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Last interglacial climates of south-eastern Australia: plant and beetle-based reconstructions from Yarra Creek, King Island, Tasmania

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ABSTRACT

This paper explores the palaeoclimatic significance of a fossil plant and insect record from Yarra Creek, on King Island, between Tasmania and the Australian mainland. The record dates, based upon a thermoluminescence chronology and other evidence, to Marine Isotope Stage 5 (MIS 5); the exact timing is impossible to ascertain given the resolution of the thermoluminescence results and the presence of an unconformity in the dated section. The presence of a cool-temperate rainforest flora, outside its modern range, and other independent evidence, suggest the sequence may represent the last interglacial (MIS 5e) rather than a later MIS 5 substage. Using coexistence methods that compare modern climatic ranges of the taxa in the assemblage we reconstruct independent beetle and plant based annual and seasonal temperate and precipitation parameters. The results imply the assemblage was deposited under a wetter summer climate and suggest conditions of enhanced temperature seasonality. It is probable that enhanced temperature seasonality is a methodological artefact reflecting the rarity of extremely equable climates (like King Island) in modern climate space. This would indicate a limitation of most methods of palaeoclimatic reconstruction that rely on modern datasets – it is only possible to reconstruct past climates as being within the range of values in that currently exist in modern climate space.

1. Introduction

Our understanding of the nature of last interglacial and Marine Isotope Stage 5 (MIS 5) climates Australia is limited. It is based on a relatively small number of biostratigraphically dated pollen records and lake level or river flow evidence from inland Australia. Terrestrial pollen records that span this period are restricted to the mesic margins of the continent and include sites in south-eastern Australian (Singh and Geissler, 1985; Harle et al., 2004; Kershaw et al., 2007), Tasmania (Colhoun, 1980; Colhoun et al., 1982, 1989, 1999), and the Wet Tropics region of north-eastern Australia (Kershaw, 1978; Moss and Kershaw, 2000; Kershaw et al., 2005). Several marine records from the northern Australian coastal margins include at least part of this period (Kershaw et al., 1993; van der Kaars et al., 2000; van der Kaars et al., 2006). High lake levels in arid-zone lakes and enhanced river flow in the Murray-Darling basin during the last and previous interglacials reflect enhanced monsoon activity and therefore higher precipitation during these periods (Magee et al., 1995; Croke et al., 1996; Bowler et al., 1998; DeVogel et al., 2004; Hesse et al., 2004).

In general palaeoclimatic interpretation of last interglacial sedimentary sequences suggests that MIS 5e was wetter than the Holocene, perhaps slightly warmer. This is based, for pollen records, upon the expansion of rainforest and other mesic taxa relative to Holocene levels (Harle et al., 2004), and for lake and river records, upon higher lake levels and flows than those attained during the Holocene (Hesse et al., 2004). In relation to the pollen data, a potential difficulty emerges in basing putative increased moisture on rainforest expansion – the Holocene is characterised by extensive and intensive aboriginal occupation in contrast to the last

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interglacial when Australia was unoccupied (Harle et al., 2004; Kershaw and van der Kaars, 2007). The trend in late Quaternary palynology of the region is to suggest that Aboriginal burning, documented by increased charcoal, resulted in contraction of fire sensitive vegetation to fire-protected habitats (Singh and Geissler, 1985; van der Kaars et al., 2000; Kershaw et al., 2002; Hope et al., 2004). This has implications for interpreting the significance of last interglacial rainforest expansion – was rainforest more extensive during this period because of wetter climates or have Holocene Aboriginal and, recently, post-European fire regimes prevented extant rainforests from reaching their climatically determined extent?

This paper provides the first quantitative analysis of MIS 5 climates for the Australian region that is based on evidence other than pollen data. We describe the results of palaeoclimatic analysis of plant and insect macrofossils from the site of Yarra Creek, on King Island in the Bass Strait region of south-eastern Australia (Fig. 1). We present luminescence ages for the sequence that firmly place it in MIS 5, and although the exact timing is difficult to determine we believe a range of evidence suggests that the organic sediments were accumulated during the last interglacial (MIS 5e). We use coexistence methods of palaeoclimate reconstruction to independently reconstruct the King Islands MIS 5 climate using bioclimatic envelope data for beetle and plant taxa.

2. Site setting and context

2.1. Site location

King Island is a continental island, the largest in Bass Strait, in between Tasmania and the Australian mainland (Fig. 1); with a drop in sea level of around 20 m it became part of Tasmania, and with a drop of around 50 m, it became part of greater Australia (Blom, 1988). The island is characterised by low relief with the highest point of the island, on the southern plateau, being less than 150 m above sea level. Lakes and swamps are common in the low-lying northern half of the island where extensive late Quaternary sand-sheet and dune development has impeded drainage. Dune systems are best developed in the west and along the southern coast reflecting the prevailing westerly and south-westerly wind-flow. The sedimentary sequence described here is exposed in a sea cliff just above modern sea level, to the north of the outflow of Yarra Creek, above a small cobble beach on City of Melbourne Bay (Fig. 1). Yarra Creek is a deeply incised system that drains the southern plateau of King Island. It flows through a gorge (up to 80 m deep) that presently contains remnant wet eucalypt forest including several temperate rainforest species.

