The Menindee Lakes: A regional archaeology

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Abstract

The Menindee Lakes are a ‘chain of ponds’ or series of large overflow lakes nestled in the Darling River floodplain, which is situated disconformably in the arid zone. They form an outpost of the greater Southeast, where it meets the Centralian desert. An intensive archaeological survey of the Lakes recorded 4,978 new sites and features at 2,432 localities. Distribution and patterning of sites was correlated with environmental data using Geographic Information Systems (GIS). Survey results revealed distinctive characteristics for this region: fields of ovens and large ashy grey deposits; two very different kinds of milling equipment; and stone tools representative of both desert and southeastern technologies. The Baakantji live on a shifting frontier, part of two larger regional systems with very different ecologies and social and biological systems. The Baakantji territory of the Menindee Lakes emerges as a distinct region, sharing features with both Desert and Riverine economies.

Peter White in the Bush

In 1978, J Peter White carried out an archaeological survey at the Menindee Lakes (Buchan and White 1981). This was followed by a well-known article entitled ‘Cambridge in the Bush – again?’ (Murray and White 1982). These papers demonstrate JPW’s involvement in the construction of a distinctive Australian archaeology at a time when Culture History was being challenged by Processualism.

The first goal of Culture History is to seek out temporal patterning as an interlinked series of events and then generalize over space. At its simplest, the goal of Processualism is to seek out spatial patterning and then look to chronology. We all wish to end up at the same place – a spatio-temporal understanding of the human endeavour – but the nature of the Australian landscape would always make Culture History a very difficult task. Australia is the perfect place in which to carry out archaeology within a Processual framework. In most of western NSW the pastoral industry, with its over-optimistic stocking rates, has consigned as much as 300mm of topsoil to the winds. Although this destroyed the context of much of the archaeological record in this unit, it has provided an unparalleled view of the distribution of archaeological materials.

The theoretical changes JPW discussed in his writing influenced his fieldwork practice. The 1978 field school at Kinchega National Park on the Menindee Lakes set out not only to provide experience for 13 students, but also to ‘survey areas of the Park in such a way as to allow predictions as to the location of relics within the Park as a whole’ (Buchan and White 1981:65). The methods were much as they are today: walk, observe, write, quantify and, most importantly, sample areas in systematic ways that reduce observational bias (in their case by using transects and samples around the lakes). The field school recorded 176 sites, categorised site types and calculated patterns in distribution against micro-environments such as floodplain, bluebush plain, source bordering dune, and water’s edge. This approach was at the heart of Processualism: a recognition of the ecological basis of human society that allows the examination of the relationship between ecology and ancient human social activity.

With the exception of Buchan and White (1981), whose research focus in the Menindee Lakes was informed by spatial questions on site distribution, the relationship between sites and water, or between sites and micro-environment, most prior research had taken an explicitly Culture Historical approach. Tindale (1955) applied to the Menindee Lakes his three part culture succession, derived from work on the Murray River. This was followed by research into megafaunal remains in potential association with human occupation and burials (Tedford 1967). Allen’s research questions (1972, 1974, 1990) explore change (or lack of it) through time. His research stimulated an ongoing debate into the antiquity of seed grinding in Australia (Balme 1991; Smith 1988; Gorecki et al. 1997). Archaeological fieldwork has been mainly concentrated on Lakes Menindee, Cawndilla and Tandou. Their exposed Pleistocene sediments have received intense archaeological examination. Elsewhere, extensive soil deflation has proven challenging to researchers wanting to examine artefacts in a chronological context.

More detailed geomorphological studies during the 1980s and 1990s (Bowler 1983; Hope *et al* 1983; Brown and Stephenson 1991; Chen 1992) refined the environmental chronology of the Darling River and Menindee Lakes (Allen 1990; Hope 1993), but questions of spatial distribution have invariably focussed on particular features of the archaeological record: middens and use of aquatic resources (Balme 1983, 1990, 1995; Balme and Hope 1990); technology and antiquity of grinding stones (Balme 1990, 1991; Allen 1974; Webb 1993); and burials (Pardoe 1985). A distributional or site-less approach to settlement and land use strategies was explored at the larger lakes (Martin and Webb 1993; Martin et al. 1994; Webb 1996). These factors have produced biases in our understanding of the spatial distribution of the overall archaeological record of the region. Hope (1993:196) commented that ‘the most neglected area is that of the stone tool assemblages, especially the questions of their sources and distribution’.

An approach such as Processualism, which privileges spatial analysis, recognises that a chronological approach can often stall in the absence of spatial detail, particularly when the passion for old sites inhibits research into later periods. The aim of the research reported here was not to contribute to an understanding of chronological sequences or the timing of the introduction of particular tool types or economies. Rather, it was hoped that a detailed documentation of spatial distribution and patterning of sites might generate new questions and interpretations. Spatial patterns offer a degree of chronological information, of course, since patterns build up over time (Pardoe 1994a, 1995).

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Since the early 1980s, the development of Geographic Information Systems, along with appropriate numerical analysis, has significantly enhanced the potential for spatial analysis. This Menindee Lakes study (Pardoe and Martin 2002) produced a predictive model of site likelihood for the region. In this short paper, I focus on several examples that have informed my regional interpretation. This paper is offered as an appreciation of JPW and his contribution to Australian Archaeology – sorry – Archaeology in Oceania.

Survey method and sampling strategies

The survey was commissioned as part of the Menindee Lakes Ecologically Sustainable Development (ESD) Project funded by the New South Wales Department of Land and Water Conservation (DLWC) in order to extend coverage of site recording throughout the Menindee Lakes storage area. The survey was designed and run by Pardoe; Sarah Martin provided local knowledge and expertise in lithic analysis; and four local Baakantji were contracted through the Menindee Local Aboriginal Land Council.

The Menindee Lakes region covers about 250,000ha (Fig. 1, shaded portion). The study area covers approximately 57,000ha. Lakes make up about 38,000ha, or two-thirds of the area. There are 17 lakes in the Menindee Lakes system as well as the Holocene Darling River, the older Darling Anabranch, feeder creeks and associated floodplain features such as billabongs.

