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Late Holocene Changes in Shellfishing Behaviours from the Gulf of Carpentaria, Northern Australia

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Abstract

Dramatic changes in shellfishing behaviours occur across northern Australia during the late Holocene, marked most conspicuously by the cessation of large shell mound construction in some areas, and the reorganisation of shellfishing behaviours towards more intensive production in the last 1000 years. Excavations reveal rapid and widespread changes within coastal sites, an increasing diversification in overall subsistence resources and patterns of increase in site establishment and use. Some of these changes have been argued to be associated with increasing climate variability and a trend towards increasing aridity during the late Holocene, argued to have transformed coastal ecosystems and mollusc availability. However, when these hypotheses are tested at the local level, more nuanced patterns of human-environment interaction emerge, which call into question interpretations based on broad-scale climate records. We suggest that disjunctions in the timing of the cessation of shell mound construction noted between the west and east Gulf of Carpentaria may be related, at least in part, to the timing and intensity of external cultural contacts with Macassan seafarers, associated with reorganisation of mobility and production strategies, rather than as yet undemonstrated environmental changes impacting on shellfish availability.

Keywords

shell mounds, shellfishing, Gulf of Carpentaria, Wellesley Islands

Introduction

Change observed in the archaeological record is often broadly interpreted in terms of cultural responses to environmental change (e.g., Day et al. 2012; Sim and Wallis 2008; Williams et al. 2010). For example, changing shellfishing behaviours across northern Australia are commonly explained in terms of increasing climate variability over the last millennium, where a trend towards more arid conditions is associated with the transformation of coastal ecosystems and mollusc availability (e.g., Faulkner 2008). If regional archaeological sequences are found not to align with broad-scale palaeoclimatic records, regional temporal variations in the climatic records are frequently proposed, often in the absence of any independent evidence to support such claims (e.g., Hiscock 2008). In some cases, researchers use local archaeological records as environmental proxies, thus creating a circular argument with respect to the relationship between human behaviours and climatic change (e.g., Faulkner 2008). In contrast, some studies have demonstrated a lack of correlation between changes in the archaeological record and local environmental records, leading to suggestions that alternative explanations are required, including those which incorporate the dynamics of social groupings (e.g., McNiven 1999; Whitaker and Byrd 2012).

In this paper we demonstrate that at the local level, late Holocene changes in shellfishing behaviours can be nuanced with no abrupt signatures that can be clearly correlated with altered environmental conditions. Investigations at the Yiinkin Embayment, Mornington Island, southern Gulf of Carpentaria, identified a rich ~3500 year coastal archaeological record comprised of shell mounds and shell scatters. Synthesising our findings from the Wellesley Islands with those for the wider Gulf of Carpentaria, we refine current understandings of shellfishing behaviour, arguing that claims for changes in the late Holocene archaeological record of this region being linked to palaeoclimatic variability should be reconsidered.

Patterns of Change

The Gulf of Carpentaria is an epicontinental sea in northern Australia, bounded to the east by Cape York Peninsula and to the west by Arnhem Land. Its coastline is characterised by prograded shores with numerous islands and archipelagos, the main groups being (from east to west) the Torres Strait Islands, the Wellesley Islands (the case study), the Sir Edward Pellew Group, and Groote Eylandt (Figure 1).

Studies have revealed a rich archaeological record across the Gulf region, characterised by changing site densities (Williams et al. 2010), site and/or regional (including island) abandonments (Sim and Wallis 2008), and the emergence of new site types such as shell mounds (e.g., Faulkner 2008; Morrison 2003, 2010). The general late Holocene patterns of coastal and island use in the Gulf parallel broader trends in the Australian archaeological record. For example, regional chronologies across northern Australia feature a marked increase in the numbers of sites in the last millennium (Ulm and Reid 2000; Williams et al. 2010), except for some notable declines in site numbers between 1250-950 BP and 450-250 BP, which have been argued to correlate with changes in ENSO frequency and intensity (Williams et al. 2010). Sim and Wallis (2008:101) proposed a three-phase model for occupation of Vanderlin Island in the Sir Edward Pellew Group with dates ranging from pre-6700 BP (before islandisation) to modern times. Two occupation hiatuses are identified for Vanderlin Island (6700-4200 BP and 2500-1700 BP) that Sim and Wallis (2008:103) argued were caused by periods of climatic instability, and extrapolate as potentially being a pan-northern Australian signature.

In the western Gulf, Clarke (1994:97) reported that, in the period prior to contact with Macassan trepangers, the people of Groote Eylandt moved seasonally to selectively exploit specific shellfish species (e.g., *Marcia hiantina*, *Anadara granosa*), resulting in monospecific shell matrix sites, and sometimes shell mounds. In contrast, during the period of Macassan contact (i.e., post-ca.400 BP), archaeological evidence points to more intensive use of fewer sites with all local resources exploited, as the middens (not shell mounds) contain a diversity of species from sand-mud shellbeds in the immediate site environments. Clarke (1994:463) argued that these changes were part of a strategy designed to provision larger groups of people camped at one location for longer periods to facilitate exchange transactions with Macassans (see also Mitchell 1994, 1995).

