The Sweet Potato in Oceania: a reappraisal

edited by

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Ethnology Monographs 19
Oceania Monograph 56

2005
Contents

1. Chris Ballard
   Still good to think with: the sweet potato in Oceania ........................................... 1

2. R. Michael Bourke
   Sweet potato in Papua New Guinea: the plant and people ........................................ 15

3. Simon G. Haberle and Gill Atkin
   Needles in a haystack: searching for sweet potato (Ipomoea batatas (L.) Lam.) in the fossil pollen record ........... 25

4. Richard Scaglion
   Kumara in the Ecuadorian Gulf of Guayaquil? ............................................................ 35

5. R.C. Green
   Sweet potato transfers in Polynesian prehistory ...................................................... 43

6. Helen Leach
   Ufi kumara, the sweet potato as yam ........................................................................ 63

7. James Coil and Patrick V. Kirch
   An Ipomoean landscape: archaeology and the sweet potato in Kahikinui, Maui, Hawaiian Islands .................... 71

8. Paul Wallin, Christopher Stevenson and Thegn Ladefoged
   Sweet potato production on Rapa Nui ....................................................................... 85

9. Serge Dunis
   Of kumara and canoes: Maori and Hawaiian mythologies and American contacts ......................... 89

10. Matthew G. Allen
    The evidence for sweet potato in Island Melanesia ................................................... 99

11. Tim Bayliss-Smith, Jack Golson, Philip Hughes, Russell Blong and Wal Ambrose
    Archaeological evidence for the Ipomoean Revolution at Kuk swamp, upper Wahgi Valley, Papua New Guinea .. 109

12. Polly Wiessner
    Social, symbolic, and ritual roles of the sweet potato in Enga, from its introduction until first contact ............. 121

13. Paula Brown and Harold Brookfield
    Sweet potato, pigs and the Chimbu of the Papua New Guinea highlands .......................... 131

14. David J. Boyd
    Beyond the Ipomoean Revolution: sweet potato on the ‘fringe’ of the Papua New Guinea highlands ............. 137

15. Anton Ploeg
    Sweet potato in the central highlands of west New Guinea ......................................... 149

16. Alexander Yaku and Caecilia A. Widyastuti
    Sweet potato research and development in Papua, Indonesia: a review ............................. 163

17. R. Michael Bourke
    The continuing Ipomoean Revolution in Papua New Guinea ..................................... 171

18. Douglas E. Yen
    Reflection, refraction and recombination .................................................................. 181

Contributor contact details ......................................................................................... 189

References .................................................................................................................. 191

Index ......................................................................................................................... 219
Chapter 3

Needles in a haystack: searching for sweet potato (Ipomoea batatas (L.) Lam.) in the fossil pollen record

SIMON G. HABERLE and GILL ATKIN

Abstract

Despite the dominance of sweet potato (Ipomoea batatas (L.) Lam.) in many agricultural systems throughout the Pacific, there is no direct evidence for this root crop in the fossil pollen record. This has frustrated attempts to construct detailed chronologies of first appearance and rates of dispersal of sweet potato across the region. Field observations and results from experiments on pollen preservation in garden soils and its resilience to palynological procedures have found that sweet potato pollen is unlikely to be recovered from sedimentary environments. This appears to be due to its strictly entomophilous (insect dispersed) pollination habit and the high susceptibility of the pollen exine to physical and chemical degradation. In the absence of direct evidence for sweet potato in the pollen records, palaeoecological studies in the highlands of New Guinea have used sediment and pollen indicators of increased landscape clearance and degradation to infer its presence in the region as early as 800 AD. We explore the nature and veracity of this evidence and suggest that alternative approaches to landscape history are required to adequately explain the sediment and pollen records.

Introduction

The appearance of fossil pollen derived from domesticated plants in sediment records has been used extensively in both Old and New World archaeology to trace the development of agriculture through time. Pollen records of cereals in the Middle East and Europe (Willis and Bennett 1994; van Andel and Runnels 1995), maize in the Americas (Pope et al. 2001), and to a lesser extent rice in South-East Asia (Maloney 1990), have played a significant part in reconstructing the origin and spread of agriculture over the last 10,000 years in those regions. In New Guinea and eastward throughout the Pacific Islands, where tubers play a central role in agricultural activity, pollen records have not been able to elucidate the process of domestication or spread of domestic crops to the same extent due to the absence of signature pollen types in these records (Haberle 1994).

