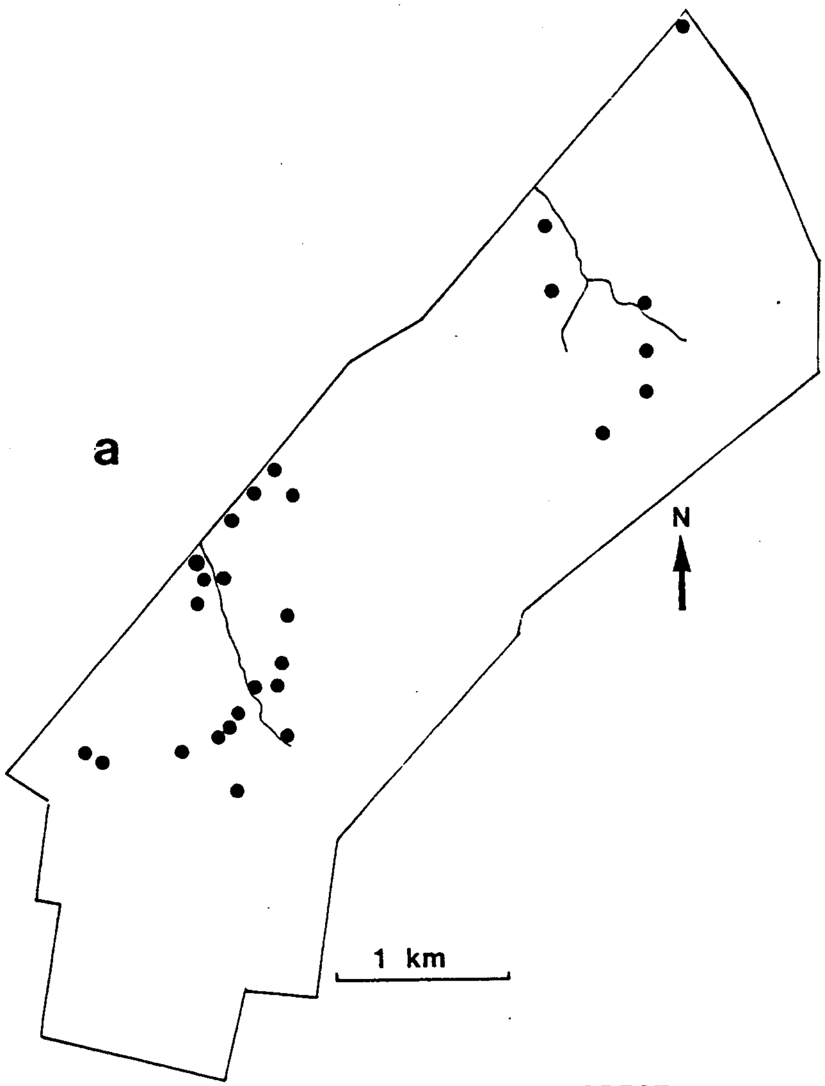
Castlereagh State Forest was selected partly because of its relatively undisturbed nature and partly because it lies between two major creeks: Rickabys Creek in the west and South Creek in the east. The soil is derived from alluvial deposits, and is usually a sandy loam with patches of clay loam. Quartzite gravels occur in places, but most of the raw materials for manufacturing stone tools would have to be carried in. The survey produced 26 sites, all small scatters of less than 50 flakes, concentrated along the waterways in the western part of the survey area. The eastern side has no permanent water and is dry for most of the year. Sites were coded CSF/1-26, and the location of the sites is shown in Figure 9.5a.

Because of the small numbers of artifacts found, gridded collections were not required. The area of each scatter was noted, and environmental parameters recorded. Particular attention was paid to the large number of plant foods present in the area.

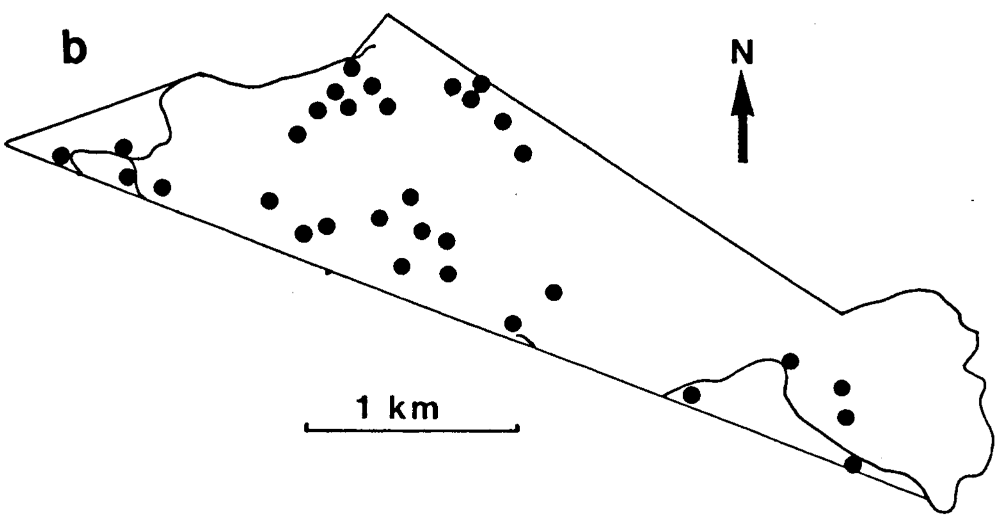
The only particularly unusual artefact was a flat slab of sandstone which was reconstructed from five fragments at site CSF/15. Cox (1875) describes portable slabs of sandstone carried by Aborigines in order to resharpen blunt edge-ground hatchets. The slab found at site CSF/15 is consistent with this interpretation. Other artefact types included backed blades, edge-ground tools and amorphous flake tools.

Rickabys Creek (RC/-)

This area extends from the western side of Rickabys Creek at Castlereagh to South Windsor and east as far as South Creek. The pattern of site distribution was similar to Castlereagh State Forest, with the vast majority of sites situated at the western and eastern extremities near the two major watercourses. Quartzite gravels again crop out, but most of the artefacts were made from silcrete, with chert, quartz and basalt (edge-ground



CASTLEREAGH STATE FOREST
SURVEY



RICKABYS CREEK SURVEY

FIGURE 9.5. a: Castlereagh State Forest Survey: location of sites.

b: Rickabys Creek survey: location of sites.

axes) also used. One site was identified as a probable quartz quarry. Tuberous plant foods were again plentiful. A total of 32 sites were identified, and were coded RC/1-32. The location of these sites is shown in Figure 9.5b.

The largest site RC/1 is on the terrace overlooking the western bank of Rickabys Creek, and is a thin scatter of flakes spread over a large area. Some notable implements include a large thick chert "scraper" with resin still adhering to the flat end opposite the working edge, and a series of silcrete adze flakes. Most of the other sites are small, only one other site having a large enough assemblage to detect any spatial patterning. This was RC/32, which had high concentrations of silcrete flakes, quartz bipolars and unworked quartz pebbles under each of three trees on the bank above a small stream which is a tributary of South Creek, at the eastern end of the survey area.

Dharruk (DH/1)

A single site was located near the junction of Richmond Road and Northern Road immediately adjacent to the Dharruk Training Centre. It location is shown in Figure 9.5a.

9.7 South Creek/Ropes Creek/Shalvey area

South Creek, the major waterway east of the Nepean River, proved to be difficult to survey. At the northern end of the study area, the visibility along the creek was exceedingly poor (Kohen, 1986), while in the south there is a great deal of disturbance. Because of the importance of such a large watercourse, limited surveys were conducted in three areas close to South Creek and Ropes Creek, which runs parallel to it. A total of six sites were located, and they are shown in Figure 9.6.

South Creek (SC/-)

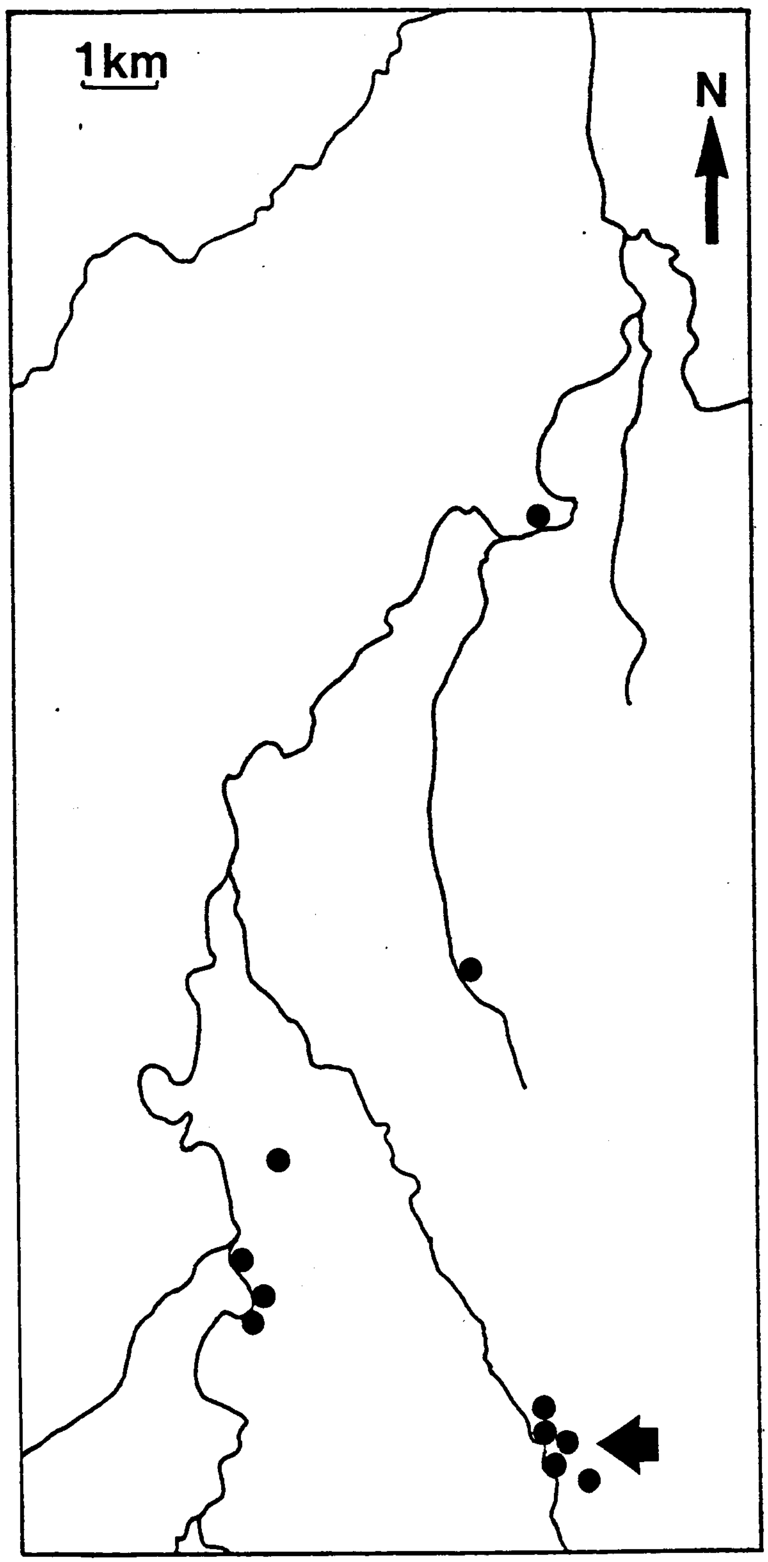
A site complex on South Creek between the Great Western Highway and the railway line was located. Two of these sites were badly disturbed by landscaping (SC/1 and SC/2), while another was exposed when a circus was located beside the creek (SC/6). An additional site (SC/5) was found at the point where Richmond Road crosses South Creek. Sites SC/3 and SC/4 were identified during an earlier survey (Koettig, 1980), but were not included in the analysis.

Shalvey (SH/-) and North St. Marys (NSM/-)

The Shalvey site (SH/1) is a small scatter of silcrete adjacent to a tributary of Ropes Creek at Shalvey. The assemblage included an elouera. Another small site was located associated with a silcrete outcrop at North St. Marys (NSM/1).

9.8 Eastern Creek/Riverstone/Schofields

The sites identified during these surveys are located around the major silcrete outcrop along and adjacent to the Plumpton Ridge. Figure 9.7 shows the location of the survey areas and the sites.



SOUTH CK./ROPES CK./SHALVEY

FIGURE 9.6. South Creek/Ropes Creek/Shalvey survey: location of sites. Colyton sites are indicated with an arrow.

Riverstone (RS/-)

This site complex is adjacent to Eastern Creek at the point where it is crossed by Garfield Road. Flaked stone, predominantly silcrete, is scattered over a wide area between the creek and a cemetery nearby. This site complex appears to be a continuation of the extended series of campsites located adjacent to Eastern Creek from the junction with South Creek at least as far as Prospect. Silcrete boulders are found *in situ* in the gravels exposed in the terraces along the creek at this point. Collections were made at five locations (RS/1-5).

At site RS/3, artefacts were found eroding from a terrace adjacent to Eastern Creek. They included several thick flake chert tools with heavy patination. At least two of these artefacts were *in situ* at a depth of 20 cm below the surface.

Between this site and RS/1, a mature eucalypt tree was located bearing a large symmetrical scar which may have been the result of Aborigines removing bark for a container or a shield.

Eastern Creek (EC/-)

This area lies northeast of the Plumpton Ridge which has been shown to contain large concentrations of flaked stone, particularly silcrete which occurs naturally on the ridgetop. Two sites (EC/1 and EC/2) were located on the western side of Eastern Creek on the eastern slope of the Plumpton Ridge. Schofields aerodrome lies immediately to the east of Eastern Creek, and surveys there produced four scatters of artefacts in the grossly disturbed environs of the runways. The concentrations were greatest near what were previously small creeks feeding into Eastern Creek, most of which are now open drains. Although the scatter may well have been continuous, four separate collections were made (EC/3-6).

Bells Creek (BC/-)

Bells Creek flows to the west of the Plumpton Ridge, eventually joining Eastern Creek at Riverstone. Three small sites were located beside Bells Creek (BC/1-3), two of which were near the point where it is crossed by Richmond Road. The third site (BC/3) was situated at the extreme western end of the Plumpton Ridge overlooking Bells Creek. The site had been exposed by ploughing, and several edge-ground hatchet heads had been turned up in addition to silcrete artefacts.

The area around BC/1 and BC/2 has great historical significance, for it was on Bells Creek that the Native Institution was set up in 1823 to educate the Sydney Aborigines (Brook, 1983; Brook and Kohen, in prep.). Prior to this, adjoining land had been granted to Nurragingy, the "Chief of the South Creek Tribe", by Governor Macquarie in 1816, and presumably the location of the grant was selected by Nurragingy.

In addition to the Native Institution building foundations, another contact site has been identified on the north side of Bells Creek. Bickford (1981) believes that this was the location of Aboriginal families moved into the area by Governor Macquarie in 1819. The contact site contained ceramic and glass similar to the materials found on the sites at Lapstone Creek and Jamisons Creek.

Southeast Plumpton (SEP/-)

This area runs parallel to and extends west from Eastern Creek. A total of ten sites were located, most of which were isolated finds or small scatters (SEP/1-10). The sites can be conveniently divided into two categories; the small sites and isolated finds scattered over the majority of the area, and the cluster of sites near the southern end of the study area. This site complex probably represents what was originally a single continuous site extending from Eastern Creek to the top of the low ridge in the southeastern corner of the study area.

This is the only location where a regular supply of water and a moderately sized ridge occur together. Scarred trees were present across the ridgetop and along the creek. Although there is no way to be certain that scars identified on the large eucalypts and on one *Casuarina* beside the creek were in fact made by Aboriginal people, the localised occurrence of the scars in association with such a wide scatter of flaked stone is strong circumstantial evidence. These trees are similar to the scarred tree which was found near the Riverstone site complex.

Quakers Hill (QH/-)

The Plumpton Ridge has been identified as a source of silcrete on the basis of the extensive outcrops and the intensity of sites in the vicinity. One such site, coded QH/1 (Quakers Hill 1), is named after the adjoining suburb, and extends along the ridgetop from a point north of Bells Creek to the eastern extremity of the ridge near Eastern Creek. A collection was made on a vehicle track across part of the ridge, and the raw materials included small amounts of chert, quartz and basalt in addition to the dominant silcrete.

Information was obtained from John Lawson of Rooty Hill regarding Aboriginal use of the Plumpton Ridge. Mr. Lawson's father was a doctor at Rooty Hill around the turn of the century, and he treated most of the local Aboriginal families. He was told that the ridge was used as a winter campsite, and was also told that the rocks on the ridge were important to the traditional owners, confirming the significance of the ridge as a source of silcrete at the time of European contact.

Schofields (SF/-)

Three small sites were located to the north of Schofields aerodrome (SF/1-3). The most unusual artefact was an isolated find of a 40 cm long cylindrical pebble of unknown (but not local) material, flaked and/or pecked unifacially on one end, and retaining traces of red ochre (SF/3). It is possible that this is a ritual object.

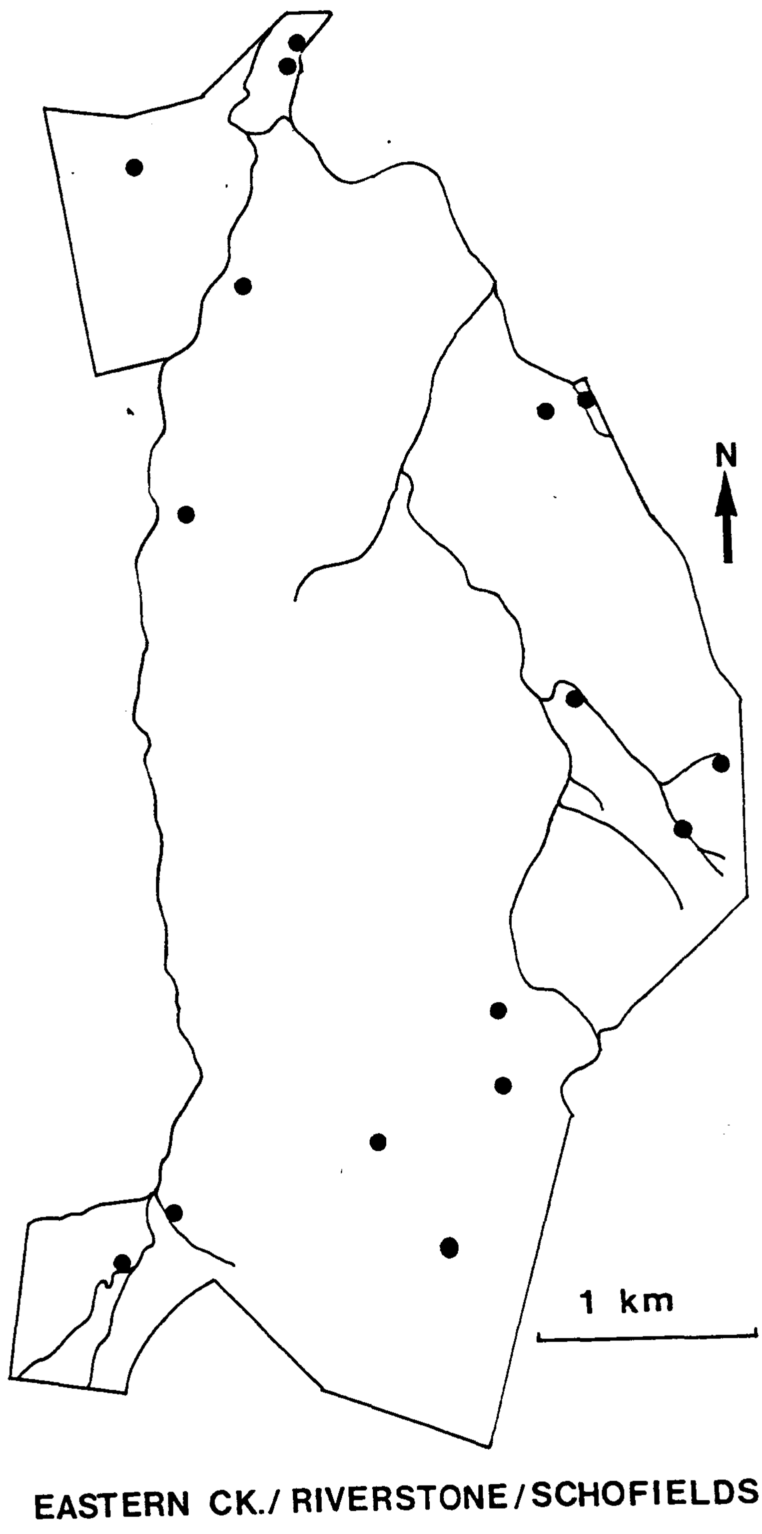


FIGURE 9.7. Eastern Creek/Riverstone/Schofields survey: location of sites.

9.9. Doonside/Blacktown

This survey area extends between Ropes Creek at Colyton and Prospect, and covers the southeastern corner of the study area. It is continuous with the southeastern corner of the Southeast Plumpton survey area, and includes Eastern Creek at Doonside.

Bungarribee (BG/-)

The survey area is centred on Eastern Creek in the region of the original Bungarribee Estate, named after the local Dharug word for the region. It is probably derived from the words *bung* or *bong* meaning water, and *gurra* meaning camp (Kohen, 1984c). At the present time, the western part of the area is occupied by an Overseas Telecommunication station (OTC), while to the east adjacent land includes Bungarribee Hill. Both Eastern Creek and Bungarribee Creek cross the OTC property. The manager, Mr. Eric Norris, gave his permission for the surveys to be conducted.

Stone artefacts were found at a total of 23 locations (BG/1-23). None of the sites were large, and silcrete was the dominant material. A broken edge ground hatchet head was found near the crest of Bungarribee Hill (BG/4). The location of the sites is shown in Figure 9.8a.

Rooty Hill (RH/-)

A site was identified on the western side of Rooty Hill, near the extreme northwest corner of the Bungarribee survey. Two edge-ground hatchet heads had been located by a local resident, and

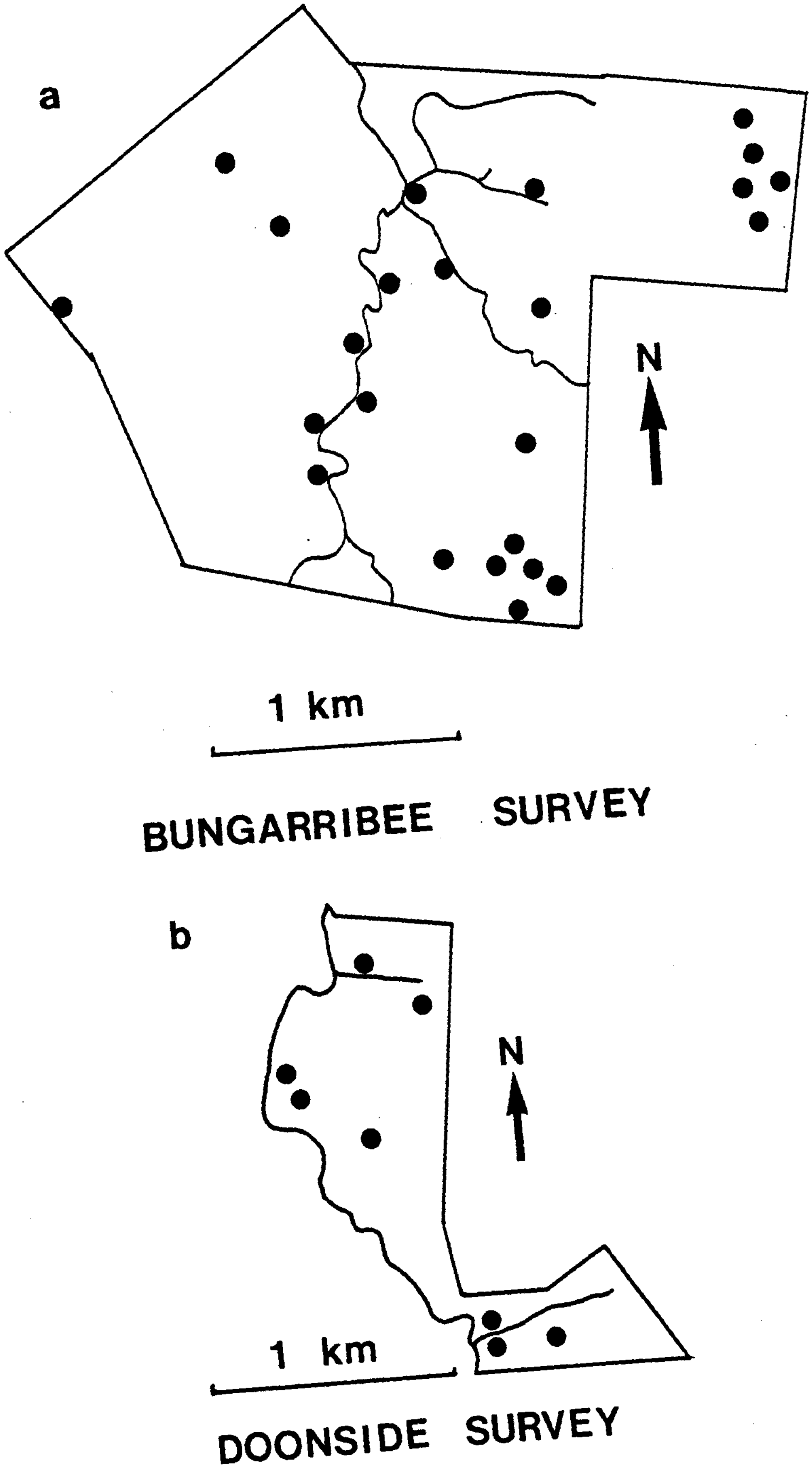


FIGURE 9.8. a: Bungarribee survey: location of sites.

b: Doonside survey: location of sites.

additional silcrete and quartz flakes were found. One of the hatchet heads is unusual in that it is made from what is apparently a local metamorphic rock derived from the Minchinbury Sandstone layers found adjacent to the Prospect and Rooty Hill doleritic intrusions. The location of site RH/1 is shown in Figure 9.8a.

Doonside (DS/-)

This site complex lies immediately to the north of the Bungarribee complex, and extends along the eastern side of Eastern Creek. Ten sites were located (DS/1-10). A sporting complex, Kareela Reserve, separates the two sections of this complex, but it appears that there was a continuous cluster of sites adjacent to the creek. The failure to locate other sites in this area is almost certainly due to poor archaeological visibility. Sites DS/4 and DS/5 were exposed when the Metroplitan Water, Sewerage and Drainage Board ran a pipeline parallel with Eastern Creek. The site locations are shown in Figure 9.8b.

Blacktown (BT/-)

A single site was located in a reserve to the northeast of the Bungarribee survey. It consisted primarily of silcrete debitage, although a wide range of tool types were also present. Its location is shown in Figure 9.8a.

South Blacktown (SB/-)

The area surveyed extends east from the Bungarribee survey, and is rather unusual because of the low availability of water in prehistoric times. There is no waterway of any significance present in this area, so if water is an important factor in site selection, one would expect that there would not be any large sites found. However several sites were found closely associated with the two ridgetops in the southwestern corner of survey. A total of ten sites was located (SB/1-10), and their location is shown in Figure 9.9.

The artefacts located at these sites are too few to allow any conclusions to be drawn except in a most general sense. There was little evidence of any stone reduction taking place; rather it appears that the artefacts located were lost or discarded after use, confirmed by the fact that a large percentage of flakes showed signs of use. It must also be assumed that a ground basalt fragment found was detached from a hatchet head.

The extremely poor archaeological visibility in this survey unit contributed to the relatively small number of sites. The largest site (SB/8) was adjacent to a tributary of Bungarribee Creek. The large proportion of debitage (13 out of 14 artefacts) is suggestive of campsite rather than an activity site. It was interesting to note that the only stone tool from the site was made of an exotic chert.

Colyton (CO/-)

Five small sites were located during a survey at Colyton to the east of Ropes Creek (CO/1-5). The sites at Colyton again suggest

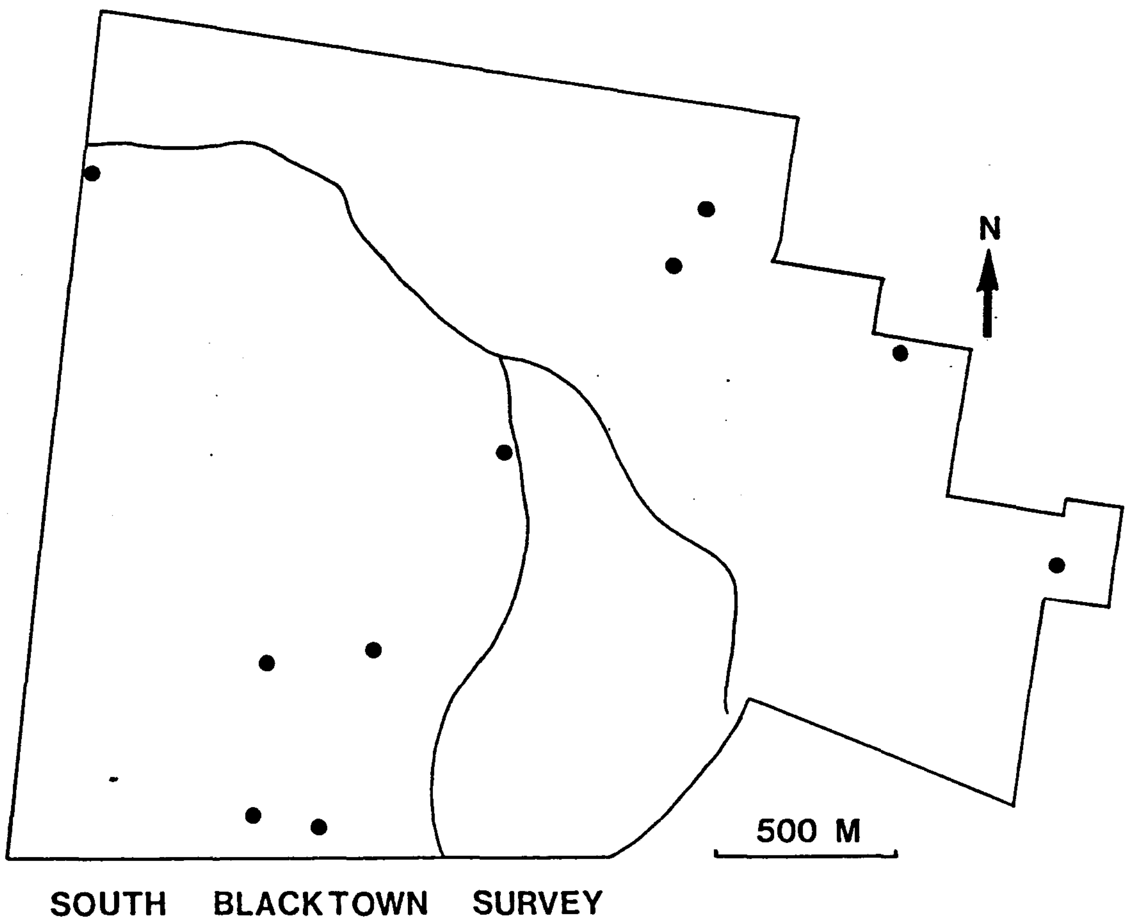


FIGURE 9.9. South Blacktown survey: location of sites.

that there exists a strong correlation between site location and proximity to water, where four of the five sites occurred within 100 metres of Ropes Creek. At any distance from the Creek, only small scatters and isolated finds were located. The location of the sites is arrowed in Figure 9.6.

9.10 Discussion

The patterns of Aboriginal land use across the study area may be summarised as follows:

1) Large campsites are clustered along the waterways, and in particular along the Nepean River and the larger creeks.

2). Ridgetops were frequently used, either for short-term visits during which task-specific activities were carried out using small numbers of tools (perhaps including butchering game, the repair of wooden artefacts or obtaining raw materials in the case of silcrete quarries), or for more permanent sites when water was locally available.

3). There are no environmental zones which show a total absence of Aboriginal activity. Isolated finds therefore may be expected throughout the area. Such finds will include edge-ground hatchet heads, discarded flakes and worn-out tools.

4). Raw materials for the manufacture of stone tools were obtained both in the form of silcrete (probably from Plumpton Ridge, although other outcrops also exist) and from the gravel beds of the Nepean River (chert, basalt, quartz and quartzite). There is a general eastwards increase in the percentage of silcrete in the assemblages.

In anticipation of the more detailed analysis to follow, it is clear that the general pattern to emerge is one of the widespread use of the resources to the east of the Nepean River after the advent of the *Bondaian* industry, and a greater reliance on immediately local resources in the recent past.

The patterns of site location identified during the surveys have been substantiated by other archaeologists carrying out consultancies within the study area. Brayshaw (1982), Dallas (1982a; 1982b; 1983; 1984), Dallas and Witter (1983), and Haglund (1980; 1983) have all identified sites within the City of Blacktown, while Rhoads (1984) has carried out an evaluation of archaeological resources in the City of Penrith.

Only 32 sites of the 222 open sites located during this study contain more than fifty artefacts, while sixty three are isolated finds. The majority of sites therefore contain between 2 and 50 stone artefacts, and should be categorised as minor sites. In subsequent analyses, these three classes of sites, major, minor and isolated finds, will be analysed separately. A full listing of the sites and the artefacts they contain is given in Appendix 2.

CHAPTER 10

STONE TOOL TECHNOLOGY AND ANALYSIS

10.1 Introduction

To understand the prehistory of the western Cumberland Plain, it is necessary to understand the distribution of the stone artefacts. The surface surveys and excavations provide a substantial database from which patterns in the archaeological record may be detected. This chapter therefore investigates the relationships between artefact types, and their relative distributions across the study area. The data gathered for each individual artefact were used to generate a new database containing a summary of the lithic assemblage from each site. The "analysis" database contained the total numbers of each artefact type found at each site. The following "types" were used for the computer analysis:

1. Manuport. This category includes any piece of stone which was not endemic to the site but which showed no signs of modification (unworked pebbles, block-fractured lumps of silcrete).

2. Chert debitage includes any flake or flake fragment made from chert which shows no evidence of use as a tool.

3. Silcrete debitage includes any flake or flake fragment made from silcrete which shows no evidence of use as a tool.

4. Quartz debitage includes any flake or flake fragment made from quartz which shows no evidence of use as a tool.

5. Quartzite debitage includes any flake or flake fragment which is made from quartzite which shows no evidence of use as a tool.

A large proportion of the quartzite was derived from pebbles.

6. <u>Basalt debitage</u> includes any flake or flake fragment made from basalt which shows no evidence of use as a tool. A large proportion of the basalt debitage was derived from pebbles.

7. <u>Other debitage</u> includes any flake or flake fragment made from any raw material other than the five identified above which shows no evidence of being used as a tool. Two raw materials represent the vast majority of this category, silicified wood and sandstone.

8. <u>Backed blade</u> includes any flake or flake fragment with evidence of backing, other than those identifiable as elouera. This category includes Bondi points, geometric microliths and tools with miscellaneous backing.

9. <u>Elouera</u> is defined as a backed artefact approximating the description given by McCarthy (1967).

10. <u>Uniface pebble tool</u> is an artefact made from a pebble which has been flaked from one surface only to produce a sharp edge (see Plate 5).

11. <u>Biface pebble tool</u> is an artefact made from a pebble which has been flaked bifacially. This category includes tools which may have functioned as biface choppers in addition to artefacts which are probably blanks for edge-ground hatchet heads.

