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Wood charcoal analysis at Riwi cave, Gooniyandi country, Western Australia

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ABSTRACT

Wood charcoals excavated from archaeological sites provide a useful tool for palaeoenvironmental reconstruction, particularly in arid and semi-arid zones, where suitable catchments for palynological archives are often limited. Preservation of organic material in northern Australia is characteristically poor, and wood charcoal analysis provides a viable alternative to understand shifts in woody vegetation in the past. The analysis of charcoal from matrix contexts at Riwi cave, located in the southern Kimberley region of northern Western Australia, has allowed a reconstruction of the local woody vegetation during occupation over the last 45,000 years. The wood charcoal assemblage from the Holocene stratigraphic units reflects the composition of the modern vegetation, and illustrates that people were occupying the site during periods of relative humidity. The Pleistocene stratigraphic units show a shift in vegetation composition from *Eucalyptus* spp. to *Corymbia* sp. dominated savanna, with an understory of secondary shrub, associated with a Late MIS 3 arid event observed in both terrestrial and marine archives, suggesting that activities continued at Riwi during this arid event. Further anthracological analysis of other sites in the Kimberley will help to build a regional picture of woody vegetation change, and will further disentangle local and regional climatic signals, particularly in relation to phases of occupation.

1. Introduction

Preservation of organic material in monsoonal Australia is characteristically poor, and the geological stability of the ancient landscape limits the creation of depositional archives for analysis. The Kimberley region of north Western Australia has a particularly poorly preserved palaeoenvironmental archive. With the exception of archaeobotanical investigations conducted at Carpenter's Gap 1 (McConnell, 1997; Wallis, 2000; Frawley, 2009), palaeoenvironmental reconstruction of the Kimberley region has relied largely upon the dating of geomorphological sequences (e.g. Bowler, 1983; Wyrwoll et al., 1992; Fitzsimmons et al., 2012, 2013), or the isotopic profiling of stalagmites (Denniston et al., 2013a, 2013b, 2015), in conjunction with the extrapolation of palynological data from the Timor Sea (Kershaw and van der Kaars, 2012:240, Fig. 1) and the southern Pilbara (van der Kaars and de Deckker, 2002). While sites with better palynomorph preservation have been analysed more recently, including Black Springs (McGowan et al., 2012), the King River region (Proske et al., 2014), and the Mitchell Plateau (Simon Haberle pers. comm.), archives of fossil flora remain the exception, and not the norm.

Anthracology is the systematic analysis of archaeological wood charcoal assemblages from stratified contexts (Vernet, 1973, 1992; Chabal, 1992, Chabal et al., 1999). A subdiscipline of archaeobotany, anthracology, or wood charcoal analysis, enables the reconstruction and investigation of both palaeoenvironment and palaeoethnobotanical practice. Previous studies have identified the merits of anthracological analysis for palaeoenvironmental reconstruction (see reviews in Smart and Hoffman, 1988; Figueiral and Mosbrugger, 2000; Asouti and Austin, 2005; Dotte-Sarout et al., 2015). In arid environments, where pollen preservation is often poor, wood charcoals excavated from stratified archaeological contexts can provide the only reliable analogue for vegetation change (e.g. Willcox, 1999; Asouti and Hather, 2001; Höhn and Neumann, 2012; Cartwright, 2013; Jansen et al., 2013; Bachelet and Scheel-Ybert, 2015; Jude et al., 2016). Analyses of charcoals from archaeological deposits make

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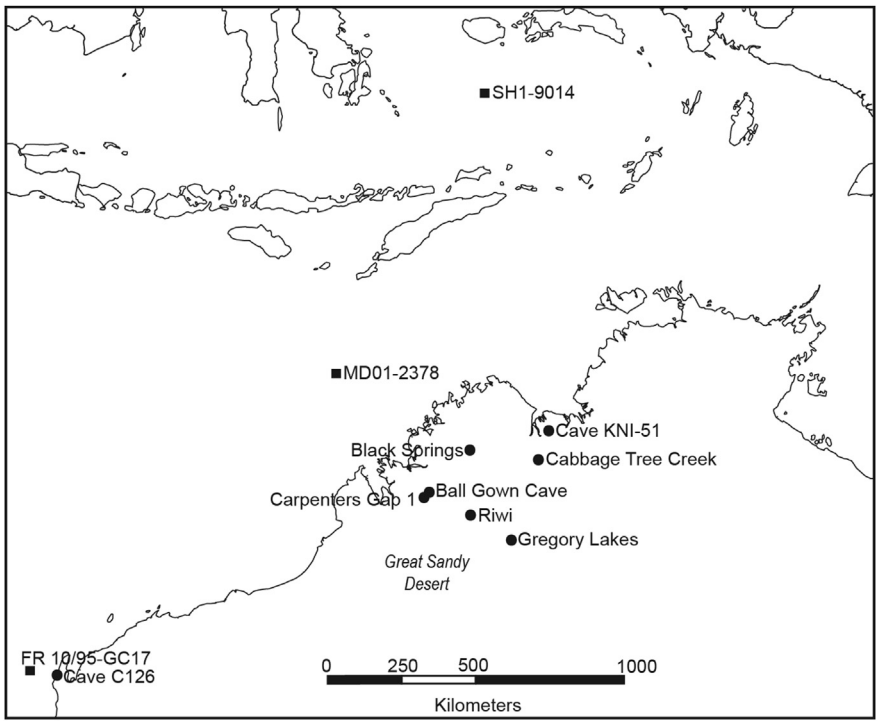

