8. Wardaman Country in Broader Context: A New Look at North Australian Prehistory

Based on the preceding observations of changing lithic technology, land use and provisioning we can begin to formulate a new and perhaps more dynamic interpretation of cultural change in Wardaman County than those presented before. There may also be potential to discover similar trends in other sites across the 'Top End'. Following David's (2002) recent work on pre-understanding and ontology, it is probably appropriate to suggest that major changes in subsistence and ecology were accompanied by significant alterations to the way people conceived of places, themselves and others in the landscape. The final chapter of this monograph deals with all of these issues, and places the sequence of cultural changes in Wardaman Country into a broader north Australian context.

The Nature of Technological Change in Wardaman Country

An accurate description of technological change is essential to understanding the nature of cultural changes in Wardaman Country since stone artefacts form the bulk of the archaeological record and reflect important aspects of the daily life of past occupants. Much of this monograph has been dedicated to building an accurate picture of the nature of technological change in this region. Through detailed analyses of rockshelter assemblages I have revealed a huge number of technological changes in Wardaman Country, including changes to the number of reduction sequences present through time, changes to the nature of stone procurement from the use of predominantly local to predominantly exotic stone, fluctuations in reduction intensity which have in turn affected the typological composition of assemblages, and many changes in the design and organisation of the transported component of toolkits. These changes have never been adequately documented before in northern Australia, and hence our understanding of technological change has been seriously compromised by poor information about the nature of assemblage variability itself. The now vastly improved picture of technological change in Wardaman Country allows a completely new depiction of changing mobility and landuse in northern Australia over time, as summarised in following sections.

Another goal of this research has been to better understand the nature of the transition between earlier and later industries which were previously thought to be discrete periods lacking technological innovation and displaying few signs of continuity across the mid-Holocene industrial transition. Instead, a set of gradual and continuous technological changes has been identified, beginning with the first detectable sings of human habitation and continuing right up until the last stone artefacts were deposited in the early contact period. Although the pace of technological change undoubtedly accelerates between 5,000 and 3,000 years ago, continuous change is nevertheless apparent over the entire period of occupation. Continuous and overlapping changes in many aspects of the production system also appear to indicate unbroken cultural transmission (i.e continuous inter-generational ancestor-descendent relations) over the last 15,000 years, which underlie the significant changes taking place in the design and organisation of technology over this period. Such a signature, coupled with the complex regional distributional pattern of implement production systems in Australia, leaves no doubt in my mind as to the indigenous development of Australian Holocene technologies, as well as the high level of ingenuity and creativity which formed the basis for solutions to the increasing problems of interannual variability and aridity during the mid to late Holocene.

Models of technological change in Australia must therefore look to internal factors as a source of explanation rather than diffusion as migration of new technologies into Australia from elsewhere. Recent work on the genetics of Aboriginal Australians in relation to global populations supports the view of long-term isolation of Australia from the rest of the world, including Papua New Guinea, and reinforces the point that technologieal innovation in Australia is of indigenous origin (Hudjashor *et al*. 2007; Huoponen *et al*. 2001; Rayser *et al*. 2001).

Many of the technological changes documented in this monograph also appear consistent with the emergence of strategies that could be argued to have facilitated the capture and extraction of resources

through better design and organisation of technology. In so doing, there are grounds to argue that technological changes were geared to the optimization of settlement and subsistence practices by pursuing the dual goals of utility increase and risk reduction. Evidence for such practices includes:

- use of a greater range of technologies geared to specific tasks during periods of heightened economic risk
- increased portability of toolkits during periods of high mobility magnitude
- greater field processing of stone during periods of high mobility magnitude
- greater standardisation of implement forms and increased reliability and efficiency during periods of economic risk
- the emergence of new ways of introducing flexibility into standardised tools as uncertainty over opportunities to reprovision with new tools increased
- lengthening artefact use-lives to recover the costs of greater technological investment during periods of high economic risk
- lengthening artefact use-lives to better ensure tool functionality in time-limited foraging during periods of greater uncertainty in resource availability
- increased use of high quality exotic stone to improve tool performance and reliability during periods of greater demands on tool performance

The sequence of technological changes documented in sites over the last 15,000 years therefore appears to indicate a gradual rise in the degree of investment in subsistence related technologies that increased utility (i.e. returns on energy expended) and reduced risk, with a big increase in technological investment and rates of technological change taking place between 5,000 and 3,000 years ago. That the optimality models used in this monograph appear to explain even some behaviour attests to their utility in anthropology and their ongoing importance in helping explain cultural change and assemblage variability in hunter-gatherer societies.