12. <u>Edge-ground tool</u> includes tools or fragments of tools which show evidence of grinding to produce a sharp cutting edge. Hatchet heads, fragments of hatchet heads and edge-ground chisels constitute the majority of these artefacts (McCarthy, 1967).

13. <u>Hammer/anvil stones</u> are artefacts which show pitting or edge damage characteristic of use as a hammer or anvil.

14. Utilised normal flake includes any flake or flake fragment weighing less then 15 g which has fine edge-damage on at least one working edge consistent with having been caused by use as a tool rather than by intentional retouch.

15. Sharp normal flake includes any flake or flake fragment weighing less than 15 g which has been retouched and has an edge angle after retouch of less than 60 degrees.

16. Steep normal flake includes any flake or flake fragment weighing less than 15 g which has been retouched and has an edge angle after retouch of more than 60 degrees.

17. Thumbnail scraper includes any flake or flake fragment with maximum length and breadth less than 2cm, retouched around a discoid or semi-circular margin.

18. Utilised thick flake includes any flake or flake fragment weighing more than 15 g which has fine edge-damage on at least one working edge consistent with having been caused by use as a tool rather than by intentional retouch.

19. Sharp thick flake includes any flake or flake fragment weighing more than 15 g which has been retouched and has an edge-angle after retouch of less than 60 degrees (see Plate 6).

20. Steep thick flake is any flake or flake fragment weighing more than 15 g which has been retouched and has an edge-angle after retouch of more than 60 degrees (see Plate 6).

21. Core tool includes any core (see definition below) which has evidence of use or secondary retouch on at least one edge.

22. Core includes all artefacts from which flakes have been removed with the intention being to use the flakes as tools rather than the core. Pebble tools are excluded from this

category unless their morphology suggests that they could not have been used as a tool.

23. Bipolar/scalar piece includes those artefacts previously referred to as "fabricators" (McCarthy, 1967). They are cores or flakes which show crushing or scaling on at least two opposing margins, consistent with manufacture by a bipolar technique.

24. Total includes all stone artefacts and manuports located at the site.

The definitions used and the tool types recognised follow closely those used for the Shaws Creek KII analysis, with a few minor exceptions. I decided to combine the categories Bondi point, geometric microlith and miscellaneous backed artefact into a single group to facilitate rapid categorisation. The problems of defining Bondi points and geometric microliths have been frequently referred to in the literature (see Mulvaney (1975) and White and O'Connell (1982) for discussions and references), and since the aims of this project were not related to such typological questions, a single grouping was deemed adequate for what is almost certainly a single functional class of artefacts (Wieneke and White, 1973). In the event that a refinement of this category is required, the metrical attributes of individual artefacts would allow later re-analysis. Similarly all edge-ground artefacts have been classified together, since I share Dickson's belief that the technology of grinding is of greater significance than the individual form of the artefact produced (Dickson, 1981). This category includes flakes showing evidence of grinding as well as complete tools.

Plate 5. Uniface pebble tools recovered from the Lapstone Creek open site after disturbance (LC/1B).


5 cm

Plate 6. Thick flake scrapers, recovered from Lapstone Creek open site after disturbance (LC/1B).


1 cm

Another tool type which was recognised at Shaws Creek but which was not included in the final analysis was the category of "burin". While technological burins undoubtedly exist, they are not particularly common within the surface assemblages, and no artefact identified as posessing burin spalling showed any firm evidence of having actually functioned as a burin.

Perhaps a more significant difference between the analysis of flake tools at Shaws Creek KII and the surface sites is the decision to define thick flake tools on the basis of weight. The dichotomy between normal flakes and "chunky" flakes which was so apparent in the rock shelter excavation was also evident on the open sites. I decided that some quantitative measure was necessary. After examining the several hundred flake tools from KII and carrying out multivariate analysis using a range of BMDP statistical packages (Dixon, 1983), no significant clusters of attributes were detected. This failure to identify distinctive "types" of flake scrapers was not unexpected. The single most diagnostic feature was weight, which had a marked bimodal distribution; so this attribute, which is directly related to the linear dimensions of the artefact, was selected as the basis for division of the amorphous flake tools. The shape of the working edge on amorphous tools was not considered for the analysis. Within the *Capertian* units at Shaws Creek, these tools frequently exhibited multiple usage with varying shapes of the working edge. Although the proportions of concave and convex working edges varied through time, the differences were not sufficient to merit further division on the basis of shape.

The manufacturing data at Shaws Creek clearly showed that blades and faceted butts are almost exclusively related to the *Bondaian* industry, and correlate with other aspects of microblade manufacture. They were therefore not considered separately.

The other major difference which is apparent between excavated assemblages and surface site collections in general is the failure to collect the smallest fraction of the debitage from the surface sites. With the excavations, standardised mesh size and wet seiving of the final fraction ensure that the same size range of artefacts is collected. On the surface sites, the smaller chips are generally difficult to see except in extraordinary circumstances (Jamisons Creek site, after exposure to 100 km per hour winds during excavation, provided the perfect clean, flat surface for seeing every tiny chip). Usually the small chips are overlooked in the grass or are partly buried. In view of this fact, the surface collections were retricted to those artefacts which were at least 1 cm long. This has the effect of slightly increasing the tools/debitage ratio, but the proportions of the raw materials in the debitage are unlikely to be seriously affected.

10.2 Methods of Statistical Analysis

Because any investigation of a prehistoric site will usually involve multivariate observations (many variables for each observed case), the interrelations between variables or sites may not be easily recognised. Many statistical techniques are available for clustering the data in order to reduce it into manageable groups. For prehistoric sites these groups may represent spatial, temporal or activity aggregations, or combinations of these variables. Clusters of artefacts within sites may reveal associations between specific tool types, between raw materials, or between tool types and raw materials. Such analyses can be used to generate or to test models of prehistoric activities.

A number of different techniques can be employed to cluster sites and variables on the basis of the lithic assemblages present, with the selection of the technique dependent on the particular questions being asked of the data. A wide range of statistical techniques has been employed to analyse archaeological data (Brothwell and Higgs, 1969; Hodder and Orton, 1976; Clarke, 1977; Hodder, 1978; Orton, 1980; Bolviken et al., 1982). In general, it is possible to analyse the data in four ways:

1. Analysis of individual artefact types, attempting to identify relationships between artefacts and specific raw materials,
2. Analysis of associations between artefact types on the basis of the distribution across sites,
3. Analysis of site type on the basis of the size of the lithic assemblages, and
4. Analysis of associations between sites on the basis of the range of artefact types found on the sites.

Each of these approaches can be used to answer questions regarding artefact and site variability across the study area.

Correlation co-efficient matrix

A simple statistical technique which allows a test of associations between individual artefact types is the partial correlation co-efficient matrix. In theory, such a matrix generated on the basis of the variations in the stone artefact assemblages on sites may reflect temporal, spatial and functional variations. If two artefact types are highly correlated, it may indicate that there is some relationship between them, probably (but not necessarily) related to at least one of these three kinds of variability. Such correlation matrices can then be used for a range of more sophisticated techniques like principal component analysis, factor analysis and cluster analysis (see Orton (1980) for discussion and references; Dixon, 1983).

Some problems arise with generating a correlation co-efficient matrix from the western Cumberland Plain raw survey data. The first decision to be made is how much of the data is necessary. If data from all sites are used, the full range of variables may or may not be required. It is likely that a relatively small proportion of the recognised artefact types will significantly contribute to the variability of the assemblages. Additionally, because there are highly variable numbers of artefacts on each site (ranging from 1 to almost 10,000), the largest sites will have the greatest influence in determining the degree of correlation. The resulting variability in the standard errors associated with the artefact types on each site means that most standard statistical methods are not strictly applicable.

For this study, the inclusion of data from site JC/1 results in high correlations because of the absolute numbers of artefacts found on the site. In general such outliers are removed from the database before analysis.

The correlation co-efficient matrix is a useful tool assuming that the data are normally distributed, or at least approximate normal distributions. It has been used frequently in archaeological data analyses, sometimes for detecting associations between specific tool types, and occasionally for relating stone tools to other data. For instance, McBurney (1973) used a partial correlation matrix to relate faunal remains to the distribution of artefact types. Although such matrices may give a general indication of possible relationships, for most data they are statistically invalid, since they are based on the assumption that the population from which the data were drawn is normally distributed. Few sets of archaeological data satisfy this condition. The main value of correlation matrices is as a guide for alternative analyses.

<u>Rank correlation</u>

Because archaeological data are seldom normally distributed, the basic premise of correlation is rarely met. However it is possible to use non-parametric statistics by ranking the data to generate a rank correlation matrix. Spearmann and Kendall's rank correlation matrices are two methods which can be employed to identify associations with ranked data rather than raw data

(Dixon, 1983). Many of the clustering processes referred to earlier will also cluster data on the basis of a rank correlation matrix.

Presence/absence data

A further method of analysis is the use of presence/absence data to determine associations between sites or artefacts. A modification of this approach involves the technique of pattern analysis, using indices of similarity or dissimilarity (Williams, 1976; Sneath and Sokal, 1973). This method has previously been used within Australia with a degree of success. McBryde (1977) used an ordination program based on the Canberra metric similarity matrix to analyse site variability in the New England area of northern New South Wales. Other dissimilarity measures which are commonly used in the field of plant ecology are the Jaccard co-efficient, the Bray-Curtis measure, Euclidian distance and the Sorenson index. While these indices are generally based on presence-absence data, modified algorithms have been calculated based on numerical data.

Reducing data variance

Another simple method of overcoming the problem of large variance is to divide the sites into smaller groups containing similar numbers of artefacts. It is far more realistic to analyse all isolated finds separately from large scatters. For some of the analyses, I clustered the sites on the basis of artefact number, and used a minimum of fifty artefacts to designate a major site. From two to fifty artefacts were classified as a minor site, and isolated finds were analysed as a group. These three groups were then analysed independently.

10.3 Analysis of single artefact types

Backed blades

Backed blades were located at 37 sites in all major environmental zones across the study area with the exception of the Agnes Banks sand. They were particularly common on the three radiocarbon dated sites (Shaws Creek rock shelter, Jamisons Creek open site and Second Ponds Creek open site) and in the vicinity of the KI rock shelter on Shaws Creek, but in general were present in low numbers at other sites. Breakages were more common on open sites than in the rockshelter site, and while this is undoubtedly due in part to post-depositional disturbance, there does appear to be a greater proportion of pre-depositional breakages on the open sites. For sites other than the Jamisons Creek complex, 37% of all backed blades were broken. When the geometric microliths are excluded, this figure rises to 52%.

In order to test whether the there were any significant differences in the dimensions of the backed blades, one hundred unbroken backed blades were selected at random from the site KII excavation, and another 100 from the Jamisons Creek (JC/1) surface collection. Two sample T tests (for comparing means) and Mann-Whitney tests (two-sample rank test for comparison of medians) were carried out on the parameters of maximum length, width and thickness (Ryan et al., 1982). The results showed that significant differences occurred at the 5% level with the mean lengths (P= 0.008) and median lengths (P= 0.027). The backed blades at KII were significantly shorter (mean = 2.23) than at Jamisons Creek (mean = 2.53). No significant differences were detected between width and thickness.

The ratio of maximum length to maximum width is often used to discriminate between Bondi points and geometric microliths (Glover, 1969; Pearce, 1977), although Wieneke and White (1973) have argued that such metrical properties were incidental to function. This ratio was examined for the two samples, and was also found to be significant at the 5% level for means (P = 0.006) and medians (P = 0.018), the mean value for Shaws Creek being 2.9 while the correponding value for the Jamisons Creek backed blades was 3.3.

At the two sites, backed blades were made from both chert and silcrete, although chert dominated at both (74% at KII and 86% at JC/1). To see if the relative proportions of silcrete and chert varied significantly between the two sites, a X^2 test was carried out, and was shown to be significant at the 5% level (X^2 = 4.5, 1 degree of freedom).

In order to test whether the greater proportion of silcrete in the backed blades at the KII assemblage contributed to the lower mean length, the silcrete backed blades were analysed separately. In fact it was found that the mean length of silcrete backed blades at KII exceeded the overall mean (2.3 cm for silcrete compared with 2.2 cm overall), so the greater mean length at Jamisons Creek is not related to the lower proportion of chert.

Since the different proportions of raw materials used in the manufacture of backed blades do not appear to contribute to the variation in mean length, some other explanation must be sought. The significant result suggests that the two samples were not drawn from the same population. The populations may be different for spatial, functional, or temporal reasons. Since the sites are relatively close to each other in similar environmental settings, and since the varying proportions of raw materials did not contribute to the differences in mean length, the spatial variable can be eliminated. Also, there can be little doubt that the backed blades served the same functions on the two sites. This leaves the possibility that the differences are a function of temporal variability.

The time span of the backed blades at Shaws Creek KII begins after 4000 years ago but before 2250 years ago, and continued until at least 1500 years ago (the latest radiocarbon date for occupation at the site). At Jamisons Creek, the excavation showed that backed blades occur *in situ* after 4000 years BP, but that from 5 - 10 cm of deposit containing backed blades remained above this date. The surface assemblage is clearly younger than the underlying *Bondaian* deposits, and may represent deflation of materials exposed over a period of time shorter than the last 2000 years. If this is the case, the varying time spans of the two assemblages could well account for the differences in the mean lengths and length to width ratios of the backed blades. The corollary to this argument is that there was a shift over time away from the production of geometric microliths and short backed blades to the production of long thin blades with a high length to width ratio. At Shaws Creek, 23% (8 out of 37) of the backed blades within the squares used to identify the technological sequence were geometric microliths. On the Jamisons Creek site, the corresponding proportion was 7% (25 out of 344), while at the Lapstone Creek rock shelter site the percentage was less than 2% (3 out of 191) (McCarthy, 1978: 56).

This variation may also be a reflection of the lower breakage rates for shorter backed blades and geometric microliths. Longer blades are more likely to be broken under the intensive treadage in the cramped conditions of a rockshelter than on a more extensive open site. A range of Bondi points, geometric microliths, elouera and thumbnail scrapers, all typical of the *Bondaian* industry, are illustrated in Figure 10.1.

<u>Elouera adze flakes</u>

Elouera adze flakes were also found across the study area, although they were usually in low numbers at each site (see Figure 10.1).

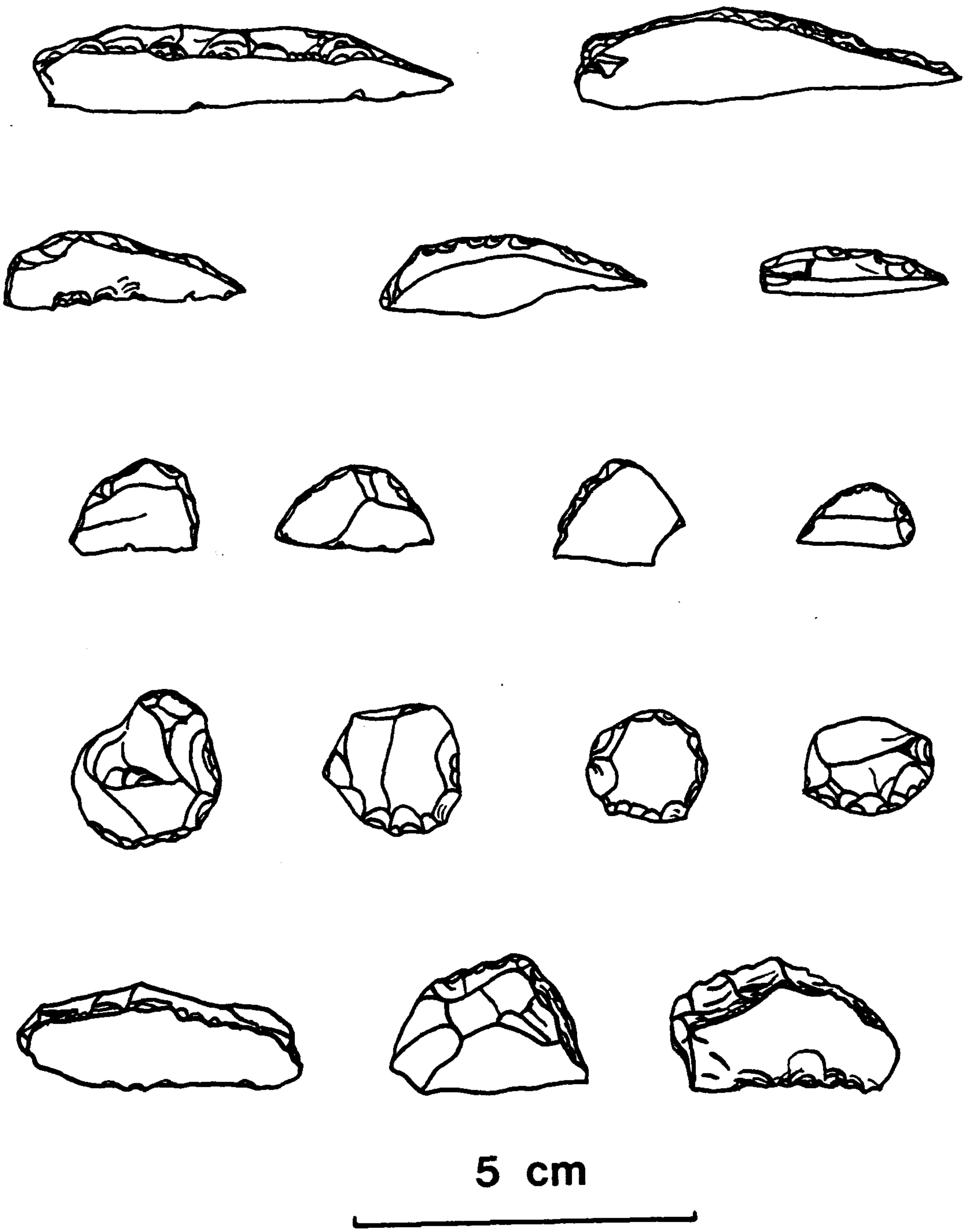


FIGURE 10.1. Stone tools typical of the Bondaian industry.

Top row	:	Large Bondi points (Jamisons Creek).
Second row	:	Medium Bondi points (Shaws Creek).
Third row	:	Geometric microliths (Shaws Creek).
Fourth row	:	Thumbnail scrapers (Jamisons Creek).
Fifth row	:	Elouera adze flakes (Jamisons Creek).

Normal flake tools

Normal flake tools, consisting of utilised flakes, sharp scrapers and steep scrapers, were also found distributed across the study area. This suggests that simple flake tools were a standard component of the stone assemblages in the western Cumberland Plain regardless of spatial, temporal or functional considerations.

Thick flake tools

Some interesting patterns emerged regarding the distribution of thick flake tools across the study area. While utilised thick flakes were common and widespread, sharp thick flakes appeared slightly more clustered in their distribution, and the steep thick flakes occurred on relatively few sites. In order to quantify this patterning, a correlation co-efficient matrix was generated comparing all stone tool types from all open sites (N=222). Figure 10.2 shows the relationship between the partial correlation co-efficients of the three categories of thick flake tool (utilised, sharp and steep) and seven other tool types (backed blades, elouera, edge-ground tools, utilised flakes, sharp flakes, steep flakes, and thumbnail scrapers). There is a remarkable uniformity within each thick flake type, with high correlations between the seven other tool types and utilised thick flakes (between 0.80 and 0.94), moderate correlations with sharp thick flakes (0.63 to 0.70), and low correlations with steep thick flakes (0.17 to 0.29).

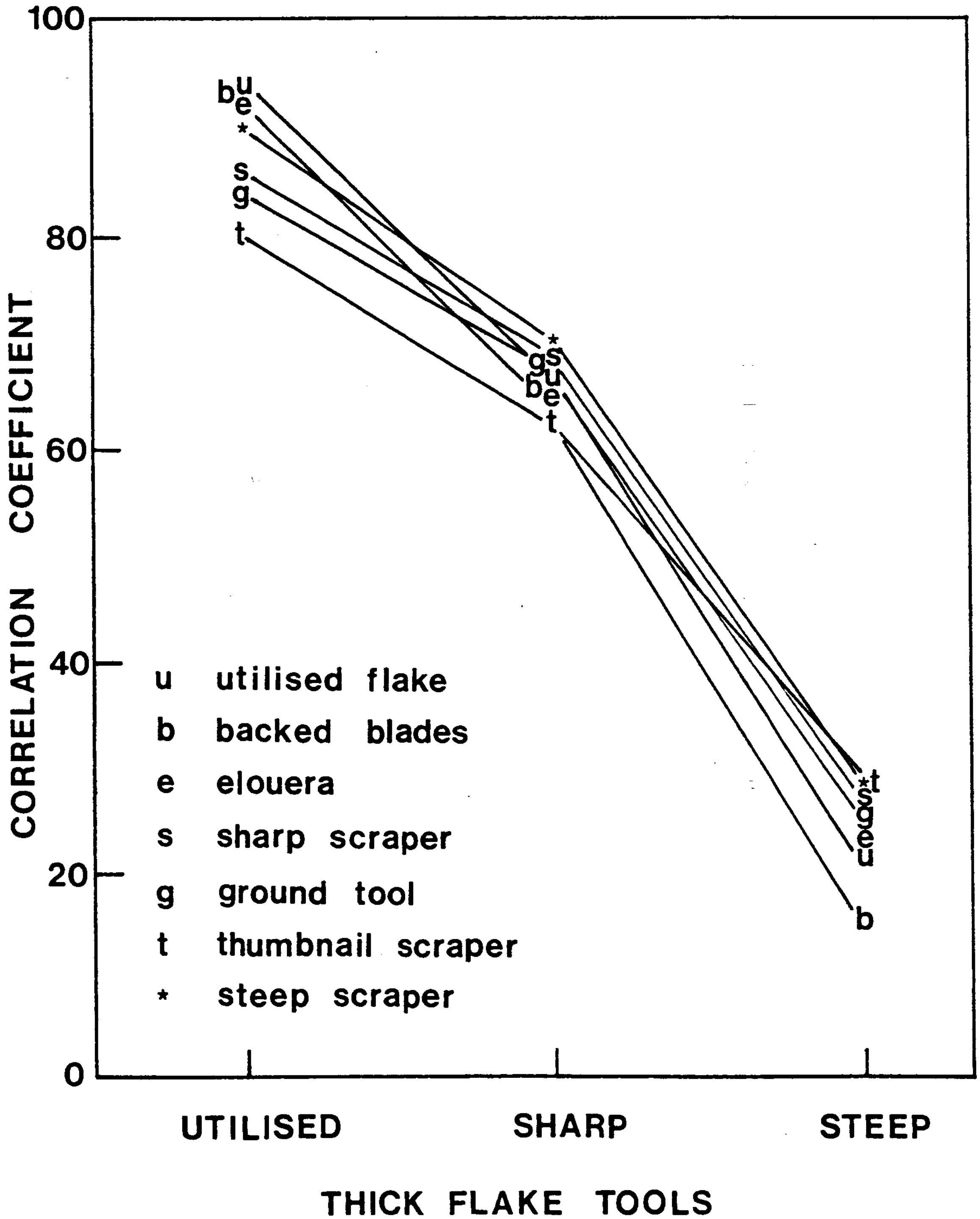


FIGURE 10.2. Partial correlation co-efficients of three categories of thick flake tools and seven other tool types.

This result may be interpreted in two ways. First there appears to be a degree of uniformity in the distributions of the seven specified artefact types relative to the distribution of thick flake tools. This is undoubtedly because the seven categories are all components of the *Bondaian* industry, and might reasonably be expected to be highly correlated with each other. The utilised thick flake tools also show a high correlation with this *Bondaian* assemblage, suggesting that utilised thick flakes were also a component of the *Bondaian* industry. From a functional viewpoint, the utilised thick flakes may well have served as knives, a functional type common in recent lithic assemblages throughout Australia and also recorded ethnographically (Hayden, 1979).

Sharp thick flake scrapers show a moderate correlation with the other *Bondaian* components, but it is likely that this general tool type, probably used for cutting and/or woodworking, is to be found in all assemblages regardless of age.

Steep thick flake scrapers show no significant correlation with the *Bondaian* tool types and are restricted to a relatively small number of sites. They are technologically similar to artefacts belonging to the *Capertian* phase at Shaws Creek KII as well as other pre-microlithic sites across Australia belonging to the Australian Core Tool and Scraper Tradition. Their presence on an open site within the study area may therefore indicate that occupation of that site may have begun prior to the introduction of the *Bondaian* industry between 3,000 and 4,000 years ago.

Edge-ground tools

Edge-ground tools were relatively common across the study area, and were found in all environmental zones surveyed. They were often found in isolation, suggesting that the discard pattern of this tool type was different from most flake and blade tools. This is consistent with the view that hatchets and other ground artefacts were "curated" tools, rather than simply being manufactured, used and discarded.

Although no direct evidence of hafting was forthcoming, a number of ground basalt pebbles had percussion pits on their two flat surfaces in positions strongly suggesting that a handle had been attached close to the end furthest removed from the ground edge (see Figure 10.3). Pitting was also common on the end of the pebble, suggesting hammer use.

Uniface pebble tools

The distribution of unifacially flaked pebble tools was distinctly clustered, with well over 90% being located within two kilometres of the Nepean River. Of those found at any distance from the river, two were apparently made on discarded broken hatchet heads, since traces of grinding remained near the flaked end. Use-polish was present on two end-flaked pebble tools, consistent with working bark or soft wood rather than use as a chopping tool.

Uniface pebble tools were found associated with a typical *Capertian* assemblage at Lapstone Creek LC/1B, with typically

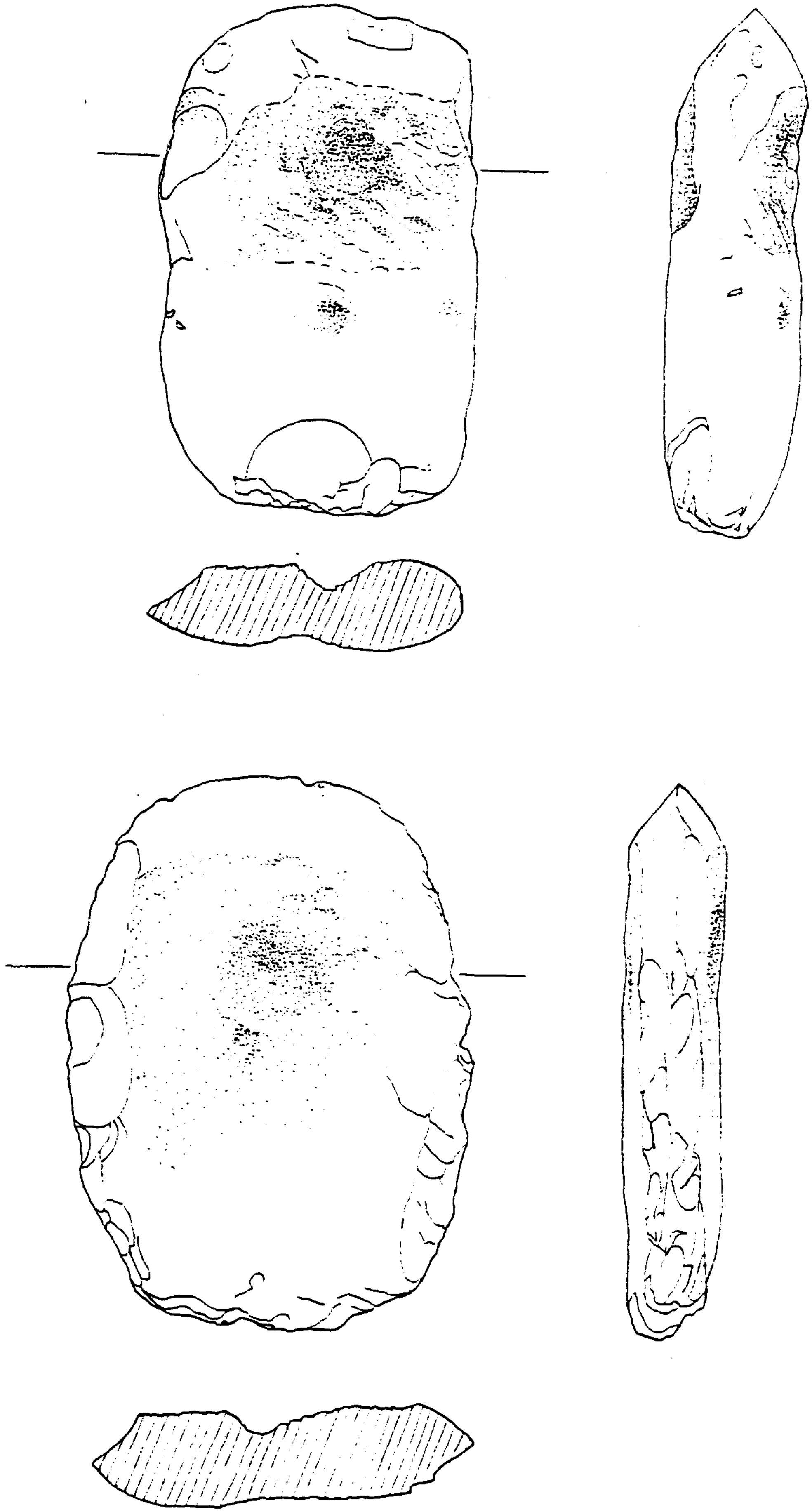


FIGURE 10.3. Edge-ground hatchet heads from Castlereagh South (CS/1). Note the presence of percussion pits.

Bondaian assemblages at Jamisons Creek JC/1 and Castlereagh CR/3, and some were found to have been made from broken edge-ground hatchet heads. Within the collections held by the Australian Museum and also private collections examined, a number of hatchet heads have been made by grinding a basalt pebble which has been unifacially flaked. In conjunction with the archaeological evidence from the New England District (McBryde, 1974), and ethnographic evidence from southern New South Wales (Flood, 1980), it seems certain that uniface pebble tools formed components of both the pre-microlithic and the microlithic industries in eastern Australia. Their spatial distribution across the western Cumberland Plain appears to be a function of proximity to the source of the raw material for their manufacture (basalt pebbles in the Nepean gravel beds).

Biface pebble tools

Biface pebble tools are not highly correlated with any other artefact type, and are restricted in their distribution to the vicinity of the Nepean River. Although a few appear to have been used as choppers, most show no edge-damage or even sharp edges suitable for chopper use. The bifacially flaked pebbles are probably a stage in the reduction process during the manufacture of hatchet heads, although incidental tool use may have occurred.

Thumbnail scrapers

Thumbnail scrapers are widespread across the study area, but are usually found on larger sites which contain backed blades. A correlation coefficient matrix generated with data from all sites except Jamisons Creek JC/1 and Second Ponds Creek 5 (excluded for reasons previously explained) shows that thumbnail scrapers are moderately correlated with steep scrapers (0.71), of which they form a sub-class, with backed blades (0.69) and with utilised flakes (0.69). While occasional thumbnail scrapers have been found in pre-microlithic assemblages, including Shaws Creek KII, they are primarily found on microlithic sites, often associated with Bondi points and geometric microliths. The association of thumbnail scrapers, backed blades and utilised flakes across the Cumberland Plain supports this proposal. Thumbnail scrapers are illustrated in Figure 10.1.

Hammerstone

Hammerstones are widespread, and are made almost exclusively from rounded quartzite pebbles. The quartzite is available in all three gravel deposits found within the study area. Across all sites, the hammerstones are highly correlated (>0.72) with all other tool types except uniface pebble tools (0.43), biface pebble tools (0.27) and steep thick flake scrapers (0.29).

Core tools

The unusual occurrence of core tools made on small cores and blade cores at Jamisons Creek JC/1 has already been discussed. The correlation matrix from all sites excluding JC/1 shows that core tools are moderately correlated only with sharp thick flake scrapers (0.63) and steep thick flake scrapers (0.63). This supports the view that core tools and thick flake tools are functionally similar, and probably woodworking tools.

Cores

Cores as a group were found right across the study area, and there was no significant correlation between cores and any other artefact type. Raw materials were almost exclusively chert or silcrete, and no significant difference was found in the relative proportions of these two raw materials and the type of core (single platform, multiple platform, blade core, etc).

Bipolars

Bipolar pieces were moderately correlated with four tool types: steep scrapers (0.88), backed blades (0.70), elouera (0.69), and utilised flakes (0.68). They were also correlated with quartz debitage (0.72), a fact which is not surprising since over 95% of all bipolars were made from quartz. The correlation with backed blades confirms the results from the Shaws Creek KII analysis, which also showed a high correlation between backed blades and bipolar pieces. However, the high correlation with steep scrapers is rather surprising. Steep scrapers, elouera adze flakes, backed blades and utilised flakes are all components of the *Bondaian* assemblages, so the preponderance of bipolars in late *Bondaian* assemblages is certainly confirmed.

10.4 Analysis of debitage

Raw materials

The analysis of raw materials is based on the debitage component of each assemblage; it is therefore used as a guide to the amount of reduction of that raw material occurring on each site rather than the total amount of the raw material present. For this analysis, sites JC/1 and SPC/5 have been excluded, leaving 220 sites for analysis.

The distribution of the six designated groups of raw materials showed a marked pattern of distribution across the sites. As might be expected, there was a general tendency for those sites near the Nepean River to contain predominantly chert, while those to the east across the Plain were dominated by silcrete. Figure 10.4 shows the trend for the larger sites to be dominated by either chert or silcrete, and this is clearly related to the distance from the source of the raw material. A partial correlation matrix was generated from the debitage data in order to identify any patterns in the distribution of raw materials. For the reasons previously stated, the two outliers (Jamisons Creek JC/1 and Second Ponds Creek SPC/5) were excluded from the calculations. The results are shown in Table 10.1.

	CHERT	SILCRETE	QUARTZ	QUARTZITE	BASALT
SILCRETE	0.14				
QUARTZ	**0.82**	0.14			
QUARTZITE	0.58	0.21	0.39		
BASALT	**0.66**	0.15	**0.73**	0.33	
OTHER	0.15	0.44	0.10	0.25	0.27

Table 10.1. Partial correlation coefficient matrix of debitage from western Cumberland Plain sites (sites JC/1 and SPC/5 excluded), N=220.

