CHAPTER 9

THE LAST MILLENNIUM: ARCHAEOLOGY AND THE CLASSIC ETHNOGRAPHIES

Within a few months of completion of the Overland Telegraph Line through Central Australia in 1872, exploring parties began to strike out into country to the east and west of the line. Without maps or native guides, exploration consisted of a series of probes into unknown country, seeking the next water, often followed by a desperate forced march to get back to the last known water before the horses or camels died. A small, privately funded reconnaissance party led by Ernest Giles was the first of several colonial exploring parties to enter western Central Australia (Giles 1889).

Giles was the quintessential Australian desert explorer, a man with an eye for the beauty and romance of these arid landscapes, who hired a novelist to ensure that his journals, published as Australia Twice Traversed, are some of the most readable and engaging accounts of desert exploration. Mounted on horses, Giles and his two companions pushed deep into spinifex and sandhill country. Small, ephemeral soakages and rockholes provide the key to this landscape. Two months into the expedition, Giles reached the painted rockshelters and waterhole at Tjungkupu (Giles’s ‘Tarn of Auber’). Rain had allowed Aboriginal people to disperse out into the sandhill country from their fallback waters – and they were busy firing the surrounding country. ‘The natives were about,’ Giles noted, ‘burning, burning, ever burning; one would think they were of the fabled salamander race, and lived on fire instead of water’ (1889: I, 81) (Figure 9.1). Further south, in October 1872, Giles reached a small desert well on the northern rim of Lake Amadeus. Forced to use this as a staging point, he named the well Glen Thirsty, ‘for whenever we returned to it ourselves and horses were choking for water’ (1889: I, 107). In nearby rock overhangs, Giles found numerous rock paintings. This was an ‘aboriginal National Gallery of paintings and hieroglyphics’, he wrote in his journal (1889: I, 101). One motif in particular caught his eye: it consisted of ‘two Roman numerals... representing the figure VI... painted with red ochre’ (1889: I, 95) (see Figure 9.11). Unable to travel further west, and blocked by the boggy
Figure 9.1. A fire drive to hunt *maala* (*Lagorchestes hirsutus*) – a small spinifex wallaby – similar to hunting fires seen by Giles in 1872. This was photographed by the naturalist HH Finlayson on 9 January 1933 in the Musgraves Ranges, Central Australia. His description is worth quoting: ‘matters are so arranged that the areas where maala tracks are thickest are within the lines of flame, and upon this space attention is focused...The world seems full of flame and smoke...they swing their weight from foot to foot, twirling their throwing-sticks in their palms, and as they scan the advancing flames their great eyes glow and sparkle as the climax of the day draws near. It is their sport, their spectacle, and their meat getting, all in one’ (Finlayson 1936: 65–6). (Photograph from the HH Finlayson collection, courtesy of Northern Territory Archives)

salt flats of Lake Amadeus to the south, the expedition retreated to the main ranges.

Although the 1872 expedition never made direct contact with the local people, Giles’s vivid account describes a well-occupied region: this was a landscape shaped by anthropogenic fire, with a patchwork of foraging territories, and inscribed with rock art. Archaeological fieldwork in this region, at sites such as Puritjarra, Tjungkupu and Glen Thirsty, shows it was largely the product of economic and social changes among these desert societies during the last millennium, where growth of regional populations had created a more closely settled landscape.

This final chapter looks at the immediate roots of the classic Arrernte and Luritja societies and their neighbours, internationally known through the hunter-gatherer ethnographies of Spencer and Gillen and others. Half a century after Giles, Spencer described these groups as relicts of an early stage in social evolution, providing a window on the origins of religion and social
institutions elsewhere in the world. In a well-known passage in *The Arunta*, he wrote:

> Australia is the present home and refuge of creatures, often crude and quaint, that have elsewhere passed away and given place to higher forms. This applies equally to the aboriginal as to the platypus and kangaroo. . . . The aim of this work is to give as complete an account as possible . . . of the organization, customs, beliefs and general culture of a people that affords as much insight as we are now ever likely to gain into the manner of life of men and women who have long since disappeared in other parts of the world, and are now known to us only through their stone implements. (Spencer and Gillen 1927: vii)

Archaeological research challenges this view, providing a richer, more nuanced historical account of the development of these societies during the centuries immediately prior to European contact. Previous chapters in this book have looked at changes during this period in trade and exchange systems, in rock art and political economy, and in material culture. This chapter looks at development of the foraging economy during the last thousand years – before summarising what we now know about the social history of these desert societies.

**THE CLASSIC ETHNOGRAPHIES**

There is a long series of ethnographies dealing with Australian desert societies, following the expansion of European influence deep into the core of the desert. The earliest accounts are of societies on the eastern and southeastern fringes of the arid zone (Roth 1897; Howitt 1904; Reuther 1981 [1906]) or in parts of Central Australia opened up by the Overland Telegraph Line (Spencer and Gillen 1899, 1904, 1927; C Strehlow 1907–20); later ethnographies deal with Western Desert groups or their neighbours (Meggitt 1962; Tindale 1974; Thomson 1977; Mountford 1976; Tonkinson 1978; Myers 1986). All of these are small-scale societies, having some of the lowest population densities on record (1 person per 200 km², ranging up to 1 person per 13 km² in the better areas), high levels of personal mobility and basic foraging economies that provide a striking contrast with the complexity of their religious life and the mythologically structured landscape.

Few social anthropologists after Spencer accepted the argument that Aboriginal society preserved elementary or primordial social traits, but the structural-functionalist approach promoted by AR Radcliffe-Brown in the 1930s discouraged direct research into the social history of Aboriginal groups, seeing this as crude historicism. Research in the 1980s, however, showed that hunter-gatherer societies were scaled in terms of population size, social hierarchy, extent of food processing and storage, mobility and territoriality (Price and
Brown 1985; Kelly 1995; Lourandos 1997). These comparative studies reju-
venated interest in the historical trajectories of hunter-gatherer societies and
the factors that promote socioeconomic growth rather than stability. They also
made it clear that if we want to reconstruct the social history of Australian
desert societies, it will be important not just to establish when life in the desert
changed to something resembling the ethnographic pattern but also to recon-
struct the order in which key elements were added over time. So, what are the
key social institutions of these societies? Social anthropologists identify several
traits that distinguish Australian desert societies from hunter-gatherers else-
where in the world (see especially Sutton 2003). These include the following:

- Social segmentation by age and gender, combined with a classificatory
  kinship system based on generational moieties, sections and subsections.
- A complex cultural and symbolic landscape based on geographic
totemism, the ‘dreaming’ and totemic identities. Almost all accounts
  emphasise the extraordinary richness of ritual and ceremony among these
groups and the complex cultural structuring of the landscape.
- A distinctive graphic system based on tracks, circles and nonfigurative
  motifs.
- Ritual property with many of the attributes of economic property, and
  which forms the basis of land rights. The importance of ritual property
  in the political economy was demonstrated in 1976, when the Aboriginal
  Land Rights (Northern Territory) Act recognised ‘primary spiritual respon-
sibility’ for a site and the surrounding land as one of the criteria for
  ownership.

Few of these traits can be traced directly using archaeological evidence, but
most have correlates in the structure of economic landscapes and in the pattern
of use of central places.

THE DYNAMICS OF HUNTER-GATHERER SOCIETIES

Also at issue here are ideas about the dynamics of hunter-gatherer societies.
Substantial social and economic change is now known to have occurred
throughout Australia during the late Holocene but without general agree-
ment on causal mechanisms. In the desert interior, the major changes took
place around 1.5–1.0 ka (Smith and Ross 2008a) – somewhat later than else-
where, where they occurred around 4 ka. Nevertheless, the region has featured
prominently in debates about socioeconomic intensification (Lourandos 1997).
Different archaeologists have emphasised different aspects of these trends: eco-
nomic intensification associated with demographic packing (Smith 1988); shifts
in settlement pattern (Thorley 1998b); changes in social relations, identity and
relations to place (David 2002); and a decline in residential mobility, increased
social interaction, and accelerated ritual and ceremonial activity (Veth 2006).
Most would agree with the sentiments expressed by Veth: ‘an appreciation of nuanced social and political actions, set against a transforming set of ecological circumstances’ will provide ‘a more persuasive and satisfactory view of Indigenous history within the Western Desert of Australia’ (2006: 253).

One question is the extent to which foraging societies are intrinsically limited by their economic mode. Ethnographic studies show that the structure of hunter-gatherer life is profoundly affected by the degree of residential mobility imposed by subsistence needs (Kelly 1995; Winterhalder 2001). Obligate residential mobility, combined with demand-sharing, limits the accumulation of surpluses of food or prestige goods and tends to promote personal autonomy rather than social hierarchy. Mobility requires portability and so constrains the richness of material culture. High residential mobility also contributes to the high infant mortality and wide birth-spacing observed in these groups, both of which depress demographic growth rates. All of these dampen capacity for population growth, social differentiation or development of highly elaborate material culture. This is pronounced in deserts, where the limited productivity of these ecologies imposes relatively high residential mobility and places strict constraints on population size (Cane 1987; Gould 1991; Keen 2004).

However, over longer timeframes (archaeological rather than ethnographic), both environment and demography present key points of historical instability for hunter-gatherer societies. Even small net rates of demographic increase, likely to evade the usual social mechanisms of population control, potentially lead to substantial population growth over a few millennia (Pennington 2001) and create points of structural instability. Climatic shifts inevitably change the environmental baseline, enlarging or contracting the living space for desert groups. Previous chapters of this book have emphasised the sheer scale of the changes in paleoecology and environment faced by desert groups since late Pleistocene colonisation of the region. Where climatic shifts affect primary production or where demographic growth constrains residential mobility, we can expect flow-on effects in terms of structural change in these societies. These need not have always involved increases in social or economic complexity but can act in reverse: falling populations fundamentally alter the social capacity of hunter-gatherer groups, as must have occurred in many parts of the arid zone between 30 and 15 ka. All of this suggests that – on an archaeological timescale – some degree of structural change in these desert societies is inevitable (Rowley-Conwy 2001).

A related question is whether the internal social dynamics of these societies create autonomous pressures for social or economic change: whether increasing social obligations, social competition and increasing demand for food and goods to finance ceremonies place pressure on production systems, independently of other factors. The classic statement is by Bender, who argued that in ‘ceremonial life lie the seeds of increased demands, more food for feasting, more goods for exchange, more intensive relations between elder and
initiate, and between elder and wives’ (1981: 154). Lourandos (1983, 1985, 1997) applied a version of this hypothesis to Australian desert societies, arguing that intergroup and interpersonal competition in these hunter-gatherer societies led to changes in ceremonial exchange, providing the crucial incentive for economic expansion and resource intensification and leading, in turn, to population growth. This created a spiral of change towards greater social complexity and the abrupt late Holocene ‘appearance of intensive and possibly ceremonially based occupation of marginal zones, for example wetlands, rainforests, highlands . . . and arid zones’ (1983: 91), as well as an economic reliance on grass and acacia seeds. Testing this sequence of events against archaeological data has been difficult: many studies simply assume that evidence of economic expansion is intrinsic evidence for social intensification. We will be on stronger ground if we can analytically decouple social and economic intensification and trace these separately in the archaeological record. The fact that the classic ethnographies describe societies that combine an extraordinarily complex ritual and ceremonial life, social segmentation and social differentiation by age and gender with a basic foraging economy should caution against the premise that social intensification inevitably drives structural changes in these economies.