Kinds or Continuums?

North Australian prehistory is largely built on stone typologies, yet the relationships between various implement forms has remained poorly understood, as has the sequence of manufacture involved in their production and the changes in morphology they undergo throughout their use-lives. To help redress this situation, a number of reduction sequence models were constructed that demonstrated the connections between apparently distinctive implement forms, as well as various offshoots and points of convergence. Four distinctive reduction sequences were documented for retouched flakes which have effectively united tens of typological classes within a series of connected sequences. While this approach might seem to have unnecessarily reduced typological diversity, the goal was to arrive at an accurate description of changing technological diversity over time that is highly resistant to the effects of greater or lesser classificatory sub-division. By ranking individual specimens according to their place in a reduction sequence, it has become possible to explore changing intensity of reduction over time using continuous rather than categorical measurement systems.

It seems that much of the diversity in northern Australian assemblages can be explained by changes in reduction intensity. Implement diversity is highest in Wardaman assemblages between 4,000 and 2,000 years ago (Figure 7.8), reflecting the occurrence of late reduction stage classes such as bifacial points, bipolar cores, reversed and plain platformed tula slugs, burrens and dihedral burins, effectively doubling the range of implement types in common circulation before or after this period, but with no change in the number of reduction sequences in existence (i.e. changes in the diversity of reduction sequences largely took place prior to 4,000 BP). Nevertheless, there is undoubtedly an increase in technological diversity in this region through time, as well as real changes in manufacturing traditions and the organisation of technology, and not all changes in assemblage composition can be explained by mere fluctuations in reduction intensity.

The importance of an improved understanding of implement manufacture and reduction sequences therefore lies not in challenging existing typologies or reducing the number of types recognised in an assemblage, but in determining real rather than apparent changes in technological diversity over

time, the place of each type in a continuum such that reduction intensity can be measured over space and time, and the overall length of reduction sequences such that extendibility and use-life can be quantified for each individual production strategy.

Documenting reduction sequences is a relatively new field of enquiry in Australian lithic studies, but it is possible to imagine many future applications for this type of analysis. These might include examining the growth of regional differences in production systems across space and time (e.g. scraper reduction that produces predominantly convex forms vs those that produce predominantly concave forms), comparing the effects of raw materials on reduction potential, examining changes in modes of use over the life of an artefact as its morphology changes, or even devising classifications with wide-ranging utility that are closely tied to the reduction process, rather than continuing to use dimensions of artefact variability that obscure those processes. These avenues of research are only just beginning to be explored, and future studies should be able to make broad-based comparisons of the cost-benefit trade-offs and similarities and differences in knapping technologies as these sequences become better understood for a number of regions.

Changing Land Use and Mobility

A major aim of this study was to identify patterned behaviour in the way sites are provisioned across the landscape, and how changes in resource structuring and abundance influenced technology as a reflection of changing land use over time.

Long-term changes in technology do indeed seem to reflect major alterations in mobility, forward planning and technological investment. These in turn appear to be closely tied to significant climatic changes, and by inference, changes in the abundance and structuring of resources over time. The regional sequence essentially appears to be one of reversals between periods of individual provisioning and place provisioning, but with a major shift in the degree of logistical mobility and subsistence risk over time.

The first inhabitants of the region appear to have begun moving into the area in low numbers after about 15,000 BP, at a time when major reversals between tropical and glacial conditions were taking place at millennial scales. These first occupants left few traces of their presence besides flakes and an occasional retouched implement. By the time a considerable signature of occupation had accumulated at around 12,000 BP, people seem to have adopted a highly mobile pattern of residential movement through the landscape. Subsistence risk appears either to have been fairly low – perhaps implying that interannual variation was quite low despite massive longer-term fluctuations in temperature and rainfall - or it was adequately kept in check by the nature of the settlement and subsistence system without need for major investment in technology. The technological strategy in place at this time appears to reflect low-investment in manufacture, with implements typically displaying short use-lives as new flakes could be easily obtained from the transported supply of small cores. This technological signature and low toolkit diversity points to resources having been fairly evenly distributed and stable over time, with high residential mobility the most effective form of land use.

