PERGAMON

Quaternary International 59 (1999) 17–26

Prehistory and palaeoecology of Yap, federated states of Micronesia

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Abstract

The island of Yap has an established prehistoric record of about 2000 yr. This is a little younger than might be expected on the basis of that known for other regions of Micronesia, and on linguistic grounds the Yapese language has some features which are indicative of an old Oceanic language. In this paper we review these issues and present two palaeoecological records. These records suggest that a major period of forest destruction, accompanied by fire, took place about 3300 BP, and subsequently a savanna vegetation developed. The latter was most pronounced about 300 BP, when the human population was probably also at a peak. We suggest that the data is consistent with a pattern of human impact about 1000 yr longer than is currently recognised from the archaeological record and that the now extensive savanna is an artefact of human impact on the vegetation and soils of the island.

1. Introduction

The islands of the Pacific provide natural laboratories for the examination of human impacts on terrestrial and coastal ecosystems at a variety of scales. This is because there is a great variety of land areas, times since first human settlement on the many islands — from millenia to very recently and changing technology and the richness of biological resources which are represented in many diverse ways across the many thousands of settled lands. Some islands have never been settled, others settled then abandoned and these provide examples of low human impact or recovery of ecosystems.

The area of land is a coarse approximation of the extent of available biological resources and space to support human cultures. Questions related to impoverishment and exhaustion of resources over time, and how human cultures respond can be examined much more readily on islands than on larger land masses such as the islands of New Zealand or the continent of Australia, yet clearly the findings on islands are relevant to those on such lands.

It is the purpose of this study to compare the archaeological and palaeoenvironmental records of the islands of Yap, to provide a broader context in which to compare both kinds of records and to enrich the range of interpretations for both kinds of study.

Micronesia extends from the Marianas, Yap and Palau in the west and to the Marshalls and Kiribati in the east (Fig. 1). This area was once thought to be the area from which people had dispersed into Polynesia, however, current archaeological evidence from Micronesia and Melanesia does not support this. The Lapita culture in Melanesia has an antiquity from 2000 to 3500 BP and is considered to have been a source area from where people dispersed into Polynesia and eastern Micronesia.

Both archaeological and linguistic evidence suggests that the history of human dispersal into Micronesia is complex (Intoh, 1996, 1997). The oldest known settlement is in the southern Marianas, at around 3600 BP, which is about the same age as Lapita populations appeared in western Melanesia. Archaeological data from other high islands, such as Yap, Palau, Chuuk, Pohnpei and Kosrae, and the Marshalls seem to indicate that these were all settled around 2000 BP. The dispersal paths into these islands are considered to be different because of the geography of the language relationships. The Eastern Caroline Islands (Chuuk, Pohnpei and Kosrae) and the Marshalls, where Nuclear Micronesian

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1040-6182/99/$20.00
PII: S1040-6182(98)00068-8

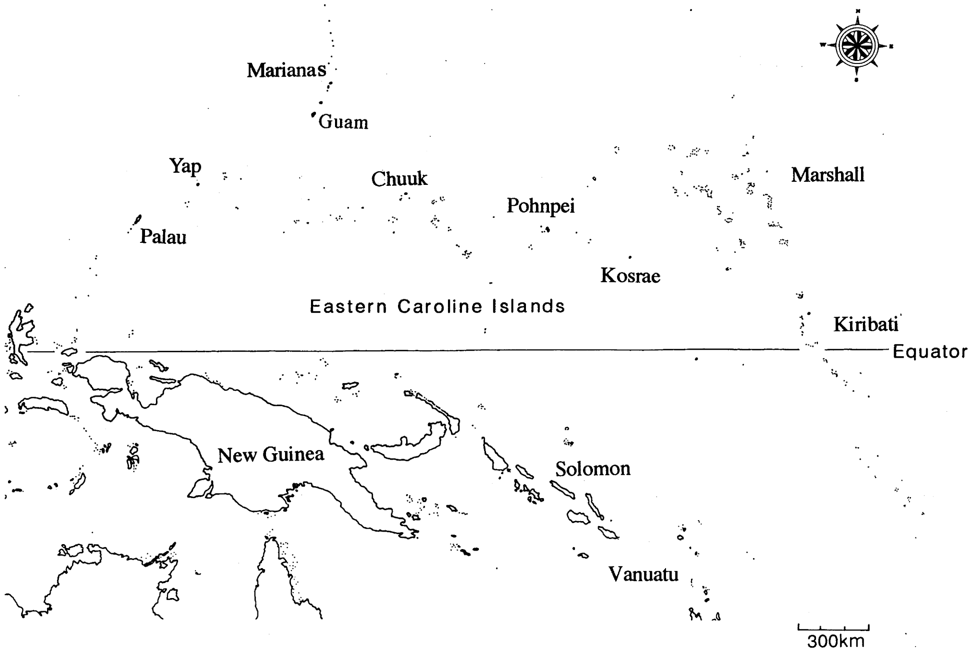


Fig. 1. Map of western Pacific showing the location of Yap and other islands mentioned in the text.