Why are pollen records of the major domesticated plants of New Guinea and the Pacific so difficult to find in the fossil record? First, at least part of the reason lies in the high proportion of insect-pollinated (entomophilous) plants present in the suite of traditional domesticated crops of the region (Table 1). The principle tuber crops of New Guinea (taro, yam and sweet potato) are all entomophilous and dispersal of pollen to sediment tends to be limited to areas proximal to the parent plant. Grasses (Poaceae), on the other hand, are wind-pollinated (anemophilous) taxa and necessarily produce a huge quantity of pollen that can disperse great distances from the parent plant. Second, the recognition of cultivated species in the pollen record is often problematic due to difficulties in distinguishing pollen morphologies of cultigens from closely related wild forms (most notably a problem in the Poaceae). In order to successfully recover fossil pollen of an entomophilous cultivar, pollen studies are required to focus on sites supporting or most likely to have supported these plants in the past (see Horrocks et al. 2000). Despite attempts to locate fossil pollen sampling sites in prehistoric agricultural features (Powell 1982; Haberle 1995, 1996), we have yet to recover fossil pollen from tuber crops in New Guinea. There is one exception noted in Garrett-Jones (1979:329)

<table>
<thead>
<tr>
<th>Species (common name)</th>
<th>Pollen taxa</th>
<th>Pollination method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ipomoea batatas (sweet potato)</td>
<td>Ipomoea batatas</td>
<td>Entomophilous</td>
</tr>
<tr>
<td>Colocasia esculenta (taro)</td>
<td>Colocasia esculenta</td>
<td>Entomophilous</td>
</tr>
<tr>
<td>Dioscorea spp. (yam spp.)</td>
<td>Dioscorea</td>
<td>Entomophilous</td>
</tr>
<tr>
<td>Pueraria lobata (kudzu)</td>
<td>Pueraria</td>
<td>Entomophilous</td>
</tr>
<tr>
<td>Psophocarpus tetragonolobus (winged bean)</td>
<td>Psophocarpus</td>
<td>Entomophilous</td>
</tr>
<tr>
<td>Saccharum officinarum (sugar cane)</td>
<td>Poaceae</td>
<td>Anemophilous</td>
</tr>
<tr>
<td>Amaranthus spp. (amaranth)</td>
<td>Amaranthaceae/Chenopodiaceae</td>
<td>Anemophilous</td>
</tr>
<tr>
<td>Oenothera javanica (water dropwort)</td>
<td>Oenothera</td>
<td>Anemophilous</td>
</tr>
<tr>
<td>Musa spp. (banana)</td>
<td>Musaceae</td>
<td>Entomophilous/Zoomorphilous</td>
</tr>
<tr>
<td>Pandanus jullianetii (karuka, nut pandanus)</td>
<td>Pandanus jullianetii – type</td>
<td>Entomophilous/Zoomorphilous</td>
</tr>
</tbody>
</table>

Table 1. Pollinating vectors for major domesticated plants in the highlands of New Guinea.
where he records two grains of taro (Colocasia esculenta) pollen dated to around 8000 BC from Lake Wanum in the Markham Valley. These grains appear to fit the criteria set out in Haberle (1995) for positive identification as taro pollen. It is not clear whether this represents a wild population or a site of early taro cultivation.