The survey, conducted during six weeks in October and November 2001, was designed to complement existing information and avoid duplication. Inspection was on foot around the shores and local drainages of five of the northern lakes, smaller associated lakes and portions of the floodplain, where accessible. We did not examine the southern part of the system or those parts of Menindee and Cawndilla Lakes that had been previously documented. We surveyed the perimeters and inlets of Wintlow, Malta, Balaka, Bijiji, Tandure, Pamamaroo and Wirryilka Creeks. We also sampled the northern and western margin of Lake Menindee, down through the overflow creek variously known as Cawndilla Creek, Morton Boolka or Lake Eurobilli to the northwestern part of Lake Cawndilla. Lakes Tandou, Nettlegoe, New and Kangaroo at the southern end of the study area were not examined. Lake Wetherell is a man-made lake constructed from the damming of the Darling River channel and banking

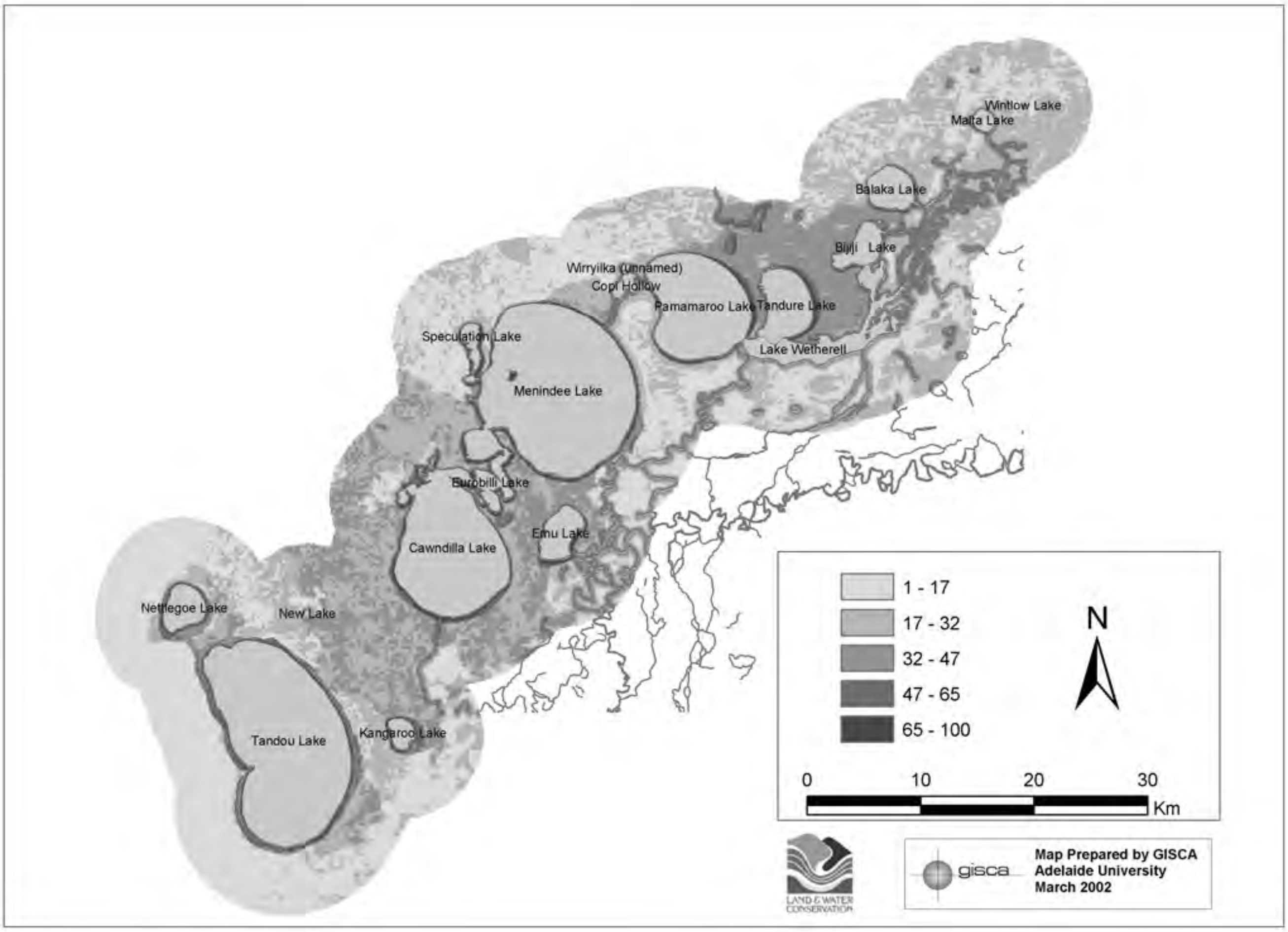

Figure 1 The Menindee Lakes on the central Darling River. Those to the south have become extinct. Most feed directly from the river. Lake Wetherell is an artificial body created by damming the main channel. The map is constructed from a predictive model of site distribution and density (Pardoe and Martin 2001, 2002). The likelihood of sites was calculated from sites recorded during the survey and correlated with environmental factors. The survey area was divided into 50m grids and each grid cell received a value based on these environmental correlates. Shading and scale (0-100) represent higher likelihood of site presence and greater expected density of sites. No specific site location is presented in this map, making it useful as a public document. For all its limitations, the predictive map gives a reasonable view of the nature and location of Aboriginal occupation on the landscape. The topography of the Menindee Lakes is created, in effect, by the likelihood of that occupation.

of the floodplain on the eastern side of the channel. The floodplain covered by Lake Wetherell was inaccessible so comparable floodplain areas were investigated in other unaffected areas.

The study area was restricted to lake margins, river edges, floodplains, lake feeder creeks and a small amount of exposed lakebeds. Survey extended away from water sources as far as the direct effects of erosion were observed, usually no more than 900m. In practice this meant the local basin area of lakes up to the crest of the surrounding plains. Survey was complete for large areas, as described above. We surveyed in localities, or site designation areas (Balme 1990), rather than transects or quadrats. In practice this would be a landform such as a meander scroll, or an ecological zone such as black box floodplain.

Sites and features were recorded according to categories used by the National Parks and Wildlife Service (Byrne 1997): open sites, mounds, shell middens, scarred trees, burials and isolated artefacts. In practice, many of these are attributes of a particular locality, which may be recognized as a *site*. *Open sites* are often taken to indicate an occupation area that may be characterized by scatters of lithic items on an eroded surface. The category *open site* has been used with reference to the Sites Register for those sites that have multiple features. Areas of dense occupation include mounds, some middens and areas that have organically modified soils, and numerous re-dug oven materials and artefacts, for which we devised the term ‘ashy grey deposit.’ Sites can contain other features that, by themselves, would also be called sites within the NP&WS framework. An ashy grey deposit might contain burials, be surrounded by scarred trees, and is itself the product of countless ovens. Isolated artefacts (mainly ochre, grinding pieces, hammers and burial paraphernalia) might be recorded as attributes of a locality, or as single features.

The number and distribution of sites and features were analysed by comparing them to environmental factors such as distance from water, landform type and vegetation community. This was done by numerical analysis and using GIS methods (ArcView). Different views of these factors were used. For instance, distance to water was calculated separately for lakes and river channels; two different landform categorizations were used; and vegetation consisted of modern and pre-1750 as well as a very detailed map layer that covered a restricted area of floodplain (Westbrooke et al. 2001; Taylor-Wood et al. 2001).