Occupational intensity appears to have steadily increased with time, either as conditions improved toward the early to mid-Holocene optimum, or because people developed strategies to better exploit local resources during this period. In any case, there is a pronounced peak in occupational intensity between 8,000 and 5,000 years ago that likely reflects increased population size. At this time there is a marked reversal in technological trajectories, with a shift to the provisioning of places with large, lightly reduced cores, less reduction and recycling of artefacts, a decline in raw material diversity and less use of high quality, exotic raw materials. Improved rainfall and low interannual variability likely increased the abundance of resources and populations appear to have increased and adopted fairly sedentary lifestyles centred on the exploitation of more locally available resources.

After 5,000 BP, mobility appears to have increased again, and the technological system changed once more. This time a suite of new technologies made their appearance between 5,000 and 3,000 BP, often in low numbers to begin with, but vastly increasing in frequency after 3,000 BP. This change is argued to mark the onset of ENSO-driven interannual variability in rainfall, with reduced effective

precipitation overall and the emergence of a regime of severe drought and flood that was revisited in quasi-cyclical fashion at frequent intervals. Resource abundance may have dropped at this time, but would certainly have fluctuated more severely than previously, and resources may also have become patchier as populations of plants and animals retreated to refuges or others were driven to local extinction. These conditions reached their greatest severity from 3,500 to 2,000 years ago. The technological response was a massive increase in investment in tool design, with increased technological diversity, standardisation, quality of materials and use-life. Retouched implements also became more portable and were likely hafted to increase effectiveness, perform certain functions and prevent loss. This new toolkit is indicative of an extreme form of individual provisioning, where toolkits are made to last and continue to perform for an unknown duration, with the potential for maintainability, rejuvenation and recycling if and when circumstances dictate. Such an extreme provisioning strategy, high toolkit diversity and frequent importation of exotic stone was likely associated with high logistical mobility, which is most effective for dealing with time-limited, mobile and/or clumped resources.

The last 1,500 years saw another peak in occupational intensity which appears to be correlated with a marked reduction in interannual rainfall variability. The provisioning system appears to have remained much the same, however, although maximising implement use-life appears not have been so important after this time. This suggests that resource access became somewhat more predictable and technological investment had also reduced, such that tools needn't function for quite so long.

Overall, the sequence of technological changes appears to be closely tied to climate change and resource abundance, but the nature of technological response was different in each period. This implies an historical component to technological change, in which the particular technologies that arose were at least partly dependent on what came before, as well as a functional component, whereby new technologies arose to meet particular needs, and their overall forms were constrained by subsistence requirements.

Thus climate, resource structure and subsistence strategy could have played a very strong role in shaping technologies in Wardaman Country over the past 15,000 years. The exact nature of those changes, however, is complex and historically contingent rather than simple and deterministic. A number of the particular technologies that rose to prominence in the last 3,000 years, for instance, are those that had already existed in the system for some time, but at low frequency. Later changes in technology seem to be an example of solving current problems using existing ways of doing things.

The resulting picture is one of constant and dynamic change, with populations, mobility, and degrees of future planning against anticipated risks all fluctuating significantly over the last 15,000 years. This stands in stark contrast to the picture painted in Chapter 1 of northern Australian technologies as composed of two clearly divided periods of typological stasis – one diverse and the other depauperate. There is probably much potential to identify such dynamic changes in other northern Australian sites, though insight will be limited so long as our evidence is constrained by currently published data. Future studies would do well to draw on older, well-dated sites to explore whether technological changes take place at these sites that may be indicative of alterations to provisioning, mobility, and resource structuring. Searching for evidence for continuities in manufacturing strategies that point to changes from within the pool of technological variants as well as transmission between regions will also be an important step in determining the origins and broader significance of technological change.

