EXPLANATIONS FOR PATTERNING IN THE "PACKAGE OF TRAITS" OF MODERN HUMAN BEHAVIOUR WITHIN SAHUL

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ABSTRACT

Late Pleistocene Sahul has provided a test for the debate surrounding the appearance of the package of modern human behaviour within the archaeological record. A detailed review of the late Pleistocene archaeological record of Sahul (Franklin and Habgood 2007; Habgood and Franklin 2008) found both chronological and geographical patterning for the appearance of the individual traits - four broad Phases and seven 'Zones of Innovation'. We consider potential causes for this patterning including taphonomy and artefact function, but conclude that it reflects material culture differences and cultural preferences.

INTRODUCTION

Late Pleistocene Sahul has provided a test for the debate surrounding the appearance of the "package" of modern human behaviour within the archaeological record. A detailed review of the late Pleistocene archaeological record of Sahul (Franklin and Habgood 2007; Habgood and Franklin 2008) found both chronological and geographical patterning for the appearance of the individual traits—four broad phases and seven zones of innovation. We consider potential causes for this patterning including taphonomy and artefact function, but conclude that it reflects material culture differences and cultural preferences.

We explore the ecological and demographic changes during late Pleistocene-early Holocene Sahul and the associated demographic processes that occurred to manage increasing population pressure caused by mounting aridity, population compression and intensive resource utilisation and control. The resultant changes in symbolic and other behaviours as manifested in the appearance of art, personal ornaments and cemeteries are explained within a demographic, social and symbolic framework and reflect the bonding or bounding of groups. We also argue for the establishment of regional symbolic activity at an early date following the initial colonisation of Sahul, and that what we are seeing in the archaeological record is the result of increasing momentum from already well-established social trends.

A focus of debate over the past decade has been the definition of modern human behaviour, lists of innovations or traits that are claimed to reflect it and the appearance of this "package" of traits within the archaeological record (see Mellars et al. 2007). Discussion initially centred on the transition from the Middle to the Upper Palaeolithic in Europe from 40,000 BP, but McBrearty and Brooks (2000) refocused the debate by including Africa. More recently the debate has been expanded to include Sahul—the combined landmass of Australia (incorporating Tasmania) and Papua New Guinea (Brumm and Moore 2005; Franklin and Habgood 2007; Habgood and Franklin 2008; O'Connell and Allen 2007).

In a detailed review of the late Pleistocene archaeological record of Sahul, Franklin and Habgood (2007; Habgood and Franklin 2008) found that the components of the "package" were gradually assembled over a 30,000-year-period following initial occupation of the continent by behaviourally modern colonists who arrived without the "package" (Figure 1). This review indicated that the appearance of the individual traits within Sahul revealed both chronological and geographical patterning. Balme et al. (2009) have recently reaffirmed our earlier observation that rather than a poor representation or patchy distribution there is both chronological and geographical patterning to the occurrence of symbolic behaviour following the initial colonisation of Sahul.

Chronologically, we identified four broad phases for the appearance of the traits in the archaeological record (Figure 1). Geographically, we used the phrase "zones of innovation" to reflect the spatial patterning observed. Six zones of innovation– Northern, Central Western, Southwestern, Central, Murray-Darling and Tasmania – were identified in Australia (Franklin and Habgood 2007: Figure 5). Here we add Papua New Guinea (Figure 2) and acknowledge that the Northern

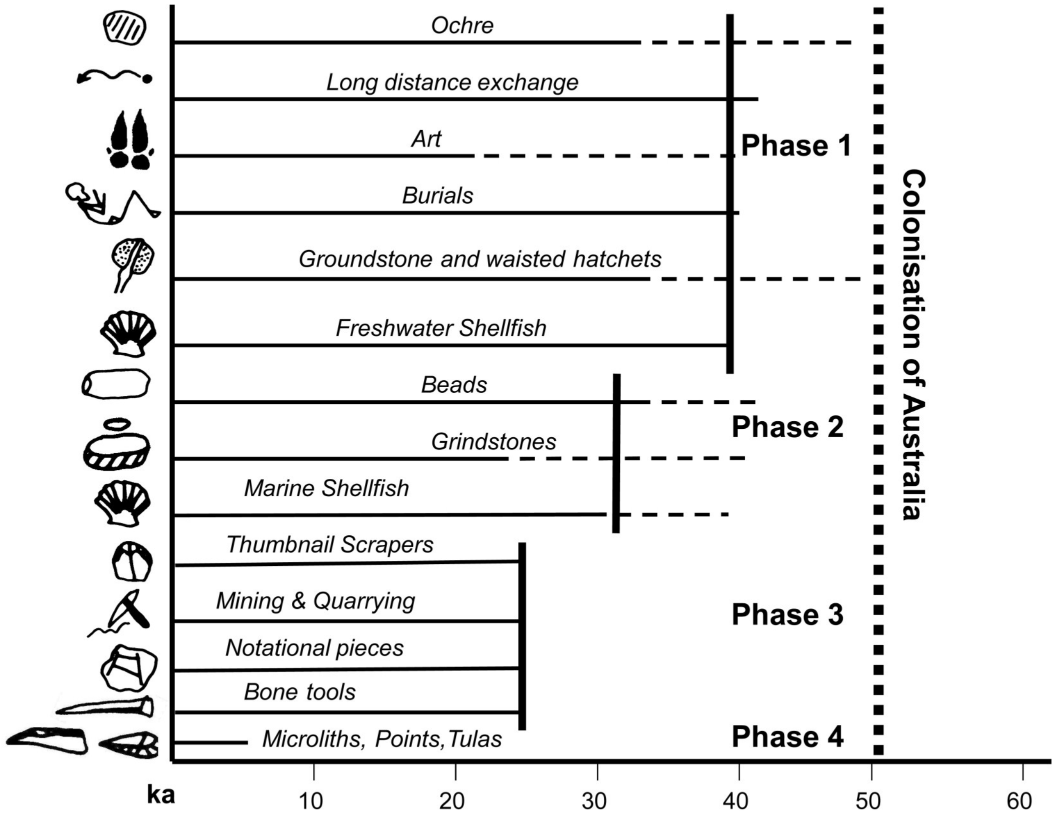


Figure 1. Phases for behavioural innovations in Pleistocene Sahul (revised from Franklin and Habgood 2007: Figure 4; Habgood and Franklin 2008:Figure 9).