is spoken, appear to have been settled from the south, such as from the southeast Solomons and northern Vanuatu. This is supported by the similarity of early pottery from the Eastern Caroline islands which indicates a late Lapita pottery tradition (Intoh, 1996). On the other hand, based on non-Oceanic language links, Palau received immigrants from the south-west (possibly from island Indonesia).

Yap Islands are considered to have an ambiguous linguistic position in Oceania (Pawley and Green, 1985). It is a complex language and may contain elements of Oceanic and non-Oceanic components. Additionally, a recent study by Ross (1996) indicates that the Yapese language is an early offshoot from the Admiralties.

The earliest known archaeological evidence of human settlement on Yap comes from two sites, Pemrang and Rungruw, at the southern end of the main island. These have both yielded dates of about 2000 BP (Gifford and Gifford, 1959; Takayama, 1982; Intoh and Leach, 1985). This indicates an age comparable with other high islands in Micronesia (Intoh, 1997). The sites contain Calcareous Sand Tempered thin pottery (CST pottery) which is similar to the early pottery found in the Marianas and Eastern Caroline Islands and dated around 2000 BP. No other cultural components are known in context for the earliest occupation period, and the distribution of CST pottery seems to be restricted to the low-lying sandy coast on the south and east of Yap (Intoh and Leach, 1985).

There is, however, a problem related to the interpretation of the deposit excavated from the Rungruw site (Intoh and Leach, 1985). The lowermost sandy layer which was excavated extends below the ground water level and is cemented by carbonate. It is unclear whether the date of 2000 BP represents the earliest settlement of the area, the limit of the archaeological excavation or a minimum age due to carbonate contamination.

After about 600 BP Laminated pottery came into general use and this persisted into the ethnohistoric period. It occurs throughout Yap, including inland areas, unlike CST pottery. Occupation of the inland for residential purposes therefore appears to be late, around 1300–1400 AD, and was associated with the use of Laminated pottery.

Yap has developed a unique social system. At the time of European contact the entire island was divided into more than 140 villages which were ranked into five levels (Lingenfelter, 1975). The highest ranked villages occupied coastal regions and the lowermost ranked were on inland sites. Location has an important impact on land use and wealth.

Subsistence on Yap is heavily reliant on agriculture. Aroids, yams, breadfruit, bananas, Polynesian chestnuts, cassava and coconuts are grown, but the major cultivated crop is giant swamp taro (*Cyrtosperma chamissonis*). The latter is grown in swamp ponds, either at the base of gradual slopes within village proper zones, or as large expanses of human constructed swamps along the coast. These landscape modifications probably developed in parallel with the stratified social system.

Yams are also important in Yap (Barrau, 1976). The ceremonial significance of the yam has been pointed out by Ushijima (1987) to indicate a long established position in Yapese society. At least 31 different varieties of yam have been distinguished amongst traditional village societies. Yams require well drained soil and an ability to shift cultivation to new areas of land after several years of use. Yam gardens are scattered in village regions of the inland areas called savanna by Barrau (1976). New yam gardens are created by cutting and burning forest or woodland. Along with the population growth, the heavy use of slash and burn, and planting of yams may have degraded the soils beyond natural forest recovery, hence creating a savanna landscape.

The surface soil was probably eroded and redeposited along the coastal lowlands. This is where large cultivated taro swamps were established and ultimately were essential in supporting the relatively large human populations.

Several anthropologists (Labby, 1976; Hunter-Anderson, 1983) have proposed that the shift from small-scale hillside agriculture to coastal taro cultivation took place to meet the increasing human population. In the early 19th century, it is estimated that about 30,000 people lived on Yap. This is based on a study of oral traditions and archaeological evidence (Hunter-Anderson, 1983). Such a large population size would have required an intensive land-use system, and the accumulated rich alluvial deposits around the coast were the only suitable areas to develop new and specialised land-use systems.