Sites and features

During the course of the work, 4,978 new sites and features at 2,432 localities were recorded using handheld GPS instruments. Table 1 shows differences in proportions of site type between our survey, one conducted by Martin and Webb (1993; Martin et al. 1994) and the database of the NP&WS Sites Register. Some differences are trivial, such as the under-representation of grinders or ochre in the Register. Others, such as burials, shell middens, ashy grey deposits and ovens reflect observational bias. The relatively large number of open sites in the Register is at least in part definitional, because it subsumes artefacts, ovens and other items.

Sites and features were correlated with different environmental features. Table 2 gives an example of one such analysis showing the relationship between a GIS map layer, ‘habitat’ (as defined in Taylor-Wood et al. 2001) and site type. It shows the area is dominated by the lake beds. Note that ‘open water with dead trees’ is categorized separately. Since the lakes are maintained near their naturally occurring high water mark, the trees fringing the lake and the feeder creeks have died. Most sites are associated with floodplain and woodland. Only shell middens and scarred trees were recorded in the dense lignum swamps. The latter may be a preservational bias, where trees were protected from felling by their location in the particularly difficult swamp environment. Scarred trees are also common along feeder channels and lake edges. Note the difference in location of open sites and ashy grey deposits, such that the former are most common around lakes and on floodplain, while the latter are restricted to woodland, particularly rarely flooded parts.

Percentage of sites and features - all sources

Site type	Current survey		Martin & Webb	NP&WS register	All sources
	n	%	%	%	%
Oven	2754	55	49	0	48
Artefacts	724	15	16	1	13
Open site	161	3	2	62	9
Grass seed grinder	345	7	12	0	7
Burial	131	3	9	21	6
Shell midden	205	4	1	15	5
Hard seed grinder	213	4	9	0	4
Ashy grey deposit	270	5	1	1	4
Scarred tree	105	2	1	1	2
Ochre	70	1	0	0	1
Total	4978		977	740	6695
Total localities	2432		228	557	3217

Table 1 Number of sites and features tabulated for each of the main sources.

Distance to water

‘Some variations in the density of relics were noted and appear generally to relate to distance from stream or lake water, but a more precise sampling would be needed for this impression to be tested’ (Buchan and White 1981:70). Figure 2 presents data on distance of sites and features to water. The same mathematical family of distributions describes the systematic decrease in number of sites, frequency of stone tools from a quarry, and genetic similarity with increasing distance. The average distance of sites and features to a water source is 368m. Virtually all sites are found within 1,500m of water, 90% of sites are within 500m and 11% are at water’s edge. The difference between distance to lakes and to channels is small but consistent. Many lakeside sites are very close to water’s edge (the high water beach, or else sites that are actually on the lake bed), with a gap building to another peak at 60-70m.

Ovens and Ashy grey deposits

Since ashy grey deposits comprise a newly recognised site type, some previously recorded sites were assigned to this category. A total of 270 ashy grey deposits were recorded in the survey, bringing the total to 286. Ashy deposits have a very different colour from surrounding sediments, showing up dark against the light beige to brown lunettes, the red and pink soils of the sand plain or linear dunes, or the grey clays of the floodplain. In texture they are usually a soft, unconsolidated

Habitat			% of sites by site type for each habitat										All sites	
	Area (ha)	% of Area	Open site	Ashy grey	Shell midden	Oven	Flaked artefacts	Hard seed	Soft seed	Scarred tree	Ochre	Burial	n	%
Rarely Flooded Woodland	6,412	11.3	9	39	26	31	23	12	20	13	24	11	312	27
Floodplain Woodland (Red Gum)	4,857	8.6	30	16	25	18	24	35	24	16	21	26	230	20
Floodplain Woodland (Black Box)	2,065	3.6	9	21	8	20	20	12	18	13	24	12	213	19
Sandy Lake Fringe	659	1.2	6	4	2	3	9	9	8	16	7	22	91	8
Open Water Lake	29,405	51.8	21	3	10	8	6	5	7	0	0	11	79	7
Open Water Lake (dead trees)	6,144	10.8	13	2	3	4	5	8	6	1	3	9	49	4
Lignum Swamp	871	1.5	3	0	0	4	2	3	5	18	3	1	36	3
Dry Lake-bed Herb, grass, sedge	890	1.6	2	1	1	3	3	2	3	6	3	4	24	2
Woodland with Lignum	935	1.6	1	7	13	1	3	2	3	1	3	0	24	2
Shallow Freshwater Marsh	1,497	2.6	4	2	6	2	3	6	4	0	0	0	23	2
Open Water Channel	799	1.4	2	5	7	0	1	1	1	1	7	2	19	2
Inflow - Outflow channel	163	0.3	0	0	0	0	0	1	0	15	0	0	16	1
Recently Exposed Lake-bed	261	0.5	1	0	0	3	2	3	1	2	0	1	12	1
Dead Trees: Persicaria &/or Lignum	395	0.7	0	0	0	0	0	0	0	0	0	0	4	0
Shallow Marsh (dead trees)	727	1.3	0	0	0	0	0	0	0	0	0	0	2	0
Chenopod Shrubland	431	0.8	1	0	0	3	1	1	0	0	3	1	2	0
Introduced species	222	0.4	1	0	0	0	0	0	0	0	0	0	1	0
Totals (n)	56,733		198	118	118	1,290	372	164	251	103	29	123	1,137	

Table 2 Percent occurrence of site types by habitat.

soil with a greater proportion of organic material, including ash and charcoal. They include many pieces of baked termite mound, baked clay, calcrete or river sandstone heat retainers, and varying proportions of stone material, including flaked and ground material. They also contain mussel shell and other faunal remains such as fish otoliths, yabbie gastroliths, turtle shell, bird bone, small mammal bone and occasional larger pieces of bone. With continued use in a particular area, ashy grey deposits may develop from ovens. These deposits were continually dug over as each day's oven was used, making it difficult to see individual events or clearly defined stratigraphy. Ashy grey deposits may be slightly mounded, measuring between 10cm and 40cm in height. In many ways they are similar to the black earth mounds of the Riverine Plain (Martin 1996, 1999; Pardoe and Martin 2001). The colour and texture of the sediment and faunal remains are almost identical, but they do not seem to have been deliberately built up and shaped in the same way as the mounds. The grey ashy deposits have an irregular shape roughly following a river or billabong levee bank or linear sandy feature on the floodplain. They vary between five and ten meters across and are only slightly raised. In contrast, mounds of the Riverine Plain are always round in outline or occasionally elliptical, and have been deliberately built up, some being two metres or more in height even after 200 years of erosion (Pardoe and Martin 2001).

Ashy grey deposits are concentrated near inlet and outlet creeks of the lakes, including Cawndilla Creek, the northern end of Cawndilla Lunette North 'Spit' and also along sections of the river and associated features, particularly in the area of floodplain between lakes Bijiji and Balaka and near many other lake inlets. Along the Darling River the deposits are concentrated on more complex or mosaic habitats, such as deep bends in the river, billabongs, and swamps with low lunettes. These are clearly focal points where dense occupation occurred over extended periods of time, and which probably date to the late Holocene period (Martin and Webb 1993; Martin et al. 1994).