Wardaman Country in Regional Context

The ultimate value of regional studies of technology lies in their contribution to answering the 'big questions' in Australian archaeology. The final objective is therefore to consider how changes in one small region may reflect and inform on socio-demographic changes in Aboriginal society over a much larger area. This last question involves consideration of multiple lines of evidence, including archaeological, linguistic, skeletal, genetic and environmental data to build an interpretive model of Holocene changes in Aboriginal society. In this role, the study of stone artefact assemblages has the potential to contribute a vital and unique perspective on the past because they provide a tangible

record of human behaviour intimately linked to the means by which people extracted a living from their environment. To address this question, four issues of significance for Australian prehistory are considered:

1. the degree to which the timing of first occupation of Wardaman Country fits with evidence for the re-occupation of large areas of Northern Australia after a prolonged hiatus spanning the Last Glacial Maximum,
2. the significance of demonstrated continuity and regionalisation of retouched implement distributions for models of linguistic diffusion and migration in Australia,
3. evidence for similar changes in technology and occupational intensity that may point to a broadly similar pattern of changes in Aboriginal society and environment over the last 15,000 years, and
4. the implications of changes in land use and technology for changes in Wardaman ontology and regional social relations.

Occupational Intensity and Re-Colonisation Around the LGM

The extrapolated dates for initial occupation of Wardaman Country fit reasonably well with other evidence for colonisation/reoccupation after the LGM of large areas of northern Australia at around 10,000 to 15,000 years ago. In Arnhem Land for instance, most sites located in large outliers on the flood plains have extrapolated basal ages of between 9,000 and 15,000 BP (e.g. Jimeri I, Ngarradj Warde Djobkeng, Jimeri II, Burial Cave, Angbangbang 1, Leichardt Site). The four exceptions to this trend are Malakananja II, Nauwalabila I, Nawamoyn and Malanagangerr which appear to have occupation spanning the LGM back to a maximum (OSL dated) age of around 50,000 to 60,000 BP (Jones and Johnson 1985; Morwood and Hobbs 1995b; but see O'Connell and Allen 2004). These last four sites are all situated in well-watered gorges where permanent water was probably available throughout the LGM. The west Kimberley sites (e.g. Mandu Mandu, Widgingarri Shelter 2, Koolan Shelter 2), on the other hand, predominantly show a long occupational hiatus spanning the LGM, with first signs of re-occupation at around 10,000 BP (Morwood and Hobbs 1995b; O'Connor *et al.* 1993). The exception in this region is Carpenter's Gap 1, where occupation appears to span the LGM despite a truncation of sediments in the late Pleistocene (O'Connor 1995). This site is located in the well-watered limestone of the King Leopold Ranges. Sites in Cape-York also show either occupational hiatuses over the LGM until around 15,000 BP or later (e.g. Sandy Creek 2, Magnificent Gallery, Mushroom Rock, and Early Man, Ngarrabulgan Cave), or else much reduced occupational intensities (e.g. Yam Camp and Sandy Creek 1) (David 2002; Morwood and Hobbs 1995b). Some sites located in sandstone gorges and limestone outcrops close to permanent water in this region show an increase in occupational intensity over this period, such as at Fern Cave (Lamb 1996). The same is true at Lawn Hill close to the Gulf of Carpentaria where occupation of caves in well-watered limestone gorges intensified over the LGM (Hiscock 1988).

Overall, hiatuses and changes in occupational intensity over the LGM indicate that large areas of northern Australia were either abandoned or left unoccupied until climatic amelioration and the onset of very tropical conditions at around 15,000 BP, while occupation tended to intensify over the LGM in well-watered gorges, karst limestone and uplands. Following initial post-LGM occupation, most sites appear to show continuous occupation throughout the Holocene, though fluctuations in occupational intensity are common. These results suggest that people were repopulating large tracts of land either from more habitable, now drowned, land on the Arafura shelf, or from refuges in the few places were reliable water sources existed throughout the LGM. Interestingly, no demographic expansion is registered in the genetics of Aboriginal Australians at any time except following initial occupation, and here it seems likely that recolonisation of landscapes after the LGM more likely involved population reconfigurations and gradual population growth than a large and sudden demographic expansion (Clarkson and Ricaut 2006). If ever there was a time to identify the movement of populations across large areas of northern Australia, however, then around 15,000 BP is it. Yet this is not the time at which retouched implements like points, burins, burrens and tulas make their first appearance in sites, and hence arguments for these implements accompanying a migration of people

at around 5,000 BP seems unlikely, at least for this part of Australia. This leads to the second issue discussed here – heritable continuity and language spread.

