Papuan pasts:
cultural, linguistic and biological histories of Papuan-speaking peoples

edited by
Andrew Pawley, Robert Attenborough,
Jack Golson and Robin Hide

Pacific Linguistics
Research School of Pacific and Asian Studies
The Australian National University

Published by Pacific Linguistics
Research School of Pacific and Asian Studies
The Australian National University
Canberra ACT 0200
Australia

First published 2005

National Library of Australia Cataloguing-in-Publication entry:

Papuan pasts: cultural, linguistic and biological
histories of Papuan-speaking peoples

Bibliography.
ISBN 0 85883 562 2

1. Papuans - History. 2. Papuans - Social life and customs.
3. Papuan languages. I. Pawley, Andrew. II. Australian National University.
Research School of Pacific and Asian Studies. Pacific Linguistics.

995.3

Cover: Bird-shaped pestle from Wonia, Western Province, Papua New Guinea
(AM Reg E065762).
Photographer: John Fields, copyright Australian Museum, Sydney.

Copyedited and typeset by Margaret Forster
Cover design by Addcolour Digital
Printed and bound by Addcolour Digital, Fyshwick, Canberra

10 *Changing landscape and social interaction: looking at agricultural history from a Sepik–Ramu perspective*

PAMELA SWADLING AND ROBIN HIDE

Introduction

The last manifestation of an inland sea in the Sepik–Ramu Basin (Figure 1) reached its fullest extent about 6500–7500[1] years ago (Chappell this volume). The presence of this inland sea had major implications not only for the occupants of the immediate region, but also for the Highlands,[2] as it placed the large inter-montane valleys in inland Papua New Guinea closer to the coast. This paper examines the interaction between the people inhabiting the shores of the Sepik–Ramu inland sea with on the one hand the Highlands and on the other the North Coast, New Guinea Islands and other parts of the New Guinea mainland. In our view, the people occupying the shores of the Sepik–Ramu inland sea played a pivotal role for much of the early to mid-Holocene prehistory of Melanesia. Our argument is based on the distribution patterns of stone mortars and pestles, in particular the greater number of bird pestles in the Sepik–Ramu and Highlands compared to the rest of New Guinea and the New Guinea Islands. We will demonstrate that these artefacts are associated with agriculturalists. After 4000 years ago the infilling of the inland sea, as well as other significant natural events on the North Coast, changed the main interaction focus within Melanesian prehistory from the shores of the inland sea and the Highlands to the New Guinea Islands.

This did not mean that interaction ceased between the Sepik–Ramu and the Highlands, rather that the spatial extent of the interaction systems declined. Over time the successor local systems increased in complexity. It is likely that these changes were comparable to the changing exchange network configurations in south Papua as modelled by Allen (1984).

[1] Radiocarbon dates that have been calibrated to calendar dates are given as 'BP' (Before Present) or expressed as 'years ago'. Uncalibrated radiocarbon dates are given as 'bp' (before present). Where not specifically referenced, calibrations of radiocarbon dates have been done using the Haberle conversion table explained by Golson in a note at the end of Chapter 8.

[2] In this chapter major regional areas have been given upper case initial letters.

Andrew Pawley, Robert Attenborough, Jack Golson and Robin Hide, eds, 2005, *Papuan pasts: cultural, linguistic and biological histories of Papuan-speaking peoples*, 289–327.

