Chapter 5
Horizons of Change: Entanglement of Paleoenvironment and Cultural Dynamics in Australian Lithic Technology

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Introduction

Australian research into ancient lithic technology has often been polarized between models that depict technological change as a response to paleoenvironmental change and models that presume paleoenvironmental change was not the principle stimulus for social change. Both propositions offer only partial representations of cultural change, especially when large-scale evolution in technology has occurred. A powerful framework for defining the articulation of technological, social, and environmental changes is niche construction theory (NCT), a perspective focused on the capacity of organisms, in this case humans, to modify natural selection in their environment and in that way to contribute to the direction of their own evolution (Odling-Smee et al. 2003; Laland and O'Brien 2010). Niche construction therefore concentrates not only on the solutions that organisms find to survive in and exploit their environment but also how those solutions modify conditions in ways that change conditions confronting the organism. Application of a niche construction framework offers substantial value in understanding technological change and will form part of the analysis in this chapter.

Australia provides a vista of considerable technological change during the terminal Pleistocene and Holocene. One widespread instance is the development of microliths and subsequently an intensification of microlith production and geographic expansion of microlith assemblages. Understanding these complex temporal and spatial patterns requires an exploration of both environmental and social contexts. Furthermore the character of microliths themselves has been puzzling. They are small, sometimes very small, and yet often standardized and precisely made. We know that many of the specimens were used as tools, and yet it is also

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clear that the objects carried social meaning. In this chapter, I examine these patterns in three steps: first, describing the spatial and temporal patterns of microlith production to depict the evolutionary change; second, characterizing the climatic and landscape contexts of those evolutionary changes; and third to offer speculations of the niche construction dynamics that might have been in operation.

Australian Backed Artifacts

In Australia, archaeologists have adopted the term "backed artifacts" to redefine the category often labeled as "microlith" elsewhere in the world. These backed artifacts are flakes with steep retouch along one or more margins. Their distinguishing feature is the near 90-degree retouch that was usually accomplished with the use of bipolar techniques on an anvil. Multivariate analyses have shown that backed artifacts are morphologically distinct from other retouched flakes and that this category contains specimens that have been selected and treated distinctively (Hiscock and Attenbrow 2005). The size of backed artifacts varies considerably between regions, and in some places, they are large; hence the reference to small size, in the term microlith, is not appropriate in the Australian context. Redefining the phenomena in terms of backing that blunted an edge has created a challenging new image of this technological system in Australia.

The new image stems in part from the more technological identification of specimens. By requiring backing retouch, my analyses exclude specimens that were unretouched but previously included in analyses from typological perspectives. There are many reasons that unretouched flakes in particular were misclassified as backed artifacts, including the confusion of dorsal platforms, platform faceting, overhang removal, and heat shattering, with backing retouch. Since error rates in identifying backed artifacts were commonly in the range on 10–40% of analyzed specimens, those previous typological characterizations were often inaccurate. By including only retouched flakes with backing in this research, it is possible to describe production, tool use, and spatial and temporal variations.

Backed artifacts display clear geographical variation across the Australian mainland. They are not found in the northern portions of central and Western Australia. Across the rest of the mainland, they are found in varying densities, with regionally different sizes, shapes, and production systems. One depiction of the spatial differences in form has been expressed metrically with an index of symmetry (Hiscock 2014a). As shown in Fig. 5.1, higher values are more symmetrical, and lower values are less symmetrical. The continental pattern is that asymmetry is more typical of marginal regions. This geographical variation in backed artifact morphology is probably related to the dispersal history of this kind of artifact, as modification of the morphological variation in backed artifact arose from transmission error, technological adjustments of retouching to different blank production strategies, and divergence in the backed forms to facilitate social signaling in learning/production contexts (see Hiscock 2014b).