In the eastern Gulf, at Albatross Bay and Aurukun on the western Cape York Peninsula, shell mounds are the dominate shell-matrix site type, with an estimated 600 shell mounds recorded, some up to 14 m in height and 200 m long although most are less than 2 m in height (Bailey 1999; Morrison 2010, 2013). Similar large shell mounds dominate wetland margins across other regions of the Gulf (e.g., Blue Mud Bay and Arnhem Land in the western Gulf see Faulkner 2006; and the Wellesley Islands in the southern Gulf, see Rosendahl 2012). The intertidal bivalves *A. granosa* or *A. antiquata* usually dominate mound contents with lesser quantities of *M. hiantina, Polymesoda erosa* and *Saccostrea* sp. (oyster) also present. Various explanations have been proposed for the sudden appearance of shell mounds in northern Australia ~4,000 years ago as well as the apparent cessation of mound construction between 800 and 500 years ago that seems to be isolated to the western Gulf in the Blue Mud Bay and Arnhem Land regions. In the southern and eastern Gulf shell mounds construction continued until contact with missionaries in the early nineteenth century (Morrison 2010; Rosendahl 2012). Some researchers attribute shell mound formation to natural origins such as changing sea-levels (Stanner 1961) or the nesting behaviours of megapodes (Stone 1989). More mainstream explanations centre on changes in the environment that alter the availability of resources (e.g., Bourke et al. 2007; Faulkner 2006; O'Connor 1999).

Faulkner (2006:262) considered mound construction to be the result of intensive, short-term exploitation strategies in response to increased environmental instability, with the reliability of *A. granosa* and related mudflat taxa underwriting reduced mobility strategies. Subsequent cessation of shell mound creation in the western Gulf by ca.500 BP is also interpreted as a behavioural response to climatic shifts that resulted in the declining availability of *A. granosa* (Bourke et al. 2007:97; Faulkner 2006). Sim and Wallis (2008:103) suggested that the decline of mangrove-dwelling shellfish species in shell matrix sites after 2500 BP is associated with increased ENSO activity that caused the permanent destruction of mangrove stands, the habitat for the shellfish. Others have proposed more socially-oriented models, suggesting instead that mounds are purpose-built as cultural markers or elevated camping platforms that ceased to be used due to cultural contact (Morrison 2010:333). Many commentators agree that mound formation represents the emergence of new production strategies in response to social and/or population changes, though they do not provide explanations for what drove the population changes (Haberle and David 2004; Morrison 2010:54). We use our research in the Wellesley archipelago to consider these varied hypotheses, and specifically investigate the sudden rise in shell mounding behaviours on Mornington Island in the context of changing local environmental conditions.

Case Study

The Wellesley archipelago encompasses some 23 islands and numerous reefs and sandy cays covering 5500 km^2 (Figure 2). The islands comprise a dynamic geomorphic system with erosional and depositional processes continually altering and reshaping coastlines and ecosystems. The Wellesley Islands are the traditional homelands of the Lardil and Yangkaal (North Wellesleys), Kaiadilt (South Wellesleys) and Ganggalida (adjacent mainland and near shore islands). Ethnographic research has identified complex and dynamic social structures, patterns of identity and territorial boundary maintenance and resource ownership and a strong coastal orientation amongst these groups (Evans 1985; McKnight 1999; Memmott and Trigger 1998). All groups employ a specialised tool-kit for marine subsistence with minor variations between groups in the range and diversity of tool types (e.g., Best 2012; Memmott 2010). Comprising over 150 radiocarbon determinations from 87 palaeoenvironmental and archaeological sites across four islands (Mornington, Bentinck, Fowler and Sweers) and the adjacent mainland (Robins et al. 1998), the Wellesley Islands dataset provides a basis for developing secure, local archaeological comparisons across the Wellesley archipelago, and between the Wellesley Islands and other regions around the Gulf.

