Technological change in the Hunter River valley and the interpretation of late Holocene change in Australia

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In recent years a number of archaeologists have concluded that in many parts of Australia during the late Holocene there was an increased intensity of occupation. They see evidence for this in an increasing number of sites inhabited and an increased discard rate of material within each site (eg. Lourandos 1983; Hughes and Lampert 1982; Ross 1981, 1985). Although the causes of these trends have been debated, their perception has not been questioned (see Lourandos 1983, 1984, 1985; Beaton 1983; Yoffee 1985). This paper queries the reality of these perceived increases and presents a case study in which neither trend occurs. Investigations into stoneworking technology in the Hunter River Valley provide evidence that in this area increases in the quantity of discarded artefacts were not maintained throughout the late Holocene, and that dramatic declines in site number and site usage occurred in the last 800 years. A survey of the literature shows this to be a widespread phenomenon and indicates that changes in Holocene Australian prehistory are even more complex than previously portrayed. It is concluded that changes in late Holocene Australian prehistory cannot everywhere be explained by population increase and that changes in the structure of settlement and technology may be better descriptions of what happened.

This paper also demonstrates the potential of technological analyses to reveal information about prehistoric change. Re-analysis of the stone artefacts recovered by Moore (1970) from the Sandy Hollow 1 rockshelter in the Hunter Valley revealed not only changes in stoneworking at the boundaries of the phases identified on typological grounds in the Eastern Regional Sequence, but also changes within one of these phases. Furthermore, the changes in stoneworking are distinctive and can be used to place non-stratified open sites into a dated regional sequence. Using this relative dating strategy it is possible to examine chronological change in settlement and site use.

Location and environment

The Hunter River Valley is located on the east coast of Australia immediately west of Newcastle (Figure 1). The Hunter River catchment covers over 20,000 square kilometres and is ringed by a loop in the Great Dividing Range. The Hunter River drains the northern part of the area before flowing eastward, where it is joined by its tributaries, the Goulburn River from the west, Wollombi Brook from the south, and the Paterson and Williams Rivers from the north, before reaching the sea at Newcastle. The region can be divided into several major types of landscape (cf. Galloway 1963). The sites discussed in this paper are from two landscapes: the Central Lowlands and the Central Goulburn Valley. The former consists of a belt of low undulating country formed on soft sandstone and shale paralleling the Hunter River from the northern boundary of the Valley until just west of Newcastle (Figure 1). The latter is a complex of plateaux on resistant sandstone and open valleys on weaker shale and sandstone, particularly along the Goulburn River (Figure 1).

Sandy Hollow 1 (SH1) is an archaeological site situated within the Central Goulburn Valley. Near Sandy Hollow 1, the Goulburn River and its tributaries, Halls Creek and Worondi Rivulet are fringed by steep rugged scarps. SH1 is located 300m north of the Goulburn River at the foot of a scarp, where a large conglomerate boulder has an habitable cavity (Moore 1970:35). The largest entrance to the shelter is approximately 3m x 1.3m and faces east, with smaller openings to the west and south.

In 1965, David Moore (1967, 1970) dug a series of four 3ft x 3ft squares (A, B, AA, BB) across the eastern entrance to the shelter; a fifth square (F) was placed further inside the overhang (Figure 2). Moore does not describe the methods by which the excavation was carried out except to note he used arbitrary 6 inch deep spits, 'in the absence of any continuous stratification . . . (Moore 1970:35).

Squares A and AA were dug to a depth of 3ft 6in in seven spits. Square B was dug to 3ft in five spits. Square BB was excavated to a depth of 2ft 6in in five spits.

Moore (1970:37) obtained two dates from the squares outside the shelter, AA and BB. The two dates were as follows:

Square BB level 1 (4-6 in. below the surface) 530±80BP (ANU 125).

Square AA level 4 (23-24 in. below the surface) 1300±100BP (ANU 12).

From these dates an age/depth curve for Squares AA and BB was constructed. While this must be regarded as an heuristic device, if we assume the rate of sediment accumulation was relatively constant it can be concluded that the deposit at the front of the shelter began to accumulate approximately 2000 years BP. Table 1 provides estimates of the age of each spit, the rate of sediment accumulation and the rate of artefact discard per 100 years. If the sediment accumulation rate was relatively uniform then spits 3-5 have the highest rates of artefact accumulation and spits 1-2 have much lower rates (cf. Moore 1981). Although artefacts occur in spits 6-7 in AA