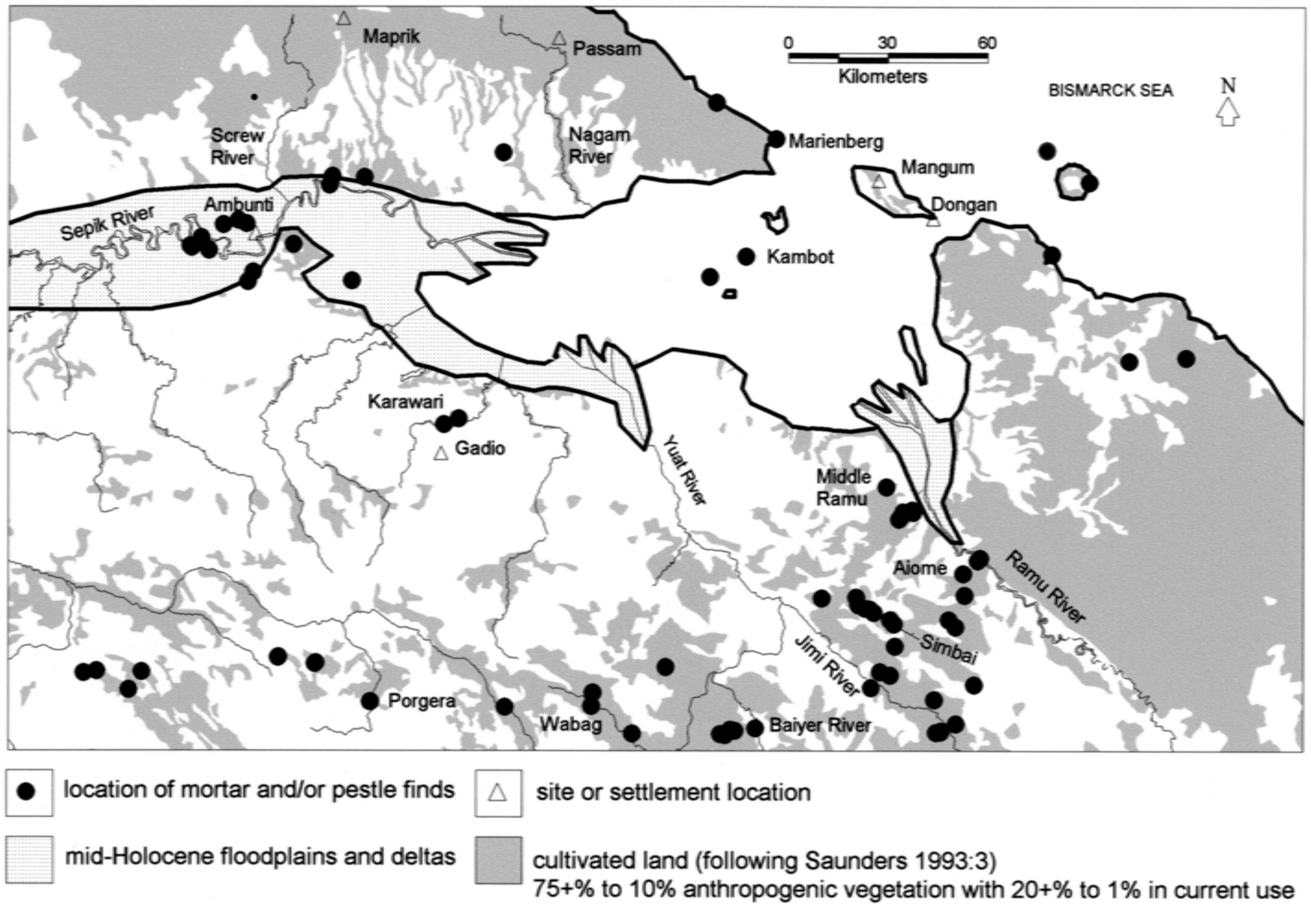


Figure 1: Distribution of mortars and pestles, cultivated land and the mid-Holocene floodplains and deltas of the Sepik–Ramu inland sea
(mid-Holocene reconstruction follows Chappell this volume)

Any discussion of agricultural history in the Sepik region has to explain the high population densities found in the southern foothills of the coastal ranges in the East Sepik Province (Figure 2). The lowland subsistence farmers who reside in this area have the largest areal extent of high population density found anywhere in the South Pacific lowlands (Brookfield 1960; Ward 1970:10). This raises the question as to whether agriculture in the southern foothills has the same antiquity as in the Highlands. The latter have the densest and most extensive subsistence populations anywhere in the South Pacific, and archaeology is revealing that agriculture began to develop there perhaps as far back as 10,000 years ago (Denham this volume; Denham et al. 2003; cf. Golson 1977; Golson & Hughes 1980). We examine below the question of the East Sepik southern foothills and their population densities.