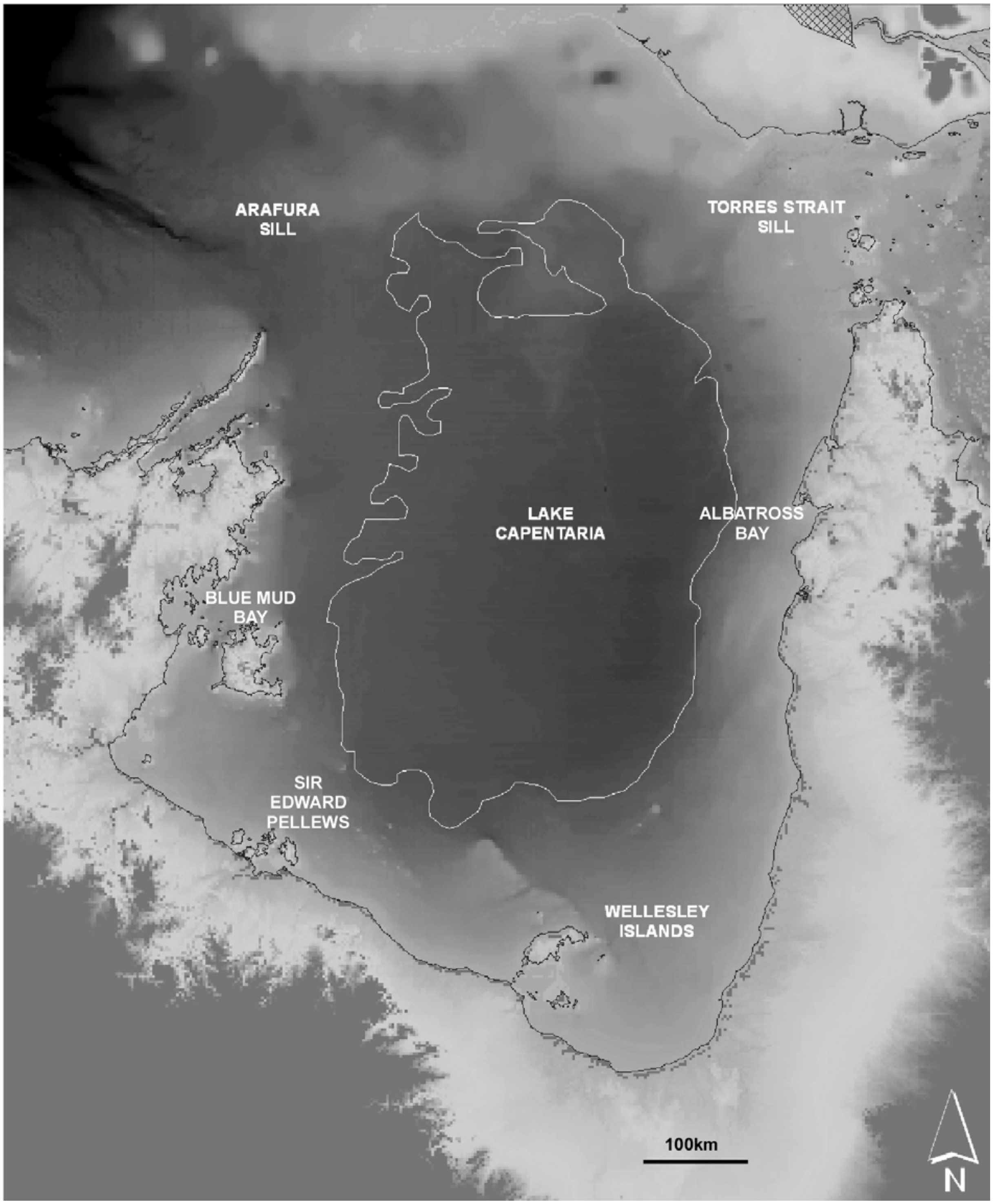

Figure 1 The Gulf of Carpentaria, northern Australia (after Torgersen et al. 1985) showing places mentioned in the text.

The radiocarbon dates available for the Yiinkan Embayment on Mornington Island can be divided into two groups, those from natural sites and those from archaeological sites. All available natural shell bioherms (death assemblages) date between 7000 to 4000 cal BP, while all cultural shell deposits from 3300 cal BP to the present; there is thus a clear gap between the two datasets between 3300 and 4000 cal BP (Figure 3). Stock (2008) and Sloss et al. (2011), reported saltpan development correlating with a sea-level high-stand ca.6600 BP and ceasing with sea-level stabilisation ca.4600 BP (cf. Woodroffe 2009). Sea-levels remained at ~2 m above present for the southern Gulf until ca.4000 BP (Sloss et al. 2011).

The Aboriginal occupation record for the embayment spans the past 3300 years, having commenced less than ~1,000 years after initial landscape stabilisation at ca.4000 cal BP. Between the initial stabilisation and earliest evidence of Aboriginal occupation there was a locally recorded ~2 m fall in sea-level (Sloss et al. 2011). The chronological gap between landform stabilisation and evidence for occupation is not a result of a lag in resource availability as proposed for other regions (Day et al. 2012). The presence of the shell-rich bioherms alone demonstrates a rich, diverse inter-to-subtidal ecosystem, including mangroves, since initial coastalisation, with the hiatus representing the transition of the embayment from shallow subtidal to supratidal, as illustrated in Figure 4 and described in Table 1. Resources, notably shellfish, would have been available in the estuaries but not on the surface of the mudflat, as is the case today.

Shell scatters dominate almost all visible surfaces on elevated coastal sand platforms and beach ridges, and are also abundant on the sandy residuals situated on the saltpan. Shell mounds are numerous but are restricted to the saltpan unit. Two types of shell mounds occur: mounds dominated by the marine gastropods *Terebralia* spp. and *Telescopium telescopium* termed 'gastropod mounds' and mounds dominated by *Anadara antiquata* and *Saccostrea* sp. (Oyster) termed 'bivalve mounds' (Figure 5). There is a clear spatio-temporal patterning of the two mound types with bivalve mounds restricted to the eastern embayment and confined to the last 1,200 years and gastropod mounds across the embayment from before 2500 cal BP. Gastropod mounds, based on their contents, represent focused exploitation of intertidal mangrove communities. Bivalve mounds denote exploitation of the mangrove-fringed estuaries and rock platforms, as well as shallow subtidal sand-mudflats. While a range of taxa from the various ecological zones are present throughout the occupation of the embayment, the major focus is on the exploitation of intertidal mangrove habitats, with a prominent increase in exploitation of the sandy-mudflat species *A. antiquata* in the past millennium. Results show a gradual intensification in use of the embayment over time that is pronounced in the past 500 years with an increase in the number of all site types. These increases do not correspond with local environmental change and likely indicate increased demand for existing, known resources to meet new demands such as an increasing population density.