Zone could be further subdivided. Tables 1a and 1b detail the key sites and characteristics of each Zone.

Importantly, the six zones of innovation in Australia (Figure 2) generally are encompassed by Peterson's (1976) culture-areas, Veth's (1993) biogeographical refuges and Franklin's (2004, 2007) regional groupings of petroglyph sites.

Peterson (1976: Figure 8) proposed seventeen culture-areas in Australia based on drainage basins, with culture-areas additional to the twelve drainage basins being recognised on the basis of the linguistic and cultural differences known from the ethnographic record. Our zones of innovation generally coincide with Peterson's Indian Ocean, Southwest Coast, Western Desert, Riverina and Tasmanian culture-areas. The only exception is our Northern Zone, which corresponds with more than one of Peterson's culture-areas.

Veth (1993) used a biogeographical approach to explore the timing and nature of the colonisation of Australia's arid zone, and identified refuges (localities providing networks of permanent water sources that can withstand climatic extremes), barriers (major deserts) and corridors between the refuges and barriers (that may have become temporary barriers during climatic extremes). The zones of innovation are encompassed within the refuges.

From analyses of engravings often represented as a homogeneous pan-Australian "style" known as the Panaramitee, Franklin (2007: Table 4) identified five regional groupings reflecting differing emphases on motif types. Our zones of innovation generally coincide with these regional groupings. Furthermore, one of the engraved regions identified by Franklin (1989) in an analysis of "simple figurative" assemblages (Port Hedland) coincides with our Central Western Zone, adding weight to the general agreement between Franklin's (1989, 2007) groupings and the zones of innovation (Figure 2).

The validity of the zones of innovation is strengthened by their general conformity with these other areas identified through the use of different data sets. Therefore, what might be the cause(s) of this chronological and geographical patterning?

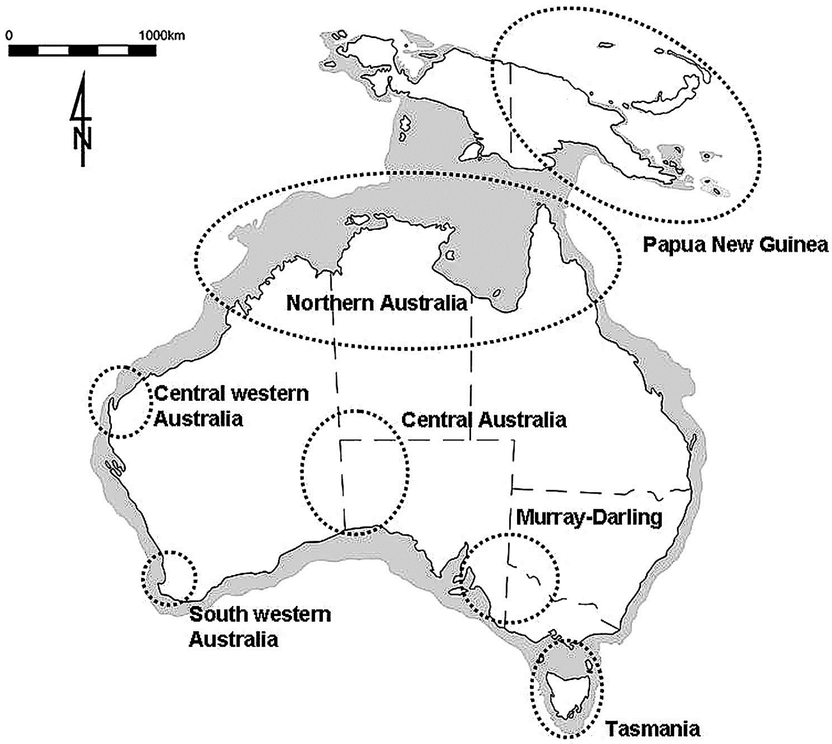


Figure 2. Zones of innovation in Pleistocene Sahul (revised from Franklin and Habgood 2007: Figure 5).

EXPLANATIONS

Taphonomy

The issues of taphonomy and archaeological sampling were considered previously (Franklin and Habgood 2007:9-10; Habgood and Franklin 2008:211-212). While acknowledging that both can and do impact on the preserved and/or recovered archaeological record (e.g. organic material is generally better preserved in limestone caves than sandstone shelters), we were of the view that the presence/absence of components of the "package" was not solely the result of taphonomic processes or directly linked to the size of excavations, amount of artefacts recovered and/or the intensity of site usage. We therefore concluded that while multiple factors would impact on site assemblages, there was patterning evident in the late Pleistocene archaeological record of Sahul, and that the presence and/or absence of an item of material culture **was** the result of cultural preferences of the Indigenous inhabitants of the site/region/continent.

Previously we detailed how sites with both small and extensive excavations but only limited assemblages have produced unique finds, while sites with large assemblages have produced few if any of the "package" traits. Here we discuss this in more detail and provide additional examples.