In some hunter-gatherer societies, increasing social competition or an escalation of social obligations may well have become an independent driver of economic change. But the latter has always seemed unlikely in Australian deserts, where there is little ethnographic evidence (a) that production for ceremonies exerted pressure for long-term structural changes in desert subsistence economies, (b) that significant quantities of food were regularly diverted towards ceremonial display, or (c) that the large ceremonies escaped strict environmental constraints on their scheduling and scale. In these societies, social intensification is more likely to be a structural adjustment to wider changes in economy and demography. The record of changes in political economy and trade and exchange discussed in previous chapters leaves little doubt that there were historical changes in the social relations of these societies. But the evidence is more consistent with the view that the social complexity of these hunter-gatherer societies is an emergent property of their demography: I see economy as architecture and social life as agency.

What does come out of these debates is the role that population density plays as a key point of articulation between social and economic changes in hunter-gatherer societies. Almost all models accept that demographic growth will create a cascade of structural changes in foraging patterns, mobility and site use, trade and exchange, social relations and political economy. Binford (2001) provides a theoretical framework for understanding the articulation of the different variables. If population density rises to a point at which it begins to constrain mobility and reduce options for relocating foraging activities, a critical ‘packing’ threshold is reached. Once this threshold is crossed,
hunter-gatherer groups have strong incentives to invest in strategies that enhance the yield from available habitat, to put more reliance on plant foods, to adopt more costly processing techniques and to use storage to offset shortfalls in the availability of bush food. Demographic packing also radically changes the scale of kinship articulations and promotes spatial in-filling by daughter groups. And the partitioning of groups into a greater number of competitive units leads to institutional stewardship of critical locations for resources. Any significant reduction in residential mobility will affect birth spacing and infant mortality, amplifying the initial population increase.

How did these factors play out in Australia’s deserts during the centuries before European contact? We can expect the region to have a mosaic of different histories based on the dynamic interplay of socioeconomic factors, the political economy and local environmental conditions. The challenge for archaeology has been to unpack the history of these groups in any detail.

ENVIRONMENTAL CHANGE 1,500–1,000 YEARS AGO

A range of evidence suggests that during the last millennium, hunter-gatherer groups in Australia’s deserts inhabited a landscape where net productivity was higher than previously.

Although the late Holocene saw the onset of a drier, more variable El Niño–Southern Oscillation (ENSO)–dominated climate in the interior at 4.0–3.7 ka, these conditions appear to have relaxed around 1.0 ka in both northern and central Australia, with a strengthening of the summer monsoon and a weakening of the ENSO circulation (Shulmeister and Lees 1995; Marx, McGowan and Kamber 2009; Smith 2009b). These changes result from a reorganisation of atmospheric circulation, driven by changes in insolation, and are reflected in other records of rapid environmental change from both high and low latitudes, including the Greenland and Antarctic ice cores, dust records and deep ocean foraminifera (Mayewski et al. 2004; Wanner et al. 2008; Marx et al. 2009; Moros et al. 2009). The regional impact of these varied, and not all sites responded synchronously or equally, but many records show modest global warming around 1.0 ka (represented in Europe by the Medieval Climate Anomaly), followed by global cooling from 0.7 ka (Bertler, Mayewski and Carter 2011) (Europe’s ‘Little Ice Age’).

In Australia’s deserts, fine-grained data on regional palaeoenvironments between 3.0 ka and 1.0 ka are still frustratingly sparse. In Central Australia, local grasslands had recovered by 1.5 ka, when the modern vegetation appears to have become established around Puritjarra (Smith 2009b). Phytolith spectra indicate an open shrubland with abundant grass in the understorey, approximating modern sandhill and spinifex communities in the region today – and with the highest Poaceae values since the last interglacial. By 800 years ago, Leporillus rat middens in the Central Australian ranges show that vegetation
on rocky slopes was also responding to changes in regional rainfall; in this case, with an increase in perennial shrub cover (Nelson, Webb and Long 1990; Berry 1991; Webeck and Pearson 2005). The last 1,500 years was also marked by an increase in the frequency of high-magnitude palaeofloods along the Finke, Todd and Ross Rivers (Pickup, Allan and Baker 1988; Patton, Pickup and Price 1993; Bourke 1998), as well as by renewed dune activity in Central Australia (Nanson, Chen and Price 1995; Twidale et al. 2001; Hollands et al. 2006) and further south in the Strzelecki and Tirari Deserts (Fitzsimmons, Rhodes, Magee et al. 2007). Taken as a set, these records suggest an expansion of summer rainfall grassland in Central Australia during the last 1,500 years, with extreme wet–dry events reflected in episodic dune mobilisation and major floods on the Central Australian river systems.

Summer precipitation in Central Australia is influenced by the interaction of several climate systems, including the northwest monsoon, tropical cyclones and ENSO, all of which attenuate towards the centre of the continent (Gentilli 1972). Collectively, these contribute to the high annual variability in rainfall in the interior, which is greater than in most other desert regions (Van Etten 2009). The ENSO, in particular, is associated with cyclic floods (La Niña) and drought (El Niño) in central Australia. The fine-grained ENSO records from South America show that the frequency of ENSO events (in this context, Australian droughts) peaked around 1.2 ka, then declined towards present levels (Moy et al. 2002; Riedinger et al. 2002; Wanner et al. 2008; Conroy et al. 2008). A decline in continental dust emissions, sourced mainly from the riverine systems east of Lake Eyre, records a similar decrease in climatic variability and ENSO activity from 0.9 ka (Marx et al. 2009). These changes clearly did not eliminate the importance of ENSO in the ‘boom and bust’ ecology of Australia’s deserts, but mark a reduction in the frequency and severity of these events.

These palaeoecological and geomorphic records necessarily provide a time-averaged picture of climate during the last millennium. Contemporary climate records, however, give a more detailed picture of the sort of interannual and interdecadal variability that may have prevailed during this period. Holmgren et al. (2006) summarise the ecological effects of ENSO in drylands. Frequent severe ENSO events destabilise local ecology, but at lower frequencies they are an important driver of environmental productivity in arid and semi-arid systems, where productivity is strongly limited by precipitation. The extraordinary increases in primary production during La Niña ‘boom’ years percolate up through entire food webs and are crucial for plant recruitment, productivity and diversity in these ecosystems. The effects of an ENSO event persist for years afterwards and drive the ‘pulse and reserve’ dynamics characteristic of these arid systems (Letnic and Dickman 2006). No one who witnessed the immense volume of floodwater moving through the desert’s river systems during the 2010–12 La Niña, or the fields of chest-high grass, waves of insects,
birds and native rats, and the extensive wildfires across Central Australia, could doubt the role of these events in revitalising the desert.

Like most foraging economies, Aboriginal societies were intimately connected to their environment: critical resources such as the distribution and persistence of wells, rockholes and soakages constrained access to country and governed which parts of it could be exploited, and the productivity of the country within foraging range of a water point determined how long a group could stay in an area. Both of these factors – access and range, and productivity – appear to have improved during the last millennium. But environmental variability remained high on world scales. ‘Boom’ years removed constraints on expansion and growth, but protracted drought periodically put considerable pressure on desert societies, amplifying population-driven resource stress. Major ethnographic droughts, such as those around 1900 and in the late 1920s, exceeded the capacity of Aboriginal groups to cope in situ, prompting major out-migration and fallback to core areas, fissioning of the remaining population into small mobile groups and high regional mortality (estimated at 10–25 per cent of the population; Kimber 1990: 162).

THE LATE HOLOCENE ARCHAEOLOGICAL RECORD

The last 1,000–1,500 years saw significant changes in the archaeological record in the interior of the Australian arid zone, with shifts in settlement pattern and site use, tool inventories and rock art. The overall trend in the interior is summarised in the time-series plot of radiocarbon dates shown in Figure 9.2. There are marked increases in counts of radiocarbon dates, numbers of dated sites in each time period and net accumulation rates of chipped stone artefacts (no. artefacts/m²/1,000 yr) at this time. Much of the evidence points to regional population growth, beginning 1.5–1.0 ka. As part of this, hunter-gatherer groups appear to have increased their use of marginal or outlying areas as these became seasonally accessible, with more extended occupation of existing sites in the better-watered ranges, more processing of acacia and grass seeds and an increase in territoriality (shown in greater differentiation of rock art complexes during the last few hundred years).

Reviewing the evidence across the arid zone, two other trends are apparent. First, population growth in the core of the arid zone seems to have lagged behind that on the arid west coast, where comparable levels may have been reached by 4 ka (Smith et al. 2008a). Binford argues that the ‘packing threshold’ should be reached earlier in more stable habitats, where population growth is faster (2001: 439). If so, the broad-spectrum transition it triggers may have occurred earlier on the west coast than in the desert core. There is some evidence for this – as Veitch (1999) argued for the switch to Anadara middens after 4 ka (see Chapter 6) – but more work is needed.
Riverine habitats on the temperate margins of the arid zone in southeastern Australia may also have seen an earlier transition, but at present we lack the data to test this. The second point is that even within the last millennium, there is evidence for changes in site use and settlement on a range of geographic scales and timescales, particularly within the last 500–200 years (Thorley 1998b; Holdaway et al. 2010). But, at present, the data are not sufficiently resolved to separate the dynamics of local systems from short-term historical trends.

A number of studies ask whether the proliferation of sites within the last millennium is a real trend or wholly an artefact of differential preservation and loss of older sites (Robins 1993; Holdaway, Fanning and Rhodes 2008; Marwick 2009). For time-series radiocarbon data, Williams (2012) tested this, imposing a theoretical correction for exponential time-decay on the radiocarbon plot. This does not remove the peak in late Holocene activity, although

Figure 9.2. Time-series distribution of radiocarbon ($^{14}$C ages) from archaeological sites in the arid interior (inland Pilbara, Western Desert, Central Australia and Lake Eyre Basin) over the last 5,000 years. N = 263 dates. (a) Standard summed probability plot, showing an increase in occupation during the last millennium. (b) The same dataset, applying a theoretical correction for exponential decay (following Williams 2012). (c) The corrected plot with a 500-yr moving average. Neither (b) nor (c) removes the peak during the last 1 ka. (Source: AustArch1 database)
it does reduce its amplitude (see Figure 9.2b). Using a computer simulation, Johnson and Brook (2011) also found that differences in site destruction could not account for the apparent increase in late Holocene occupation. Both studies give confidence that the time-series trends record real changes in archaeological settlement during the late Holocene. However, the strongest evidence for late Holocene expansion relies on a multiproxy approach, in which counts of radiocarbon dates and numbers of dated sites in each time period coincide with changes in tool inventories, net accumulation rates of chipped stone artefacts (number artefacts/m²/1,000 yr) and patterns of site use. Many rockshelters have occupation debris intercalated within sedimentary sequences that are more or less continuous over the last 3 ka. These are well placed to record systemic changes towards more extended or more frequent episodes of occupation.

