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Pattern and Context in the Holocene Proliferation of Backed Artifacts in Australia

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ABSTRACT

Australian backed artifacts appear in the terminal Pleistocene but "proliferate" to become the dominant retouched form in the southeast of the continent only in the mid-Holocene. This change was triggered by the onset of an ENSO-dominated climatic pattern 4,000 to 5,000 years ago, and increased backed artifact production was one of a number of strategies that reduced risk during the mid-Holocene. Adoption of technologies featuring standardized kinds of artifacts was advantageous at that time, but the parallel response of the different technological systems in southern and northern Australia reveals historical contingency in the evolutionary trends.

A major quest for Australian archaeologists is to understand the "proliferation" of typologically regular and finely made flaked implements during the mid-Holocene. This proliferation consists of an increased rate of production of those implements in many regions across the continent. In an earlier attempt to explicate this process a model proposed that mid-Holocene exploitation of the landscape involved significant risks, and the adoption of particular toolkits assisted in reducing risk (Hiscock 1994). That model dealt with the possible connection between the three most widespread implement types (points, backed artifacts, and tulas) and increased risk associated with environmental change, high mobility, and colonization of previously unoccupied landscapes. In this chapter aspects of the proliferation of backed artifacts in Holocene southeastern Australia are examined further and a simple cultural-selectionist model presented as a means of advancing that risk-response hypothesis. By emphasizing selection as the mechanism responsible for differential persistence of cultural traits, such a model provides a powerful framework for understanding the effects of changing environmental contexts on assemblage variation through the effects of different technologies and assemblages on the success of individuals (Bamforth and Bleed 1997; Dunnell 1980; O'Brien and Holland 1990).

A review of the temporal distribution of backed artifacts reveals they existed in southeastern Australia for thousands of years before the mid-Holocene, when knappers began to produce them in extremely large numbers. As a consequence the proliferation of backed artifacts in mid-Holocene Australia cannot have been caused by the invention/importation of either the idea of a new type of tool or a specialist technology with which to manufacture it. Instead, the mid-Holocene increase in backed artifact production is explicable as one of a number of strategies that acted to reduce risk at that time. The factors inducing risk are probably numerous, but one was the initiation of a drier and more variable climate. It will be argued that in that context the production of backed artifacts was given new emphasis as a means of creating abundant standardized and maintainable stone artifacts that were beneficial in reducing risk incurred by environmental uncertainties.

Microliths or Backed Artifacts?

This chapter discusses what I will call *backed artifacts,* which are flakes with steep retouch along one or more margins. Their distinguishing feature is the near 90-degree retouch that was often accomplished with the use of bipolar techniques on an anvil. This "backed" surface often contains bidirectional scaring, and the "backing" retouch sometimes removes the platform and/or distal end of the flake.

In Australia the term *microlith* has now been abandoned, for reasons Hiscock and Attenbrow (1996) explore. This is not a trivial issue of regional preferences in terminology, but a reflection of the classificatory constructions upon which our models are founded. One researcher to appreciate this issue is Hallam (1985), who expressed concern that the archaeological problems of assemblage variation being examined may merely be "a non-problem, a construct of semantic usage." She suggested that in the 1970s Australian archaeologists were using the term *microlith* as a label for particular kinds of backed blades, while outside Australia it was backed blades that were seen as a particular variant of microliths. The incompatibility of categories revealed by Hallam encourages an examination of the nature of relevant antipodean classifications.

Etheridge and Whitelegge (1907) are credited with the identification of flakes with steep backing retouch. They called their specimens "chipped-back surgical knives," emphasizing a functional terminology for an artifact they inferred to have acted as a "surgical lancet." In their discussions Etheridge and Whitelegge reveal three characteristics of the objects they recovered from Bondi and Maroubra beaches in Sydney that were employed in classifications throughout the twentieth century:

• The plan shape of these objects was distinctive, with specimens being markedly asymmetrical, typically with one rounded end and one pointed end (see Figure 11.1).

• They were small, ranging in length from 10 to 50 mm (Etheridge and Whitelegge 1907:239).

• Specimens displayed one lateral margin that was steeply retouched and that Etheridge and Whitelegge described as a "delicately carved back."

The first of these characteristics, plan shape, was employed in a number of classifications, both to distinguish these items and to divide them into subclasses. Kenyon (1927), for example, claiming that Etheridge and Whitelegge's functional ascription was erroneous because many specimens were "without a cutting edge worthy of such a description," subdivided these forms into shape categories such as "crescents" and "points." In later classifications, most influentially that of McCarthy et al. (1946), distinctions on the basis of symmetry were maintained, with symmetrical ones being termed *microliths* (such as "geometric microlith") and the asymmetrical ones labeled *points* (such as "bondi point"). This is the usage of the term *microlith* to which Hallam (1985) was referring; a usage that separated technologically similar items into typologically different groups and in which asymmetrical variants were seen to be closer to bifacial points than "microliths." Because "microlith" in this sense was too exclusive a category it complicated the analysis of space-time patterns in backed objects, and the term has fallen from favor during the past two decades.

A very different classificatory custom has been the use of size as the key criterion for differentiating some types of implements. The most obvious example of this is the literal reading of "microlith" as small stone artifacts, of any regular form, even if not backed (e.g., Gould 1968). Other terms in use in the early decades of the century, such as "pygmy implements" (Turner 1932), also emphasized size as a variable of overwhelming importance. Numerous researchers condemned this usage of "microlith" as being too inclusive a category to isolate