Devil's Lair is a large limestone cave in southwestern Australia where extensive excavations have been undertaken (Dortch 1984). Limited numbers of stone artefacts were recovered, but the site produced 13 bone points and 3 bone beads, both made from macropod long bones, possible limestone and bone pendants, a notational piece and ochre (Dortch 1984; Table 1b, Figure 2). Unique finds were recovered from this site which has only a limited archaeological assemblage. No shell beads were identified even though this site is closer to the coast (50 km at the height of the last glacial maximum [LGM]) than other sites with such finds, such as those in the Kimberley described below.

In northwestern Australia, the Kimberley sites of Riwi Cave, Carpenter's Gap and Widgingarri Shelter 1 display contrasting patterns. At the limestone shelter of Riwi Cave, 10 *Dentalium* shell beads dating to 30-40,000 BP were recovered from levels with little other shell material preserved (Balme 2000; Balme and Morse 2006; Table 1a, Figure 2). These marine shells were transported over 300km to the site. Carpenter's Gap is a limestone shelter currently 100km from the coast which, despite "exceptional preservation conditions" (O'Connor 1995:59), has also produced *Dentalium* shell beads, but little other shell material (Balme and Morse 2006; O'Connor 1995:59). Like Riwi and Carpenter's Gap, Widgingarri Shelter 1 has very little Pleistocene shell, but still has evidence for long-distance contact with the coast, this time in the form of a ground sea urchin artefact in a level dating to approximately 18,000 years (O'Connor 1999). Inter-

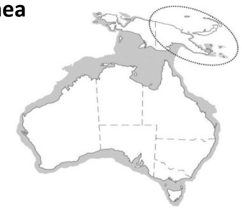
Region	Key Sites	Characteristics
Papua New Guinea 	Buang Merabak Matenkupkum Bobangara Kosipe	Long-distance transport and/or exchange networks – c. 40,000BP Shark tooth pendant – c. 39,500BP Early exploitation of marine resources Obsidian transport/exchange -- late Pleistocene
Northern 	Carpenter' s Gap Widgingarri 1 Miriwun Riwi Cave Nawamoyn Malangangerr Nauwalabila Malakunanja Early Man	Long-distance transport and/or exchange networks – c. 40,000BP Shell beads -- c. 40,000BP Ground stone hatchets and waisted axes -- possibly c.40,000BP Grindstones -- c. 22,000BP Pigment processing and ochre – c. 42,000BP Rock art -- c. 42,000BP
Central Western 	Mandu Mandu Creek Noala Cave Gum Tree Valley	Long-distance transport and/or exchange networks -- c. 25,000BP Shell beads -- c. 32,000BP Ochre -- c. 20,000BP Rock art -- c. 18,500BP Possible early marine exploitation – c. 22,000BP

Table 1a. Zones of innovation in Pleistocene Sahul, with key sites and characteristics. *(continued on next page)*

estingly, it has no shell beads. Also at Widgingarri Shelter 1, even though macropod bone is common in the Pleistocene levels, there are no bone points or bone beads. All four sites have macropod remains, but no bone beads or bone points, and no limestone or bone pendants have been identified. All four sites also have demonstrated contact with the coast, but only Riwi and Carpenter's Gap have shell beads.

At the Mandu Mandu Creek limestone rockshelter in central western Australia, extensive excavations have uncovered 22 small cone shell (*Conus* sp.) beads from levels dating to 32,000 BP (Morse 1993a, b; Table 1a, Figure 2). Negligible amounts of other shell material were recovered from the late Pleistocene deposits at this coastal site (Morse 1993a: Figure 2). While faunal material is present, no bone beads or bone points were recovered.

Late Pleistocene Tasmanian sites provide an interesting contrast to those from Western Australia. Southwest Tasmanian limestone cave sites yield very rich late Pleistocene archaeological assemblages (Table 1b, Figure 2). At Kutikina Cave 37,000 stone artefacts and over 250,000 fragments of animal bone were recovered from less than 1m^3 of deposit, along with a single bone point (Ranson *et al.* 1983). No bone beads were found. Similarly, Bone Cave has produced extensive faunal material and 13 bone points (Webb and Allen 1990), but no bone beads.

Mannalargenna is a limestone cave on Prime Seal Island in Bass Strait, currently off the northern coast of Tasmania, but during peak occupation it would have been situated on a hill within the Bassian Plain that joined Tasmania to mainland Australia (Brown 1993). Mannalargenna Cave has an extensive archaeological assemblage from levels dating from 15-20,000 BP, including stone and fossil-shell artefacts, faunal material, Emu egg shell fragments, red coloured ochre pieces and a bone spatula (Brown 1993). No bone beads or shell beads have been identified at the site, despite the preservation of some otherwise fragile items, such as the Emu egg shell.