Fig. 1. Map of northern Western Australia with sites mentioned in the text.

possible a local-scale vegetation reconstruction that is more complex than regional palaeoclimate archives, and at a temporal scale that directly corresponds with prehistoric habitation (Asouti and Austin, 2005). Here we present results from wood charcoal analyses at Riwi, a limestone cave in the southern Kimberley region of Western Australia, on the edge of the Great Sandy Desert (Fig. 1), where excavations have revealed evidence of human occupation stretching back around 45,000 years (Wood et al., in press).

Despite the breadth of anthracological analyses conducted in Europe, South-West Asia, and South America, the application of anthracology in Australia is uncommon, with sampling thresholds largely untested (Dotte-Sarout et al., 2015). The first Australian anthracological studies were undertaken in the 1960s (Megaw, 1966; Donoghue, 1979), and were contemporaneous with the pioneering stages of the discipline in Europe (Salisbury and Jane, 1940; Godwin and Tansley, 1941; Momot, 1955; Santa, 1961; Couvert, 1968, 1976). However, Australia and wider Oceania have lagged in their application of the newer techniques and methods that have been developed elsewhere (see Théry-Parisot et al., 2010). With the exception of one Masters' thesis (Frawley, 2009; Frawley and O'Connor, 2010) and a handful of publications (Smith et al., 1995; Boyd et al., 2000; Dortch, 2004), the majority of anthracological applications in Australia have been undergraduate Honours dissertations (Donoghue, 1979; Dolby, 1995; Edgar, 2001; Carah, 2010; Mackay-Dwyer, 2011; Purssell, 2012), two of which have been published (Burke, 2004; Byrne et al., 2013). Consequently, anthracological research in Australia has been heavily constrained by both time and a lack of technical expertise, which has resulted in reduced sample sizes that have limited utility for archaeological and palaeoecological inquiry (Dotte-Sarout et al., 2015). In this paper we present results from one of the largest anthracological assemblages analysed in Australia to date.

2. Regional setting

2.1. Site description

Riwi is located within the Mimbi area of the country of the Gooniyandi Indigenous group, which is in the southern Kimberley region of Western Australia. Mimbi is defined by the Emanuel and Lawford Ranges to the west and east respectively (Fig. 2), both of which are composed of uplifted Devonian limestone reef. On the edge of the Great Sandy Desert, Mimbi has a semi-arid to subtropical climate, and is within the lower limits of the Australian Summer Monsoon, receiving approximately 500 mm of rainfall per annum (Bureau of Meteorology, 1996). Vegetation is largely delimited by effective precipitation during the wet season (October–May), geology, fire, and cattle-grazing, with diversity and abundance of woody vegetation decreasing in a southeast gradient towards the arid interior of the continent (Beard, 1979). Broad scale mapping of the region shows that the dominant vegetation type within the Mimbi area is sclerophyll, and grades between woodland savanna, steppe, and grassland (Beard et al., 2013). The vegetation associations and alliances for each of these units are flexible, and a number of species combinations with different upper and ground stories are possible (Perry, 1956; Beard, 1979).

A southwest-facing cave at the base of the Lawford Range, Riwi is comprised of two chambers. The main chamber is approximately 13 m deep and 7 m wide, with a high ceiling, while the chamber at the back of the cave is smaller, with a low ceiling that restricts movement (Fig. 2). Prehistoric rock art, including a boomerang and phytomorphs, decorate the cave walls. The mouth of the cave is littered with lithic artefacts. The site has outstanding botanical preservation, particularly in the Holocene deposits, with paper bark fragments, wood shavings, seeds, nuts, and fruits preserved by desiccation and carbonisation (Dilkes-Hall, 2014). Analysis of the faunal remains is yet to be conducted. A carpological study has

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