Re-Occupation, Continuous Transmission and Linguistic Origins

Strong evidence for continuous transmission of stone artefact manufacturing traditions spanning the last 15,000 years was presented for Wardaman Country in Chapter 7. These results make the sudden appearance of new retouched technologies between 5,000 and 3,000 BP as a signal for the incursion of new populations or language speakers into the region at this time highly unlikely, especially in the light of the recent genetic evidence for long-term population isolation. Furthermore, it seems likely that some of the new retouched implements found in Wardaman Country in large numbers after 3,000 BP are indigenous to the region (such as lancets and burins), while some likely have a northern origin (i.e. points), and others a southern one (i.e. tulas). This situation points more toward medium to long-term social contacts between regions resulting in gradual diffusion of new technologies across large areas, than it does to regional populations being overrun by new arrivals or the spread of technological ideas and/or new languages out of a single homeland and in a single direction.

McConvell's (1990, 1996) and Evans and Jones's (Evans and Jones 1997) ideas of linguistic spread did not take account of the problem of widespread northern bifacial point technologies, except to make the link with northern non-Pama-Nyungan (NPN) languages that are supposedly older, *in situ* developments. Yet the appearance of bifacial points across a region of vast linguistic diversity and therefore supposed great antiquity in its current spatial configuration also requires explanation – particularly since this study offers some evidence of heritable continuity in one region over this period.

Unifacial points, found in both northern and southern Australia, are usually lumped together with the hypothesized outward spread of Pama-Nyungen (PN) languages with other new implement types (such as tulas and backed artefacts) at around 5,000 BP from a supposed homeland in the Gulf of Carpentaria and into most parts of southern Australia. The unity of this southern spread is supposedly confirmed by the homogeneity and ancestral connections between languages spoken across the southern two thirds of Australia. Yet this argument for southern homogeneity may not be entirely correct. The people of large areas of southeastern Australia were almost entirely decimated by disease before much linguistic information could be recorded for these areas (Butlin 1983). Little linguistic material exists for the Murray River corridor, for instance, a region containing the greatest diversity in skeletal populations known in Australia (Pardoe 1984, 1993), and hence it is surely difficult to appraise how diverse the languages of southern Australia were before contact. New linguistic evidence suggests that the southeast may in fact have been an area of very high linguistic diversity (Clendon 2006). The differences between northern and southern language groups is still not well understood, and there are at least some linguists who would argue that differences do not exist on a large enough scale to advocate migration and language replacement (e.g. Dixon 1997).

The real problem with current models of linguistic spread from a technological point of view, however, is that much of the variation in the spatial distribution of distinctive regional technologies is ignored, as pointed out in Chapter 1 and illustrated in Figure 1.3. For such a complex distribution to have emerged means either that the spread of individual stone implement manufacturing traditions is not coincident with the spread of languages in the mid-Holocene, and/or that a single spread did not take place. The technological evidence seems in favour of both of these explanations. The regionalized nature of technologies suggests that the advent of new standardized implement forms may represent a series of localized solutions to the problem of increased risk and climatic variability from the mid-Holocene on, with the later spread of these technologies perhaps resulting from transmission and information exchange between neighbouring groups. Social networks that facilitate the transfer of information, goods and genes have probably always existed to some degree between hunter-gatherer populations in Australia (Edwards and O'Connell 1995), but these may have strengthened and become more wide-reaching over the last 5,000 years. Increased unpredictability in resource abundance would have created a need for social storage as a form of risk reduction, creating alliances based on reciprocal access to resources in the territories of other groups during bad times.

Clendon (2006) makes the argument that a northern and southern language division may have existed since the separation of northern and southern populations by the broad expanse of an emptied central Australian arid zone during the LGM. The linguistic picture might therefore represent two *sprachbünde* of great antiquity rather than the results of phylogenetic spreading from proto-language ancestors. The linguistic division seen today might therefore represent the meeting of northern and southern populations repopulating the interior once climate ameliorated in the last 15,000 years (with some areas of central Australia probably not colonized until the mid-to-late Holocene – thereby accounting for pockets of extreme linguistic homogeneity) (Veth 1989).