Of all the domestic plants in the highlands of New Guinea, sweet potato presents as an ideal candidate for palaeobotanical investigations, given its relatively recent introduction and its widespread occurrence across the region. Sweet potato is of American origin and is generally believed to have dispersed to New Guinea and the western Pacific via European sailing vessels during the 15th and 16th centuries (Yen 1974). Radiocarbon dating of organic material associated with carbonised remains of sweet potato has suggested an earlier prehistoric spread from northern South America to central and eastern Polynesia around 1100 AD (Hather and Kirch 1991). Whether or not there was a prehistoric dispersal beyond central Polynesia to western Polynesia and into Melanesia remains a contentious issue (see Green, Chapter 5 and Allen, Chapter 10, this volume). In the absence of direct evidence for sweet potato in the pollen records, palaeoecological studies in the highlands of Papua New Guinea (PNG) have used sediment and pollen indicators of increased landscape clearance and degradation to infer its presence in the region. Based on palynological and soil depositional evidence, Golson (1977a) suggested that sweet potato may have reached the highlands of New Guinea as early as 800 AD. This suggestion was expanded upon by Gorecki (1986), who proposed a three-stage introduction at 800 AD, the late 1600s and the 1930s. In a review of the palynological and sedimentary evidence over the last two millennia by Haberle (1998a), two periods of increased land degradation in the highlands of New Guinea (780–1000 AD, 1300–1500 AD) were identified as a possible result of pre-Magellanic (pre-1500 AD) introductions of sweet potato into the highlands.

In this chapter we examine the factors that have led to uncertainty in identifying the arrival of sweet potato in the landscape. We explore the limits on the preservation of sweet potato pollen in sediments and its recovery in the laboratory. Modern pollen rain analysis from active sweet potato gardens in the highlands of New Guinea provides an example of the problems of recovery of key indicator pollen from field sites. Laboratory tests have also been designed to investigate the impact of chemical procedures on sweet potato pollen. Finally, we review key palaeoecological indicators of sweet potato in the fossil record and make recommendations for further progress.

Sweet potato pollen in the environment

Pollen deposition in sweet potato gardens

Modern pollen studies use pollen extracted from the upper 1–2 cm of surface sediment or moss polsters as fundamental precursors to the interpretation of fossil pollen assemblages. Modern pollen rain data from studies in New Guinea show that forest canopy species with wind-dispersed pollination (such as Nothofagus, Castanopsis and Casuarina) dominate the pollen assemblage of surface samples (Fienley 1973). Many species, however, have no significant regional pollen dispersal. In highland areas there is a net upward transfer of wind-blown pollen, with movement in the opposite direction rare. The role of surface run-off and direct deposition is also important in the process of pollen deposition, leading to high local values for some pollen types that do not contribute to the wind-transported component.

In a study of modern pollen rain from the Tari Basin, Southern Highlands Province, PNG, surface samples were taken at 200 m intervals along a 2600 m transect incorporating swampland, sweet potato gardens, regrowth forest, and mid montane forest between 1630 m and 1900 m altitude (Figure 1). The summary pollen diagram (Figure 2) shows a clear difference between forest and non-forest samples with forest taxa making up to 70% of the total pollen sum in forested sites compared with only 10–30% in the non-forested sites. There are clear groupings of dominant taxa in the pollen spectra such as high Nothofagus pollen in the Nothofagus forest samples, high Gramineae and Cyperaceae pollen in the swampland samples, and high Cyathea and monolete fern spores in the sweet potato garden samples. Many other taxa are represented by low and often sporadic occurrence. There were no common cultivated plants represented in the pollen spectra, with the possible exception of Pandanus borbonicus type that may reflect the local presence of the cultivar P. julianetce (Haberle 1996). The absence of sweet potato pollen in all samples in this study is consistent with the results from other studies in New Guinea (Powell 1970; Fienley 1973; Hope 1976). Despite the apparent high fern spore component occurring in samples from garden sites, this is not diagnostic of gardening activity as high fern spore levels have also been recorded in forest margin and wetland areas. The carbonised particle count clearly shows that deposition of airborne and local charcoal is almost absent in forest samples and highest in the regrowth vegetation. Most of the vegetation types outside the Nothofagus forest are subject to burning as a result of agricultural activity in the basin. These results highlight the complexity of transfer of pollen from source to sediment, and that a detailed understanding of the mechanisms for pollen dispersal and preservation is required for us to improve our interpretation of fossil pollen spectra.

Preservation of pollen in controlled sediment environments

One explanation for the lack of sweet potato pollen in modern surface sediment samples from gardens may relate

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1 Ages are reported as AD/BC in this chapter. All radiocarbon dates have been calibrated using CALIB 3.0.3 (Stuiver and Reimer 1993).