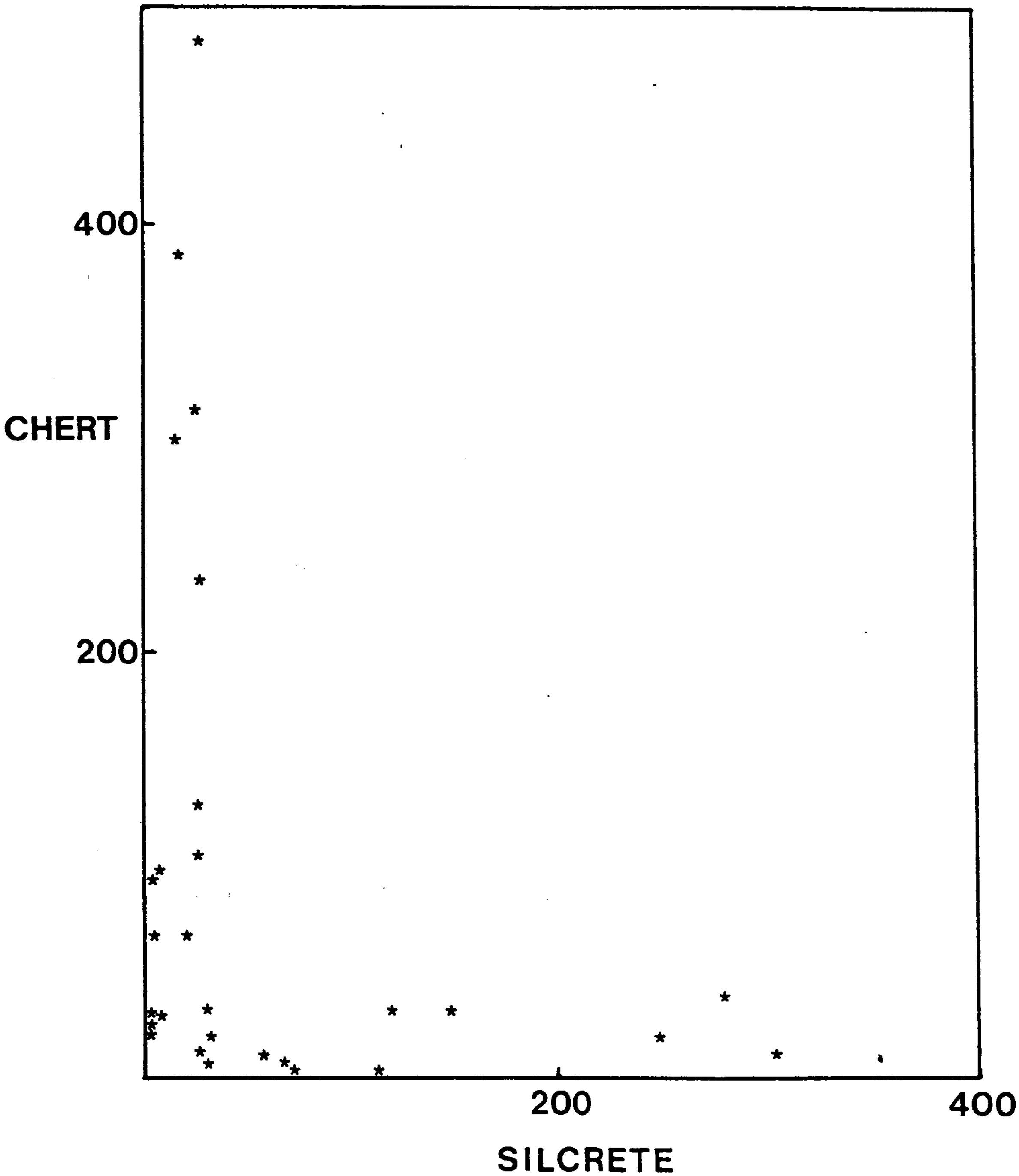


FIGURE 10.4. Relative numbers of chert and silcrete flakes on major sites within the study area.

It is apparent that correlations exists between chert and quartz, chert and basalt and quartz and basalt. This clearly reflects the fact that all three raw materials occur together, and were probably exploited together, albeit at different levels. The synchronous pattern which was detected in the distribution of chert and quartz between sites SPC/5 and SPC/4 on Second Ponds Creek is therefore a more general phenomenon across the study area, suggesting that the exploitation of quartz is unrelated to silcrete exploitation. The relationship between basalt and quartz detected in the upper levels of Shaws Creek rockshelter is also repeated across the entire study area.

Quartzite shows a slight correlation with chert, but this is not significant. Similarly, the category "other" is not strongly correlated with any other raw material.

10.5 Assemblages on major sites

In order to detect statistically reliable patterns in the data, a subset of the sites was used. This subset consisted of the thirty two sites containing at least 50 stone artefacts.

Correlation Co-efficient Matrix

A correlation coefficient matrix was generated on the basis of the 32 sites containing more than 50 artefacts. The results for the debitage are summarised in Table 10.2.

	CHERT	SILCRETE	QUARTZ	Q'ZITE	BASALT
SILCRETE	.52				
QUARTZ	.99	.55			
Q'ZITE	.99	.53	.98		
BASALT	.99	.51	.99	.98	
OTHER	.87	.81	.88	.88	.87

TABLE 10.2. Correlation coefficient matrix of debitage for different raw materials on major sites (N = 32).

The dichotomy between the chert and silcrete dominated sites is clear. High correlations exist between the proportions of chert, quartz, quartzite and basalt. The silcrete does not correlate significantly with any other variable, a reflection of the fact that the chert, quartz, quartzite and basalt are all derived from the Nepean gravels.

Stone tools

A second correlation matrix was generated for the stone tools located on the major sites (Table 10.3). It shows a high level of correlation between most of the stone tool types on the major sites. Three stone tool types are clearly divergent: uniface pebble tools, biface pebble tools, and steep thick flake scrapers. However, uniface and biface pebble tools are highly correlated with each other, suggesting that sites which contain uniface pebble tools will also contain biface pebble tools. This is a spatial relationship, with both artefact types being largely restricted to the Nepean River area, close to the source of basalt pebbles.

	BB	EL	UPT	BPT	EGD	HAM	UT	SH	ST	TN	UTTF	SHTF	STTF
EL	.96												
UPT	.49	.47											
BPT	.22	.19	.87										
EGD	.93	.88	.70	.48									
HAM	.91	.92	.48	.28	.89								
UT	.99	.97	.49	.21	.91	.90							
SH	.94	.96	.44	.21	.87	.95	.94						
ST	.95	.96	.48	.18	.88	.87	.97	.94					
TN	.87	.85	.41	.14	.75	.75	.88	.84	.91				
UTTF	.95	.90	.48	.19	.88	.85	.95	.87	.91	.81			
SHTF	.81	.76	.65	.39	.89	.79	.79	.77	.80	.68	.80		
STTF	.10	.09	.24	.01	.18	.12	.13	.07	.15	.13	.32	.36	
CT	.99	.96	.51	.22	.93	.90	.99	.92	.95	.84	.96	.83	.16

<u>KEY</u>

BB = backed blades EL = elouera UPT = uniface pebble tool
BPT = biface pebble tool EGD = edge-ground HA = hammerstone
UT = utilised flake SH = sharp scraper ST = steep scraper
TN = thumbnail scraper UTTF = utilised thick flake scraper
SHTF = sharp thick flake scraper STTF = steep thick flake scraper
CT = core tool

TABLE 10.3. Partial correlation coefficient matrix of stone tools from major sites (N = 32).

The distribution of steep thick flake scrapers presents a more difficult problem to interpret. The pattern which was evident across all sites is even more pronounced on the larger sites, suggesting that this tool type does not fit neatly into the wider array of tool types present on the large sites. There are three possible solutions to this problem:

1) Steep thick flake scrapers are found predominantly in early *Capertian* assemblages,

2) Steep thick flake scrapers are found predominantly on small task specific sites, or

3) The tool type does not form a significant component of any assemblage within the western Cumberland Plain.

In view of the substantial numbers which occur in the lower levels of Shaws Creek KII and at Lapstone Creek LC/1B, there is little doubt that they do occur in the *Capertian* toolkit, but they also occur within the *Bondaian* levels, albeit as a minor component of the assemblage. It is clear that the tool type was significant at least along the Nepean River, so the third possibility can be eliminated. In order to decide whether temporal or spatial variability, or a combination of both, is responsible for the lack of correlation with other tool types, an analysis of the smaller sites is required.

The other important fact to emerge from this analysis is that there exists an underlying unity within the large site assemblages, confirming the designation of the *Bondaian* as the dominant lithic industry throughout the study area, with no discernible differences (other than the presence of pebble tools and the use of different raw materials) on the surface assemblages. The excavated sequences clearly show that minor technological changes did occur during the *Bondaian* (loss of backed blades, increase in quartz), but the evidence suggests that, at least when these changes are observed on large sites, there are no significant technological differences between the sites, i.e. the same trends are observable on all large sites.

Rank Correlation matrix

In order to confirm the results obtained from the partial correlation coefficient matrix, a Kendall rank correlation matrix was generated using the BMDP statistical package (Dixon, 1983). Rank correlation can be used with populations which are not normally distributed, but the resulting hypothesis testing for correlation is not as powerful. For this analysis, a critical level of .05 was used, with a rank correlation coefficient greater than 0.30 being significant (N = 32 major sites).

The results of the rank correlation matrix are shown in Table 10.4. The trends identified using the partial correlation matrix were generally confirmed by the rank correlation analysis.

	BB	EL	UPT	BPT	EGD	HAM	UT	SH	ST	TN	UTTF	SHTF	STTF
EL	S												
UPT	.18	.20											
BPT	.15	.06	S										
EGD	.12	.11	.25										
HAM	S	S	S	.16									
UT	S	S	.15	.13	.08								
SH	S	S	.21	.10	.16	S							
ST	S	S	.16	.10	.08	S	S						
TN	S	S	.15	.16	.05	.26	S	S					
UTTF	S	.24	.15	.17	.11	S	S	S	S				
SHTF	S	S	S	.25	.18	S	S	S	S	S			
STTF	S	S	S	.17	.15	S	S	S	S	S	S		
CT	S	S	.26	.19	.13	S	S	S	S	S	S	S	

KEY

BB = backed blades EL = elouera UPT = uniface pebble tool
BPT = biface pebble tool EGD = edge-ground HA = hammerstone
UT = utilised flake SH = sharp scraper ST = steep scraper
TN = thumbnail scraper UTTF = utilised thick flake scraper
SHTF = sharp thick flake scraper STTF = steep thick flake scraper
CT = core tool

S = Significant at 0.05 level

TABLE 10.4 Kendall rank correlation coefficient matrix of major sites (N = 32). Artefact types which are significantly correlated at the 95% level are indicated by the letter "S".

The minor differences included:

1) Edge-ground tools are not significantly correlated with any other tool types,

2) Sharp thick flake scrapers and steep thick flake scrapers are significantly correlated with all tool types except biface pebble tools and edge-ground tools.

3) Utilised thick flakes are not correlated with elouera.

These differences may be explained by the loss of precision which results from using ranked data. The edge-ground tools are probably different because of their curated nature, in that they will rarely be discarded, even on large sites. The fact that steep thick flake scrapers appear to be significantly correlated with other flake tools cautions against rigid interpretion of the unweighted correlation data.

Pattern analysis

A further method of analysing the data is the use of the techniques of pattern analysis. The use of a Canberra metric programme has already been discussed (McBryde, 1977). For the western Cumberland Plain data, a version of the CSIRO Divinfre programme, modified by Peter Hughes of the School of Biological Sciences, Macquarie University, was used to identify clusters of artefact types. The methodological considerations are discussed by Williams (1976). In brief, this computer programme divides the data (in this case the 23 categories of artefacts, including manuports, tools, cores, bipolars and debitage, from the 32 sites containing more than 50 artefacts) using the criterea of maximum information fall at each division based on the degree of similarity. Subsequent divisions are made until the required number of groups are produced. For this analysis, a division of the artefact types into eight groups was undertaken. The results are shown in Figure 10.5.

The groups generated by this technique appear to be related to the function of the artefacts within the group. The eight groups of artefact types generated were:

GROUP 1: Uniface pebble tools, biface pebble tools, and edge-ground tools. These artefact types are all made primarily from basalt pebbles, and function as cutting, chopping and wedging tools.

GROUP 2: hammerstones, elouera, and sharp thick flake scrapers. Sharp thick flake scrapers and elouera adze flakes are probably both woodworking tools, but the association with hammerstones is probably of no significance.

GROUP 3: thumbnail scrapers, utilised thick flakes, and manuports. The clustering of these three artefact types does not appear to have any functional basis.

GROUP 4: core scrapers. A group of one is unusual, but represents a probable woodworking activity.

GROUP 5: cores, chert debitage, silcrete debitage, quartz debitage, bipolar pieces, sharp scrapers. There is little doubt this group characterises the reduction of stone. The presence of sharp scrapers in this group may be related to the fact that this tool type is common and widespread.

GROUP 6: utilised flakes, steep scrapers, steep thick flake scrapers. This group also appears to represent woodworking activity.

GROUP 7: backed blades, basalt debitage. If backed blades are accepted as spear points and barbs, then this group may represent a hunting activity site. While the presence of basalt debitage would not appear to be directly related to any known hunting activities, the primary use of basalt was for the manufacture of edge-ground hatchet heads, which functioned (among a variety of uses) as tools for collecting possums and other arboreal game.

GROUP 8: quartzite debitage, other debitage. This group is also related to the reduction of stone.

While the Divinfre analysis may not provide any immediate answers to the problems of artefact distribution across the Cumberland Plain, it does reveal that patterns of activities may be present and can be identified in the archaeological record.

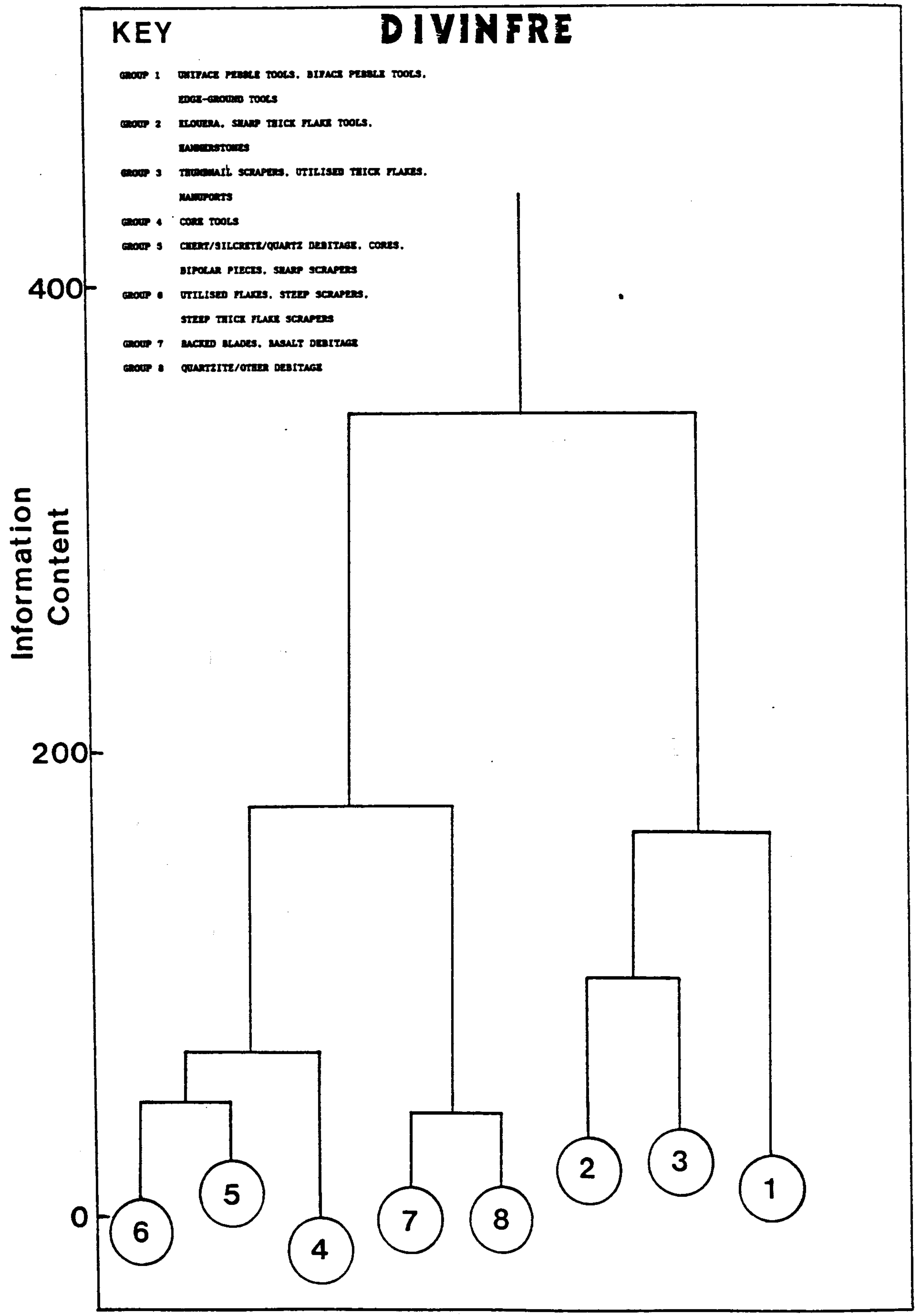


FIGURE 10.5. Divinfre analysis of all sites to show clusters of artefact types.

10.6 Assemblages on minor sites

Of the open sites located during the surveys, 127 contained between 2 and 49 stone artefacts. The numbers of artefacts on these minor sites are shown in Figure 10.6a. From this figure, it can be seen that 50% of these sites contain between 2 and 5 artefacts.

The distribution of the 23 classes of artefacts closely parallels that on the major sites with the exception of thumbnail scrapers, which occur on only three of the minor sites. Also whereas the major sites usually contained both chert and silcrete debitage, the minor sites frequently have one of these two categories absent. The occurence of the various raw materials within the sites is shown in Figure 10.6b.

There are also some minor variations in the percentages of sites containing the various "scraper" types. These are shown in Figure 10.7. It is apparent that the steep thick flake scrapers form a more important component of the minor sites than the utilised thick flakes and the sharp thick flakes, occuring on twice as many sites as the other two artefact types. This may be an important consideration if the steep thick flake scrapers are to be used as a temporal or activity marker, for it appears that their use may have been predominantly on small sites. This could be interpreted as a characteristic of either the low density scatters of the *Capertian* assemblages or a specific activity site.

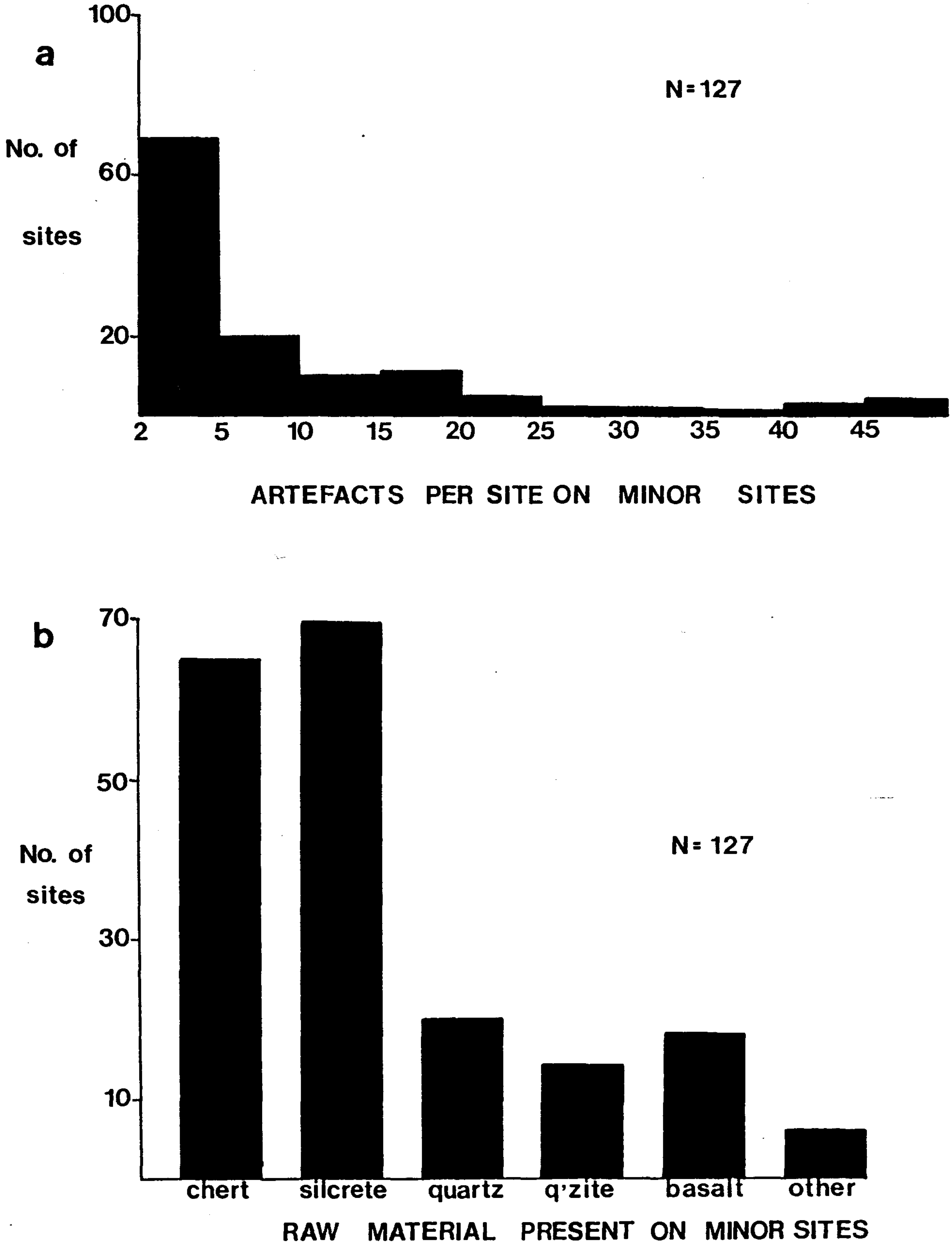


FIGURE 10.6. a: Absolute numbers of artefacts located on minor sites.

b: Occurrence of raw materials on minor sites.

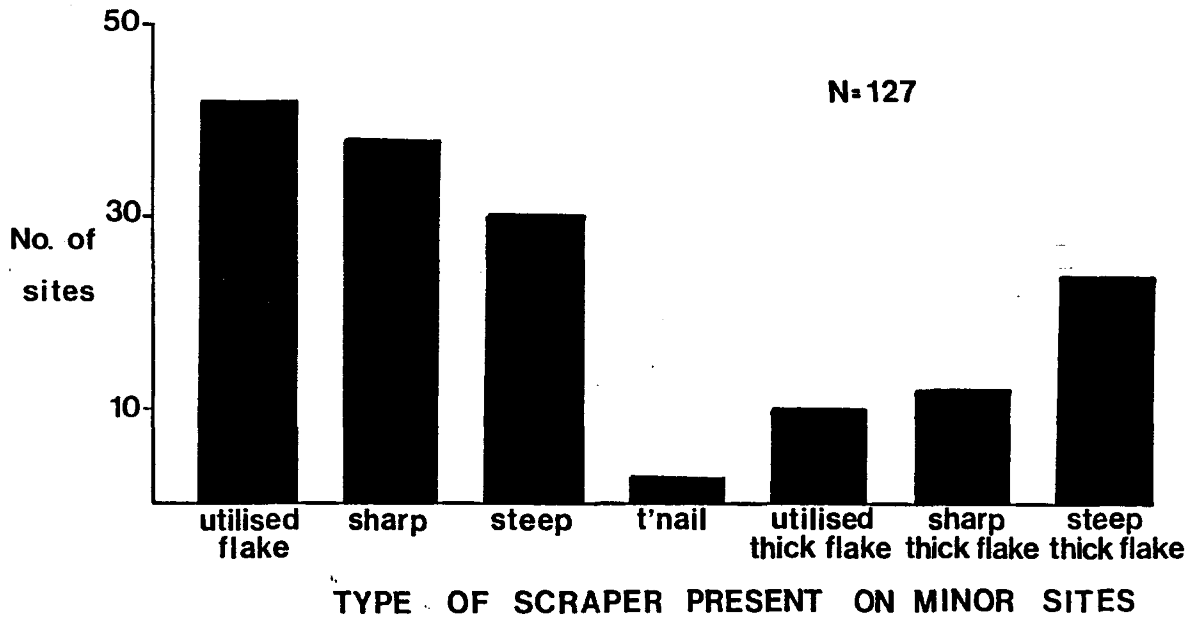


FIGURE 10.7. Numbers of "scraper" types on minor sites.

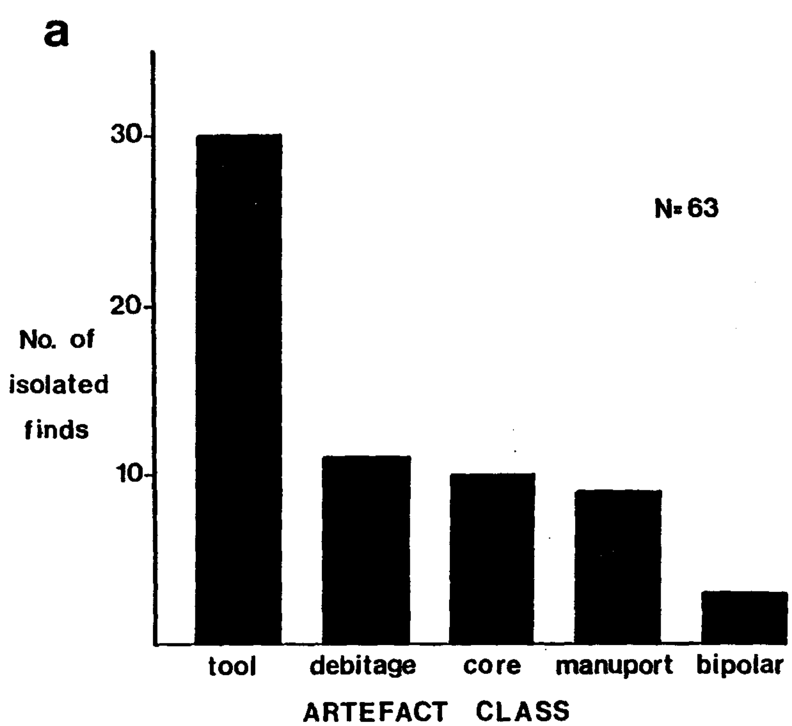
10.7 Isolated finds

The third group of sites considered were those which consisted of a single artefact in isolation. A total of 63 such sites were found, and in almost 50% of these sites the artefact located was a stone tool (see Figure 10.8a). The remaining isolated finds were cores, bipolar pieces, debitage or manuports.

The proportion of different tool types within the isolated finds is shown in Figure 10.8b. The most common tool type was the steep thick flake scraper, which accounted for almost 25% of the tools found in isolation, while edge-ground hatchet heads constituted another 17%. No backed blades, biface pebble tools, sharp scrapers or utilised thick flake scrapers were found in isolation.

These results suggest that the discard or loss of some tool types, particularly steep thick flake scrapers and edge-ground hatchets, is likely to occur away from base camps. From the ethnographic evidence, hatchets are known to have been carried about by their owners. The same may apply to steep thick flake tools, in that a steeply retouched hand held scraper may have been a useful item to carry for on the spot repairs to spears and other wooden artefacts.

Cores also constitute a significant proportion of isolated finds (18%), and it is also likely that they were carried in order to provide a quarry for sharp flakes when required.



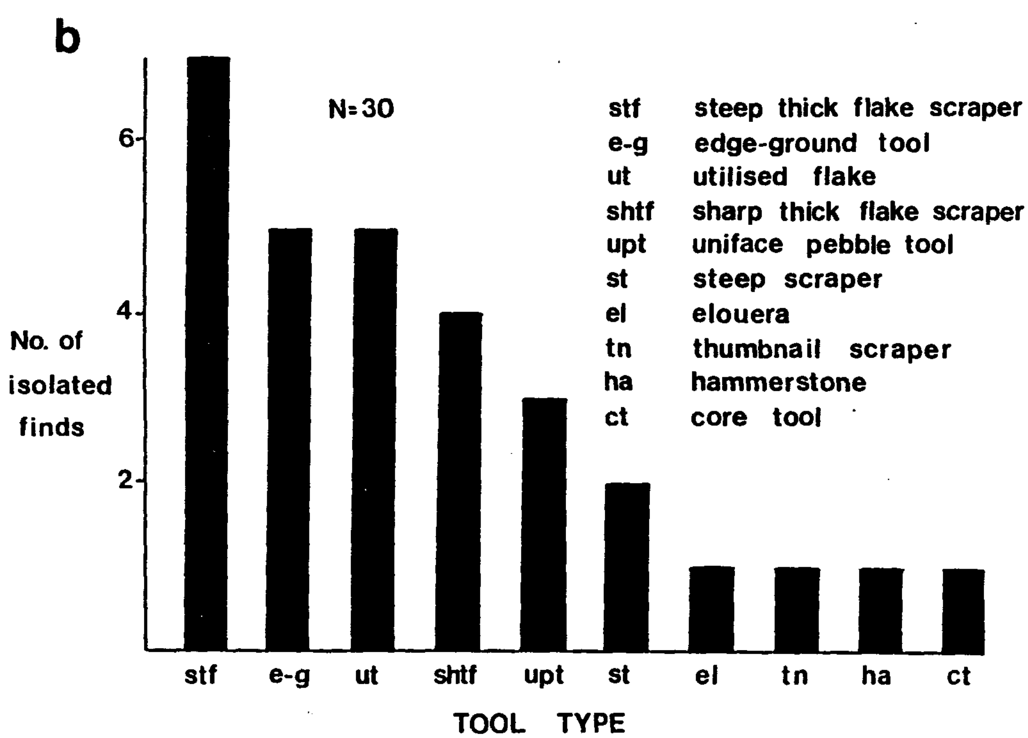


FIGURE 10.8. a: Classes of artefacts located as isolated finds.

b: Relative frequency of tool types located as isolated finds.

10.8 Usewear

A major problem associated with the identification of usewear is the need to be able to distinguish between edge-damage resulting from use and intentional secondary retouch. The traditional method of overcoming this problem is to produce a series of standards against which prehistoric artefacts can be compared. Such an experimental program was undertaken using chert and silcrete, the two dominant raw materials across the study area. Chert pebbles were obtained from the Nepean River at Castlereagh, and silcrete nodules collected from the Plumpton Ridge and Riverstone. After initial platform preparation, fresh flakes were struck from cores. Both flakes and cores were then used for predetermined periods of time cutting, scraping and planing both green and cured wood.

The results of these experiments were anything but conclusive. A wide range of modified edges were produced, many of which corresponded to patterns evident in the archaeological assemblages. However, when the experimental tools were examined under a low power stereo microscope, the range of variation within a single experiment was so great that, with two exceptions, no diagnostic traits were apparent. The exceptions were:

1) the presence of use polish on chert flakes after prolongued use on green wood;

2) the failure to reproduce the fine edge damage evident on the archaeological specimens designated as utilised flakes.

Use polish of the kind produced during the experiments was generally scarce within the archaeological assemblages, but was identified on two elouera and three utilised flakes. The only other artefacts which showed evidence of use-polish were two end-trimmed uniface pebble tools made from basalt pebbles.

The fine nibbling evident on the utilised flakes may have been caused by cutting softer tissues, although no experiments were undertaken using meat or fresh bone.

10.9 Temporal indicators

Considering the entire range of stone artefacts recovered during the excavations and open site surveys, a number of artefact types lend themselves for use as temporal indicators.

Bondi points

Since McCarthy's Lapstone Creek publication in 1948, Bondi points have long been recognised as the diagnostic artefact for identifying *Bondaian* assemblages. Excavations at both Shaws Creek and Jamisons Creek confirm that their first appearance in the Sydney region was certainly later than 4000 BP, and probably closer to 3000 BP. From the excavated sequence at Second Ponds Creek, it appears that they were still in use on the western Cumberland Plain within the last millennium, and continued to be used until as recently as *circa* 650 BP. These time-spans correlate with those proposed for the Blue Mountains (Stockton and Holland, 1974; Johnson, 1979), and to a lesser extent on the coast, where Bondi points may have dropped out of the toolkit at an earlier date.

Any site within the study area which contains backed blades was therefore occupied sometime between 3000 BP and 500 BP, although the presence at a site does not preclude the possibility of earlier or later occupation. The technology intimately associated with backed blade production, including blade cores and faceted butts, can also be used to indicate at least temporary occupation during this time span.

Edge-grinding

Edge-ground hatchets and chisels are restricted to the *Bondaian* industry. They were still in use at the time of European contact, and as such are not particularly useful for further refining the period of occupancy of a site.

Thick flake tools

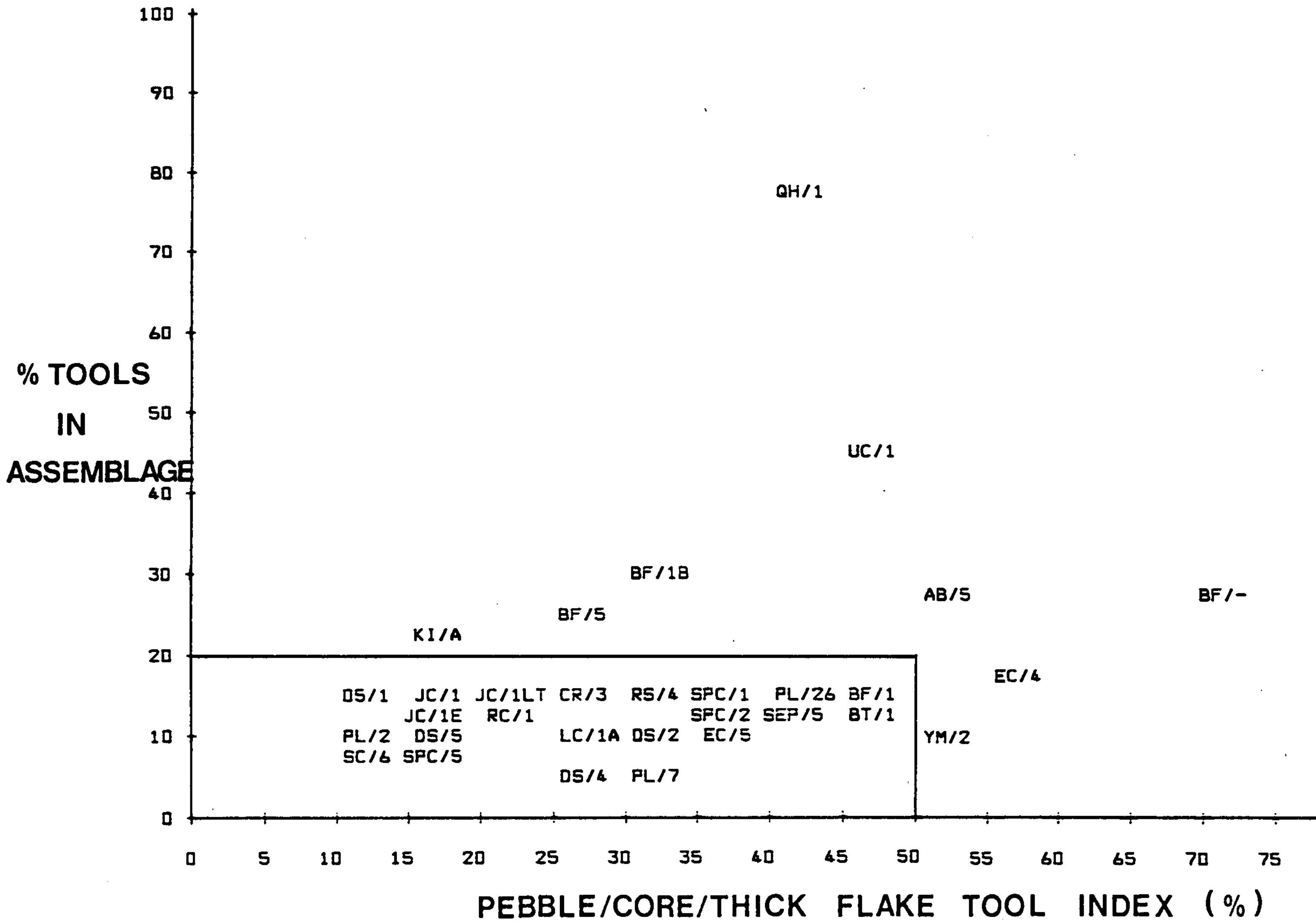
Thick flake tools are components of both the *Capertian* and the *Bondaian* assemblages in the western Cumberland Plain. However, the relative importance of this tool class appears to diminish over time. The presence of thick flake scrapers within an assemblage cannot be taken as evidence of early occupation, but an assemblage lacking the diagnostic *Bondaian* traits and containing a high percentage of thick flake tools probably represents a *Capertian* assemblage.