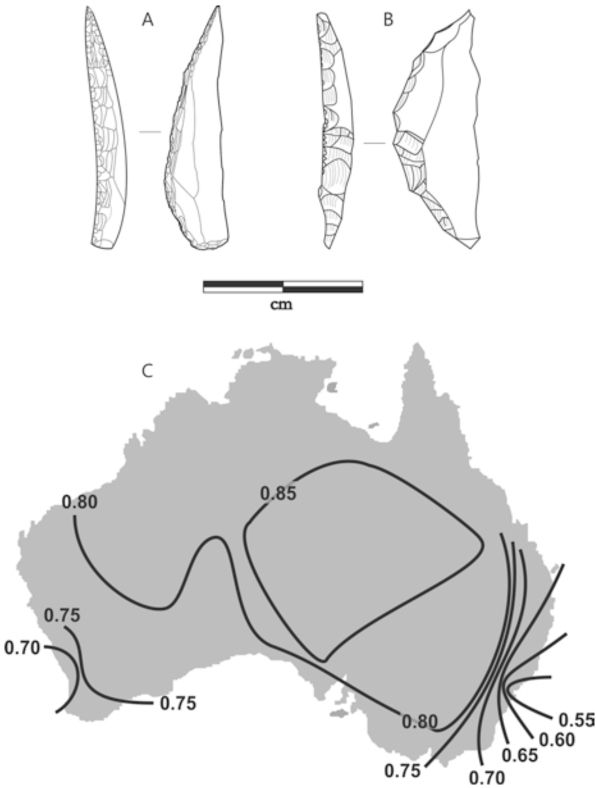

Fig. 5.1 Illustration of the geographical variation in backed artifacts. (**a**) Asymmetrical specimen from the east coast; (**b**) symmetrical specimen from the interior; (**c**) isopleths of the backed artifact symmetry index (Hiscock 2014a) in which higher values are more symmetrical

At any one location, backed artifacts are often extremely uniform in size and shape. The process of creating standardized forms was sometimes assisted by the production of flakes with regular shapes, but it did not depend on standardized blank creation. Specimens were made on a variety of flakes that were selected because they had an appropriate cross section, width, and one straight or gently undulating margin of sufficient length (Hiscock and Attenbrow 1996; Hiscock 2006). This means that prehistoric manufacturing did not involve, typically, mechanically applying a procedure to a uniform blank but required the artisan to select a suitable section of each flake to retouch. Standardization was then achieved by careful and extended retouching of flakes on an anvil.

Backed artifact production typically involved considerable investment. In some regions we know that high levels of backed artifact manufacture were associated with switches to the procurement of higher-quality lithic materials, reflecting a restructuring of economic activities. In some locations, knappers also improved material responsiveness by subjecting the rock to controlled thermal alteration. Heat treatment was often undertaken late in the production process, when the specimens

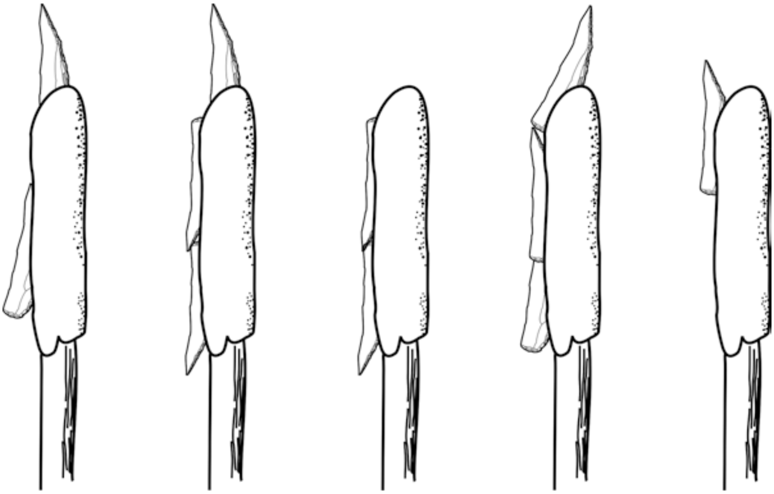

Fig. 5.2 Idealized images of possible backed artifact hafting positions, inspired by McCarthy's (1976) illustration but excluding those options which are unlikely given existing use-wear and residue evidence