CENTRAL AUSTRALIA: SITES AND ASSEMBLAGES

The best regional dataset is that from Central Australia (Thorley 1998b; Ross 2003; Smith and Ross 2008a), where there are now forty-two excavated sites, although only thirty-one of these have radiocarbon chronologies (Table 9.1). Most research has focused on areas south of the main MacDonnell Ranges or in the middle reaches of the major river catchments (Figure 9.3). Although the regional spread of sites is circumscribed, the sample includes sites in a range of localities: plateau and sandplain sites, sites in the middle reaches of major drainages, sites near springs, sites in the dunefields and sites both on the rim and in the lower part of the Amadeus basin. The archaeological record for the late Holocene shows an expansion of settlement beginning around 1.5 ka and taking a millennium or so to play out. This involved more sites, more intensive use of existing sites and more use of peripheral localities within the main ranges and of marginal habitats in sandhill and spinifex country beyond the ranges.

Site Histories

Excavated sites show several patterns of use (Figure 9.4). Single-phase sites have a discrete, relatively dense occupation unit, often with large amounts of charcoal in addition to high densities of chipped or ground artefacts (A on Figure 9.4). In most cases (n = 17), this is a late Holocene occupation unit, dating to within the last 1,500 years (but with considerable variability in basal age), either resting on bedrock or overlying sediments containing few artefacts.

The pattern is one of more extended occupation of sites previously used in a more expedient or intermittent way. Comparison of artefact densities (calculated as no. of lithics/10 kg deposit) across this change reveals a mean increase
TABLE 9.1. **List of excavated late Holocene archaeological sites in Central Australia (updated from Smith and Ross 2008a)**

<table>
<thead>
<tr>
<th>Site name</th>
<th>Type</th>
<th>Site history(^{a})</th>
<th>Late Holocene unit(^{b}) (basal age ka)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arngu</td>
<td>Rockshelter</td>
<td>A</td>
<td>1.29</td>
<td>(14)</td>
</tr>
<tr>
<td>Glen Thirsty 1</td>
<td>Rockshelter</td>
<td>A</td>
<td>1.40</td>
<td>(7)</td>
</tr>
<tr>
<td>Glen Thirsty 3</td>
<td>Rockshelter</td>
<td>A</td>
<td>0.29</td>
<td>(7)</td>
</tr>
<tr>
<td>Intirtekwerle (James Range E)</td>
<td>Rockshelter</td>
<td>A</td>
<td>0.78</td>
<td>(2.9)</td>
</tr>
<tr>
<td>James Range NW</td>
<td>Rockshelter</td>
<td>A</td>
<td>1.57</td>
<td>(15)</td>
</tr>
<tr>
<td>Kweyunpe 1 (106)</td>
<td>Rockshelter</td>
<td>A</td>
<td>0.58</td>
<td>(3.4)</td>
</tr>
<tr>
<td>Kweyunpe 2 (107)</td>
<td>Rockshelter</td>
<td>A</td>
<td>0.37</td>
<td>(3.4)</td>
</tr>
<tr>
<td>Kweyunpe 6</td>
<td>Rockshelter</td>
<td>A</td>
<td>1.16</td>
<td>(8.10)</td>
</tr>
<tr>
<td>Tjungkupu 1</td>
<td>Rockshelter</td>
<td>A</td>
<td>0.90</td>
<td>(10)</td>
</tr>
<tr>
<td>Watarrka NEP23</td>
<td>Rockshelter</td>
<td>A</td>
<td>1.36</td>
<td>(18)</td>
</tr>
<tr>
<td>Atnetye</td>
<td>Open site</td>
<td>A</td>
<td>0.19</td>
<td>(19)</td>
</tr>
<tr>
<td>Keringke</td>
<td>Open site</td>
<td>A</td>
<td>0.73</td>
<td>(12)</td>
</tr>
<tr>
<td>Kulpi Mara open site</td>
<td>Open site</td>
<td>A</td>
<td>0.75</td>
<td>(14)</td>
</tr>
<tr>
<td>Simpson Desert 275</td>
<td>Open site</td>
<td>A</td>
<td>5.11</td>
<td>(5)</td>
</tr>
<tr>
<td>Therreyererte</td>
<td>Open site</td>
<td>A</td>
<td>0.58</td>
<td>(10)</td>
</tr>
<tr>
<td>Tjungkupu 2</td>
<td>Open site</td>
<td>A</td>
<td>0.81</td>
<td>(10)</td>
</tr>
<tr>
<td>Urre</td>
<td>Open site</td>
<td>A</td>
<td>1.15</td>
<td>(10)</td>
</tr>
<tr>
<td>Wanmara</td>
<td>Open site</td>
<td>A</td>
<td>1.44</td>
<td>(10)</td>
</tr>
<tr>
<td>Ilarari 17</td>
<td>Rockshelter</td>
<td>B</td>
<td>–</td>
<td>(8.10)</td>
</tr>
<tr>
<td>James Range S</td>
<td>Rockshelter</td>
<td>B</td>
<td>0.40</td>
<td>(2)</td>
</tr>
<tr>
<td>Rrewurlmuurlpme kweke</td>
<td>Rockshelter</td>
<td>B</td>
<td>–</td>
<td>(10)</td>
</tr>
<tr>
<td>Watarrka NEP22</td>
<td>Rockshelter</td>
<td>B</td>
<td>–</td>
<td>(6)</td>
</tr>
<tr>
<td>Jesse Gap Sand Quarry</td>
<td>Hearth(^{d})</td>
<td>B</td>
<td>–</td>
<td>(1)</td>
</tr>
<tr>
<td>Mosquito Bore</td>
<td>Hearth(^{d})</td>
<td>B</td>
<td>–</td>
<td>(1)</td>
</tr>
<tr>
<td>Simpson Desert 226</td>
<td>Hearth(^{d})</td>
<td>B</td>
<td>–</td>
<td>(5)</td>
</tr>
<tr>
<td>Ilarari 19</td>
<td>Rockshelter</td>
<td>C</td>
<td>2.85(^{c})</td>
<td>(14)</td>
</tr>
<tr>
<td>Kwerlpe (66)</td>
<td>Rockshelter</td>
<td>?C</td>
<td>3.90(^{c})</td>
<td>(15)</td>
</tr>
<tr>
<td>Iritikiri</td>
<td>Rockshelter</td>
<td>D</td>
<td>0.35</td>
<td>(14)</td>
</tr>
<tr>
<td>Kulpi Mara</td>
<td>Rockshelter</td>
<td>D</td>
<td>3.95(^{c})</td>
<td>(13)</td>
</tr>
<tr>
<td>Puritjarra</td>
<td>Rockshelter</td>
<td>D</td>
<td>0.70</td>
<td>(11)</td>
</tr>
<tr>
<td>Wanga East W04</td>
<td>Rockshelter</td>
<td>D</td>
<td>0.74</td>
<td>(18)</td>
</tr>
<tr>
<td>Camel Hump (17)</td>
<td>Rockshelter</td>
<td>?</td>
<td>?</td>
<td>(16)</td>
</tr>
<tr>
<td>Camel Hump (23)</td>
<td>Rockshelter</td>
<td>?</td>
<td>?</td>
<td>(16)</td>
</tr>
<tr>
<td>Deep Well Cave (63)</td>
<td>Rockshelter</td>
<td>?</td>
<td>?</td>
<td>(16)</td>
</tr>
<tr>
<td>Kwerlpe (70)</td>
<td>Rockshelter</td>
<td>?</td>
<td>?</td>
<td>(16)</td>
</tr>
<tr>
<td>Kwerlpe (71)</td>
<td>Rockshelter</td>
<td>?</td>
<td>?</td>
<td>(16)</td>
</tr>
<tr>
<td>Madigan Cave (111)</td>
<td>Rockshelter</td>
<td>?</td>
<td>?</td>
<td>(16)</td>
</tr>
<tr>
<td>Ooraminna rockshelter</td>
<td>Rockshelter</td>
<td>?</td>
<td>?</td>
<td>(17)</td>
</tr>
<tr>
<td>Ooraminna (ORH16)</td>
<td>Open site</td>
<td>?</td>
<td>?</td>
<td>(8)</td>
</tr>
<tr>
<td>Simpson Desert 162</td>
<td>Open site</td>
<td>?</td>
<td>?</td>
<td>(5)</td>
</tr>
<tr>
<td>Simpson Desert 86A</td>
<td>Open site</td>
<td>?</td>
<td>?</td>
<td>(5)</td>
</tr>
<tr>
<td>Simpson Desert 86b</td>
<td>Open site</td>
<td>?</td>
<td>?</td>
<td>(5)</td>
</tr>
</tbody>
</table>

Most excavated rockshelter sites also contain rock art assemblages, and many of the open sites have rock art assemblages on nearby rock faces or in adjacent rockshelters.

\(^{a}\) For definitions, see Figure 9.4. Not all sites have been reported in sufficient detail to establish the pattern of occupation.

\(^{b}\) Interpolated ages (cal BP) for the base of the main late Holocene occupation unit at each site. Not all sites have been dated or have significant late Holocene occupation.

\(^{c}\) These sites represent an earlier phase of occupation c. 2.5–3 ka. All appear to have a veneer of more recent occupation with well-preserved organics c. 0.20 ka.

\(^{d}\) Isolated hearths.

Figure 9.3. Central Australia. Land more than 700 m above sea level is shown in dark grey and marks the major range complex (including the MacDonnell Ranges, James and Krichauff Ranges, and the George Gill Range). Triangles show late Holocene sites mentioned in the text: (1) Glen Thirsty, (2) Puritjarra, (3) Tjungkupu – Tarn of Auber, (4) Watarrka NEP22 and 23, (5) Wanga East W04, (6) Wamnara, (7) Irtkiri, (8) the Kulpi Mara complex, (9) the Illarari sites, (10) Arnngu, (11) Rwerlpmwerlpme kweke, (12) the Kweyunpe sites, (13) James Range Northwest, (14) Urre (Rainbow Valley), (15) Intirtekwerle (James Range East), (16) Kwerlpe, (17) Keringke (Santa Teresa) and (18) Therreyererte.

of 6:1 from the underlying levels to the major occupation unit. Tjungkupu – the locality visited by Giles in 1872 – is an example of this. Here, excavations in the largest rockshelter show a rich occupation unit with a basal age of 0.9 ka, capping a layer of aeolian sands and sandstone rubble (Figure 9.5). This marks the point at which the input of anthropogenic sediments became the dominant element in an otherwise natural accumulation of aeolian sands and sandstone rubble (Table 9.2). Another example is the Intirtekwerle (James Range East) site in Central Australia (Gould 1978a; Smith 1986b, 1988). Here, the rockshelter sediments are an extension of the sand sheet that forms the valley floor.
Figure 9.4. Schematic diagram illustrating different site histories (after Smith and Ross 2008a). (a) Sites with a major occupation unit <1.5 ka, either overlying a pattern of ephemeral usage or resting on bedrock (N = 17). (b) Sites with ephemeral usage throughout their history (N = 7). (c) Sites with a single major occupation unit >1.5 ka, with a subsequent decline in usage (N = 2). (d) Sites with multiple rich occupation units (N = 4). Calibrated ages (ka) are shown. Sites shown include James Range Northwest (JR NW), Intirtekwerle (IDK), Kweyunpe 6 (KYB6), Armngu (ARN), Illarari 17 (IL17), Rwerlpmwerlpme kweke (RMK), Illarari 19 (IL19), Irtikiri (IRT) and Kulpi Mara rockshelter (KM).