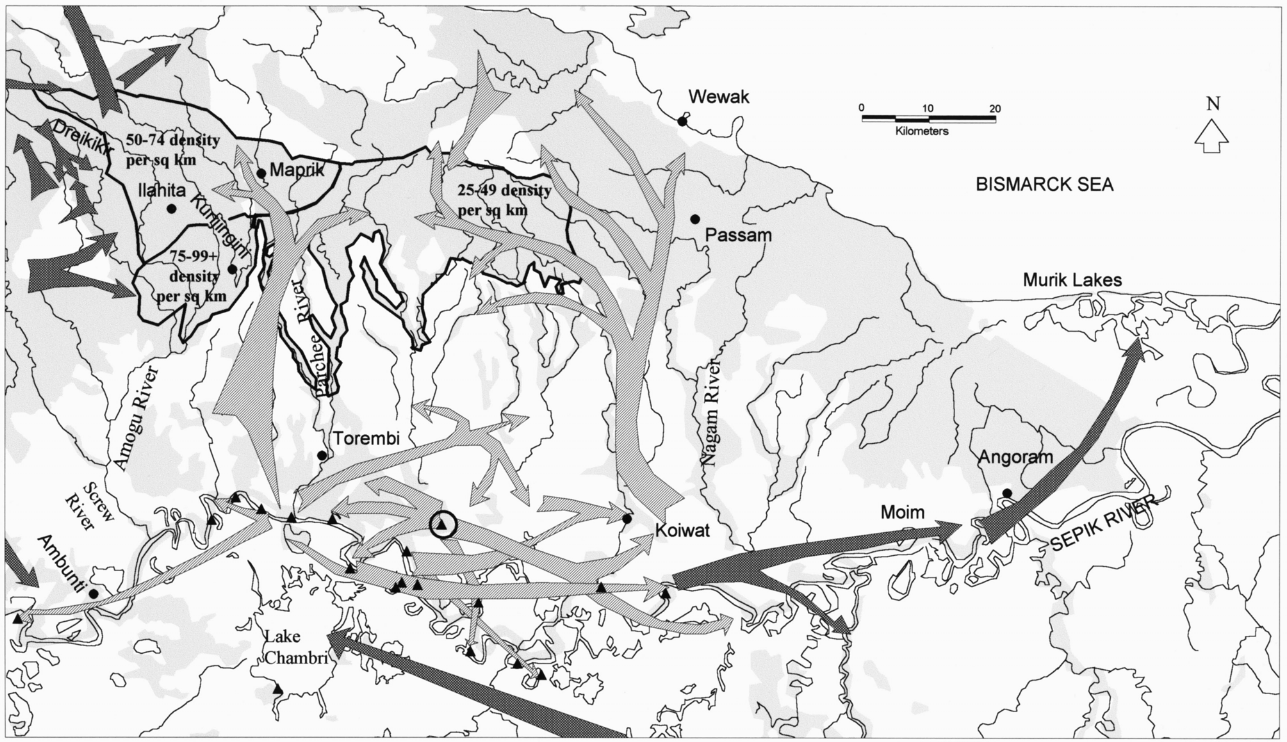
Changing landscape

Warmer conditions followed the last glacial maximum which is dated at 21,000 years ago. The fastest rate of sea level rise occurred in the period between 16,000 to 8000 years ago. In the Sepik–Ramu this rising sea level created an expanding inland sea with its fullest extent being reached by 6500 to 7500 years ago. Subsequent infilling occurred by 4000 years ago (see Chappell this volume).

While the inundation of a large part of the Sepik–Ramu Basin by an inland sea in the mid-Holocene is now established (Swadling et al. 1989; Chappell this volume), we do not have any modelling of the geomorphic and related vegetation changes that have occurred in the last 50,000 years. For instance, it is known that the Sepik River would have down-cut during times of low sea level, because the North Coast lacks a continental shelf (Chappell this volume), but we do not understand the full impact that this would have had on the Upper Sepik drainage.

Was the Upper Sepik prior to the infilling of the inland sea better drained by its southern tributaries, the May, Frieda, Leonhard Schultze and Wogamush rivers (Figure 7), making it more suitable for human habitation than it is today? These poorly drained alluvial plains are currently occupied by people at very low population densities of usually less than 3 persons per km^2 (Allen et al. 2002b:25, 61). Sago is everywhere the major food staple. People living along the Sepik also make significant use of coconut, and may cultivate small gardens of yam, taro and banana on the seasonally flooded levee banks. Those living on the tributaries, if they cultivate at all, have few gardens and a very small harvest of crops such as banana, taro and sweet potato.