2. The study area

Yap, the setting of this study, consists of four main islands: Yap, Maap, Rumung and Gagil-Tamil islands (Fig. 2); which lie within a fringing reef system. These are regarded as high islands as they have solid rock cores, well above present sea level. The main core geology of the islands is soft volcanic breccia and in the north of Yap Island green chlorite, talc schists and amphibolite outcrop. In the northern and eastern parts of Gagil Tamil, and Maap, schist and conglomerate dominate with small areas of soft volcanic breccia. The coastline of all islands consists of rocky areas, sandy calcareous beaches, areas of alluvium and peat soils (US Department of Agriculture, 1983).

The value of the soils for subsistence can be assessed from the survey carried out by the US Department of Agriculture (1983) which identified about 16 main soil types. Soils on coral limestone are nearly level, somewhat excessively drained, very deep and sandy; or where associated with rock outcrop are steep, well drained, shallow and loamy. Upland soils are well or poorly drained and fine textured. The soils of bottom lands range from well to very poorly drained and in texture from sandy, clayey or mucky (including peats).

The region has a warm tropical climate with very little seasonal variation in mean annual temperature, around 27°C, (on average about 1°C variation between the warmest and coolest months), whereas mean diurnal variation is about 7°C. From July to October the islands are under the influence of the Intertropical Convergence Zone. The prevailing winds are south-westerly during this period which is also the wettest season with precipitation of about 33 cm/month. Thunderstorms are relatively infrequent and most cyclones pass north and north-westward of the area. Between November and June the area is under the influence of the north-east Trade Winds, and the driest part of the year is between February and April when precipitation is about 18 cm/month (US Department of Agriculture, 1983).

The present vegetation of Yap is fairly well demarcated (Falanruw et al., 1987; Falanruw, 1994). The lagoon area between the islands (Fig. 2) and the fringing reef is filled with seagrass meadows and sand flats, while beach strand and mangroves occupy most of the hard rock coast. The terrestrial vegetation is dominated by upland and valley forests (13% of the area), secondary forest and regrowth vegetation (19%), gardens and taro patch (27%) and savanna (22%) (Falanruw, 1994). Most of the primary rainforest has been cleared for agriculture, most especially while the island had a large Japanese contingent during the Second World War (Fosberg, 1960).

Some of the ethnohistoric evidence of land use has been described above. Today the landscape carries abundant evidence of the past and present food production systems. Village tree gardens (*Cocos nucifera*, *Inocarpus edulis*, *Areca* palms and others) and taro patches (*Cyrtosperma chamissonis*, and *Colocasia esculenta*) are often surrounded by forests with openings created in the dry season to grow yams (*Dioscorea* spp.) and other crops. These are mostly tended by women. After 2 to 3 yr these yam gardens may be abandoned to secondary succession or use may continue at a lower rate if the gardener has planted tree or shrub crops (such as papayas, cassava and mangoes) which can be harvested for longer periods.

Savannas may be a special case. They occur as *Pandanus* spp. with an understorey of *Gleichenia* and/or other ground ferns with *Nepenthes* and grasses. It is not clear if these are natural, or as is thought for many other regions of the Pacific, derived from altered primary forest which has not been able to recover from over use of agriculture (e.g. Budowski, 1956; Fosberg, 1960, 1962; Nunn, 1991). This latter idea is supported by extensive ditches in the savanna which were probably in use when human population numbers were higher. Fosberg (1960) also noted that it was possible to detect some of the stages in the formation of savanna, along burning and clearing gradients.

3. Methods

The new results reported in this work are the collection, analysis and discussion of palaeoecological records

