Preliminary Report on Pollen and Sedimentary Records from Nuku Hiva, Marquesas Islands, East Polynesia

Melinda S. Allen1, John Flenley2, Kevin Butler2, and Mark Horrocks3

1 Department of Anthropology, University of Auckland, Private Bag 92019, Auckland, New Zealand.
   Corresponding author: ms.allen@auckland.ac.nz

2 Geography Programme, School of People, Environment and Planning, Massey University, Palmerston North, New Zealand

3 Microfossil Research Ltd., Auckland, New Zealand

INTRODUCTION

Palynological research in central Polynesia has largely centred on questions of the timing of human arrival. In these contexts, late Holocene records have both supported (e.g., Kennett et al. 2006; Parkes 1997) and challenged archaeological accounts, sometimes suggesting a much longer human presence than direct archaeological evidence (e.g., Kirch and Ellison 1994 versus Anderson 1995). Considerably less attention has been directed to the post-settlement vegetation histories of these islands, and the potential of palynology to inform on changing climatic conditions and anthropogenic influences in this later period. Increased interest in climate variability over the last millennium, including discussions of Pacific expressions of the Medieval Climatic Anomaly (MCA) and the Little Ice Age (LIA) (e.g., Cobb et al. 2003), make the latter particularly relevant.

The palynological history of the Marquesas Islands of French Polynesia is of interest for a number of reasons. Foremost, the indigenous vegetation is poorly known, having been much reduced by anthropogenic activities, including historically introduced herbivores, and alien plant species (Decker 1970; Florence and Lorence 1997). Second, lying in the heart of the El Niño-Southern Oscillation (ENSO) region, Marquesan palynological records potentially inform on vegetation responses to regional climate variability. Recently, coral oxygen isotope records from Palmyra in the Line Islands have suggested an unexpected pattern of climate variability over the last millennium in this equatorial setting. Cobb and associates (2003) found evidence for cool-dry conditions during the MCA and warm-wet conditions during the LIA, findings which are at variance with Northern Hemisphere patterns. Palynological records may give insights into whether or not the Marquesas Islands, which lie in the same modern climate response region (Salinger et al. 2001), experienced similar shifts in background climate. Finally, archaeological accounts of prehistoric socio-political change (Allen 2009; Kirch 1991; Suggs 1961) have often assigned a causal role to environmental variability, but palaeoecological records of appropriate temporal duration have been lacking. Pollen and sediment cores are an important means of tracking changes in terrestrial conditions, and in some cases anthropogenic influences, over extended periods of time. This paper summarises findings from a pollen-sediment core from the interior To’ovi’i Plateau of Nuku Hiva Island, results which are detailed in a forthcoming paper (Allen, Butler, Flenley, and Horrocks ms).

ENVIRONMENTAL SETTING

The Marquesas Islands are situated ca. 1500 km northeast of Tahiti, between 7° 53’ and 10° 35’ S latitude and 138° 25’ and 141° 27’ W longitude. The islands have a mesic tropical climate, with temperatures ranging from 25 to 27 degrees centigrade. Precipitation, in
contrast, is highly variable, with annual rainfall averages varying from 700 mm in leeward areas, to nearly 1500 mm on windward coasts (Cauchard and Inchauspe 1978). Rainfall is particularly high in the interior of Nuku Hiva, where the To’ovi’i Plateau receives 2000-3000 mm annually (ORSTOM 1993). Inter-annual variation also is marked, and generally tied to El Niño-Southern Oscillation (ENSO) and Interdecadal Pacific Oscillation (IPO) cycles (Allen 2009). The islands are well known for their prolonged droughts, which historically often led to famines. However, torrential rains also can occur, especially during El Niño years.

The Marquesan flora is predominantly Indo-Malaysian in origin, although 42% of the 320 vascular species are endemic (Wagner and Lorence 1997). There is a remarkably high percentage of pteridophytes, which at 33% is among the world’s highest (Wagner and Lorence 1997:222). Several kinds of native forest are recognized (Hallé 1978; Mueller-Dombois and Fosberg 1998; Florence and Lorence 1997) despite large areas having been heavily degraded in the recent past. At European contact, much of the lowland region was in Polynesian cultivation, but by the mid-1800s many valley bottoms had been transformed into commercial coconut plantations (Decker 1970). Even inland localities have not escaped anthropogenic disturbances, with large areas of To’ovi’i Plateau being converted to grassland and pine forestry. Nevertheless, remnants of native vegetation persist in ravines and on ridgelines in this upland zone. Florence and Lorence (1997) identify two main forest types in the To’ovi’i region today: 1) a relatively open, low stature forest dominated by *Metrosideros* and *Weinmannia parviflora* which commonly occurs on the drier slopes and ridges; and 2) a considerably taller (6-8 m) *Hernandia* and *Cyathea* forest which is typical of more humid valleys and gulches. Pteridiophytes (ferns) are common in both areas.

**FIELD AND LABORATORY METHODS**

Several areas were investigated for palynological study in 2003. Initially, work concentrated on the To’ovi’i Plateau where wet sediment traps were common but, as it turned out, typically only a few centimetres deep. A lake depicted on the 1:50,000 topographic map was located but proved to be man-made and unsuitable for palynological study. Eventually, three small wetlands with coring potential were identified, one on the To’ovi’i Plateau and two in lowland contexts (Hatiheu and Taipivai Valleys). The focus here is a 2.47 m core secured at 810 m on the To’ovi’i Plateau (8° 51’ 140” S latitude, 40° 9’ 35” W longitude). This small swamp measured ca. 55 m long by 49 m wide and was largely covered with *Cyperus kyllinga* (an aggressive European-introduced sedge) and grasses.