If this area was better drained in the early to mid-Holocene, it may explain why a large (27 cm) adze made of giant clam shell (*Tridacna gigas*) was found at a depth of 3 m in drain-digging during the construction of the Frieda airstrip (Figure 7; for illustrations see Swadling et al. 1988:Plates 48–49). It dates to 4980+/- 90 bp after correction for seawater effect (Swadling et al. 1989:109, Table 1) and this gives a calibrated range from 5912 to 5582 BP (Spriggs 2003:71) or roughly between 5600 and 6000 years ago. No similar shell adzes, only a few small dorsal ones from coastal localities, are known in the extensive adze and axe collection from the Sepik–Ramu Basin held in the National Museum in Port Moresby. Nor have comparable adzes made from stone been collected in the area, negating the possibility that the adze might be a one-off made from fossil shell. These observations lend further support to Golson's argument (this volume) that the artefact was in the Sepik



Cultivated land (following Saunders 1993:3), 75+% to 10% anthropogenic vegetation with 20+% to 1% in current use

Areas of high population densities with persons per square kilometre indicated (Allen et al. 2002b)

Ndu migrations (from oral history following Roscoe 1994; Newton 1997). Note most movement is to the foothills, downriver, upriver, with little south of the immediate Sepik River.

Non-Ndu migrations (following Roscoe 1994; Newton 1997)

Main ancestral area of the Iatmul (following Newton 1997)

Iatmul villages (there are none north and few south of the immediate Sepik River)

Figure 2: The distribution of cultivated land, high population densities and the prehistoric migrations of the Ndu and their neighbours

The regional divisions of the Sepik are as follows: the Upper Sepik is upriver from Ambunti, the Middle Sepik from Ambunti to Angoram and the Lower Sepik downriver from Angoram to the river mouth.

Basin as a result of the existence of the inland sea and the depth from which it was recovered indicates that it was there some time before the effective infilling of the sea by 4000 years ago, which itself suggests that the adze was made when the shell was fresh. The shell would have originated from a coastal reef environment, not from the inland sea.

The possible significance of this find is increased by the results of research in another discipline. Comparative linguistics indicates that the greatest lexical and structural diversity in the Sepik language family is found in the area between the May and Wogamush rivers (Foley this volume; see also Figure 7 here), suggesting that its linguistic homeland may occur in the region. This is an interesting observation, as today the Sepik language family is the largest language family, in terms of number of speakers, found in the East Sepik and Sandaun (West Sepik) Provinces. Taken together, the findings suggest that the area between the May and Wogamush rivers warrants a joint geomorphic and archaeological survey.

Distribution of mortars and pestles

Stone mortars and pestles are the main markers of social interaction used in this paper. Some elaborate examples are illustrated in Plates 1–5. Small mortars, comparable in size to modern betel mortars, such as the 15 cm-long human figure mortar from Manam (Thorpe 1930), are not included in this discussion.

In their review of Highlands prehistory, Susan and Ralph Bulmer (1964:69–72) reported similarities between the stone mortars and figures from the North Coast and the Highlands and suggested that these artefacts signalled some association with agriculture and possible immigration into the Highlands. Subsequently, Newton (1979) demonstrated that the greatest density of mortars and pestles and stone figures occurred in an arc across the Highlands valleys (Western Highlands to Simbu) inland of the Sepik–Ramu. Some dates for mortars and a pestle (all from the Highlands) have become available since then and are shown in Table 1a. The age range is roughly from 8000 to 3000 years ago. The Ambum stone figure from Enga (Figure 10) is the only dated figure, the date provided by the radiocarbon dating (by Accelerator Mass Spectrometry) of rootlets penetrating a small fracture and given as ‘approximately 3500 years ago’ and ‘1508-1438 BC’ (Tworek-Matuszkiewicz 2001; Table 1b here). It is significant that no stone mortars and pestles have been recovered from Lapita sites in the New Guinea Islands. On the basis of the Highlands dates, and the relationship of findspots of mortars and pestles to the shoreline of the mid-Holocene inland sea (Figure 1), it is argued here that most of these artefacts in New Guinea and the New Guinea Islands date between 8000 and 3000 years ago. The only communities to use stone mortars or pestles in the twentieth century were on Buka (Specht 1974) and in the Solomon Islands (Swadling 1981:50–53).

