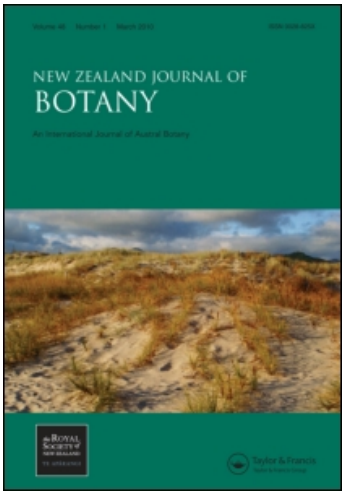

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Introduced *Dioscorea* spp. starch in Lapita and later deposits, Vao Island, Vanuatu

M. Horrocks[ab]; S. Bedford[c]
[a] Microfossil Research Ltd, Auckland, New Zealand [b] School of Environment, University of Auckland, Auckland, New Zealand [c] Research School of Pacific and Asian Studies, The Australian National University, Canberra, Australia

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Introduced *Dioscorea* spp. starch in Lapita and later deposits, Vao Island, Vanuatu

M Horrocks[a,b]* and S Bedford[c]

[a]*Microfossil Research Ltd, Auckland, New Zealand;* [b]*School of Environment, University of Auckland, Auckland, New Zealand;* [c]*Research School of Pacific and Asian Studies, The Australian National University, Canberra, Australia*

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Analysis of deposits at a Lapita site in Vanuatu revealed putative starch grains of *Dioscorea nummularia* in ~2800–3100 cal. BP layers and of *Dioscorea pentaphylla* in a ~2000 cal. BP layer, suggesting local cultivation of these tuberous crops. The Dioscoreaceae are a new addition to the introduced cultigens thus far directly identified for prehistoric Vanuatu.

Keywords: prehistoric horticulture; ancient starch; *Dioscorea*; Lapita; Vanuatu

Introduction

Microfossils of introduced cultigens (outside their natural range) have recently been identified in Lapita and subsequent prehistoric era deposits at sites in Vanuatu (non-*Colocasia* Araceae starch/raphides and *Musa* phytoliths) (Horrocks & Bedford 2005; Horrocks et al. 2009). Archaeological evidence of the Lapita Cultural Complex has been found from Western Island Melanesia (~3300 cal. BP) to Tonga and Samoa (~2800 cal. BP) (Kirch 2000). This represents initial human colonization in Remote Oceania (all Pacific islands, including Vanuatu, to the north, east and south-east of the Solomon Islands chain). In this study, deposits from one of the Vanuatu microfossil sites not previously examined for starch, Vao Island, were analysed to test for further evidence of ancient horticulture.

The study area and site

Vao Island is one of a string of small, low-lying islands (each $< 2\,km^2$) located off the north-east coast of the much larger Malekula Island in northern Vanuatu. Apart from sandy beaches on the western coasts facing Malekula, the islands are fringed by coral reefs. Details of the geology and geomorphology of Vao are given in Bedford (2006, 2007) and Horrocks et al. (2009).

Archaeological excavations were undertaken at Vao in 2002–2004. In one of these (Area A, 3×2 m), five distinct layers were identified. These comprise: layer (L) I, a dark brown tephra-rich deposit capped by a humic topsoil which contained artefacts including historic items; L II, a compacted layer of imported worn branch coral and pebbles, and associated cultural material dating to ~2000 cal. BP; L III, a dark brown sandy deposit and later Lapita midden; L IV, a concentrated Lapita midden in a sand and tephra deposit dating to ~2800–3100 cal. BP; and L V, the surface of the original coral sand beach (Bedford 2006; Horrocks et al. 2009). The Vao Lapita site is the earliest to date identified for Malekula.

Methods

Five samples from Vao Island (L I–V) were analysed for microscopic starch remains.