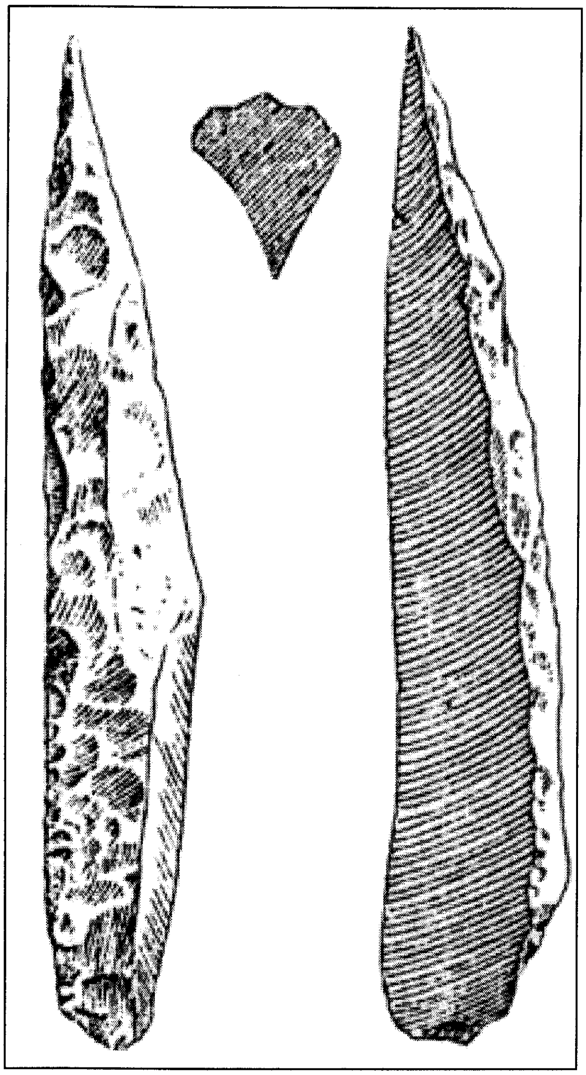

Figure 11.1. Examples of backed artifacts published by Etheridge and Whitelegge (1907) as "chipped-backed surgical knives." No scale available.

the space-time patterns of distinctive points and backed flakes (e.g., Glover and Lampert 1969; Hallam 1985; Mulvaney 1985). In classificatory terms size alone fails to isolate any category of retouched flake that conforms to a conventional implement type (as per McCarthy [1967] or similar analysis). Furthermore, small size is not a good chronological marker since we now know that small retouched flakes are common throughout Australian prehistory, as illustrated by McNiven (1994, 2000). One solution to this observation is to focus the classification on a trait other than size, such as the presence of the backed margin.

Systematic use of the term *backed blade* for specimens containing steep retouch to a lateral margin was proposed by Richard Wright and widely adopted (Mulvaney 1985:211). The immediate benefit of this terminology was that it isolated an accepted typologically distinct grouping that appeared to possess well-defined space-time distributions (Mulvaney 1985; Pearce 1974) while uniting backed specimens of a variety of shapes (Pearce 1973). In many publications the term *backed blade* therefore replaced *microlith* in the early 1970s as a means of emphasizing backing rather than size as the defining characteristic. *Backed blade* has now been rejected in favor of the term *backed artifact* because *backed blade* conveyed the unfortunate connotation of a specialized blade technology (see below).

The importance of this terminological change has been to reveal patterns hidden by the original emphasis on size. For instance, it is true that the two major subcategories of backed artifact traditionally recognized (the "bondi" and "geometric" forms) contain specimens that are often small, averaging 23 mm in length (N = 1,300), with the vast majority of specimens being less than 35 mm. But it is clear that not all specimens within those conventional categories are small, as there are specimens in excess of 60 mm. Even larger specimens, technically the same, were hidden by classifications that labeled them as other implement types, such as "Juan knives" or "Eloueras" (see Figure 11.2 for an example). All of these typologically different classes containing flakes backed on one margin can be subsumed under the single category of "backed artifact," even though in some regions and in some time periods they may be relatively large (up to 190 mm in length). Consequently the reexpression of terminology, from *microlith* to *backed artifact,* has encouraged a refocusing of attention from small size to standardization of size and shape. The question now being addressed is therefore not simply about a chronological trend to artifacts of smaller size but why, at a

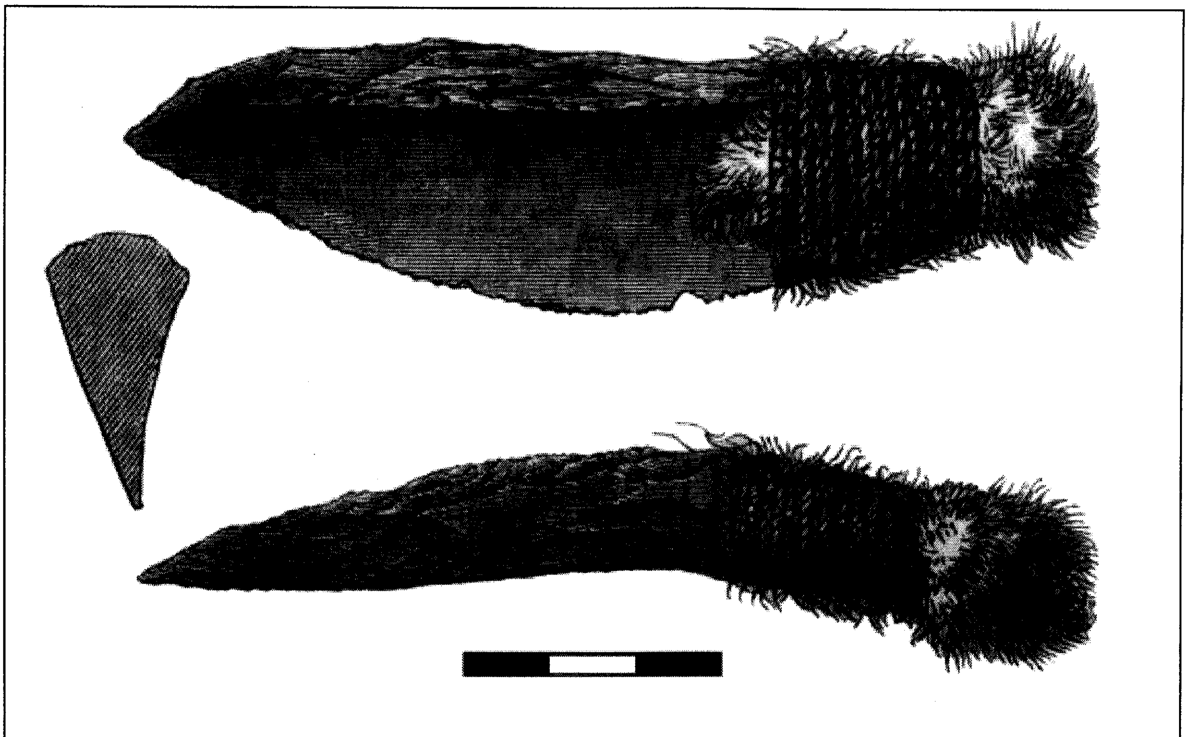

Figure 11.2. Large asymmetrical backed artifact traditionally called a Juan knife (from Evans 1872:264). Scale in centimeters.

particular time in the prehistory of Australia, production and use of regular backed artifacts was dramatically emphasized by foragers.