Plate 1: Pestle with crouching human figure, Yanitobak, Karawari, Middle Sepik, height 14.3 cm. Photo by Olaf Wipperfürth, courtesy of Anthony J.P. Meyer and Könemann Verlag (Meyer 1995 (1) 15, fig.4)

Plate 2: Mortar from Iniai, Karawari, Middle Sepik, height 14.5 cm. Photo by Olaf Wipperfürth, courtesy of Anthony J.P. Meyer and Könemann (Meyer 1995 (1) frontispiece)

Plate 3: Mortar from Vrimsebu, Middle Ramu, height 42 cm. PNG National Museum. Photo by Wally Ainui

Plate 4: Bird pestle from Marienberg, Lower Sepik, height 14 cm. Photo Vatican Museum, Rome

Plate 5: Bird pestle from Tokain Creek, opposite Karkar Island, Madang, height 17 cm. Anthropos Institut (Höltker 1968: Plate 38)

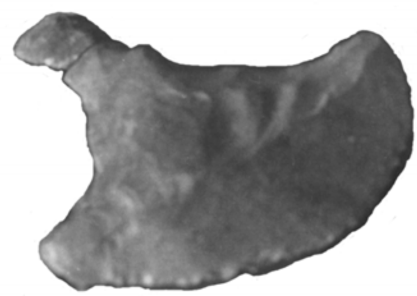


Plate 6: Stemmed obsidian tool from the Bien (Porapora) River area, Lower Sepik. Type 2 in the classification of Araho et al. (2002:63–66). About 10 cm wide, the artefact is lying on a flat surface. Photographed by Ted Schwarz around 1965 at the Marienberg Mission station. (Photo courtesy of Ann Chowning and J.P. White)

Table 1a: Dated finds of stone mortars and pestles

Site	Artefact	Location	Uncalibrated radiocarbon dates for associated archaeological deposits	Years ago
NFB	1, possibly 2 mortar fragments	open site just south of Kainantu, Eastern Highlands	3000 bp above 3500 bp below	3150 above 3700 below
Nombe	mortar fragment	rock shelter site in Simbu	<4500 bp	<5000
Nombe	pestle	rock shelter site in Simbu	<4500 bp	<5000
Warrawau	mortar	swamp site near Mount Hagen, Western Highlands	<5000 bp	<5700
Kuk	mortar fragment	swamp site near Mount Hagen, Western Highlands	7000–7500 bp	7800 to 8300

A mortar fragment reported in the literature from Wañelek, Simbai Valley, Schrader Range has proved to be a potsherd (S. Bulmer pers. comm. 2000).
Sources: Ambrose 1991; 1996–97:1087–1088; Golson 2000; Jack Golson pers. comm. 2004; Mountain 1991:516; Mary-Jane Mountain pers. comm. 2002; Watson and Cole 1977:15, 28, 130; White 1972:134–135.

Table 1b: Dated find of stone figure

Site	Artefact	Location	Date
Ambum	figure	cave in Yambu clan territory, Ambum Valley, Enga (made from volcanic sandstone or crystal tuff which is available locally).	approx. 3500 years ago (1508–1438 BC) (see text for details)

Source: Tworek-Matuszkiewicz 2001

The distribution of mortars and pestles within the New Guinea Highlands is irregular. There is no chain of finds through the main Highland valleys. Their absence from the Grand Valley of the Baliem in West Papua is striking. As a general pattern, the greatest inland densities occur in the hinterlands of coastal embayments. It is suggested here that these hinterlands were characterised by an agricultural subsistence base. This will be demonstrated below for the Sepik–Ramu inland sea shoreline and the Highlands on the one hand and for the former indented Oro Coast and Kokoda and adjacent inland valleys on the other. In addition, the presence of mortars and pestles not only in New Guinea but also in the New Guinea Islands indicates that there is a maritime component to their distribution, as Riesenfeld (1950:666) was the first to recognise.

The distribution of mortars and pestles shows a strong association with areas suitable for taro cultivation in the Sepik–Ramu, the Highlands and the New Guinea Islands (see Swadling 2004 for a case study of New Britain). In areas where little taro is currently (or was historically) grown, mortars and pestles have not been found. For instance, they are absent in areas where either yams are a major staple, like the Maprik–Wosera area in East Sepik, or where banana is a major crop, as in the Markham Valley.

It is possible that the mortars and pestles found in the Highlands of Papua New Guinea were used to produce a smooth consistent paste by pounding cooked taro moistened with water. In many Pacific communities water was used as the emollient when pounding cooked taro, rather than coconut cream or canarium. This was the case on Hawaii, where coconuts were not abundant (Handy & Handy 1972:113). Whether this was the case in the Highlands can only be confirmed or rejected by residue work on mortars and pestles, especially those not subjected to recent ritual use. However, it does provide an explanation as to how these artefacts came to be distributed in the Central Highlands, lowlands and New Guinea Islands, a wide range of environments, but all areas where taro now is, and could potentially have been grown. Interestingly, where mortars and pestles (whether wood or stone) are still used to pound taro and coconut cream and canarium in Melanesia, they are customarily used by men in ceremonial contexts (for some examples see Swadling 1981:52). The main exception would be the Trobriands, where women pound the taro with mallets and prepare the cakes that are cooked by men (Young 1998:166–168).

