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Early human occupation of a maritime desert, Barrow Island, North-West Australia

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ABSTRACT

Archaeological deposits from Boodie Cave on Barrow Island, northwest Australia, reveal some of the oldest evidence for Aboriginal occupation of Australia, as well as illustrating the early use of marine resources by modern peoples outside of Africa. Barrow Island is a large (202 km^2) limestone continental island located on the North-West Shelf of Australia, optimally located to sample past use of both the Pleistocene coastline and extensive arid coastal plains. An interdisciplinary team forming the Barrow Island Archaeology Project (BIAP) has addressed questions focusing on the antiquity of occupation of coastal deserts by hunter-gatherers; the use and distribution of marine resources from the coast to the interior; and the productivity of the marine zone with changing sea levels. Boodie Cave is the largest of 20 stratified deposits identified on Barrow Island with 20 m^3 of cultural deposits excavated between 2013 and 2015. In this first major synthesis we focus on the dating and sedimentology of Boodie Cave to establish the framework for ongoing analysis of cultural materials. We present new data on these cultural assemblages – including charcoal, faunal remains and lithics – integrated with micromorphology, sedimentary history and dating by four independent laboratories. First occupation occurs between 51.1 and 46.2 ka, overlapping with the earliest dates for occupation of Australia. Marine resources are incorporated into dietary assemblages by 42.5 ka and continue to be transported to the cave through all periods of occupation, despite fluctuating sea levels and dramatic extensions of the coastal plain. The changing quantities of marine fauna through time reflect the varying distance of the cave from the contemporaneous shoreline. The dietary breadth of both arid zone terrestrial fauna and marine species increases after the Last Glacial Maximum and significantly so by the mid-Holocene. The cave is abandoned by 6.8 ka when the island becomes increasingly distant from the mainland coast.

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1. Introduction

The islands of the North-West Shelf of Australia provide a unique opportunity to address several inter-related questions focusing on the archaeology and palaeoenvironment of the coastal-desert interface. Here we focus on the antiquity and nature of occupation of coastal deserts; the use and distribution of marine resources across the Pleistocene coastal plain; and profile data on the relative productivity of the marine zone. Barrow Island now lies 60 km from the mainland and is optimally located on the edge of the continental shelf to sample earlier marine adaptations and occupation of the now-drowned North-West Shelf.

A three year survey program of the 202 km^2 limestone island located 30 open surface sites and 20 caves and rockshelters, of which Boodie Cave is the largest at > 3000 m^2 (Figs. 1 and 2 and Appendix Figs. A1–A5). These sites, and others on the nearby Montebello Islands, were abandoned by 6.8 ka when rising sea levels reached their present levels. Abandonment and lack of evidence for re-incorporation by watercraft-using peoples after this date, likely reflects their significant distance off-shore and the declining returns for risk consistent with models of island human biogeography for Indo-Australian waters (Kealy et al., 2016; Manne and Veth, 2015; Veth et al., 2017; Ward et al., 2014, 2015). In this study, we present evidence for occupation dating to between 51.1 ka and 46.2 ka, with direct dates on shellfish from 42.5 ka representing the oldest marine dietary remains in Australia. Equivalent-aged dietary molluscan and fish remains have been reported in other ancient limestone contexts from New Ireland, Timor-Leste and Niah Cave in Borneo (Barker, 2013; Langley et al., 2016; Leavesley and Chappell, 2004; O'Connor et al., 2011). Several sites from Cape Range located to the southwest of Barrow Island have previously returned dates in the 39–35 ka range (Morse, 1999). The increasing body of evidence for early and ongoing occupation of coastal deserts is consistent with recently obtained dates for the occupation of interior deserts and models for coastal dispersion in Australia (Bird et al., 2016; Hamm et al., 2016; O'Connell and Allen, 2012; Veth et al., 2017; Ward et al., 2014; Wood et al., 2016). The early consistent use of marine resources by peoples occupying the Australian North-West Shelf throughout the terminal Pleistocene attests to the relative productivity of the coastline during lowered sea stand (d'Alpoim Guedes, 2016; Ward et al., 2015).

While it is widely acknowledged that most sites with evidence of early marine resource use have been drowned by rising sea levels, our deliberate targeting of Barrow Island has provided the earliest evidence for early coastal economies and lifeways in northern Australia (Erlandson and Braje, 2015; Veth et al., 2014; Ward et al., 2013; and see Morse, 1999).