were smaller, so that application of heat had a higher chance of successfully improving fracture quality of specimens. Heat-treated pieces of rock were typically knapped with care, and in many instances flake production in preparation for backed artifact manufacture involved regular and precise knapping of small pieces of stone, typically involving careful platform preparation and structured core reduction. The combination of high investment in materials and regular skillful knapping conserved material by extracting a large number of specimens per stone unit, and there may have been some degree of craft specialization involved in the organization of production. If the geographically localized patterns of standardized backed artifacts reflect localized craft traditions and practices, then we can hypothesize that those manufacturing systems reflected social structures involved with learning, such as recognized craft specialists or craft contexts involving apprenticeship learning.

The way backed artifacts were used as tools suggests similar mechanisms. Backed artifacts may have sometimes been used as tools held individually in the hand, but there is abundant evidence that many were hafted as part of composite tools. Resin residues and stains from hafting adhesives have been widely found and suggest that specimens were most commonly positioned with backed edge toward a shaft and with the sharp chord edge parallel or subparallel to the shaft. Residues and stains are typically concentrated along the backed edge, indicating that specimens were held in place by resinous compounds packed around them and encircling or partly encircling the shaft. Figure 5.2 illustrates some of the possible hafting patterns. The length of the shaft remains unknown, and it has often been presumed to be long, reflecting the widely held proposition that backed artifacts were armatures on spears, either hafted along the shaft as barbs and/or at the tip as projectile points. This use of backed artifacts cannot be entirely ruled out, and one recent review finds projectile armatures are still a plausible hypothesis (Fullagar 2016), but the weight of evidence indicates that at least in the southeast of the continent backed artifacts were commonly used on composite craft tools rather than on projectiles.

In southeastern Australia, at places such as the Mangrove Creek catchment, use-residue studies reveal that backed artifacts were primarily used for many tasks involving multipurpose cutting and slicing of both plant and animal materials but rarely as thrown spears (Robertson 2002; Attenbrow et al. 2009; Robertson et al. 2009). Many specimens have residue or wear patterns documenting that they were used for two or more purposes, indicating that the composite tool on which they were hafted was capable of being employed for diverse craft activities. This evidence compels us to abandon visions of Australian microliths as always being spear armatures and eliminates explanations that rely on that proposition, such as suggestions that they had been used as spears for large game hunting (McBryde 1974) or in individual pursuit strategies (Morwood 1986, 1987) or during periods of intensive warfare/violence (Flood 1995; McDonald et al. 2007). The early version of Hiscock's (1994) risk reduction model, which hypothesized that backed artifacts were made in regular shapes to provide easily maintainable spears that would reduce foraging risk in unpredictable environments, is also refuted by this evidence. The functional evidence we have instead reveals that backed artifacts were used to create intricate, sometimes delicate, crafts made from hide, bone, wood, feathers, and other organic materials. These items were scraped, carved, incised, and sliced. None have been preserved or recovered, and so we cannot at this point describe the kinds of craft items being constructed. However there are two possibilities to consider.

It may be that backed artifacts were being employed as a craft tool to make diverse material culture of directly utilitarian kinds: clothing, bags, hunting gear such as nets/traps, shelters, bedding, boats, and so on. If these were the goods being made, then Hiscock's (1994) risk reduction model should be reformulated to state that regular-shaped backed artifacts were produced as the edges of critical multipurpose craft tools capable of manufacturing a diverse range of utilitarian tools that provided economic advantage and acting as a buffer against foraging risk. In this model artisans maintain standardized backed artifact sizes and shapes because the regularity of artifact form assists in the maintenance of the composite tool which can be kept in a functional state.