10.10 Pebble/core/thick flake index

One of the principal aims of this study is to relate the undated surface scatters to a dated excavated sequence. The use of the p/c/tf tool index was found to be a useful tool when dealing with substantial numbers of artefacts from excavated deposits and large open sites. However, since most of the sites across the study area consist of fewer than fifty artefacts, the index is generally not applicable.

The Shaws Creek excavation clearly showed that the transition from the *Capertian* industry to the *Bondaian* was accompanied by a far wider range of changes than just the stone tools. Another significant change was the substantial increase in the amount of debitage. An early *Capertian* assemblage is likely to have both a high p/c/tf index and a significant proportion of tools in the assemblage. To test whether any of the 32 major open sites located during the surveys showed this combination of traits, the relationship between the p/c/tf index and the percentage of tools in the assemblage was investigated graphically. The results are shown in Figure 10.9. The assemblage from the eastern end of the lower terrace on Jamisons Creek was also plotted. Twenty two of the thirty two sites had a pebble/core/thick flake tool index of less than 50% and contained fewer than 20% of tools in the assemblage. Two sites had a p/c/tf index slightly above 50%, but with fewer than 20% tools in the assemblage. Five sites had a p/c/tf index of less than 50%, but greater than 20% of their assemblages were tools.

FIGURE 10.9. Relationship between pebble/core/thick flake tool index and percentage of tools on major sites. Most sites have a p/c/tf index below 50% and less than 20% tools in the assemblage.



% TOOLS IN ASSEMBLAGE
PEBBLE/CORE/THICK FLAKE TOOL INDEX (%)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
90
100
QH/1
UC/1
BF/1B
AB/5
BF/-
BF/5
KI/A
EC/4
DS/1
JC/1
JC/1LT
CR/3
RS/4
SPC/1
PL/26
BF/1
JC/1E
RC/1
SPC/2
SEP/5
BT/1
PL/2
DS/5
LC/1A
DS/2
EC/5
YM/2
SC/6
SPC/5
DS/4
PL/7

Only four sites fit the criteria for suggesting that they may be primarily *Capertian* assemblages. They were Agnes Banks 5, Blacks Falls 1A, the lower assemblage on the Lapstone Creek open site, and the Jamisons Creek lower terrace east. Three of these four sites contain assemblages comparable to the lower units at Shaws Creek, with only the Blacks Falls site being unusual. At Blacks Falls the tools are almost exclusively unifacially flaked pebbles and edge-ground hatchet heads, and the site, situated immediately adjacent to the Nepean gravel beds, should be interpreted as a specific activity site involving the collection and modification of basalt pebbles.

The two other sites which have p/c/tf indices greater than 50% are Yarramundi 2 and Eastern Creek 4. The Yarramundi site has relatively few tools, and those which were found suggest that this site was occupied during the late *Bondaian*, with edge-ground hatchets being present but no backed blades. This particular site, located on the eastern bank of Yarramundi Lagoon, was in use by Aborigines in 1789 when Tench's expedition camped there with the members of the Boorooberongal band (Tench, 1793).

Eastern Creek 4 is located on Schofields aerodrome beside Eastern Creek, and is directly opposite the Plumpton Ridge, a major source of silcrete. The site has a large percentage of thick flake scrapers in the assemblage, including some made from chert. However the status of this site is not clear.

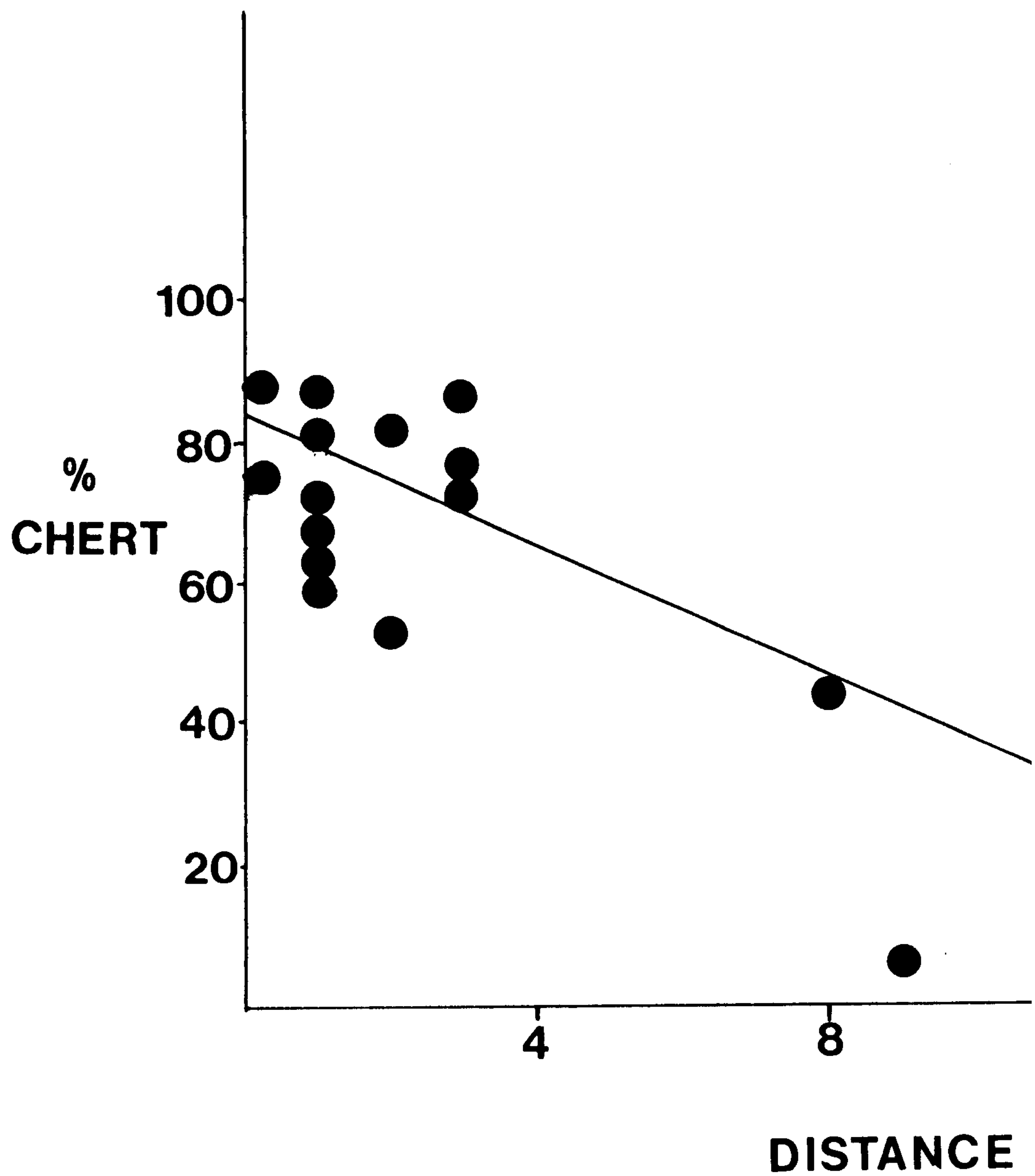
Those sites with low p/c/tf indices but a high percentage of tools in the assemblage all appear to be specific activity sites. Quakers Hill 1 is a silcrete quarry and includes an elouera adze flake, the two Blacks Falls sites are associated with the production of pebble tools and hatchet heads, the open assemblage around the KII site is also dominated by pebble tools, while Upper Castlereagh 1 is situated on a terrace overlooking a gravel bed, and was probably also a quarry site.

10.11 Spatial indicators

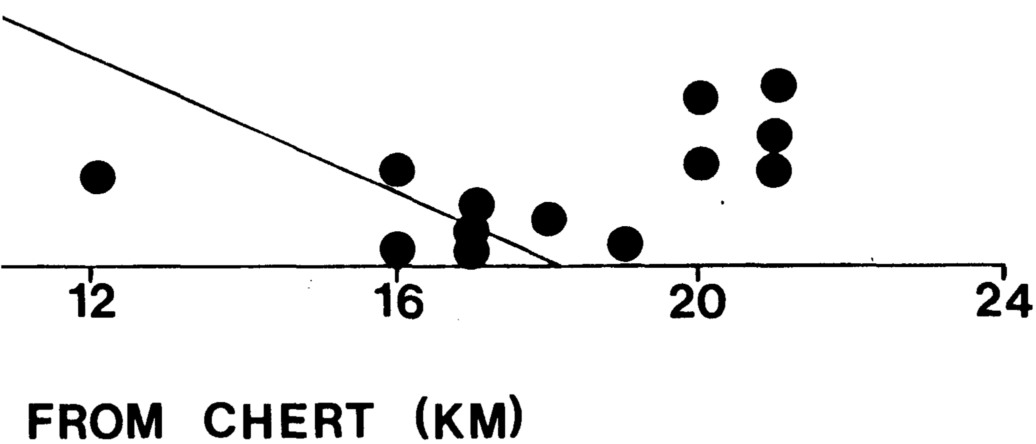
Raw materials

Several artefact types vary spatially across the landscape. The general trend of an easterly increase in the proportion of silcrete in the assemblages has already been noted, and corresponds with a decrease in the quantity of chert, quartz, and basalt. The different trends apparent in the distribution and density of specific raw materials appear to be related to the distance from resources. Figure 10.10 shows the proportion of chert in the major assemblages across the study area. There is a general tendency for the proportion of chert to decline towards the east, suggesting that predominantly locally available materials were used. It is significant to note that even in the *Capertian* levels at Shaws Creek KII, a few silcrete flakes were found. Similarly all the major assemblages contain at least a small proportion of chert.

FIGURE 10.10. Relationship between percentage of chert on major sites and distance from the nearest source.



100
80
%
CHERT
60
40
20
4
8
DISTANCE


12
16
20
24
FROM CHERT (KM)

Pebble tools

The only stone tool types which show marked geographic limits in their distributions are the uniface pebble tools and biface pebble tools. Pebble tools are clearly retricted to the the immediate vicinity of the gravels beds, extending east as far as the boundary of the flood plain at Cranebrook and Agnes Banks. The rare pebble tools found further to the east are re-used hatchet heads or in one case a crude chopper made on a quartzite pebble. The implications are clear: pebble tools were manufactured and used within a short distance of the source of the pebbles and were generally not transported.

10.12 Multivariate analysis

A number of multivariate techniques can be employed to generate patterns of relationships between sites and between artefacts within sites. Although many multivariate algorithms have been used on archaeological data, most of them are designed to cope with data which does not exhibit the variability often found in prehistoric sites. Bolviken et al., (1982: 42) clearly identify a major problem associated with one of the most common methods applied to archaeological data when they criticise Principal Components Analysis. They state that in Principal Components Analysis, "the association between variables is measured by covariance or correlations, which makes the method to some extant linked with the normal law, and which does not fit in with the distinctly non-normal nature of the (archaeological) data". As an alternative, they suggest the use of Correspondence

Analysis, a technique first used on archaeological data by Hill (1974), and based on the more commonly known technique of reciprocal averaging (Hill, 1973).

In order to investigate the applicability of multivariate techniques to the western Cumberland Plain data, a series of analyses were carried out. The statistical packages selected for the preliminary investigations were primarily those included the BMDP software package (Dixon, 1983).

BMDP1M

The BMDP1M package carries out a cluster analysis of variables, and displays the results as a tree printed over the absolute correlation matrix, clustering by the minimum distance method (Dixon, 1983:448-55). The results on the data from all sites confirmed that those stone tool types which contributed most to the variability within the assemblages were steep thick flake scrapers, biface pebble tools, uniface pebble tools and sharp thick flake scrapers, while the distribution of silcrete was the dominant cause of variation within the raw materials. These results confirmed the results of the correlation matrices.

BMDP2M

In order to investigate the similarities between sites, an analysis was carried out which clustered sites on the basis of their stone assemblages. The method initially considers each site as a separate cluster, and then amalgamates sites on the basis of distance between centroid clusters (Dixon, 1983: 456). The output is in the form of a tree diagram showing the relationships between sites and a shaded matrix of distances between sites. The analysis was carried out on all sites (n=222) and major sites (more than fifty artefacts) (n=32). However, the output from both analyses clearly showed that the dominant factor which resulted in sites clustering together was the number of artefacts present (or the number of artefact types absent). Larger sites like Jamisons Creek and Second Ponds Creek always produced clusters containing only one site.

BMDP3M

An alternative algorithm was used in an attempt to cluster sites. This method, block clustering, produces block clusters of the data, with each block being defined by a cluster of cases (sites) and a cluster of variables (artefact types) such that each variable in the block is constant (except that cases may belong to other blocks, i.e. overlapping may occur) (Dixon, 1983:474). The analysis was carried out on major sites, but again no discerable patterns were evident in the output.

BMDPKM

A third method of clustering, K-means clustering, which partitions a set of cases (sites) on the basis of Euclidean distance between cases and the center of each cluster, was also used on data from the major sites (Dixon 1983: 464). A similar pattern was evident with this analysis, with large sites producing solitary clusters regardless of the numbers of clusters selected. When the number of clusters was set at eight, the solitary clusters were Jamisons Creek 1 (JC/1), Lapstone Creek 1B (LC/1B, the older assemblage), Blacks Falls 1A (BF/1A), Second Ponds Creek 5 (SPC/5) and Eastern Creek 4 (EC/4), with one cluster of three sites, one cluster of four sites, and the remaining twenty sites all falling in the final cluster. While this approach did appear to produce at least one site which may have been separated on the basis of temporal variation (the presumed *Capertian* unit at Lapstone Creek), no clear patterns were evident.

BMDP4M

In order to investigate the factors influencing the relationships between the sites, a factor analysis was carried out on the major sites (Dixon, 1983:480). This process extracts and displays the relationships between the principal components. The first three principal components accounted for 90% of the variation. The first component was dominated by the absolute number of artefacts on the site and the variation in raw materials and common tool types, the second component was dominated by biface pebble tools and uniface pebble tools, while the third component was almost entirely the product of the presence of the category "manuports". Since these factors are generally unhelpful in grouping sites in terms of temporal variation, with pebble tools and manuports best interpreted as representing aspects of spatial variation, an alternatve method was used.

Correspondence Analysis (CA)

Although the technique of Correspondence Analysis did produce interpretable results for Bolviken et al. (1982), the methods they employed can be criticised on a number of grounds. One of the problems which they encountered in their first example was "noise", the variability in the data generated by the wide number of typological classes used in the preliminary data set. To overcome this problem they excluded all unworked stone, and grouped "thirty seven lithic variables into nine tool categories after presumed functional similarities" (ibid: 46). While there may be some justification for this in Norway, there can be no such reduction for the western Cumberland Plain data, since no presumptions are made regarding the "functional similarities" of the various stone tool types. Indeed, the function of particular tool types is one of the problems under investigation.

Detrended Correspondence Analysis (DECORANA)

From the point of view of the statistician, while Correspondence Analysis does have certain advantages over Principal Component Analysis, it also has inherent problems, some of which Bolviken recognises (ibid: 57). One problem is the quadratic relationship between the second axis and the first axis, which results in the "arch" or "horseshoe" effect (Hill, 1979:1). At least some of these problems can be overcome by using the modified algorithm in the form of Detrended Correspondence Analysis (DECORANA). The method is described and evaluated by Hill (1979), who suggests that many archaeological data are appropriate for DECORANA (ibid:10). It was Hill (1974) who first examined archaeological data with Correspondence Analysis, and his early application of CA to seriation was acknowledged by Bolviken et al (1982:57). The basic differences are that DECORANA ensures that there are no systematic relations of any kind between the higher axes and the first, and also rescales the axes.

Initially the complete data set was analysed using the DECORANA programme. The results were similar to those produced by the Principal Components Analysis, in that the variation was largely determined by the number of artefacts and the presence or absence of particular raw materials and manuports. The sites reflected this variability, with no interpretable pattern evident.

In order to partially overcome this problem, two changes were made to the data. All sites with fewer than fifty artefacts were deleted, and the "manuport" class of stone artefacts was removed. This modified data set was analysed again using DECORANA. The results are shown in Figures 10.11 and 10.12. The units of each axis are standard deviations. Only the first two axes were considered, as the eigenvalues of the subsequent axes were significantly lower, and therefore unlikely to have much meaning (Hill 1979:22).

Figure 10.11 shows the relationships between the 22 classes of artefacts present on the 32 major sites. Axis 1 appears to be related to the range of artefact types present, while the second axis reflects the variability of raw materials present in the debitage. There appear to be three major clusters of artefact types. The first cluster, consisting of edge-ground hatchet heads, uniface pebble tools, basalt debitage and quartzite debitage, is clearly a cluster representing the activity of acquisition, modification and use of basalt and quartzite pebbles. The second cluster, consisting of backed blades, quartz debitage, utilised flakes, and possibly bipolar pieces, confirms the earlier correlations between these types, and suggests that the cluster may represent an activity such as a macropod hunting or spear barbing and repair. The third cluster, which includes elouera adze flakes, sharp scrapers, steep scrapers, bipolars, and hammerstones strongly suggests woodworking activities. Other types do not cluster.

Figure 10.12 shows the relationship between the sites. There is a remarkable separation of the sites into those which occur to the east of South Creek and those which occur near the Nepean River. Rickabys Creek 1, which is geographically located between the two areas, is also located between them on the DECORANA plot. This strongly supports the concept that the second axis is primarily related to the nature of the raw materials present in the debitage, with those sites dominated by silcrete being distinct from those dominated by chert.

Two additional small clusters are distinctive. Site Quakers Hill 1 (QH/1) is in isolation, while sites Lapstone Creek 1B (LC/1B) and Upper Castlereagh 1 cluster together. Comparison with

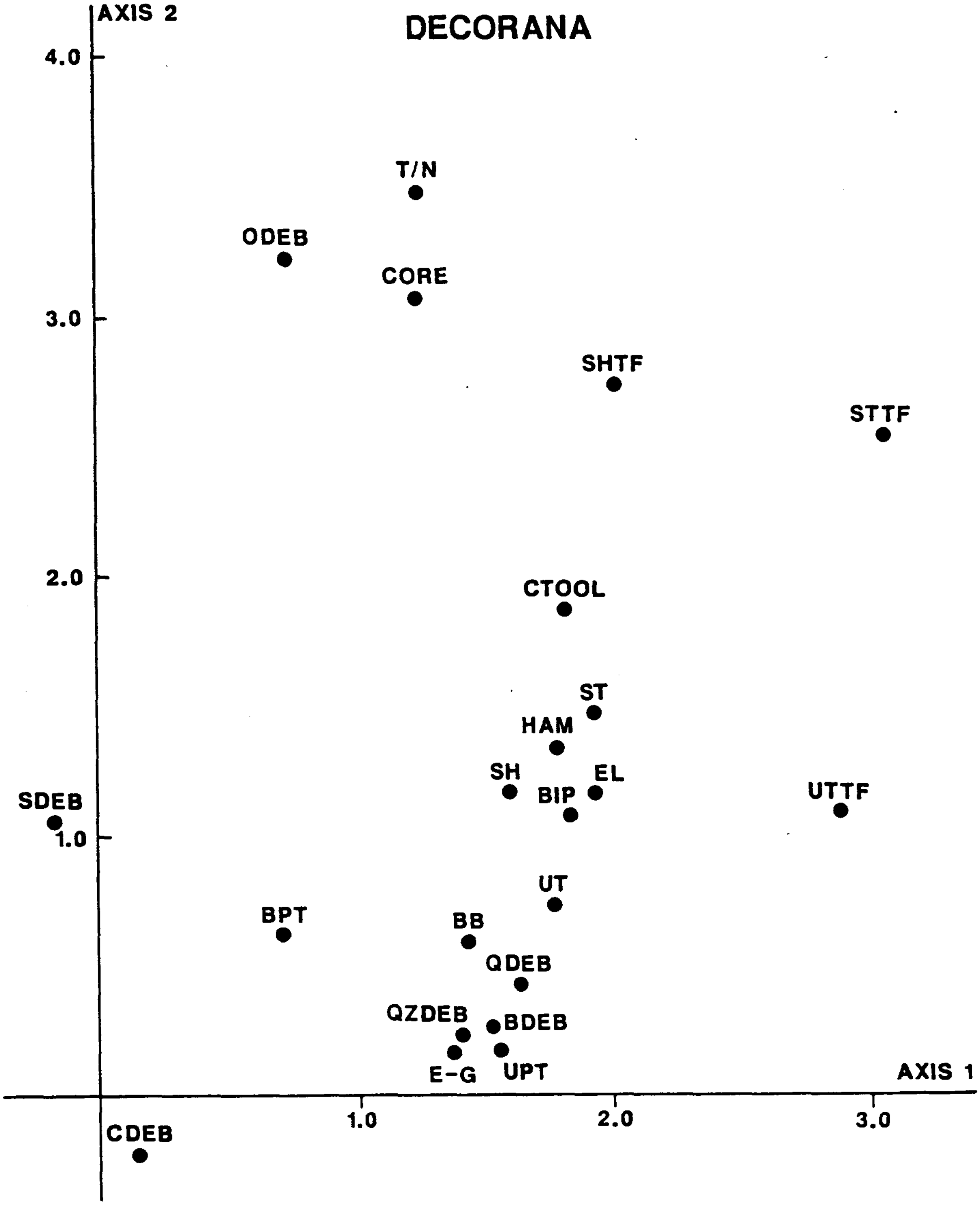


Figure 10.11. DECORANA analysis of artefacts on major sites (n=32). Units are standard deviations.

Figure 10.12. DECORANA analysis of major sites (n=32). Units are standard deviations.

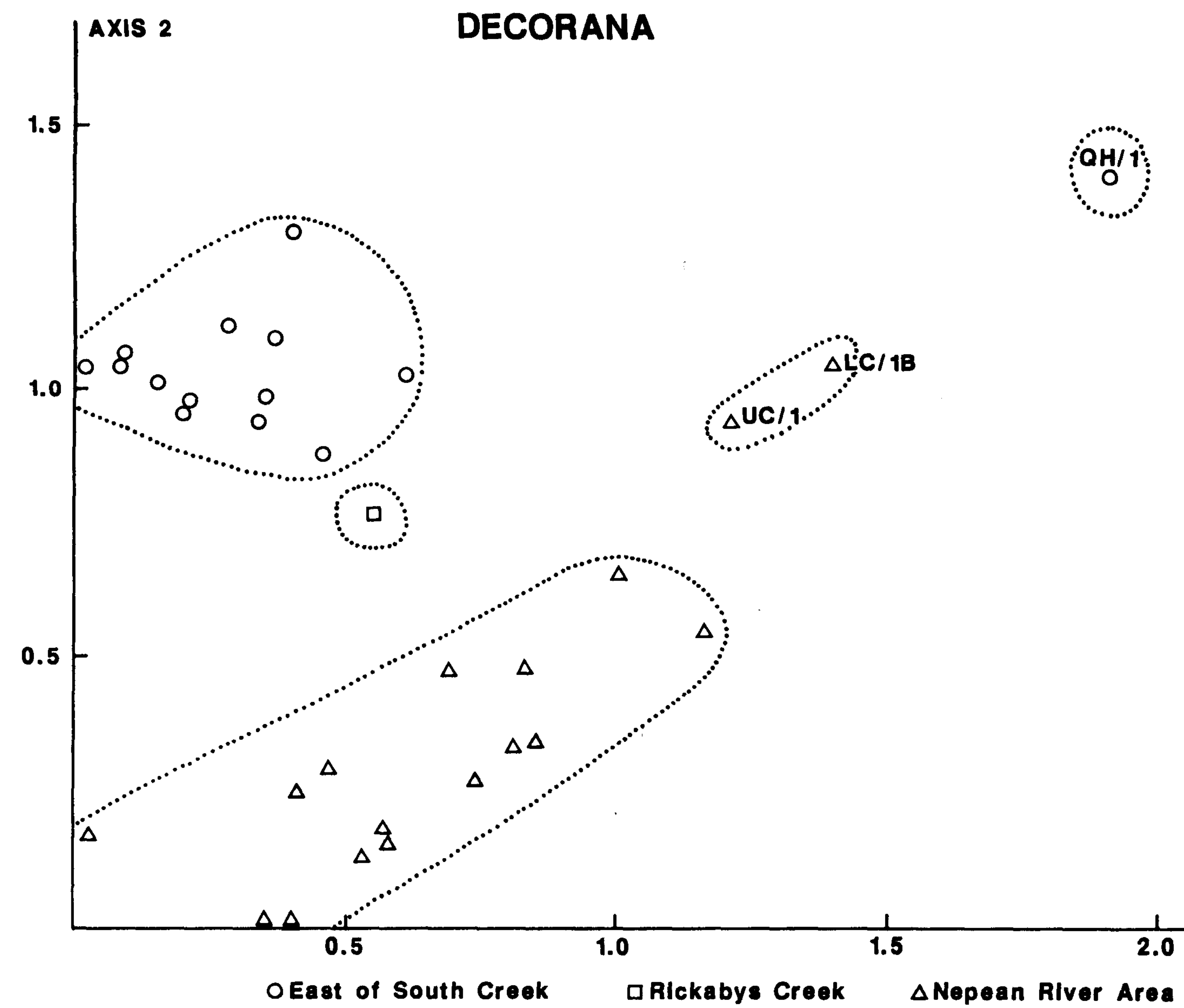

DECORANA
AXIS 2
1.5
1.0
0.5
0.5
1.0
1.5
2.0
QH/1
LC/1B
UC/1
East of South Creek
Rickabys Creek
Nepean River Area

Figure 10.11 suggests that the presence of thick flake tools is the major factor contributing to the separation of these three sites from the other 29 sites. This strongly indicates either temporal or functional reasons for the separation, rather than the spatial considerations evident in the second axis.

In order to eliminate the effect of the variation in raw materials, the categories of debitage were deleted from the data and the analysis carried out again. The plot of the first two axes are shown in Figures 10.13 and 10.14. With the effects of raw materials removed, a different pattern emerges. For the first time, cores and hammerstones cluster together, clearly representing stone reduction. Backed blades are found in isolation as a distinct activity, although possibly forming a component of the group including elouera adze flakes, utilised flakes, bipolar pieces, core scrapers, steep scrapers and thumbnail scrapers. This cluster clearly represents woodworking, and these artefacts are all significant components of the *Bondaian* assemblages. The remaining artefact types are the pebble tools, hatchets and thick flake scrapers. These are the tool types which cause particular sites to stand out from the majority.

The final analysis of sites is shown in Figure 10.14. For comparison, site JC/1LTE was included in this analysis. Although it did not contain fifty artefacts, it did contain a substantial number of stone tools, and was significant when using the p/c/tf index (see Figure 10.9). With the variation due to raw materials removed, the distinct clusters of Figure 10.12 have disappeared. Twenty nine sites have merged into a single cluster, with silcrete and chert dominated sites equally dispersed. The additional change is that site Upper Castlereagh 1 (UC/1) is now included within the large cluster, and site Blacks Falls 1A (BF/1A), which contains substantial numbers of uniface and biface pebble tools, is found in isolation. Sites Lapstone Creek 1B (LC/1B) and Jamisons Creek Lower Terrace East (JC/LTE) cluster together, while site Quakers Hill 1 (QH/1) remains isolated.

This pattern is remarkably similar to the pattern identified by the use of the pebble/core/thick flake index in Figure 10.9. The same interpretation is therefore applicable, with the Blacks Falls site best interpreted as a pebble tool manufacturing site, the Quakers Hill site as a silcrete quarry site, and the two Emu Plains sites (LC/1B and JC/LTE) as genuine *Capertian* sites. It is of interest to note that these latter two sites were both exposed after removal of topsoil, confirming their antiquity.

10.13 Discussion

The analysis of the stone assemblages across the western Cumberland Plain indicates that there are few sites which can be identified as exclusively *Capertian*. The trend is for occupation to continue on the early sites into the *Bondaian* period, although there may be a period of low site usage between four and five thousand years ago. The *Capertian* sites appear to be restricted to a narrow band adjacent to the Nepean River, although one site

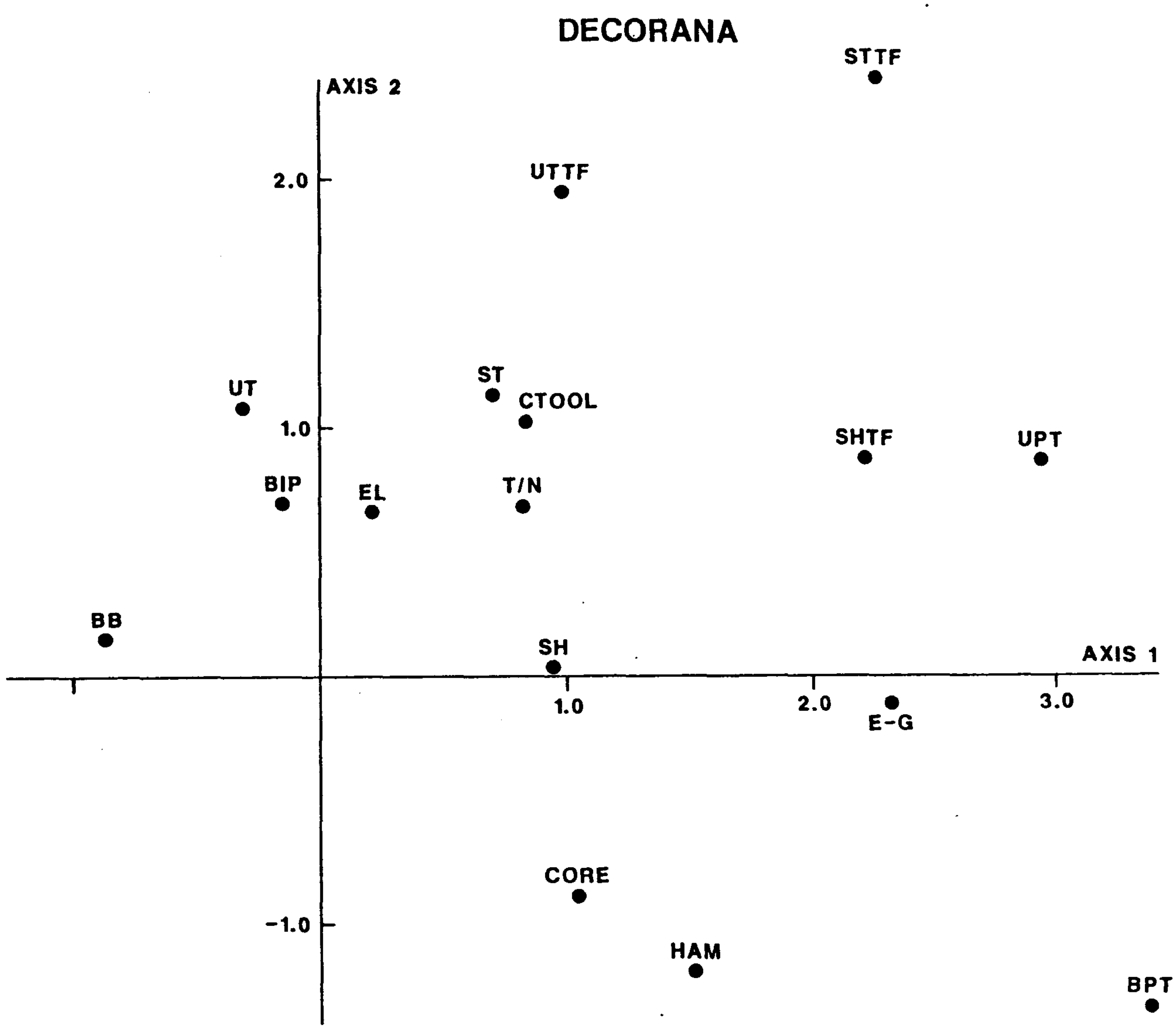
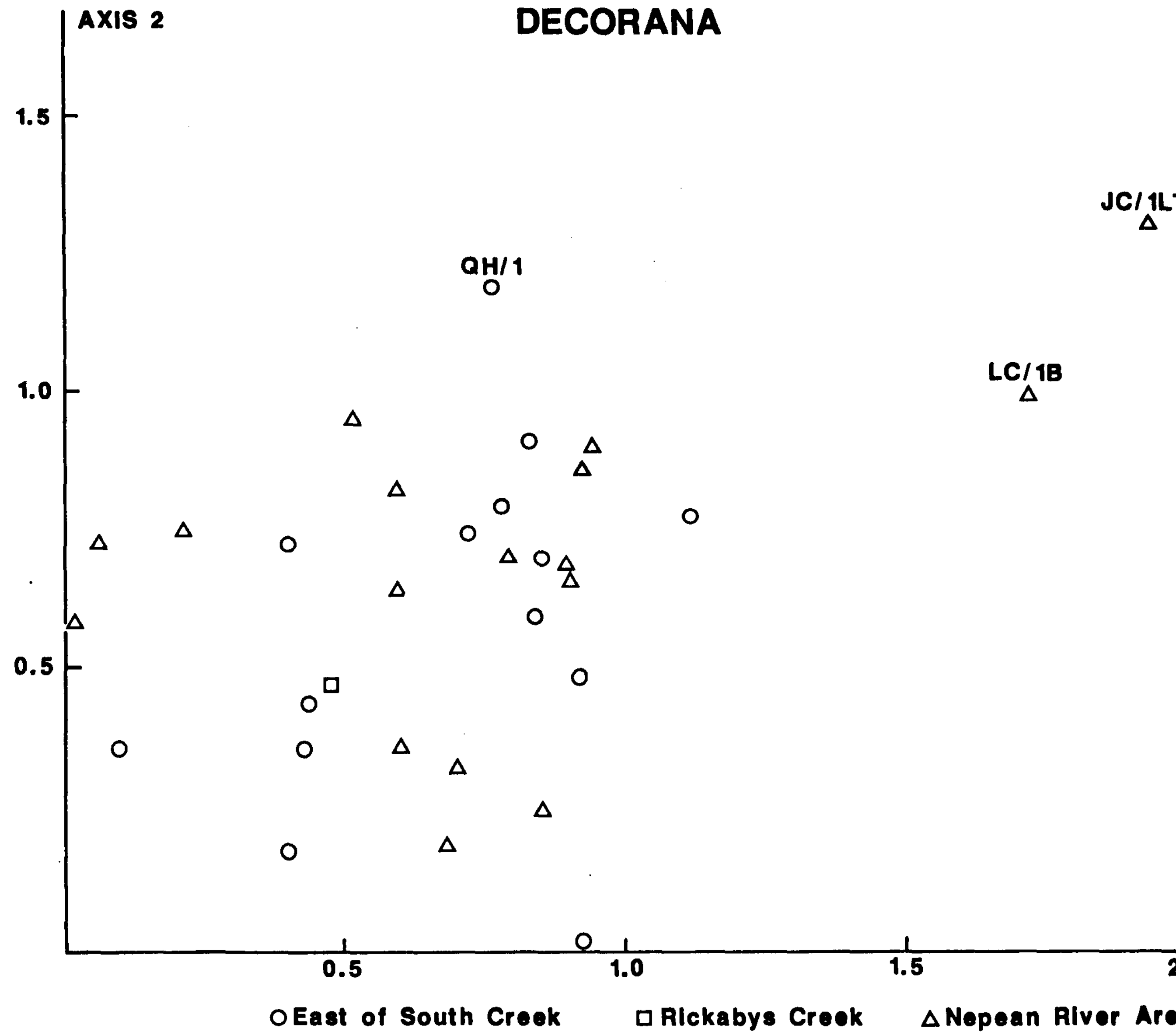


Figure 10.13. DECORANA analysis of stone artefacts from major sites with debitage deleted. Units are standard deviations.