Ashy grey deposits are dense occupation areas where resources such as water and firewood were required for large numbers of people. Apart from cooking meat, tubers, rhizomes and fibrous vegetables, ovens were also used for the production of fibre for twine.

Rushes, from which they make their twine, … are

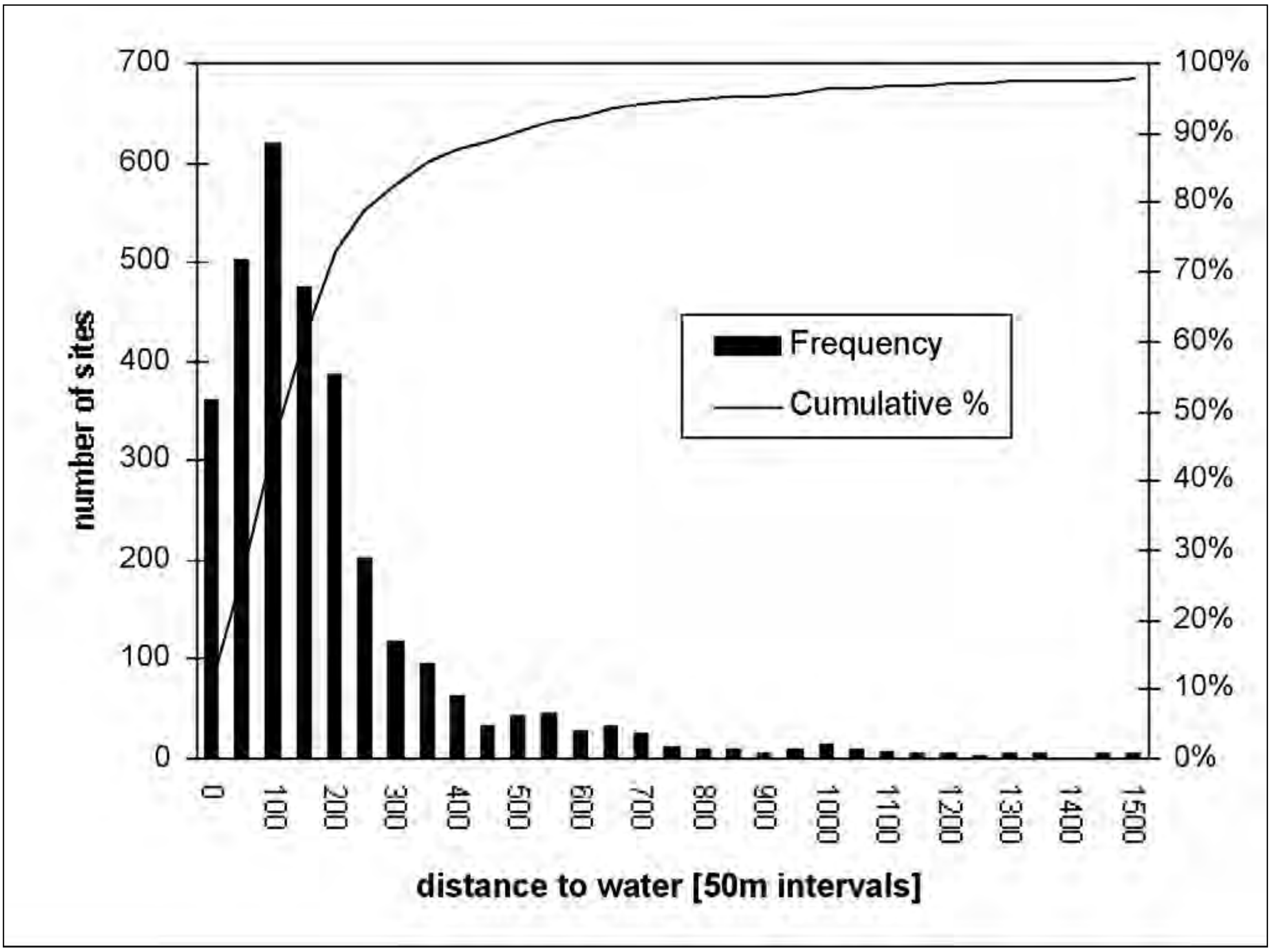

Figure 2 The distance of all sites and features to water in 50m intervals. The distribution peaks at 100-150m, with an average distance of 368m.

> put into a deep hole, which has been well heated. With the rushes are put in a salsolaceous plant, which contains a great quantity of moisture, the whole is then well covered in, and the steam arising from the plant saturates the rush, and after being thus subjected, it becomes extremely tough, and gets torn abroad, and is then twisted. (Brock 1844 [1988]:52)

If descriptions of trade are accurate (Howitt 1904:717), the production of twine and nets may have been an important part of the local economy. We might expect to see ovens in these locations associated with ochre for the preservation of the fibres and grinding materials for the pounding of the fibres. Ochre is indeed found in dense occupation areas, related to the ashy grey deposits.

In some localities, these deposits may equate to the larger Holocene sites that Balme (1995:18) associates with 'longer periods of camping by larger groups of people than the Pleistocene occupations evidenced in the older "single species" sites'.

Burials

To date 370 burials in 320 localities have been recorded. Single burials represent 94% (301), whereas 2.5% are double and 3.4% are between three and nine individuals. 59% (190) of burial localities are on lakes with 53% of these on the lunette. Nine single burials were found in the red dunes. The number of burials is strongly correlated with lake perimeter length ($R^2 = 0.61$). The length of the lake perimiter explains 61% of variation in burial numbers. Lakes Cawndilla and Eurobilli have much higher than expected numbers (Table 3). The former has 42% of burial numbers, but only 22% of total lake perimeter and 13% of all sites. Lake Eurobilli has 16%, 10% and 2% respectively.

There is a strong relationship between distance from water and number of burials, with single burials roughly three times further away than clusters with two to four individuals. The larger clusters, of which four were recorded, are well within 100m of water compared to 761m for single burials and 328m for all other site types.

Multiple burials were found at 19 localities. Of these, 18 occurred in two areas at the northern end of Lake Cawndilla and its feeder channel, what is now Lake Eurobilli. This has been considered one of the core residences of Menindee Baakantji by many archaeologists (Balme 1990; Witter 1993) based on the concentration of evidence. The density of burials is suggestive of cemetery usage (Pardoe 1988), particularly on the narrow peninsula that separates the two lakes. Before water regulation, the inlet/outlet creek would have wound through Eurobilli between Menindee and Cawndilla, providing a secure centre for access to a large rangeland with a high diversity of environments. In some ways, one is struck by the similarity to Lake Victoria's southern edge, where the feeder creeks cross the lunette tail. Areas of highest occupation at these localities at Lake Victoria were very close to the enormous cemetery.