In the study area, exploitation of *A. antiquata* is documented throughout the entire period of occupation, with consistent, yet low frequencies from ca.3500 cal BP until 1200 cal BP, after which the species is heavily exploited until the present. This sudden appearance of *Anadara*-dominated mounds may indicate further ecological development of the Yiinkan Embayment, with conditions for *A. antiquata* becoming optimum after ~1200 cal BP. Alternatively, as *A. antiquata* was available and exploited throughout the entire occupation record of the embayment (albeit in lower quantities in the earlier period), the pattern may indicate that local Aboriginal populations were increasing their exploitation of known resources due to increasing demands, i.e., population increase, reduced territory size or altered ecological conditions resulting from the silting up of the embayment and contraction of mangrove communities (see Figure 4). As *A. antiquata* mounds emerge there is no corresponding decrease in the construction of marine gastropod mounds, therefore overexploitation of gastropod resources does not appear to be occurring or a local ecological shift (see also Codding and O'Connell, this volume; Whitaker and Byrd, 2012; Whitaker and Byrd, this volume). Instead, both continue at equal concentrations until the period of sustained European contact (after AD 1914), demonstrating that *A. antiquata* was not merely exploited as a substitute for a declining gastropod resource.

The sudden emergence of *A. antiquata* mounds does not necessarily mean that it was not heavily exploited previously, rather the shell meat may have been removed with the shell discarded during collection (Codding and O'Connell, this volume). Cyril Moon, Lardil, elder states that the mounds were not used as camp sites but as processing sites where the shell was discarded and the meat taken to be cooked at a larger camp site (pers. comm., June 2013). The sudden emergence of these mounds at ~1200 cal BP could then be a result of population increase, reduced territory size and subsequently reduced distance from resource base to camp site.

Table 1. Phases of environmental change and patterns of human-environment interaction on Mornington Island, southern Gulf of Carpentaria.

Phase 1: 7000 cal BP	Post-glacial sea-level rise inundates the Carpentaria plain, resulting in Coastalisation of the Wellesley Archipelago as a peninsula and subsequent islandisation of Mornington Island at close to sea-level high-stand c.7000 cal BP. The arrival of the sea at close to its maximum level abutting the lateritic bedrock along the southern margin of the modern Sandalwood River embayment is evidenced in the rapid establishment of open bay mangrove communities and associated mudflats as inferred from the bioherm deposits.
Phase 2: 7000-6000 cal BP	Sea-level continues to rise to c.+1.68m above present-day levels with increased sediment deposition and initial beach ridge development by c.6200 cal BP and as early as 6800 cal BP (Sloss *et al.* 2010; Stock 2012). The rising sea-level deposited sediments such as silt, sands, shell hash and gravels along the open bay bedrock margins and base of the embayment forming the foundations for the elevated beach ridges that characterise the northern section of the study area (Stock 2008). The margins were populated by extensive mangrove communities as indicated by mangrove attachment scars on black-lipped oysters dating to this period and also a saltpan core sample on nearby Bentinck Island where mangrove wood was identified in sediments dating to 6577 cal BP (Sloss *et al.* 2010).
Phase 3: 6000-4000 cal BP	Sea-level continued to rise to c.+1.98m above present levels, with continued deposition of sediments along the margins of the saltpan. Mangrove communities remained abundant along the tidal margins, however the presence of buried bioherms identifies the continuing process of progradation and coastward retraction of mangroves. Beach ridge development and progradation continued, with a northward projection of the coastline. Beach ridge patterning indicates that the drainage of the embayment was significantly larger than the contemporary Sandalwood River with two channels of equal size in the eastern and western embayment. The most recent bioherms are dated to c.4000 cal BP indicating that by this time much of the deep water in the embayment had succumbed to infilling sediments, removing the last ecological niches required for the black-lipped oysters.
Phase 4: 4000-2700 cal BP	Sea-level stabilises after a fall of almost 2m, although the precise chronology of stabilisation is uncertain. Sea-level data for other regions in the Gulf indicate stabilisation as late as c.3500 BP (Harris *et al.* 2008; Reeves *et al.* 2007; Torgersen *et al.* 1985), but possibly with minor fluctuations as late as 2000 cal BP as identified for the northeast coast of Queensland (Woodroffe 2009). Initial Lardil occupation is confirmed at a shell scatter situated on a beach ridge that most likely formed the coastline at that time. Focused exploitation of mangrove communities is indicated in the emergence of gastropod shell mounds along the southern and northwestern margins of the embayment.

Phase 5: 2700-1500 cal BP	The archaeological record demonstrates exploitation of a wide range of ecosystems including intertidal and shallow subtidal sand bars and mudflats as indicated by the presence of *Anadara antiquata* as well as subtidal rocky platforms and reefs, indicated by the presence of *Placuna placenta*. There is, however, a focus on mangrove communities with the continued construction of gastropod mounds.
Phase 6: 1500 cal BP-Present	Increase in exploitation of a wide range of ecosystems including intertidal and shallow subtidal sand bars and mudflats as indicated by the emergence of bivalve mounds dominated by *Anadara antiquata* and *Saccostrea* sp. as well as continued exploitation of mangrove communities with the continued construction of gastropod mounds. Both types of shell mounds continue through to the present i.e. missionary period that commenced 1914 AD.