Late Pleistocene exploitation of marine resources is evident at sites on the islands off the northeast and northwest coasts of Sahul, including Buang Merabak, Matenkupkum and Matenbek, New Ireland and Lene Hara Cave, East Timor (Habgood and Franklin 2008: Table 8 and references therein). Marine shell beads have not been identified at any of these sites, although a perforated tooth from a tiger shark (*Galeocerdo cuvier*) has been recovered from Buang Merabak, New Ireland, in levels dating to between 39,500–28,000

Region	Key Sites	Characteristics
Southwestern 	Devil's Lair	Ochre -- c. 31,000 Bone points -- c. 26,000 Notational pieces -- c. 25,000 Bone beads and other personal ornaments -- c. 20,000
Central 	Puritjarra Puntutjarpa Koonalda Cave	Long-distance transport and/or exchange networks – c. 32,000 Flint mining – c. 24,000 Ochre -- c. 32,000 Rock art – c. 20,000
Murray-Darling 	Willandra Lakes Roonka Cuddie Springs Kow Swamp	Long-distance transport and/or exchange networks -- c. 40,000 Ochre -- c. 40,000 Ritual burials -- c. 40,000 Grindstones -- c. 35,000 (but disputed) Exploitation of freshwater shellfish – c. 40,000
Tasmania 	Kutikina Bone Cave WargataMina Warreen Cave Cave Bay Cave Mannalargenna	Long-distance transport and/or exchange networks -- c. 35,000 Bone points – c. 29,000 Ochre -- c. 22,000 Rock art -- possibly c. 35,000 Intensive exploitation of resources (Bennett's wallaby) -- c. 30,000

Table 1b (Continued from 1a). Zones of innovation in Pleistocene Sahul, with key sites and characteristics.

years BP (Leavesley 2007). No bone beads or bone points have been identified at these sites.

At Early Man, a sandstone shelter on Cape York Peninsula, faunal material, stone artefacts and ochre were recovered from late Pleistocene levels along with rock engravings dated to at least 13,200 BP (Rosenfeld 1981: Table 1, Figure 2). No bone points or bone beads were recovered from the Pleistocene levels. Nurrabullgin Cave, another sandstone shelter in north Queensland, has also failed to yield bone points or bone beads despite extensive amounts of bone being recovered from the Pleistocene levels (David 1993: Table 2). Similarly, at Fern Cave, a limestone cave on Cape York Peninsula, stone artefacts, faunal material and ochre were recovered from late Pleistocene deposits, but no bone points or bone beads (David 1991).

These examples demonstrate that the presence or absence of components of the "package" (specifically shell beads, bone beads and bone tools), is not directly linked to taphonomic processes or archaeological sampling in that:

- Shell beads are found at sites with little shell preserved, whereas sites with lots of shell do not have shell beads;
- Bone beads have been recovered from a site with a limited archaeological sample, but not from sites with extensive faunal samples; and
- Bone tools are generally found at sites in southern Australia, but not at sites in northern Australia, which have macropod remains preserved;
- Also, grindstones and hatchets have limited distributions even though stone artefacts are found at sites throughout Sahul. (Habgood and Franklin 2008)

Therefore, the patterning evident for the "package" must reflect material culture differences and cultural preferences. The following sections explore possible explanations for the chronological and geographical patterning we have identified (Figure 1).