Figure 9.5. Stratigraphic profile for Tjungkupu 1, showing a dense occupation unit (layer I) with a basal age of 0.9 ka, overlying a layer of aeolian sand and sandstone rubble with a basal age of ~3.0 ka. (Source: Smith 1988: fig. 5.3)
in front of the shelter (Figure 9.6). Occupation debris extends out across this for 30 m beyond the dripline. Excavations show that stone artefacts occur in low numbers (75/m²/kyr) throughout an essentially continuous sedimentary sequence beginning around 3 ka (the base of layer III). Use of the site was more intensive after 0.8 ka (layer I), creating a dense charcoal-rich deposit with large quantities of burnt bone and grindstones and a high density of chipped stone artefacts (1241/m²/kyr), all of which reflects a fundamental shift in the way this site was used. This is a pattern repeated throughout Central Australia, at both rockshelters and open sites.

Less common is a pattern in which a dense, discrete occupation unit occurs prior to 1,500 years (see C on Figure 9.4). There are only two examples of this: Ilarari 19, where a rich occupation unit dating 3.0–2.1 ka is overlain by a veneer of more ephemeral recent use (probably postcontact) (Thorley 1998b); and possibly Kwerlpe 66, where the major occupation unit dates to about 3.9 ka and is overlain by a more recent but undated layer. Essentially, these represent sites where extended occupation ceased prior to the last 1,500 years.

A small number of sites have multiple occupation units (n = 4) (see D on Figure 9.4), all with significant densities of occupation debris and artefacts, and sometimes with disconformities between the units. These sites include

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**Table 9.2. Excavated assemblages at Tjungkupu 1, comparing the major late Holocene occupation unit (layer I) (0–0.9 ka) and underlying levels (layer II, 0.9–3.0 ka)**

<table>
<thead>
<tr>
<th>Layer</th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal g/m³</td>
<td>5.971</td>
<td>12</td>
</tr>
<tr>
<td>Bone g/m³</td>
<td>828</td>
<td>–</td>
</tr>
<tr>
<td>Eggshell g/m³</td>
<td>5</td>
<td>–</td>
</tr>
<tr>
<td>Ochre g/m³</td>
<td>38</td>
<td>–</td>
</tr>
<tr>
<td>Lithics no./m²/100 yr</td>
<td>1.974</td>
<td>4</td>
</tr>
<tr>
<td>Grindstones no./m²/100 yr</td>
<td>13</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

**Lithics (total no.)**

| Geometric microliths | 14 | – |
| Tula adze slugs      | 20 | – |
| Burren adzes         | 2  | – |
| Amorphous retouched tools | 68  | 1 |
| Cores                | 16 | 1 |
| Redirecting flakes   | 3  | 0 |

**Grindstones (total no.)**

| Seed-grinders         | 6  | – |
| Amorphous grindstones | 3  | 1 |
| Grindstone fragments  | 28 | – |
| Flakes from ground-edge axes | 1  | – |

*Source: Smith (1988)*
Figure 9.6. Stratigraphy in Trench 1, Intirtekwerle (James Range East) rockshelter. This shows the interdigitation of sandsheet sediments and sandstone rock fall (layers II and III) and the major late Holocene occupation unit (layer I). (Source: Smith 1988: fig. 7.2)

Irtikiri, where a basal unit dating to 2.7 ka is overlain by a rich late Holocene unit dating within the last 350 years; Wanga East (W04), where the major use of the rockshelter dates to between about 9.0 ka and 5.0 ka, overlain by a late Holocene unit dating within the last 500 years; and two sites with long Pleistocene records of occupation: Puritjarra (Smith 2006) and Kulpi Mara (Thorley 1998a). Irtikiri, Puritjarra and Wanga East have discrete late Holocene units, equivalent to those in Figure 9.4a. Kulpi Mara has a veneer of occupation debris dating to 0.6 ka overlying an occupation unit dating to 2.6 ka (Thorley, Faulkner and Smith 2011). There is also dense, late Holocene occupation on the open sandplain nearby (the Kulpi Mara open site) and also rich assemblages of late Holocene stencil art in nearby rockshelters. This is probably the clearest evidence in the sample for a local shift in the focus of occupation from rockshelters to open sites. Finally, there are a series of sites that register only intermittent use throughout their history (see B on Figure 9.4). These include Watarrka NEP 22, Ilarari 17, Rwerlpwmlpme kweke and James Range South (and also the three isolated hearths listed in Table 9.1).

Overall, the pattern is one of more sites with extended occupation during the last 500–1,500 years, superimposed on an earlier pattern of expedient use of the same localities. There are several sites with longer records of occupation and several which fall out of use after 5.0–2.5 ka. Although there may be a geomorphic as well as an occupation signal in these patterns – rates of aeolian deposition on sandplain sites and in some rockshelters are high, typically 500–1,000 mm/1,000 years (Smith 1988; Thorley 1998b: 244) – there has
been considerable testing of deposits where there is no obvious indication of late-phase occupation. This has included exploratory augering, test excavation and the prospecting of erosion gullies cut into sediments in focal localities. In addition, at some sites – Intirtekwerle, for example – excavations exposed several metres of sandplain sediments underlying the latest occupation unit, without finding comparable earlier occupation units. Rich ‘buried’ occupation units are genuinely rare in this landscape.

At sites with significant late Holocene occupation, the basal age of this unit ranges from 0.3 ka to 1.6 ka, with a mean of 0.90 ± 0.4 ka. For most sites, the switch to more intensive use took place between 1,500 and 500 years ago. The spread of ages suggests that at the regional level, this is not an ‘event horizon’ but rather the outcome of a process that progressively affected sites over the course of a millennium.

Site Inventories

Comparison of site inventories is difficult because of differences in reporting of excavated assemblages and because of the limited number of artefact classes in these assemblages. Smith and Ross (2008a) were able to assemble data for thirty-seven assemblages, spanning the last 4,000 years, using the most commonly reported classes of artefact. Bone is rarely present in these assemblages and not routinely quantified. Red ochre is common but usually reported on a presence/absence basis. Smith and Ross (2008a) used multivariate analysis of these excavated assemblages to prospect for groups of sites and to examine whether there were differences between assemblages dating to less than 1.5 ka and those dating to 4.0–1.5 ka. The results show that there is a shift at 1.5 ka towards dense grindstone-rich deposits and larger, more diverse lithic assemblages (this is apparent even when the size of excavation is held constant; Figure 9.7). This is consistent with the idea that most plant processing gear will be associated with sites with extended occupation.

Detailed analysis of individual site sequences – as at Puritjarra (Smith 2006) – corroborates this overall pattern: the major late Holocene unit, in this case dating within the last 800 years, is richer (richness: number of tool types/log (sample size) = 5.63 compared with 4.80) and more diverse (Shannon-Weaver diversity index, \( H = 1.95 \) compared with 1.74), with less residential mobility indicated than in the immediately underlying levels.

Rock Art

A separate line of evidence is provided by rock art: both pigment art (painting and stencils) and rock engravings (see Chapter 7 for more detail). The main temporal trends (loosely dated to 1.5 ka) include a significant increase in
Figure 9.7. Principal components analyses of site inventories in Central Australia. This shows variability in excavated assemblages \( (n = 37) \) and contrasts assemblages of less than 1.5 ka (black circles) with those of more than 1.5 ka (grey circles). The frequency of grindstones and ground-edge implements is more strongly correlated with the density of remains than with assemblage size. (Source: Smith and Ross 2008a, fig. 4)

the number of art complexes, with a change from discrete focal art sites to larger complexes, each with an array of satellite sites containing smaller assemblages (Table 9.3). Overall, there is also greater differentiation among art complexes and greater production of rock art. Motif counts also illustrate the scale of differentiation between sites in the later period: 61 per cent of art complexes have fewer than 200 motifs, whereas 16 per cent \( (n = 8) \) have more than 1,000 motifs. Ross (2003: 160) also shows a statistically significant association of hand stencils and handprints at sites with grindstones, paralleling

| Table 9.3. Changes in number and distribution of rock art sites in Central Australia |
|-----------------------------------------|--------|----------------|
| Period \(^a\)                        | No. art complexes \(^b\) | No. satellite sites \(^c\) |
| Art assemblages < 1.5 ka              | 49     | 247            |
| Art assemblages > 1.5 ka              | 21     | —              |

\(^a\) Estimate based on relative sequence and archaeological associations.

\(^b\) \( N = 51 \). These are clusters of art sites in a locality, containing from one to thirty-two individual sites. Some complexes have multiple phases of art production.

\(^c\) Satellite sites are outlying art sites associated with a complex. Most date within the last 0.5 ka.

Source: Smith and Ross (2008a)
the high frequency of grindstones in excavated late Holocene assemblages. At present, the lack of precise dating for rock art means that we cannot determine whether the changes in rock art lead or lag the changes in economic landscapes.

Site Location and Settlement Pattern

Although this period involved some restructuring of land use within the main drainage systems and a broadening of resource zones, there does not appear to have been a major redistribution of population away from the middle and lower reaches of river valleys to sites on sandplains on the margins of the ranges or towards the lower reaches of these river systems.

Analysis of site location shows that spinifex hummock grassland communities dominate site catchments throughout the last 3 ka (Smith and Ross 2008a). This is unsurprising because with more than 32 per cent of important or staple food species (36 of 112 species), spinifex-dominated sandplain communities have the richest and most diverse suite of plant food species (Latz 1995). The main temporal trend is for exploitation of a wider range of vegetation communities during the last millennium.

One change that is evident in the data but is hard to quantify is greater use after 1.5 ka of peripheral locations. Within the main ranges, this involved establishment of new occupation sites and rock art sites away from the focal river channels. The establishment of sites in outlying areas near ephemeral waters includes sites visited by Giles in 1872 – Tjungkupu and Glen Thirsty 1 (Figure 9.8). Both are complexes of sites in an area where there is a long record of late Pleistocene and early Holocene occupation (at Puritjarra rock-shelter), but neither locality was used in an extended fashion prior to 1.5 ka. Both are dependent on ephemeral rain-fed soakages and waterholes focused on isolated sandstone strike ridges, and use of both sites is likely to be sensitive to shifts in rainfall and evaporation. In both cases, local rock paintings and engravings appear to relate to the late Holocene occupation. Within the Glen Thirsty complex, the rock art and occupation histories of the sites provide intrinsic evidence for the establishment and consolidation of a new cultural landscape; they document a gradual expansion of use of this locality, moving outwards from initial focal areas, and a shift towards the painting of large site-specific iconic motifs at these sites (Smith and Ross 2008b).

These data suggest some restructuring of land use and settlement in the last millennium or so. This requires better definition, but the overall pattern is one of local expansion of settlement, into peripheral areas within the core drainage systems and ranges, and into more marginal areas in sandhill and spinifex country dependent on very ephemeral waters.
Large Ceremonial Aggregation Sites

A common pattern is for large open sites, often associated with major ceremonial gatherings, on sand mantles at the mouth of gorges with focal rock holes. Only two have been excavated in Central Australia – Therreyererte and Atnetye – but at these, the major occupation unit dates within the last 500 years (see Chapter 7). Although limited, the evidence indicates that the intensification of ceremonies at these major totemic sites postdated changes in economic landscapes. Nevertheless, the large number of seed-grinders on these sites highlights the importance of grass, acacia and chenopod seeds in underpinning these ceremonial gatherings.