Lake	Lake size				All other sites		Burials									
	area (ha)		perimeter (km)		sites		# of burials in cluster						by locality		by individual	
	n	%	km	%	n	%	1	2	3	4	6	9	n	%	n	%
Pamamaroo	6647	17	33	12	727	33	36	1					37	15	38	13
Tandure	2315	6	23	8	313	14	13						13	5	13	4
Cawndilla	9362	24	61	22	290	13	96	2		3	2		103	42	124	42
Bijiji	1022	3	20	7	281	13	3						3	1	3	1
Menindee	16388	41	65	24	193	9	32	3					35	14	38	13
Malta	313	1	7	3	134	6	12						12	5	12	4
Balaka	1301	3	19	7	129	6	3	1					4	2	5	2
Eurobilli	884	2	27	10	55	3	18	1	2	2	1	1	25	10	49	17
Emu	1189	3	15	5	49	2	8						8	3	8	3
Wintlow	50	0	3	1	18	1	3						3	1	3	1
Wirryilka	47	0	4	1	0	0	1						1	0	1	0
Total	39518	100	275	100	2189	100	225	8	2	5	3	1	244	100	294	100

Table 3 Lake sizes and number of burials by lake.

Stone tools

As discussed above, soil deflation and the nature of the landscape in the area has inhibited chronological analysis of stone tools. It was important, therefore, to document spatial distribution of lithic material in terms of location, environmental context, habitat, material and type. Only a summary description of results is provided in this paper.

Artefact density and diversity were variable, but highest on sites with a greater diversity of other cultural material. The north east portion of Lake Cawndilla and both sides of Cawndilla Creek had particularly dense distributions, as did sites near inlet and outlet creeks of lakes, and mosaic habitats on the floodplain containing a range of billabongs, swamps and anabranch creeks. While variety of stone material is likely to be greater where there is more of it (Hiscock 2001), in this case variety of occupation materials and variety of stone are also correlated.

Flaked stone tools

Martin's analysis of the flaked stone tools show that four main industries predominate in the region. The *Utilitarian Flake Tool Industry* (Witter 1992) dominates the Menindee Lakes and adjacent Darling River. Varying percentages of on-site flake manufacture and tool retouching, resharpening and reduction were found. Typical tools were burren adzes, discoidal tools, nosed and notched tools, and flakes with edge or end retouch and/or usewear.

In this region, the *Microblade Industry Industry* is characterised by relatively small numbers of thin blades and specialised tools including backed blades and other micro tools such as 'thumbnails' or micro-discoidals. The backed blades appeared to be located in small clusters, sometimes with un-retouched blades made from a fine white silcrete. The backed blades were all crescentic in shape, varying in length 12-34mm, with average length of 21mm. This is consistent with the known picture for southwestern New South Wales (Pardoe and Martin 2001; 2002). There were no extensive microblade manufacturing sites such as those found in the Southern Highlands.

Quartz Split Pebble Industry tools were found in most sites, but in low numbers. The pebbles are mostly split in half and the sharp edges retouched to form small adze-like tools. Sometimes they are further reduced to a more block-like shape and retouched the same way.

The *Tula Industry* was found in many sites, but nearly always reduced to slugs. Tulas were brought in from a considerable distance to the north and west, as the source material tends to be a very fine yellow to orange material that is not used in the local Utilitarian Flake Industry. There was a slight trend for tulas to be more common relative to burrens in the northern lakes, decreasing southward or downstream. From north of Pamamaroo to Malta a total of 25 tulas to 19 burrens (a ratio of 130:100) were recorded and measured. From Pamamaroo south to Cawndilla, the ratio was 5 tulas to 12 burrens (40:100). This may indicate a natural trend to replace tulas with burrens with increasing distance from the source of tula flakes. It is significant, though, that the northern lakes abut red dune field country, which might suggest that they were visited by more desert-oriented groups, given the value of tulas in desert economies (Hiscock and Veth 1991; Hiscock 1994).

Pirri points were rare throughout the entire survey area, which is to be expected as they are made from large specialised blade cores. As with the tulas, most if not all pirri points or blanks would have been brought in from a long way to the north and west. One site on the northern end of Lake Malta had two pirri points, another was found on the Lake Malta floodplain, and the fourth on the Pamamaroo lunette. This may indicate a trend for more pirri points in the northern area, as for the tulas, but the numbers are too small to say anything definite.

Raw Materials

Silcrete comprises 80%-90% of flaked stone. Most of the silcrete used for the manufacture of Utilitarian Flake Tools probably comes from the Scropes Ranges, 30-50km from the lakes. This silcrete tends to be medium to coarse grained. Fine silcrete is the only material used for the specialised backed blades, tulas and pirri points. There is a noticeable increase in quartz on the western side of Lake Cawndilla and Cawndilla Creek. Most of it is Broken Hill reef quartz that has been brought a distance of 80-100km from the west (S. Martin, pers. comm. 2002). This quartz is found around the area where Yancowinna and Stephens Creeks come into or close to Lake Cawndilla, these being the traditional routes of access between the Broken Hill and Menindee areas (Sturt 1849). Very large lenticular cores of reef quartz were found on the large Cawndilla Creek burial site. None of the reef quartz from Broken Hill was found north of the southern side of Pamamaroo, but quartz pebbles found their way into most sites. Split pebble tools and block tools are dominated by quartz.

Grinding and pounding

The timing for the introduction of seed grinding in Australia has been the subject of extended debate. Researchers have drawn on Smith (1985, 1986, 1988) to distinguish between millstones, mullers, mortars, pestles and amorphous grindstones. Balme (1991:6) refers to large quartzite grindstones and their dual use as seed preparation and as a source of stone for obtaining flakes. She also provides a table (Balme 1991:7) that documents all types of grindstone recognised by Smith, including millstones and mortars, but she does not distinguish between these in her analysis. Webb (1993) emphasises the use of mortars as sources for flaking stone.

Since grinders have many uses besides milling seed, Pardoe and Martin (2002) made a clear distinction between soft seed grinding and hard seed pounding. This approximates Smith's millstones and mullers and his mortars and pestles. In order to examine the distribution of these objects, a number of functional and structural features were considered. The term dish is used in its commonly understood sense of a flat, thin slab made, in virtually all cases seen in this survey, from indurated sandstone commonly exposed in the Barrier and Scropes Ranges to the west and northwest. Virtually all dishes were trimmed. The term mortar is used for block-like items fashioned from silcrete nodules or quartzite cobbles. Most combination mortar/pestle items are made from quartzite. Very few mortars or pestles required trimming.

During the survey, 217 whole grinding/pounding artefacts were measured and described (Table 4). Data collected include length, width and thickness, number of anvil pits, number and type of facets, facet surface features including sheen, ring cracks, smoothness, edge trim, and material type, as well as a descriptive designation of mortar, pestle, grinding dish or top stone. The first two terms are associated with hard seed grinding, the latter two with grass, or soft seed grinding. A number of artefacts were clearly a combination of mortar and pestle, so this was added as an extra category. Many of the characteristics of grinding stones serve to differentiate the two kinds.