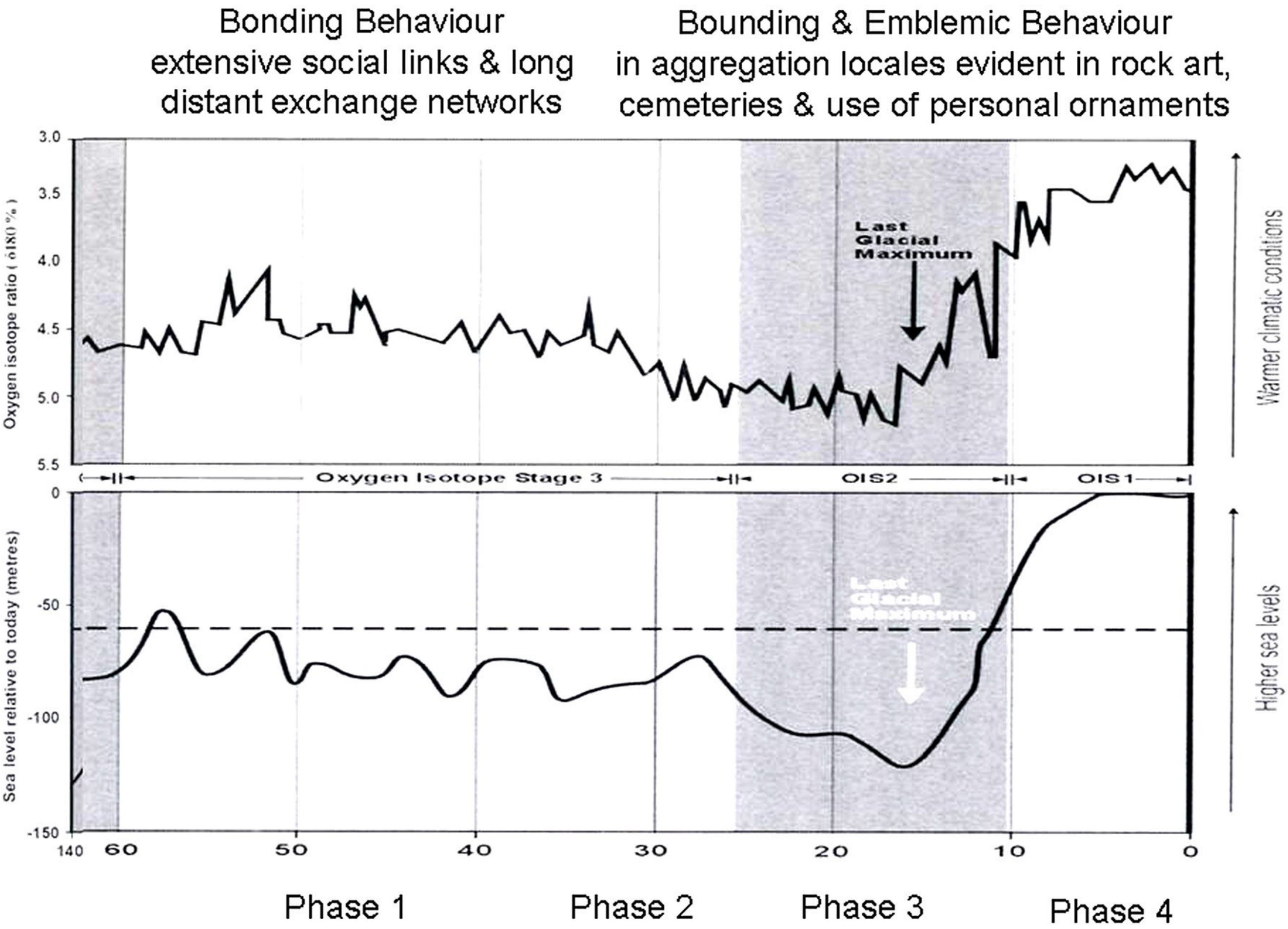


Figure 3. Social and symbolic model for behavioural innovations in Pleistocene Sahul (after Hiscock 2008:Figure 2.1).

Function

The distribution of some elements of the "package" may be related to the function of the artefacts (see Habgood and Franklin 2008 and references therein). For example:

- Bone Points: The majority of sites with late Pleistocene bone points are in southern Sahul, where they may have been used in skin working and cloak making in these colder southern regions.
- Grindstones: The late Pleistocene multi-functional grinding tools from northern and southeastern Australia were used for grinding ochre, the processing and leaching of toxic plants and for seed-grinding.
- Hatchets: The late Pleistocene edge-ground and waisted hatchets found in northern Sahul may have been used for a range of adzing and axing activities, including ring-barking and clearing trees, working wood, making watercraft and/or chopping holes in trees to hunt possums and collect honey.

The chronological and geographical patterning would, therefore, reflect the incorporation of these activities and artefacts into the adaptive strategies and material culture of different groups.

Social and symbolic

Outside Sahul, population growth, population pressure, demographic expansion and increasing contact between populations have also been viewed as possible reasons for the appearance of the "package", and/or the behavioural traits that were needed to facilitate access to limited resources (McBrearty and Brooks 2000; Kuhn et al. 2001; Shennan 2001; Henshilwood and Marean 2003).

We do not believe that the chronological and geographical pattern we identified is consistent with an explanation based on a continent-wide population increase and the reaching of a continental population threshold. However, the "driving forces" for the pattern may have been regionally-based population pressure and/or the reaching of regional population thresholds at different times in different regions.

Australia is an arid country, with water being a crucial determinant of Aboriginal subsistence and settlement, so population numbers would have varied at a regional level based on resource availability (Hiscock 2008; Lourandos 1997; Mulvaney and Kamminga 1999). Climatic and ecological changes have direct impacts on the availability and distribution of water, faunal species and resource plants within the landscape. Changes in resource availability would affect population density/pressure, which may be the trigger for the crossing of population density/pressure thresholds at different times in different regions and the appearance of "symbolic behaviour".

Population size and demographic change is difficult to establish for Sahul, although the number of sites and intensity of site usage (discard and sedimentation rates) suggest relatively low population densities throughout the late Pleistocene. Models based on late Pleistocene, mid-Holocene or bi-directional population growth either side of the LGM have been proposed (see Hiscock 2008). We agree with Hiscock (2008:243) that population fluctuations would have been complex in character, regionally based, of varying magnitude and at different scales. The late Pleistocene demographic history would have involved population growth, expansion, replacement, contraction, and differing amounts of population stress and pressure.

Mounting aridity leading into the LGM would have impacted significantly on resource availability and therefore Aboriginal settlement patterns and population numbers during the late Pleistocene. As Veth (1993:7) observed, "the timing and magnitude of climate changes are unlikely to have been in parallel throughout the late Pleistocene and the Holocene in both northern and southern Australia". For example, O'Connor et al. (1993) detailed how, during the LGM, northwestern Australia would have been drier and colder, whereas southwestern Australia would have been wetter and colder. They also demonstrated that discard rates/occupation intensity/population varied between the two areas at this time, decreasing in the northwest while increasing in the southwest.

During this period of increasing aridity in much of Sahul, some sites and regions were abandoned, especially in the more arid areas, while other areas and/or sites experienced increased occupation intensity when people moved to refuge areas with networks of permanent water sources and reliable resources (Hiscock 2008; O'Connor et al. 1993; Veth 1993). This demographic process would have resulted in what Witter (2007:21) referred to as a "process of population compression". Witter (2007) also proposed that Aboriginal people adopted sociological solutions such as the establishment of "Dreaming tracks" to manage irregular aridity. We would suggest that similar processes occurred to manage increasing population pressure caused by mounting aridity, population compression and intensive resource utilisation and control, with resultant changes in symbolic and other behaviours as manifested in the appearance of art, personal ornaments and cemeteries.

Therefore, do the broad phases we identified (Figure 1) relate to periods of climatic and ecological change that would have resulted in increasing population pressure from reduced resources and/or population compression?

Phase 1: From c. 40ka BP

Phase 1 equates with the initial colonisation of Sahul and the movement of small groups into a range of environments and landscapes across the continent. While the climate would have been cooler and drier than at present and sea levels lower, there were oscillations of warmer/wetter and colder/drier periods (Hiscock 2008: Figure 4.7). There were changes in vegetation and some expansion of the arid and semi-arid zones within the continent and the extinction of a number of mega-faunal species that may be related to environmental change (see discussion in Hiscock 2008). The continent would have been sparsely populated during Phase 1, with some regions and/or environments with very low populations.