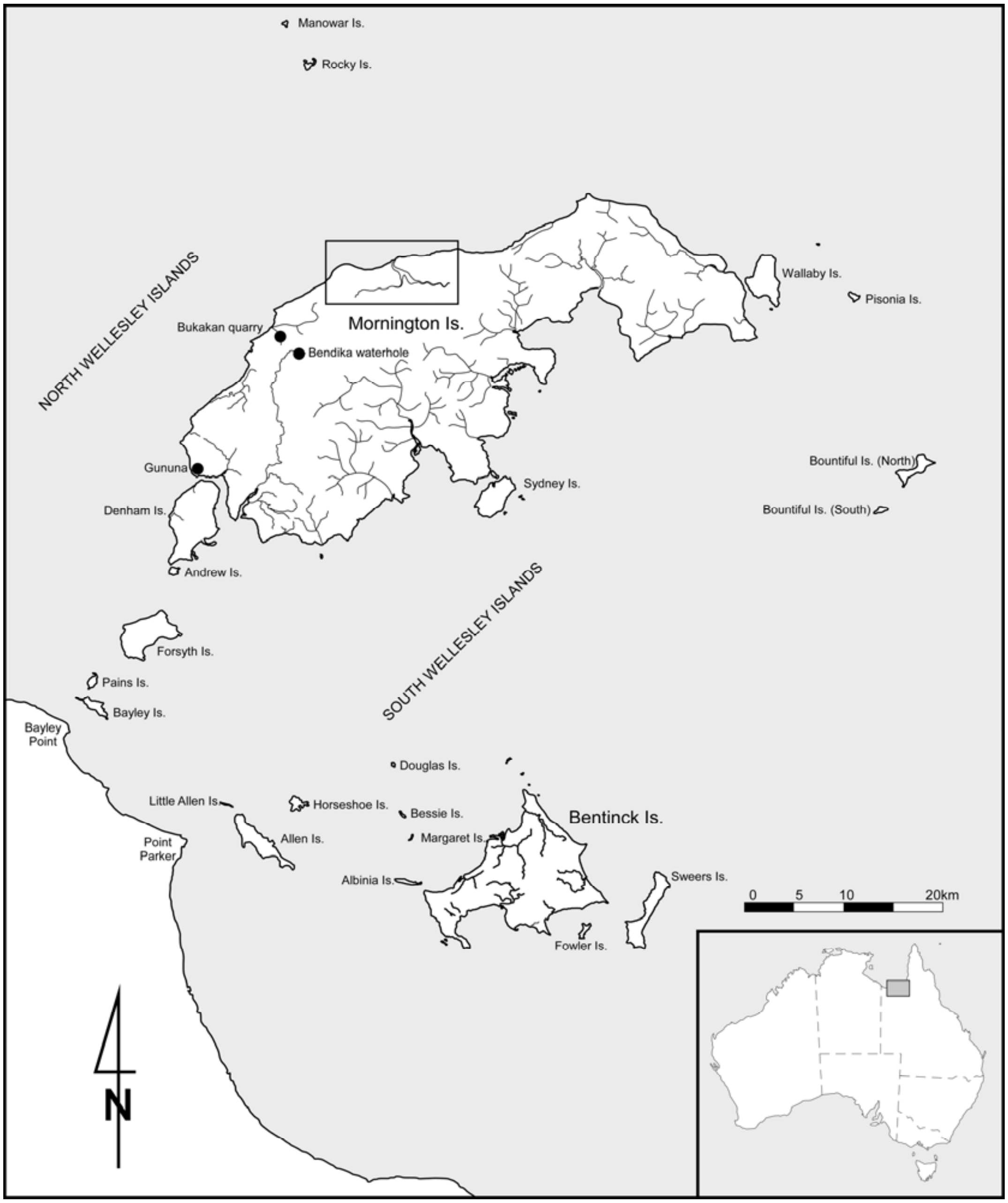

Figure 2. The Wellesley Islands, southern Gulf of Carpentaria, north Australia. Box outlines the Yiinkan Embayment case study area.

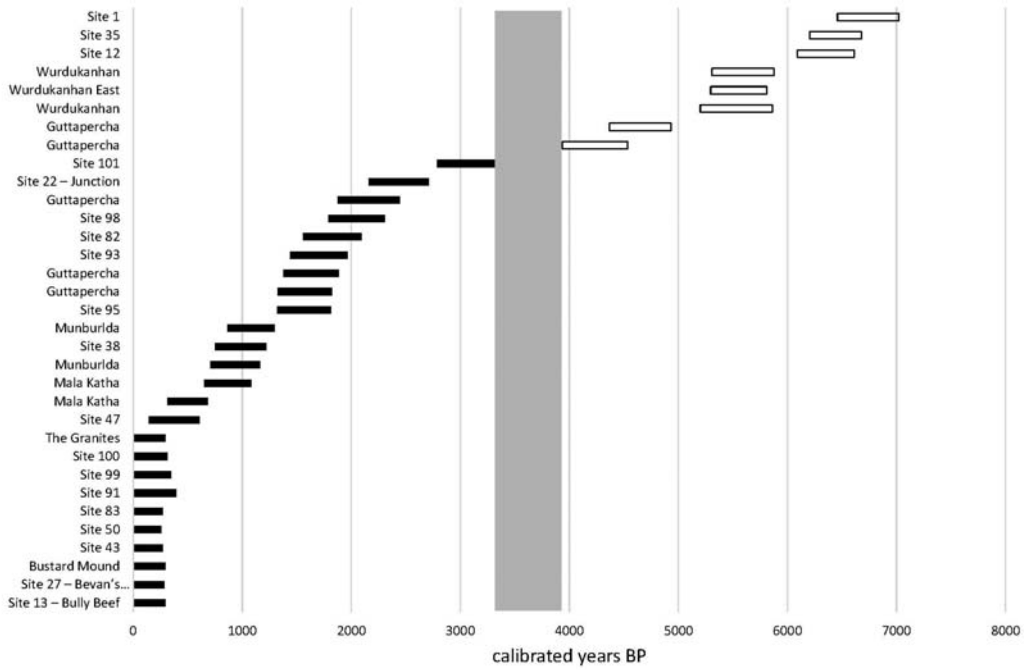

Figure 3. Distribution of radiocarbon dates available for the Yiinkan Embayment: bioherms (white); cultural deposits (black). Grey bar indicates period of landform stabilisation following the end of transgression. Sites listed along y-axis. Radiocarbon ages in this study were calibrated using OxCal 4.1 (Bronk Ramsey 2009) and the IntCal09 and Marine09 datasets (Reimer et al. 2009), with a ΔR of -49±102 for marine samples (Ulm et al. in press). All calibrated ages are reported at the 95.4% age range.