*Corresponding author. Email: info@microfossilresearch.com

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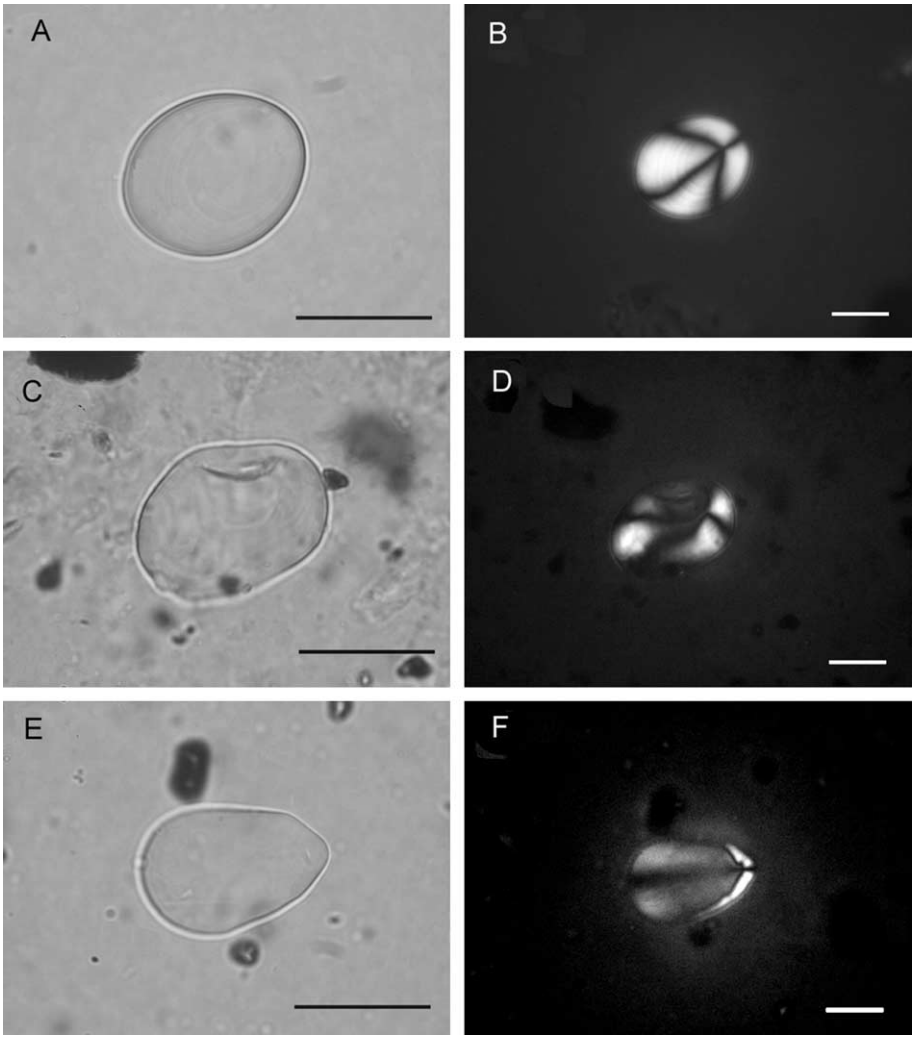

Fig. 1 Ancient starch from Vao Island [mounted in glycerol jelly; transmitted or cross-polarized light (CPL), the latter with black background; 600 × and 400 ×; (B), (D) and (F) shown at lower magnification to increase light contrast because the Maltese cross on ancient grains is often faded; scale bars: 20 μm]. (A–D) Starch grains consistent with *Dioscorea nummularia* tuber (cf. Fig. 2A–D). (B) and (D) shown in CPL with eccentric Maltese crosses. (E,F) Starch grain consistent with *Dioscorea pentaphylla* tuber from sample L II (cf. Fig. 2E,F). (F) Shown in CPL with eccentric Maltese cross.

Samples were prepared for analysis by density separation (Horrocks 2005; Torrence & Barton 2006). Starch grain identification was carried out with the aid of a modern reference collection. Previous reports of starch grain morphology were also consulted (Fullagar et al. 2006; Loy et al. 1992; Rao & Beri 1955; Reichert 1913; Torrence & Barton 2006). Starch grains are normally colourless. The position of the hilum (developmental origin of the grain) can be seen in cross-polarized light; grains characteristically show birefringence with dark lines intersecting at this point ('Maltese cross').