Figure 10.14. DECORANA analysis of major sites with debitage deleted. Site JC/LTE is included. Units are standard deviations.


DECORANA
AXIS 2
1.5
1.0
0.5
0.5
1.0
1.5
QH/1
JC/1L
LC/1B
East of South Creek
Rickabys Creek
Nepean River Are

which may have contained an early assemblage was identified near Eastern Creek.

The *Capertian* industry is characterised by the dominance of thick flake tools, although normal flake tools are also present. Uniface pebble tools form a component of this assemblage on open sites, but were not found within the *Capertian* units of the Shaws Creek KII rockshelter site. The low density of stone artefacts, high proportion of worked tools, and presence of multiple working edges on thick flake tools all typify the *Capertian* industry.

Over 95% of the sites located during the surveys showed evidence of occupation during the *Bondaian* phase on the basis of the diagnostic artefacts present (backed blades, hatchets), the technology used (blade production, bipolar flaking), and the high proportion of debitage within the assemblages. Backed blade production began before 3000 years ago and continued well into the last millennium. Edge-grinding may have begun around the same time or a little later, and increased in importance over the last 1500 years. This was associated with increasing use of quartz along the Nepean River, and exploitation of silcrete resources further east.

Uniface pebble tools have a restricted distribution, and are rarely found at any distance from the source of raw material. They form components of both *Capertian* and *Bondaian* open sites, but not rockshelter sites, suggesting that, at least in the western Cumberland Plain, their use was almost exclusively away from rockshelters. They may have functioned as wedges (supported by use polish on some specimens) as well as general purpose tools.

Finally the pebble/core/thick flake tool index, in association with other assemblage-wide traits, was shown to be a useful tool for distinguishing generalised *Bondaian* campsites from early assemblages and specific activity sites. Similarly, DECORANA was found to be a useful tool for isolating and identifying components of variability within assemblages and for clustering sites.

CHAPTER 11

SITE LOCATION ANALYSIS

11.1. Background to site location analysis

Having identified the location of prehistoric sites in the western Cumberland Plain and quantified the stone assemblages present on the sites, the next step in understanding the changing settlement patterns over time is to relate the sites and their lithic assemblages to the surrounding environment. The relationship between the site and its environment is basic to any interpretation of prehistoric land use.

One popular approach to the study of the relationship between a major site and its environment has been the use of site catchment analysis (Vita-Finzi and Higgs, 1970; Higgs, 1975). Although this approach was originally intended for use with grazing and farming settlements, its potential for hunter-gatherer sites has long been recognised. The severe limitation of site catchment analysis is the fact that it depends on the concept of a "base camp" from which hunter-gatherer groups foraged, and assumes that a radius of 2 hours walking time around this base camp (10 km in flat country) represents the exploitation territory. This figure of 10 km was proposed by Lee (1969), and was obtained from observation of the foraging strategies employed by the !Kung Bushman. To equate foraging strategies of prehistoric Aboriginal populations with those in use by the !Kung is fraught with danger. Use of the ethnographic analogy within populations exploiting the same environment is often criticised, but the suggestion that direct comparisons can be made between such diverse economic systems as the African !Kung exploiting an arid environment and the Australian Aborigines exploiting temperate forests, rivers and swamps, can have little basis in reality.

The concept of a base camp must also be viewed with caution. In a relatively flat landscape such as that of the Cumberland Plain, is it possible to identify such base camps? Certainly a major rockshelter site like Shaws Creek KII, containing tens of thousands of stone artefacts with occupation extending back into the Pleistocene, could justifiably be designated a base camp, at least during the *Bondaian* phase of occupation, but few of the open sites approach this site in terms of the density of stone artefacts. Only two open sites located during the surveys contained more than 1000 stone artefacts. Can these two sites be reasonably described as base camps? If so, what is the significance of the other 220 sites with lower density scatters? There are no adequate ethnographic descriptions of Aboriginal foraging strategies in the Sydney area to decide if the concept of a base camp is applicable at the time of European settlement, so the interpretation of prehistoric settlement pattern must depend on the data obtained rather than by testing a site catchment model which may be totally irrelevant to the foraging strategies employed by the prehistoric population of the western Cumberland Plain.

Other approaches have been adopted for investigating the relationship between the location of a prehistoric site and the resources around the site. Foley (1977) describes a method for quantifying the biological productivity around a site, and from these data he defines a home range. At the same time he cautions that any assumption of ecological constancy is extremely dangerous, that the application of productivity data will "lose resolution when applied to prehistoric contexts", that recovery of organic remains from a site will form an important part of the approach, and that the approach does not accomodate the inorganic resources. This method can be of little value in the Cumberland Plain where there have been major environmental and climatic changes over the time span under investigation, where organic remains are almost totally absent from the archaeological record, and where the proximity to lithic resources appears to have played a role in the distribution of sites.

A number of approaches to the analysis of spatial patterning of archaeological data are described by Hodder and Orton (1976), who consider the distribution of artefact types within sites and across the landscape as well as the distribution of sites. Such studies often implicitly assume that the location of all sites within the study area is known, and this may result in misleading spatial patterning. To the south of the Cumberland Plain, one significant attempt has been made to quantify the factors contributing to site location. This was the work of Sullivan (1976), who examined the distribution of sites on the south coast of New South Wales. It was apparent that the major consideration in this area was the availability of marine resources, and in particular molluscs, with 145 out of 220 sites recorded being coastal or estuarine open shell middens. However, the relative ease with which shell middens can be identified undoubtedly contributed to the apparent degree of concentration of sites along the coastal strip. The problem of poor visibility of other site types was recognised in this study, but no means of overcoming the problem was suggested. Of greater relevance to the selection of site location was a second factor, the accessibility of drinking water.

Another factor which appears to have influenced site selection is the availability of suitable raw materials for the manufacture of stone tools. Hughes et al. (1973) point out that silcrete formed a significant component of lithic assemblages on the New South Wales south coast, particularly during the middle *Bondaian* phases of occupation. To what extent the distance from a source of silcrete influenced the selection of a campsite is not clear, but it is suggested that silcrete and other raw materials may have been traded over distances of up to 160 kilometres.

11.2 Site location and resources

Geological setting

An analysis was carried out on the geological and geomorphic setting of the sites located within the study area. The results are shown in Figure 11.1. Sites were located on all major geological substrates. In general, the number of sites

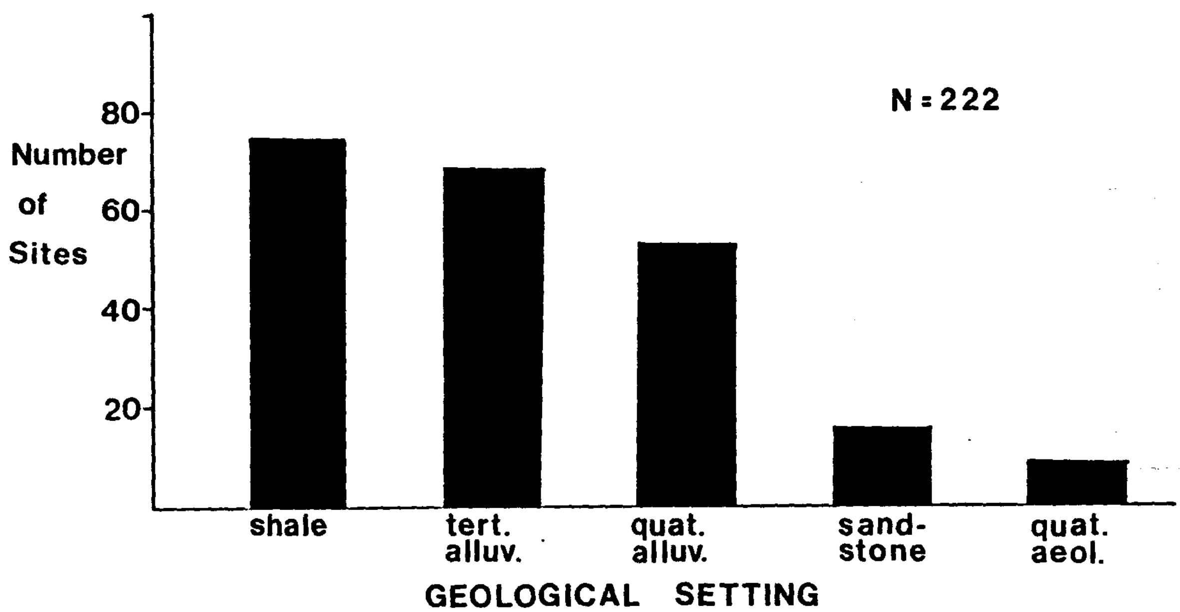


FIGURE 11.1. Location of all sites in relation to geological and geomorphological setting.

corresponded with the area of each geological unit surveyed. The notable exception is the relatively high number of sites situated on Quaternary alluvial deposits (53), a far greater proportion of the total than might be expected on the basis of the relatively small area of this geomorphic unit. The data suggest that although evidence of prehistoric occupation was found right across the study area, sites tend to be more concentrated on Quaternary alluvial deposits.

Distance from water

One possible explanation for the concentration of sites on Quaternary alluvial deposits is that the availability of a permanent supply of water was a significant consideration in the selection of a campsite or activity site. To test this the distance from each site to a permanent supply of water was plotted. Figure 11.2a clearly shows that water was indeed a major consideration for site selection, for 65% of all sites are located within 100 metres of a permanent water supply. While the present courses of the Nepean/Hawkesbury River and the permanent creeks may not reflect the availability of water during the late Pleistocene, there is little evidence to suggest that major environmental changes occurred during the late Holocene (Chappell and Grindrod, 1983; Young, 1986), so the presence of water may be interpreted as a major factor in site selection during the last 5000-6000 years. Only 7% of sites were more than 500 metres away from a source of water, and while this may be related to the need for water, because water is relatively abundant within the study area there are few locations which are more than one kilometre

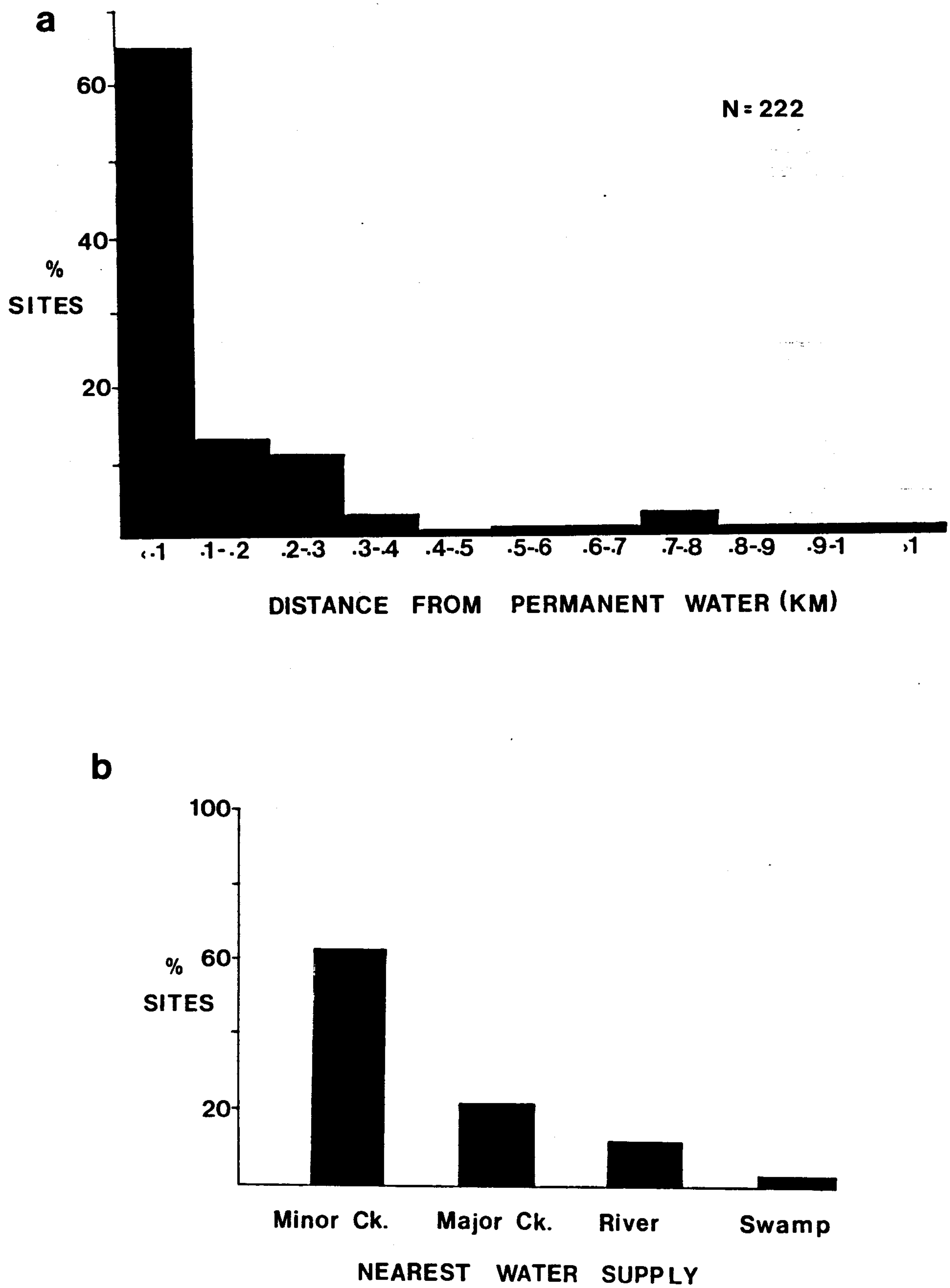


FIGURE 11.2. a: Relationship between the number of sites at varying distances from water.

b: Nature of the nearest water supply to sites.

from a regular supply.

Nature of water supply

A consideration with regard to water is also the nature of the supply. One might expect that the Nepean/Hawkesbury River and the larger creeks (South Creek, Eastern Creek, Ropes Creek) would be favoured by hunter-gatherers, since they would provide a substantial variety of plant and animal foods in addition to a regular supply of water. However, Figure 11.2b shows that 63% of all sites are closest to a minor creek, closely approximating the relative frequency of these waterways. It should be stressed that this analysis deals with all sites regardless of size. In fact there is a marked variation in the size of the site relative to the size of the water source, with sites adjacent to the Nepean River generally showing evidence of far more intensive occupation compared with the sites adjacent to the smaller creeks.

Site location and disturbance

The initial experimentation carried out when planning the survey strategy indicated that the likelihood of locating a site was greatly enhanced if the site was disturbed. To test if this phenomenon was indeed a major factor contributing to the identification of a site, the nature of exposure at each site was compared. Figure 11.3a shows that only 3% of the 222 sites located had not been subjected to some form of disturbance. The majority of sites (58%) were identified on a vehicle or animal track, with significant proportions being exposed by bulldozing and alluvial scouring. While it can justifiably be argued that the survey method was biased in favour of finding sites located on tracks, no survey was exclusively carried out on tracks. The relatively low proportion of sites with archaeological visibility in the absence of disturbance argues heavily in favour of the proposition that the principal contributing factor in the identification of sites is disturbance.

Because most archaeological sites in the study area were exposed after disturbance, it follows that the vast majority of sites will be covered by varying depths of soil and leaf litter. One of the parameters measured for all sites was an estimate of the maximum depth of disturbance at each site. This ranged from a few centimetres on shallow animal tracks to several metres on river terraces. Figure 11.3b shows the proportion of sites with varying amounts of disturbance. It is clear that most sites were identified where the disturbance was relatively shallow, with 81% of sites having less than 20 cm disturbance. This is probably related to two contributing factors:

1) the relatively shallow soils which occur in the study area, particularly those on sandstone and shale, and

2) the proximity of the sites to the surface.

The proximity to the surface cannot be used as a direct argument for relatively recent deposition of the artefacts, for even in relatively deep alluvial and aeolian deposits the rate of accumulation of deposit will be slow on open sites (e.g. 20 cm of deposit accumulated over 4,000 years at Jamisons Creek JC/1). The corollary is that older sites are also likely to be exposed in regions with shallow soils, but are less likely to be exposed if

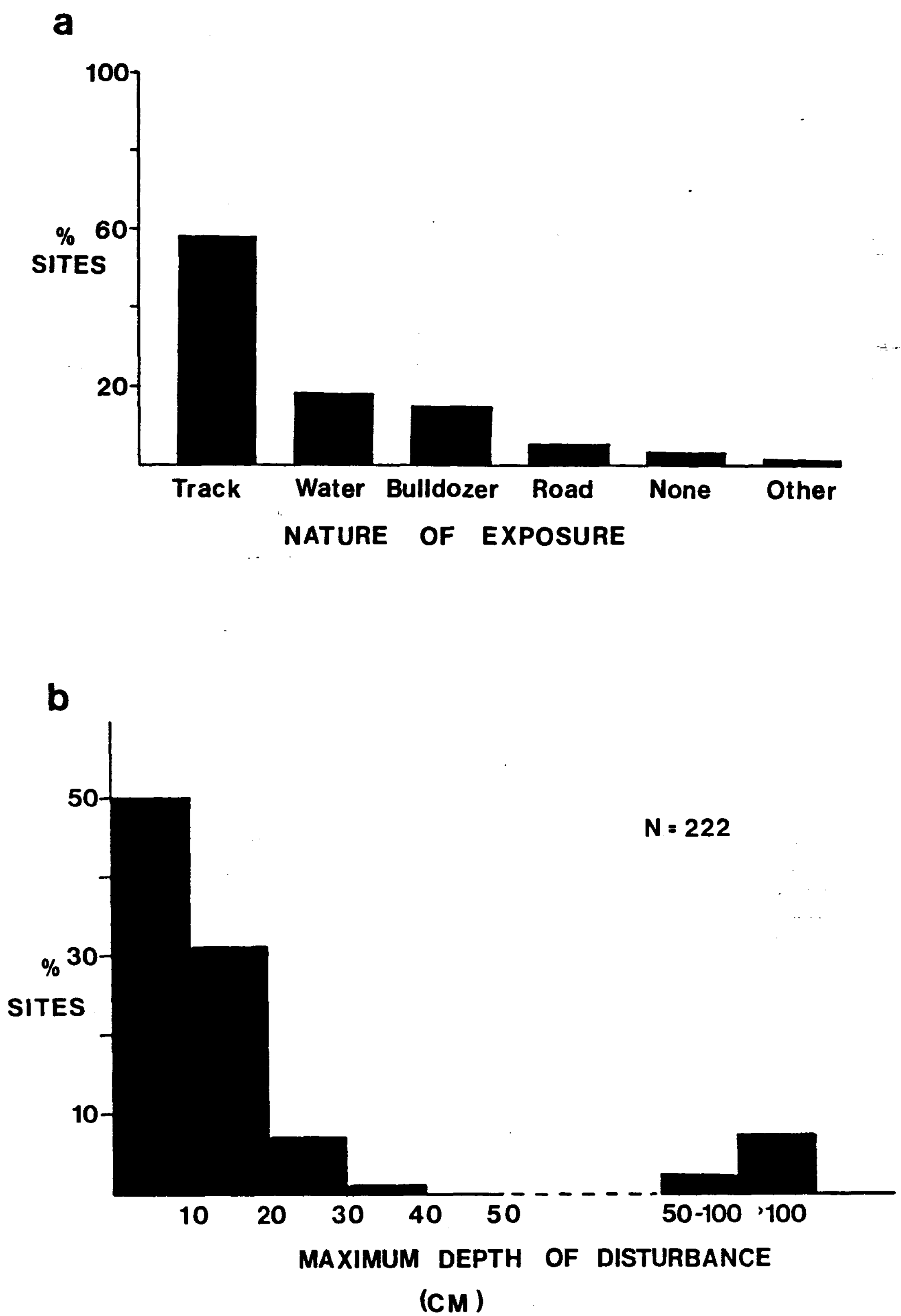


FIGURE 11.3. a: Nature of the disturbance which exposed sites.

b: Depth of disturbance on all sites.

they are buried in deep alluvial or aeolian deposits.

Site location and vegetation

The nature of the vegetation association surrounding each site located within the study area was recorded. To see if any present vegetation associations had significantly larger numbers of sites, the number of sites in each vegetation category was plotted. The results are shown in Figure 11.4. The distribution of sites closely parallels the percentage distribution of each vegetation type identified within the study area, indicating that the relative number of sites does not vary significantly across the landscape. Although 55% of sites occurred on land which had been cleared, 31% of all sites (68% of sites in vegetated areas) were found to have at least one species of edible indigenous plant within a distance of 100 metres. Bearing in mind the changes in vegetation patterns over the last 200 years, with a general decline in the number and variety of native food plants, the evidence strongly suggests that site location was influenced by the local availability of plant foods.

Site location and height above surrounding area

The initial surveys which were undertaken adjacent to the Nepean River produced a substantial proportion of sites located on ridges and terraces elevated above the surrounding landscape. The height of each site relative to the surrounding area was recorded, and it was found that 69% of the sites were less than 5 metres above the surrounding landscape. This is not surprising, since most of the western Cumberland Plain is relatively flat,

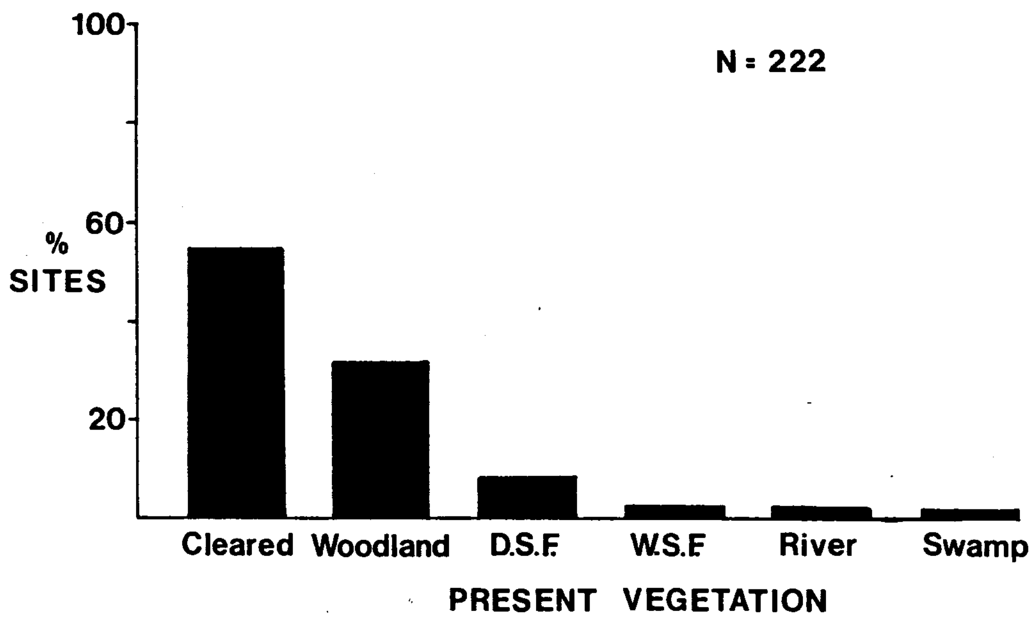


FIGURE 11.4. Relationship between the number of sites and existing vegetation.
D.S.F. = dry sclerophyll forest (open forest).
W.S.F. = wet sclerophyll forest (closed forest and rainforest-margin vegetation).

and a high correlation has already been established between waterways and sites, with waterways generally being at a low point in the landscape. Only 31% of the sites were in an elevated position on a ridge, rise or terrace, suggesting that height above the surrounding landscape was a minor consideration when selecting a site. However, of the 32 major sites located within the surveys, 16 (50%) were elevated at least 5 metres above the landscape, indicating that this parameter may be a more important consideration for selection of a intensively occupied location as opposed to a short-term or specific activity site.

11.3 Site location and lithic assemblage

Site location and distance from raw materials

For the purpose of investigating the relationship between site location and raw materials, each site was categorised on the basis of the dominant raw material present. Figure 11.5 shows that 52% of the sites are dominated by silcrete, 35% by chert and 8% by basalt, with the remaining raw materials making up the balance. The relatively high proportion of basalt is related to the fact that edge-ground hatchet heads and uniface pebble tools are often found in isolation; hence basalt is the dominant raw material on these sites.

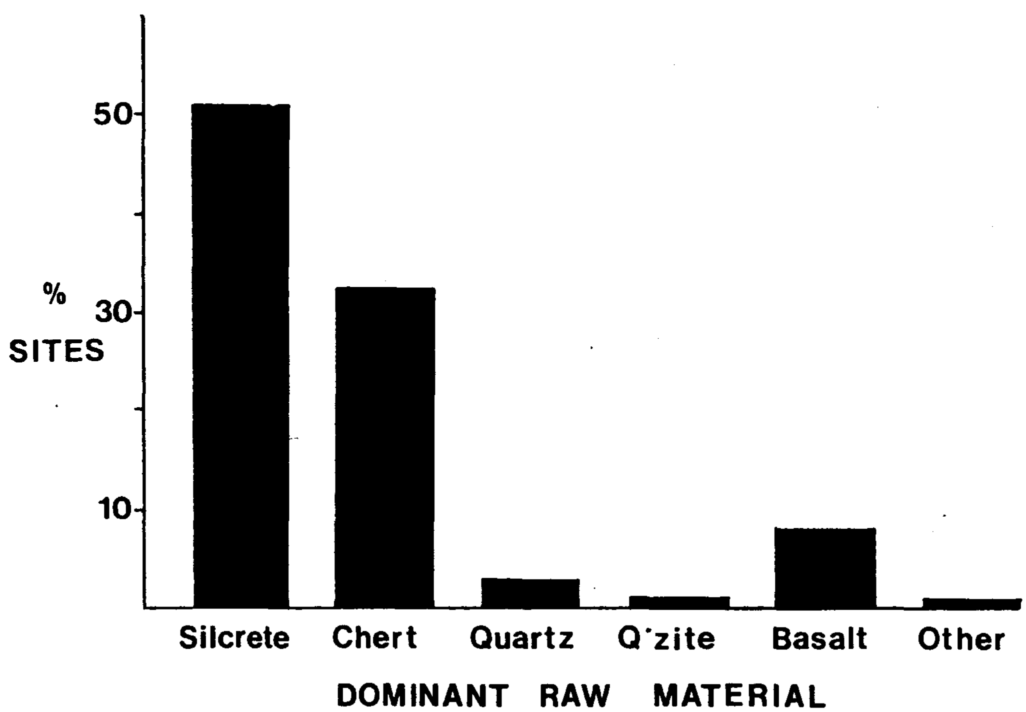


FIGURE 11.5. Dominant raw materials on sites.

Chert

The sources of chert within the study area are easily identified, being associated with the exposed gravels in the present bed of the Nepean/Hawkesbury River (although small quantities sporadically occur within the Tertiary gravels). The relationship between the number of sites with chert dominating and the distance from the chert supply was plotted, and this is shown in Figure 11.6a. The number of sites with chert dominating declines markedly with increasing distance from the source, with 67% of all chert-dominated sites being located within 5 km of the Nepean/Hawkesbury River. Figure 11.6b shows that there is a semi-logarithmic relationship between the proportion of chert-dominated sites and the distance from the source. From this figure, it is apparent that no chert-dominated sites (including isolated finds) are found at a distance greater than 25 km from the chert supply. However, small numbers of chert artefacts are still found within assemblages right across the study area.

Silcrete

Because silcrete is found over a much wider area than chert, the pattern of silcrete-dominated sites is markedly different from the chert-dominated sites. Figure 11.7 shows that unlike chert, a significant proportion of silcrete-dominated sites occurs between 5 and 10 kilometres distant from the source (43%), although the greatest percentage is still within 5 kilometres of the silcrete outcrops (54%). The fact that 97% of the silcrete-dominated sites occur closer than 10 km from the source is related to the central location of the silcrete sources within

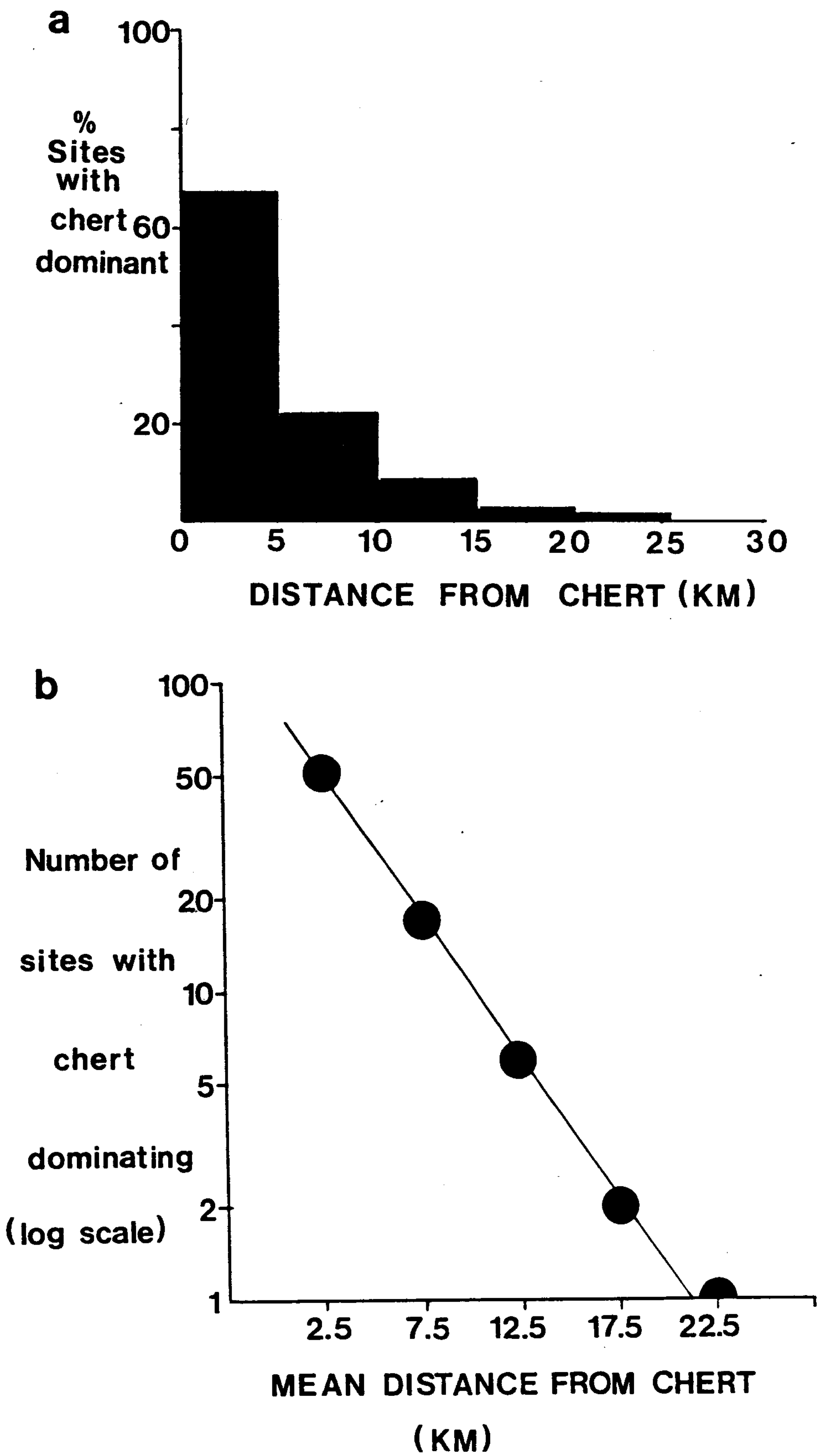


FIGURE 11.6 a: Relationship between the number of chert-dominated sites and the distance from a source of chert.

b: Relationship between the $\log_{10}$ number of chert-dominated sites and the distance from a source of chert.

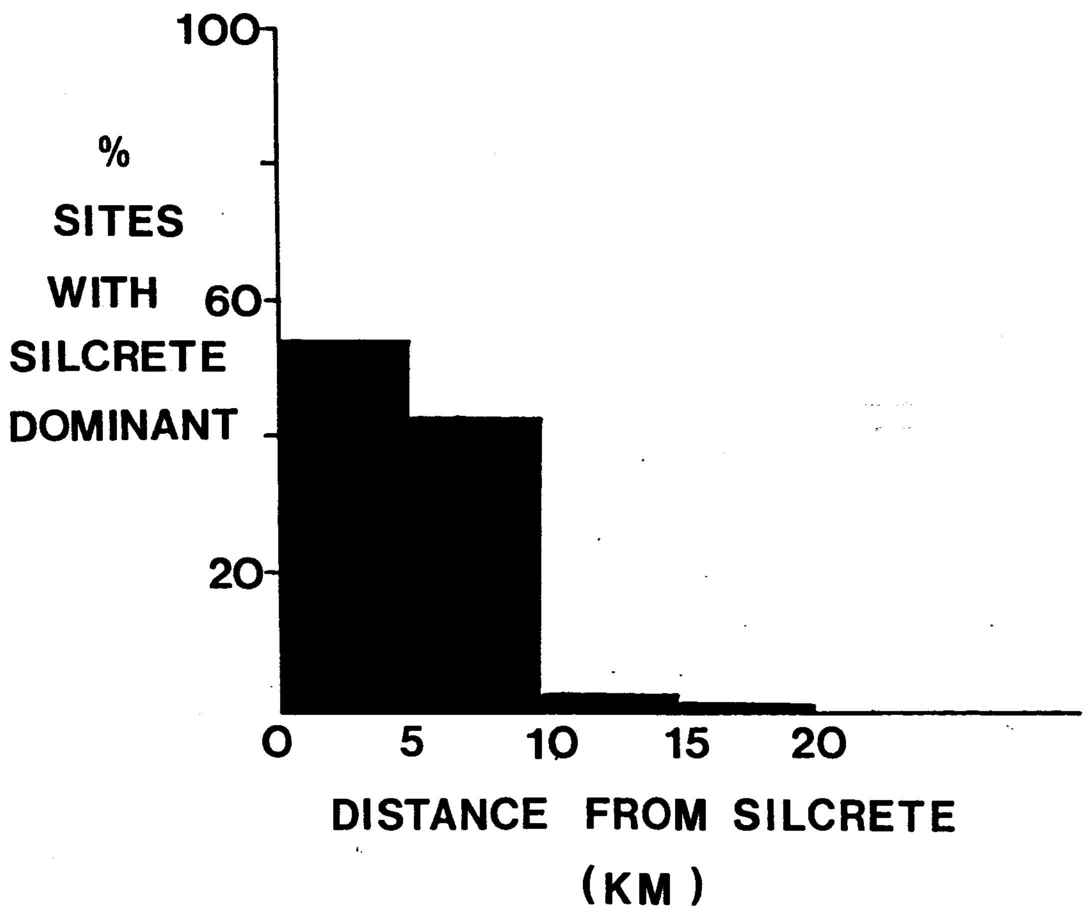


FIGURE 11.7. Relationship between the number of silcrete-dominated sites and the distance from a source of silcrete.

the study area and the fact that chert dominates to the west. However it is apparent that there is a general dependency on raw materials available within a radius of ten kilometres of the source. There is no evidence of large scale transportation of a specific raw material over any considerable distance.

While the bulk of lithic reduction is carried out on locally available stone, there is still a considerable amount of silcrete found in assemblages to the west near the Nepean River, and a significant amount of chert to the east on silcrete-dominated sites.