Soft seed grinders and topstones

Soft seed grinders are usually made from tabular sandstone grading to quartzite, although a few are shaped from non-tabular stone that is extensively shaped through flaking and pecking to achieve the desired shape. Dishes typically have flat surfaces or single or double 'troughs'.

Soft seeds that were ground included several kinds of grasses (using a wet milling process), portulaca, gum tree and a variety of saltbush. The silica rich grass seed grinds the surface of both the dish and topstone so it becomes perfectly smooth and has a distinctive sheen. It is thus possible to detect grass seed grinding implements even if broken up into small pieces, although advanced weathering would damage the sheen.

Hard seed mortars and pestles

Hard seed mortars and pestles are typically made from silcrete nodules or quartzite cobbles. They are block-like and in comparison with soft seed grinders they have slightly more facets, of which 93% are concave for mortars and 70% convex for pestles. The facets are usually pounded or smooth rather than having sheen. Mortars suffer ring cracks from pounding with a hard pestle and have more anvil pits.

Ring cracks are unlikely to be seen on thin dishes since the type of treatment that causes such damage on mortars and pestles would simply break them. The shape, texture and cracking of facets demonstrate different processing uses. This is obvious when observed in the field and the point is belaboured here only because of the inference made that

A.

Artefact type	n	mean size (mm)			anvil pits		trim (%)		material type (%)			
		L	W	T	av.no.pits	% w.pits	flaked	pecked	silcrete nodule	quartzite cobble	indurated sandstone	other
mortar	68	192	145	103	0.13	10	11	2	50	49	0	2
mortar/pestle	9	130	91	64	0.22	22	11	0	11	78	0	11
pestle	57	101	84	63	0.14	12	0	0	49	49	0	2
dish	23	320	210	38	0.09	4	52	48	0	4	96	0
topstone	60	126	97	27	0.02	1.6	32	6.6	0	16.6	78.3	5

B.

Artefact type	n	Facets										
		number		shape (%)				texture (%)				damage (%)
		total	mean	concave	convex	flat	trough	smooth	pounded	pounded/ smooth	sheen	ring cracks
mortar	68	108	1.6	93	0	7	0	3	3	94	0	21
mortar/pestle	9	24	2.7	48	48	4	0	0	11	89	0	11
pestle	57	134	2.4	0	70	30	0	2	28	70	0	5
dish	23	32	1.4	6	0	78	16	22	0	0	78	0
topstone	60	98	1.55	1	0	99	0	28	0	0	72	0

Table 4 Characteristics of grinding materials.

dishes are used for soft seeds and mortars are used for hard seed.

Hard seeds require specialised tools that are heavy and strong enough to withstand the pounding of the pestle against the mortar. The mortar usually has bowl shaped facets, so the seeds do not jump out as they are first pounded. After a certain amount of smashing, the seeds are then ground between the two stones. The pestles often have different facets used for the smashing and grinding; some facets show only pounding marks and one or two facets have a smoother face which is used for the final grinding. Many food plants in the Menindee area have hard seeds, the most common ones being the acacias and nardoo. A number of roots that were pounded are mentioned as being a major part of the diet in dry times at Menindee (Sturt 1849).

Comparative distributions

The distribution of grindstones and mortars was correlated with vegetation communities, where grasses and hard seed producing plants such as acacias might be distinguished. As seen in Table 2, grinding and pounding material for hard and soft seeds are most common in woodland and floodplain settings, but are distributed widely. Hard seed pounders are more common than soft seed grinders in the red gum floodplain woodlands, along feeder creeks on lake beds, chenopod shrubland and around marshes. Soft seed dishes were more common in rarely flooded woodland and black box floodplain woodland.

When site types and features were compared across habitat and vegetation distributions, hard seed mortars had similar distributions to open sites and ovens, but were negatively associated with ashy grey deposits; soft seed dishes were found in proportions similar to ashy grey deposits. This indicates that while these site types may not necessarily correlate one-to-one, their overall distribution on the landscape is similar. The soft seed dishes are found in the denser occupation areas, while hard seed mortars are found in areas that show evidence of smaller groups, with individual ovens, or ill-defined open sites that are generally found away from the river, but may be seen around lakes.

To the extent that the described distributions of dishes and mortars differ, soft seed grinding dishes occur in areas of densest archaeological record. From this we may infer different behavioural strategies. Soft seed grinders indicate a trend to central place collecting and processing, while mortars indicate a foraging strategy of moving to the resources, probably in smaller groups.

Summary of results

In summary, the nature and distribution of archaeology at the Menindee Lakes is characterized by dense occupation consisting of fields of ovens and circumscribed ashy grey deposits that are the functional analogue of mounds found on other rivers of the Murray – Darling Basin. The density of sites decreases markedly and systematically very quickly away from water source. More sites and features than expected were found in the linear red dune fields abutting the lakes. Milling equipment can be differentiated into hard and soft seed grinders. In comparison with vegetation distributions, it is possible to demonstrate a clear preference for central place collecting rather than nomadic foraging. Stone tools typical of both desert and southeastern technologies are found, sometimes in residences within 50m of each other, yet seemingly consistently separate.

The Murray River model

Based on studies of burials, biological investigations, ecological patterning and historical documentation, Pardoe (1988, 1990, 1994a, b) developed an archaeological model of social organization that identifies differences between populations inhabiting riverine and semi-arid/arid environments (Table 5). In this model riverine populations tend towards exclusive social behaviour such as endogamy and boundary maintenance whereas arid zone populations tend towards inclusive social behaviour including greater exogamy and more permeable boundaries. The model was based on research along the Murray and Darling Rivers, and the semi-arid hinterland.

Riverine (Exclusive social behaviour)	**Arid and Semi-arid (Inclusive social behaviour)**
Predictable, stable, rich environments	Unpredictable, less rich environment
High population density	Low population density
Highly territorial groups, with well-defended borders and exclusion of outsiders	Inclusive social networks, spread across large areas with fluid boundaries
Endogamous	Exogamous with a highly extended kinship system
Distinct biological groups	Genetic continuity
Cemetery	Individual burial

Table 5 Comparison of riverine and arid/semi-arid groups.

In this model, the Murray Valley corridor is characterized by a rich and relatively stable environment offering permanent water and a variety of resources throughout much of the year. These rich river resources are bordered by semi-arid country that is unpredictable in resource availability. Resources are widely distributed, rather than concentrated as they are on the floodplain. Evidence of large and dense populations (Butlin 1983) has been supported in gene flow models (Pardoe 1990, 1993, 1994b). Cemeteries were defined and described as visual symbols of land ownership, mediated by the graves of the ancestors. This land ownership was seen to be associated with restricted and densely packed resources, boundary maintenance and exclusive social organization. A chronological model (Pardoe 1995) elaborated the social and biological models, defining a distinct archaeological region. Murray River groups were characterised by exclusive behaviour, while arid zone peoples exhibited inclusive social behaviour.