2.2. Previous research

King Island has been the focus of geomorphic and palaeoenvironmental analyses that have examined extensive continental and marine dune systems (Jennings, 1957, 1959), and several extended lake, swamp, and partly marine sequences (D'Costa et al., 1993; D'Costa, 1997). Jennings (1959) described the fossil site here referred to as 'Yarra Creek' in an overview of the geomorphology of King Island and suggested that the organic sand and peat sequence represented deltaic deposits derived from Yarra Creek. Several aspects of the site were examined superficially. A single radiocarbon determination on wood collected from the base of the deposit by Jennings returned a result of 37,500 ± 1900 (NZ-349), which Colhoun (1985) interpreted to reflect probable

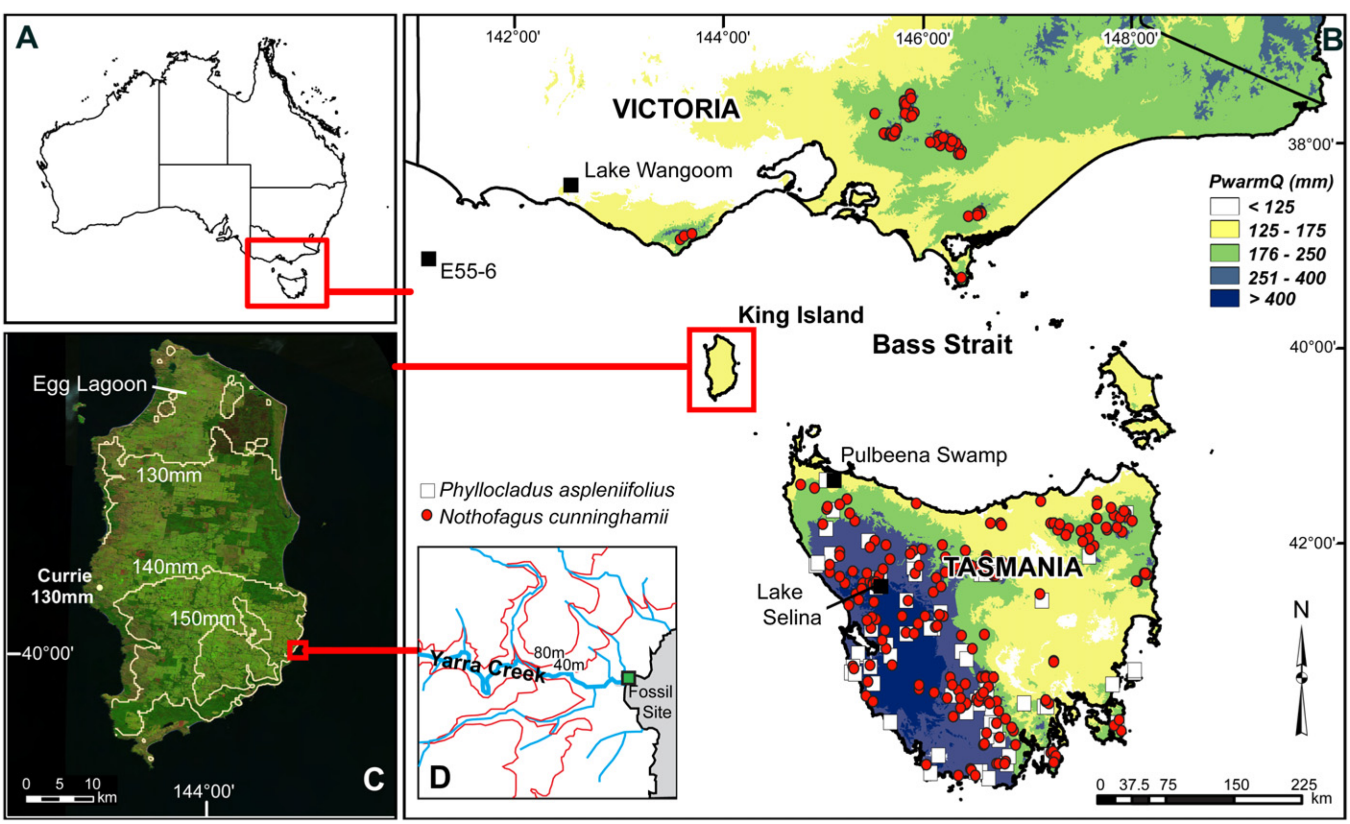

Fig. 1. Location and setting of King Island and the Yarra Creek section. A. Continental location. B. Southern Victoria, Bass Strait and Tasmania showing the location of King Island, other sites mentioned in the text and the modern distribution of the rainforest trees *Nothofagus cunninghamii* and *Phyllocladus aspleniifolius* in relation to summer precipitation (Precipitation of the Warmest Quarter, PwarmQ). C. King Island with isohyets of summer rainfall (PwarmQ) overset on satellite image of modern vegetation (Source: Geoscience Australia NatMap Raster Premium 2005). D. Local setting of Yarra Creek site.