The Non-Association of Backed Artifacts and "Blade Technologies"

One of the main notions that has impeded investigations of backed artifact proliferation in Australia is that the regularity of implement form reflects the use of a specialized "blank" produced by a "blade technology." This idea is revealed in a number of different ways. Most blatant are those synthetic articles that imply the spread of "microliths" and a blade technology to Australia (e.g., Foley and Lahr 1997; Mellars 1989). Such arguments link blade production and "microlith" production in Australia, even though no such connection has been demonstrated (see Hallam 1985). They suggest that the nature of Middle to Upper Paleolithic technological changes in Europe finds a parallel in Australia, an idea that has been explicitly toyed with even in recent decades (e.g., Jones 1977). Such parallels have been explained by some authors as a result of diffusion of technology/knowledge into Australia from the Old World, perhaps along with the dingo and even social structures. I (Hiscock 1994) have provided an extended discussion of the effect of these diffusionist arguments on explanation of the proliferation of backed artifacts.

It is curious that such arguments persist inasmuch as it has long been argued by Australian archaeologists that many backed artifacts were not made on blades. For example, in discussing specimens from the western side of the continent Hallam (1985:219) concluded:

> The set of Australian objects to which the term "backed blade" is applied comprises, in the main, pieces which were *not* blades before the process of blunting or backing was applied, though some have acquired blade-like proportions during the process of secondary retouch.

Similar conclusions have been drawn by researchers working in central and eastern Australia (e.g., Dickson 1973, 1975; Gould 1977). In an early overview of backed artifact patterning Mulvaney (1985:213) also separated the observation of backed artifacts from the inference of blade "blanks," saying,

> "Backed blade" is often a misnomer, for most artefacts are better termed backed flakes. Yet true blade cores and thin blades and bladelets also occur widely.

It is possible to conclude that although "thin blades and bladelets" may be found in many assemblages they do not derive from a blade technology that was introduced into Australia during the mid-Holocene (see also Gould 1977:85; Hiscock 1993). This conclusion has the effect of disconnecting the process of producing backed artifacts from the phenomenon of a knapping system geared to produce blades, at least in Australia. The argument that no blade technology appears in the Holocene has been delivered elsewhere (Hiscock 1993), but a couple of generalizations will illustrate the evidence for this conclusion:

1. Flake elongation varies little through time and space; indeed it varies more with raw material. In eastern Australia modal length/width indices are almost always between 0.5 and 1.5, throughout both the Pleistocene and Holocene, and the percentage of flakes, in most assemblages, with length/width indices greater than 2 is below 15 to 20 percent in all time periods (Hiscock 1993).

2. Backed artifacts are not segments of "blades," but are made on any flake that has an appropriate cross section and one straight or gently undulating margin of sufficient length. The unretouched chord is often the distal end of a short, wide flake, and in some instances even one with a hinge termination (Lamb 1996:154–155).

Uncoupling the production of backed artifacts from the systematic production of blades makes it necessary to draw two conclusions:

1. Standardized sizes and shapes of Australian backed artifacts are created by careful retouching of flakes on an anvil, and although the process may have been assisted by the production of flakes with regular shapes it did not depend on these flakes.

2. Since a blade technology is not associated with the manufacture of backed artifacts there is no need to invoke the importation of such a technology to explain the production of backed artifacts in the Holocene. The production of short but regular flakes, the delicate retouching of flakes, and the use of bipolar techniques are all aspects of knapping present during the Pleistocene (see McNiven 1994, 2000). Hence the initial production of backed artifacts involved combining a set of preexisting knapping procedures; no new knapping techniques needed to be introduced or invented before people could make backed artifacts.

The implication of these conclusions is that a model of the time-space patterns in Australian backed artifacts must incorporate mechanisms that explain why previously existing technological components were given greater emphasis during the Holocene, rather than seeking the introduction of some new technology as a magic bullet with which to explain away complex changes in the archaeological record (see Hiscock 1994). New information about backed artifact patterning through time in southeastern Australia reinforces this view.

Space and Time Patterns within Australia

Backed artifacts are found across most of the continent (Figure 11.3), but appear to be absent from the northwestern regions of the Kimberley and Arnhem Land as well as Tasmania and New Guinea (see Smith and Cundy 1985). In those portions of mainland Australia where backed artifacts occur, spatial variation in their morphology has long been acknowledged (e.g., Glover 1967; Mitchell 1949; Pearce 1973). This variation has usually been depicted in terms of symmetry in plan shape using the conventional division between symmetrical and asymmetrical forms. The following discussion of chronology is restricted to the southeastern portion of mainland Australia.

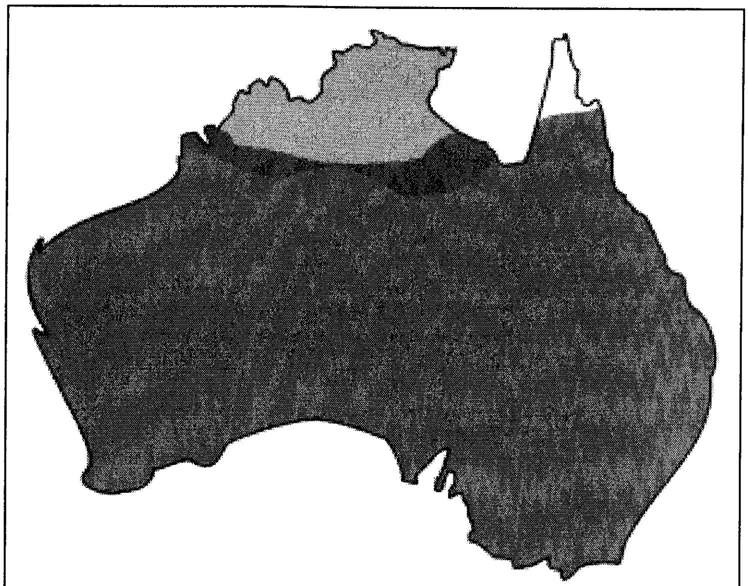

Figure 11.3. Distribution of backed artifacts and bifacial points across Australia.