THE INLAND PILBARA AND WESTERN DESERT

In the Pilbara, there is an increase in radiocarbon-dated sites during the late Holocene, especially after 1.2 ka, although regional data alone are currently too weak to substantiate these trends (Marwick 2009; Ryan and Morse 2009). The picture is stronger in the Western Desert. Here, almost all excavated sites show more dense accumulations of artefacts and charcoal during the last millennium – including Serpents Glen (O’Connor, Veth and Campbell 1998), Puntutjarpa (Gould 1977) and Bush Turkey 3 (Veth et al. 2008). At Kaalpi, there is a switch to a grindstone-rich assemblage around 1.2 ka (although the concentration of flaked stone artefacts declines after 0.8 ka) (Veth, Smith
and Haley 2001). In the north of the region, excavated sites in the Rudall River area show the same pattern with ‘a consistent trend in increasing rates of artefact discard, accelerating during the period 1400 to 800 BP’ (Veth 1993: 66). On the southwestern margin of the Western Desert, Walga rock records a two- or threefold increase in artefact densities around 0.9 ka (1,040 ± 180 BP L Y-2098) (Bordes et al. 1983).

THE SOUTHEASTERN SECTOR OF THE ARID ZONE

Archaeologists working in the southeastern part of the arid zone have also commented on the abundant traces of late Holocene occupation in the region (see Hughes and Lampert 1980; Lampert and Hughes 1987; Williams 1988, 1998; Veth, Hamm and Lampert 1990 for the Strzelecki dunefield and Cooper Creek area; Florek 1993 for campsites associated with mound springs along the western side of Lake Eyre; Holdaway et al. 2002 for the Barrier Ranges region; Slaytor 2005; Hughes et al. 2011 for the Lake Torrens area; and Ross 1981 for the Victorian mallee). Many of these are surface scatters of stone artefacts: although typological criteria only narrow their age to within the last 4 ka, wherever radiocarbon dates on hearths and shell are available, the trend is for most to date within the last millennium. Two regional studies illustrate these trends in more detail.

The Coongie Lakes were studied by Williams (1988, 1998). These shallow, ephemeral and semipermanent freshwater lakes form an important arid-zone wetland at the terminus of the northwest channel of Cooper Creek. In 1862, explorer John McKinlay recorded unexpectedly large numbers of Aboriginal people in this area, often in groups of several hundred. Ethnographic accounts for the Cooper basin describe people living on fish and freshwater mussels, the seeds of portulaca and panicum, waterfowl and small marsupials, and rats, which Howitt describes being ‘roasted in the coals’ and ‘eaten seriatum, very much like biting a sausage’ (1862: Diary, 10 July). Systematic field surveys in the Cooper basin complement the ethnography, confirming that the Coongie Lakes were a focal point for occupation (Veth et al. 1990; McConnachie 1996; Hutchins 1998). In this area, archaeological sites often extend over 2,000–10,000 m^2 and include scatters of heavily reduced stone artefacts (tula adze flakes and adze slugs, cores, small scrapers and unmodified flakes), grindstones, burnt animal bone, shell fragments, burials, burnt clay, intact hearths with termite-mound heat-retainers and the remains of hut frames (Williams 1988, 1998). Radiocarbon dates on hearths, fireplaces, burials and shell artefacts all cluster between 1.0 ka and 0.4 ka (Pretty 1968; Williams 1998). There are few sites older than this: Williams (1998) located a single hearth in dune sediments dating to 3.2 ka.

The second study deals with spatially extensive stone artefact scatters on deflated surfaces along drainage lines in the region between the Cooper and Darling River systems. The large numbers of stone artefacts on this kind
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of arid-zone site have attracted repeated attention over the years. But the practical difficulties of untangling both a complex palimpsest of material of different ages and different types of occupation and the effects of geomorphic reworking of these scatters have defeated most researchers. In one of the most ambitious attempts to tackle this problem, Holdaway et al. (2002, 2005, 2008, 2010 – but see also Shiner 2008) used geographical information system (GIS) techniques to map artefact scatters in detail across more than 10,000 m² in four separate study areas and used a large series of radiocarbon dates (n = 96) on heat-retainer hearths, preserved as residuals on the eroded land surfaces to provide a chronology. These small alluvial systems are some of the most geomorphically complicated parts of the arid landscape: with discontinuous accumulation of sediments, plugs of sediments working downstream and phases of erosion and surface stripping. Fanning (1999; Fanning et al. 2009) used OSL dating of sediments and ¹⁴C dating of carbonates to determine the age of land surfaces and to factor out the effects of destruction of older archaeological remains. Even when allowance was made for geomorphic visibility, the results showed a temporal concentration of hearths between 1.0 ka and 0.4 ka and many fewer dated hearths between 3.5 ka and 2.0 ka (Holdaway et al. 2008, 2010). Unlike the Coongie Lakes sites, few of these artefact scatters represent central-place sites, semipermanent camps or large aggregations of people: rather they appear to reflect repeated but low-intensity use of resource zones along drainage lines within these foraging territories.

In this area, Burkes Cave, located in Scropes Range about 30 km from the Darling River, also shows a dense, charcoal-rich occupation deposit with much higher densities of retouched artefacts and unmodified flakes after 1.7 ka (1,850 ± 240 BP ANU-704) (Allen 1972: 138–218). Shiner et al. (2007) show that this unit represents a palimpsest of different sorts of occupation, but they did not attempt to characterise changes in site use over time.

Holdaway’s study illustrates some of the problems of separating fine-grained historical trends from the normal perturbations within a regional ecology. In this example, short gaps in the dated hearth series within the last 1,500 years may correlate with climatic shifts – as Holdaway et al. (2002) suggest. Alternatively, these may reflect vegetation dynamics within a single climatic regime. Arid rangelands typically have multiple stable states under a given climate, and flood and fire events can trigger a local flip between semi-arid grasslands and woodlands (Westoby, Walker and Noy-Meir 1989; Friedel 1991). This would have the effect of laterally shifting the foci of foraging within these river corridors, changing encounter rates for large kangaroos and local availability of seed grasses, and presumably affecting local rates of hearth construction.

FIRE AND PATCH BURNING

The shorter timescales represented by the archaeology of the last millennium allow us to look at the interplay of human modification of the landscape
with climate change. Fire is the major vehicle for this, as Giles saw in 1872. A patchwork landscape made up of vegetation in early and late successional stages formed a key part of the landesque capital of these foraging economies. More than 30 years ago, Latz and Griffin (1978) outlined the importance of fire in the ecology of spinifex grasslands: it thins out climax vegetation (such as mature spinifex), unlocks nutrients stored in perennial vegetation, promotes the short-term productivity of herbaceous plants, increases local vegetation diversity and creates a more stable ecosystem, in which small frequent fires reduce fuel loads and the risk of extensive, intense, destructive fires (see also Morton et al. 2011).

In Australia, much of the debate about the impact of anthropogenic fires has been dominated by questions about whether the initial entry of people into Australia around 50,000 years ago led to a massive increase in fires that transformed the continent's vegetation, denuded its soils and led to extinction of some genera of megafauna (Tindale 1957, 1959; Latz 1995, 2007; Miller et al. 2005). Recent research, however, suggests that fire has played a more interesting and more critical role during the last millennium in structuring the economic landscapes seen in the classic ethnographies (Bowman 1998; Haydon, Friar and Pianka 2000; Bird et al. 2005, 2008; Burrows et al. 2006). Aboriginal groups in Australia's deserts used fire for a variety of purposes: to flush out small marsupials, to hunt burrowing animals and reptiles, to 'clean up country', to encourage new growth to attract kangaroos and bustards, to burn fire breaks to protect religious sites or stands of fire-sensitive trees, to assert ownership of land and for signalling when travelling (Gould 1971b; Kimber 1983; Bird et al. 2008). Work over the last decade has used satellite imaging to map anthropogenic fire mosaics in the Western Desert, including landscapes used by contemporary foragers (Bird et al. 2008) and landscapes recently abandoned by foragers (including that by the 'Pintupi Nine' in 1984) (Burrows et al. 2006). This work shows that anthropogenic fires are localised and patchy, modifying the structure of the landscape locally but with little effect on the composition of vegetation at the regional level. The characteristic signature of human fires is a mosaic of small patches of vegetation in different successional stages, closely mapping the density and distribution of the hunter-gatherer population, and produced as an epiphenomenon or incidental effect of fires lit for hunting small marsupials and lizards and for signalling (Table 9.4).

As Bird et al. point out, 'Martu burning does not increase the absolute amount of fire, it rescales its temporal and spatial impact' (2008: 14800).

Patch burning had clear economic benefits for foragers in Australia's deserts, especially in the spinifex grasslands of Central Australia and the Western Desert, where it increased yields from staple plant-food species, medium-sized marsupials and reptiles. Most of these benefits accrue to women's foraging rather than men's pursuit of larger mobile game (Bird et al. 2005). Many plant-food species are promoted by fire (Table 9.5), including staple seed-food plants, most of the important Solanum (bush tomato) species, and key bulb or tuber
species such as *Cyperus bulbosus* (onion grass *yalka*) and *Vigna lanceolata* (pencil yam). The resilience of fire-sensitive seed species, such as *Brachychiton gregorii* and the various species of *acacia*, and fruit trees such as *Ficus platypoda* (rock fig) and *Santalum acuminatum* (quandong), also depends on reducing the extent of destructive wildfires. These species are destroyed by intense wildfires but are given a measure of protection in a landscape made up of a mosaic of small successional patches.

Bird et al. (2008: 14800) argue that efficient exploitation of seed resources may be critically linked to the creation of the small-scale successional mosaics created by anthropogenic burning. Of the sixteen most important seed-plant species listed in ethnobotanical research (Latz 1995), at least seven are most

<table>
<thead>
<tr>
<th>No. plant food species</th>
<th>No. fire-promoted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia seeds</td>
<td>40</td>
</tr>
<tr>
<td>Grass seeds</td>
<td>14</td>
</tr>
<tr>
<td>Other seeds</td>
<td>25</td>
</tr>
<tr>
<td>Fruits</td>
<td>30</td>
</tr>
<tr>
<td>Tubers, bulbs and roots</td>
<td>9</td>
</tr>
<tr>
<td>Grubs, lerp and galls</td>
<td>19</td>
</tr>
<tr>
<td>Honey</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
</tr>
</tbody>
</table>

* Other tree seeds, forbs and chenopods.
* Edible gums, mushrooms and greens.
* Includes several staple seed species: *Eragrostis criopoda*, *Panicum decompositum*, *Brachiaria subquadripa*, *Fimbrystylis oxystachya*, *Portulaca oleracea*, *Dysphania kalpari* and *Yakirra australiense*.
* These are all species of *Solanum* including several staple species.
* Includes several staple species: *Boerhavia diffusa*, *Cyperus bulbosus* and *Vigna lanceolata*.

Data from Latz (1995: table 3).
abundant in early successional sandplain habitats; these include annual grasses (*Brachiaria subquadripara*), perennial grasses (*Eragrostis eriopoda*, *Panicum decompositum* and *Yakirra australiense*), chenopods (*Dysphania kalpari*), annual sedges (*Fimbristylis oxystachya*) and succulent herbs (*Portulaca oleracea*). In contrast, the most important acacia seed species, such as *Acacia aneura*, are limited to late successional stages. For grass and acacia seeds, therefore, net yields over several consecutive years are likely to be highest in areas with a habitat mosaic that includes a range of successional stages.