2 Use of the term 'highlands of New Guinea' refers to the inland regions above an altitude of about 1200 m on the island of New Guinea and not exclusively to the present-day highland provinces of Papua New Guinea.
to rapid destruction of the pollen within the sediment environment. In order to monitor the state of preservation of sweet potato pollen in a sedimentary environment, an experiment was conducted using an average of 350 grains of sweet potato pollen placed between two glass fibre mesh squares (five samples in all) and buried in a soil environment (Gunning, NSW). The mesh was recovered after four months and the pollen grains were examined, without using any chemical preparation techniques, under light microscope. Figure 3 (Experiment 1) shows that on average 23% of the pollen grains had been lost after four months' burial and of those that remained up to 90% were degraded. This suggests that sweet potato pollen may be susceptible to unspecified (physical, chemical or biological) degradation processes in sedimentary environments (Figure 4).
Figure 2. Summary pollen diagram for samples H1 to H14 at Hacapugua. At least four samples were collected over an area of 100 m² at each site and later bulked together, mixed and sub-sampled for pollen analysis. Samples were prepared by first boiling in 10% KOH solution, overnight in hydrofluoric acid, standard acetylation treatment and finally mounting in silicone oil following Faegri and Iversen (1989). The samples were normally counted at x400 magnification with a Zeiss photomicroscope with a pan-apochromatic objective. Counting was continued until at least 200 grains of terrestrial taxa had been identified. Carbonised particle density was calculated from the pollen preparation sample by standard point counting methods outlined in Clark (1982).
Searching for the sweet potato in the fossil pollen record

<table>
<thead>
<tr>
<th>Experiment 1: Field study</th>
<th>Experiment 2: Lab study</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sweet potato pollen placed in glass fibre mesh (x5) and buried for 4 months</td>
<td>• Sweet potato and morning glory pollen processes in laboratory (x5) using standard KOH, HF and acetylation preparation techniques</td>
</tr>
</tbody>
</table>

![Pie chart showing percentage of non-degraded and degraded pollen.]

100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0%%

% of surviving grains

1 min acetylation 5 min acetylation 5 min KOH 1 hr HF

Morning glory

Sweet potato

Figure 3. Results of two experiments conducted in the laboratory on pollen collected from fresh flowers of sweet potato (*Ipomoea batatas*) and morning glory (*I. pes-caprae*).

Figure 4. Surface of sweet potato pollen (*I. batatas, Convulvulaceae*). Grains are spheroidal (90–150 μm diameter) with pores spread all over the surface (pantoporate). The exine is 2–3 μm thick with echinate and baculate processes. Individual echini (spines) are approximately 5–10 μm long and bacula are 2–5 μm long.

**Pollen in the laboratory environment**

A second experiment was conducted in the laboratory using standard chemical preparation techniques (Faegri and Iversen 1989) on samples of pollen extracted from sweet potato flowers to examine the impact of laboratory procedures on pollen preservation. As a control in this experiment, a closely related Convulvulaceae species with similar morphology to the sweet potato pollen (morning glory, *Ipomoea pes-caprae*) was treated using the same pollen preparation techniques. The procedure involved treating pollen samples with acetylation for one minute and five minutes, 10% potassium hydroxide for five minutes (hot) and hydrofluoric acid for one hour (hot) and counting the percentage of original grains remaining after each treatment. The results (shown in Figure 3, Experiment 2) suggest that sweet potato pollen is unlikely to survive the standard chemical treatment for extracting pollen from sediment samples, whereas the *Ipomoea pes-caprae* pollen grains are scarcely affected. The most destructive part of the treatment is associated with hydrofluoric acid and acetylation (five minute) treatment: both can produce strong exothermic reactions with sediment, which is potentially destructive to sweet potato pollen.