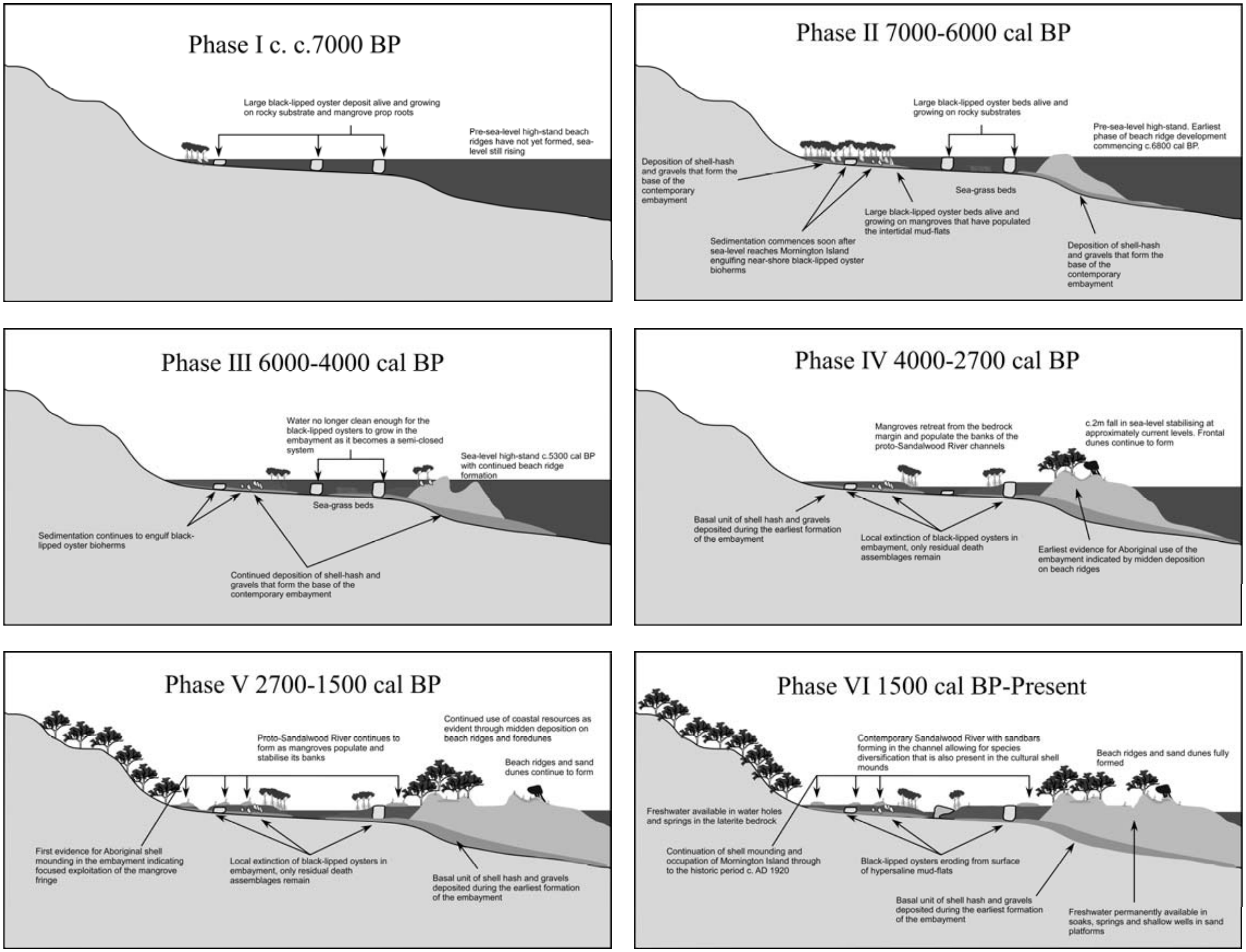

Figure 4. The Yiinkan Embayment six-phase model for landscape development and occupation chronology.