Similar benefits appear to accrue with respect to small and medium-sized game (Bolton and Latz 1978; Burbidge and McKenzie 1989). A mosaic of successional stages provides both food and cover for small- and medium-sized marsupials, such as hare wallaby, *Lagorchestes hirsutus* (Bolton and Latz 1978), and reptiles, and new growth attracts larger mobile species, such as kangaroo, emu and bustard. Some work suggests that patch-burning regimes do not directly benefit rat- and mouse-sized mammals but rather increase the resilience of species otherwise affected by widespread destruction of cover during wildfires (Letnic et al. 2004). Perhaps the most important effect here is that small-scale habitat mosaics allow for rapid recolonisation of suitable habitat by small- and medium-sized mammals, providing a more stable game resource than the ‘boom-and-bust’ pattern produced by spatially extensive wildfires.

There are few opportunities to trace the development of fine-grained anthropogenic fire mosaics directly, but some associated changes predicted by behavioural ecology can be recognised in the archaeological record. Coddington (2012) shows that these fire mosaics are an epiphenomenon of foraging economies based on small marsupials and reptiles. Bird et al. (2008: 14800) argue that proliferation of seed-grinding gear should closely correspond with establishment of anthropogenic fire mosaics. Both of these lines of evidence are explored in the following sections.

**FAUNAL ASSEMBLAGES AND FORAGING PATTERNS**

In Central Australia and the Western Desert, faunal assemblages from occupation units dating within the last millennium typically contain a wide range of small game: rodents; varanid lizards and other reptiles; small marsupials such as bandicoots, bettongs (rat kangaroos) and brush-tailed possums; small- to medium-sized macropods such as hare wallabies (*Lagorchestes* sp.), rock wallabies (*Petrogale* sp.) and nailtail wallabies (*Onychogalea* sp.); large macropods such as the red kangaroo (*Macropus rufus*) and euro or hill kangaroo (*M. robustus*); as well as emu eggshell (Gould 1977; Webster 1982; Smith 1988, 2009b, 2010; Smith and Ross 2008b; Veth 1993; O’Connor et al. 1998). These reflect a foraging economy in which the meat component largely focused on small game but was supplemented by large macropods.
To date, however, faunal assemblages have not played a major role in reconstructing changes in prehistoric economy in any detail. Most assemblages are too small to be analytically useful. The major limitation, of course, is preservation: bone is usually highly fragmented in desert sites, often with few diagnostic elements remaining, and the acidic nature of desert sand means that bone is generally only well preserved in levels dating within the last millennium. The only sites with significant excavated faunal assemblages are Puntutjarpa in the Western Desert (n = >17,167 pieces; Gould 1977) and Intirtekwerle (James Range East) rockshelter in the Central Australian ranges (n = >6,514 pieces; Gould 1978a).

Some work uses an index of fragmentation (IOF – total bone weight/total number of fragments) as a proxy for dietary stress, arguing that prehistoric resource stress was particularly marked in the Western Desert (Gould 1980, 1996; O’Connor et al. 1998; Veth 2005a). This assumes that extreme fragmentation of archaeological bone directly reflects the pulverising of bone meal for consumption. Since this was first proposed, other work has shown that anthropogenic patterns of fragmentation are obscured by post-discard and post-depositional taphonomic factors, such as scavenging of bone by animals, post-discard burning of bone, post-depositional fragmentation within the deposit, fragmentation during excavation and handling during analysis (Webster 1982; Gould 1996; Walhe 2000). These analyses have also shown that there is no systematic difference in IOF values over time or between sites in the Western Desert and Central Australia (Webster 1982; Gould 1996) (Table 9.6).

A more productive line of analysis looks at changes in the relative contribution of large macropods in these foraging economies (Codding 2012). Based on ethnoarchaeological research with contemporary Martu foragers in the Western Desert, Codding et al. (2010) show that variation in the proportion of large macropods to small game in foraging economies is a function of the success in hunting larger mobile prey (where returns are unpredictable) versus the time spent foraging for smaller game (with more predictable returns). Extended use of foraging territories quickly reduces encounter rates for larger macropods, increasing travel time for hunters and leading to greater reliance on women’s foraging for small game and plant foods (see Figure 9.9). Codding (2012) tested this with an analysis of excavated faunal material from Puntutjarpa, which showed a greater reliance on small marsupials and reptiles during

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**Table 9.6. Index of fragmentation values (IOF) for faunal bone assemblages from archaeological sites in the Western Desert and Central Australia**

<table>
<thead>
<tr>
<th>Site</th>
<th>Fragmentation (IOF)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Western Desert</strong></td>
<td></td>
</tr>
<tr>
<td>Puntutjarpa Trench 2</td>
<td>0.53</td>
</tr>
<tr>
<td>Serpents Glen</td>
<td>0.06</td>
</tr>
<tr>
<td>Kaalpi</td>
<td>0.10</td>
</tr>
<tr>
<td><strong>Central Australia</strong></td>
<td></td>
</tr>
<tr>
<td>Intirtekwerle Trench 1</td>
<td>0.50</td>
</tr>
<tr>
<td>Puritjarra</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Data from Gould (1996), Webster (1982), Veth (2005a), Veth et al. (2001), and Smith (2010).
Figure 9.9. Changing foraging patterns, comparing (a) the early Holocene and (b) late Holocene. Smaller foraging territories and declining residential mobility reduce encounter rates and hunting returns for large macropods. Human behavioural ecology predicts a widespread shift to small marsupials and reptiles, in association with a fine-grained anthropogenic fire mosaic as a corollary of more extended occupation of sites. (Source: Codding 2012: fig. 6.14)

the last millennium (Table 9.7). Similar trends are evident at other desert sites, wherever faunal remains are preserved beyond the last thousand years, including Puritjarra, Intirtekwerle and Serpents Glen (Codding 2012 – see also Webster 1982; O’Connor et al. 1998; Smith 2010), and the Nullarbor sites, where faunal assemblages are increasingly underpinned by reptiles and small marsupials (Walshe 1994; Cane 1995). At Puntutjarpa, these are not primarily taphonomic trends: Codding (2012: 237–46) was able to show that the shift recorded in Table 9.7 is not explained by sampling bias, differences in fragmentation, selective removal of small bone or differential preservation of the more robust elements of large macropods.

Human behavioural ecology posits a widespread shift to small marsupials and reptiles as a corollary of more extended occupation of sites. If better samples and more detailed analyses of faunal assemblage confirm this archaeological trend, there are some interesting implications for foraging technology and for

<table>
<thead>
<tr>
<th>Stratigraphic unit</th>
<th>Zone A: Last millennium</th>
<th>Zone B: Mid-Holocene</th>
<th>Zone C: Early Holocene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small marsupials and reptiles^a^</td>
<td>59</td>
<td>47</td>
<td>30</td>
</tr>
<tr>
<td>Large macropods</td>
<td>41</td>
<td>53</td>
<td>70</td>
</tr>
</tbody>
</table>

^a^ Excludes murids and introduced rabbits.

Data are percentage minimum number of individuals (MNI) from Codding (2012).
the social relations of production. First, the shift to more logistical foraging associated with innovations in hafted tool kits around 4 ka (described in Chapter 6) may represent an attempt to maintain hunting success at a time when the natural abundance of large macropods in sandridge deserts was declining as environmental stochasticity increased. Second, greater reliance on women’s foraging sharpened the gender division of labour – as shown in the ‘dual technology’ of late Holocene tool kits (see Chapter 6) – in which men adopted a high-risk/high-return strategy in hunting large mobile game and women foraged for reliable staples such as small marsupials, lizards and plant foods. This also created the circumstances in which men increasingly sought to control women’s labour as a form of capital, through polygyny and the reciprocal bestowal of daughters as the marital partners of older men (Gale 1978). As Codding puts it,

If hunters are more likely to be successful when encounter rates are higher, and this leads to variability in the gender-division of labor, including effects that resound into social and political arenas, then the distribution and abundance of kangaroo likely influences not only hunting success and foraging outcomes, but larger aspects of human social and political organisation as well. (2012: 132–4)

SEED-BASED ECONOMIES IN THE LAST MILLENNIUM

The increasing proliferation of grindstones and seed-grinding implements in desert assemblages from 1.5 ka (Table 9.8) – as well as ethnographic evidence showing continuing pressure to expand or stabilise the supply of wild grain – shows that exploitation of seed-foods continued to intensify throughout the late Holocene. By the time the classic ethnographies were compiled, it was clear that historic population levels in the arid zone were underpinned by the use of seed-foods. When European explorers first entered the desert, they noted that Aboriginal people there relied on wild seeds as food, harvested from a wide variety of plants, including forbs, grasses and acacias. On Cooper Creek, in 1845, Sturt commented that the women were ‘employed beating the seed for cakes, between two stones, and the noise they made was exactly

<table>
<thead>
<tr>
<th>Layer</th>
<th>Age (ka)</th>
<th>Seed-grinders</th>
<th>Expedient grindstones</th>
<th>Undiagnostic fragments</th>
<th>Total (n)$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0–0.8</td>
<td>33</td>
<td>8</td>
<td>72</td>
<td>113</td>
</tr>
<tr>
<td>II/III</td>
<td>0.8–3.8</td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>2</td>
</tr>
</tbody>
</table>

$^a$ An additional twenty-two grindstones from layer I are listed in the excavation catalogue but cannot be located in the museum collections. Data from Smith (1988).
like the working of a loom factory’ (Sturt 1849: II, 79). In the Diamantina area, Hodgkinson made a similar observation in 1876, recording ‘an incessant pounding of nardoo goes on, resembling nothing so much as the chipping of a stone-cutter’s yard’ (Hodgkinson 1877: 15). While on the upper reaches of Cooper Creek during his 1858 expedition, AC Gregory famously noted that the natives reap a Panicum grass. Fields of 1,000 acres are there met with growing this cereal. The natives cut it down by means of stone knives, cutting down the stalk half way, leaving the straw which is often met with in large heaps; they winnow by tossing seed and husk in the air, the wind carrying way the husks. (Gregory 1887: 132)

For most ethnographic groups, the period of greatest stress during the annual cycle was late in the dry season, when the population had been tethered to country within reach of the permanent waters for some time. High-ranking bush foods such as fruit, tubers, bustards and large and medium-sized marsupials were quickly depleted. Seeds were particularly important at this time and were often stockpiled to meet expected shortfalls (Thomson 1964: 402; Cane 1984: 76).

The pressure on seed resources was evident in foraging economies across the arid zone. For instance, there was extensive use of ngardu sporocarps (Marsilea quadrifolia) in the Cooper basin, and occasional consumption of Triodia seeds in parts of the Western Desert, although both are poor foods and have high handling costs. Other features suggest that there was pressure to expand seed resources during the last few hundred years: for example, the construction of earthen dams to flood stands of seed grasses, patch-burning to promote early to mid-succession stands of grass or to protect stands of fire-sensitive mulga, the storage of seed in pits in the Cooper basin and the introduction of seed species into new areas (W Jones 1979: 140–3; Kimber 1984; Smith 1986; Gerritsen 2008). Some of these features warrant further comment.