**The fossil environment**

The introduction of sweet potato to the New Guinea highlands has undoubtedly had a major impact on local food production strategies and population growth (Bayliss-Smith 1995; Swadling 1996; Golson 1997). In the absence of direct fossil evidence for sweet potato in the pollen records, palaeoecological studies in highland New Guinea have used changes in sediment and pollen records as proxy indicators for the impact of sweet potato on the landscape. This approach relies on the assumption that the incorporation of sweet potato into highland agroecosystems would have resulted in significantly greater forest clearance and sediment disturbance than what has been experienced prior to its introduction. Clearance of forest can have a number of detrimental effects upon soils including physical erosion.
due to exposure of surface soils) and chemical erosion or alteration (due to leaching of exposed soils and burning). Physical erosion is most readily detected in lake or swamp sediment records by an increase in inorganic sediments derived from catchment soils.

Chemical erosion can be detected both indirectly by an increase in chemically leached elements (Engstrom and Wright 1984) and indirectly in the pollen record. As soils become depleted through chemical weathering and rapid crop turnover (reduced fallow times), nitrogen levels commonly decline, which is recorded in the pollen record by an increase in nitrogen-fixing plants such as *Casuarina*.

Here we briefly review three lines of circumstantial evidence for the introduction of sweet potato into highland New Guinea: increased erosion; increased reliance on *Casuarina* silviculture and greater use of high-altitude environments (>2000 m above sea level).

**Sediment erosion**

Sedimentological evidence from lake and swamp environments may record changes in soil conditions resulting from different land use. Mineral magnetic analysis has been used successfully to reveal much about the nature of sediment accumulating in swamp and lake environments (Thompson and Oldfield 1986). Several sediment studies in the highlands of PNG have used mineral magnetic properties of sediment records to identify volcanic ash, soil in-wash and soil-alteration events.

Fine resolution sediment and pollen investigations of three lake sites within small catchments in the central highlands region of PNG (Oldfield et al. 1980; Worsley and Oldfield 1988) show evidence for soil in-wash associated with forest disturbance immediately after the fall of Tibito ash3 around 1665–1666 AD (see Bayliss-Smith et al., Chapter 11, this volume). Further to the south, at Haapapuga in the Tari Basin, sediment analysis of six short cores shows increased inorganic accumulation and an increase in altered ferrimagnetic minerals (fine-grained ferrimagnetic minerals, \(X_{f3}\)) above the Tibito ash level (Figure 5). Increased cultivation activity and burning in response to the adoption of sweet potato after 1666 AD is considered the most likely explanation for these changes in the sediment record (Haberle 1998a).

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3 Briffo et al. (1998) have placed the Long Island eruption that produced Tibito ash at around 1666 or 1675 AD, based on temperature-sensitive tree ring density chronologies from the Northern Hemisphere. This falls within the range of estimates for this eruption based on radiocarbon, lead-210 and historical evidence (1645–1680 AD, Haberle 1998a; Bayliss-Smith et al., Chapter 11, this volume).

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**Figure 5.** Sediment analysis (bulk density, g/cm³, and frequency dependent susceptibility, \(X_{f3}\)) of six short cores taken from Haapapuga in the Tari Basin (for locations see Figure 1). A process of magnetic enhancement through burning of the topsoil (Mullsins 1977) has been suggested as a probable source of fine-grained ferrimagnetic minerals and is identified in sediments by high values (>5%) of \(X_{f3}\). Tibito ash can be identified in the field based on its colour and texture properties and is likely to have been derived from an eruption of Long Island in 1665–1666 AD (Haberle 1998a; Bayliss-Smith et al., Chapter 11, this volume).
If sweet potato were introduced to the central highlands region of PNG in the late 1600s, this would be consistent with a post-Magellanic (post-1500) introduction of sweet potato into the western Pacific. However, not all highlands sites accord with this interpretation. The sediment records of the Wahgi Valley show a localised intensification of cultivation activity up to 300 years before the fall of Tibito ash, between 1300 and 1550 AD (Haberle 1998a). At the swamp site of Tugupuwa at 2350 m altitude in the Labani (Lavani) Valley where sweet potato is grown close to its upper altitudinal limit, the first evidence for soil erosion in the catchment occurs around 1050–1300 AD, although it is not until 1350–1500 AD that a rapid reduction in forest cover occurs, coincident with expansion of grassland (Haberle 1998b). This marks the development of conditions similar to those seen in the valley today, where forest cover has been cleared from the lower slopes and replaced by extensive, regularly burnt grassland. Whether this data is indicative of a pre-Magellanic introduction of sweet potato into the western Pacific remains problematic due to the uncertainties associated with the low temporal resolution of most palaeoecological sites and lack of a necessary causal link between erosion and the introduction of sweet potato.