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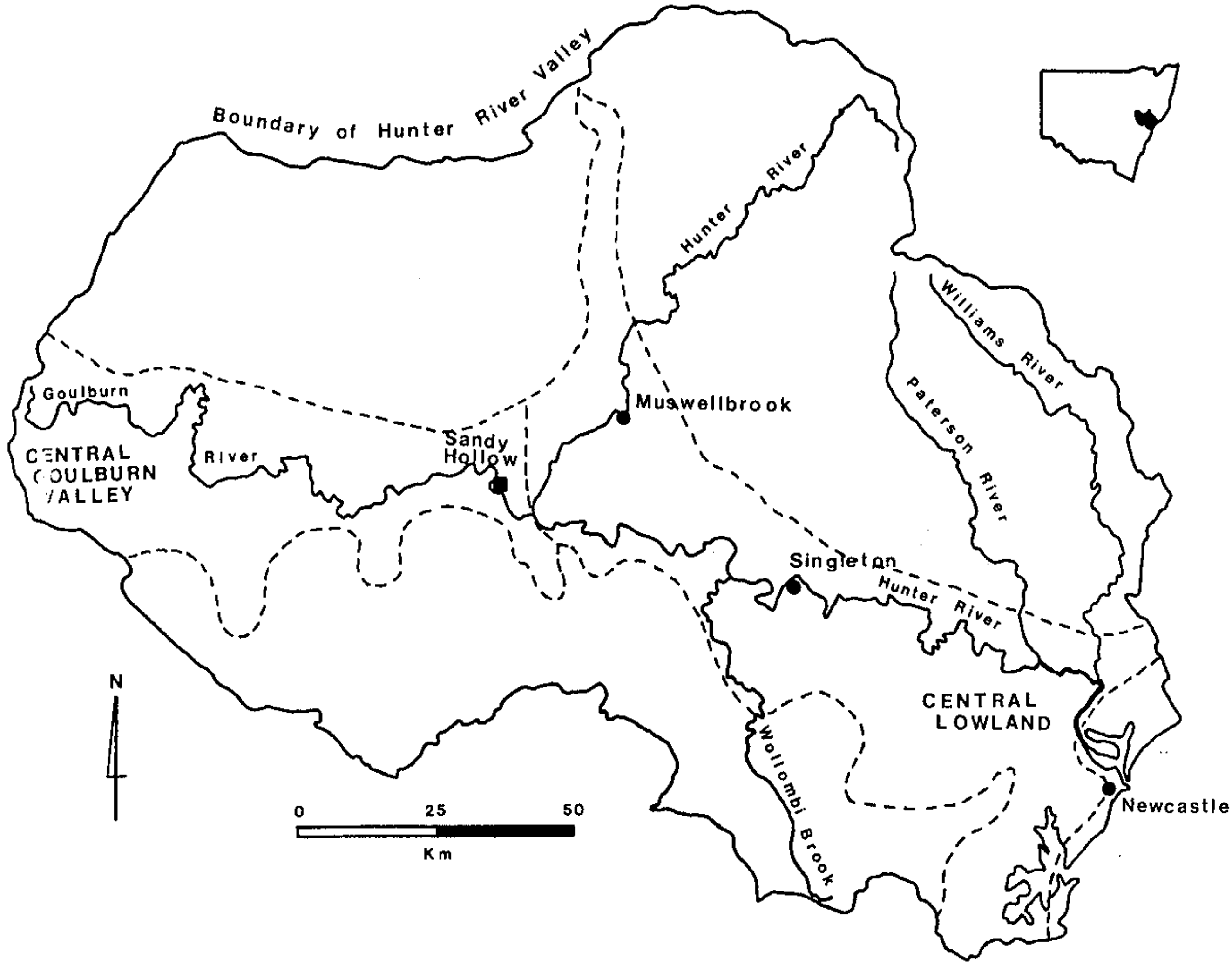

Figure 1. Location of the study area showing major environmental zones and Sandy Hollow 1.

Level	Depth below surface (in)	Estimated age in years bp	No. of years in level	Inches of sediment /100 years	No. of Artefacts	Density of Artefacts/ cubic yard	No. of Artefacts/ 100 years	No. of Backed blades	No. of Backed bl./ 100 years	Artefacts: Backed blades
1	0-6	0-570	570	1.05	278	834	48.8	3	0.5	91.7
2	6-12	570-820	250	2.40	223	669	89.2	5	0.8	43.6
3	12-18	820-1080	260	2.31	1246	3738	479.2	52	20.0	23.0
4	18-24	1080-1320	240	2.50	618	1854	257.5	23	9.6	25.9
5	24-30	1320-1570	250	2.40	505	1515	202.0	0	0	-
6	30-36	1570-1820	250	2.40	5	15	2.0	0	0	-
7	36-42	1820-2070	250	2.40	2	6	0.8	0	0	-

Table 1. Sandy Hollow 1: age and content of levels. Data from Moore 1970.

they are very rare. The numbers of each class of implement recognised by Moore all peaked in spit 3. Implement types which occur in low numbers (eg. 'worked points', 'adze flakes' and 'fabricators') appear only in spit 3 and their absence in other spits may be related to smaller sample sizes rather than an absence in prehistoric times. Similarly, the absence of backed blades from spits 6-7 might be a function of sample size. However, the absence of backed blades in spit 5 is not so easily seen as a sampling problem, and in this context it is interesting that backed blades are more frequent relative to other artefacts in spit 3 and 4 than they are in spits 1 and 2. Thus it is difficult to explain the absence of backed blades at the base of the deposit and at the front of the shelter, other than by regarding it as real.

This is not to say that backed blades were introduced to the area only after 1300 BP. The oldest date obtained at this site is from level 4 of Square AA. Estimating the age of level 5 at 1320-1570 years BP assumes that the rate of sediment accumulation was constant and that no depositional and occupational hiatus occurs between level 4 and level 5. Such a

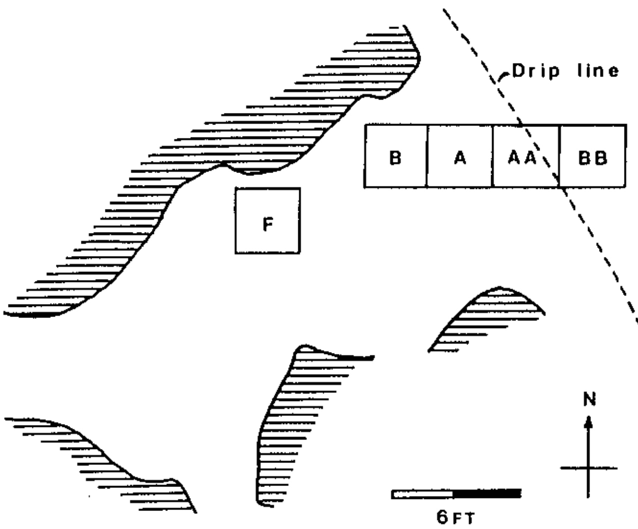

Figure 2. Plan of Sandy Hollow 1 showing the location of the excavated squares (after Moore 1970).

hiatus is claimed for many rock-shelters in the Blue Mountains immediately prior to the levels containing backed blades (Kohen, Stockton and Williams 1984:71; Johnson 1979:73, 108). If such a hiatus occured at Sandy Hollow 1 then the artefacts in level 5, with no associated backed blades, might be much older than the estimates of 1300-1600 years BP. Consequently, since sedimentation rates in level 5 may have been lower, the discard rate of artefacts might be much lower than that calculated in Table 1. This issue can only be resolved by re-excavation.