1.1. Regional setting

Barrow Island is located on the North-West Shelf of Western Australia (Fig. 1) and lies within the northern Carnarvon bioregion (Kendrick and Mau, 2002; Veth et al., 2014). The island is part of the Trealla Limestone formation that covers much of the North-West Shelf providing shelters and caves with excellent preservation for archaeological deposits (Veth et al., 2007). The climate is arid with 300 mm of variable summer and winter rainfall. Details on the environmental and historical (industrial) context of Barrow Island are provided by Moro and Lagdon (2013).

Located on the northwestern coast of Barrow Island, Boodie Cave is optimally positioned near the edge of the Australian continental shelf (Fig. 1). For most periods of lower sea level this cave would have been within the foraging range of the Pleistocene coastline; the thick bathymetric line at −130 m denotes the approximate position of the coast during the Last Glacial Maximum (LGM) between 22 and 18 ka. This large island was connected to the mainland for the duration of the terminal Pleistocene and early Holocene, eventually becoming a super-island connected to the Montebello Islands by an isthmus. This was drowned and the islands became a far flung archipelago after c. 7 ka (Veth et al., 2007).

2. Material and methods

2.1. Field methods

Boodie Cave and the surrounding valley were surveyed using a Leica C10 Terrestrial Laser Scanner (Vosselman and Maas, 2010; Leica, 2011). A representative cross-section of the cultural deposits was excavated over three successive field seasons (2013–2015) by way of 10 excavation squares. These provide a sample from outside the cave mouth to the interior edge of the light zone, comprising c. 20 m^3 of deposit (Fig. 2; Appendix Fig. A4). This represents a significant sample volume within the wider Australian context (Langley et al., 2011). In this paper we report on a well-preserved and well-dated record from two of the sample squares, A102 and A103.

Disturbance by burrowing bettongs (*Bettongia lesueur*) is limited to darker parts of the cave with the first 10–15 m of the cave entrance unaffected by their activities (Fig. 2) (Manne and Veth, 2015). Excavation was carried out in c. 2–3 cm excavation spits within stratigraphic units, to a depth of 220 cm. Archaeological deposits extended to a culturally sterile unit below 180 cm. Augering to 3.5 m revealed a continuing culturally sterile deposit. The locations of stratigraphic features, micromorphology columns and *in situ* finds – comprising charcoal, lithic and shell artefacts, and larger invertebrate and vertebrate fauna – were recorded with a total station. All excavated materials were wet-sieved through 4 mm, 2 mm mesh and (a sample) through 1 mm mesh.

2.2. Laboratory methods

Accelerator mass spectrometry (AMS) radiocarbon age determinations on charcoal and shell were undertaken at the University of Waikato Radiocarbon Dating Laboratory and the Australian Nuclear Science and Technology Organisation (ANSTO). Conventional radiocarbon ages were calibrated using OxCal 4.2 (Bronk Ramsey, 2009) and the SHCal13 (Hogg et al., 2013) and Marine13 dataset (Reimer et al., 2013), with a regional ΔR of 109 ± 25 ^{14}C years for marine samples calculated as part of this study (see Table 1). Details of radiocarbon sample preparation and calibration procedures are provided in Appendix A1.1. All calibrated ages are reported at the 95.4% probability range. Optically stimulated luminescence (OSL) samples were analysed at University of Adelaide's Prescott Environmental Luminescence Laboratory (Ad14030 to Ad14036) and at the Oxford Luminescence Dating Laboratory (L008/15-1 to L008/15-3). Details of sample preparation and calibration for OSL dating analyses are provided in Appendix A1.2. Bayesian analysis using a Sequence depositional model (Bronk Ramsey, 2008) with an embedded Outlier Model (General t-type) analysis (Bronk Ramsey, 2009) was used to provide the most probable chronology. The dated determinations were grouped in the model using four phases, namely SUs 2, 3, 5 and 6–8. Given some intra-phase off-sets between the radiocarbon and OSL chronologies (see Tables 2 and 3), modelling them as depositionally ordered Phases is the most conservative approach. Phases assume that the dates they contain are uniformly distributed with no order (Bronk Ramsey, 1998). Full details of Bayesian analyses are provided