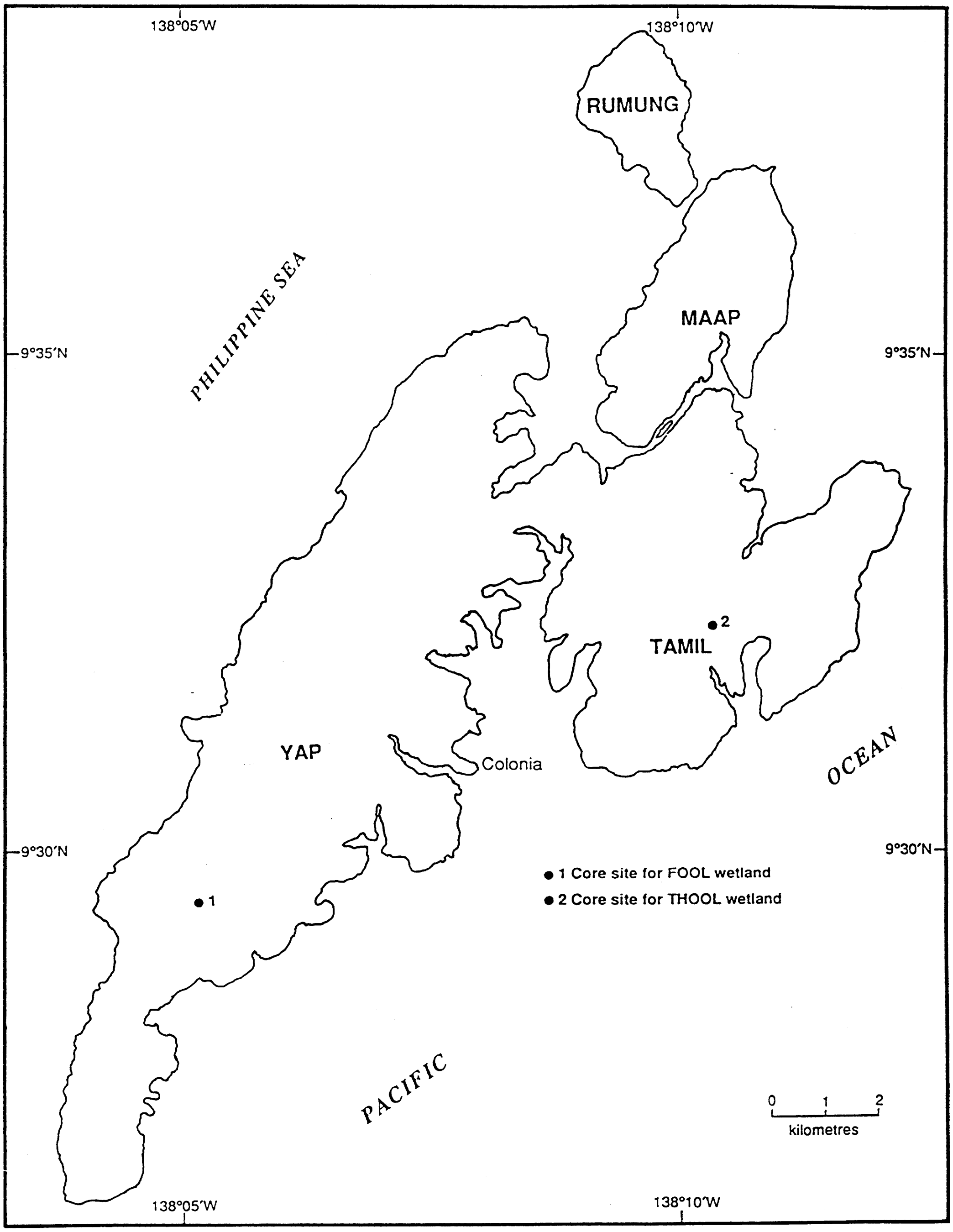


Fig. 2. Map of Yap Islands showing the locations of Thool and Fool Swamps.

for comparison with the archaeological records established over the last 35 yr. Two locations were selected for pollen analysis after testing a number of sites for the depth of organic materials. The sites were deliberately selected away from the coast, i.e. 1–2 km inland, so that they were not of the type which were established in recent history for Aroid planting. These were at Thool, near Maaq on Tamil, and a site called Fool near the Yap Airport. Both sites (Fig. 2) are within 5 m of present day sea-level and are used for growing giant swamp taro (*Cyrtosperma* sp.). At each site the maximum depth of sediment which could be located were collected with the aid of a Russian sediment sampler (Jowsey, 1965). Sections were collected in 40 cm lengths and wrapped in plastic film, aluminium foil and strapped into polypropylene tubes for transport back to the laboratory.

The two sediment sections were opened in the laboratory and described. These sections were also subsampled for radiocarbon dating and for pollen and charcoal analyses. The samples for radiocarbon analysis were oven dried at 70°C, weighed and packed in plastic bags. These were then sent to Beta Analytic Radiocarbon Dating Laboratory in Miami (USA) where they were given an acid wash before combustion for analysis.

Pollen preparations were made using standard techniques applied to peats. Some of the sediments contained significant quantities of sand and clay and were accordingly subjected to heavy liquid separation to remove them (Moore et al., 1991). Each sample was spiked with a known quantity of exotic *Alnus rugosa* pollen grains to enable charcoal abundance to be estimated. Pollen counts were made until at least 200 identified grains of terrestrial flowering plants had been counted. At the same time aquatic taxa, fern spores and marker grain counts were made. Charcoal abundance estimates were made using the point count method described by Clark (1982).