Nevertheless, the material excavated from SH1 is relevant to a study of Hunter Valley stone technology. The site provides the only useful sequence of radiocarbon dates from the Hunter Valley and in combination with the depth of the deposit and the large numbers of artefacts it can be used to examine chronological changes in stoneworking technology.

Re-analysis of artefacts from SH1

I re-analysed the artefacts from SH1, reclassifying all implements and analysing the unretouched flakes from Square AA. The discard rates of various artefact classes in Square AA were calculated.

Retouched flakes

This study was undertaken twenty years after Moore originally examined the artefacts, and it is based on an understanding of stoneworking technology, rather than Moore's typological perspective. In this reclassification, many stones Moore (1970:38-39) classified as one type of implement have been placed in different categories, or regarded as not implements at all.

This reclassification drastically changes the perception of the typological record of Sandy Hollow 1. Moore (1970) originally described a variety of types: backed blades (72%), eloueras (7%), scrapers (12%), points (4%), adzes (4%), and fabricators (1%). The reclassification yielded a much smaller range: backed blades (91%), amorphously retouched flakes (8%), and one unifacial point (1%). This range and proportion of implement types is virtually identical with that obtained from open sites within the area.

Reclassification made little difference to the chronological changes in backed blade frequency which Moore perceived. For example, in Square AA he found no backed blades in spits 5-7, 19 in 4, 25 in 3, four in 2 and one in 1. After reclassification, the chronological changes in definite backed blades remain similar to that identified by Moore: none in spits 5-7, 13 in spit 4, 15 in 3, two in 2, and one in 1. Spits 3 and 4 stand in strong contrast with later levels, where there are fewer backed blades, and with earlier levels where there are none. On this basis it is possible to divide the archaeological sequence at this site into three periods: Pre-Bondaian (spits 5-7), Phase I Bondaian (spits 3-4) and Phase II Bondaian (spits 1-2).

No Post-Bondaian material occurred at the site. The upper level is less than 500 years old, and it is likely that in this region the manufacture of backed blades continued until European settlement.

Changes in raw material usage

Throughout the deposit most artefacts are made on indurated mudstone. To quantify changes in raw material usage all artefacts in Square AA were examined (Table 2). In the lower levels the percentage of artefacts not made on indurated mudstone is extremely low, but it doubles in the upper two spits. Most of these non-mudstone artefacts are of quartz, but a few are of silcrete.

Attribute analysis of flakes

Chronological changes in stone working technology were examined by measuring the unretouched flakes in one raw material type: indurated mudstone. Flakes result from all stages of the stoneworking process, and thereby reflect the range of technological practices more completely than either cores or retouched flakes. By examining flakes made on only one type of stone, changes in the stoneworking technology caused by differences in the flaking properties of raw material are excluded. Only complete flakes were included in this analysis.

Square AA was chosen for analysis since it was the deepest and best dated. A total of 742 complete flakes from this square were identified. The sample size for each spit is: 1:63; 2:53; 3:287; 4:171; 5:168. There were no complete flakes in spits 6 and 7. Seven measurements and seven nominal observations were made on each flake, and two ratios were calculated. Definitions are given in the Appendix.

Many of the attributes concerned with flake size show similar chronological changes: artefacts in spits 2-4 are relatively large, and artefacts from spit 1 are the smallest (Table 3). Average platform dimensions show a different trend: spit 5 has the largest platforms, spits 3 and 4 have platforms similar in size but smaller than those of spit 5, and flakes in spits 1 and 2 have yet smaller platforms (Table 4). Flake elongation shows a different pattern again, with flakes in spits 3 and 4 being on average more elongate than others, and spit 5 being least elongate (Table 5). The average parallel index of flakes in spits 3 and 4 is lower than that of other spits (Table 5). The majority of these changes in flake size and shape coincide with the three phases defined earlier. Pre-Bondaian flakes were medium sized, relatively

Level	Artefacts (n)	Mudstone artefacts (n)	Mudstone artefacts (%)
1	144	126	87.5
2	105	88	83.8
3	407	376	92.4
4	383	358	93.5
5/6	285	274	96.1

Table 2. SH1: raw materials in AA.

Variable	Measure	Spits 1	2	3	4	5
Weight (gm)	Mean	2.0	3.2	4.5	3.0	2.8
	Minimum	0.1	0.1	0.1	0.1	0.1
	Maximum	71.3	32.0	120.0	95.0	44.0
	Range	71.2	31.9	119.9	94.9	43.9
	Std dev.	9.1	6.5	10.6	8.9	5.7
Length (cm)	Mean	1.3	1.8	2.1	1.8	1.6
	Minimum	0.3	0.4	0.2	0.4	0.3
	Maximum	4.8	5.8	6.6	6.4	6.6
	Range	4.5	5.4	6.4	6.0	6.3
	Std dev.	0.9	1.2	1.3	1.2	0.9
Width (cm)	Mean	1.2	1.5	1.7	1.5	1.7
	Minimum	0.4	0.1	0.4	0.4	0.2
	Maximum	3.8	4.2	6.6	11.1	5.5
	Range	3.4	4.1	6.2	10.7	5.3
	Std dev.	0.7	0.8	1.0	1.1	1.0
Ventral Area (cm^2)	Mean	1.9	3.3	4.2	3.3	3.2
	Minimum	0.2	0.3	0.2	0.2	0.2
	Maximum	18.2	16.2	38.0	51.1	23.9
	Range	18.0	15.9	37.8	50.9	23.7
	Std dev.	2.7	3.7	5.0	5.2	3.9

Table 3. Size of unretouched mudstone flakes in AA.

