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Human-environment dynamics during the Holocene in the Australian Wet Tropics of NE Queensland: A starch and phytolith study

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ABSTRACT

The timing and nature of hunter-gather exploitation of tropical rainforests is a topic of ongoing debate. In contrast to most other tropical regions, permanent settlement in Australian rainforests developed much later, and in the absence of adjacent agricultural economies. Here we explore how the tropical rainforests of northern Queensland were exploited during the late Holocene through an ancient starch and phytolith record spanning the last 2000 years. Sequences at the two sites under study – Urumbal Pocket (a '*Eucalyptus* pocket' surrounded by rainforest) and Goddard Creek (within the rainforest) – indicate a human presence since the early Holocene, coincident with the re-establishment of rainforest in the region. Toxic starchy nuts and the associated complex processing underpinned permanent settlement. Using a geometric morphometric approach to starch analysis, a range of economic starch producing plant species were identified including *Endiandra palmerstonii*, *E. insignis*, *Lasjia whelani* and *Beilschmiedia bancroftii* in the Urumbal pocket sequence. The phytolith record shows that Urumbal Pocket has been a '*Eucalyptus* pocket' for at least the last 2000 years, the open nature of the vegetation maintained by regular burning. Goddard Creek, on the other hand has been closed forest, with a changing profile as fire was used more frequently over time. The starch and phytolith sequence provide a unique insight into the local history of these rainforest archaeological sites, with a record that can be viewed against the backdrop of regional sequences documenting climatic and environmental patterns during the late Holocene.

1. Introduction

Humans arrived in Sahul (Pleistocene Australia-New Guinea landmass) around 50,000 years ago and rapidly dispersed across the continent, entering most environmental zones within a few thousand years (O'Connell and Allen, 2012, 2015). A wide-ranging Pleistocene human presence has been documented, extending from the more arid regions of Sahul to the peri-glacial environments of south-western Tasmania and the montane valleys of New Guinea (Cosgrove, 1995; O'Connor, 1995; Cosgrove and Allen, 2001; Smith, 2006; Summerhayes et al., 2010; David et al., 2011). Denham et al. (2009: 38) have argued that it was a '*generalist set of practices tailored to different regions and biotic resources*', perhaps developed in SE Asia (see Niah Cave: Barker et al., 2007), that equipped people to rapidly adapt while moving into and through these new landscapes.

Where rainforests were widespread during the Pleistocene, such as northernmost Sahul and offshore islands, a human presence is also found (Pavlides and Gosden, 1994; Summerhayes et al., 2016). Palaeoenvironmental data for other parts of northern Sahul (present day North Queensland) indicates significant tropical rainforest contraction and fragmentation over the last 50,000 years. The dramatic decline in tropical rainforest may have precluded the development of rainforest cultures prior to the Holocene (see Kershaw, 1983, 1986, 1993, 1994; Nix, 1991; Hopkins et al., 1993, 1996; Kershaw et al., 2007). Opportunities for exploitation of any of the rainforest resources by people would have centered on highly contracted distributions – in some places confined to gullies and other sheltered locales.

It is evident that a primary consideration in the timing and mode of rainforest settlement in Australia is the impact of global climatic change through the terminal Pleistocene and early-mid Holocene periods. An understanding of how major changes in the composition, configuration and range of tropical forests unfolded (Schneider and Moritz, 1999) will necessarily be an important

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factor in determining how people responded to change, and how they exploited these regions through this transitional period. We are constrained, to some extent, in answering these questions by the small number of archaeological sites known from the rainforest and the limitations of the data preserved therein (Ferrier, 2015).

Recent archaeological investigations in NE Queensland have identified the presence of people in the sclerophyll forests (adjacent to modern tropical rainforests) before and after the Last Glacial Maximum. While a human presence in the tropical rainforest is coincident with their re-establishment in the early Holocene, intensive use of the rainforest and permanent settlement by people does not emerge until c. 2000 years ago (Cosgrove et al., 2007). The apparent late development of rainforest cultures in Australia may be due to a complex interplay of factors. These include: 1. the pace of increases in population density across the region in the Holocene, which may have driven the need for access to more reliable resources; 2. the development of technologies facilitating exploitation of rainforest resources such as toxic starchy tree nuts (Cosgrove and Raymont, 2002); and/or 3. climatic constraints on tropical rainforest size and distribution during the Pleistocene-Holocene transition (see Bell et al., 1987; Kershaw, 1994; Kershaw et al., 2007 for climatic data).