At least on the eastern seaboard some backed artifacts have been reported from contexts older than 5,000 B.P. (see Hiscock and Attenbrow 1998). Hence we can state that backed artifacts began being made in the terminal Pleistocene or early Holocene, but in many regions were not manufactured in large numbers until after about 4,000 years ago. This argument was originally developed by Pearce (1974) but has had few supporters until recently (although see Dortch 1975; Hiscock 1994; Hughes and Djohadze 1980; Mulvaney 1985). All doubt about the existence of early Holocene backed artifacts in southeastern Australia has now been dispelled with the demonstration of specimens that certainly predate 5,000 B.P. and are most likely to be 7,000 to 8,000 years old (Hiscock and Attenbrow 1998). These early Holocene backed artifacts are recovered in low numbers and were manufactured infrequently. Most dated specimens are between 4,000 and 1,500 years old, and it is obvious that intensive production of backed artifacts occurred at that time. During the past millennium backed artifacts were still being manufactured, although infrequently (Hiscock 1994; Syme 1997; White and O'Connell 1982). Some researchers have argued that backed artifacts were only manufactured between 4,000 B.P. and 1,000 B.P. (e.g., Bowdler and O'Connor 1991; Johnson 1979; White and O'Connell 1982), but these notions are now known to be an incorrect reading of the record (Hiscock 2001; Hiscock and Attenbrow 1998). However, it does appear to be true that high rates of backed artifact production occurred between 4,000 B.P. and 2,000–1,000 B.P., while at earlier and later times production rates were substantially lower.

An illustration of this trend is the sequence of backed artifacts recovered from Mussel Shelter in eastern New South Wales (Figure 11.4). At this site the lowest backed artifacts were recovered from a level estimated to date to 7,500 years B.P., but from then until 4,000 to 3,500 years B.P. the discard rate (and by implication the production rate) was 0.23/100 yr/m^2. From approximately 3,500 B.P. until 2,500–2,000 B.P. the discard rate for backed artifacts at Mussel Shelter was several orders of magnitude higher at 50/100 yr/m^2, after which rates decline to about the same level as previously. Similar trends have been widely documented, although with minor local and regional variations in the timing of the onset of higher production rates.

It is worth emphasizing two points about the onset of higher production rates between 4,500 and 3,500 years ago. First, this characterization appears to be broadly applicable across many portions of southern Australia (see Mulvaney 1985), despite the typological and environmental differences that exist in such a large area. This suggests that while a multicausal view of factors underlying the proliferation of backed artifacts in so many

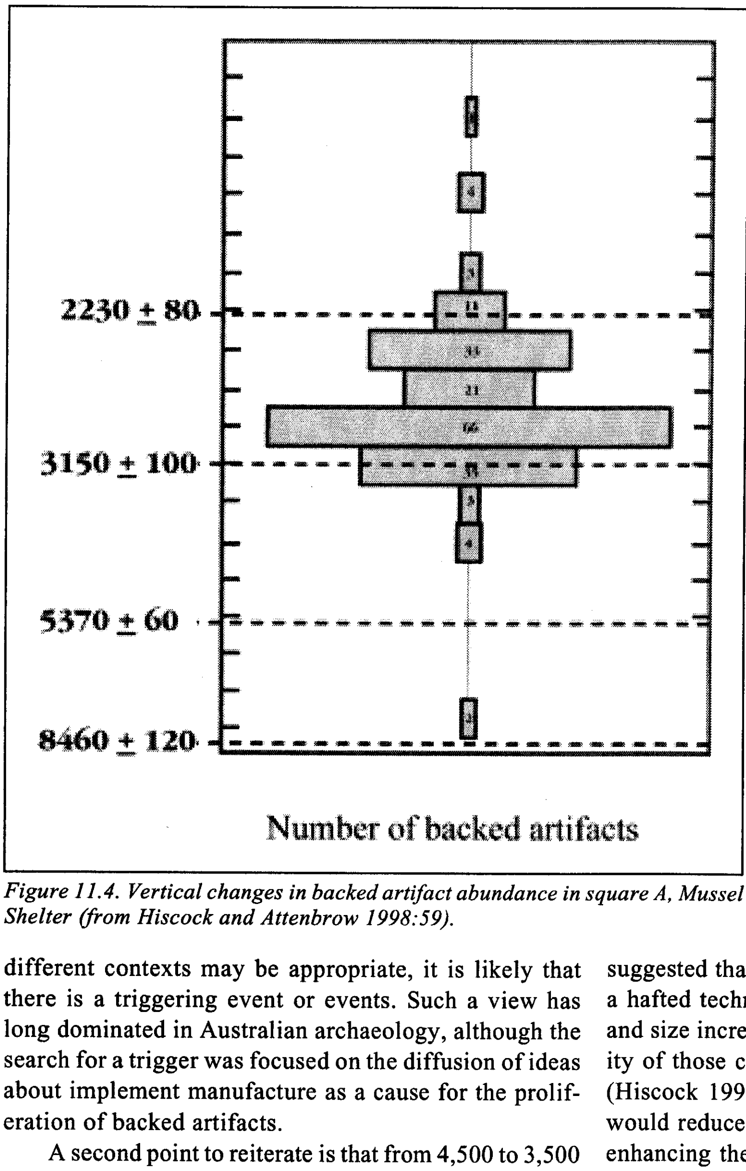

Figure 11.4. Vertical changes in backed artifact abundance in square A, Mussel Shelter (from Hiscock and Attenbrow 1998:59).

different contexts may be appropriate, it is likely that there is a triggering event or events. Such a view has long dominated in Australian archaeology, although the search for a trigger was focused on the diffusion of ideas about implement manufacture as a cause for the proliferation of backed artifacts.