The isolation of northern and southern populations in fact finds some support in non-linguistic evidence as well. Genetic studies of Australian mt-DNA suggests some deep divisions could exist within the Australian Aboriginal population (Huoponen *et al*. 2001; Ingman and Gyllensten 2003; van Holst Pellekaan *et al*. 1998), possibly running along north-south lines. Our own reanalyis of the mt-DNA data, however, points to more complex patterns of interaction and isolation (Clarkson and Ricault 2006). Pardoe's (1984, 1990) study of non-metric cranial traits also found a major division between northern and southern populations. Claims for a northern rock art province have also been mirrored in claims for a pervasive southern Panaramitee style. Layton (1997:384) proposed a similar model to Clendon's to explain such geographic divisions: "the simplest model might conceive of two refuge areas during the last Glacial, the southeast (home of geometric art) and the north coast (home of large silhouettes)."

Dixon (1997) has argued that such periods of punctuated language division as might result from separation of a northern and southern population over the LGM can be later smoothed over by long-periods of equilibrium, as might have occurred after recolonisation of previously abandoned areas and the continuous occupation of both north and south Australia since the terminal Pleistocene. Clendon sees widespread sharing of linguistic features since reoccupation as a likely explanation for widespread phonological and grammatical similarities in Australia, and also for a fuzzy band of overlap in linguistic features between northern NPN (or what he calls *Arafuran Languages*), and southern PN languages. The pattern of distribution seen in retouched technologies could therefore represent localised adaptations to changing environmental conditions overlayed over a linguistic divide of much greater antiquity (i.e. since before the LGM). The spread of technologies across much smaller areas likely indicates nothing more than the continued regional interaction and transmission that characterizes all human groups in all times and places (Edwards and O'Connell 1995), resulting in the spread of new and regionally specific approaches to dealing with increased stochastic variation in resource abundance after 5,000 BP. In many cases, these technologies likely had their origins as variants that had already been in existence for some time in some regions, and burgeoned and spread only once local conditions brought them to prominence in some areas and favoured their adoption as 'optimal solutions' in others. Hiscock (2002) has recently made essentially the same argument in relation to the advent and spread of backed artefacts out of a southeastern Australian homeland, though new Pleistocene dates for backed artefacts from North Queensland suggest some revision of Hiscock's model is necessary (Slack *et al*. 2004).

ENSO and Regional Technological Change

If my model of fluctuations in mobility, risk and provisioning in Wardaman Country can be linked to changes in the predictability and quantity of rainfall over time, then we should expect similar changes to take place over wide areas of northern Australia. Unfortunately, comparable technological studies are non-existent for the Top End of Australia. There are, however, glimpses in the published literature which suggest that broadly similar changes, both in terms of their gradual nature and directionality, were taking place in other parts of northern Australia throughout the Holocene. A classic case is to be found in the rockshelter sequences from the gorges and flood plains of Arnhem Land. These sites display a series of gradual changes in stone artefact production systems and raw material selection that are closely timed with major environmental changes in flood plain evolution and increased climatic variability in that region over the Holocene (Allen and Barton n.d.; Hiscock 1994b; Jones and Johnson 1985; Kamminga and Allen 1973; Schrire 1982; White 1971). These include

a shift from core and scraper manufacture early on, to a later use of points and bipolar cores after 6,000 BP. In the case of Nauwalabila, the changes in raw materials and flake size are gradual, with peaks in one raw material gradually giving way to peaks in another, as the average size of artefacts also decreased (Jones and Johnson 1985). Several of Schrire's (1982) plain (Malangangerr, Nawamoyn) and plateau sites (Jimeri II) as well as Jones and Johnson's (1985) excavations at Nauwalabila, indicate two distinct peaks in charcoal and artefact deposition, with the lower peak situated between 6,000 and 8,000 BP, and an upper peak somewhere between 1,000 and 3000 BP, similar to Wardaman Country. These sites also show signs of the gradual adoption of bifacial flaking techniques leading up to the first appearance of points. It is difficult to assess changes in reduction intensity in this region over time as numbers of unifacial and bifacial points have not been published for any of the main sites, and nor have core types such as single platform, multiplatform or bipolar, that might allow broad changes in reduction intensity to be identified. These patterns are nevertheless suggestive that significant, and possibly broadly similar patterns of technological change in parity with those taking place in Wardaman Country may have occurred in this neighbouring region.