**Casuarina silviculture**

*Casuarina* pollen is a wind-blown pollen type that is recorded in most palaeoecological sites. An increase in *Casuarina* pollen abundance is picked up in at least fifteen sites across the highlands of New Guinea at around 800 AD and has been implicated in the deliberate planting of *Casuarina* (mainly *Casuarina oligodon*) as a silvicultural tree (Haberle 1998a). This may relate to deliberate planting in order to alleviate nitrogen depletion or for other utilitarian purposes such as for building materials and firewood supply in a forest-depleted environment, and the reduction of taro beetle infestation in taro gardens where *Casuarina* was planted. Alternatively, natural colonisation in nitrogen-depleted soils may also be a factor in the increased incidence of *Casuarina* in the highlands over the last millennium.

A causal relationship between the introduction of sweet potato and the adoption of *Casuarina* silviculture practices at around 800 AD has been proposed by Golson (1977a). Recent assessment of the palaeoecological and archaeological data relating to *Casuarina* silviculture suggests that the early rise in this pollen type is related to long-term land degradation processes, beginning around 2000 years ago (Haberle 1998a), and that periods of chronic drought stress and volcanic ash deposition may have initiated the need for enhanced soil management practices (Figure 6). A second period of increased *Casuarina* pollen occurring highlands-wide around 1300–1550 AD, commensurate with increased soil erosion and the development of raised-bed cultivation, is consistent with continued intensification of agricultural activity, but is not necessarily a response to the introduction of sweet potato to New Guinea.

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*Figure 6.* Increases in *Casuarina* in the pollen record from five sites across the New Guinea highlands compared with palaeoclimatic and volcanic eruption reconstructions over the last 2000 years. Proxy climate records include drought periods (Quelcaya ice core dust particles >1.59 μm, Thompson et al. 1994) from the equatorial Andes and a composite time series for the recurrence of El Niño events since 1000 AD (after Anderson 1992).
High altitude (>2000 m altitude) disturbance

One of the most significant effects of the introduction of sweet potato is believed to be the altitudinal extension of agriculture to land above 2000 m (Golson 1977b:632). In the Chimbu Valley, PNG, where sweet potato is grown as a staple food up to 2700 m altitude, the pollen records (Mt Wilhelm - Corlett 1984a, 1984b) show destruction of forest-limit taxa and burning at high altitude by 1300 AD (Figure 7). There has been no archaeological work on Mt Wilhelm to support these palaeoecological findings, although in the Chimbu Valley and on nearby Mt Elimbari a number of rockshelters have been excavated. Lemoure rockshelter (2450 m, Gillieson et al. 1986) is close to the altitudinal limit of gardens on Mt Elimbari. The shelter floor has accumulated sediment at a very high rate (130–180 cm/1000 years) since some time between 1400 and 1650 AD, which is up to nine times the rate of accumulation recorded in the preceding 1000 years (20–24 cm/1000 years).

The reasons for increased burning and clearing activity at these high altitudes relate to increased human populations and utilisation of the mountain environments that may be associated with the introduction of sweet potato. However, this argument needs to be re-evaluated in the light of apparent extensive clearance at 2500–2600 m altitude in the Lai-Ambum Valley, possibly as early as 5000 years ago (Walker and Flenley 1979), and the presence of an agricultural spade at 2240 m altitude in the Tambul Valley around 4500 years ago (Golson 1996). This evidence contradicts the models proposed by Brookfield (1964) and Golson (1977b), and maintained in the literature by many others, that sweet potato was exclusively necessary for sustained and widespread agriculture and settlement above 2000 m. Bayliss-Smith (1985) considers a low-intensity form of taro swiddening may have been a viable proposition for inhabitants of the higher valley during the mid Holocene.

