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A Late Holocene palaeoenvironmental reconstruction of Ulong Island, Palau, from starch grain, charcoal, and geochemistry analyses

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ABSTRACT

This study represents the first starch grain analysis undertaken in Palau, performed on a sediment core extracted from a sinkhole on Ulong Island. Radiocarbon dating indicates the core spans the likely period of human occupation on Ulong (ca. 3000 years) as established by prior archaeological evidence. Samples were analysed for macrocharcoal, starch content, and geochemical composition. The results of the analyses indicate an initial period of intensive clearance and gardening from ca. 3000–2000 BP, during which banana (*Musa* spp.), yams (*Dioscorea* spp.), Polynesian arrowroot (*Tacca leontopetaloides*), Tahitian chestnut (*Inocarpus fagifer*), and breadfruit (*Artocarpus* sp.) were being utilised and/or cultivated. This initial phase was then followed by a period of reduced and stabilized gardening activity until ca. 1000 BP, during which banana (*Musa* spp.) disappears from the starch record. The period after 1000 BP represents the transition between the first permanent settlements on Ulong, abandoned between 500 and 300 BP, and the arrival of Europeans in 1783. This period is marked by a dearth of charcoal indicating the absence of significant burning, as well as a decrease in the variety of starch grains from cultigens.

1. Introduction

1.1. Starch grain analysis in the Pacific Islands

The analysis of starch grains preserved in sediments as a means of palaeoenvironmental reconstruction is a relatively new but potentially important technique (Lentfer et al., 2002). Exploratory studies have shown that starch grains preserve particularly well in sediments from tropical environments, and they have been utilised successfully for palaeoenvironmental reconstruction in the Pacific Islands (e.g., Denham et al., 2003; Fullagar et al., 2006; Horrocks and Nunn, 2007; Horrocks and Rechtman, 2009; Horrocks and Weisler, 2006; Lentfer et al., 2002). This study applies, for the first time, starch grain and geochemical analyses of ponded sediments from Palau as proxies to better understand human arrival and environmental changes in this archipelago.

Starch is a complex, insoluble carbohydrate that is the main substance of food storage for plants and is most commonly found in underground stems (i.e. rhizomes and tubers), roots, and seeds. Because their semi-crystalline nature makes them birefringent, an extinction cross is visible in each grain when viewed under cross-polarized light, and the presence of this cross allows starch granules to be differentiated from other microscopic plant fossils with relative ease (Horrocks et al., 2004).

In the past, starch grains were often assigned to species based on their morphological characteristics, relying upon the visual comparison between individual archaeological granules with reference granules (Wilson et al., 2010). However, this approach is not ideal as the comparison of discrete granules is likely to be unreliable (Torrence et al., 2004). To address this problem, multivariate analysis of data recorded from digital images can be used to construct a system of classification that facilitates the discrimination of the starch grains among different plant types with a high degree of consistency by recording a number of metric and nominal variables (Torrence et al., 2004). However, a potential limitation to this method for analysing starch is the representation of three-dimensional starch granules in a two-dimensional image. Since any species of plant starch will contain a variety of granule shapes, a population approach to the analysis can address this problem, resulting in more reliable starch grain identifications than can be achieved with single-grain identification (Wilson et al., 2010).

Starch grain analysis is a particularly useful technique in the Pacific region, where research on the age, development, and diversity of early