Archaeological and historical evidence from the Menindee Lakes area challenge this model. Baakantji social behaviour does not neatly fit either the Riverine or Arid Zone model. Instead, it demonstrates features of both.

Environment and resources

Historical accounts of the landscape and people's activities provide a firsthand view of the region unaffected by water regulation and the pastoral industry. Depending on the time of year, early explorers and pastoralists saw both desert and oasis offering contradictory accounts of environmental resources. Some, such as Mitchell (1839:261) describe large stretches of water with plentiful waterfowl and fish. Others (Sturt 1849, Morey n.d.[1846]) saw lakes dried up, destitute of water, the people reduced to subsistence on roots with no animal food in any quantity.

Environmental histories for the region (Hope 1993) show that resources were rich but unstable, following an unpredictable cycle over years and decades rather than seasons. This core contradiction in resource predictability underpins a difference between socio-economic life on the Murray and Darling Rivers. Although inhabitants of the Murray were liable to periods of seasonal food shortage, the cycle was short enough to maintain high levels of population density (Pardoe 1988).

Population density

While it has proven very nearly impossible to estimate population sizes from the archaeological record (Pardoe 2000), relative densities can be indicated. Many of the ashy grey deposits discussed above suggest large aggregations. Large ovens capable of cooking 'half a ton' of food have been recorded on the Murrumbidgee River. These ovens remain in the archaeological record as mounds (Mathew 1899:9). Ashy grey deposits of the Menindee Lakes may be their functional equivalents. Supporting evidence can be found in the documented distribution of wooden shovels, which are recorded only in association with mounds (Massola 1959; Pardoe and Martin 2001).

Historical evidence for population density is contradictory. Mitchell (1839: 237) describes a village on the river just north of Menindee near a 'hill of tombs' and suggests that a large number of people resided there for relatively long periods.

> We found a native village, in which the huts were of a very strong and permanent construction. One group was in ruins, but the more modern had been recently thatched with dry grass. Each formed a semi-circle, the huts facing inwards, or to the centre, and the open side of the curve being to the east. On the side of the hill of tombs, there was one unusually capacious hut, capable of containing twelve or fifteen persons, and of very substantial construction, as well as commodious plan, especially in the situation for the fire, which, without any of the smoke being enclosed, was accessible from every part of the hut. (Mitchell 1839:262)

He also observed the intensive use of grasses, where 'the grass had been pulled and piled in hayricks... extending for miles... Not a spike of grass was left, the whole of the ground where it lay somewhat resembling a harvest field' (Mitchell 1839 vol I:237).

Mitchell (1839:267) described 'the Fishing Tribe' at Menindee itself, though, as being relatively small, for it did not exceed 60 even when people were 'gathered along the river bank for many miles back.' This indicates that the Cawndilla group was separate from the group living nearby on the Darling. On his return south from Menindee, Sturt (1849:347) described passing on average two such 'camps' per day, each consisting of about 50 people, which works out to about one camp every 13 km.

Boundary maintenance

Historical accounts provide examples of boundary maintenance and territoriality as well as examples of inclusive behaviour, such as people coming in from other areas for large gatherings or seasonal activities (Martin 1999, 2001). These contradictions reflect the nub of the position occupied by the Baakantji: river and desert; southeast and centre.

On the Darling River near the Menindee Lakes, 'The natives certainly do not allow strangers to pass through their territory without permission first obtained' (Sturt 1849:138). Individual groups occupied different portions of the river. They owned the resources in their territories including the water in the river.

> The Spitting tribe desired our men to pour out the water from their buckets, as if it had belonged to them; digging, at the same time a hole in the ground to receive it when poured out; and I have more than once seen a river chief, on receiving a tomahawk, point to the stream and signify that we were then at liberty to take water from it, so strongly were they possessed with the notion that the water was their own. (Mitchell 1839:304)

Despite the exclusive ownership of Menindee area by local Baakantji groups, however, it was (and still is) a focal point for other people. Menindee attracted people from further away during extreme drought and for ceremonies and large gatherings of people, particularly when the fish were running (see Martin 2001). The Wilyakali and Pulaali from the Barrier Ranges around Broken Hill and Parrintji from the east spoke the same language, travelling to the Darling River when freshes in the river brought an abundance of fish. Sturt (1844-5) found at Menindee that 'several of the natives of the hills [Wilyakali of the Barrier Ranges] have been forced to the river for want of water'. Mitchell (1839 Vol I: 264-270) noted that in 1835 groups of people from the east visited Menindee to fish. This strategy was reinforced in the historic period with the forced movement, during the 1933 drought, of language groups from further east to 'Old Menindee Mission' (Martin 2001). Menindee Lakes people also moved far afield for a variety of reasons. For example, Sturt's guide Toonda, whom he met at Lake Victoria, was from Cawndilla.

Biology

Analysis of biological variation between people of the Darling River, the Murray River and Arid Zone populations provides two salient points (Pardoe 2001). First, while Darling River populations group within a larger cluster of Riverine populations of the Southeast, they also show significant differences. The meeting of two major continental morphologies – Riverine and Desert – at the Murray-Darling Junction, produced significant diversity (also Pardoe 1990, 1994). Willis (1991, 1997) found less morphological diversity along the Darling River than along the Murray, but it was patterned in a fashion linking the whole of the Darling River.

Second, Darling River peoples are most similar in relative body proportions to Central Desert peoples and less like Murray River peoples. They are taller, with relatively and absolutely longer limbs, and a slighter build. Theirs is a typical desert adaptation. While natural selection and adaptation to environment are probably responsible for these body proportion differences, group affinities are mediated by relatively endogamous gene flow (intermarriage) and exclusive social behaviour (Pardoe 1990, 1994, 2001). In the biology of adaptation and group affinities, the Baakantji betray their links to both Centre and Southeast.

Burials and cemeteries

Most groups along the Murray River used cemeteries. In contrast, the Baakantji are the only group resident on the Darling River for most of its length. Burials are mainly individual, but there are two indications of cemetery use – one near the Murray (Littleton 1999b, 2000) and the other at Williorara Creek (and the modern Lake Eurobilli) connecting Lakes Menindee and Cawndilla. Generally, though, burials do not satisfy the criteria established for cemeteries: number, contiguity, boundedness and exclusivity of use (Pardoe 1988).

The Baakantji had items of burial ritual that are distinctive and closely bounded to their territory. This religious system was characterized by *kopi* (gypsum) mourning caps worn by widows (Mathews 1908/9), *kopi* eggs that were buried with people (Mathews 1908/9; personal observations), and cylcons that were part of funeral rites, but which probably had other functions as well (Etheridge 1916; Hamm 1987).