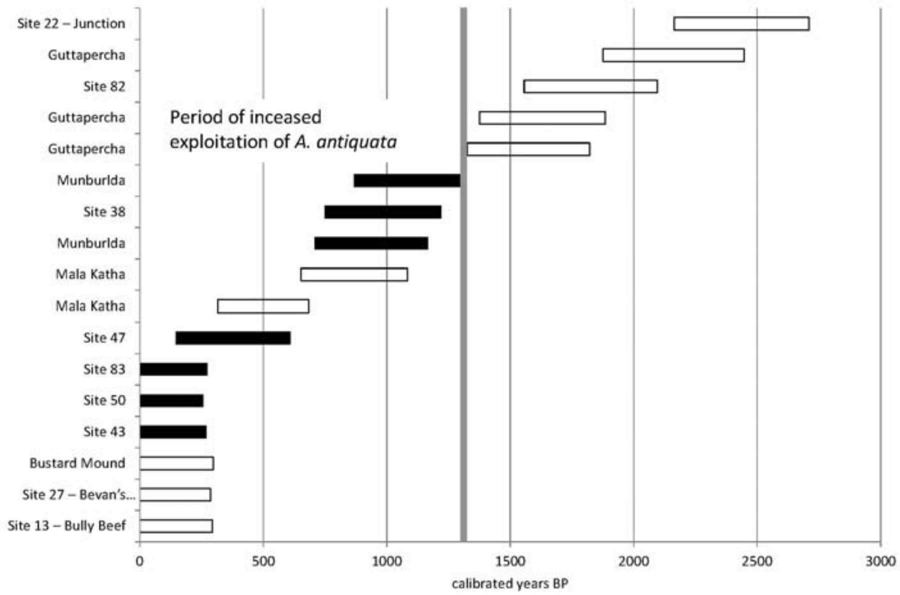

Figure 5. Radiocarbon determinations obtained from shell mounds illustrating period of increased A. antiquata exploitation after 1200 cal BP (grey bar). A. antiquata bivalve-dominated mounds (black). Gastropod-dominated mounds with lower concentrations of A. antiquata (white).

Discussion

The occupation record for the Wellesley Islands, juxtaposed with known, local environmental events, shows no obvious correlations between the occupation pattern and major local environmental patterns, with human-environment interactions appearing more subtle than is argued elsewhere. It is apparent that Williams et al.'s (2010) broad pattern of gradual increase in new sites in the last millennium across northern Australia is somewhat understated for the Gulf, with a significant increase in sites post-500 cal BP (Figure 6). When dates are considered at the two-sigma calibrated age-range, the claimed occupation hiatus on Vanderlin Island from 2500-1700 cal BP (Sim and Wallis 2008) becomes less pronounced (Figure 6). If Vanderlin does exhibit a short occupation hiatus for this period it is unlikely a result of increased climatic instability as the Mornington Island dataset (less than 300 km to the east with a similar climate regime), indicates no evidence for offshore island abandonment at this time; in fact it illustrates the opposite, with a greater frequency in new site creation.

The most pronounced difference in the archaeological record of the eastern and western Gulf is the apparent cessation of shell mounding at Blue Mud Bay in the western Gulf after ~500 cal BP. Here changes in the representation of *A. granosa* in shell matrix deposits have been interpreted to represent local environmental changes or overexploitation, resulting in local extinction or population collapse of the species (e.g., Faulkner 2008; Hiscock and Faulkner 2006). As this pattern however, is not represented elsewhere in the Gulf (e.g., Albatross Bay (western Cape York Peninsula) and Wellesley Islands) it cannot be attributed to broad-scale environmental change or local variations in the timing of such change as some have argued. These claims were proposed with an absence of local environmental studies with local changes inferred from broader regional patterns and local shell-matrix archaeological deposits, which skew understandings of local shellfishing behaviour. Without supporting evidence from independent local palaeoenvironmental indicators the observed patterns of change at Blue Mud Bay, in the western Gulf may not relate to environmental pressures instigating changes in the archaeological record. Rather, it may relate to change in cultural preferences, such as camp-site location and shellfish exploitation. However there is still not substantial evidence in this region to support one claim over the other.

An alternative hypothesis is that cultural contact with new groups may have been the catalyst for regional variations in both the timing of shell mound cessation in areas across northern Australia, as well as increased occupation levels at various locales in the trans-Gulf region, which manifested in intensification of marine exploitation (e.g., Clarke 1994). The dates for cessation of mound construction in the western Gulf align closely with the minimum period for foreign Macassan contact in Arnhem Land before 280±25 BP (SANU-6813) (Taçon et al. 2010), therefore the stepwise decrease in shell mounding in Blue Mud Bay may indicate a gradual increase in the frequency of Macassan contact, trade and associated changes in mobility and production strategies relating to cross-cultural contact (Mitchell 1994, 1995). Notably, Macassan contact in the eastern Gulf is minimal reaching as far east as the Wellesley Islands, where shell mound creation continued, only ceasing upon sustained European and missionary contact in the early twentieth century.

Furthermore, all prior models of shell mound construction across northern Australia are based on only one type of shell mound, *Anadara* (*A. granosa*) mounds. The Mornington Island mound assemblage includes mounds that are dominated by gastropods. This result identifies that shell mounding was not just a result of a hyper-abundance of *Anadara* spp. but possibly, on Mornington in any case, the result of intentional discard to create elevated camping platforms on the saltpan (cf. McKnight 1999; Cyril Moon, pers. comm., June 2013), and/or to create visible discrete features onto the landscape to mark boundaries or sites of communal activities (McNiven 2012; Morrison 2003, 2010). The emergence of *Anadara*-dominated mounds in equal abundance to gastropod mounds in the past 1,200 years may indicate decreasing territory size with an increase in population densities on Mornington Island.