In the 1980s Bailey and Headland (Headland, 1986; Bailey et al., 1989; Headland and Reid, 1989) argued that forest dwellers depended on exchanges/interactions with agriculturalists and horticulturalists outside the rainforest to counter the lack of resources therein. The implication was that people did not use tropical rainforests prior to the Holocene. Recent findings of Pleistocene rainforest occupation elsewhere in the world, often independent of subsistence patterns outside these habitats, contradict these controversial ideas, and suggest that where rainforests were present so were people (e.g. Barton, 2005; Barker et al., 2007; Kourampas et al., 2008; Roberts and Petraglia, 2015; Summerhayes et al., 2016). In Australia, the development of rainforest adaptations can only have emerged during the Holocene primarily because these environments were not established in large enough tracts to be viable prior to this time (but after human colonization). The unique archaeological record documented in the Australian tropics offers a particularly interesting case study: not only because are there long term regional environmental sequences documenting shifts in vegetation composition through the Pleistocene and Holocene, but the lack of agricultural societies in Australia provides an opportunity to track Holocene tropical rainforest use uncomplicated by the possibility of agricultural food exchanges.

Here we present the results of an exploratory study to determine whether phytolith and ancient starch were preserved in late Holocene open-site archaeological deposits from the North Queensland Wet Tropics, Australia (Fig. 1), and if so, how they may inform us about human exploitation of tropical rainforests. In particular, we are interested in the development of subsistence strategies and forest management/niche maintenance during the late Holocene in two sites, Goddard Creek and the Urumbal Pocket in the Wet Tropics World Heritage Area (WHA). Initially conceived as a pilot project to evaluate the preservation of micro-botanical remains in Queensland tropical soils, the surprisingly good preservation makes it possible to sketch human-environmental impact and plant use at both sites.

2. Background

2.1. Niche construction and rainforest occupation in Northern Queensland

One of the strategies implemented by people in adapting to the expansion of tropical rainforests during the early to mid-Holocene was forest and gap management, or niche construction (Laland and Brown, 2006; Laland et al., 2007; Laland and O'Brien, 2010). There is growing evidence (outside Australia) that as tropical forests expanded, people maintained gaps in the forest through burning and other strategies, to support and maintain concentrations of economic plants and animals (Kealhofer, 2003; Terrell et al., 2003; Hunt and Premathilake, 2012).

Niche construction theory (NCT) provides a useful interpretive framework within which to consider the outcomes of human-environment interactions in the Australian context (e.g. Laland and O'Brien, 2010). As an heuristic tool, NCT aids in identifying the driving factors in rainforest settlement and charting the evolution of rainforest culture in Australia. The Australian case has a number of parallels with the arguments concerning the emergence of agriculture in other societies (see Smith, 2016). While many of the apparent features of pre-agricultural societies are shared with that of rainforest Aborigines in northeastern Queensland, the trajectories are clearly very different. Notably, plant and animal domestication, as described for eastern North America or South America (Smith, 2016), never eventuated in Australia.

As Smith (2016: 312) states "*NCT recognizes the capacity of organisms to shape their own evolutionary trajectories through engineered enhancement of their surrounding environment. Adaptation is not always in response to disequilibrium in local environments. Niche construction involves an organism altering the relationship between itself and its ecosystem, and such modification can provide individuals and populations with an evolutionary advantage.*"

2.2. Environmental and archaeological context

The history of tropical rainforest settlement in far northeastern Australia appears to differ markedly from the Pleistocene records observed further north from northernmost Sahul. To better understand the relatively late settlement of rainforest environments in Australia, we need to consider the impacts of the last Glacial cycle in terms of reconfiguration of these eco-zones. The Last Glacial cycle was characterized by climatic variability coupled with a trend to increasing aridification that began hundreds of thousands of years ago (see Nanson et al., 1992; Wroe et al., 2013). As different vegetation communities reconfigured in response to these profound changes in water balance and temperature, rainforest zones contracted to be replaced by sclerophyllous vegetation (Moss and Kershaw, 2007; Reeves et al., 2013). Notably, in their study of charcoal evidence from rainforest from this region, Hopkins et al. (1993: 370) speculate that for NE Queensland "the distribution of rainforest in the late Pleistocene was a highly fragmented version of that which exists today with rainforest persisting in fire-proof topographic and edaphic location(s)". If people did exploit these rainforests fragments, it likely occurred in a mosaic environment, with high resource diversity. With the onset of more stable climatic conditions, in the early Holocene, rainforest tracts and boundaries stabilized by approximately 8000 BP (Moss et al., 2012), when the earliest signal of people in these newly established rainforest tracts appears.

Current knowledge about tropical forest occupation has been greatly expanded in the last two decades following systematic survey and excavation in the Wet Tropics World Heritage Area, southwest of Cairns, in northeastern Australia (see Stevens, 2004; Cosgrove et al., 2007; Ferrier, 2015; Fig. 1). The results of this work have greatly improved our understanding of the sequence and timing of human colonization of these environments (see Cosgrove et al., 2007; Ferrier and Cosgrove, 2012). This more recent work builds on earlier investigations at Jiyer Cave on the Russell River and the Mulgrave River 2 site by Horsfall (1987, 1996) and Cosgrove and Raymont (2002). Furthermore, Murubun Shelter, located in what is currently wet sclerophyll forest (on the

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