Stone tool technologies

Two very different grinding technologies associated with semi-arid environments have been described and analysed: the grinding of grass and other soft seed on flat sandstone dishes and the pounding of hard seeds such as acacia on large silcrete or quartzite blocks. Although there are differences in distribution of hard and soft seed grinding materials in different ecosystems, they are also characterized by their overlap.

Where the distributions of dishes and mortars differ, soft seed grinders are found in areas of densest archaeological record and hard seed mortars are found nearest their target resources. From this we may infer different behavioural strategies. Soft seed grinding dishes indicate a trend to central place collecting and processing, perhaps as groups in hamlets or villages. Mortars indicate a foraging strategy of moving to the resources, probably in smaller groups. The correspondence of hard seed mortars with ovens might suggest smaller, family-sized groups foraging more widely and processing hard seed resources on the spot. The hard seed pounding technology is harder work and associated with more marginal environments.

It is suggested that these two technologies were being used concurrently over the long term. Most grinders occur on Holocene deposits (Balme 1991, Pardoe and Martin 2002). The different technologies suggest that larger Holocene populations were diversifying their resource base by eating a wider variety of foods. This response may have had two causes. First, changes in climate saw the introduction of plants and animals from the semi-arid zone moving north and westward with the amelioration of climate following the end of the last Ice Age. Second, population increase following the same climate changes may have forced a reliance on these ground foods, in the same fashion as the Middle East and other places where agriculture developed.

The Utilitarian Flake Tool Industry, microblades, quartz split pebbles, and tulas and pirri lithic industries are represented in the region. The first two are shared with southeastern groups; while tulas and pirris are closely associated with desert economies. The coexistence of stone tool technologies normally associated with different economic and environmental resources allows for two interpretations. First, Baakantji used different food exploitation strategies at different times and Baakantji who had been living at some distance returned to the lakes with foreign tools and materials manufactured during their travels. Second, visitors from some distance were able to use specific localities. Both interpretations argue for inclusive social behaviour.

Allen (1974:311-12) argued that unpredictability of resources required opportunistic and flexible behaviour. He related riverine activities to summer months, followed in winter months by dispersal over a wider territory and a greater reliance on acacia seeds, chenopods and flax plants. The variety of stone industries at the Menindee Lakes may indicate technological responses to resource unpredictability and risk (Hiscock 1994, 2002).

An unpredictable environment may well demand flexible use of overlapping technologies, but it is not currently possible to interpret the pattern of flaked and ground stone tools as entirely local and permanently based or as seasonal movement between river and back blocks. Foraging and collecting both appear to be present as well as settled occupation in large residential areas and wide-scale movement. In order for the Baakantji to deal most effectively with the environment of the Darling River, they used behavioural strategies drawn from both arid zone and southeastern neighbours.

Conclusion: A regional archaeology

The culture and biology of people of the Darling River form a coherent region. By this I mean the data are internally consistent but different from other regions. Each of the major river systems of the Murray – Darling Basin had its own regional pattern, but all had a riverine focus that could be contrasted with the arid zone.

People of the desert to the west and north of the Darling River were characterized by small and thinly-spread populations. The people themselves were typically desert adapted (Birdsell 1993, Pardoe 2001). Being lean and lanky, they were taller than people of the Murray and not nearly so stocky. This is evident in the oldest remains as well as people living today. Desert technologies that were widespread include grass seed grinding dishes, tula adzes, the characteristic woodworking implement of the desert, and pirri points.

Murray River populations were large and dense. The groups were more settled, with mounds marking settlements in some areas. They buried their dead in cemeteries, indicators of territoriality. People relied on riverine resources for protein and on tubers and rhizomes for their carbohydrate staple, rather than flour from ground seeds. Flake stone technology was insignificant. Similarly, their neighbours on the Murrumbidgee River and the eastern Riverine Plain (Pardoe and Martin 2001) also had mounds, relied on wetland resources, and lived in large settlements for at least part of the year, but their use of cemeteries was more limited (Pardoe n.d.; Littleton 1999a, 2002). Their technology included a greater reliance on flaked stone, which is typical in many ways of the greater Southeast, with microliths appearing in the last few thousand years.

Baakantji, the people of the Darling River, shared similarities with both their riverine and arid zone neighbours. As river people, they exploited birds and fish. Their settlement patterns included large central places represented by ashy grey deposits that are the functional equivalent of mounds (Pardoe and Martin 2001). Although burials were mainly individual, there are indications of cemetery use. Some lithic technology, including microliths and the Utilitarian Flake Tool Industry, was shared with southeastern groups.

The Baakantji also shared features with their desert neighbours. People lived in small groups or in larger settlements, with the many individual ovens as evidence of a small group settling in for a shorter time. They needed to rely on more than the unpredictability of the Darling River (Whetton et al. 1990) and so used flour that was pounded and ground from both hard and soft seeds. Tulas and pirri points show up in many sites on the Menindee Lakes, predominantly where the red linear dunes touch the water. Whether these reflect people visiting from further afield or the return of Baakantji from visits away from the river is not known. Either way, these artefacts indicate links between groups. The Baakantji themselves provided a link in the biological web of relations between the major regions of arid zone and Murray – Darling basin.

The use of both southeastern and arid zone technologies characterized the socio-economic system of this area. Certain Holocene innovations common along the length of the Murray River, such as living in large groups and the use of cemeteries can be found in the Menindee Lakes area. At the same time, the more precarious nature of the Darling River flow meant that the population could not be river focussed. Since river flow may have had long periods between pulses, people would have been required to maintain an arid zone focus (Allen 1974). At times of extreme drought, people would congregate at decreasing freshwater sources, necessitating increased reliance on available foods within their striking range.

The Baakantji are part of a larger biological, cultural and linguistic bloc that extends the length of the Darling River eastward to the Riverine Plain (edge of the Mallee) and westward toward the Flinders Ranges of South Australia. There is good material evidence of a unique religion that spanned the Baakantji and these related tribes. My interpretation of the Menindee Lakes archaeological record is probably applicable to other centres along the Darling River (Lake Victoria and environs, the lower Anabranch lakes, and possibly the lakes of the Paroo River to the north).

We need to remind ourselves that distinctions made in terms of riverine and arid zone environments and social models of inclusion and exclusion are not dichotomies, but simplifications of continuous variation. Nevertheless, the interpretation of the largely spatially oriented information within this model (even if grossly summarized) serves to highlight some of the contrasting patterns of behaviour required in this area of the Darling River.

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While the Menindee Lakes was not a major area of study for JPW, his influence extends beyond the field survey of 1978. His stewardship of the journal *Archaeology (and Physical Anthropology) in Oceania* is well known and needs no comment except to note that much of the literature of Baakantji archaeology has been published in that journal and bears the mark of his editorial hand. JPW's part in the development of a modern Australian archaeology that incorporated the methods and theoretical views of Processualism has been as large as his voice.

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