4. Results

4.1. Thool swamp

The site at Thool was overgrown with *Phragmites* reed swamp with small areas of *Cyrtosperma* sp. The surrounding vegetation included gardens of cassava, pineapple, mangoes, banana, papaya, and further away savanna with largely grassland and fern understorey and scattered trees, especially *Casuarina equisetifolia* and *Pandanus* spp.

The stratigraphy of Thool consisted of the following:

0–15 cm:	watery peat
15–51 cm:	unconsolidated dark brown fibrous peat with *Phragmites* remains
51–66 cm:	peat becomes gradually darker
66–118 cm:	unconsolidated dark brown fibrous peat, becoming more humified with depth
118–119 cm:	yellow grey clay
119–337 cm:	well humified black brown fibrous peat
337–343 cm:	banded blackish yellow clay
343–360 cm:	yellow grey clay
360 cm:	base of sample collection.

Samples for radiocarbon dating were selected from 120–130 cm depth, 210–220 cm depth and 325–335 cm depth (see Table 1).

The pollen diagram for Thool Swamp (Fig. 3) shows percentages calculated against total terrestrial pollen (including unknowns). Rare taxa, those which occurred in less than three samples with only a few grains in each case, plus unidentified and damaged grains are listed as pollen counts in Table 2. In the pollen diagram two zones are shown, pollen grains below 345 cm depth were oxidised and recovered in low numbers and are not considered further here. The bulk of the sediment was very young (less than about 300 radiocarbon yr). These are conventional ages based on Libby half life and the error term represents 1 standard deviation and is based on the combined measurements of sample, background and modern reference standards.

Table 1
Results of radiocarbon analyses. These data are uncalibrated radiocarbon ages

Site	Depth (cm)	Lab. number	Result (yr BP)
Thool	120–130	Beta-74,939	140 ± 70
	210–220	Beta-74,940	260 ± 60
	325–335	Beta-74,941	2320 ± 60
Fool	125–135	Beta-74,934	240 ± 50
	225–235	Beta-74,935	3340 ± 80
	330–340	Beta-74,936	5230 ± 70

(i) *Zone* T2: (325–75 cm depth): This is characterised by moderate but declining values of *Pandanus* pollen (55 to about 15%), relatively consistent values for Palmae (around 10%), Moraceae, Melastomataceae and Piperaceae pollen. Poaceae (10–60%) dominates the herb flora and there are consistent but small occurrences of other herb taxa. Cyperaceae is the most prominent of the aquatic taxa and there are relatively consistent values of several fern spore taxa. *Pteridium* spores are in relatively small amounts and are most pronounced in the early part of the record.

(ii) *Zone* T1: (75–0 cm depth): In this zone there is a pronounced peak value in Araceae pollen. Its values dominate the pollen sum until the very surface sample and the decline in most taxa are a result of this. In general, the pollen mix is similar to Zone T1 apart from the high Araceae and *Schizea* values at the surface depth.

4.2 Fool Swamp

Fool Swamp is surrounded by savanna with *Pandanus* spp. the major tree taxon and an understorey of *Melastoma*, *Verbena*, *Gleichenia*, other ground ferns, *Nepenthes*, *Scaevola* and grasses. The swamp surface includes *Cyrtosperma* sp., *Polygonum*, *Gleichenia*, *Phragmites*, *Juncus* and Cyperaceae.

The stratigraphy at the core site at Fool consisted of the following:

0–5 cm:	blue grey clay with modern roots
5–12 cm:	brown root mass in water
12–20 cm:	brown stained water with some suspended matter
20–92 cm:	unconsolidated fibrous peat, poorly humified, yellowish band at 50–51 cm depth
92–100 cm:	yellow grey clay with fibrous peat
100–123 cm:	fine fibrous dark brown peat