The Use of Nardoo and Spinifex

‘Nardoo’ (ngardu) is one of best known native ‘grains’, largely because of its association with the iconic 1861 Burke and Wills expedition. The plant, Marsilea quadrifolia, is a clover-leaf fern that grows in shallow water, and its lentil-sized sporocarps are abundant on the flood plains and dried swamps in the arid river systems east of Lake Eyre. The sporocarps are very hard and require quite laborious pounding before being mixed into a thin paste and cooked into cakes. Because the spores contain comparatively little starch within a gelatinous spore wall (Schneider and Pryer 2002), ngardu makes a filling but poor ‘farinaceous’ food. In the last entry in his journal, Wills – one of the expedition members who died of malnutrition and beriberi at Cooper Creek (Earl and McCleary 1994) – wrote that ‘starvation on nardoo is by no means very unpleasant’ (Wills 1863: 302). Actively growing plants
also contain high levels of thiaminase, an enzyme that destroys vitamin B₁ and promotes beriberi. Major seed-foods – such as *Portulaca oleracea*, *Panicum decompositum* and acacia seeds – are prolific in the Cooper basin after rain or flooding. In this context, the use of such a high-cost, low-return food as *ngardu* suggests a subsistence system with very strong seasonal pressures on resources, and it is significant that *ngardu* was only used extensively in the Cooper basin, being almost entirely ignored in the Murray–Darling basin and in Central Australia.

Another example of seeds with high handling costs and poor returns is from the Western Desert, where there are occasional references to the consumption of *Triodia* (spinifex) seeds (Clement 1904; Cane 1987: table 1). Some archaeologists have taken this to mean that the hummock grasslands were a major seed resource in their own right. This is unlikely. *Triodia* is known to be a poor seeder: it produces abundant florets but very little seed, except after exceptionally good rain, a time when higher-ranked plant foods are usually widely available – including other seed grasses. The only circumstances in which the necessity to use spinifex seeds would coincide with the availability of this seed is where good rainfall allowed people to move into a large area of mature spinifex that had not been burnt for some time.

**Reaping Knives and Hayricks**

Gregory’s (1887) reference has been very widely quoted but, in fact, it is the sole reference to the use of stone reaping knives in the Australian literature. All of the major grass seeds – including *Panicum* – can be harvested by hand-stripping the heads off the plants into dishes. The only circumstance in which it might be cost effective to cut the grass – and pile it into ‘hayricks’ – is where there is pressure to accelerate ripening of the seed and to synchronise seed fall. In this context, Gregory’s account provides another example of periodic pressure on seed resources in the Cooper basin.

**Seed Storage**

Various methods of storing or stockpiling grain were used – pits, wooden dishes on platforms, skin bags, parcels covered with mud and grass – but, in most cases, this was on a small scale and involved short-term storage. Howitt’s 1862 observation is typical of many firsthand accounts: in an Aboriginal camp on Cooper Creek, he found a mud-and-grass parcel containing about 30–50 kg of portulaca (‘one and a half bushels’; quoted in Allen 2011: 264). The largest recorded cache of seeds was described by Ashwin (1932), a member of a droving party supplying Overland Telegraph Line construction teams in 1871. At Newcastle Waters, on the northern margin of the desert, Ashwin noted a store of about 1 t of grain (possibly Australian wild rice *Oryza australiense*) in wooden dishes. Given that he recorded groups of 200 men assembled for a
ceremony in this area, even this large store of grain represents only 10–14 days’ supply. The main problems in scaling up the storage of grain appear to have been logistical (to be effective, large granaries would need to be co-located with major water storage) and technical (the moisture content of native grain is too high for long-term storage of large quantities of seed, unless parching is employed – W Jones 1979). None of the ethnographic accounts describes ‘granaries’ or seasonal and massive storage of staples. However, the repeated references to use of seed-storage pits (paua kudu ‘a seed-grain pit’) (Reuther 1981 [1914]: II 329–982(4), II 155–903(3), III 119–1700(11), IV 60–3013(3), VII 278–1841) represent another example of the distinctiveness of the Cooper basin: this region had a large Aboriginal population, episodic hyperproduction during flood cycles, with marked subsistence stress between resource ‘booms’. By the late nineteenth century, these stresses were clearly evident: although this was one of the most productive parts of the desert, these groups had an extensive famine vocabulary (Table 9.9).

_Proliferation of Seed-Grinders in Archaeological Assemblages_

Although specialised seed-grinding implements appear in desert assemblages around 3.8–3.2 ka (see Chapter 6), their main phase of proliferation there occurred within the last 1,500 years (see Table 9.8). When these implements first appear, they are not common in archaeological assemblages, and seed-grinding may have been a supplement to seasonal shortfalls in other bush foods. However, from 1.5 ka, there is a shift towards more extended use of sites, with a corresponding increase in the use of grindstones (about 30–50 per cent of which are seed-grinding implements). Of the 378 grindstones recovered from radiocarbon-dated late Holocene contexts in Central Australia, 352 (93 per cent) date to less than 1.5 ka (Smith and Ross 2008a). This is also the period when the few dated mortars occur in sites in the Central Australian ranges. Their presence is an archaeological example of pressure to broaden seed use during the last millennium, in this case to include hard seeds – mainly varieties of acacia seeds that need processing in a mortar, prior to wet milling (see Smith 1985 for an account of these mortars).

All of this shows that there is both ethnographic and archaeological evidence for pressure on these foraging economies during the last millennium. ‘Economic intensification’ is usually defined as the substitution of capital, labour and skills in a situation in which additional land cannot be brought into production. For hunter-gatherer groups, mobility is the main means of offsetting declining yields. However, the last millennium saw periodic shortfalls in subsistence despite modest climatic amelioration. This suggests that the more closely settled landscape, indicated in the archaeology, constrained mobility to the extent that it became worthwhile to invest in plant foods with high handling and processing costs, and which required specialised gear. The
Between 1888 and 1906, Lutheran missionary JG Reuther compiled a thirteen-volume, 5,000-page manuscript, *The Diari*, detailing the language, beliefs and customs of the Diyari people of the Cooper Creek area. His glosses on the Diyari word for drought (‘pitaru’) provide a vivid word-picture of famine – in a region otherwise known for its richness and high population density.

**Source:** Reuther (1981)

The proliferation of grindstones in desert assemblages is one consequence of this shift; fine-grained anthropogenic fire mosaics are likely to be another.

**EXPANSION OF THE WATI (WESTERN DESERT) LANGUAGE GROUP**

These economic changes were not the only consequences of the growth of desert populations during the last millennium. The expansion of the Wati (Western Desert) language group is another example of the restructuring of the cultural world of the desert at this time (McConvell 1996; Smith 2005).

Most Aboriginal people in the Western Desert today speak one or more of a series of closely related languages (e.g., *Pitjantjatjara* or *Pintupi*), known
collectively as *Wati*. The recent expansion of this language group to cover the entire western half of the Australian arid zone is one of the few cases that unequivocally involved migration of people (unlike the earlier spread of Pama-Nyungan languages—see Chapter 6). This movement created a common language and culture and remarkable genetic homogeneity over a huge area spanning 2,000,000 km$^2$. Linguistic and genetic data suggest that this spread took place at some time early in the last millennium, but the timing is not known with any certainty.

Western Desert groups were making incursive movements east and southeast during the late nineteenth century. Major movements of *Pintupi*, *Pitjantjatjara* and *Yankunytjatjara* people took place in the first few decades of the twentieth century as people migrated eastwards, partly in response to severe drought conditions in their homelands. These groups were the most fluid of desert societies, lacking corporate descent groups and with a land tenure system focused more on individual connections than were other desert societies (Sutton 2003: 140). Hamilton (1980) argued that this was a society still in transition following recent migration into the area. A range of traits—linguistic, ceremonial, mythic and genetic—shows a marked cleavage between Western Desert groups and the Arandic speakers of Central Australia and points to a historical discontinuity between these populations (Sutton 2003: 96–7) (Figure 9.10).

Genetic data emphasise the distinctiveness of Western Desert groups (Balakrishnan, Sanghvi and Kirk 1975; Birdsell 1993; White 1997). This is particularly clear in serological data (in which the highest frequencies of blood group A are in the Western Desert) and in the phenotype for tawny hair (which is characteristic of this population) (Birdsell 1993: figs. B-1 and D-4). The genetic evidence indicates a rapid expansion of a small founding population drawn from existing desert groups. At the southeastern margin of their spread, Birdsell (1993) estimated there could have been no more than 500–1,200 years of genetic exchange between Western Desert and Arandic populations.

McConvell (1996) outlined the linguistic prehistory of the region. He suggested that the break-up of Northern Nyungic languages around 3 ka involved movement of groups into the Tanami Desert, the Pilbara, the Gascoyne–Murchison region and the western edge of the Western Desert. Over the next 2,000 years, *Warnman* and *Wati* languages differentiated, and speakers of the latter moved south and east to occupy the desert, reaching the western edge of the Central Australian ranges by about 1 ka. This chronology is necessarily speculative: historical linguistics provides only a relative sequence of language differentiation, with poorly constrained estimates of the rate of change. But, by 1870, Western Desert groups occupied the Mann–Musgrave Ranges in central Australia, as well as the western and southwestern margins of the main Central Australian range complex. The implication is that some well-occupied archaeological landscapes in western Central Australia saw a recent replacement of population. At present, we cannot detect this in excavated sequences or in
Figure 9.10. Geographic distribution of the Western Desert language (Wati), shown as percentage of words shared with Pintupi (PIN) (using a 100-word lexicostatistical test list). Abrupt boundaries to the south and east, and gradual boundaries to the north and west, suggest that Wati speakers have migrated to the southeast, corresponding with genetic patterns. (After O’Grady 1996)

rock art with any confidence, but more detailed analysis of changes around 0.5 ka might change this.

Linguistic and genetic data suggest the following scenario. First, increasing environmental stochasticity, associated with the shift from 4 ka to an ENSO-dominated climate, disrupted settlement in such a way as to accelerate linguistic divergence among existing groups and create a genetic bottleneck. When climatic variability declined after 1.5–1.2 ka, Western Desert groups were able to expand rapidly and occupy new territory. During historic droughts, these groups were observed to fission and disperse into small groups, with the bulk of the population falling back on better-watered country. It is not difficult, therefore, to see this process acting as a sort of ‘cultural pump’, drawing people into the desert during good seasons and forcing them out towards the margins during drought periods. This process requires demographic growth. It is relevant that the best archaeological evidence for population growth – on both sides of the Western Desert – is dated 1.5–1.0 ka (Smith 1988; Veth 1993; Smith and Ross 2008a).
THE SPREAD OF SUBSECTION SYSTEMS

Another example of changes associated with growing populations during the last millennium is the spread of subsections. Aboriginal groups in the northern half of the arid zone have a distinctive segmentary social system based on subsections – colloquially known as ‘skins’. This is a classificatory kin system that divides people into eight divisions; these govern behaviour according to quasi-kin relations between the subsections (e.g., potential ‘spouse’ or ‘classificatory father’). This system provides a framework for governing social interaction between people who are not direct kin, especially during initial contact with strangers. Yengoyan (1968) showed that population size is a critical factor in the operation of subsection systems: communities of less than 500 people contain too few eligible spouses to sustain the preferred marriage rules. Subsections, therefore, are a way of integrating larger numbers of people in these hunter-gatherer societies and cannot operate effectively in smaller dispersed communities.