Variable	Measure	Spits 1	2	3	4	5
Platform width (cm)	Mean	0.8	0.9	1.2	1.1	1.2
	Minimum	0.1	0.1	0.2	0.1	0.1
	Maximum	3.2	3.2	6.0	5.6	4.5
	Range	3.1	3.1	5.8	5.5	4.4
	Std dev.	0.6	0.6	0.8	0.7	0.9
Platform Thickness (cm)	Mean	0.25	0.25	0.31	0.34	0.38
	Minimum	0.1	0.1	0.1	0.1	0.1
	Maximum	1.9	1.0	1.7	1.2	3.0
	Range	1.8	0.9	1.6	1.1	2.9
	Std dev.	0.29	0.23	0.26	0.23	0.36
Platform area (cm^2)	Mean	0.32	0.33	0.50	0.38	0.66
	Minimum	0.01	0.01	0.02	0.01	0.01
	Maximum	4.94	3.20	8.40	3.30	9.90
	Range	4.9	3.2	8.4	3.3	9.9
	Std dev.	0.8	0.6	0.9	0.6	1.2

Table 4. Platform size of unretouched mudstone flakes in AA.

Variable	Measure	Spits 1	2	3	4	5
Elongation	Mean	1.22	1.24	1.46	1.34	1.10
	Minimum	0.25	0.25	0.20	0.39	0.24
	Maximum	4.09	3.33	6.63	4.38	6.00
	Range	3.84	3.08	6.43	3.99	5.76
	Std dev.	0.75	0.67	0.98	0.69	0.69
	% L>2w	9.52	13.21	19.51	15.20	7.14
Parallel index	Mean	2.14	2.22	1.73	1.87	2.01
	Minimum	0.64	0.25	0.50	0.64	0.50
	Maximum	14.00	7.00	6.00	10.00	11.00
	Range	13.36	6.75	5.50	9.36	10.50
	Std dev.	1.89	1.43	0.91	1.28	1.58
	% Contracting	13.11	13.21	13.52	10.37	14.63

Table 5. - Shape of unretouched mudstone flakes in AA.

Aspect of technology	Trait	Measure	Spits 1	2	3	4	5
Amount of force	Termination	Ratio feather:non-feather	3.2:1	3.4:1	3.8:1	4.2:1	2.5:1
Angle of force	Termination	Ratio hinge:step	4.0:1	4.5:1	10.2:1	7.0:1	8.0:1
Precision of blow	Platform size	% focalized platforms	17.5	13.2	6.7	9.3	8.9
Platform angles	Platform angle	% flakes >80	20.6	26.4	22.5	29.5	7.1
		% flakes <60	15.9	7.6	10.2	7.2	23.8
		mode	70-79	70-79	70-79	70-79	60-69
Platform preparation	Platform surface	% of flakes with facetted platforms	0	0	10.2	8.7	0
		% flakes with several scars on the platform	9.5	7.6	20.0	20.9	2.3
		% flakes with cortical platforms	20.6	22.6	18.6	21.5	42.3
Overhang removal	Overhang removal	% flakes with overhang removal	38	22	16	17	15
Core rotation	Platform removal	% flakes with remnants of platforms on dorsal face	1.6	1.9	6.3	2.3	1.2
	M or D scars	% flakes with M or D scars	1.6	7.6	9.2	5.8	5.4

Table 6. Technological attributes in SH1.

squat and with very large platforms. Phase I Bondaian flakes were larger, more elongate and parallel sided, and had medium sized platforms. Phase II Bondaian flakes were relatively small, squat and with small platforms.

These changes in flake size and shape result from differences in the application of blows and the preparation of cores and retouched flakes. A number of technological changes can be demonstrated by measuring attributes which reflect the various combinations of platform preparation and force application (Table 6).

The large relatively wide flakes with large platforms which are common in Pre-Bondaian levels (spit 5) result from a combination of the following practices:

- Large amounts of force applied with little control.
- Mostly normal or inward directions of force application.
- Imprecise blow application.
- The use of relatively low platform angles on cores.
- Very little platform preparation of any kind and with many blows being placed on cortical surfaces. In particular there was no platform facetting at all.
- Infrequent overhang removal.
- Low or moderate amounts of core rotation.

The larger, more elongate, more parallel flakes with larger platforms which occur in Phase I Bondaian levels (spits 3-4) are a result of a combination of the following practices:

- Relatively high amounts of force.
- Mostly normal or inward directions of force application.
- Imprecise blow applications.
- High platform angles.
- Large amounts of platform preparation including significant amounts of facetting as well as larger amounts of other flaking onto the platform.
- Infrequent overhang removal.
- High amounts of core rotation.

The shorter, wider flakes with small platforms which occur in the Phase II Bondaian levels (spits 1 and 2) result from the following practices:

- Low or moderate amounts of force.
- Outward directions of force application.
- Precise application of force.
- High platform angles.
- Moderate amounts of platform preparation in the form of flaking onto the platform, but not facetting.
- Frequent overhang removal.
- Moderate or low amounts of core rotation.

Thus technological changes do accompany the three phases recognised on the basis of backed blade frequency. For example, the presence of backed blades in spits 1-4 is accompanied by extensive platform preparation and overhang removal, and conversely the absence of backed blades in spit 5 is paralleled by the virtual absence of platform preparation. Spits containing both backed blades and frequent platform preparation can be divided into two phases based on the amount and type of platform preparation and overhang removal. Thus, at SH1 it is possible to divide the artefact assemblage into three periods on the basis of general stone-working technology as well as the type and frequency of retouched flakes.

There is technological continuity between each of these periods as well as difference. For example, the application of force in the Pre-Bondaian and Phase I Bondaian periods was similar, whereas both Phase I and II Bondaian knappers achieved control over platform angles, platform size and platform surfaces by various platform preparation/overhang removal procedures.