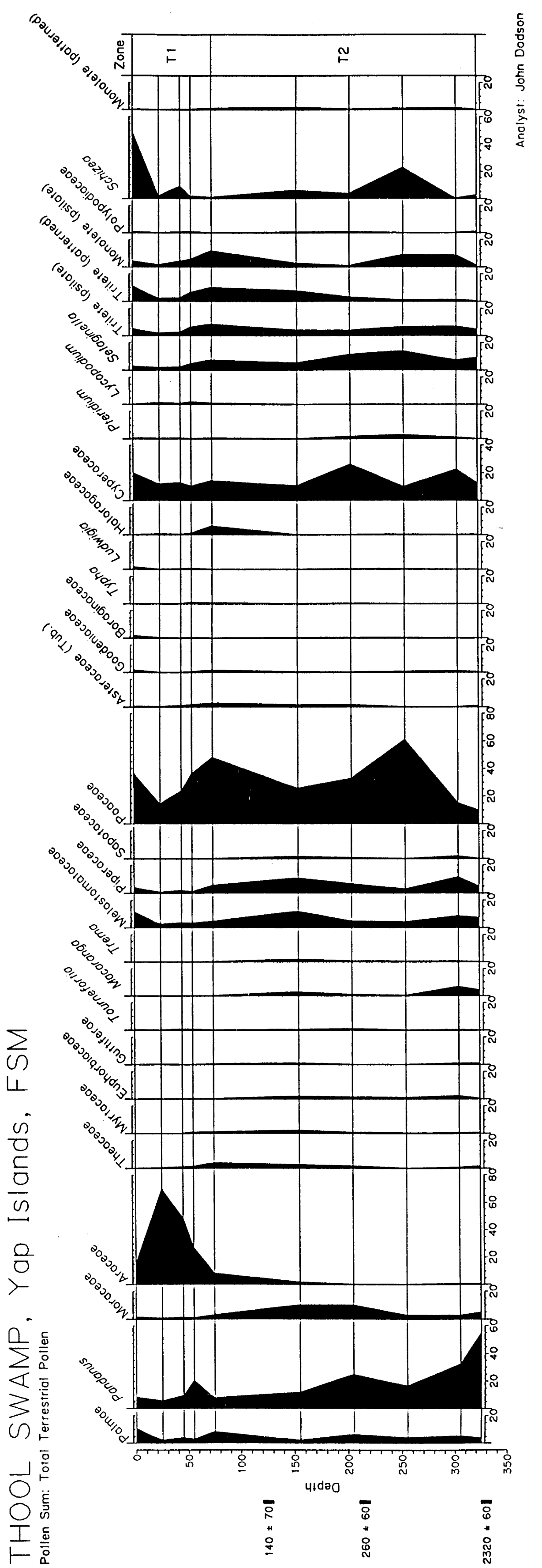


Fig. 3. Pollen diagram from Thool Swamp.

123–124 cm:	yellow clay layer
124–136 cm:	fine fibrous dark brown peat
136–221 cm:	dark grey clay with fine fibrous peat
221–282 cm:	blackish brown fibrous peat
282–345 cm:	dark grey clay with some red yellow mottled components and flecks of organic, becomes more clayey with depth
345 cm:	base of sample collection.

Samples for radiocarbon dating were selected from 125–135 cm depth, 225–235 cm depth and 330–340 cm depth. The results of the radiocarbon analyses are shown in Table 1.

The pollen diagram for Fool Swamp, which shows percentages based on a pollen sum of total terrestrial pollen (including unknowns), is shown in Fig. 4. Rare taxa are listed in Table 3. In the pollen diagram three zones are shown. However, for sediments below 280 cm depth the pollen was found to be sparse and oxidised and no record is presented here. The stratigraphic record indicates mottled and oxidised clays below 282 cm. Fig. 4 also shows the relative abundance of charcoal which was determined on the same slides as those used for pollen analysis.

(i) *Zone* F1: (280–160 cm depth). This is characterised by moderate and variable *Pandanus* values (5–40%), relatively low but increasing Poaceae values (1–20%), and the representation of many tree and shrub taxa which either decline (e.g. Palmae, Fabaceae, Anacardiaceae, Solanaceae, Araliaceae) or disappear from the record (e.g. *Macaranga*, *Trema*, Sapotaceae, Asclepiadaceae, Flacourtiaceae). Also during this phase there is a peak in Apiaceae and relatively high psilate Trilete Spore values (15–80% expressed against the pollen sum). Charcoal values were relatively high during the early part of this zone (1–4 cm^2/cm^3) then values declined by about a factor of 10.

(ii) *Zone* F2: (160–50 cm depth). *Pandanus* values are highly variable, peaking at 55% and declining to 15% in this zone and remain the most important tree or shrub taxon. Palmae values are relatively high, Melastomataceae values are relatively low as are most woody taxa. Poaceae values peak (to 60%) during this zone, although there is a noticeable trough at about 90 cm depth. *Pteridium* and *Lycopodium* spores become important components of the record. Charcoal values were generally high during this zone.