Phase 2: From c. 32ka BP

Phase 2 incorporates the commencement of increasing aridity from late within oxygen isotope stage 3 and the resulting climatic deterioration in the lead-up to the LGM (Hiscock 2008: Figure 4.7). For example, the study of phytoliths from Carpenter's Gap documents increasing *Spinifex* grass in the area, indicating increasing aridity from 33,000 BP (Wallis 2001). This phase was also lacustrine, with the levels of many inland lakes higher than today due to reduced evaporation as a result of lower temperatures and possibly increased runoff (CLIMANZ 1983). There is also evidence for the aggregation of peoples focused on the exploitation of particular resources (e.g. southwest Tasmania and around the lakes of southwest NSW; see discussion in Habgood and Franklin 2008 and Hiscock 2008).

This phase is characterised by ongoing changes in the distribution of water, faunal species and resource plants across the landscape and the resultant changes in population distributions and density. Some areas would have seen a reduction in population density, others an increase, depending on resource availability.

Phase 3: From c. 20ka BP

Phase 3 incorporates the LGM with its increased aridity and reduced temperatures in much of Sahul (CLIMANZ 1983). This arid period is marked by significant changes in the distribution and availability of resources, resulting in some areas being abandoned, while others experienced increased occupation intensity. Areas with reliable water sources and food resources would have experienced a process of population compression and packing of more groups into smaller territories within refuges.

Phase 4: From c. 5ka BP

Following climatic amelioration and associated changes to the distribution of resources across the landscape during the early Holocene, there is evidence of increased use of many areas, while other areas were re-populated (Hiscock 2008; Lourandos 1997). Sea levels gradually rose, resulting in Sahul being broken into the Australian mainland, Tasmania and Papua New Guinea by 6,500 BP. Significant changes within Australian prehistory around the mid – late Holocene have been referred to as an "intensification phenomenon" (see Lourandos and Ross 1994 and Lourandos 1997 and references therein).

O'Connor et al. (1993:95) argued that late Pleistocene Sahul "experienced significant changes in demography and that these changes are fundamental to our understanding of postglacial economies and territorial organisation". We would contend that these "changes in demography" commenced prior to the LGM and that they impacted on economies and territorial organisation throughout the late Pleistocene and into the Holocene.

Wadley (2001) argued that modern human behaviour is evident in the archaeological record when items of external symbolic storage (art, ornaments, lithics) are used in the definition of individual or group identity, reflecting what we will refer to here as bonding or bounding of groups.

Bonding refers to long-distance links between groups of people. It is reflected in the alliances between groups that were needed in times of resource stress, enabling access to the resources of other groups during periods of shortage in the uncertain environments (Gamble 1982). Studies of recent Aboriginal territorial organisation (e.g. Peterson 1986) have found that in areas with unpredictable and precarious resources, such as the arid zone, Aboriginal groups tended to be small, and social and territorial networks extended over large areas facilitating easy movement across fluid boundaries to gain access to the resources of other groups. Hayden (1987) noted that the effectiveness of alliances between groups depended on very strong emotional bonds between members, which were forged through ritualised procedures that were shared between groups. Bonding behaviour would be reflected archaeologically by similarities in items of material culture across large areas of the continent and in the long-distance movement of materials.

Emblemic behaviour, which reinforces *bounding*, is represented by items of material culture that transmit a message of group identity to a defined target population. The function of this behaviour is to deliberately mark the boundaries and territories of a particular social group (Wiessner 1983), which we will refer to as *bounding*. It is particularly apparent in resource-rich areas with material culture traits acting as territorial markers. For example, in areas such as coastal Arnhem Land and southeastern Australia, the environment can support a significantly larger population density than in arid regions, so that in recent times, Aboriginal groups tended to be larger, territories smaller and more clearly defined, and boundary maintenance was required to a greater degree (Peterson 1986).

Bounding behaviour is also frequently demonstrated in areas where different groups come together (aggregation locales). Innovation is most likely to occur in such areas, and diversity in material culture is likely to be highest (Conkey 1980). Furthermore, the consequences of innovation appear to be far more successful in larger populations than in smaller ones (Shennan 2001).

Archaeologically, bounding and emblemic behaviour is likely to be particularly evident in rock art, burials and the use of ornaments (beads and pendants). For rock art, bounding behaviour is manifest in the occurrence of distinct styles with spatially restricted distributions, and in increasing levels of regionality through time. For burials, cemeteries may be an indication of bounding behaviour. In terms of ornaments, Vanhaeren (2005) found that beads in traditional societies play at least fourteen different and often multiple roles, including markers of individual and group identity, age, gender, class or social status. Different bead types in different regions which occur at multiple sites over long periods of time have been interpreted as integrated markers of individual and group identity (d'Errico and Vanhaeren 2007; Kuhn and Stiner 2007; cf. White 2007). The visual display of information about social identity through personal ornaments seems to most often target strangers or infrequently encountered individuals (Wobst 1977; Kuhn et al. 2001). The presence of unique bead types on the other hand may reflect the use of ornaments by an individual to reinforce personal identity (d'Errico and Vanhaeren 2007).

The early evidence of long distance movement of ochre, shell and stone that we have detailed (Habgood and Franklin 2008: Table 1) indicates the presence of extensive social networks over extremely large areas in late Pleistocene Australia, when population numbers would have been low and widely spaced. This bonding behaviour evident in our Phase 1 would have been particularly useful during colonisation (Figure 3). We would contend that such behaviour is also evident in rock art, including:

- the similarities between the widely-distributed rock engraving sites that have been referred to the "Panaramitee tradition" (Franklin 2004, 2007), which is at least 14,000 years old (Rosenfeld 1981) and may be much older; and
- the similarities between engraved faces over thousands of kilometres, argued to be an early phase within the Panaramitee tradition (McDonald 2005).