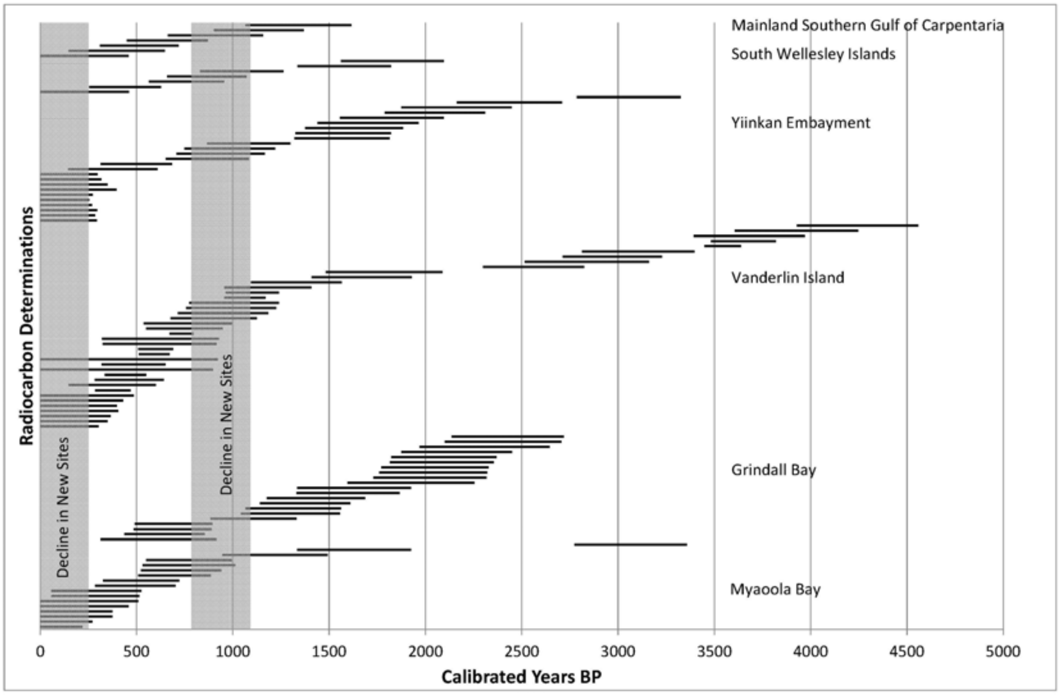

Figure 6. Southern and western Gulf radiocarbon datasets juxtaposed with broad-scale patterns of chronological change (blue columns) as identified by Williams et al. (2010) for the past 2,000 years (La Niña 700-1350 BP, El Niño 500 BP-700 BP).

Conclusions

There are clear indices of change in the archaeological record of the past 3,500 years in the Yiinkan Embayment that relate to shellfishing behaviour. First there is a shift in focused subsistence at 2,700 years ago with the emergence of shell mounds that, along with shell scatters, continue into the European contact period. Second there are the noted spatial patterns for dominant shellfish represented in the mounds i.e., the emergence of *A. antiquata* mounds at ~1,200 years ago. This is hypothesised to represent not only altered ecologies and proximity to resources, but also an increase in local population densities inferred from intensified exploitation of specific shellfish resources. This hypothesis is supported by the long-term exploitation of *A. antiquata*, with a focused increase in exploitation in the past millennia in conjunction with a continued exploitation of mangrove communities, notably *Terebralia* spp. and *T. telescopium*. As there is no abrupt pattern of change that can be linked to environmental factors in the embayment, it is taken that the archaeological record accurately portrays continuous use of the embayment with a gradual increase in new occupation sites and a local increase in population densities towards the ethnographic present.

This research demonstrates that shell mound emergence in the Yiinkan Embayment is not a result of a shift in local environmental conditions with the sudden appearance of *A. antiquata* shell beds. *A. antiquata* had been present in the cultural deposits in the study area from ca.3500 cal BP even though *A. antiquata*-dominated mounds only emerged at ~1200 cal BP. There is no evidence for the cessation of shell mounding, correlating with Morrison's (2010) findings at Albatross Bay, in the eastern Gulf. This provides further, local evidence that mound cessation was not universal across northern Australia. Rather than being a result of broad-scale climatic conditions wiping out *Anadara* spp. beds (Faulkner 2006, 2008; Hiscock and Faulkner 2006), the pattern appears to be a north-western Australian phenomenon that closely aligns with cultural contact with Macassan traders (Taçon et al. 2010), as proposed by Bourke (2003:43) and Morrison (2010:11, 333). While more research is needed to fully understand the effects of Macassan contact, we note that the archaeological record demonstrates that after contact, people seemed to shift their economies in order to take advantage of growing trade relations with Macassans. This might have resulted in economic reorganisation away from subsistence production towards exchange production, which may explain some of the patterning in midden composition.

The broad trans-Gulf regional archaeological shell matrix site dataset does not support a story of increased mobility of foragers in response to changing environmental conditions in the late Holocene. Nor does it show a unilateral, homogenous record of gradual intensification. The record identifies continuity of landscape use and interaction in a dynamic environment. It demonstrates that people did not respond to local environmental change by abandoning areas, but rather drew on their knowledge of the environment and continued to exploit the available resources (cf. Amesbury 2007).

This paper demonstrates the need for local-scale chronologies and a focus on regional studies to identify and interpret patterns of regional diversity in shellfishing behaviours. There is no secure link between local- or broad-scale environmental events and observable change in the archaeological record, at least in the Yiinkan Embayment. At the local and regional scale the pattern of change in the archaeological record shifts from responses to changing climatic and environmental conditions to a more nuanced pattern of increased occupation. These findings highlight the value of secure, local and regional archaeological and palaeoenvironmental chronologies to enhance understandings of shell matrix sites and shellfishing behaviours.

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