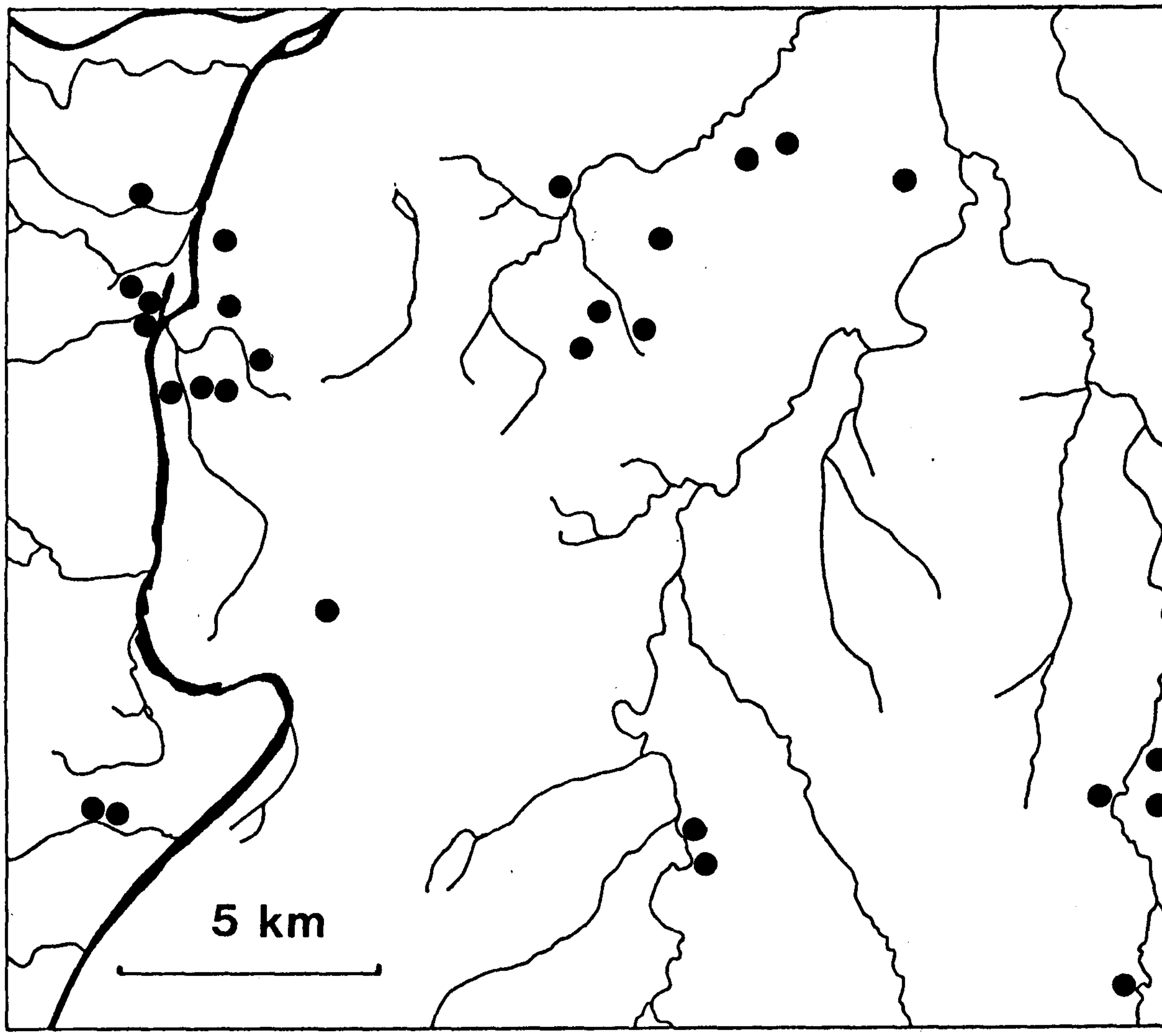
Location of specific tool types

A number of specific tool types appear to have restricted distributions across the landscape. These distributions were examined to see if they correlated with any environmental parameters.

Backed blades

The distribution of sites containing backed blades (other than elouera) is shown in Figure 11.8. It is clear that this tool type is widespread across the study area, being found on 37 sites in all environments with the exception of the Agnes Banks sands. There are no clear correlations with any specific environmental parameters, but it is significant that of the 514 backed blades located on the open sites, 451 (88%) occur within 1 kilometre of the Nepean/Hawkesbury River, while another 30 (6%) were found at the Second Ponds Creek complex.

FIGURE 11.8. Distribution of sites containing backed blades.


5 km

Elouera

The distribution of sites containing elouera is shown in Figure 11.9. Again the distribution is widespread, with 89 examples of this tool type being located on 29 sites. However, of these 89 elouera, 70 (78%) were found within 1 kilometre of the Nepean/Hawkesbury River, and 41 (45% of the total) were located on Emu Plains, within a kilometre of McCarthy's excavated site after which the *Eloueran* was named (McCarthy, 1948).

Uniface pebble tools

The distribution of uniface pebble tools is shown in Figure 11.10. A total of 130 uniface pebble tools were recovered from 32 sites, and in this case there is a strong correlation between the site location and proximity to the Nepean River. Only three sites occur further than 1 kilometre from the river, and a single pebble tool was found at each of these sites. Since 98% of uniface pebble tools were located in close proximity to the source of raw material (almost exclusively the basalt pebbles in the bed of the Nepean), and since the three found away from the river were all atypical (two made of quartzite and one re-flaked from a discarded edge-ground hatchet head), there can be little doubt that pebble tool blanks were collected and uniface pebble tools manufactured and used in the immediate vicinity of the Nepean River. There is no evidence to suggest that this tool type was transported or traded away from the source.

FIGURE 11.9. Distribution of sites containing elouera.

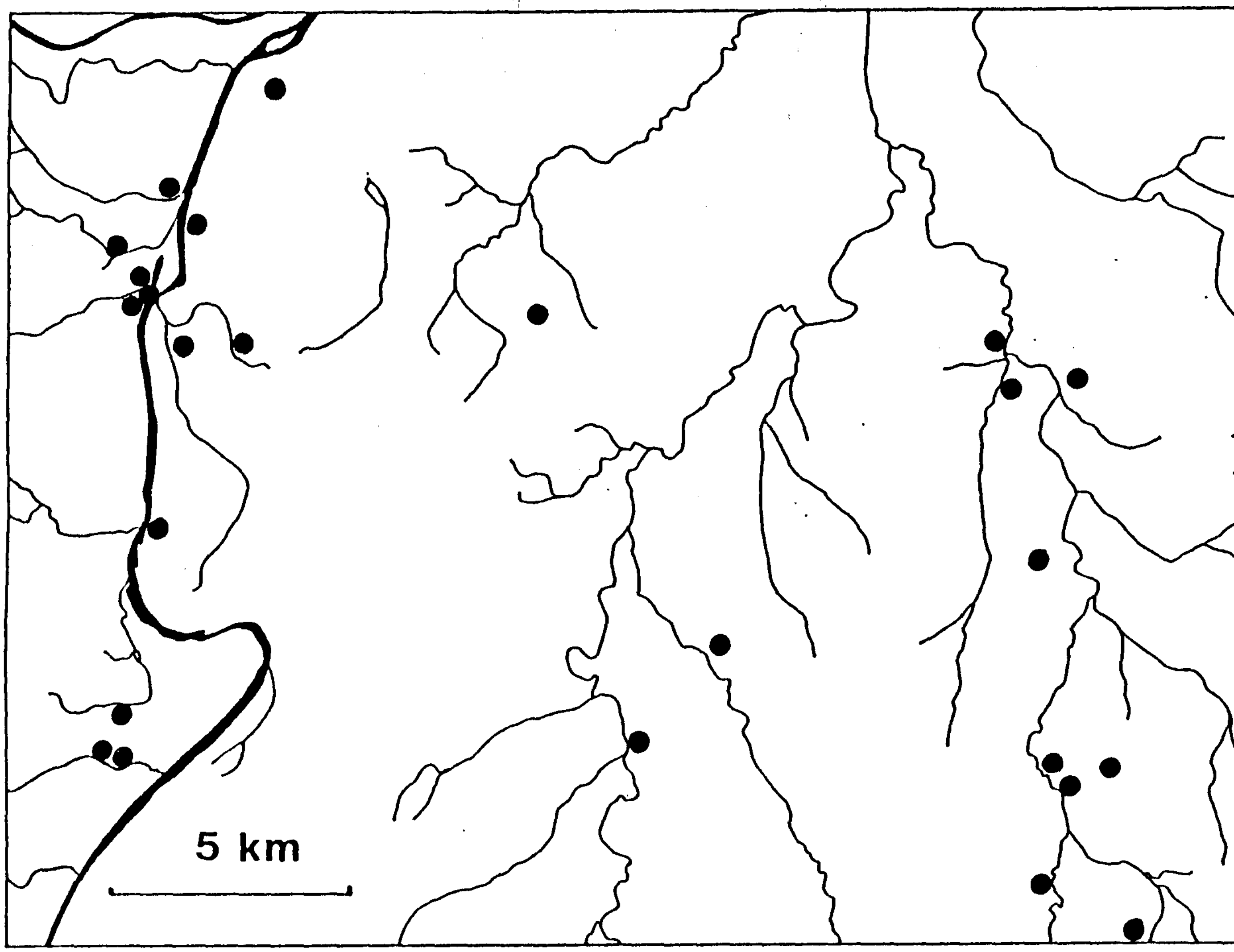
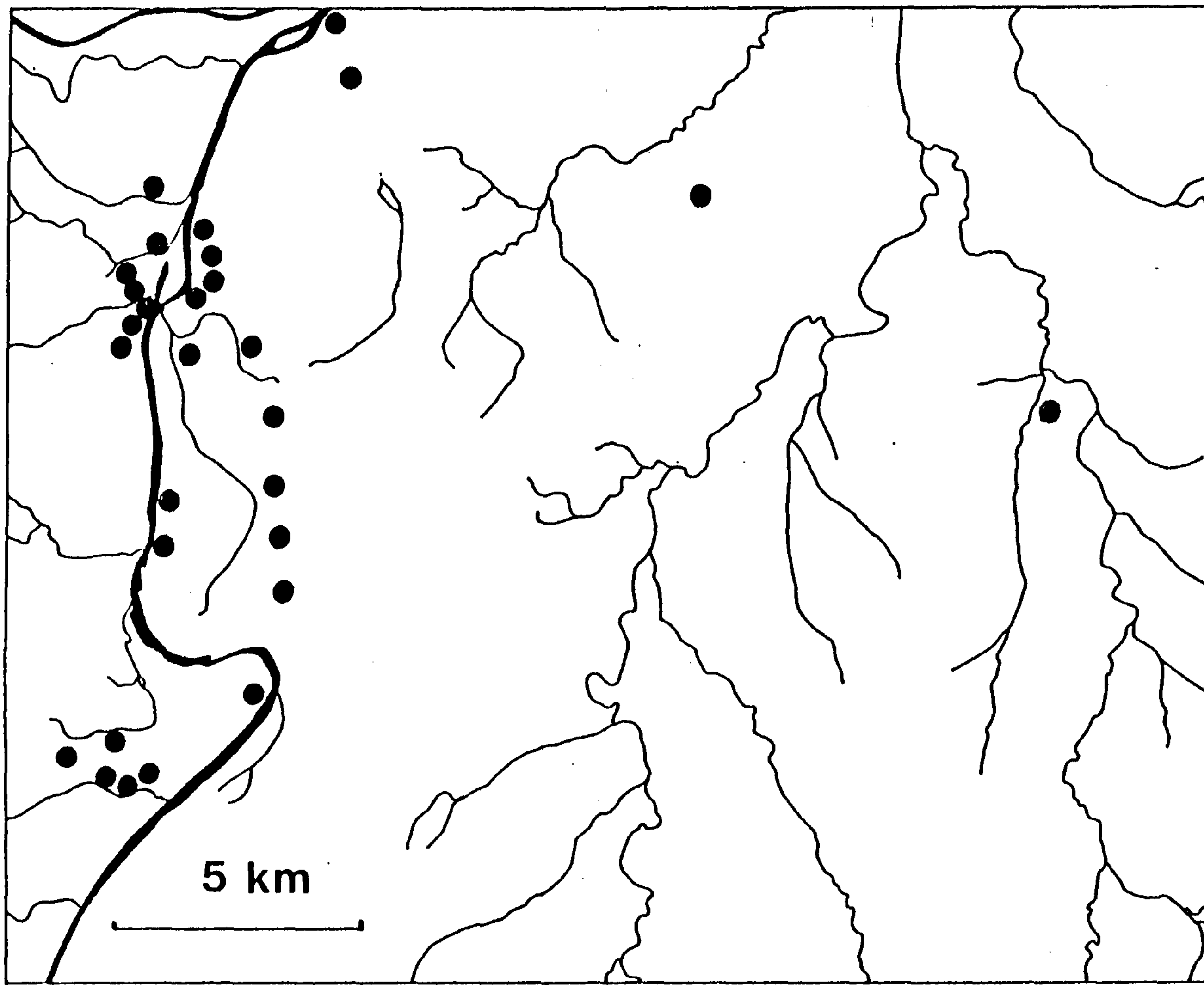

5 km

FIGURE 11.10. Distribution of sites containing uniface pebble tools.


5 km

Biface pebble tools

The distribution of bifacially flaked pebble tools is shown in Figure 11.11. While there is again a strong correlation with sites adjacent to the Nepean River, with 32 out of 35 (90%) found within a kilometre of the river, the other three are between fourteen and nineteen kilometres away. They are typical of the types found along the river, with rough bifacial flaking and no obvious sharp edges, and are best interpreted as edge-ground hatchet blanks.

Edge-ground tools

A total of 47 edge-ground tools were found at 26 sites, and the distribution of the sites is shown in Figure 11.12. All of the edge-ground tools were made from basalt pebbles with the exception of a hatchet head which was made from an exotic green indurated mudstone and a second made from a local indurated sandstone. The most notable aspect of the distribution of the edge-ground tools is that they are usually found in low numbers at each site. Table 11.1 shows the frequency of edge-ground tools across all sites.

NUMBER OF EDGE-GROUND TOOLS	NUMBER OF SITES	TOTAL
1	19	19
2	4	8
3	1	3
4	1	4
> 4 (13)	1	13
TOTAL	26	47

Table 11.1. The distribution of edge-ground tools at sites across the western Cumberland Plain.

FIGURE 11.11. Distribution of sites containing biface pebble tools.

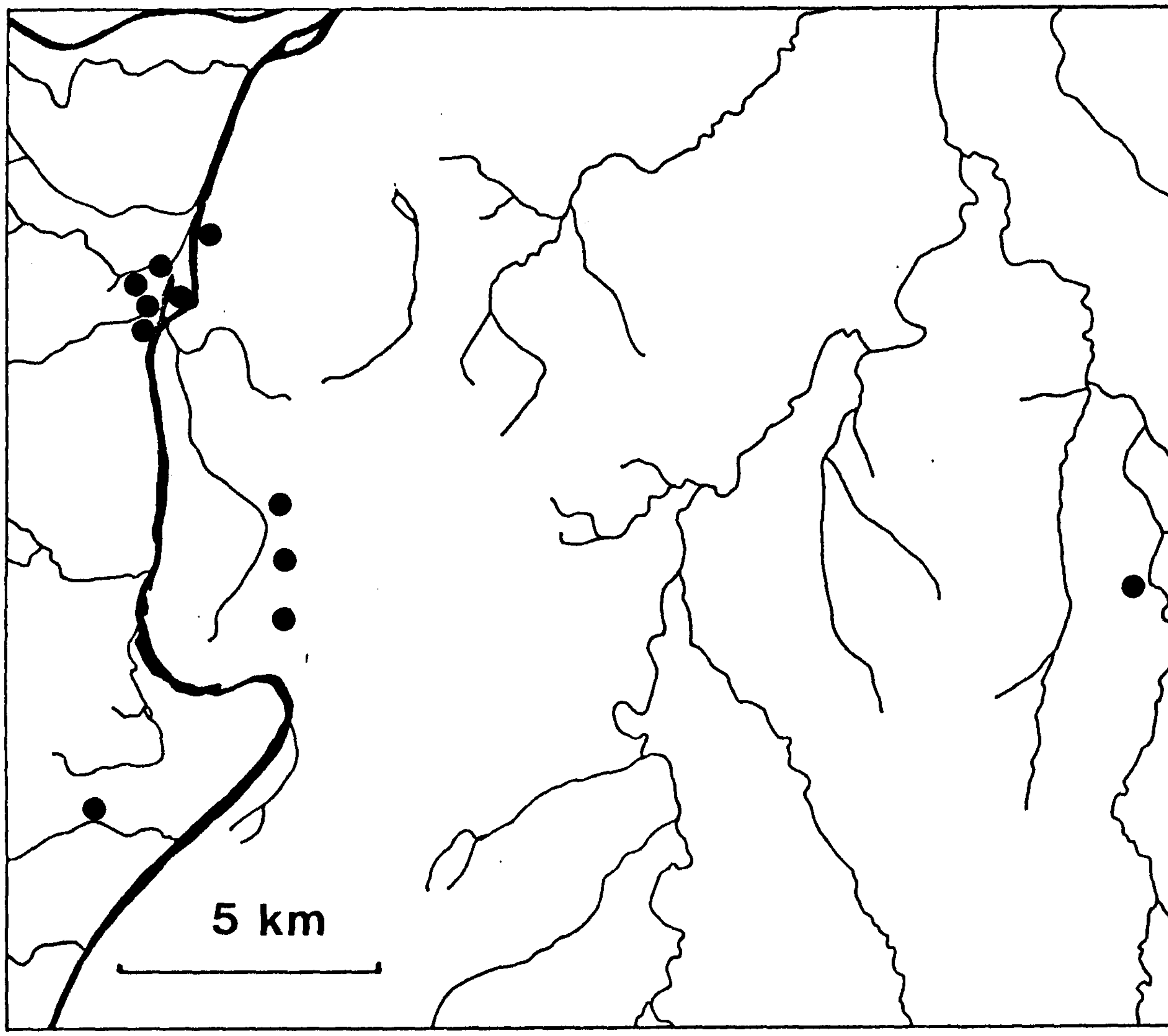
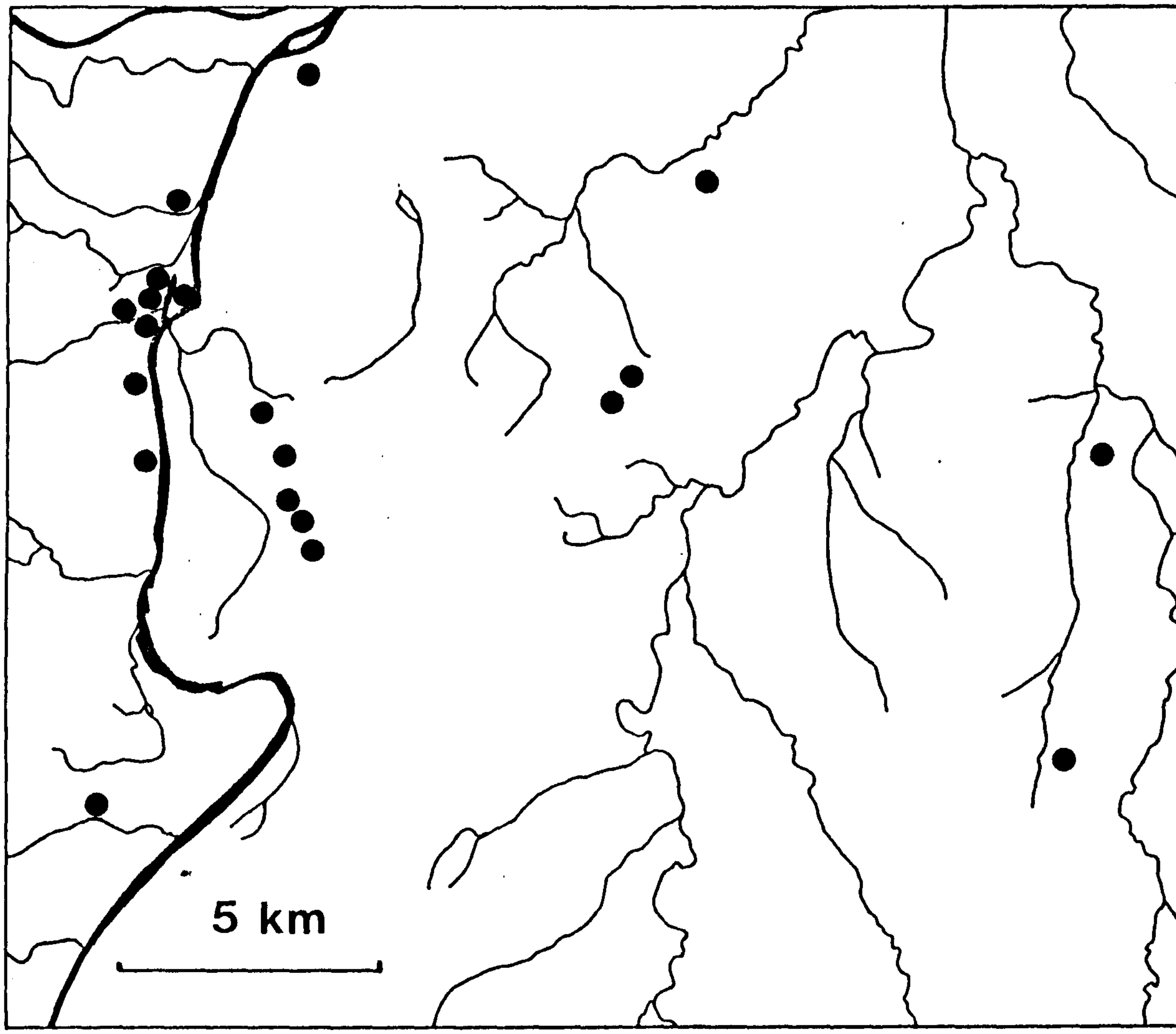

5 km

FIGURE 11.12. Distribution of sites containing edge-ground tools.


5 km

The distribution of edge-ground tools, most of which are almost certainly hatchet heads, is in stark contrast to the distribution of uniface pebble tools, a stone tool type which uses the same raw materials obtained from the same sources. From the ethnographic evidence it is clear that hatchets were common and widespread throughout the Sydney region, with at least one account of a coastal Aborigine collecting basalt pebbles from the gravel beds at Castlereagh to be later manufactured into hatchet heads. The multipurpose nature of edge-ground hatchets has resulted in this tool type being widely distributed across the landscape.

Steep thick flake scrapers

The occurrence of steep thick flake tools within early sites necessitated some detailed investigation of this tool type. The tool occurs on 58 sites, and a total of 138 artefacts were identified. Figure 11.13 and Table 11.2 show their distribution and frequency of occurrence.

NUMBER OF STEEP THICK FLAKE TOOLS	NUMBER OF SITES	TOTAL
1	31	31
2	9	18
3	5	15
4	5	20
5	5	25
6	-	-
7	2	14
> 7 (15)	1	15
	58	138

Table 11.2 The distribution of steep thick flake tools across all western Cumberland Plain open sites.

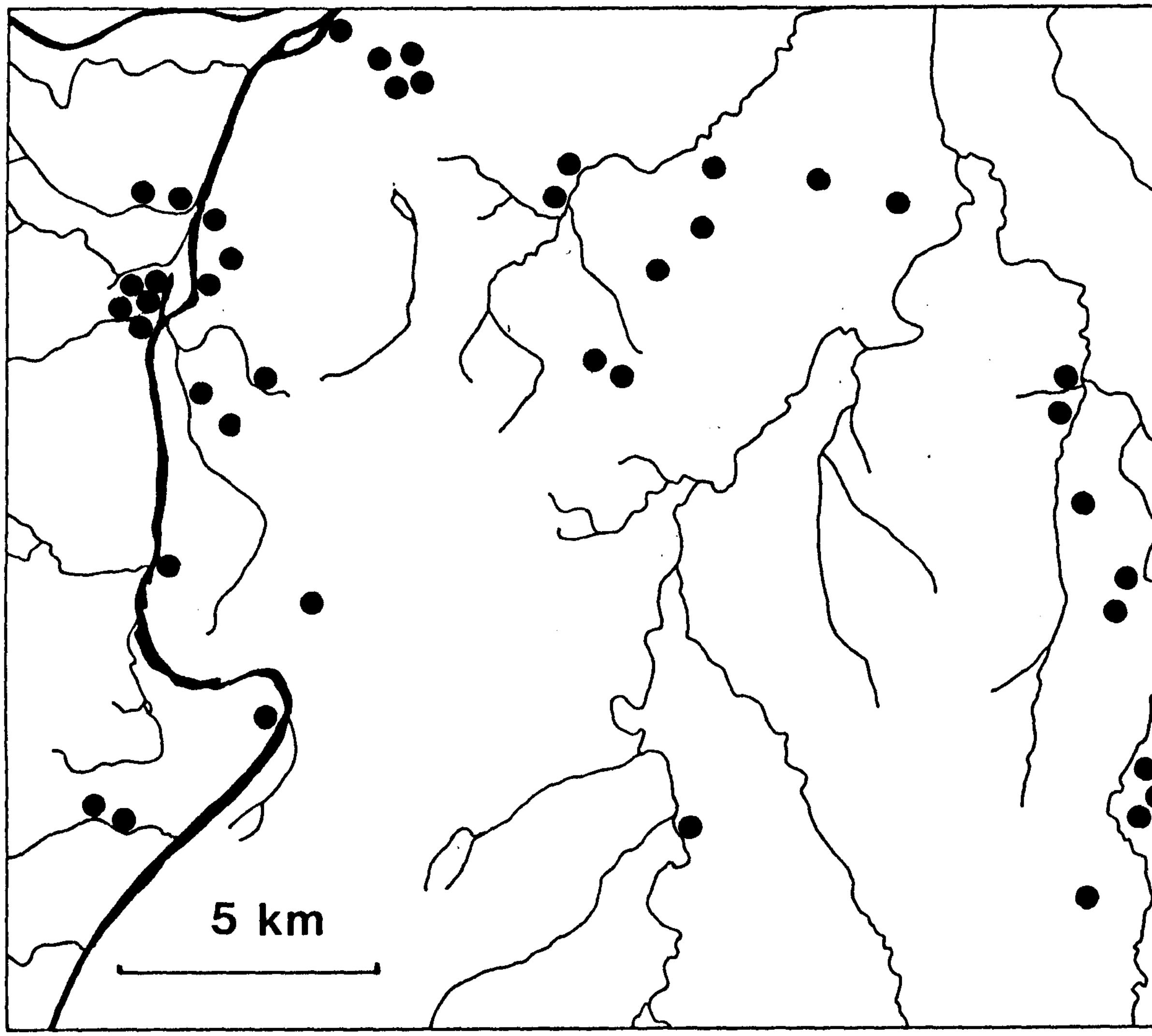
The distribution is widespread, and there are no obvious correlations with any specific environmental parameter. This might be expected, since steep thick flake scrapers are best interpreted as woodworking tools and would therefore be found on most sites where this activity was carried out. The important observation from Table 11.2 is that few sites contain large numbers of this tool type. Of the sites which have four or more steep thick flake scrapers, twelve out of thirteen occur within 500 metres of a source of chert or silcrete, the exception being Second Ponds Creek site 6.

It appears that a number of factors is involved in the distribution of thick flake scrapers across the landscape. Four factors which have been identified are:

1) the tool type is more likely to be found in large numbers close to a source of raw material.
2) they are found in large numbers in early assemblages,
3) they may be found at any site where woodworking occurs, and
4) they are frequently discarded in isolation.

The first point is undoubtedly related to thick flakes being an early stage in the reduction process of chert and silcrete pebbles and lumps. The availability of raw material, temporal and cultural variation, functional variation and spatial discard patterning all appear to contribute to the final distribution.

FIGURE 11.13. Distribution of sites containing steep thick flake scrapers.


5 km

11.4 Changes in Aboriginal settlement pattern over time

The distribution of sites has demonstrated that evidence of prehistoric occupation of the western Cumberland Plain is to be found continuously across the landscape, with no environmental zone left unexploited. On the basis of the location of the sites and their lithic assemblages, it is also possible to identify trends in the use of the resources over time.

The earliest securely dated occupation site within the study area is the Shaws Creek KII rockshelter, with a consistent sequence of radiocarbon dates extending back at least 13,000 years. Stockton and Holland (1974) suggest that pebble tools found buried in gravels near Penrith may be as old as 28-30,000 years, and while there is still some doubt about the identification of these pebbles as tools, there is no reason to doubt that Aborigines were indeed using the resources along the Nepean River at this early period. At least two New South Wales coastal sites have been dated to the period between 15,000 and 25,000 years ago (Bowdler, 1970; Lampert, 1971).

Because of the infrequent opportunities to date open sites other than those buried by alluvial or aeolian processes, the only dated open sites on the western Cumberland Plain are the Jamisons Creek complex at Emu Plains and Second Ponds Creek 5. These two sites produce a spread of carbon dates extending over the last 7,000 years. The sand and silt deposits which cover the gravels along the Nepean River contain archaeological sites, and on the basis of a radiocarbon date and also on geomorphic grounds, the lowest levels are no older than 8,000 years (Stockton and Holland, 1974).

All firm evidence of prehistoric occupation of the western Cumberland Plain prior to the introduction of the *Bondaian* cultural phase is restricted to a narrow area within a few hundred metres of the Nepean River and on the adjoining sand deposit at Agnes Banks. However there are some indirect means for concluding that at least occasional visits to the silcrete sources adjacent to Eastern Creek occurred during the *Capertian* phase. Within the lower levels of Shaws Creek *KII*, silcrete artefacts were identified, although in considerably smaller numbers than during the *Bondaian* occupation. This confirms that at least one resource 15 kilometres to the east of the Nepean was being exploited, so it is reasonable to assume that other non-lithic resources were also being used.

The difficulty in identifying *Capertian* sites is compounded by several factors. The vast majority of *Capertian* sites in the vicinity of the Nepean River are undoubtedly buried beneath alluvial sediments, and therefore have no archaeological visibility. In addition, those *Capertian* sites which have been identified continued to be occupied into the *Bondaian*. On open sites exposed by deflation, a mixture of early and late materials will result, with the more easily identifiable *Bondaian* components masking the earlier stone industry. Only at sites like the Lapstone Creek open site, where near-surface and deeply buried deposits were exposed differentially, will the divergent natures of the two assemblages become apparent.

The lack of diagnostic artefacts in the *Capertian* assemblages and the lower density of worked stone also contribute to failure to identify these sites. The relative paucity of artefacts within the *Capertian* levels of Shaws Creek KII, so typical of pre-*Bondaian* sites, with only 1,442 stone artefacts recovered from almost ten thousand years of accumulation, may well be a reflection of the use of tools rather than the reduction of raw materials at the site. If this is the case, the preliminary stages of the reduction sequence may have occurred adjacent to the source of raw materials on the banks of the river. Evidence of such activities would be difficult to detect, since the erosional and depositional processes of the river would have buried or destroyed most of these sites.

Bearing these factors in mind, the nature and extent of the open sites located during the surveys are for the most part typical of *Bondaian* assemblages, with intensive reduction of stone, low tool:debitage ratios, low mean weight of artefacts, and occurrence of tool types dominant during the *Bondaian*. The evidence suggests that the vast majority of the sites located during the surveys date from the last 4,000 years, and that prior to this time intensive Aboriginal exploitation of resources was largely restricted to the region adjacent to the Nepean River. However a number of sites adjacent to Eastern Creek have components which may reflect earlier occupation.

The diagnostic value of backed blades as a temporal indicator of the *Bondaian* needs careful evaluation. While the presence of Bondi points and geometric microliths on a site confirms that the site was occupied at some time during the period 4000-500 B.P., their absence particularly from small sites cannot be used as evidence for lack of occupation during this period. The presence of large sites containing other diagnostic *Bondaian* artefacts but which lack backed blades, blade cores and other evidence of microblade technology strongly suggests that these sites were either occupied after the backed blades dropped from the toolkit or that they served a function fundamentally different from those where backed blades were found. Since reduction of stone was still occurring, and on the evidence from the excavated sequence at Second Ponds Creek where the backed blades did not occur in the top 20 cm of the deposit, the weight of evidence suggests that such sites were probably first occupied during the last 500-1000 years.

11.5 Discussion

The significant factors which have influenced the identification of prehistoric open sites on the western Cumberland Plain can be ranked as follows:

1) Disturbance. Archaeological visibility is increased dramatically when the soil surface is cleared of vegetation and slightly deflated.

2) Availability of water. Two out of three sites are found within 100 metres of a permanent supply of water. Large campsites are

always located close to a supply of water unless they are associated with a specific activity (e.g. QH/1 silcrete quarry).

3) Availability of plant foods. The majority of sites are located in close proximity to a range of plant foods. The larger sites are generally found near the junction of different environmental zones, resulting in a wide range of animal foods also being locally available.

4) Height above surrounding landscape. A significant proportion of sites, and particularly those with a high artefact density, are located on a terrace or rise.

5) Availability of suitable stone. There is some evidence to suggest that major sites are more likely to occur close to sources of useful raw materials like chert, silcrete and basalt. However, since the distribution of these resources coincides with two of the major waterways (Nepean River and Eastern Creek), it is not possible to separate these two influences.

The general pattern which emerges from the site location analysis is that by far the single most important consideration in locating archaeological sites is the nature of the disturbance on the site. If a site is not disturbed the chances of locating it are between twenty and two hundred times less than if some moderate disturbance has taken place. The implications of this fact for archaeological surveys in forested and relatively undisturbed areas are profound.

The major waterways form a focus of prehistoric activity, with large campsites located almost exclusively within a distance of 100 metres of a permanent water supply. Because the Nepean River flows along the foot of the Lapstone Monocline, has a mosaic of diverse environments surrounding it, and contains an abundant supply of raw materials for the manufacture of stone artefacts, it has been the most intensively occupied location for the last 15,000 years. Likewise South Creek and Eastern Creek, situated at the junction of Tertiary alluvium and shale deposits supporting a diverse range of vegetation associations, and which contain silcrete gravels, were important at least in the recent past.

Where a supply of water, raw materials, plant and animal foods, and an elevated situation coincide, there is every likelihood of finding a major archaeological site. Notwithstanding this, smaller archaeological sites were located in all environmental zones across the study area.

Plate 7. The site complex at Jamisons Creek, Emu Plains, facing north.

CHAPTER 12

DISCUSSION

12.1 Distribution of sites on the Cumberland Plain

The surveys undertaken on the western Cumberland Plain clearly show that substantial numbers of archaeological sites do exist, and are to be found across the full range of environmental settings. The principal limitation to the identification of archaeological sites is the poor archaeological visibility which characterises so much of southeastern Australia.

The survey method resulted in 222 areas of prehistoric activity being identified on the basis of lithic scatters, and because the analysis was not biased in favour of the "sites" with high surface densities and site visibility, it has been possible to identify a number of factors which have influenced the distribution of stone artefacts across the landscape. The availability of a regular supply of water was the most important single factor, with other contributing factors being the proximity to diverse environments supporting a range of plant and animal foods, availability of lithic materials and to a lesser extent an elevated situation.

The number of artefacts exposed on a site is more likely to be related to the nature and degree of disturbance than the absolute amount of stone which has actually been deposited. Along Second Ponds Creek, where high salinity and clearing have contributed to large-scale removal of all vegetation from the banks of the creek, it was seen that an almost continuous artefact scatter, albeit with varying densities, occurred beside the creek. On the basis of this observation and the relatively poor visibility beside most other creeks, it seems likely that this pattern is typical for the western Cumberland Plain rather than this being an exceptional site. Invariably, wherever large scale disturbance was located in close proximity to a permanent waterway, stone artefacts were identified.