The core was obtained with a D-section corer by Butler. To augment the extant Massey University pollen reference collection, 116 vouchered reference samples and fifty-one modern pollen samples were collected. Thirty-seven wood specimens also were taken for wood charcoal identification work.

In the lab, Horrocks sub-sampled the core at 10 cm intervals, beginning 5 cm below the top. Standard acetylation methods were used, with the hydrofluoric acid step being replaced by density separation using sodium polytungstate (specific gravity 2.0). At least 200 pollen grains and spores were counted for each sample. As well as relative (percentage) counts, pollen concentrations were determined. Tablets of a known quantity of exotic *Lycopodium* spores were added to the samples to determine pollen concentrations, the tracer species being morphologically distinct from the native species.

Three radiocarbon samples were taken from the core. One sample derives from 125 cmbs, where the pollen concentration diagram indicated a marked and sustained increase in pollen and spore deposition. A second sample was taken at 185 cmbs, ca. three-fourths of the
way down the core and at a point where a change to slightly more fine-grained sediments was indicated. A third sample was taken from the base of the core.

AMS determinations were made on pollen concentrate, rather than charcoal, in an effort to directly date the material of interest and reduce the possibility of dating younger or older carbon contaminants (see Vandergoes and Prior 2003). The samples were processed by Christine Prior at the Rafter Radiocarbon Laboratory where they were subjected to density separation as described in Vandergoes and Prior (2003). The resulting pollen concentrate was dried and AMS dated at the Rafter Lab.

RESULTS

Chronology and Stratigraphy

A sample from the base of the To’ovi’i core returned a 1σ age range of AD 1288-1421. Archaeological evidence from elsewhere on the island places these results within the period of human settlement. Current archaeological estimates suggest human arrival in the Marquesas Islands around AD 700-900 (Allen 2004) or, more conservatively, after the 11th century AD (Anderson and Sinoto 2002). By the 13th century AD communities were established throughout the archipelago, with early sites in both the northern and southern groups. Late prehistory saw dense occupation in most valleys, as indicated by widespread and numerous raised stone house foundations (e.g., Addison 2006; Suggs 1961).

Using the three AMS determinations, an age-depth curve was constructed. The results indicate that initially sedimentation was very rapid. Between ca. AD 1350 and 1630, sedimentation slowed, while after ca. AD 1630, rates increased again, although deposition was less rapid than in the initial period.

Pollen results

Pollen and spores were abundant and fairly well preserved in all of the To’ovi’i core samples. As a whole, the To’ovi’i record is dominated by ferns and fern allies. In addition to the identified taxa, many of the psilate (smooth and unornamented) spores, including both monolete and trilete types, are also ferns. Grasses, (Poaceae), woody trees and shrubs, and other herbaceous taxa, in contrast, are minor components. Given that ferns and fern allies are not only a significant component of the island’s vascular flora, but also are common understory plants in the remnant native upland forest today, these findings are not surprising. A relatively open woodland with a dense fern understory is suggested by the pollen profile.

Among the woody species represented in the core are Metrosideros, a second unidentified Myrtaceae, Asteraceae, Malvaceae (probably Hibiscus), and Pandanus. The Asteraceae representative could be the endemic Oparanthus, a species which Florence and Lawrence (1997) associate with the wetter Hernandia-Cyathea formation. Notably there is a modest rise in Cyathea at roughly this same depth interval, from 115 to 75 cmbs. Alternatively, the Asteraceae might be a woody Bidens, as for example, B. bipontin, which is found today in association with Metrosideros-Weinmannia forest (Smithsonian National Museum of Natural History 200).

Today the Hibiscus-Pandanus forest is found at slightly lower elevations. Given that Hibiscus is insect pollinated (Ellison 1989:332), the presence of its pollen in the To’ovi’i core suggests trees once grew in the nearby vicinity. The Pandanus grains, in contrast, could be the result of either local deposition or long-distance transport, as this is a wind-pollinated species.
The main period of change in the To’ovi’i core occurs post-1630 AD, when pollen and spore values increase markedly. This pattern could result from a decrease in sediment deposition. However, the age-depth curve, constructed from three radiocarbon determinations on pollen concentrate, suggests that the sedimentation rate increases in the upper part of the core, a change also suggested by the sediment textural characteristics. Assuming pollen rain remained constant, the effect of increasing sedimentation would be to reduce the pollen concentration values. The combination of increased pollen accumulation and increased sediment deposition suggests some other factor was involved.

Notably, the 17th century is the height of the Little Ice Age in many regions of the world. The Palmyra Island coral oxygen isotope records indicate that during this period the central Pacific experienced warmer conditions and increased precipitation, as well as intensified El Niño activity (Cobb et al. 2003). One interpretation is that the warmer-wetter conditions favoured plant growth and by extension pollen production. Alternatively, these conditions may have enhanced pollen preservation, as the local sediment trap became more consistently wet. Both interpretations are made with caution, as there are only three radiocarbon dates and the pollen concentrate samples could potentially be contaminated by either older pollen deriving from slope wash, or younger pollen arising from bioturbations.

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REFERENCES CITED