Other faint traces of similar patterning come from Cape York Peninsula in Queensland, the Port Keats region of the Joseph Bonaparte Gulf in the Northern Territory and the western Kimberley of Western Australia. Mackay (2005), for instance, has documented increasing mobility from 5,000 until 1,000 BP as indicated by changing technology at three rockshelters on Ngarrabulgan Mountain in southeast Cape York Peninsula. Mackay was able to demonstrate a move away from place provisioning toward greater reliance on individual provisioning, particularly between 3,000 and 2,000 BP, despite an absence of formal types in these assemblages. This shift in provisioning and increased mobility was followed by apparent total abandonment of the mountain and surrounds at 900 BP.

At Yarrar rockshelter, in the Port Keats region south of the Daly River, Gregory (1998) has documented a peak in intensity of occupation at c. 1,500 BP. However, Gregory also argues that mobility was very high over the 3,000 to 5,000 years of occupation contained within the shelter. Flood (1970) also found in her analysis of point manufacture at Yarrar that flake blanks and bifacial blanks were transported to the site from quarries at medium distances to the shelter, suggestive of the transport of only those implements with high utility to weight ratios. Most significantly, Flood found that bifacial points were more abundant in the lower than the upper levels, where unifacial points dominated the assemblage. This change in proportions proved significant as indicated by a chi square test.

At Widgingarri 2, there is a peak in artefact discard at c .7,000 BP and another one around 1,000 years ago (O'Connor 1999). Cores and scrapers also gradually decrease in number as points increase, with the first points dated to around 4,970 ± 60 BP (Wk 1398). It is difficult to tell whether bifacial points occur earlier in the sequence, but it may be significant that many of the bifacial points occur in the bottom spits at both Widgingarri 1 and 2.

In summary, there are tantalising indications that broad patterns in occupational intensity, changing extent of reduction and provisioning are mirrored in other sites in the region during the Holocene. Furthermore, there is clearly evidence of gradual changes and *in situ* developments in technologies that are more suggestive of continuous cultural transmission than of a sudden break in technologies accompanying the first appearance of points and other heavily retouched forms. This suggests that regional transmission through social networks that were perhaps geared toward social storage could provide a plausible model of the spread of new technological ideas in the last 5,000 years. Unfortunately, the data is too coarse-grained to get much of an idea of the subtle and gradual changes in technology taking place in regions neighbouring Wardaman Country. There is therefore a great deal of research that still needs to be conducted to place the trends in mobility, provisioning and land use documented in Wardaman Country into a regional context. It is clear, however, that potential exists to build an exciting and dynamic picture of long-term cultural change from stone artefact assemblages, and to understand the nature of the feedback relationship between ecological and social processes and pressures that have shaped northern Australian prehistory since humans first entered this continent more than 45,000 years ago.

Land Use, Sociality and Ontology

The results of detailed technological investigations need not end at discussion of economic and environmental changes, but may also shed light on shifting world views and relationships between people and landscape over time. David (2002) sees ontology - or the system of meaning with which people interpret the world and their own place in it - as fundamentally shaped by our experience of the landscape, material objects and other people, such that a change in any one of these variables will likely also result in a change in belief systems. This idea has important implications for the way we should view the sorts of changes in technology, subsistence and land use argued to have taken place over many thousands of years in Wardaman Country. Although change is continuous over this period, increases in the rate of change have also been identified that points to major and rapid readjustments to the way people related to the landscape over time, albeit within the context of broad cultural continuities. If David is correct in this view, then we should expect such periods of major economic and technological restructuring to be accompanied by alterations in systems of signification and world view, as well as perhaps a reconfiguration of the ways in which people related to each other.

For example, a relatively sedentary group spending large amounts of time in each other's company and tethered to only a few resource patches, a few large waterholes, and a number of familiar rockshelters, and possessing clearly demarcated boundaries with frequently encountered neighbours, may relate quite differently to each other, and to the landscape around them, than to those living in, say, dispersed groups, moving constantly over large areas with which they are less familiar, and potentially travelling long distances to make contact with neighbouring groups whom they encounter more rarely. David argues on this basis that major discontinuities in the archaeological record should also signify rapid changes in world view, because the material world is meaningful, and any change in the patterning of material phenomena will likely also indicate a change in the meanings ascribed to them.