Also, the cementing of alliances through ritual envisaged by Hayden (1987), is manifest in Dreaming tracks, which reflect the activities of the Dreamtime ancestors as they emerged from the earth and travelled across the country along lengthy tracks, creating various geographical features before re-entering the earth (e.g. Chatwin 1987; Elkin 1934; Peterson and Langton eds. 1983; Spencer and Gillen 1938; Strehlow 1978; Witter 2007). Dreaming tracks frequently extended across group boundaries and often correlated with the trade routes documented in recent times (Ross 1997), suggesting that both formed a means for the interaction of people across the landscape, and for the diffusion of similar motifs and other material culture similarities across vast areas. We would argue that trade networks and Dreaming tracks extended well back into the late Pleistocene, constituting the linking mechanisms which would explain the widespread similarities between Panaramitee tradition engraving sites, as envisaged in the discontinuous Dreaming network model (Franklin 2004, 2007). All of these observations are consistent with the view that bonding functions for material culture traits were required at times of resource uncertainty, apparent in particular during this colonisation phase.

However, bonding behaviour would have continued through time, and would have also been useful throughout the lead-up to and during the LGM, our Phases 2 and 3. This is evident from:

- the results of a sourcing study of ochres at Puritjarra, central Australia, where ochres in layers dated between 32,000 and 13,000 years ago came from a distant quarry across a significant dune field barrier (Smith et al 1998), indicating extensive social networks at that time; and
- the continuation of Panaramitee tradition engraving sites through time.

Bounding and emblemic behaviour becomes apparent in Sahul as the environment becomes drier leading into the LGM with groups aggregating in refuge areas, and is especially evident during the LGM. This would correspond with our Phases 2 and 3, and would be expressed differently in different regions and at different times according to regional/ local conditions (Figure 3).

As noted above, our zones of innovation generally coincide with the refuge areas identified by Veth (1993), the culture-areas identified by Peterson (1976) and regional areas within the Panaramitee tradition (Franklin 2004, 2007). Aggregation, an expression of bounding behaviour, would be expected in these refuge areas, and is evident in:

- Franklin's (2004, 2007) Central Region within the Panaramitee tradition, where the greatest diversity in motifs occurs;
- the Dampier Archipelago in our Central Western Zone (Figure 2), where the high stylistic diversity in rock engravings supports its interpretation as a major aggregation locale for the Pilbara (McDonald and Veth 2009); and
- Devil's Lair in our Southwestern Zone, where there is a diversity of material culture over a prolonged period of time from about 20,000 to 12,000 BP, with bone beads, a bone pendant, a limestone pendant and a notational piece. At this time, Devil's Lair would have been located in an environmentally rich refuge area, and would have been an area of "population compression" (Witter 2007), creating the conditions for such innovations and diversity in material culture.

Other examples of bounding and emblemic behaviour during Phases 2 and 3 in rock art include:

- the engraved archaic faces noted above as being part of the Panaramitee tradition, although in this case the figurative nature of these motifs allowed them to be developed and elaborated into a variety of complex forms at aggregation sites in the refuges of the Cleland Hills (central Australia), Calvert Ranges and Durba Hills (Western Australia) during the LGM (McDonald 2005);
- engraved thylacine and "fat-tailed" macropod motifs in the Pilbara refuge area and our Central Western Zone (Figure 2), dated to a minimum of 4,000 years BP based on age estimates for the extinction of the thylacine (Mulvaney 2009). However, these engravings may be considerably older than this as they are highly patinated and in an area where the rate of weathering and repatination of rock surfaces is slow, in the order of several thousands of years (Mulvaney 2009);
- the use of local sources for ochre at Puritjarra, central Australia, combined with a far more intensive use of the site and the initial production of pigment art between 13,000 BP and 7,500 BP, suggesting a contraction in territory and an increasing need to assert corporate rights and relationships to the site (Smith et al. 1998); and
- the increasing levels of regionality through time, from the more homogeneous, Australia-wide Panaramitee tradition, to the proliferation of distinct and more figurative styles occupying spatially restricted areas from the terminal Pleistocene through the Holocene (Franklin 2004, 2007). The latter would correspond with our Phases 3 and 4, at a time of population packing and repopulation of areas after the last glacial maximum.

Bounding behaviour is also apparent in cemeteries and personal ornaments, which would be particularly expected to occur during our Phase 2, in the lead-up to the LGM, and in Phase 3, during and subsequent to the LGM, as people congregated in the refuge areas (Figure 3).

Ornaments in our Northern, Central Western and Southwestern zones of innovation are all different and were used over a considerable period of time, as expected if they were being used as expressions of group identity. At Riwi and Carpenter's Gap in our Northern Zone, the ornaments comprise beads of *Dentalium* sp. shell dating between about 30,000 and possibly back to about 42,000 years ago at the former site (Balme and Morse 2006; O'Connor 1995; Habgood and Franklin 2008: Table 3). There is also evidence for the use of such beads into the recent past in coastal parts of the Kimberley (Balme and Morse 2006). At Mandu Mandu in our Central Western Zone, beads are made of *Conus* sp., but are also found over a long period of time from the basal occupation horizon at about 32,000 BP to about 21,000 BP (Morse 1993; Habgood and Franklin 2008: Table 3). Use of beads in these Zones corresponds mostly with our Phase 2.