(iii) *Zone* F3: (50–0 cm depth). *Pandanus* values peak in this zone (around 60%), Poaceae values decline (to around 20%), Melastomataceae, *Nepenthes*,

Table 2
Pollen for rare and unidentified pollen grains from Thool Swamp

Depth (cm)	0	25	45	55	75	155	205	255	305	325
Acanthaceae	0	0	0	2	0	0	1	0	0	0
Fabaceae	0	0	1	0	0	1	0	0	1	0
Verbenaceae	1	2	0	0	1	2	1	0	1	0
Polyscias	1	0	0	0	0	0	0	0	0	0
Araliaceae	0	0	4	0	0	0	0	0	1	0
Ebenaceae	0	0	0	0	0	0	0	0	0	1
Glochidion	0	0	0	0	0	2	0	0	3	0
Solanaceae	0	1	0	0	1	1	0	0	1	0
Rubiaceae	0	0	0	0	0	1	0	0	2	0
Malpighiaceae	0	0	0	0	0	1	0	0	0	0
Dodonaea	0	0	0	0	0	1	0	0	0	0
Flacourtiaceae	0	0	0	0	0	0	1	0	0	0
Terminalia	0	0	0	0	0	0	0	1	1	2
Mimosaceae	0	0	0	0	0	0	1	1	0	0
Sapindaceae	0	0	0	0	0	0	1	1	0	2
Selaginella	0	0	0	0	0	0	0	0	1	0
Apiaceae	1	0	0	0	0	0	0	0	0	0
Campanulaceae	0	0	0	0	0	0	0	0	0	1
Labiateae	0	0	0	0	0	0	0	0	1	0
Convolvulaceae	0	0	0	0	0	1	0	0	0	0
Alternanthera	0	0	0	1	0	0	0	0	0	0
Nepenthese	0	0	0	3	2	0	1	0	0	0
Hydrocharitaceae	2	0	0	0	0	0	0	0	0	2
Unidentifed	8	5	5	4	3	1	5	10	2	0
Crumpled	1	0	1	1	2	4	1	2	3	1
Parkeriaceae	0	1	1	0	1	0	0	0	0	0

Asteraceae (Tubuliflorae) show their highest representation during this zone. Fern spore values are variable with strong peaks for *Selaginella* and psilate Trilete spores just before the close of the record, and small increases in patterned Trilete spores and psilate Monolete spores in the surface layer. Charcoal values were relatively low during this zone.

5. Discussion

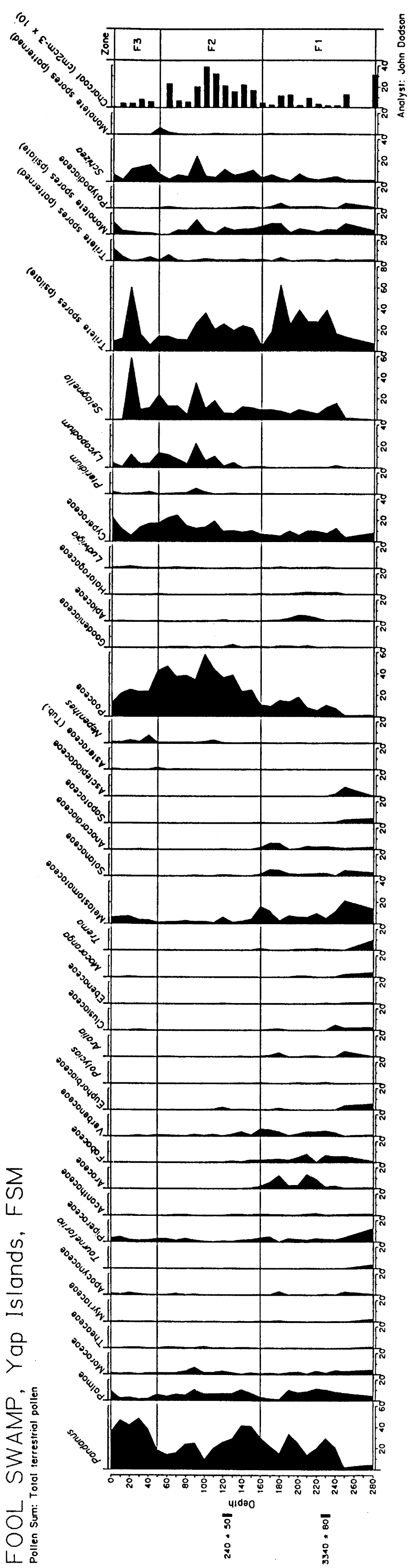
The palaeoecological data are consistent with the three stage model of land use and landscape modification resulting from human activities, and furthermore provide a temporal framework for the changes.