Following this argument, we might expect the changes in subsistence, technology and land use documented in Wardaman Country to be accompanied by major changes in social relationships, rock art styles and signification and even the mythological basis of the Dreaming itself. David *et al*. (1994) found two peaks in ochre deposition in excavations beneath large painted panels in Wardaman Country dating to 1,500 BP and 380 BP. At Menngen-ya where occupation is dated to greater than 2,109 ± 60 (NZA 1624) radiocarbon years, the younger peak in ochre is thought to relate to the painting of two large striped anthropomorphic figures that dominate the panel, while the older peak probably dates faded paintings that are of a different style and which underlie the striped anthropomorphs. If this is correct, and changes in rock art styles indicate changes in ontology, then the timing of changes in art styles and world view are neatly coincident with two important technological changes in Wardaman Country – the peak in occupational intensity at 1,500 BP and the first appearance of Leilira blades in large numbers at 330 BP. In the latter case, these blades are known to have been traded over very large areas, and point to the emergence, or more likely a change in nature and orientation, of regional networks of social interaction at this time. Technology and social changes therefore seem closely tied to one another as David predicts they should be.

Technology can therefore indirectly inform us about many of the larger issues in northern Australian prehistory that have proved more difficult to access through conventional archaeological techniques of excavation and cataloguing. As yet, the data and interpretation offered can only take us so far, because so few detailed regional studies of technology have been undertaken in Australia. Perhaps our most pressing need in northern Australian archaeology then is a wide-ranging program of interconnected regional studies that will help us to comment on the specific nature of technological, economic and social change in this region for the tremendous span of human occupation of the country.

Conclusion

Writing prehistory is a difficult business no matter what the theoretical stance or the type of data chosen to base it on. It is arguably at its most difficult, however, when trying to extract an understanding of the past lives of complex cultural beings from variation in chipped pieces of stone.

This research has been successful in so far as it has documented major changes in the system of stone artefact procurement, manufacture, transport and discard through time, and has identified general ecological processes as important factors shaping assemblage variability in this region. Seemingly, increased inter-annual variability in rainfall after 5,000 BP is a major factor that has noticeably transformed Aboriginal technologies and modes of land use across northern Australia, with likely consequences for the way people related to each other, assimilated each other's ideas and maybe even used each other's resources. Such major alterations to the social and physical environment must also have had ramifications for the ontologies of people and the way they graphically depicted their world.

The apparent success of this research both confirms the importance of ecological modelling as a useful tool in exploring the forces that partly shaped past human behaviour, and the value of stone artefact assemblages as an important interpretive window on the past. It is a great pity that so few detailed analyses of this kind have appeared in Australia, for much of their impact is lost without companion studies in nearby regions with which to compare results. The need for regional studies that connect broad geographic areas and provide the necessary comparative data for expansive treatments of socio-demographic change has perhaps never been more urgent than at present, since theoretical modelling of Aboriginal cultural changes appears to be outstripping the rate at which the necessary data required to test these models is gathered.

This monograph has proposed a very specific model of technological, economic and social change that has many testable components within and outside of Wardaman Country and involving many independent lines of enquiry. Changes in mobility range, mobility frequency and mobility type could be easily explored using faunal data from sites in nearby areas with well-preserved faunal assemblages. The Kintore Caves site excavated by Mulvaney and Golson in 1963 and located near Katherine, for instance, has a very large and intact faunal assemblage, that could be used to explore these questions on a different class of material with a different set of methods. Evidence of intensified inter-regional exchange and social storage, on the other hand, could be addressed by gradually building a database of geochemical fingerprints for stone sources, such that exotic materials (especially for trade items such as Leilira blades) may be traced to particular distant quarries. The use of changing artefact discard numbers at sites to represent fluctuations in occupational intensity could be further tested by examining changes in site formation, the taphonomy of artefacts and the changing nature of prey selection, faunal reduction and exploitation. The notion that technological changes across the Top End represent continuous transmission through time rather than significant breaks could also be further explored by examining evidence for fine-grained, continuous and overlapping technological change in other rockshelters with large and well-stratified assemblages in nearby regions. Such studies are relatively straightforward and yet they are rare despite the massive amount of information they can provide about the prehistory of northern Australia.

In conclusion, an approach that unites processual and behavioural archaeologies with evolutionary ecology and design theory offers us clear direction as to how we should structure our observations of the record, construct temporal and spatial frames of reference, and begin interpreting our data with relevant models in mind. The ultimate measure of success in attempting to understand the past will likely rest on our ability to develop explanations of social and economic processes that take us from subsistence into the more complex domain of social structure and ontology.