A more likely proposition is that a proportion of the craft goods being produced were also employed as social signals, perhaps in the context of creating valued items for exchange and/or for use in performances associated with cult practices. Given the residue evidence of red ochre and feathers being used in making the composite tools, I argue that they were not only used for cutting, scraping, and sawing; they were simultaneously employed to send signals about social phenomena. The key questions for this model are why people invested in production of paraphernalia, and what mechanism was in operation that produced uniform specimens? These questions arise because it might have been possible to send social signals with a composite tool, or to use the tool to make paraphernalia that sent the signal, simply by hafting suitable unretouched flakes. Small stone artifacts hafted into a composite tool will sometimes be barely visible and, at a distance, it could be hard to distinguish a backed artifact from a simple and less costly flake. So, why invest in the production of backed artifacts?

It must have been important for members of any forager group to know that these items were produced to specified norms. This implies that there were circumstances in which there was scrutiny of the truthfulness of the signal—truthfulness being the accurate production relative to socially constructed standards. There are two mechanisms I will discuss here that are capable of maintaining production regularity across time and space. The first is the power of master-apprentice relationships to construct and maintain normative traditions of artifact production. In apprenticeship learning, there is a need for group approval: usually, the establishment of "authenticity" through public performance. Even informal guilds of craft people might apply significant stabilizing pressure on performance if reputation and exchange opportunities were dependent on meeting normative judgments (see Hiscock 2014b). A second mechanism for scrutinizing truthfulness of the signal is a physical exchange between maker and user, in which the receiver can examine the specimens in detail and comment on any departure from the expected form. This idea has been proposed as an explanation of backed artifact standardization in the Howieson's Poort industries of southern Africa, but not explored in detail, and not proposed in the Australian context (Hiscock et al. 2011). In the African context, discussions typically focus on the idea that public signaling coordinated relationships between neighboring groups, and therefore the proposed models expect that exchanges were across group boundaries, a proposition that would predict backed artifacts were often made from material exotic to the local area. Within Australia, this expectation is not generally met: backed artifacts are not typically made on materials from distant areas; instead they are often made from good-quality local rock. And so, if this process was in play, I would predict exchanges of backed artifacts were normally within group, probably between social units such as subsections.

My purpose here is not to test which of these or other stabilizing mechanisms were operating but rather to examine the paleoenvironmental contexts of the production behaviors. Thus far, I have shown that Australian backed artifacts are best characterized as being carefully made, relatively energy expensive, and locally regular in form. They were usually inserted into multipurpose composite craft tools, and in those portions of southeastern Australia where detailed functional studies have been carried out, they were used to scrape, carve, incise, and slice hide, bone, wood, flesh, and feathers; they were rarely if ever employed as attachments to thrown spears. Their major role was, therefore, in craft production of organic artifacts, which probably had both utilitarian and signaling purposes. The maintenance of a standard and distinctive form for a hard to see element in elaborate craft tools is taken to indicate that backed artifacts were socially scrutinized; their form was judged against agreed norms, perhaps in apprenticeship/guild contexts or in contexts of exchange. Investigations of why this craft production and social signaling operated can be examined by discussing the context of chronological changes in production rates.

Every region in which they are known archaeological sequences shows a single significant proliferation event, in which the production rates of backed artifacts increased substantially for a short period and then decreased to very low levels before backed artifact manufacture ceased altogether in the last millennium. Low chronological resolution makes the length of the event difficult to measure, but it is probably between a few hundred years and slightly more than a thousand years. The antiquity of the proliferation varies regionally and may generally be later in the arid zone than in better-watered continental margins. In the well-studied Sydney Basin, the proliferation occurred between 3500 and 2500 years ago, and this timing appears to apply broadly along the eastern seaboard. Archaeological examinations of why this proliferation occurred have focused on identifying the social and paleoenvironmental conditions at the time when the proliferation began. The rationale for these investigations is that context, at the time when a dramatically increased investment in construction of craft tools and paraphernalia began, is likely to provide an insight into the selective pressures operating.