The first stage of landscape change was observed in the pollen and charcoal records from Fool Swamp sediments. A forest decline was accompanied by fire around 3300 BP. From then, and including the period of overlap in time in the pollen diagrams from Fool and Thool Swamps, the landscape was dominated by a savanna with grassland and fern understorey with *Pandanus* and a few other tree species in the canopy. There is stratigraphic evidence of periodic inorganic deposition in the swamp sediments which probably resulted from erosion. It is possible that the forest change is a natural one but given the climate and the sustained nature of the change it seems more likely it was brought about by human activity to establish an agricultural base.

The peak of the savanna can be measured from maxima in Poaceae and fern spores, and minima in tree and shrub pollen. For both sites this occurred within the last 1000 yr. More radiocarbon dates are needed to measure this more precisely, and more sites would need to be examined to see if the two sites are representative of the whole region. However, on the evidence available it is likely that the peak in savanna development occurred within the last 300 yr.

The final stage in land use is seen as a small recovery in some forest and shrub taxa, especially within the last few decades. This is consistent with the idea that the human population of Yap was substantially higher than seen when first European contact was established in the early 19th century, then has undergone a decline.

This analysis has implications for the interpretation of the archaeological record on Yap and how this may be related to other areas in Micronesia and the western Pacific region. An age of 3300 BP for human occupation and disturbance of vegetation on Yap is over 1000 yr



earlier than the available archaeological evidence of human settlement on Yap. This is problematical because the sparse archaeological remains dated to 2000 BP makes it difficult to imagine large populations before this time. Yet perhaps the analysis is more in accordance with the linguistic evidence. A search for a possible earlier third of Yapese habitation history is now necessary.

The supposed earlier settlement of Yap places it before that of other Caroline islands to the east. The first date of settlement is often problematical, it presupposes the evidence of first settlement can be identified and that it can be reliably dated. For example a radiocarbon date of 3600 BP returned from charcoal from the Marshall islands (Streck, 1990) has been questioned because it appears to be drift wood from South America (Weisler, 1996). In any case large pieces of wood from slow growing trees can inflate the age of the supposed event by hundreds or thousands of years. The peat dates from the material in the present study are likely to contain no such systematic errors.

In the early 19th century about 30,000 people may have lived on Yap, (Hunter-Anderson, 1983) and this high population may well have been a causal agent in the development and spread of savanna, and the peak of population and grassland around 300 BP may have coincided. After European contact Yap experienced a severe population decline; to around 7800 in 1898 and 2500 in 1945 (Ushijima, 1987). This decline, as a reduction in pressure on land use, may well explain the small recovery evident for forest and shrubland during the last few decades. It is unlikely, however, that substantial stands of primary forest with the richness of that which existed about 3300 yr ago, will ever occur on Yap.

Palaeoecological evidence from a number of areas in the Pacific has yielded a variety of new information concerning the nature of the environment before and after initial human settlement and land-use changes (e.g. Flenley et al., 1991; Kirch and Ellison, 1994; Athens and Ward, 1995). The earliest date for human settlement on the Mariana islands is around 3500 BP for Saipan, based on archaeological data (Butler, 1994). The earliest archaeological data for Guam is 2700 BP yet the first consistent charcoal appears at about 3600 BP (Athens and Ward, 1993, 1995; Ward, 1995). If this can be interpreted as evidence of human impact, then Guam and Saipan were settled at about the same time. The interpretation of the present data as indicating human impact at about or just before 3300 BP places settlement of Yap close to the same general time frame.

Fig. 4. Pollen and charcoal diagram from Fool Swamp.

Table 3
Pollen counts for rare and unidentified pollen grains from Fool Swamp

Depth (cm)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	280
Sterculiaceae	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tournefortia	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	8
Malvaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Glochidion	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Dodonaea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Malpighiaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ebenaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Rubiaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Barringtonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	1	0	0	1	0
Flacourtiaceae	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	4	14	15	0	1	9	5	7	4	1	5
Loranthaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Liliaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Loganiaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Borganinaceae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0
Campanulaceae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Convolvulaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2	0
Labiateae	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Chenopodiaceae	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Typha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0
Terminalia	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Unidentified	2	0	1	1	1	0	1	7	2	0	1	0	2	3	2	2	13	16	6	8	9	6	4	2	13	1	0

Acknowledgements

We thank the late Andrew Kugfas, Yap Historic Preservation Officer, for his interest and assistance in providing logistic support, and Rolf Obermeyer who carried out the charcoal abundance estimates for the Fool Swamp site. This research was generously supported by the Toyota Foundation (Japan) (#93-II-050).

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