A second point to reiterate is that from 4,500 to 3,500 years ago, when Australian backed artifacts "proliferate" (i.e., display an increased production rate), that class of retouched flake had already been manufactured and discarded for thousands of years. In cultural selectionist terminology this pattern is clearly one in which the generation of typological/technological variation is independent of, and substantially predates, the emphasis on backed artifacts in the mid-Holocene. And clearly the reasons that backed artifacts were selected as a preferred item of technology in the mid-Holocene need not relate to the functions that made the form attractive when it was initially adopted/invented. Consequently it is inappropriate to attempt to explain the proliferation of backed artifacts by reference to either the invention or the initial introduction of this technological practice into Australia, as has been done so frequently in Australian archaeology (see discussions in Bowdler 1981; Dortch 1981; Mulvaney and Joyce 1965). Howsoever researchers choose to explain the initial appearance of backed artifacts in Australia (external introduction or local invention), it is necessary to seek an explanation for the mid-Holocene proliferation of these forms in terms of their selection as a response to circumstances being encountered at that time. This principle leads me to consider the context, from 4,500 to 3,500 years ago, in which that selection took place.

Backed Artifacts and Risk

One connection between temporal variations in risk and the widespread mid-Holocene emphasis on backed artifacts might be revealed by the argument that such implements were easy to transport, were multifunctional, and would be preferred in circumstances of increased uncertainty in exploiting the environment (Hiscock 1994). Furthermore, it is suggested that these artifacts were often components of a hafted technology and that their uniformity of shape and size increased both the maintainability and reliability of those composite tools of which they were a part (Hiscock 1994:277–278). The use of such implements would reduce the chance of failure during foraging, by enhancing the "readiness" of the toolkit, and therefore act to reduce subsistence risk. Risk in this model includes both "failure probabilities" and high "failure cost," although Bamforth and Bleed (1997:116) correctly diagnose that the emphasis is on the former aspect, simply because at this stage the costs of failure are poorly known.

It is now clear that the phenomenon to be explained is the proliferation of backed artifacts and that this represents a selection of that form rather than other implement forms for the tasks at hand. If the environmental and social contexts of mid-Holocene Australia were transformed in such a way that the production and use of backed artifacts was more advantageous than the production of other artifact forms then we might expect backed artifact production to be emphasized. I have suggested both greater mobility and uncertainty in resource procurement to be contexts in which backed artifact production would be beneficial (Hiscock 1994).

I have previously described two situations involving uncertainty in resource acquisition that might have arisen during the mid-Holocene (Hiscock 1994): when hunter-gatherer groups colonized unknown landscapes, and when environmental change reduced familiarity with resources. The former mechanism has now received support from linguistic evidence of Pama-Nyungan expansion across large tracts of Australia, particularly desert central Australia (McConvell 1996), and given the strong covariation between the distribution of Pama-Nyungan languages and backed artifacts it seems possible that we may be looking at multiple migrations of backed artifact–using groups during the Holocene (see McConvell 1990). There is both genetic and archaeological evidence for colonizing/recolonizing events in central Australia (McConvell 1996). However, there has been debate about the interpretation of the evidence, with Mulvaney and Kamminga (1999:266) denying a linguistic spread while others accept it but hypothesize it does not reflect movement of people (e.g., Evans and Jones 1997).

Unfamiliarity with resources arising from the colonization of landscapes is a mechanism that I (Hiscock 1994) emphasized as a setting in which technological strategies that reduced the chance of foraging failure would be highly advantageous. Since it is unclear how much of the Pama-Nyungan expansion involves migration and population displacement, it is not clear whether that mechanism was overemphasized. But it is increasingly clear that the notion of increased risk related to environmental change was given neither adequate emphasis nor an appropriate direction. The emphasis was inadequate both because it seems likely that many groups were not moving to new landscapes and because large-scale geomorphic change of the kind cited (Hiscock 1994:282) was localized.

The search for environmental contexts that explain the mid-Holocene proliferation of backed artifacts need not be focused on rapid, continuous, and massive environmental change. More likely the conditions evoking this response involved an increase in the level of environmental variability (see Rowland 1999). Even relatively small changes in climatic variation could make prediction of resource availability much more difficult for foragers. Recent paleoenvironmental studies describing temporal changes in the El Niño Southern Oscillation phenomenon have given this mechanism new life as a trigger for the onset of contexts containing heightened risk.

In reflecting on the nature of risk in Holocene Australia, David and Lourandos (1998:212) argue for a consideration of social decisions as an integral part of both the construction of risk and the selection of responses to risk, saying,

> We suggest here that risk-management strategies that may have emerged during the late Holocene to cope with more patchy conditions, as argued by Hiscock (1994) to explain the advent of new, specialized stone tool types, should be considered in such a context of *effective* (that is, socioculturally-mediated) rather than purely "natural" environmental patchiness—that is, territoriality itself constructs patchiness.

Of course at one level this comment is undoubtedly correct, since it must be true that at least some components of risk may be induced, or at least negotiated, through social mechanisms. For that reason I (Hiscock 1994) followed Torrence (1983, 1989) in acknowledging that even some long-term risks may be a consequence of the organization of hunter-gatherer groups. Indeed, group composition, and the character of territorial boundaries and intergroup relationships, constraining as they do access to resources, have been seen as important factors in risk-minimizing strategies in Australia (e.g., Gould 1991). It could even be that components of a toolkit, such as backed artifacts, reduce risk by acting as symbols in the negotiation of resource rights within and between groups. Nevertheless, the connection between the emergence of compartmentalized cultural landscapes (as proposed by David and Lourandos [1998]) and the mid-Holocene proliferation of backed artifacts is ambiguous for two reasons. First, the regionalization/territorial restructuring that David and Lourandos (1998) discuss in northeastern Australia may have begun around 3,5000 B.P. but it was most apparent in the past 2,000 years and therefore occurred most intensively during the phase of declining backed artifact production. Second, and more important, the explanation offered by David and Lourandos (1998:211) for the emergence of new territorial systems is these systems' capacity to maintain population levels in spite of the drier climatic conditions of the middle to late Holocene. Hence, even David and Lourandos imply that if a changed structure of territoriality is involved in creating/managing risk it is a mechanism that is mediating environmental uncertainty. It therefore remains desirable to explore some of the dynamics of climatic variation in Holocene Australia.