Exposures with high artefact densities are generally concentrated within one hundred metres of a permanent water supply, although one such site was also identified on a silcrete quarry. Ethnographic documentation and oral history confirm that this site was in use at the time of European contact. The tendency for major archaeological sites to be situated in close proximity to water is not unexpected, but it does confirm that even on a relatively flat and well-watered plain larger sites show a marked pattern of clustering around waterways, a characteristic which, while still apparent in the smaller scatters, is not as significant.

Two different models for Aboriginal settlement pattern in the Sydney area in 1788 have failed to satisfy the archaeological and ethnographic data. The model proposed by Ross (1976) predicts that there would be few recent archaeological sites found, and that the ethnographic data would produce little evidence of Aboriginal bands permanently occupying the western Cumberland

Plain. Poiner's model of settlement pattern suggests that, for the coastal region to the south of Sydney, bands migrated seasonally from the coast to the hinterland, exploiting marine and estuarine resources during the summer and terrestrial resources during the winter. The ethnographic data clearly invalidates both models for the Sydney region, for numerous bands are recorded living permanently within territories which extend between Parramatta and the Lower Blue Mountains, an area totally lacking coastal resources (Kohen, in press). The archaeological data also do not support either model, although there is a possibility that there were seasonal variations in localised population densities across the Cumberland Plain depending on the availability and fruiting times of plant foods.

12.2 Patterns of Land Use

Site types

Because organic remains are rarely preserved, open archaeological sites on the western Cumberland Plain consist almost exclusively of lithic artefacts. If any residual patterning in the archaeological record is to be detected, it will be due almost entirely to activities related to stone flaking and the use of stone tools. However the environmental setting of a site can often be related to the artefacts found within the site. The thrust of this study is related to the fact that the interaction between the site and its location can be used to obtain a clearer picture of the nature of the activities being carried out on the site.

A number of sites were located which contained evidence of prehistoric occupation other than stone tools. The nature of the activity at these sites is generally obvious, and includes engravings, paintings, and axe grinding grooves within the sandstone areas, the possible fish trap at Blacks Falls, and the scarred trees which are generally restricted to the vegetated zones adjacent to the waterways.

One site type which clearly stands out may be described as a generalised campsite. Such sites exhibit traits characteristic of the full range of activies which might be expected to occur on an intensively occupied location, including reduction of stone, woodworking, and the preparation, cooking and consuming of food. An important consideration is that such a site will be located close to a regular supply of water, and will frequently occur on a ridge, terrace or rise. The lithic assemblages on these sites will contain a wide range if not the full complement of artefact types in use during the period of occupation. These sites will occur near the junction of a range of ecosystems, permitting exploitation of the full range of resources available nearby. From the survey data, it appears that such sites may be occupied over several millennia, particularly adjacent to the Nepean/ Hawkesbury River. Sites which fit neatly into this class include the Jamisons Creek and Lapstone Creek complexes on Emu Plains, the Shaws Creek and Castlereagh complexes, several of the Penrith sites which are located on the Cranebrook Ridge, the larger sites on South Creek and Eastern Creek, and the Second Ponds Creek complex. The rock shelter sites KI and KII could also be included in this category.

The distribution map of these major campsites leaves a rather large gap between the Cranebrook Ridge, Rickabys Creek and South Creek (see Figure 12.1). Although many sites were found in this area, none contained 50 or more artefacts. While this may be partly due to exposure, the relatively high number of smaller scatters suggests that the low availability of water militated against regular campsites being established within this area. A similar situation exists between South Creek and Eastern Creek, where the density of sites is low at distances greater than 100 metres from the creeks.

A number of smaller sites appear to be related to specific activities, the most obvious being those related to the acquisition and reduction of basalt pebbles near Blacks Falls. Within a kilometre of the Castlereagh gravel beds are the pebble tool and edge-ground hatchet manufacturing sites, a component of which is the the axe-grinding complex on the east bank of the Nepean River. Similar quarry sites can be identified for other raw materials: silcrete at Quakers Hill and Riverstone, and chert at Yarramundi and Upper Castlereagh. There is often a significant proportion of thick flake tools within these assemblages.

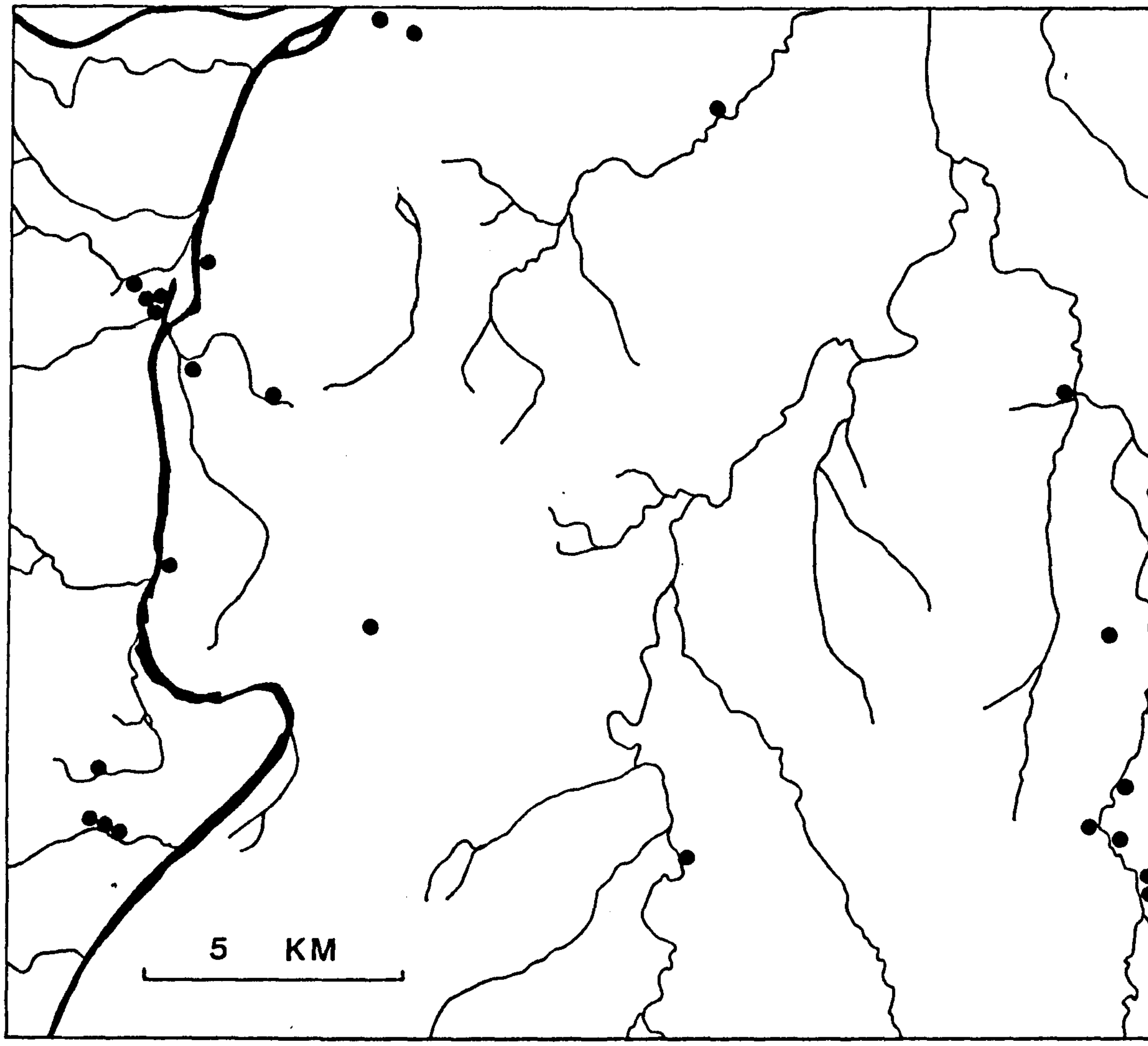
Another class of sites appears to be related to woodworking activities. They generally contain relatively few stone artefacts but have a high tool;debitage ratio. A significant proportion of the tools are related to woodworking (utilised flakes, normal flake scrapers, thick flake scrapers and elouera). They are widespread across the study area.

The nature of the isolated finds can be conveniently divided into three categories: casual loss or discard of tools, loss of cores and manuports, and loss of unworked flakes. The isolated finds are most common in those areas at some distance from a major campsite, and were particularly common in the Rickabys Creek and Castlereagh State Forest surveys. The distribution of these artefact types suggests that:

1) stone flakes and tools (often thick flake tools) were carried by groups utilising the woodland resources away from the major campsites. They were probably required for immediate use in the repair of wooden artefacts when no local supply of raw material was immediately available. Those located during the surveys were either accidentally lost or intentionally discarded.

2) unworked pieces of raw material (manuports) or cores were also carried into the wooded environments, presumably so that sharp flakes could be produced as required. The flakes may have served as knives for cutting game, for sharpening wooden spears, or to produce spear barbs. It is relevant that none of the cores found in isolation were blade cores, with blade cores being retricted to larger sites. It must be presumed that the manuports were lost, but cores could have been either lost or discarded.

FIGURE 12.1. Distribution of major campsites (N=32).



MAJOR SITES (N›50 ARTEFACTS) WITHIN THE STUDY ARE

A final category of site can be considered. These sites may be characterised by the presence of a relatively small number of unworked flakes (generally less than 10), sometimes accompanied by backed blades and/or one or two flake tools. This site type occurs throughout the study area, but generally within woodland or open forest settings, and it is possible that it represents the remains of a hunting site, with the unworked flakes and backed blades being components of stone barbed spears. The flake tools were probably used in the maintanance and repair of the spears.

Vegetation

A number of different site types and artefact types have distributions which correlate with particular vegetation associations. Major sites are almost totally absent from woodland environments, while minor sites are relatively common within the low rainfall areas. Intensive occupation along the Nepean River is associated with the production and use of uniface pebble tools, whereas this tool type is almost totally absent from other areas. Grinding grooves, by virtue of the necessity for suitable sandstone and running water, are restricted to the sandstone areas adjacent to a supply of running water. While many of these associations are coincidental, there are valid reasons for assuming that at least some occurrences are a reflection of the foraging strategies employed by Aboriginal people.

A commonly observed characteristic of traditional Aboriginal societies is a division of labour, with the men concentrating on hunting for foods which produce high protein yields, but at a considerable cost in terms of energy expenditure. Conversely, women in general are involved in the gathering of more easily obtained foods which will provide the band with a staple diet. This could include tuberous plant foods, fruits and small game. The two different kinds of activities, hunting and gathering, require two very different sets of tools. The process of digging yams along the banks of the river in general requires only a digging stick. The same would apply for the acquisition of lily and orchid tubers in woodland environments. For these tasks, there is no requirement for any form of stone tool with the possible exception of an adze flake for sharpening a digging stick. The materials required by Aboriginal women are largely organic, consisting of digging sticks, nets, baskets and coolomons. As such, they would leave no evidence in the archaeological record of the open sites because of the poor preservation of organic materials.

The activities of the female half of the prehistoric population will certainly be under-represented on prehistoric sites in the western Cumberland Plain. Only by indirect means is it possible to assess the relative contribution of the women to the economy. If the major sites are concentrated in close proximity to plant resources, then it is likely that the plant resources were being exploited. Although there is a ring of circularity to this argument, it is inconceivable that such resources would not be exploited provided they were readily accessible from the campsite and had no cultural prohibitions attached to their consumption.

While the gathering of fruits required no specialised technology, the manufacture of digging sticks for the extraction of tuberous plant foods does require the use of stone tools for their manufacture and repair. Mazel and Parkington (1981) have analysed assemblages in a number of South African sites, and have come to the conclusion that adzes were wood-working tools which were used in the manufacture and repair of digging sticks. Because of the excellent preservation of organic materials in their sites, they were able to conclude that adze frequency was closely related to the density of underground plant food residues. In explaining why adze flakes were so common in mountain sites, they suggested that

> " ... another factor which may have influenced the turnover rate of digging sticks is the variable character of the soils in the different physiographic zones. The mountain soils are shallow, course-grained and often very stony, whilst those on the Sandveld are fine grained loose sandy soils for the most part and far easier to dig. It is possible that this difference accelerated damage to the tips of digging sticks in the mountain areas, thus increasing the need for tool maintenance". (ibid: 22).

The other factor which contributed to the high frequency of adze flakes in mountain sites was the occurrence of wood suitable for the manufacture of digging sticks. This description of exceptionally high levels of adze flakes, rocky soils, ethnographic description of reliance on tuberous plant foods, and local availability of hardwood vegetation parallels the situation in the upper levels of McCarthy's Lapstone Creek rockshelter site, where each of these condition applies. There can be little doubt that the high levels of elouera adze flakes in the Lapstone Creek site are a reflection of increasing woodworking activity, probably associated with the manufacture and repair of digging sticks, replacing a technology dominated by backed blades (a technology which is generally considered to be related to hunting).

Seasonality

Again because of the poor preservation of organic remains on the open sites, no direct evidence of seasonal occupation was forthcoming. The Shaws Creek KII excavation, while containing a small faunal assemblage, did not provide any examples of species which could be used as seasonal indicators. The resources which were identified were available throughout the year, and nothing in the stone tool assemblages provided any clues. Some animal resources which are recorded ethnographically as having been used by the local Aborigines, do only occur at specific times of the year. Freshwater mullet and bass migrate upstream during the summer months, eels were reported as having been an important food during the month of April (Autumn), while fruit bats became available during the summer. Most of the animal resources (macropods, possums, birds, freshwater mussel, reptiles) were continually available.

The plant resources present a rather different picture. At least some fruits and tubers are available at all times during the year, and the local availability varies depending on the particular vegetation association. Generally the autumn and winter months provide the widest range of fruits along the foot of the Lapstone Monocline, where the diversity is greatest. Further east within the woodlands a smaller range of edible species occurs, but the availability of fruits and tubers is influenced to a far greater extent by the amount of rainfall in the preceding few months.

The ethnographic evidence is not really helpful. Walker (1821) suggests that people from the South Creek Tribe spent some time on the Hawkesbury River, probably in the late summer or early autumn, while the local oral history suggests that the sites adjacent to the silcrete quarry at Plumpton were used during the winter months. In any event, whatever seasonal movements did occur took place *within* the study area, for there is no evidence to suggest that large-scale movements out of the core territory occurred for other than social or religious purposes.

Having established what the settlement pattern was like in 1788, it would be unwise to project this pattern back in time. Although the settlement pattern in 1788 is clear, there is some evidence to suggest that the seasonal movements which were proposed by Poiner between the coast and the hinterland may in fact have occurred at some time in the past. Backed blades are widespread on undated open coastal sites, and many of them are made from the red silcrete which is so characteristic of the sources on the western Cumberland Plain. Artefacts from surface collections made at Bondi to the immediate south of Sydney and Kurnell on the south side of Botany Bay both contain significant proportions of silcrete. This suggests that perhaps there was greater fluidity of movement during the early or mid *Bondaian*, or alternately that trade between the coast and the plain was more important. There is certainly an indication of changing patterns of social contact.

12.3 Variability in stone tool assemblages

Four factors have been identified which influenced the variation in the stone tool assemblages: spatial, temporal functional and taphonomic variability. Obviously for some stone artefact types, more than one of these variables will contribute to the variation. For example it was found that uniface pebble tools were found in a restricted environment, so both the spatial distribution and the function of the tool type is reflected in the distribution. Similarly, backed blades have a spatial component (concentrated on large sites), a functional component (hunting), and a temporal component (between *circa* 4,000 BP and 500 BP). However, by treating the sources of variation individually, the relationships between the parameters can be identified.

Temporal variability

The fundamental division between the *Capertian* and *Bondaian* assemblages has been firmly dated as no earlier than 4,000 BP on the basis of radiocarbon dates from both Shaws Creek KII and Jamisons Creek. This is supported by the Lapstone Creek rock shelter date which, although it should be treated with caution, at least confirms that the early *Bondaian* industry first arrived in the Nepean River area after 4,000 years ago. Johnson (1979) argues for the introduction of backed blades during the period 3,000-4,000 BP, and the data from the western Cumberland Plain confirm this assessment.

Associated with the backed blades is a range of technological changes, all of which are generally recognised as belonging to the *Bondaian* industry. These changes include the major innovations of blade production and grinding technology. Associated with these innovations were the continuation of a range of earlier tool types in reduced numbers (thick flake and core tools) and the increase in significance of others (thumbnail scrapers and bipolar flaking).

At some time during the *Bondaian* and after 650 BP, the backed blades dropped out of the toolkit. There is no evidence to support the proposal that bipolar pieces actually replaced Bondi points, as has been suggested for the South Coast (Lampert, 1971). At Shaws Creek, the backed blades and bipolar pieces are highly correlated, but it should be remembered that no radiocarbon dates were obtained from Shaws Creek within the last millennium. On sites to the east, the relative importance of bipolar pieces is slight. This is almost certainly a reflection of the technological process necessary to reduce quartz - bipolar flaking (Dickson, 1977). Quartz is a minor component of recent assemblages at sites more than 10 kilometres east of the Nepean River, and as a result bipolar flaking is not a significant reduction process at these sites.

Elouera adze flakes occur throughout the *Bondaian*, and are not diagnostic of any particular time period. On the basis of the evidence from coastal sites, elouera appear to have been retained in the tookit later than the other backed blades, but there is still no certainty that this tool type was in use in 1788. The dominance of elouera adze flakes in the Lapstone Creek rockshelter is best explained in terms of functional variability rather than temporal variability. It also seems likely, on the basis of the clustering of elouera adze flakes and sharp thick flake scrapers by the Divinfre analysis, that sharp thick flake scrapers served a similar if not identical function, and many tools which are formally defined as sharp thick flake scrapers may in fact have functioned as hafted adze flakes.

Spatial variability

Edge-ground hatchets form a class of tools which are widespread across the study area, although they do tend to be more common near the gravel beds of the Nepean River. It is apparent from the ethnographic evidence that this tool type was used in a range of processes including the hunting of possums and the removal of bark and wood from trees. The distribution of the edge-ground tools reflects the fact that the collection of possums was a widespread occurrence at the time of European settlement. The presence of sandstone slabs at two sites in the wooded environment of Castlereagh State Forest may also be a relection of the use of edge-ground tools, for such slabs were recorded as having been used for re-sharpening blunt hatchet heads.

Uniface pebble tools, made from the same raw material obtained from the same sources as the hatchet heads, show a markedly different pattern, being concentrated adjacent to the Nepean River. This spatial variation suggests that either the resource for which the pebble tools were required was not found away from the river, or alternately that another artefact type (possibly the edge-ground hatchet) replaced it to the east of the river. The function of the uniface pebble tools becomes crucial in assessing which of these two alternatives is correct.

Well formed pebble tools were largely restricted to open sites adjacent to the river, were found in geomorphic settings consistent with continuous manufacture over the last 7,000 years, and were sometimes found exhibiting use-polish. This has led to the proposal that they may have been used as wedges and involved in the removal of bark from trees for the manufacture of canoes (Kohen, 1984b). While other possibilities exist, there can be no doubt that the presence of uniface pebble tools on a site is highly correlated to the distance from the pebbles. This argues strongly against the use of uniface pebble tools as diagnostic of the pre-microlithic industries, and also brings into question the interpretation of high pebble/core/thick flake tool index values for open sites.

Steep thick flake scrapers are another tool type which appear to be a significant component of early assemblages. The presence of many chert steep thick flake scrapers within the *Capertian* layers at Shaws Creek confirms this, but they are also found on quarry sites. While this is probably because large flakes are produced during the reduction process, it does not preclude the possibility that the quarry sites were in use prior to the introduction of the *Bondaian* industry.

In the light of the spatial variability observed within several components of the pebble/core/thick flake tool index, its value in assessing the status of open sites must fall under closer scrutiny. It is apparent that some open sites with high p/c/tf tool indices are almost certainly pre-microlithic in age, but others are clearly specific activity sites probably of recent origin. The value in the use of the p/c/tf index would appear to be in the identification of sites which are clearly *Bondaian*, as reflected in their assemblages, and distinguishing them from sites which may be either early sites which contain a pre-microlithic component, or sites which represent specific activity areas related to quarrying or pebble tool use.

Since low density of stone is one of the characteristics of the excavated *Capertian* assemblages in the study area and in the Blue Mountains to the west, many of the isolated finds of heavily patinated thick flake tools are likely to have been discarded before 4000 BP. The nature of the secure *Capertian* open sites like Lapstone Creek LC/1B and Jamisons Creek Lower Terrace East (JC/LTE) confirm that pebble tools and thick flake tools did dominate, but that even in areas close to sources of raw materials there is a relatively small percentage of debitage present. These sites are best viewed as campsites at which reduction of stone was a minor activity, rather than a major activity as appears to have been the case in the later *Bondaian* sites.

12.4 The prehistory of the western Cumberland Plain

Before 15,000 BP

There is little evidence to suggest that the western Cumberland Plain was occupied prior to about 30,000 BP, although radiocarbon dates from Western Australia confirm that Aboriginal people have lived in Australia for a least 40,000 years (Pearce and Barbetti, 1981). The first tenuous evidence suggesting the presence of man in the Sydney region comes from the discovery of possible pebble tools in gravel beds at Penrith dating from the period around 28,000 B.P., and a later occupation site at King's Table Shelter with a radiocarbon date of 22,240 ± 1000 BP (Stockton, 1973b; Stockton and Holland, 1974). Bowdler (1981) disregards the King's Table date when assessing archaeological sites in the Eastern Australian Uplands because it is associated with a single stone artefact. While both early discoveries have been treated with scepticism, the presence of firmly dated late

Pleistocene sites from the period between 15,000 and 22,000 B.P. at Bass Point (Bowdler, 1970) and Burrill Lake (Lampert, 1971) within a few hundred kilometres of Sydney at least confirms the possibility of Aborigines exploiting the resources of the western Cumberland Plain before 15,000 BP.

Prior to 15,000 BP the western Cumberland Plain provided a very different environmental setting in which Aboriginal people may have existed. The period from 25000 to 15000 BP in southeastern Australia was characterised by cold, dry and windy conditions (Singh, 1983). Geomorphic processes may well have covered most open sites from this period if occupation was concentrated along the Nepean River. The significance of Agnes Banks sand deposit is apparent if it is of late Pleistocene age and formed by strong winds and dry conditions during the glacial maximum, for it may contain the only stratified evidence of occupation in the area which has not been subjected to gross alluvial disturbance.

The Bass Point and Burrill Lake sites are generally viewed as inland foraging sites infrequently visited by people largely dependent on coastal resources (Bowdler, 1977). Bowdler argues that colonisation of Australia was coastal, and thence up the major rivers. Whether or not this model is correct, the riverine resources of the Nepean and Hawkesbury Rivers could well have been exploited during this time.

15,000 - 4,000 BP

There is ample evidence for prehistoric use of resources along the Nepean River and in the Blue Mountains during this time period. Rock shelter sites like Shaws Creek KII (and presumeably KI) and open sites like Lapstone Creek and Jamisons Creek on Emu Plains have produced lithic assemblages firmly dated to this period. The stone tool kit is primarily one of large utilised flakes and scrapers, although pebble tools are also a significant component on the open sites. The local chert was the principal stone in use, but some exploitation of silcrete from the plain to the east was observed in the Shaws Creek KII sequence, and a small percentage of the sites near the silcrete sources near Eastern Creek show some tentative evidence for early occupation.

The types of stone tools in use during this *Capertian* technological phase are similar to other pre-microlithic assemblages throughout southeastern Australia, particularly the Blue Mountains sites described by Stockton and Holland (1974) and the Capertee 3 assemblage (McCarthy, 1964). Tools are found in low numbers, but it is significant to note that there is relatively little debitage at these sites, particularly on the open sites. This may be because the initial production of flakes was taking place near the sources of raw material (principally the Nepean gravel beds), rather than at the place of discard of the tools (the sites). The *Capertian* sites would then appear to be fundamentally different from the later *Bondaian* sites in one important regard: the reduction of stone and associated production of large quantities of debitage, so characteristic of the *Bondaian*, did not occur to any significant extent. The activities being carried out on the *Capertian* sites were related primarily to domestic activities and woodworking.

The period between 6000 and 4000 B.P. is characterised by a layer within Phase IV at Shaws Creek KII with a distinct decline in the density of stone discarded per unit volume of deposit. This low density layer was also identified across the Jamisons Creek open site, and these findings support the proposition that the significant decline in artefact density identified in Blue Mountains sites by Stockton (and referred to by him as a hiatus) was a widespread phenomenon occurring on both rock shelter sites and open sites. This eliminates the possibility that there was a general shift from rockshelter sites to open sites at this time, so the reason for the low density layer must be sought in the taphonomic processes which lead to the accumulation of an archaeological deposit. Either the number of artefacts discarded per unit time decreased significantly, or the rate of sediment accumulation per unit time increased significantly. Since there is no firm evidence for any major climatic change to have occurred during this timespan (Chappell and Grindrod, 1983; Young, 1986), if the low density layer is a result of geomorphic processes it may be related to a localised phenomenon. One possible mechanism for an increased rate of sedimentation is a change in Aboriginal burning patterns, a process which may have been accelerated by the reduction from the high precipitation levels identified across much of southeastern Australia at around 7,000 B.P. (Chappell and Grindrod, 1983: 88).

4,000 - 1,000 BP

The stone industry found on all the sites within the study area dating from this time span belongs to the *Bondaian* technology, and these sites are recognised by the dramatic changes evident in the lithic assemblages. The period between 4,000 and 3,000 BP saw the introduction of backed blades and the microblade technology, and the decrease in the mean weight and size of debitage. Over the subsequent 1,000 years the proportion of backed blades in the toolkit increased, peaking sometime between 2,000 and 1500 BP, edge-ground tools become more common, and there is a gradual change in the proportions of various raw materials. The sudden technological change on the south coast which occurred about this time, with the Bondi points and geometric microliths dropping out of the toolkit altogether, was not paralleled in the Sydney area, where a more gradual transition was evident. The economy being practised during this time appears to have been similar on the coast, across the plain and in the Blue Mountains, since the same microblade technology dominated. Undoubtedly the shellfish on the coast provided a regular and secure staple, a role which may have been fulfilled by tuberous plants across the plain. In view of the presence of silcrete in coastal assemblages at this time, it seems likely that the same population was exploiting these various resources seasonally, as suggested by the model proposed by Poiner (1976).

McBryde (1977: 234-6) has suggested that, on the basis of the results of excavations in the New England region, the backed blade technology was associated with hunting kangaroos and other large macropodids. If this interpretation is correct (and by analogy with other sites containing backed blades there is strong circumstantial evidence to support this argument), then the open woodlands of the western Cumberland Plain could well have been exploited seasonally for kangaroos by populations based on the coast in addition to those along the Nepean River.

1000 BP - 1788 AD

The decline of backed blades continued although they were still in use on plains sites until at least 650 BP. Ethnographic evidence from the end of the eighteenth century confirms that edge-ground hatchets, stone adze flakes and spear barbs (although not backed blades) were all components of the stone tool kit during this time away from the coastal strip, but that only the edge-ground hatchet was in use along the coast, where stone had been replaced by shell and bone was used for scrapers and barbs (Kohen and Lampert, in press).

For the Southern Highlands, Flood (1980: 250) has suggested that unworked quartz flakes and bipolar pieces replaced backed blades as spear barbs, the loss of backed blades being interpreted as a technological change but with functional continuity. The evidence from Shaws Creek KII shows that the increasing use of quartz paralleled the use of backed blades at least until around 1500 BP. In sites situated in the sandstone areas at the foot of the Blue Mountains, backed blades may well have been replaced by unworked quartz flakes, but across the

Cumberland Plain the ethnographic and archaeological evidence suggests that it was untrimmed silcrete flakes rather than quartz which were used in compound stone barbed spears.

The reason for this major technological change during the *Bondaian* may have been an economic or a purely cultural phenomenon. Certainly the absence of backed blades on coastal sites is more easily interpreted as an economic change, with a general shift from a hunting to a fishing economy. The ethnographic and archaeological data indicate that the economy of the "woods tribes" was based on plant foods and possum exploitation. The dominance of edge-ground hatchets, described in the ethnography as being used primarily for the capture of possums, and adze flakes (which may have been used to manufacture and sharpen digging sticks for plant foods) in at least some localised areas, tends to reinforce the idea that the demise of backed blades in the western Cumberland Plain was also for sound economic reasons. Kangaroos were not a significant component of the diet, so the specialised stone component of the technology required to hunt them was lost.

If this model is correct, then at least some recent sites should be found where possums and other tree dwelling animals dominate in recent deposits. At Shaws Creek KII, there was no direct evidence of occupation of the shelter within the last 1,500 years, so it is unlikely that evidence of possum exploitation would be found. However McBryde (1977: 234) has excavated sites in the New England area which do show a significant correlation between faunal remains of phalangeridae and an increasing proportion of edge-ground tools. Additionally, a site to the northwest of the study area on Mogo Creek, a tributary of the MacDonald River, has produced a lithic assemblage including backed blades and blade cores from a lower unit dated to 2340 ± 110 BP (SUA-1840), and an upper unit lacking backed blades dated to 800 ± 130 BP (SUA-1841) (Kohen, in prep.). The substantial faunal assemblage revealed that 95% of the faunal remains from the lower unit were macropodidae, while over 50% of the upper unit were phalangeridae.

1788 - 1850 AD

A rapid and severe population decline due to smallpox occurred in the period 1789-90, drastically reducing the Aboriginal population in the vicinity of Sydney. The disease preceded Europeans across the Cumberland Plain (and probably spread rapidly though southeastern Australia), and as a result many Aboriginal bands on the western Cumberland Plain were destroyed as social entities prior to actual contact.

The remaining Aboriginal bands on the plain remained well away from the settlements until the mid 1790's, when farms were first established along the banks of the Hawkesbury and Nepean Rivers. The farms destroyed the yam beds which had provided the staple diet (at least seasonally) to those bands which traditionally exploited these rivers (Palmer 1795). As a result the Dharug remained in those areas which were minimally affected by Europeans, including Emu Plains, the Mulgoa Valley and the western side of the Nepean River, and continued to live on some traditional campsites until the 1840's.

Within a few years of white settlement, the Aborigines began to incorporate European items into their own material culture, substituting broken bottle glass for stone and using metal axes and nails. Clay pipes, ceramic shards and metal fragments are also found on contact sites dating from this period. By the end of the nineteenth century, those few Dharug who were still living a semi-traditional lifestyle were confined to missions and other similar institutions.

12.5 Regional significance

The archaeological evidence from the Cumberland Plain provides an insight into the spatial, temporal and functional relationships between coastal, plains and montane sites. Before the introduction of the microlithic assemblages into the Sydney region, archaeological sites have been identified on the coast, in the Blue Mountains and now on the coastal plain. Although some minor variations occur in the stone toolkit within these various environmental zones, there is an underlying uniformity in the assemblages which enable all sites to be given the regional label *Capertian*.

The most significant variations in the tool kit are undoubtedly related to the availability of raw materials, with certain artefact types like uniface pebble tools only used in proximity to sources of this material. The distribution of sites suggests that intensive occupation occurred near the coast and along the Nepean River, both ecologically diverse and rich zones, with a wide range of plant and animal foods being exploited. There is no evidence for economic specialisation of any kind.

The evidence from the Blue Mountains is sparse, but it would appear that there was little if any occupation of the highlands during the glacial maximum. It was not until well after 15,000 BP when temperatures began to rise that there is some evidence for visits, probably during the summer months.

Between 6,000 and 4,000 BP, a number but not all sites show an accumulation of deposit with a relatively low discard rate of stone artefacts per unit volume (but not necessarily per unit time). This may be a reflection of increased firing of the landscape resulting in a relatively short period of increased runoff and sediment transport until the establishment of a vegetation pattern adapted to greater firing frequency. The lower rainfall after 7,000 BP may have been a contributing factor to this changing fire regime.

The introduction of the *Bondaian* technology occurred between 4,000 and 3,000 BP, and the technology was used in all three environmental zones in both rock shelter sites and on open sites. The poor visibility on undisturbed wooded and forested areas has resulted in only a relatively small proportion of the open sites being identified, whereas in those areas which have been systematically surveyed almost all of the rock shelter sites have been identified. Again there is a basic similarity in artefact types, but specialisation or rather a change in emphasis occurs in particular areas. Uniface pebble tools are generally found only where pebbles are available (adjacent to the Nepean River).

In the early part of the *Bondaian*, the Bondi points are ubiquitous. Favoured raw materials for backed blades were obtained from the following primary sources; chert from the Nepean gravels or the Grose River, silcrete from the ridges and gravels along Eastern Creek and South Creek, and silicified wood from the same outcrops as the silcrete and several locations on the south coast. Blue Mountains and Nepean River sites were dominated by chert, while those to the east of South Creek were dominated by silcrete. Coastal sites east of the George's River contained both south coast raw materials and Cumberland Plain silcretes.

On the basis that backed blades were almost certainly used as spear barbs, it appears that kangaroos were hunted from all of these sites prior to about 1000 years ago. On the coast, there is a pronounced decline in backed blades, and a significant increase in a technology which is adapted to fishing and shellfish gathering. This is accompanied by a dramatic reduction in the use of all stone with the exception of quartz. One possible reason for the reduction in the variety and overall use of stone is that traditional sources of silcrete were no longer available for cultural reasons. Under these circumstances, the only stone suitable for producing sharp edges within the coastal sandstone belt is quartz, a material most easily reduced by bipolar flaking, particularly if the size of the raw material was small.

Excavations carried out by Megaw at Kurnell produced a large number of edge-ground hatchets in the upper units, most of which were made from a wide range of foreign raw materials (Megaw 1974: 38). An examination of the excavated material from this site revealed literally thousands of quartz bipolar pieces in the uppermost units of the deposit, a timespan of less than 2,000 years. It would appear that two important stone artefacts used on coastal sites in the last 1000-2000 years were edge-ground hatchets obtained by trade, and quartz obtained from the conglomerate bands in the local sandstone.

Quartz also becomes a more significant component of the assemblages along the Nepean River and in the lower Blue Mountains within the last 1000-1500 years, but backed blades, mostly made from chert, remain in use well into the last millennium. On the western Cumberland Plain to the east of South Creek, quartz is a minor component of the assemblages which, on the basis of the ethnographic evidence, continue to be dominated by silcrete apparently until after European contact.

The loss of backed blades on the coast and their later retention on the plains and in the Blue Mountains could just be a reflection of the lower use of stone near the coast, but on the basis of the regional evidence discussed above, it is more likely that a range of economic and cultural factors contributed to these changes. The lack of availability of raw materials suggests an increasing territoriality developing, where resources which were once freely available became restricted or inaccessible. This lack of access to lithic raw materials (and presumably other resources from the western Cumberland Plain), which was accompanied by the decline of backed blades at the coastal sites, may have been the result of an increasing population requiring a more regular supply of a staple resource. As a result the technology on the coast became increasingly specialised towards fishing and shellfish gathering.