Other hypotheses seek to explain the increase in forest disturbance and soil erosion since 1300 AD. One explanation for recent increased forest clearance and soil erosion is that these changes were the result of the introduction of malaria, which led to movement away from swampy valley floors to upland slopes, thus increasing forest clearance and soil erosion in these areas (Flenley 1988). However, Groube (1993) claims that malaria was present during the Pleistocene in New Guinea, possibly within a few millennia of initial settlement. The range of possible explanations to account for landscape changes at high altitudes again highlights the tenuous link between the introduction of sweet potato and its impact on the environment.

Discussion

The sweet potato pollen grain with its large ‘honeycomb’ structure does not appear to be suited to long-term preservation in the physical or chemical environments that are generally considered quiescent for most other pollen grains. It is clear that a combination of factors associated with its relatively fragile pollen grain has led to the lack of recovery of sweet potato pollen grains in the fossil record. These factors include entomophilous pollination, rapid degradation in sedimentary environments (although it is uncertain whether as a result of physical, chemical or biological factors) and rapid degradation when subjected to standard pollen preparation techniques in the laboratory.

If the pollen grains can survive in very specific sedimentary environments such as peats or lake sediments, then a number of alternative methods for extracting or identifying the large sweet potato pollen grain may be developed, including:

- improved gentle chemical extraction of pollen grains
- sieving sediment samples into the 80–100 μm fraction that includes sweet potato pollen
- searching for the broken parts, particularly spines, that may have survived pollen preparation.

In the absence of direct evidence for sweet potato in the archaeological or palaeoecological record, there are three possible lines of sediment and pollen evidence for the introduction of sweet potato into highland New Guinea: increased erosion; increased reliance on Casuarina silviculture; and greater use of high-altitude environments (>2000 m above sea level). A review of this evidence suggests that an early (~800 AD) introduction of sweet potato is unlikely given the alternative cultural and environmental explanations for increased land degradation and expansion of cultivated land at this time. However, the argument for a pre-Magellanic introduction remains an
open one, with all three lines of sediment and pollen data pointing to the most significant and most recent landscape changes begining around 1300 AD, some 200 years before the proposed post-Magellanica arrival of sweet potato.

Is this discrepancy in timing between the historical and the palaeoecological record real or is it related to site-specific or methodological factors? There are two major methodological problems that need to be addressed in palaeoecological studies in order to resolve this discrepancy. Pollen and sediment sampling intervals in a sedimentary sequence will determine the chronological resolution of the analysis. In many of the sites studied, the temporal resolution averages around one sample per 100 years, which is significant when trying to determine the timing of an event possibly occurring within the last 300 to 400 years (only 3–4 samples). The second methodological uncertainty arises with dating sediments between about 600 and 200 years before the present, and is due to a change in the atmospheric $^{14}$C production rate of ± 10% over this period as reconstructed from wood samples of known age. The differential production of $^{14}$C can result in a single radiocarbon age corresponding to more than one calendar age range (for example 290 ± 60 $^{14}$C yr BP calibrates to between 1460–1680 AD, 1750–1805 AD and 1935–1950 AD). This limits our ability to accurately determine the timing of events within the archaeological and palaeoecological records across the critical period spanning pre- and post-European colonisation of Pacific islands. These problems require detailed high-resolution analysis of lake and swamp sites from different environments in New Guinea, applying $^{14}$C wiggle-matching (multiple sampling) techniques (Kilian et al. 1995) in order to provide the most accurate date for arrival and impact of the sweet potato in New Guinea.

Conclusions

The absence of sweet potato from fossil pollen records in New Guinea is a function of the unusually high susceptibility of the pollen grain to degradation in the natural environment and under standard pollen preparation treatments in the laboratory. This has frustrated attempts to construct detailed chronologies of first appearance and rates of dispersal of sweet potato in New Guinea and the rest of the Pacific. Palaeoecological studies have not been able to provide a definitive answer to the question of when sweet potato arrived in New Guinea, however, renewed efforts to refine the temporal resolution of palaeoecological and archaeological techniques may go some way to solving this problem.

Acknowledgments

The authors would like to thank Chris Ballard, Geoff Hope and Jack Golson for valuable discussion on the subject of this manuscript. The pollen analysis was conducted in the Pollen Laboratory of the Department of Archaeology and Natural History, RSPAS, The Australian National University.
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