El Niño Southern Oscillation

El Niño is a term describing interannual variation in oceanic and atmospheric circulation across the tropical Pacific (Allan et al. 1996; Enfield 1989; Rowland 1999; Trenberth 1996; Webster and Palmer 1997). At the start of an El Niño event trade winds weaken and the warm surface waters that are normally pushed into the western Pacific move eastward toward the central Pacific. The result is that ocean temperatures in the western Pacific are lower than usual, very little moisture is picked up from colder ocean surfaces, and cool dry air is descending, resulting in much-decreased rainfall.

Changes in sea surface temperature indicative of the El Niño phenomenon are linked with a change in atmospheric pressure known as the Southern Oscillation, and these ocean-atmospheric interactions are collectively labeled the El Niño Southern Oscillation, or ENSO. Today El Niño events typically last about 12 to 18 months, but their duration and structure are highly variable. Oscillations in the ENSO system have a periodicity of roughly three to seven years between El Niño events, but this too is extremely variable. Models of the ENSO phenomenon using historic data reveal a complex positive feedback system in which the progress of each El Niño event differs in detail from other events, in terms of factors such as the rate of onset and decline and the magnitude of the event (Trenberth 1996:168). Furthermore, the severity and nature of effects produced by broadly similar El Niño events also vary in detail. Consequently the ENSO phenomenon during the past 100 years can be characterized as extremely variable and difficult to predict.

El Niño–induced drought across Southeast Asia, Indonesia, Papua New Guinea, and northern, central, and eastern Australia is the most obvious effect of the ENSO mechanism. Historically these droughts have been both prolonged and severe, with annual rainfalls typically as much as 45 percent below the long-term average. When such conditions are regularly repeated and/or extend for lengthy periods it is easy to imagine that the availability of bush foods, both plant and animal, may be greatly diminished, particularly in a landscape with a low carrying capacity (see Webb 1998). Secondary consequences of such rainfall anomalies may include increased bushfire prevalence, changes to the homogeneity/patchiness of resource distributions, and alteration of erosional regimes.

Other environmental effects have also been historically observed. For example, Allan et al. (1996:67) document that El Niño events are accompanied by lower than normal sea level in the western Pacific–Indonesia region, which can result in widespread coral bleaching and death. Cyclone frequency and intensity may also be associated with these changes, although the nature of the association is not clear.

ENSO events are not new, and historical records (e.g., Godley 1998) suggest they have been a feature of weather and climate for thousands of years. However, there is growing evidence that these ocean-atmospheric interactions have varied in frequency and intensity through time and that the structure of this variation is an important factor in changing environmental conditions during the Holocene.

Of particular interest in the context of this chapter are those paleoenvironmental investigations that have concluded that an ENSO-dominated climate became established across large tracts of Australia for a portion of the Holocene (Shulmeister and Lees 1995; see also McGlone et al. 1992; Markgraf et al. 1992; Singh and Luly 1991). The connection between Effective Precipitation (EP) and ENSO is demonstrated in historical datasets covering 100 years, in which rainfall and Darling River discharge are strongly correlated with the Southern Oscillation Index (Whetton et al. 1990). Drawing upon geomorphic and palynological indicators of EP, these researchers suggest EP increased throughout the early Holocene, to plateau at a high about 5,000 years B.P. ENSO events are not documented prior to this date. After that time the onset of a dominant Walker Circulation and ENSO is observable in two ways. First, a significant decline in EP has been identified in widely separated localities of northern, central, and eastern Australia. Second, between 5,000 and 2,000 B.P. there is an increase in climatic variability. Additionally, there are suggestions of a south-north trend in the onset of this low EP phase, with the initiation at roughly 5,000–4,500 years B.P. in southern Australia and somewhat later (4,000–3,800 B.P.) in northern Australia (Shulmeister and Lees 1995). During the past 2,000 years EP increased again and variability in rainfall is reduced although it remains observable.

This overview of climatic trends is obviously generalized, and certainly not all paleoenvironmental syntheses concur with the summary provided above (see, for example, Ross et al. 1992). Nevertheless, the onset of an ENSO-dominated period in the mid-Holocene is a model gaining popularity and provides an image of Holocene environmental change that makes for an intriguing comparison with archaeological trends. These climatic models of reduced EP in the mid-Holocene, and the linkage of this change to environmental variability associated with ENSO, may be tentative, but if they withstand future investigations they offer an exciting framework for explaining the proliferation of backed artifacts.

The Covariation of ENSO and Backed Artifacts

A strong coincidence appears to exist between the start of a period of intensive backed artifact production and the onset of an ENSO-dominated climate that involved reduced EP and increased climatic variability. Table 11.1 summarizes the broad chronological relationship between climatic trends, drawn largely from the Shulmeister and Lees (1995) interpretation, and the archaeological trends, as synthesized here. This summary undoubtedly glosses over uncertainties and regional variations, and those complexities deserve attention in another forum. However, even acknowledging that the environmental-cultural connection will ultimately prove more complex, and intriguing, the observation of these trends provides an opportunity for thinking about the environmental context of technological selection in Holocene Australia.

In light of this I offer the following model, which posits that broad chronological trends in backed artifact production may well reflect one cultural response to environmental changes, in particular, a response to risk incurred by increased environmental variability. The mechanism proposed here is not intended to be the sole explanation for those archaeological trends, but adds to the earlier factors discussed in modeling of technological risk response in the Australian Holocene (Hiscock 1994).