Discard rate

Chronological changes in discard rate were calculated for three different classes of stone artefacts in Square AA: backed blades, all chipped artefacts, complete mudstone flakes (Figure 3). The same general trend occurs in each: discard rates were initially very low, rose dramatically during the middle phase of occupation, and then declined in the most recent levels. Discard rates of all three classes are highest during the Phase I Bondaian. The calculated rates are much lower in the Phase II Bondaian, but are not as low in the later stages of the Pre-Bondaian. Taken literally it might be argued that discard rates, and by implication the amount of occupation, are higher in the Pre-Bondaian than in the Phase II Bondaian. The dating difficulties which were discussed earlier, however, necessitate more cautious conclusions. Nevertheless it seems likely that the discard rate of artefacts and perhaps the intensity of occupation at Sandy Hollow 1 declines sharply from the Phase I to the Phase II Bondaian. The implications of such a trend are raised later in the paper.

Dating open sites in the Hunter Valley

Surface scatters of stone artefacts are the most common archaeological manifestation of prehistoric acitivities in the Central Lowland zone of the Hunter Valley. It would be extremely useful to be able to date these open sites: even a relative dating system would greatly increase our capacity to interpret the archaeological record. Separating sites into temporal units greatly facilitates studies of

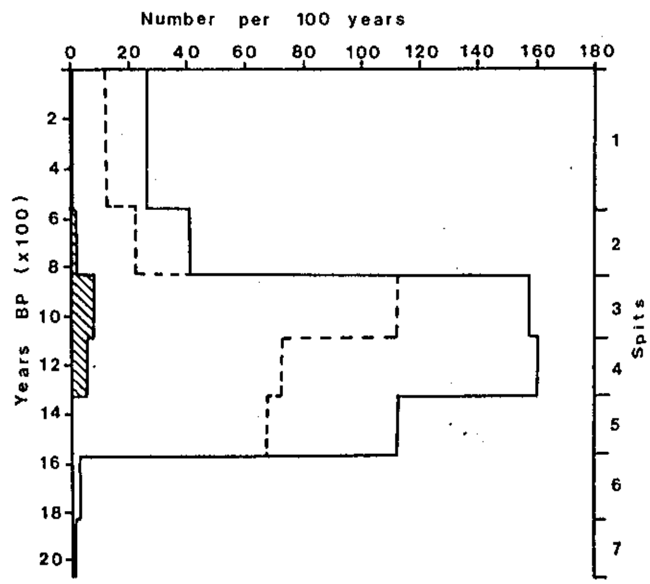

Figure 3. Discard rates of artefacts at Sandy Hollow 1. Solid line: all artefacts; broken line: complete mudstone flakes; shaded: backed blades.

Aspect of technology	Trait	Measure	Phase II Bondaian	Phase I Bondaian	Pre-Bondaian
Amount of force	Termination	Ratio feather:non-feather	3.0-3.5:1	>3.5:1	<3.0:1
Angle of force	Termination	Ratio hinge:step	<6.0:1	>6.0:1	>6.0:1
Precision of blow	Platform size	% focalized platforms	>10.0	<10.0	<10.0
Platform angles	Platform angle	% flakes >80	>20.0	>20.0	<10.0
		% flakes <60	<16.0	<16.0	>20.0
		mode	70-79	70-79	60-69
Platform preparation	Platform surface	% of flakes with facetted platforms	0	>8	0
		% flakes with several scars on the platform	5-10	>15	<5
		% flakes with cortical platforms	15-25	15-25	>40
Overhang removal	Overhang removal	% flakes with overhang removal	20-40	<20	<20
Core rotation	Platform removal	% flakes with remnants of platforms on dorsal face	1.5-2.0	>2.0	<1.5
	M or D scars	% flakes with M or D scars	<10	5-10	<1.0

Table 7. Changes between phases in technological attributes at SH1.

settlement patterns or population change. The only relative dating system which has been widely employed on artefact scatters in eastern Australia, including the Hunter Valley, has been to use backed blades as a cultural marker. A number of problems are inherent in this approach:

1. It can only be applied to large sites on which the likelihood of backed blades occurring is high. While it is possible to infer the relative ages of artefact scatters or portions of scatters which contain backed blades, this cannot be done for sites or portions of sites which do not contain backed blades. This often excludes many small sites including knapping floors and quarry sites from any discussion of chronological change.
2. It assumes that sites are occupied only during one period and that all material now associated with backed blades in the site were created and used by the backed blade makers.
3. The method is not responsive to chronological changes during the main period of backed blade manufacture and use.
4. The method is particularly sensitive to the activities of amateur collectors, who are more likely to take backed blades than almost any other sort of stone artefact.

The results of the technological analysis at Sandy Hollow 1 indicate that in the Hunter Valley a more precise relative dating system is feasible. Analysis of flakes carried out along the line of that at SH1 should distinguish artefacts from each of the three periods even on unstratified and undated sites. The ability of this analysis to indicate the relative age of artefacts in the Hunter Valley rests upon a number of findings at SH1:

1. There are distinct changes in technology through time, including changes within the Bondaian levels.
2. These changes are identified on the basis of unretouched flakes and should therefore be applicable on small as well as large scatters and in areas which have been subject to amateur collecting.
3. The chronological differences are based on a large number of attributes which are combined in distinctive ways.
4. Relative chronology is based on quantative changes and not on the presence/absence of unusual artefacts.

Throughout the Hunter River Valley technological characteristics are able to act as chronological indicators because although artefacts are made on several raw materials, they are made using the same reduction systems as those at SH1. Unlike many areas in Australia the availability and nature of stone materials has had only minor effects on the stoneworking. The characteristics of unretouched flakes which best serve to separate the three phases at SH1 are listed in Table 7. By measuring these attributes on the flakes from any particular site it should be possible to assign that site to one of the three phases defined at SH1 *or* to determine that the assemblage cannot be dealt with in this system.