The populations on the western Cumberland Plain and in the Blue Mountains may have continued to exploit macropodids, until increasing pressure on this resource led to localised macropodid depopulation, a phenomenon which would have already occurred on the coastal strip. As the macropodid population declined, alternative resources would be required. The ethnographic data suggest that possums and plant foods (at least near the Nepean River) formed the most important components of the diet for those Aborigines who lived across the western Cumberland Plain, and the archaeological data confirms this interpretation by the widespread distribution of edge-ground hatchets and the locally high concentrations of elouera adze flakes at favourable locations like Emu Plains. The steeply dissected mountains would have supported a lower Aboriginal population density than either plains or coast, and macropodids probably formed a larger component in the diet than elsewhere.

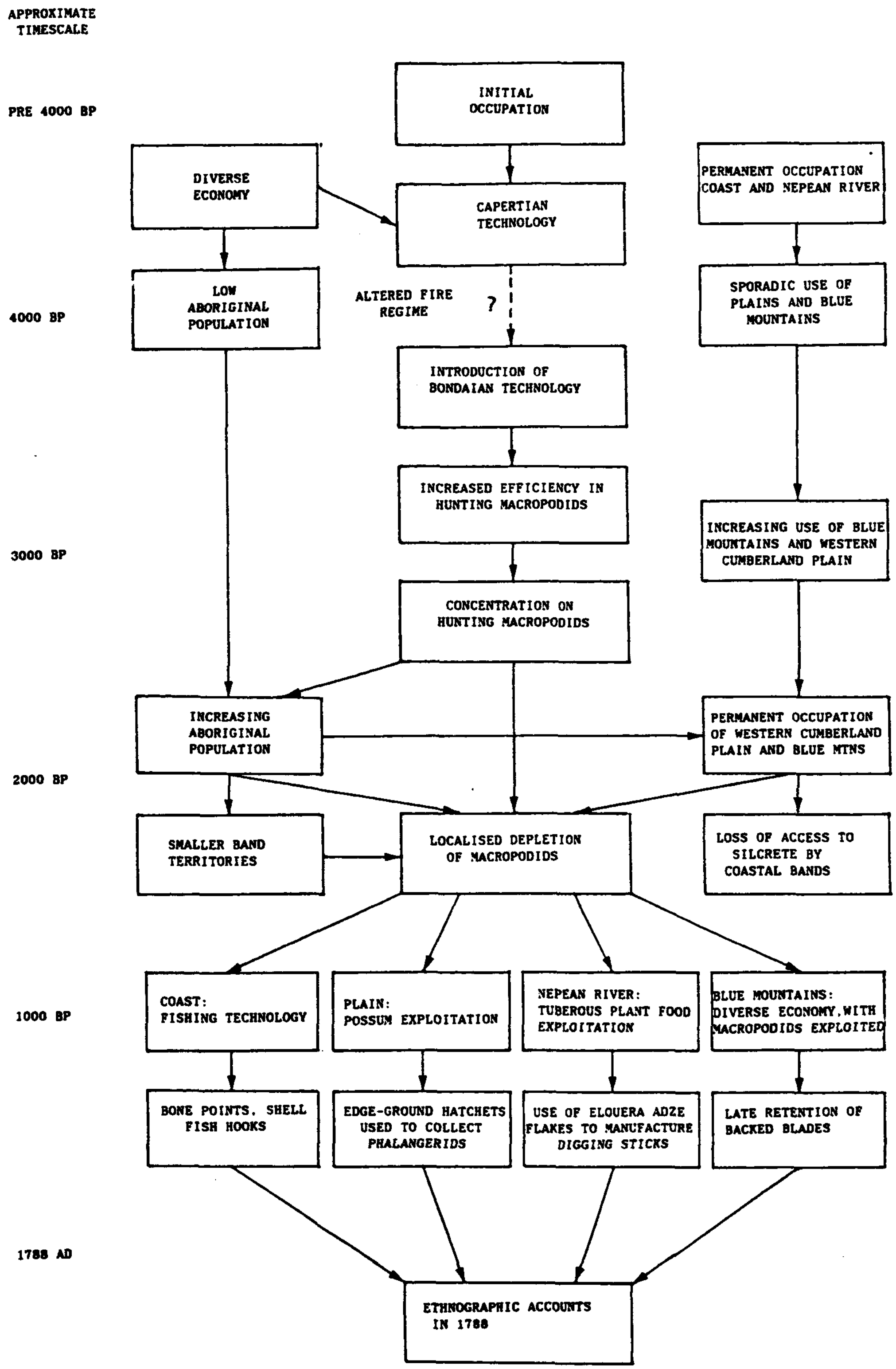


FIGURE 12.2. A model for prehistoric change in the Sydney region.

A model which summarise the changes in the archaeological record for the Sydney region is shown in Figure 12.2.

Crucial to this explanation is the premise that an increasing Aboriginal population can have a significant effect on a localised macropodid population. Winter (1970) summarises the biological data to calculate the harvest rate for kangaroo species so that the population will remain stable. For the Grey Kangaroo, this figure is 15% of the mean annual population. Based on data from forested areas in southeast Queensland, the overall population density which could be supported on the Cumberland Plain would fall within the range of 1-4 kangaroos/km^2. The approximate area of the Cumberland Plain between the Hawkesbury River, Botany Bay and the Blue Mountains is 7000 km^2, suggesting that the kangaroo population around Sydney would have been between 7000 and 28,000. Since 15% of the kangaroos could be hunted each year without a decline in the population, the number which could be killed annually would be between 1000 and 4000 animals.

On the basis of the ethnographic reconstruction, the density of Aborigines in the Cumberland Plain was between 0.5/km^2 and 1/km^2, that is between 3,500 and 7,000 people. If we make the assumption that 30% of the population can be classified as "hunters" (excluding all females, male children and old men), then there were between 1000 and 2000 hunters on the Cumberland Plain in 1788. Comparing the two sets of figures, we see that if each hunter kills only a single kangaroo in a year (assuming 1000 hunters and a kangaroo density of $1/km^2$), the kangaroo population remains stable, but more than one animal killed per year will cause a decline in the population. Even assuming the minimum Aboriginal population density and the maximum kangaroo population density, any more than four kills per year would cause a decline in the kangaroo population.

These figures will only produce a crude estimate of possible harvesting rates, but even allowing for this it is apparent that Grey Kangaroo could not have provided a significant component of the diet for this number of people.

12.6 Implications for Australian prehistory: Intensification

This interpretation of prehistoric change in the Sydney area is based on the premise that a change in technology can be equated with a change in the resource base. Pre-microlithic assemblages are generalised, and probably reflect a low population density, with tool use restricted to woodworking and cutting. The *Capertian* assemblages have no specialised tools which are diagnostic of any particular economic specialisation. Australian backed blades can be compared with microlithic assemblages in other parts of the world, and in most cases such assemblages can be associated with the hunting of small to medium animals or cereal crops (see Clark (1977) for references). Since there has been no evidence for cereal crops and sickle use amongst the Aborigines of southeastern Australia, it is not unreasonable to conjecture that the analogy holds true, and that

Australian backed blades were used as projectile points and barbs for hunting small to medium sized animals, presumably macropods. If the interpretation of economic change and specialisation amongst the prehistoric population in the Sydney area is correct, then there are a number of indirect tests which can be used to confirm or reject the hypothesis that these changes were the result of an increasing Aboriginal population. Cohen (1977: 78-83) proposed a number of indicators of population growth which could be investigated through careful analysis of the archaeological data. If a significant proportion of these criteria are satisfied, he maintains that there is strong evidence for an increasing population. His indicators are:

1. People are travelling increasing distances for food.

This certainly does not fit the Cumberland Plain model, where, as competition for resources increases, the available territory to exploit <u>decreases</u>.

2. Expansion into new ecological zones.

Within the Sydney region Blue Mountains are occupied on a permanent basis for the first time, so this agrees with increasing population.

3. Increased exploitation of microniches.

The intensive use of the woodland resources on the plain fulfills this criterion.

4. Reduced selectivity in foods eaten, fuller utilisation of all resources.

There can be little doubt that an increase in the exploitation of shellfish, possums and tuberous plant foods satisfy this requirement.

5. Increase in use of water-based resources, e.g. shellfish.

This appears to be true, although there is some doubt as to the degree of shellfish exploitation prior to the advent of the microlithic industry.

6. Shift from eating large mammals to small mammals, birds and reptiles.

Cetainly true with possums replacing macropodids.

7. Consumption of organisms at lower trophic levels.

The concentration on yams and other plant foods agrees with this prediction.

8. Use of foods requiring a great deal of preparation.

Macrozamia exploitation could fulfil this requirement, as suggested by Beaton (1982).

9. Environmental degradation via the use of fire.

This seems likely in the Sydney region.

10. Skeletal evidence of increasing malnutrition through time.

No evidence is available from the Sydney region.

11. Exploitation of smaller individuals within a species.

No evidence is available from the Sydney region.

12. Exploited species disappears from the archaeological record.

Two species of macropodid tentatively identified from the Shaws Creek KII rockshelter have never been recorded from the Nepean River area. This is a possible confirmation.

13. Scarcity of resources.

The loss of the silcrete supply by the coastal people fits this pattern.

14. Sedentism.

There are certainly indication of increased sedentism particularly along the coast, with descriptions of villages.

Of the fourteen indicators suggested by Cohen, eleven appear to apply in the Sydney region. For two no archaeological data are available, and for one there is strong disagreement. In fact his points 1 and 14 are diametric opposites. Cohen points out that it may seem paradoxical that population pressure can be cited as the basis for both sedentism and seasonal transhumananance, and I agree. It can be one or the other, but not both. Therefore, if his indicators have any validity at all, there is strong circumstantial evidence for population increase in the Sydney region during the last 4000 years.

The ethnographic reconstruction which I carried out for this study confirmed a relatively high Aboriginal population density at contact, with the 600 km^2 survey area supporting between 5 and 8 bands, an overall minimum population density of around 0.5 persons per km^2. For the coastal strip in 1788, the estimated population of 1500 persons was supported by my reconstruction, and this represents a population density of approximately 1.2 persons per km^2. Lourandos (1980) reports a population density of 0.3-0.4 persons per km^2 for inland Aborigines in south-west Victoria, and 0.4-0.7 persons per km^2 for coastal Aborigines in the same region. The estimated population densities for both the western Cumberland Plain and the coastal strip around Sydney are slightly higher than the figures cited by Lourandos, but in view of the depopulation which followed the smallpox epidemic and the relatively late acquisition of the ethnographic data from south-west Victoria, the figures are not unreasonable.

Indeed, there is strong evidence to support a high Aboriginal population density at contact, and the archaeological data confirm that a number of economic and cultural processes have occurred and support the view that there has been a significant increase in Aboriginal population density, particularly since the introduction of the microlithic industry between 3000 and 4000 years ago, although the process may well have begun earlier in the Holocene.

12.7 Evaluation of the open site survey methodology

A more traditional and rigid survey methodology, had it been adopted for this study, would not have produced an adequate number of sites for the analyses to be carried out. It is sometimes necessary to use an opportunistic methodology in order to answer basic questions about the distribution of sites across the landscape. The use of disturbance as an aid to increasing archaeological visibility is entirely justified provided there is no other method available which will provide enough data to answer the questions which the study sets out to answer.

The use of existing tracks provides for easier surveys and greater visibility. For this study, it increased visibility by up to 200 times. The evaluation of the areal extent of a site is fortuitous, and depends on the nature of exposure. As long as an awareness of the taphonomic processes at work is maintained, the use of appropriate statistical techniques can elucidate a great deal of information even on greatly disturbed sites. However, surface areas of sites or measures of site density across a landscape are meaningless without some measure of the degree of exposure.

Even in areas with major vegetation changes, the physical environment still reflects the potential resources which were available to prehistoric populations. Unless the full range of possible sites and environments is examined, it is not possible to interpret the regional archaeological record.

CHAPTER 13

CONCLUSION

13.1 Prehistoric change in the Sydney region

The initial aim of this study was to locate and identify prehistoric sites on the western Cumberland Plain. In order to achieve this goal, a survey strategy was designed which took full advantage of the fact that disturbance significantly increases archaeological visibility in forested areas. The results confirmed the value of the method, for a sustantial number of sites were identified, analysed and evaluated. As a result of the analysis, I achieved an understanding of the processes which led to the formation, distribution, preservation and subsequent exposure of the stone artefacts. Recent disturbance was identified as the factor most likely to influence the identification of a prehistoric site, while proximity to a regular supply of water was found to be most important in the selection of a camping place.

To demonstrate the range of artefact variation on intensively used sites, excavations of a rock shelter site and two major open sites were undertaken. These excavations provided securely dated assemblages extending back over the last 13,000 years. Undated surface scatters were then compared with the dated sequence.

The difficulty in comparing surface assemblages was circumvented by using a range of analytical techniques designed to identify undateable open sites which may have been in use prior to the introduction of the *Bondaian* technology. An index of pebble, core and thick flake tools was found to be of value when used in conjunction with the percentage of tools in the assemblage. The results of the analysis suggest that *Capertian* sites tend to be smaller, contain a high proportion of steep thick flake tools, and have a much lower proportion of debitage than *Bondaian* sites. This implies that the initial reduction of stone may have taken place at the source rather than on the site, and that the *Capertian* sites are primarily tool-using and tool-discarding sites rather than tool-producing sites.

A re-evaluation of the ethnographic data, archaeological surveys, environmental surveys, and excavations resulted in the changes in Aboriginal settlement pattern and land use on the Cumberland Plain being identified. Two previous models of Aboriginal settlement patterns which may have applied in the Sydney Region were tested and found wanting. The model of Ross (1976) proposed a low population density across the plain, while Poiner (1976) suggested that seasonal movements may have occurred between the coast and the hinterland. The ethnographic evidence does not support either proposition, although the archaeological data do imply that there was either a greater fluidity in movement or increased trade between the coast and the mountains during the mid-*Bondaian* period.

An alternative model was proposed which relied on the fact that technological change can be equated with economic change. The variations in the distribution of artefact types were related to the function of the artefact and its role in the subsistence economy of the prehistoric population. This thesis demonstrates that a shift had occurred within the Sydney region during the late Holocene from a common economy based on the hunting of macropodids to geographically and culturally distinct more specialised economic systems based on resources which were locally abundant. These economic systems included fish and shellfish exploitation on the coast, heavy reliance on possums and other phalangerids on the plain, and tuberous plant food exploitation along the Nepean and Hawkesbury Rivers.

Since the decline in backed blade production was a widespread phenomenon throughout southeastern Australia, the economic changes evident in the Sydney region are typical of wider changes in Aboriginal exploitation strategies, and an underlying causal mechanism would appear to be in operation. One likely reason for such dramatic shifts in the economic base is a reduction in the availability of the staple protein resource. If backed blades were used as barbs on spears, and this technology significantly increased the capacity to exploit the large macropodids (which seem to have contributed substantially to the diet), then localised depletions of the macropodid stocks may have necessitated modifications to the economic base.

13.2 Population increase during the late Holocene

The model of economic specialisation was tested against a series of indicators of population growth proposed by Cohen (1977), and found to fulfill most of his requirements for increasing population. Expansion into new economic zones, reduced selectivity in foods eaten, increase in water-based resources, shift from large mammals to smaller game, consumption of organisms at lower trophic levels (including increasing use of plant foods), use of foods requiring a great deal of preparation (e.g. *Macrozamia*), environmental degradation by the use of fire, scarcity of resources (loss of access to silcrete), and increased sedentism are all indicators of increasing population which have been identified in the archaeological and ethnographic evidence from the Sydney region.

The conclusion to be drawn from this study is that the changes in settlement pattern, land use, technology and economy identified in the Sydney region following the introduction of the Australian Small Tool Tradition are consistent with an increasing Aboriginal population.

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APPENDICES

Appendix 1. Forms used for lithic and site analysis.

WESTERN CUMBERLAND PLAIN SURVEY: LITHIC ANALYSIS SITE NAME:

RAW MATERIAL						PRIMARY STATUS			CLASS					BACKED				RETOUCH/USEWEAR					
C	S	Q	Qz	B	O	Unm	Mod	Bip	Peb	Lump	Core	Flk	Frag	BP	GM	El	Misc	U	R/U	Pol	Grd	Anv	Per

SHEET 2

WESTERN CUMBERLAND PLAIN SURVEY: LITHIC ANALYSIS

SITE NAME: ________

DIMENSIONS			WEIGHT	ST/PL DIM		% CORTEX				EDGE ANGLE		COMMENTS
L	W	T	(GM)	W	T	0	0-20	20-50	50+	LT 60	GT. 60	

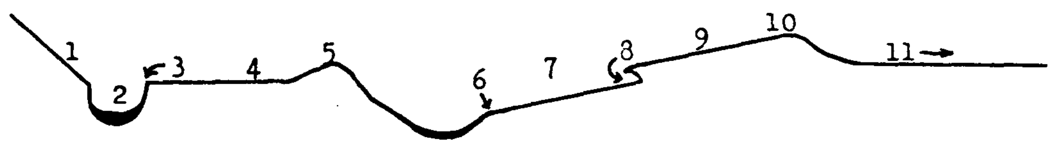
WESTERN CUMBERLAND PLAIN SITE SURVEY DATA

MAP	SCALE	MAP REFERENCE
Penrith	1:100,000	________
________	1:25,000	________

SITE NAME: ________________ **CODE:** ________ **NUMBER:** ________

SITE TYPE: Isolated find Surface scatter Exposed section
Rockshelter Grinding grooves Engravings
Other (specify) ________________

SITE LOCATION: ________



SOIL TYPE: Aeolian sand Alluvial sand Sandy loam Clay loam
Clay Other (specify) ________________

SUB-SOIL: Sandstone Shale Alluvium Igneous Other ________

GEOMORPH: Nepean gravels Quartzite gravels Silcrete gravels
Silcrete outcrops Laterite Other (specify) ________

DEGREE OF DISTURBANCE: Total 50-90% 10-50% Track only None

NATURE OF DISTURBANCE: Water Vehicles Bulldozing Animals None

VEGETATION: Cleared Woodland Open DSF Closed DSF WSF Swamp

PLANT FOODS WITHIN 100M:
Taxa ________________ Date ________
Taxa ________________ Date ________
Taxa ________________ Date ________
Taxa ________________ Date ________

.../p2

WESTERN CUMBERLAND PLAIN SITE SURVEY DATA (CONT'D)

DISTANCE TO WATER: Seasonal creek __________ Permanent creek __________
Nepean River __________ Swamp/lagoon __________

HEIGHT ABOVE SURROUNDING AREA: __________ meters

RAINFALL ISOH.: 500-600 600-700 700-800 800-900 900-1000
1000-1100 1100-1200 G.T. 1200

DOMINANT RAW MATERIAL: Chert Silcrete Quartz Basalt Quartzite

OTHER RAW MATERIAL: Chert Silcrete Quartz Basalt Quartzite Other

SURFACE COLLECTION: None Partial Total/non grid Total/grid

DEPTH OF DISTURBANCE: __________ cm

AREA OF SURFACE COLLECTION: __________ square meters

DISTANCE FROM CHERT/BASALT SOURCE: __________ kilometers

DISTANCE FROM SILCRETE SOURCE: __________ kilometers

DISTANCE FROM SANDSTONE: __________ kilometers

ASSOCIATED FAUNA: __________

COMMENTS: __________

MAP/DIAGRAM:

Appendix 2. Computer printout of stone artefact data from all sites (N=222).

KEY

COLUMN	**ARTEFACT CLASS**
1	Manuport
2	Chert debitage
3	Silcrete debitage
4	Quartz debitage
5	Quartzite debitage
6	Basalt debitage
7	Other debitage
8	Backed blade
9	Elouera adze flake
10	Uniface pebble tool
11	Biface pebble tool
12	Edge-ground tool
13	Hammer/anvil stones
14	Utilised normal flake
15	Sharp normal flake
16	Steep normal flake
17	Thumbnail scraper
18	Utilised thick flake
19	Sharp thick flake
20	Steep thick flake
21	Core tool
22	Core
23	Bipolar/scalar piece
24	Total

TEMP.DAT;1 23-MAY-1986 11:22

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AB/2		0	0	0	0	0	0	0	0	0
0	0	0	1							
AB/3		0	3	0	0	0	0	0	0	0
0	0	0	4							
AB/4		0	1	0	0	0	0	0	0	0
0	0	0	1							
AB/5		2	30	4	3	0	0	0	0	0
1	1	1	60							
AB/6		0	1	0	0	0	0	0	0	0
0	0	0	1							
AB/7		0	0	0	0	0	0	0	0	0
0	0	0	1							
AB/8		0	0	0	0	0	0	0	0	0
0	0	0	1							
AB/9		0	0	0	0	0	0	0	0	0
0	0	0	1							
BC/1		0	1	2	0	0	0	0	0	0
0	0	0	5							
BC/2		0	1	5	0	0	0	0	0	0
0	0	3	18							
BC/3		2	1	0	0	0	0	0	0	0
2	1	0	14							
BF/1		0	65	7	21	2	8	0	2	2
0	3	3	128							
BF/1A		7	1	0	0	1	21	3	0	0
2	5	0	35							
BF/1B		1	25	1	4	0	6	0	0	1
1	5	2	60							
BF/2		0	0	0	0	0	0	0	0	1
0	0	0	4							
BF/3		0	0	0	0	0	0	0	0	0
0	0	0	2							
BF/4		0	1	0	0	0	0	0	0	0
1	1	1	4							
BF/5		7	100	3	46	0	18	0	5	4
5	3	36	291							
BF/6		0	0	0	0	0	0	0	0	0
0	0	0	4							
BG/01		0	1	1	0	0	0	0	0	0
1	0	1	4							
BG/02		0	0	1	0	0	0	0	0	0
0	0	0	1							
BG/03		0	0	1	0	0	0	0	0	0
0	0	0	1							
BG/04		2	1	2	0	0	1	0	0	0
0	0	0	8							
BG/05		0	0	2	0	0	0	0	0	0
0	0	0	2							
BG/06		2	1	1	0	0	0	0	0	0
0	0	0	4							
BG/07		1	0	1	0	0	0	0	0	0
0	0	0	2							
BG/08		6	3	2	0	0	0	0	1	0
0	1	0	13							
BG/09		0	0	0	0	0	0	0	0	0
0	0	0	2							
BG/10		0	0	1	0	0	0	0	0	0
0	0	0	3							

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0	0	0	0	1	1	0	0	0	0	0
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BG/13		1	0	0	0	0	0	0	0	0
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BG/14		0	0	3	0	0	0	0	0	0
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BG/15		0	0	0	0	0	0	0	0	0
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BG/20		2	0	2	0	0	0	0	0	0
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BG/23		0	0	0	0	0	0	0	0	0
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BT/1		2	2	68	0	0	0	2	1	1
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CO/2		1	0	15	0	1	0	0	0	0
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CO/3		0	0	2	0	0	0	0	0	0
0	0	0	2							
CO/4		0	0	1	0	0	0	0	0	0
0	1	0	2							
CO/5		0	0	3	0	0	0	0	0	0
1	0	0	4							
CR/1		0	0	0	0	0	0	0	0	0
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CSF/06		0	4	1	1	0	0	0	0	0
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CSF/09		0	8	14	2	2	0	0	1	0
1	5	2	49							
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CSF/26		2	0	2	0	0	0	0	0	0
0	0	1	9							
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DS/03		0	8	33	0	0	0	0	0	0
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DS/04		0	2	111	2	1	0	1	2	0
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DS/08		0	0	0	0	0	0	0	0	0
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DS/09		2	0	25	0	0	0	0	0	0
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EC/2		0	0	0	0	0	0	0	0
0	0	0	1						
EC/3		0	1	2	0	0	0	0	0
1	1	0	6						
EC/4		20	18	33	0	3	1	1	2
4	4	3	105						
EC/5		0	26	147	4	2	2	7	2
0	4	2	208						
EC/6		1	0	0	0	0	0	0	0
0	1	0	3						
EP/1		0	8	0	0	1	1	1	0
0	3	1	20						
EP/2		0	1	0	0	0	0	0	0
0	0	1	2						
EP/3		0	3	0	0	1	0	0	0
0	0	0	4						
EP/4		0	0	0	0	0	0	0	0
0	0	0	3						
FT/1		0	2	0	0	0	0	0	0
0	0	0	5						
FT/2		0	11	3	0	0	0	0	0
0	0	0	20						
JC/1		0	6060	609	766	230	210	33	378
71	95	206	9311						
JC/1E		0	229	31	31	0	2	0	13
4	2	12	370						
JC/1LT		0	93	3	19	7	5	0	0
1	7	5	166						
JC/1LTE		0	7	1	3	0	1	0	0
4	1	0	30						
JC/2		0	0	0	0	0	0	0	0
0	1	0	3						
KI/1		2	315	29	104	1	24	0	26
4	4	13	30	658					
KII/1		0	0	0	0	0	1	0	0
0	3	0	23						
LC/1		1	336	34	39	2	13	1	5
0	12	8	603						
LC/1a		0	30	1	1	0	2	1	1
5	6	1	92						
LM/1		0	0	0	0	0	0	0	0
0	0	0	1						
LM/2		0	0	0	0	0	0	0	0
0	0	0	1						
LM/3		0	0	0	0	0	0	0	0
0	0	1	1						
LY/1		0	4	1	0	1	2	0	1
0	3	0	14						
LY/2		0	5	0	0	0	0	0	0
1	2	1	16						
NSM/1		0	0	1	0	0	0	1	0
0	0	0	2						
P/1		1	13	3	2	3	4	3	0
1	0	1	36						
PL/01		0	9	0	0	0	0	0	0
0	1	0	10						

0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	2	1	3	2	1	0	3	2
0	0	0	0	0	2	1	3	1	1	1	3
0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	1	1	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	2	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	1	0	0	0	0	1
0	3	0	0	0	2	1	0	0	0	0	0
31	13	2	13	31	323	55	89	9	22	12	4
5	0	0	0	1	17	7	4	0	1	1	1
0	0	0	0	2	7	3	6	0	1	0	2
0	2	0	0	0	0	0	0	0	2	3	5
0	1	0	0	0	0	1	0	0	0	0	0
6	5	1	0		2	48	10	21	4	3	1
0	8	4	0	1	1	1	0	0	0	0	0
5	0	1	1	12	6	18	7	0	0	2	0
0	7	1	2	4	4	1	1	0	4	5	15
0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1
0	1	0	1	0	1	1	0	0	0	0	3
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	1	1	0	1	1	0
0	0	0	0	0	0	0	0	0	0	0	0

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PL/02		1	294	20	30	10	4	1	2	1
0	2	0	390							
PL/03		0	10	3	0	0	0	0	0	0
0	1	0	19							
PL/04		0	0	0	0	0	0	0	0	0
0	0	0	1							
PL/05		0	1	0	0	0	0	0	0	0
0	1	0	2							
PL/06		0	6	0	0	1	0	0	1	0
0	1	0	9							
PL/07		0	479	26	29	4	14	1	5	0
1	4	3	597							
PL/08		0	0	0	0	0	0	0	1	0
2	1	0	5							
PL/09		0	0	0	0	0	0	0	0	0
1	0	0	1							
PL/10		0	0	0	0	0	0	0	0	0
0	0	0	1							
PL/11		0	0	0	0	0	0	0	0	0
0	0	0	2							
PL/12		0	7	0	3	0	0	0	0	0
0	0	0	10							
PL/13		0	0	0	0	0	0	0	0	0
0	1	0	1							
PL/14		0	0	0	0	0	0	0	0	0
0	1	0	1							
PL/15		0	2	0	0	0	0	0	0	0
0	0	0	4							
PL/16		0	1	0	0	0	0	0	0	0
0	0	0	2							
PL/17		0	1	0	0	1	0	0	0	0
0	1	0	3							
PL/18		0	0	0	0	0	0	0	0	1
0	0	0	1							
PL/19		0	0	0	0	0	0	0	0	0
0	0	1	2							
PL/20		0	0	0	0	0	0	0	0	0
1	1	0	4							
PL/21		0	7	2	3	0	0	0	0	0
2	2	2	24							
PL/22		0	0	0	0	0	0	0	0	0
0	0	1	1							
PL/23		0	0	0	0	0	0	0	0	0
0	0	0	2							
PL/24		0	4	1	2	0	1	0	0	0
0	0	0	8							
PL/25		0	0	0	0	0	1	0	0	0
0	0	0	7							
PL/26		7	60	25	25	3	3	0	1	0
1	4	4	151							
PL/28		0	0	0	0	0	0	0	0	0
0	1	0	3							
QH/1		0	0	4	2	0	0	0	0	1
4	3	2	56							
RC/01		1	32	33	8	0	0	0	2	0
0	7	4	100							
RC/02		0	1	1	0	0	0	0	0	0
1	0	0	3							
RC/03		4	12	3	6	3	0	0	0	0
0	2	0	33							

1	0	1	0	6	6	8	0	0	0	1
0	0	0	0	1	2	1	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
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2	0	0	2	5	8	4	2	1	1	5
0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	0	0	0
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0	0	0	0	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	0
0	0	0	0	0	2	0	0	0	0	3
0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0
0	1	0	4	2	6	2	1	0	1	1
1	0	1	0	0	0	0	0	0	0	0
0	0	0	0	14	4	7	0	6	1	7
0	0	0	0	5	1	2	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	2

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RC/04		0	0	0	0	0	0	0	0	0
0	0	0	1							
RC/05		0	0	0	0	0	0	0	0	0
0	0	0	1							
RC/06		4	3	3	1	0	0	0	1	0
0	1	0	20							
RC/07		0	0	0	0	0	0	0	0	0
0	0	0	1							
RC/08		0	0	0	0	0	0	0	0	0
0	1	0	2							
RC/09		0	1	0	0	0	0	0	0	0
0	0	0	3							
RC/10		1	6	2	0	3	1	0	0	0
0	0	0	19							
RC/11		10	0	4	0	0	0	0	1	0
0	0	0	18							
RC/12		1	0	0	0	0	0	0	0	0
0	0	0	1							
RC/13		1	0	0	0	0	0	0	0	0
0	0	0	1							
RC/14		1	0	0	0	0	0	0	0	0
0	0	0	1							
RC/15		0	0	0	0	0	0	0	0	0
0	1	0	1							
RC/16		0	0	0	0	0	0	0	0	0
0	1	0	1							
RC/17		0	0	0	0	0	0	0	0	0
0	0	0	1							
RC/18		1	0	1	0	0	0	0	0	0
0	0	0	2							
RC/19		0	1	0	1	0	0	0	0	0
0	0	0	3							
RC/20		2	0	0	0	0	0	0	0	0
0	1	0	3							
RC/21		0	0	0	0	0	0	0	0	0
0	1	0	1							
RC/22		2	7	2	0	0	0	0	0	0
0	1	0	13							
RC/23		0	0	0	0	0	0	0	0	0
0	0	0	1							
RC/24		1	0	0	0	0	0	0	0	0
0	0	0	1							
RC/25		0	0	0	0	0	0	0	0	0
0	1	0	1							
RC/26		0	0	0	0	0	0	0	0	0
0	1	0	1							
RC/27		0	0	0	0	0	0	0	0	0
0	0	0	1							
RC/28		0	1	2	0	0	0	0	1	0
0	2	0	6							
RC/29		0	1	0	0	0	0	0	0	0
0	0	0	1							
RC/30		0	2	1	1	0	1	0	0	0
0	0	1	8							
RC/31		1	0	0	0	0	0	0	0	0
0	0	0	1							
RC/32		6	5	3	8	0	0	1	0	0
0	5	16	48							
RH/1		1	0	3	1	0	0	0	0	0
0	3	2	13							

0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	4	1	1	0	0	0	1
0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	1	1	0	0	0	0	0
0	0	0	1	2	0	2	0	0	0	0
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0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	0
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0	0	0	0	0	1	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0
0	0	0	2	0	1	2	0	0	1	0
0	0	2	0	0	0	0	0	0	0	0

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RS/1		0	7	60	1	1	1	0	0	3
1	7	0	19							
RS/3		0	2	19	0	0	0	0	0	0
2	0	0	23							
RS/4		1	9	55	1	0	3	1	0	2
1	5	2	90							
RS/5		1	0	0	0	0	1	0	0	0
1	1	0	10							
SB/01		0	1	0	0	0	0	0	0	1
0	0	0	3							
SB/02		0	0	1	0	0	0	0	0	0
0	0	0	2							
SB/03		0	0	0	0	0	0	0	0	0
0	0	0	1							
SB/04		0	0	0	0	0	0	0	0	0
0	0	1	1							
SB/05		0	0	3	0	0	0	0	0	0
0	0	0	4							
SB/06		1	0	0	0	0	0	0	0	0
0	0	0	2							
SB/07		0	0	0	0	0	0	0	0	0
0	0	0	1							
SB/08		0	0	11	2	0	0	0	0	0
0	0	0	14							
SB/09		0	0	1	0	0	0	0	0	0
0	0	0	1							
SB/10		0	0	2	0	0	0	0	0	0
0	0	0	3							
SC/1		0	3	13	0	0	0	2	0	0
0	0	0	19							
SC/2		0	0	10	0	0	0	0	0	0
0	1	0	14							
SC/5		0	1	0	0	0	0	0	1	0
0	1	0	4							
SC/6		0	19	250	9	0	1	1	5	2
2	9	3	312							
SEP/01		0	0	0	0	0	0	0	0	0
0	1	0	3							
SEP/02		0	0	0	0	0	0	0	0	0
0	0	0	1							
SEP/03		0	0	4	0	0	0	0	0	0
0	0	0	7							
SEP/04		1	1	7	3	0	0	0	0	0
0	1	0	14							
SEP/05		4	6	35	2	0	0	0	1	0
1	5	0	60							
SEP/06		0	0	3	0	0	0	0	0	0
0	5	0	15							
SEP/07		0	0	0	0	0	0	0	0	0
0	0	0	1							
SEP/08		0	1	0	0	0	0	0	0	0
0	0	0	1							
SEP/09		0	1	0	0	0	0	0	0	0
0	0	0	1							
SEP/10		0	1	0	0	0	0	0	0	0
0	0	0	1							
SF/1		0	0	0	0	0	0	0	0	1
1	0	0	2							
SF/2		0	0	0	0	0	0	0	0	0
0	0	0	1							

0	0	0	1	3	0	0	0	0	0	4
0	0	0	0	1	0	0	0	0	0	0
1	0	0	0	1	2	3	1	1	0	1
0	0	0	0	1	3	2	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	1	0	2	0	0	0	0
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0	0	0	0	3	3	4	2	0	0	1
0	0	0	0	0	1	1	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	2	0
0	0	0	0	1	0	0	0	0	0	0
0	1	0	0	1	0	1	1	1	0	0
0	0	0	1	1	3	3	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0

SF/3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1															
SH/1	0	0	3	0	0	0	0	0	1	0	0	0	0	2	0	1	0	0
0	0	0	7															
SPC/1	1	28	120	15	0	0	1	0	1	0	0	0	0	4	4	3	0	1
5	10	1	195															
SPC/2	1	12	31	5	2	0	1	0	0	0	0	0	0	2	1	2	0	0
0	1	2	63															
SPC/3	0	1	4	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0
0	1	0	9															
SPC/4	0	4	25	0	0	2	1	1	1	0	0	0	0	0	1	1	0	0
1	5	0	43															
SPC/5	7	149	763	69	6	8	17	29	0	0	0	2	0	16	7	11	2	2
4	47	12	1179															
SPC/6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	1	1	7															
SPC/7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1															
UC/1	0	22	0	3	0	0	0	0	2	3	0	0	1	7	2	4	0	0
4	7	4	67															
YM/1	0	0	0	0	0	0	0	0	0	4	0	0	1	0	0	0	0	0
1	0	1	8															
YM/2	2	107	23	6	0	7	0	0	1	0	0	1	4	0	3	2	0	0
1	3	8	139															