Between 4,000 B.P. and 5,000 B.P. broad regions in southern Australia began to suffer drier and more variable climatic conditions. This created a context in which resource distribution and availability were less easily and reliably mapped or predicted. This change occurred at a time when population size in many regions was either steady or slightly increasing, when at least some human groups were moving into new landscapes, and when consequences of sea level rise were ongoing. A number of adjustments to foraging practice, and perhaps organization and interaction, were made to reduce the increased risk attached to these new circumstances. One widespread adjustment was that a preexisting implement form, the backed artifact, began to be produced at far higher rates. This class of object is hypothesized to have been a component of a toolkit that reduced foraging risk, because of the tools' characteristics of versatility, reliability, and maintainability (see Hiscock 1994). Individuals and groups employing this technology may have been advantaged, providing a mechanism for the proliferation of that behavior. The degree of emphasis on the production and use of backed artifacts varied through both time and space in response to (a) the level and nature of foraging risk, (b) the cost-benefit of this technological response relative to other available technological strategies, and (c) the relationship between stoneworking technology and the other risk-response adjustments being made. When EP increased in the past 2,000 years, backed artifact production rates dropped away dramatically as the technological system responded to other pressures affecting foragers.

Table 11.1. Summary of trends in effective precipitation and backed artifact abundance

Years B.P.	Effective Precipitation	Backed Artifact Production
0–2,000	Increasing but still variable	Low
2–4,000	Low and variable	High
4–5,000	Declining	Increasing
>5,000	High	Very low

The idea that increased risk of foraging failure may have been partly countered by reorganizing the role of stone artifacts in foraging need not imply they were the sole or even the dominant response to this increased risk. Nothing discussed above limits risk-reduction responses to the emphasis on a technological activity such as backed artifact production. A number of changes to food-procurement strategies are recorded:

• During the mid-Holocene many foraging strategies display an expansion of diet breadth (David and Lourandos 1998:212). Claims for intensive exploitation of previously unused taxa, such as moths (Flood 1980) or toxic nuts (e.g., Beaton 1982), have been the centerpiece of many discussions of dietary change, but more subtle increases of faunal richness have also been documented in the mid-Holocene. For example, Sim (1999:267) advances the argument that resource switching and diet breadth change in Tasmania 3,500 to 4,000 years ago are linked to the ENSO onset (see also Allen 1979; Sim 1998).

• Methodological concerns of Gorecki et al. (1997) notwithstanding, seed milling grindstones only became common across much of the Australian arid zone between 4,000 and 2,000 years ago, also signaling a dietary expansion to incorporate lower ranked but more reliable grass seeds as a major food resource (see Smith 1986).

• Veitch (1999) argues that exploitation of molluscs displays a pronounced shift to targeting of r-selected taxa starting in the mid-Holocene. He argues that these taxa are more resilient to both environmental fluctuations and over-predation by humans.

All of these shifts in resource use represent the emphasis on strategies that are comparatively robust in the face of environmental variation as well as increased pressure on the resource base through population increase and/or reduction of territory size. These changes would have functioned to reduce foraging risk. Altered foraging strategies and emphasis on more standardized and presumably more reliable and maintainable technological systems, as well as the likely colonization of little-used landscapes, are all aspects of risk-reduction mechanisms accentuated in the mid-Holocene.

At this juncture it is useful to comment on one recent criticism leveled at my (Hiscock 1994) original construction of a risk explanation, as a means of explaining aspects of these mid-Holocene modifications of human behaviors. The critique reads in part:

> The assumption that it would have taken hunter-gatherers thousands of years to become familiar with a region's resources recalls Sandra Bowdler's "coastal colonisation hypothesis," in which coastal-adapted populations were incapable of inhabiting the interior of Pleistocene Sahul. Both hypotheses ignore the ability of hunter-gatherers to master new environments with simple technology. They draw upon principles of animal biology, overlooking the reality of human inventiveness and adaptability in overcoming obstacles. (Mulvaney and Kamminga 1999:266)

This criticism fundamentally misunderstands, and misrepresents, risk-reduction models of the kind being discussed here. To begin with, it is a curious inconsistency in an argument championing "human inventiveness" that Mulvaney and Kamminga are unable to recognize a technological strategy that reduces risk as a remarkable way in which humans have overcome obstacles. That paradox is compounded by the inappropriateness of basing the criticism on a view that hunter-gatherers "master" environments quickly, since we know no such thing for the mid-Holocene of Australia; indeed, the rate with which groups restructured their activities at that time to cope with new environments is one of the questions being addressed. In contexts of high environmental variability it is conceivable that the development of new technological and subsistence strategies could be an extended process. Furthermore, the idea that a risk-reduction model implies that people took thousands of years to become "familiar" with resources fails to acknowledge environmental fluctuations of different scales. Mulvaney and Kamminga imply that there is no need for technological solutions to risk because aboriginal knowledge of the landscape is adequate. Trapped at an ethnographic scale this argument does not allow either for the differences between historic and mid-Holocene environments or for environmental variations at a scale beyond a few months or years that constitute the ethnohistoric image of Australia. The possibility of larger-scale variations not observed each year or even each generation had prompted me (Hiscock 1994:276) to write that "some risk reduction strategies are permanently in place, even though the benefits of that strategy may be only occasionally realized." But, in any case, there is nothing in the model offered here that implies the technological responses to risk were required for the entire period in which backed artifacts were produced at high rates. A technological response to even short periods of high risk might become integrated into the structure of the overall technology. This is because the intensive production of items such as backed artifacts did not operate in isolation, but would have been articulated into the system of procurement, transportation, and general reduction of siliceous rocks (see Hiscock 1993). Hence even when the level of foraging risk declined, the risk-reducing technological strategy may well have endured, since "those technologies will continue to function effectively for many tasks, and may have even become incorporated in traditional patterns of behaviour" (Hiscock 1994:284). It is not the diminution of foraging risk that is responsible for the late Holocene decline in backed artifact production, but the onset of new environmental and social contexts, involving factors such as sedentism, territoriality, and population increase, that has a more potent effect on the selection of appropriate technology (see discussion in Hiscock 1994:284–286). This might explain Bellwood's (1997:134) observation of the uncoordinated pattern of declining backed artifact production in the late Holocene (see also Mulvaney 1985).