In order to demonstrate the application of this scheme, collections from two areas near Muswellbrook were analysed. A large number of open sites from the Mount Arthur North and Mount Arthur South Coal leases were excavated by Hiscock and Koettig (1985) as part of a salvage project. Artefacts from 15 sites were classified into the three categories defined at SH1. One site was Pre-Bondaian, ten were Phase I Bondaian, three were Phase II Bondaian, and one was both Phase I and Phase II Bondaian. This pattern of high numbers during the first Bondaian period and decreased numbers in the second phase of the Bondaian is similar to the changes indicated by artefact discard rates at SH1. The low numbers of Pre-Bondaian sites contrast with the trend in calculated discard rates at SH1. Since all of these sites were found eroding out of clearly defined Holocene sediments only 10-30cm thick the paucity of Pre-Bondaian sites cannot be explained as a lack of exposure. Nor can the paucity of Pre-Bondaian sites be explained as the destruction of early sites, since even if erosion had occurred lags of artefacts should still have been preserved. Thus this pattern probably accurately represents the gross changes in site numbers near Muswellbrook during the Holocene.

Similar patterns have been observed at other parts of the Central Lowlands, although not quantified in this manner. In several areas which have been examined nearer to Singleton all sites could be unambiguously assigned to one period, and on each occasion Pre-Bondaian sites were extremely rare, and Phase I Bondaian sites were far more numerous than Phase II Bondaian sites. This suggests that the patterns identified at Mount Athur North and Mount Arthur South reflect the chronological trends in site numbers throughout the Central Lowlands of the Hunter Valley. Decreases in the number of sites as well as in the discard rate at SH1 during Phase II of the Bondaian indicate that in the more recent period of Hunter Valley prehistory the quantities of stone artefacts manufactured, used and discarded were less than in the Phase I Bondaian.

Discussion

> By all indications intensification of social and economic relations would appear to have been increasingly taking place during the Holocene period on the Australian mainland, the process being nipped in the bud by the coming of the Europeans.
> (Lourandos 1983:92)

This statement by Lourandos is based largely on an argument that between 4000 and 2000 years BP until the European invasion the number of sites and the discard of artefacts at each site continued to grow. Presenting data from the south coast of New South Wales, Hughes and Lampert (1982) had perceived a similar trend in archaeological materials and interpreted it as population growth. Lourandos has preferred to view the change as one of intensifying production because he took the accompanying trends toward more complex strategies of resource exploitation and the occupation of new landscapes as an indication of increasingly more complex social and economic relations. A number of other archaeologists have stressed that greater numbers of sites and artefacts are found in the late Holocene than in any other period. After excavating 16 sites within the Mangrove Creek Dam storage area north of Sydney, Attenbrow (1982) concluded that they were predominantly occupied over the last 5000 years. Ross (1981) found that in the arid Mallee landscape of north-western Victoria the majority of sites contained artefacts related to the 'Australian Small Tool Tradition' and were therefore probably more recent than 3500 BP. Allen's (1972) work in the Darling Basin yielded a sequence of sites which show a similar increase over the last 4000-5000 years. Bowdler (1981) argued that the occupation of the eastern Australian highlands took place only in the last 4000 years and was associated with ceremonial activities. Beaton (1977) and Jones (1977) have both suggested that ceremonial events became greatly elaborated after 4000 BP. Working in the south-western corner of Western Australia Hallam (1977) has found greater numbers of sites after the initiation of the Small Tool Tradition.

Lourandos (1983) and Hughes and Lampert (1982) have quoted these studies to support their case that middle to late Holocene intensification and/or population growth was a widespread phenomenon. Despite the variety of interpretations placed upon the perceived increase in archaeological debris all authors believe that once the increase in sites and artefact numbers began it continued, and at an increasing rate, until the process was interrupted by European intervention.

The late Holocene decrease in archaeological material from the Hunter River Valley stands in strong contrast to this. There are also other sites and other regions which provide clear indications that within the last 2000 years or so the amount of debris discarded either levelled off or declined. At Native Well 1 in the southern Queensland highlands the artefact accumulation rate between 2500BP and the present is about one-eighth the rate between 4000 and 2500 BP (Morwood 1981:32). At the nearby Kenniff Cave the discard rate of unretouched flakes declines from 197/100 years between 2500 and 1600 BP to only 1.17/100 years between 1600 BP and the present (calculated from data given in Mulvaney and Joyce 1965). Smith's (1982) re-analysis of the material excavated from Devon Downs revealed a dramatic decrease in artefact discard rates approximately 1900 years BP.

In three of the five sites studied by Hughes (1977; Hughes and Djohadze 1980; Hughes and Lampert 1982) in southern New South Wales the implement accumulation rates either do not continue to increase or actually decline over the last 2000 years. About 1500 BP the discard rate at Bass Point ceases to increase (Hughes and Lampert 1982:18). Discard rates at Currarong 1 increase from 4000-1500 BP, and then decline noticeably (Hughes and Lampert 1982:17). At Sassafras 1 the discard rate of 'tools' increases rapidly from 4000 BP until 2000 BP and then decreases almost as rapidly (Hughes and Lampert 1982:18). In the catchment of Mangrove Creek Attenbrow (1982:77) suggests that while discard rates at some sites, such as Loggers, continued to increase in the last 2000 years, at other sites, such as Deep Creek and Mussel, they decline markedly.

In his re-excavation and analysis of Capertee 3 in the Blue Mountains, Johnson (1979) does not present information on the discard rate of artefacts. He does, however, present data on the density of artefacts at different levels and these are two or three times lower between 300 BP and 1300 BP than between 1300 BP and 2300 BP. Jones and Johnson (1985:183) interpret the Lindner site in the Northern Territory using artefact densities rather than discard rates, noting that '... the densest occupation occured ca. 2-2500 years ago and that after that there was a lessening of average usage even within the past 1000 years up to the 'ethnographic present'.' Many of the sites studied by McBryde (1974:327) in the New England uplands either cease being occupied between 500-2000 years BP or have lower discard rates of implements in upper levels (eg. Chambigne, Jacky's Creek, Bendemeer 1, Bendemeer 2, Graman 1, Graman 4).