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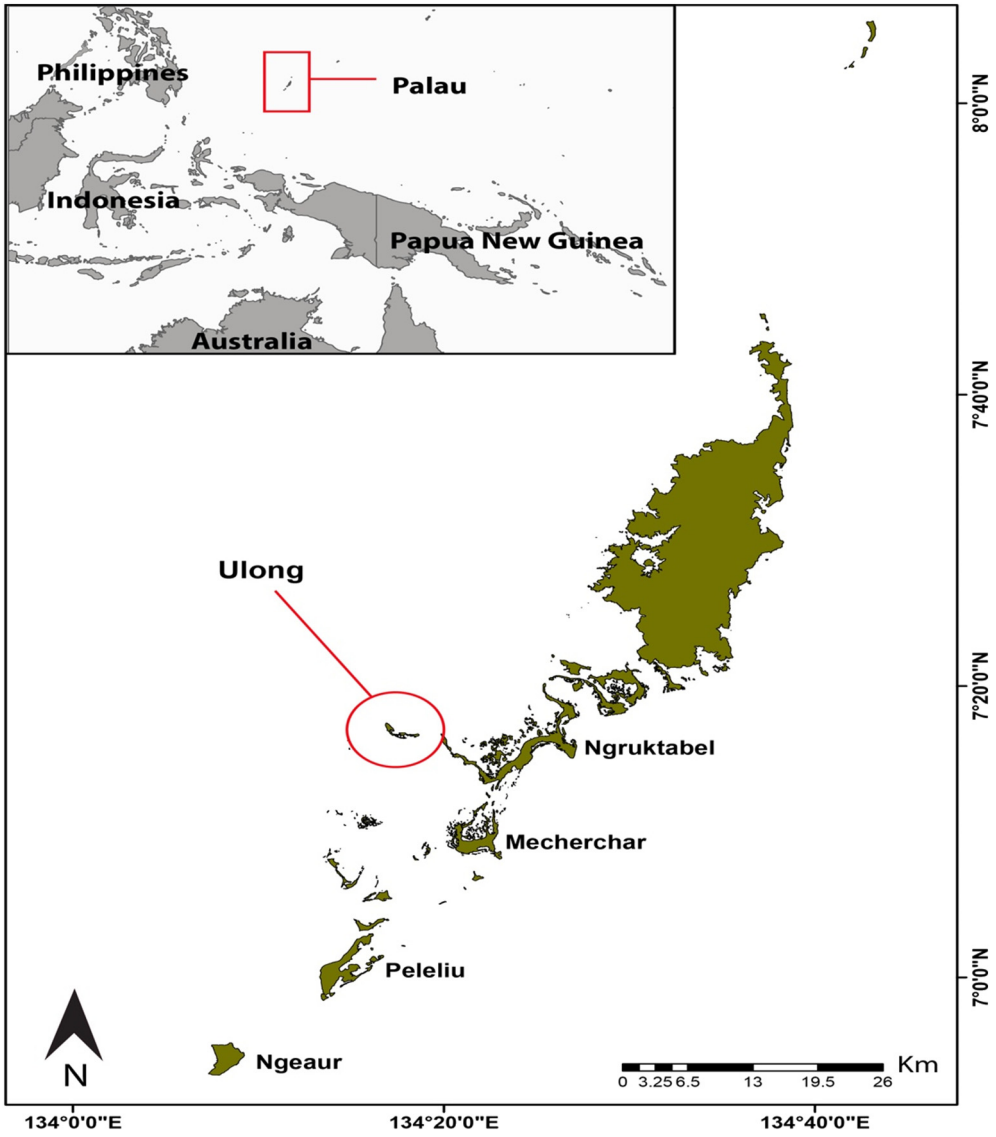

Fig. 1. Maps showing the location of Palau within the Pacific (inset) and the location of Ulong Island within Palau.

Fig. 2. Photograph of Ulong Island.
(Photo taken by G. Clark)

agriculture has been hindered by an archaeological scarcity of crop fossils (Horrocks and Weisler, 2006). Furthermore, archaeological deposits in the Pacific often have limited pollen and phytolith production, and the more robust starch grains are therefore ideal proxies to add to the line of evidence for cultivation and other environmental changes in that region (Horrocks et al., 2004).

In this study, we tested whether or not starch grains can be assigned to species with a high degree of confidence in ponded sediments of Ulong Island in Palau. We were specifically interested in using the variation in starch assemblages to interpret human utilisation and/or

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