In the 1890s, subsections were actively spreading south across Central Australia (Spencer and Gillen 1899). Linguistic comparison of the subsection terms used by different groups reveals that the system originated in northern Australia and spread south into the desert and north into Arnhem Land within the last 500 years (McConvell 1985, 1996). This provides another example of the dynamic social effects of population growth in the recent past.

OVERVIEW: ARCHAEOLOGY AND THE CLASSIC ETHNOGRAPHIES

Both the foraging landscapes Giles travelled through in 1872 (Figure 9.11) and the elaborate ritual and ceremonial life recorded a generation later by Spencer and Gillen, in 1896, appear to be products of historical changes within the last millennium. Some elements of the desert cultural system were in place in the late Pleistocene – as the various lines of evidence discussed in this book show – but ethnographic societies were largely the product of a rolling series of transformations in technology, foraging economy and political economy in the recent past.

Foraging Economies during the Last Millennium

During the last millennium, foraging economies in Central Australia and the Western Desert appear to have undergone a ‘broad spectrum’ transition (Bird et al. 2008). Increasing population density was associated with lower residential mobility and extended site use, and a shift towards greater logistical foraging. This was a landscape where anthropogenic fires had created a fine-grained successional mosaic of vegetation. The subsistence pattern increasingly focused
on small game, plant foods and resources that need elaborate processing, such as grass and acacia seeds.

There is scope for more research on these matters, but current evidence suggests that a dynamic interplay of factors underlies archaeological trends during the last millennium. A modest amelioration of climate and environmental stochasticity around 1.5–1.0 ka provided the basis for more extended use of key sites and closer settlement overall. The reduction in residential mobility made it cost-effective to shift to more labour-intensive processing of plant foods, especially the winnowing, parching and grinding of grass and acacia seeds. It also led to creation of a small-scale successional mosaic as an epiphenomenon of closer settlement, as foragers hunting burrowing marsupials and reptiles regularly burnt the same areas around focal points in the landscape. In turn, this mosaic represented a form of landesque capital (i.e., improvements to a productive estate) generating higher and more stable net yields of plant foods and small game. ‘Aboriginal foragers,’ said Bird et al., ‘thus construct their own ecosystem’ (2008: 14799). Although the evidence suggests a productive mosaic would be established within a single generation, this is not simply a consequence of closer settlement but probably also a necessary corollary of more intensive economic use of these landscapes. The feedback this entails amplified the effects of modest climatic amelioration on hunter-gatherer settlement at the beginning of the last millennium, explaining the
disproportionate response evident in regional archaeological records. It also amplified the stress in the system — when increasingly large regional populations faced intermittent and protracted drought — as shown in the mortality rates reported for historic droughts.

These trends parallel broad-spectrum transitions among hunter-gatherer groups in other parts of the world in the late Pleistocene or early Holocene, but they occur much later in Australia (Edwards and O’Connell 1995). The low productivity of these regions, combined with high interannual and decadal environmental variability in Australia’s deserts, placed persistent constraints on population growth in this region and periodically destabilised hunter-gatherer settlement in the interior (Davidson 1990; Smith et al. 2008).

The Social History of Desert Societies

What can we say about the social history of desert societies? Archaeologists working in Central Australia inevitably operate in the shadow of Spencer and Gillen, who were explicitly interested in the evolution of social institutions and religious life among these societies. The changes in economic landscapes at the beginning of the last millennium suggest that much of the social apparatus of these societies — their social segmentation, their political economy and the complexity of the ritual-mythological landscape — either took shape within the last millennium or altered their form within the new economic mode. This includes many of the traits considered to be most characteristic of Australian hunter-gatherer groups. However, to properly review the social history of desert groups, we need to range over the earlier history of these societies.

DEMOGRAPHIC TRENDS

The desert during the last millennium was a much larger social world than before. The late Pleistocene appears to have been characterised by isolated small groups of closely related people attached to particular locales. Regional populations seem to have been significantly lower than their ethnographic counterparts (possibly <1 person per 80–200 km²); territories appear to have been significantly larger, and foraging and residential mobility may have been extremely high. It seems likely (but hard to test) that the corollary of lower population density was an open inclusive social system, a high degree of personal autonomy and ceremonial gatherings that were small in scale and more concerned with social integration than ritual property. A smaller, unevenly distributed population also means that not all nodes in a social network can interact equally, so these societies would have been marked by a degree of localisation.

Whatever form of a desert society was established prior to 30 ka, late Pleistocene groups would have faced protracted adjustments to an increasingly sparsely occupied social world, as last glacial maximum aridity intensified and
fragmented foraging territories. In the desert interior, societies must have been marked by extreme social fluidity between 24 and 15 ka. During the last glacial maximum, societies probably differed from the founding groups (45–35 ka) as much as they differed from ethnographic desert groups.

Regional populations grew during the early to mid-Holocene as large-amplitude climatic variability decreased, creating a more reliable resource base. The flow-on effects on patterns of residence and mobility, and on networks of interaction, transformed these societies. Increasing population density in the early to mid-Holocene coincides with the appearance of rock art because living space was increasingly embedded in a process of negotiation of territory and identity. Further growth of regional populations in the last millennium created a more closely settled landscape and expansion into more marginal habitats. Lower residential mobility reduced birth interval and postpartum infant mortality and so may have amplified the effects of moderate climatic amelioration. Irrespective of the actual trigger, archaeological evidence suggests that much of the desert appears to have gone through a period of rapid demographic growth during the last millennium.

**LONG-TERM CHANGES IN FORAGING ECONOMY AND TECHNOLOGY**

Late Pleistocene societies in the desert appear to have been based on generalised small-game foraging economies: there is no evidence for targeted exploitation of particular species, either on the coast or in the interior. Foraging ranges are likely to have been large, but there is no direct evidence for long-distance transhumance. The role of large macropods appears to have declined as foraging territories became smaller in the late Holocene. Archaeological evidence suggests a switch to greater reliance on grain and other plant foods, small mammals and reptiles, coupled with more use of fire to manage these landscapes, more logistical mobility and small-scale storage or stockpiling of food to cover seasonal shortfalls. In Central Australia and the Western Desert, foraging economies developed their ethnographic structure after 1 ka, but on the arid west coast it is possible that similar shifts occurred earlier (around 4 ka).

The most distinctive items of the ethnographic tool kit – seed-grinders, and hafted composite tools such as adzes and composite spears – first appear around 4–3 ka and relate to economic and technological restructuring in the late Holocene. These represent a nexus of technological additions that, along with dingo as hunting dogs, gave desert people greater economic capacity than ever before.

**SHIFTS IN SOCIAL RELATIONS**

Social segmentation by sections and subsections is clearly recent in these societies because both were observed to be spreading south into the desert in the late nineteenth century. But some other aspects can be given a deeper historical context. The technological changes at 4–3 ka indicate a sharper gender
division in material culture, and the economic shifts around 1 ka may have further accentuated the sexual division of labour in these foraging economies. Some of the dialectic between ideology and practice observed in ethnographic societies probably originates in the economic changes taking place at the beginning of the last millennium: men sought to control women’s labour as a form of capital; women’s ownership of large millstones and the cooperative nature of women’s work groups imposed a degree of matri-local residence on men. The limited ecological productivity of Australia’s deserts, and the levels of personal autonomy that these foraging economies allowed, imposed strict constraints on the extent of social hierarchy, mostly limiting this to differentiation by age and gender.

CHANGING REGIONAL NETWORKS

Desert societies were connected not only to their environment but also to each other. The nature of these linkages appears to have changed over time. Growing population saw an acceleration of social interaction and exchange across the desert (the ‘ritual engines’ of Gibbs and Veth 2002). By the mid-Holocene, the Pilbara and Central Australia represented separate systems of interaction. And, by the last millennium, the arid riverine area east of Lake Eyre had begun to diverge from the rest of the desert with the development of distinctive long-distance exchange systems for red ochre, *pituri* and millstones, and evidence for significant pressure to expand production of exotic goods. Finally, although site records like those from Puritjarra provide evidence of long continuity in occupation, historical linguistics also reminds us that desert people spoke fundamentally different languages prior to the spread of Pama-Nyungan (PN) languages in the early Holocene and the spread of the *Wati*-Western Desert language around 1.5 ka: the implications for ideology, graphic systems and social interaction have barely been explored.

RITUALITY AND RELIGION

The ‘dreaming’ encodes proprietary relationships to land. For ethnographic groups, it provided both a mechanism for maintaining the ecological spacing of deserts groups, as well as a means of reinforcing a system of land tenure in the face of environmental variability and high residential mobility. As Myers explains, ‘holding country’ primarily consists ‘in control over the stories, objects, and rituals associated with the mythological ancestors of the Dreaming at a particular place’ (1993: 45). If the totemic landscape provides a framework for the negotiation of rights in country, rock art suggests that this system began to take shape in the early to mid-Holocene with the first appearance of Panaramitee-style rock engravings using the distinctive graphic system familiar from ethnographic art. Totemism and a belief in ancestral figures that shape the land is widespread across Aboriginal Australia – and so is probably much earlier than the mid-Holocene – but the inscription of landscapes
suggests the development of a more place-based system in the desert in the first half of the Holocene. The differentiation of rock-art sites and radiocarbon dates for sites associated with large ceremonies suggest that geographic totemism assumed a more corporate character during the last millennium. The complex symbolic landscape, the extent and character of ceremonial apparatus, and the link between ritual property and corporate rights in land all appear to be developments of the last millennium. The limited field evidence suggests that these were structural adjustments to shifts in economy and demography rather than autonomous drivers of change.

EPILOGUE

This book began with Spencer and Gillen and the 1896 ingkuwer ceremony. This was a watershed event in anthropological literature, a profound intellectual exchange between elite members of two very different societies. The chapters in this book attempt to historically situate the desert groups recorded in the classic ethnographies. In a sense, I have tried to approach the 1896 ingkuwer from ‘the other side’, reconstructing the long history that shaped the world of the Arrernte elders sitting across the ceremonial ground from Oxford biologist Baldwin Spencer and Alice Springs postmaster Frank Gillen.

We can now see that the classic ethnographic societies encountered by anthropologists on the desert frontier were the historical product of a long period of autonomous cultural development, shuffled and reassembled through a range of filters as aridity waxed and waned throughout the Quaternary. On the one hand, this process amplified and elaborated the social and economic traits of an ancient hunter-gather culture. On the other hand, archaeology shows that the classic ethnographies portray societies that fundamentally took shape in the centuries immediately prior to colonial contact. The last millennium is one of the most interesting periods of desert prehistory, a time when archaeological investigations are beginning to give a more nuanced historical picture of changes in the foraging economy, in trade and exchange, in rock art and in the political structure of these groups. As Rhys Jones once reminded us, ‘contemporary hunters are not static relicts from a frozen past; they also have their own past that can be investigated archaeologically’ (1984: 59).

As I write this, there is a lively grassroots movement by remote desert communities – from Fregon and Blackstone to Punmu and Port Hedland – to bring their art, traditions and dance to the national stage. I hope my book adds a historical dimension to this celebration of the desert as a cultural landscape.