The beads at Devil's Lair in the Southwestern Zone, which are of macropod long bones from layers dating between 12-20,000 BP, again indicate a long period of use. At this time, there was an increasing rate of discard of artefacts (O'Connor et al. 1993: Figure 7), implying population packing during and after the LGM (our Phase 3), when this region would have been a resource-rich refuge area.

These regional differences in bead types and continuity in use over an extensive period of time argue for their role in group-identifying behaviour. The different types of beads are also found in different refuge areas identified by Veth (1993), at periods both pre- and post-dating the LGM (our Phases 2 and 3), when people would have been congregating in the refuges at times of environmental stress. The impact of increasing aridity in the lead-up to the last glacial maximum is also likely to have been felt much earlier in desert and semi-desert areas in central and north-western Australia (Hiscock and Wallis 2004; see above), corresponding with our Northern and Central Western Zones. Furthermore, in the Kimberley (Riwi and Carpenter's Gap) and Cape Range Peninsula (Mandu Mandu), the use of non-local materials in the manufacture of beads implies that maintenance of social networks to the coast was important at this time of increasing aridity (Balme and Morse 2006). This interpretation is consistent with the use of ornaments in the visual display of information about group identity from a distance (Kuhn et al. 2001).

Ornaments and burials in the Murray-Darling Zone (Figure 2) can also be interpreted as integrated markers of ethnic, social and personal identity (see d'Errico and Vanhaeren 2007). Pardoe (1988) argued that the appearance of cemeteries throughout the Murray River corridor following the LGM (our Phase 3) may reflect the need to legitimise control and ownership over restricted riverine resources in an area of high population pressure and demand for resources. This provides further support for the argument for increasing territoriality through time noted above for rock art. Furthermore, cranial modification as possibly practiced at Coobool Creek and Kow Swamp in the Murray-Darling Zone may be another example of a system to enforce group identity and distinguish one group from another in a region experiencing population pressure (Pardoe 1993).

There is also spatial patterning within the types of ornaments found in some of the burials in this Zone, as follows:

- an eastern group comprising Cooma and Kow Swamp, where the burials contain necklaces of kangaroo and wallaby incisors;
- a central group, consisting of Lake Nitchie and David's Dune, where the individuals were buried with Tasmanian Devil teeth necklaces; and
- a more variable western group comprising the burials at Roonka, which have a range of grave ornaments (Habgood and Franklin 2008:Table 3).

There also seems to be a difference in burial orientation between these groups (Pardoe 1995). These spatial differences, with different bead types in different regions, may indicate the use of ornaments as markers of group identity. The time periods in which ornaments occur in the burials in the above regions coincide with our Phases 3 and 4, the latter being a period previously identified as one of population increase, colonisation of new areas and intensification (Lourandos 1997; Lourandos and Ross 1994).

Other ornaments in the Murray-Darling Zone were probably used as markers of personal identity. At Roonka, there is a range of unique grave ornaments made from different types of material (teeth, shell, vertebrae, skulls), and with apparently different uses (necklaces, pendants, headbands) (Habgood and Franklin 2008: Table 3). The clearest examples are an adult male, who was buried with a double-stranded headband of notched wallaby teeth, and a band of wallaby incisors across his shoulder, and a child who bore a bird skull pendant and a necklace of reptile vertebrae (Pretty 1977). Both burials are dated to about 4,000 BP, corresponding with our Phase 4. These differences between the burials suggest the use of the ornaments as personal markers of status based on the age of the individuals.

Overall, the pattern of distribution of ornaments in our zones of innovation comprises: shell beads in the Northern and Central Western Zones; a shark tooth pendant in Papua New Guinea; macropod bone beads in the Southwestern Zone; and necklaces and headbands of teeth in the Murray-Darling Zone. Broadly, then, we have shell ornaments in the north and northwest of the continent, bone beads in the southwest and ornaments made of teeth in the south east. However, as noted above, within these Zones there are additional patterns of distribution for the different types of beads. These patterns and the use of ornaments over a prolonged period of time strengthen the argument that they served as integrated markers of personal and group identity.

CONCLUSION

We have argued in this paper for the establishment of regional symbolic activity at an early date following the initial colonisation of Sahul. We contend that the patterns we have identified in the "package" of modern human behaviour in late

Pleistocene Sahul are most probably the result of increasing momentum from already well-established social trends and their consequent greater visibility in the archaeological record in more recent times.

Late Pleistocene Sahul experienced significant climatic, ecological and demographic change throughout the late Pleistocene and into the Holocene that would have resulted in increasing population pressure from reduced resources and population compression. These changes are fundamental to our understanding of the appearance of symbolic behaviour and social organisation within Sahul.

We used the terms bonding and bounding behaviour to reflect the archaeological pattern we have identified in the "package" of traits. Bonding behaviour is reflected by similarities in art across large areas of the continent and in the long-distance movement of materials, including ochre and marine shells, following the initial colonisation of Sahul and movement throughout the continent. These linkages became integral components of the sociological solutions adopted by Aboriginal people to manage irregular aridity, population compression and intensive resource utilisation and control within Sahul (see also Witter 2007).

Bounding and emblemic behaviour becomes evident in Sahul with increasing aridity leading into the LGM, as groups throughout the continent aggregated in refuge areas (aggregation locales), resulting in regionally-based population pressure and/or the reaching of regional population thresholds at different times in different regions. This process would have been especially evident during the LGM. Archaeologically, bounding and emblemic behaviour is apparent in the increasing regionality of rock art, the appearance of cemeteries and the use of personal ornaments during the late Pleistocene and early Holocene.

There is therefore, both chronological and geographical patterning to the occurrence of symbolic behaviour following the initial colonisation of Sahul that can be explained within a demographic, social and symbolic framework.

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