Environmental Change and Its Articulation to Technology

There is evidence for climate change in the Holocene, commencing or intensifying around 4000 years ago, or slightly before that time. At this time, there was enhanced variability in rainfall and reduced precipitation related to the strengthening of the El Niño-Southern Oscillation (ENSO) system (e.g., Shulmeister and Lees 1995; Tudhope et al. 2001; Andrus et al. 2002; Koutavas et al. 2002; Lynch et al. 2007). Reductions of effective precipitation were probably mirrored in a reduction in the gross resource availability in many landscapes, diminishing carrying capacity, and increased the patchiness of resource distribution. Archaeologists have suggested that decreased productivity and heightened resource variability acted as powerful selective pressures to modify landscape use, foraging strategies, and associated technological systems (e.g., Rowland 1999; Hiscock 2006; Asmussen and McGuiness 2013). One indication of human responses to resource reductions during the Holocene may be the increased foraging for lower-ranked foods such as moths, toxic nuts, and grass seeds, a shift in foraging strategies that can be characterized as an expansion of diet breadth (see David and Lourandos 1998: 212). Reduction of procurement costs and risks through an emphasis on different technological strategies would constitute a companion response. Hiscock (1994, 2002, 2006) proposed that in the circumstance increased standardization of lithic tools would have enhanced the readiness of tools, effectively creating a partial buffer against reduced foraging uncertainty. Key tests offered for the backed artifact proliferation as a response to heightened foraging risk were (1) the multifunctionality of backed specimens (Attenbrow et al. 2009) and (2) the covariation of backed artifact production rates and climatic conditions (Hiscock 2002, 2006).

A clear but imprecise coincidence exists between the start of the period of intensive backed artifact production and the onset of an ENSO-dominated climate that involved reduced effective precipitation and increased climatic variability. An increasingly high-resolution record of climate proxies is being created by several

Table 5.1 Summary of trends in effective precipitation and backed artifact abundance for the southeastern region of Australia

Years BP	Effective precipitation	Backed artifact production
0–2000	Increasing but still variable	Low
2–4000	Low and variable	High
4–5000	Declining	Increasing
>5000	High	Very low

From Hiscock (2002)

lines of paleoenvironmental research (e.g., Black et al. 2008; Conroy et al. 2008; Petherick et al. 2013), but the cultural timeline is currently of far lower resolution, limiting analysis of the covariation in temporal phases. An example is Table 5.1, taken from Hiscock (2002). The relationship as presented shows an inverse relationship between effective precipitation and backed artifact production rates in southeastern Australia. Hiscock's interpretation was that the onset of more variable climatic conditions created a context in which resource distribution and availability were less easily and reliably mapped or predicted. Adjustments to foraging practices and social interactions were made to reduce the increased risk attached to these circumstances, and a component of the response was the increased use of craft tools containing a specific insert to produce organic craft items. When effective precipitation increased in the last 2000 years, backed artifact production rates declined as the technological system responded to other pressures affecting foragers.

The environmental changes that occurred 3000–4000 years ago were not limited to climate change. Human introduction of the dingo triggered altered faunal structures with serious implications for foragers. The effectiveness of this new high-order predator is revealed by its likely role in exterminating the thylacine from mainland Australia (Fillios et al. 2012; Letnic et al. 2012), but the really dramatic change was wrought by its impact on large and small fauna. Comparisons between modern regions, with and without dingos, indicate that the dingo would have suppressed kangaroos to a small fraction of their numbers (Fillios et al. 2010). The onset of this direct competition with human foragers created resource reductions at almost the same time as the El Niño amplification magnified the climatically driven resource decrease. While long-term climatic fluctuations of greater size had occurred in the Pleistocene, this conjunction of both climate-derived and competition-derived depression of terrestrial resources has few parallels in Australian prehistory.