Other researchers have found no evidence for a decline in the amount of archaeological material in the last 1500-2000 years but have found that the rate of increase slows noticeably. In the Mangrove Creek catchment Attenbrow (1982:76) finds that the rate at which new sites are occupied is greatest between 3000-1500 BP and decreases in more recent times. Lourandos (1983:86) has presented information on the dates at which nineteen sites in south-western Victoria were first occupied. He uses these data to demonstrate that site numbers are much greater in the last 2000 years than in the preceeding 10,000 years. What he does not point out is the noticeable decline in the rate of site occupation in the last 1000 years.

Although these comparisons are by no means exhaustive they do demonstrate that the chronological trend observed in the Hunter River Valley is widespread. In no sense do these observations deny the existence of middle to late Holocene increases in archaeological debris. At some time since 4000 BP the amount of discarded material and the number of locations at which it was discarded did increase markedly, and even though the quantity of debris has declined in some areas since then it has generally remained greater than before the increase began. Nevertheless, these examples do indicate that in some sites and some regions the increases, once begun, were not maintained during the last 2000-1000 years. Questions about late Holocene change in Australian prehistory must not, therefore, be limited to investigating the increase in debris, but must incorporate the subsequent decrease.

The above data have several implications for arguments in favour of generalized and continuing late Holocene intensification and population increase. For example, if the dramatic increase in archaeological material which takes place between 2000 and 4000 BP is to be interpreted as an intensification of social or economic relations, and/or as an increase in population, then the more recent decline in amount of debris could be interpreted as either a reverse of this intensification or a decrease in population.

The simplistic equation between numbers of artefacts and the size of prehistoric populations or the structure of their social and economic relations is further complicated by the recognition that during the last 2000 years discard rates continue to increase at some sites but decrease at others. For example, on the south coast of New South Wales, if implement discard rates are reflecting changes in demography as Hughes and Lampert (1982) have claimed, then two of the four shelter sites studied by Hughes (1977) suggest increases in population and two suggest decreases over the last 1500-2000 years. Is this period one of population increase or of population decrease or, as Attenbrow (1982:77) has suggested, do the two trends cancel each other out and imply relatively stable population sizes? Perhaps the trend towards lower 'site usage' of some shelters on the south coast implies that increases in population size had slowed by 2000 BP and that Hughes and Lampert's (1982:20) observation of increasing numbers of sites during the last 2000 years reflects not greater population but a more dispersed settlement pattern.

Translating amounts of archaeological debris into estimates of quantities of prehistoric activities, be it population size or complexity of social relations, is a difficult task (cf. Hiscock 1981; Lourandos 1983:92; Hughes and Lampert 1982). Both Smith (1982) and Jones and Johnson (1985:183) have emphasised that local effects may account for the variations in artefact discard rate within their sites. But such particular events are unlikely to result in widespread and largely synchronous changes in widely separated regions. Decreases in discard rates at some sites need not imply any devolution, but may simply reflect changes in the nature and structure of settlement, technology or resource use. Testing this possibility will necessitate archaeologists gathering data other than numbers of sites and discard rates. New measurements of the intensity of activities within sites have been suggested by several researchers. For example Hiscock (in press) has recently used fragmentation of flakes to infer changes in the amount of walking and cooking which occurred at different times in a site. Walters (1985) has shown that damage to fish bones at coastal sites in South-east Queensland can be used as a measure of the intensity of campsite activities. Lourandos (1980, 1983) has used variations in the range of faunal material and the type of site to infer changes in the intensity and complexity of occupation.

Future explanations of prehistoric changes in Holocene Australia will need to take account of the contrast between regions which in the last 2000 years have declining quantities of debris and those which have continued increases. For example, in areas as dispersed as the lower Murray (Devon Downs), the Queensland highlands (Native Well 1), Arnhem Land (Lindner) and the Hunter Valley there are suggestions of decreased amounts of debris over the last 2000 years; in south-western Victoria this period is one of greatly increased amounts of debris. Further, the initial date of increases in artefact numbers varies greatly between sites and regions. Hughes and Lampert (1982), Ross (1981), Morwood (1981), Attenbrow (1982) and Smith (1982) give this date as about 3500-5000 BP. Jones and Johnson (1985), Johnson (1979), and Mulvaney and Joyce (1965) found that increases were initiated between 2000 and 3000 BP. In the Hunter Valley and in south-western Victoria (Lourandos 1983) the increases in site numbers and discard rates occur within the last 2000 years. Even in those sites and regions which show a trend towards decreasing amounts of debris in the late Holocene there are variations in the timing of the changes. For example, at Native Well 1 the decline begins at 2500 BP, at Sassafras 1 and Devon Downs the date is 2000 BP, at Kenniff Cave and Currarong Shelter 1 the decrease begins about 1500 years ago, and at Sandy Hollow 1 the change is dated to about 800 BP. These differences in the direction and dating of changes in the archaeological record indicate that there is no evidence for a single continuing middle to late Holocene increase in sites and site usage in all parts of the Australian mainland; rather, during the last 5000 years many areas show increases in debris, and some areas show decreases in the number of sites and/or artefacts.

These variations in the timing of change in the rate of artefact discard and site occupation raise the issue recently framed by Jones,

> ... was there, throughout the continent a relationship, perhaps a fixed relationship between the productive capacity of the landscape and the number of Aboriginal people living per unit area? Or was the density and organisation of Aboriginal populations related to improvements in technology or changes in social organisation of production brought about by an 'intensification' of economic activity?
>
> (Jones 1985:293)

Hughes and Lampert (1982:26) note with suspicion that their hypothesised increase in south coast population coincides with 'major changes in stone tools'. This coincidence is also seen at such sites as Native Well 1 and Capertee, as well as in the data from the Hunter Valley. Although obvious changes in the types of stone implements do not always precede changes in artefact discard rates in other areas, as for example in south-western Victoria (cf. Lourandos 1983), this does not mean that more subtle alterations in stoneworking and associated aspects in the economy do not accompany changes in the quantity of archaeological debris. The perceived decrease in discard rates at SH1 and sites throughout the Hunter Valley during recent prehistoric times is accompanied by the introduction of a different stoneworking technology, a change which is not reflected in the types of implements manufactured. Detailed examinations of stoneworking technology are therefore required before the relationships between knapping, other economic activities and the quantity of debris become clear. Such detailed descriptions of technology may also aid in the identification of chronological changes by enabling open sites to be dated relative to each other.