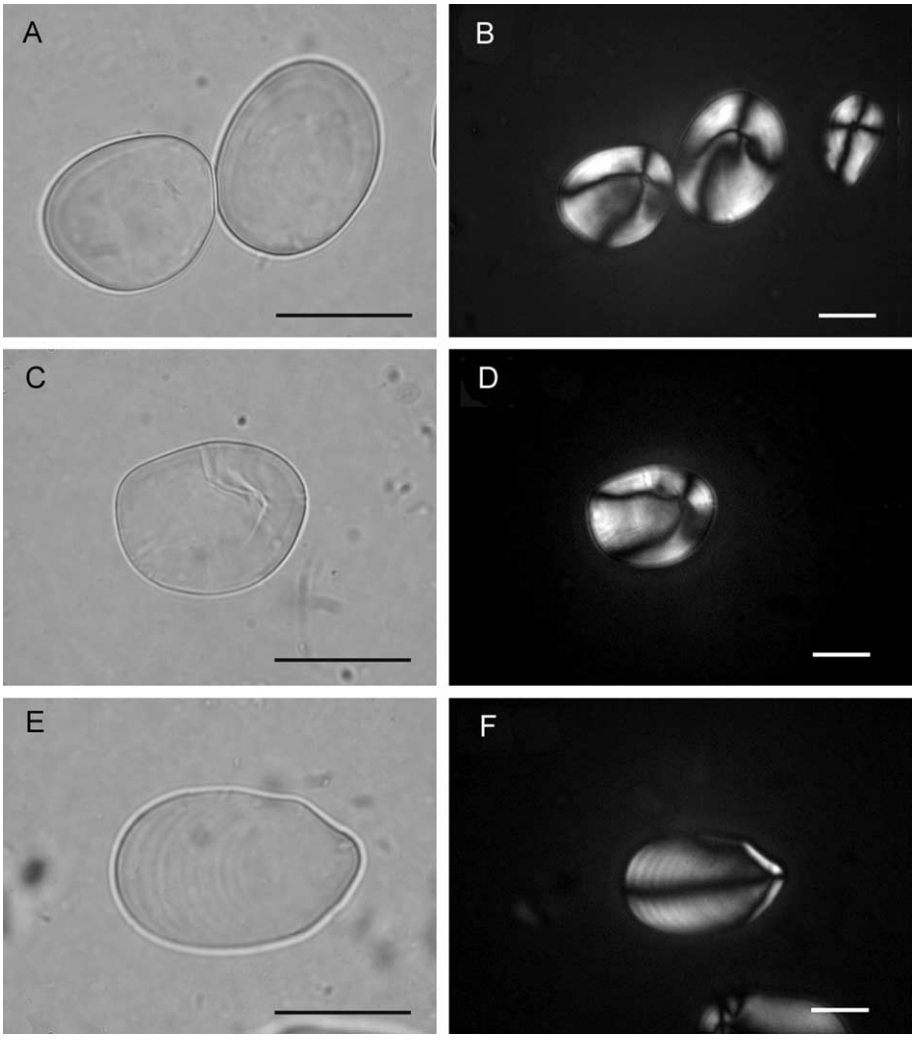

Fig. 2 Starch grains from modern reference samples [mounted in glycerol jelly; transmitted or cross-polarized light (CPL), the latter with black background; 600 × and 400 ×; (B), (D) and (F) shown at lower magnification; scale bars: 20 m]. (A–D) Starch grains of *Dioscorea nummularia* tuber. Grains are triangular, sometimes oblong to ovate, with a width:length ratio of ~0.6, up to ~45 µm long (Fullagar et al. 2006). Grains also often have a fissured hilum, shown in (C). (B) and (D) shown in CPL with eccentric Maltese crosses. (G,H) Starch grain of *Dioscorea pentaphylla* tuber. Grains are ovate to triangular, up to ~75 µm long, commonly with a 'clearly sculptured' or 'pinched' narrow end, fan-like (Fullagar et al. 2006). (F) Shown in CPL with eccentric Maltese cross.

Results

Small amounts of starch grains consistent with tubers of *Dioscorea nummularia* and *Dioscorea pentaphylla* were found in the Vao Island samples, the former in L III and L V, and the latter in L II (Fig. 1). Examples of starch grains of these two species from modern reference material are shown in Fig. 2.

Discussion and conclusions

All Dioscoreaceae in Remote Oceania are human introductions (Whistler 1991). Five species are prehistoric introductions: *Dioscorea alata*, *Dioscorea bulbifera*, *Dioscorea esculenta*, *Dioscorea nummularia* and *Dioscorea pentaphylla*. On the basis of size and shape, starch grains of this group can be differentiated. Mature grains of *D. esculenta* are small, $< 10\,\mu m$ in diameter, sub-triangular, angular and faceted, with a central Maltese cross. Grains of the remaining four species are many times larger (up to $\sim 100\,\mu m$) and have an ovate or triangular, often elongated shape, and an eccentric (i.e. not central) Maltese cross. Only *D. nummularia* grains are commonly ovate or triangular (see modern reference examples, Fig. 2); the other two species are more elongated. Similarly, only *D. pentaphylla* grains commonly have a distinctive 'clearly sculptured' or 'pinched' narrow end (Fullagar et al. 2006), giving a fan-like appearance shown in the modern reference example (Fig. 2). Starch grains of the other introduced Vanuatu starch cultigens either have a different shape or are smaller. We conclude that of the potential starch cultigens, the starch grains found in this study are most likely *D. nummularia* and *D. pentaphylla*. However, given that the starch taxonomy of local non-economic plants is not well known and the small amount of fossil starch grains found, our identifications should be viewed cautiously.

The presence of putative *Dioscorea* starch grains in archaeological deposits in Remote Oceania provides strong evidence for the presence of this genus; the region is outside its natural distribution and lacks close relatives. The results provide direct evidence that *D. nummularia* (L III and L IV) and *D. pentaphylla* (L II) were cultivated at Vao Island during Lapita and subsequent times, respectively. The Dioscoreaceae are a new addition to the introduced cultigens thus far identified for prehistoric Vanuatu.

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