Reduction of terrestrial fauna required altered foraging strategies. A shift in hunting emphasis toward smaller game may have occurred, although elements of the small mammal fauna may also have been depleted. The economic balance between hunting and gathering probably shifted, as we have evidence of increased exploitation of lower-ranked plant resources, as ENSO intensification increased subsistence risks and lowered productivity (Asmussen and McInnes 2013). Additionally, as terrestrial game availability reduced and coastal ecosystems stabilized following sea-level stabilization marine resources probably took on a significant role. In concert these multiple resource shifts would have required new economic systems that pursued the different resource structures and available biomass that were in place by around three and a half thousand years ago.

There are also claims that population increases occurred at this time. Recently such claims have been based on summed probabilities of radiometric dates (e.g., Turney and Hobbs 2006; Williams 2013), with interpretations of measureable population increase in the late Holocene. If such demographic changes were true, they occurred during a time of terrestrial resource depletion, and the economic and social reorientation already mentioned must have been capable of supplying food for significantly greater numbers of people. However, it is not clear that demographic interpretations of these data are sound, and it may be that the new economic systems yielded a new archaeological pattern without radically larger populations (see Attenbrow and Hiscock 2015). A reorganization of landscape use might translate into altered site abundance, and Attenbrow (2003) has documented shifts in the dispersal or clustering of activities and therefore in the potential number of sites/dates preserved. If there were higher densities of people in the late Holocene landscape and/or higher mobility or smaller residential group size, then burning may have become more widespread with consequences for resource availability.

The outcome of these cultural and environmental interactions was the transformation of the ecological space occupied by human foragers, with substantial changes initiated approximately 3000–4000 years ago. It was this transformed niche that provided the context for the backed artifact proliferation.

Technology and Environmental Context

Backed artifact production was emphasized during the proliferation event, in new economic and social contexts. However the backed artifacts themselves were not normally used directly as extractive tools; their role typically was for processing resources. While some of the processing may have been involved in food preparation, the primary use of hafted backed artifacts was in the construction of craft objects: things made from hide, wood, bone, feathers, etc. The objects manufactured may have been extractive tools such as wooden spears, boomerangs, throwing and digging sticks, and so on. Craft objects may have additionally been made for storage and transport of things including food, or for shelter, clothing, and other practical purposes. Such objects may all have had value in negotiating economic actions during the onset and intensification of conditions of lower and less predictable resource availability, around 3000–4000 years ago. It is additionally likely that the craft items being manufactured were providing social signals that acted to mediate human actions. David and Lourandos (1998) suggested that the stone tools such as backed artifacts acted as social mechanisms in the negotiation of territory and group composition. It is now clear that while backed artifacts may themselves have had social meaning, their low visibility allowed them to be viewed only in limited transactions between individuals. Those transactions may have been important in validating subsequent public signals and social actions, and it was the craft items (perhaps elaborately decorated) being manufactured with the backed artifacts that were being used as part of social negotiations in processes of cultural changes. Those changes were situated in a context of resource scarcity and unpredictability and may therefore have involved patterns of migration, altered territorial boundedness, and new social arrangements for resource access. The public signaling represented by this craft production, like the signaling represented by rock art, is often thought to have been used in expressing identity and in constructing and/or managing rules about access to resources (e.g., David and Lourandos 1998). Such connections of public signaling to resource use are plausible but require independent testing.

Conclusion

This niche construction framing of the relationship between ancient technology and paleoenvironment reveals how unhelpful were previous debates about whether the backed artifact proliferation was driven by "social" or "environmental" factors. No such simple dichotomy can be extracted from the evidence for the cultural and natural processes that interacted to create niches in the mid- to late Holocene. Similarly, lithic technologies were entangled in the varied processes by which people occupied those niches, technologies being widely emphasized/adopted simultaneously in response to environmental contexts and social contexts. At least some elements of technological change in Australia over the last few millennia are clearly synchronized to paleoenvironmental transitions, and yet the mechanisms which sync technology and environment were not direct or simple. The intensified use of microliths, backed artifacts, in the Holocene of southeastern Australia reflects an emphasis on the production of craft objects, for acquisition/processing of resources and for conveying social information in changing times.

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