Conclusion

In a recent review article Ross (1985:87) concluded that in south-eastern Australia during the last 4000 years there had been a dramatic population increase. Her argument hinged on the assertion that during this period the number of sites increased and that the intensity of occupation at each site did not decrease. Ross advances this position strongly, saying:

> The only behavioural change which could produce more occupation sites in an area ... without involving an increased number of people, would be a change involving the same number of people spending shorter periods of time at more sites. The obvious archaeological expression of this would be more sites, but with each site containing sparser occupation debris. This is clearly not the case in the middle to late Holocene in south-eastern Australia.
> (Ross 1985:87)

In light of the evidence from the Hunter Valley, and from many other areas, this argument contains little substance. Decreases in the discard rate of artefacts in the recent levels of sites can be perceived in many regions. Furthermore, the date at which discard rates and site numbers initially increase, and the date at which they subsequently decrease varies greatly between sites and regions. On this basis I conclude that the direction and timing of archaeological changes in Australian during the middle to late Holocene cannot readily be seen as a single phenomenon as some archaeologists would like. In particular, the recent decrease in the amount of artefacts and/or sites is a trend which has previously been under-emphasized by those arguing for generalized and continuing late Holocene intensification and population increase.

The diversity of prehistoric trends which are observable in archaeological sites across Australia and the fact that this diversity has not been fully recognised again raises the issue of how we are to interpret changes in the amount of archaeological debris (cf. Hiscock 1981). It has yet to be demonstrated that increases in the quantity of archaeological debris necessarily reflect either intensification of Aboriginal occupation or a larger population. Consequently, it has not been demonstrated that decreases in debris need to be interpreted as disintensification of occupation or as a decline in population. Since changes in the amount of debris often appear to coincide with new technologies and/or with alterations in the number and location of sites, it is possible that within Holocene Australia there are underlying changes to the structure of discard behaviour, technology, settlement patterns and economy. Interpretation of these aspects of the archaeological record awaits three sorts of studies. First, the invention and use of independent measures of the nature and intensity of activities at a site. Secondly, detailed investigations of small regions rather than of widely dispersed sites. Thirdly, the integration of data from numerous open sites into the chronological scenarios generally derived from investigations of rock shelters. Until we have these data we will be unable to accurately describe the trends which occur in the archaeological record or to distinguish simple functional change from complex functional change (cf. Smith 1982). Only when the prehistoric human behaviour in each site and each region has been described and explained will it be possible to determine whether or not all Holocene changes can be best accounted for within terms of a single process.

Appendix

Definitions of attributes

Weight was measured to the nearest 0.1 gram.

Length was the distance along the percussion axis from the ringcrack to the distal margin. The measurement was taken with callipers to the nearest millimetre.

Width is the distance between the lateral margins measured at right angles to the length midway between the ringcrack and the distal end. The measurement was taken with callipers to the nearest millimetre.

Area of the ventral surface is gained by multiplying length and width.

Platform width is the distance across the platform from one lateral margin to another. The measurement was taken with callipers to the nearest millimetre.

Platform thickness is the distance across the platform surface from the centre of the ringcrack to dorsal face. This measurement was taken in line with the percussion axis. The measurement was taken with callipers to the nearest millimetre.

Platform area is obtained by multiplying platform width and platform thickness.

Elongation is calculated by dividing length by width. The higher the value the longer the flake is relative to its width.

Parallel index is calculated by dividing the width by the platform width. A value of 1.0 indicates that the flake is square or rectangular in shape, with parallel sides. Values less than 1.0 indicate that the flake contracts along its length away from the platform. Values greater than 1.0 indicate that the flake expands along its length away from the platform.

Termination. The three types of terminations dealt with in this paper follow the definitions given by the HoHo Committee (Hayden 1979:133-135). Steps occur most often under conditions of outward force. Hinge terminations indicate insufficient force.

Platform type is a measurement of the relationship of the Point of Force Application (PFA) to the platform area. The category of platform type of interest in this paper is Focalised platforms. These were instances in which the area of the platform was less than twice th area of the ringcrack. Such platforms indicate th: the PFA was close to the core edge and the applied force was not excessive. Focalised platforms often result from overhang removal and/or precise PFA placement.

Platform angle is the angle between the dorsal surface of the flake and the flake platform. This was measured in 10 degree units with a goniometer and a protractor.

Platform surface. Four different categories of platform surface are used. *Cortical* surfaces are those which have not been modified at all. *Single flake scars* result from minimal platform preparation. *Several scars* represent a greater attempt to alter the platform. *Facetting* consists of a series of small scars, sometimes overlaying larger ones. Each type of platform surface confers different advantages upon the knapper. Cortical surfaces are usually rougher than conchoidal ones and provide greater friction with the hammer and therefore more efficient force transfer. Surfaces consisting of one or more large flake scars provide less friction but allow greater control over platform angles. Facetted platforms give even greater control of platform angles, roughen the surface to cause friction, and often isolate the platform or remove overhangs.

Overhang removal is accomplished when the knapper strikes or brushes the edge of the core platform and removes small flakes from the edge. This prevents th platform from shattering. The presence or absence of overhang removal scars on a flake was recorded.

Platform removal occurs when a flake is detached from part of a core which contains an old platform. The old platform can be observed on the dorsal surface of the flake. The presence or absence of such old platforms was recorded on each flake.

M or D scars are dorsal scars which derive from the lateral margins (M) or the distal end (D) of the flake. Such scars were created when the knapper was using platforms different from the one from which the flake was struck, and the presence of these scars therefore indicates core rotation. The number of these scars was recorded on each flake.

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