Implications: Contingency in Mid-Holocene Responses

If this model is correct, the onset of the ENSO-controlled climate was one factor acting to increase foraging risk in the mid-Holocene, and the increased production and use of backed artifacts, perhaps as part of a composite toolkit, was one response to the new context. Models of this kind are often derided with an accusation of being "deterministic," but in reality cultural selectionist arguments such as this contain no determination of response. As discussed here and noted by others (e.g., David and Lourandos 1998; Gould 1991) there are nontechnological responses to contexts of greater foraging uncertainty, which may complement or be alternatives to a technological response. However, even in terms of technological responses there are alternatives, and the reason that one technological strategy is employed rather than another may arise from the historical developments occurring within each group of foragers.

An outstanding example of contingent processes is visible in Australia. Of the major categories of implement types recognized by Australian typologists two are of interest here: bifacial points and backed artifacts (see Hiscock 1994). Bifacial points are found in the northwest of the continent, overlapping only to a small extent with the generally more southerly distribution of backed artifacts (see Figure 11.3). While the manufacturing sequences and the final form of these two classes are distinctly different, they share a number of properties, including having standard shapes, being small and easily transported, suitable for hafting and multifunctionality, and suitable for constructing readily maintainable composite tools. And intriguingly, bifacial points in the well-studied area of western Arnhem Land display a chronological trend very similar to that discussed here for backed artifacts. In that region bifacial points become archaeologically visible in low numbers between 7,000 and 5,000 B.P., but points are only produced at very high rates from 3,500–3,000 B.P. until 2,000 B.P., at which time production rates decrease dramatically (see Hiscock 1999 for details). This proliferation of bifacial points can be explicated using a model similar to the one presented here for backed artifacts: drier and more variable climatic conditions related to the onset of ENSO increased risk attached to foraging practices, and one of a number of adjustments to these new circumstances was that a preexisting implement form, the bifacial point, was produced and used at higher rates because its characteristics of versatility, reliability, and maintainability reduced foraging risks (see Hiscock 1994). Note that the timing of this proliferation of bifacial points appears to be 500 to 1,000 years later than the proliferation of backed artifacts in regions farther south. This offset coincides exactly with the later onset of ENSO-dominated climate in northern Australia inferred by Shulmeister and Lees (1995; see above). On the basis of these observations it is possible to hypothesize that increased production rates of both bifacial points and backed artifacts are responses by foragers to increased risk in the mid-Holocene.

If these arguments are sustained we now have an answer to a fascinating question: Why did people in northwestern Australia employ bifacial points as a technological response to risk at a time when people in more southerly realms employed backed artifacts as one response? The answer invokes contingency. When increases in foraging risk occurred in the mid-Holocene, groups selected from their existing technological practices those elements that could be emphasized profitably in the new context. The most advantageous characteristics were found in small, standardized forms of retouched flakes able to be integrated into reliable and maintainable multipurpose composite tools. In southern Australia one of the preexisting forms that possessed these characteristics was the backed artifact, and this was preferentially emphasized. But in northern Australia backed artifacts had never been in use and a different preexisting form that possessed these characteristics, bifacial points, was preferentially emphasized. Obviously the selection of artifact forms for emphasis could only have been made from those variations available in the existing toolkit. In the northwestern portions of the continent, use of biface technology is widespread, including not only bifacial points but also large discoid bifaces on the Barkely Tablelands and bifacially shaped axes in Arnhem Land since the Pleistocene. The origins of these bifacial knapping strategies are not at issue here, but it was their existence in the mid-Holocene combined with the absence of backed artifacts that constructed the technological variation from which the basis of a risk-reducing technology could be fashioned. Hence the reason that in northwestern Australia bifacial points formed the basis for the technological response to riskier conditions, while in southern Australia it was backed artifacts that played this role, relates to the preceding historical developments in each of those broad regions, rather than either the new contexts of greater risk themselves or the choice of a response involving a reorganized technological system.

This issue of contingency is also central to the question of why "similar technologies and tool kits had not emerged in response to risk of this kind at earlier times in Australian prehistory" (Hiscock 1994:283). Although earlier technology-based risk-reduction strategies can be recognized, they employed items other than stone points or backed artifacts, such as the increased use documented by McNiven (1994) of regularly shaped thumbnail scrapers in southwest Tasmania as a technological response to the "demands" of increasing mobility during the glacial maximum. In the absence of implement varieties such as bifacial points or backed artifacts Pleistocene technological responses to heightened risk involved selecting from a different range of material culture than was available later in the Holocene. Elements of any earlier response to foraging risk will of necessity have been different from those of the Holocene responses.

Conclusion

In Australia there is evidence for technological responses to increased foraging risk in the mid-Holocene. One of these responses is the use of a toolkit employing numerous backed artifacts, indicated archaeologically by the initiation of greatly increased production rates of these artifacts approximately 3,500 to 4,500 years ago. Aspects of this "proliferation" of backed artifacts in Holocene southeastern Australia have been examined in this chapter and a number of conclusions reached:

• Proliferation of backed artifact production in mid-Holocene Australia is not caused by the invention/importation of either the idea of a new type of tool or a specialist technology with which to manufacture it. In particular, the response does not involve the appearance of a blade technology in Australia at that time.

• Knappers produced backed artifacts in large numbers for a period in the mid-Holocene, but these forms of retouched flakes and the technology that produced them had existed in Australia for thousand of years before that time. Accepting the tenets of cultural selectionist models that separate generation and selection of variation facilitates understanding of this pattern. The proliferation of backed artifacts is explicable in terms of a model that describes the selection of that form.

• Increased backed artifact production is chronologically associated with increased environmental variability as well as landscape colonization, and the onset of an ENSO-dominated climatic pattern 4,000 to 5,000 years ago may have been one factor triggering greater foraging risk. This pattern is consistent with my (Hiscock 1994) suggestion that the abundant production of standardized and maintainable stone artifacts may well reflect cultural responses to those increased foraging risks, in particular, responses to risk incurred by environmental uncertainties.

• Emphasis on the production of standardized kinds of artifacts is merely one of a number of strategies that probably acted to reduce risk during the mid-Holocene. The development of a range of strategies, which could have buffered a group's foraging against environmental variability, is a conjunction seen to be consistent with an explanation involving risk reduction.

• Historical contingency is visible in the parallel response of the different technological systems that existed in northern Australia.

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