The distribution of mortars and pestles within the Sepik–Ramu (Figure 1) shows two main clusters in the former delta regions in the vicinity of Ambunti and in the Middle Ramu, with a smaller cluster in the Karawari area and another in the vicinity of former islands near Kambot. From an agricultural point of view the alluvium of the deltas would have been much the same as the modern floodplain, while it is impossible to say whether the frequency of floodwater inundation would have been any different (Chappell pers. comm. 2004). Sediment and pollen records from the Bimba Lagoon in the Ambunti region and Lake Vargu in the Middle Ramu, which have not been investigated, might give some answers as to what was happening there in terms of land use in the early-mid Holocene.

The former deltas aside, Figure 1, following Saunders (1993:3), shows a number of areas suitable for agriculture on what was, 6500 to 7500 years ago, the shoreline of the inland sea. No direct evidence for crops such as sago, taro, yam or bananas has been found to date in archaeological sites in the Sepik–Ramu, but we do have evidence of arboriculture (Swadling et al. 1991). Numerous fruits and nuts were recovered from the Dongan midden site (Table 2), which is located on a former island at the mouth of the inland sea (Figure 1). Radiocarbon dates through the midden where most of this material was found calibrate at 2 standard deviations from about 6400 to 6800 years ago (Spriggs 2003:71). *Galip* (*Canarium indicum*), *ton* (*Pometia pinnata*), coconut (*Cocos nucifera*) and betel nut (*Areca catechu*) still feature prominently as tree crops in the Sepik–Ramu. No soft tissue material or stone tools with use residues were recovered from the Dongan site, only fibres and casings from fruits and nuts. This means that no conclusive statements about the presence or absence of tubers and other crops can be made.

While evidence for mid-Holocene agriculture in the Sepik–Ramu is minimal, one possible scenario is that agriculture may have been comparable to that found along the lower Screw River (Figure 2) today, but with greater opportunities for taro cultivation and possibly less sago than found today. Currently the major staple food crop of the people living in the former mid-Holocene delta regions of the Sepik and Ramu rivers is sago, a crop eminently suited to a landscape seasonally flooded to considerable depths. The secondary staples, besides the tree crop coconut, are taro (*Colocasia esculenta*) and banana (*Musa* spp.), along with (non-traditional) Chinese taro (*Xanthosoma sagittifolium*) in Ambunti (Sepik) and taro and bananas with sweet potato in the Middle Ramu. It has been estimated that taro occupies perhaps 10–20 per cent of garden area in both the Ambunti and Middle Ramu areas, though the garden areas cultivated in such sago-dominant regions are generally small.[3] The role of taro and banana in the contemporary agriculture of these areas lends some support to our proposal that the mortars and pestles found were probably associated with processing of taro. The joint cultivation of taro and bananas in both regions is of interest, as Denham et al. (2003) have demonstrated that taro and banana were the main cultivars at Kuk swamp in the upper Wahgi Valley in the early Holocene.

Table 2: Direct evidence for arboriculture
The following fruits and nuts (not all foods) were recovered from the mid-Holocene midden (around 6400 to 6800 years ago) at Dongan in the Lower Ramu, Madang Province

FRUITS		NUTS	
Genus/species	common/*tokpisin* name		
Cordia		*Aleurites*	candle nut
Pandanus	pandanus	*Areca catechu*	betel nut
Pangium	*sis*	*Canarium*	*galip*
Parinarium	(putty)	*Cocos*	coconut
Pometia	*ton*		
Sterculia			

The clusters of stone mortars and pestles collected in the alluvial regions of the former Sepik and Ramu deltas are striking. Table 3 lists the mortars and pestles reported for the Ambunti region and Figure 3 shows the locations where they were found. Although no systematic survey has been made in the region, these items have been collected or reported consistently over the years. Unlike Ambunti, few social scientists have visited the Middle Ramu. Father Kasprus (1973) and Dirk Smidt (the latter then at the PNG National Museum) have been the main researchers. Nick Araho and Swadling made a brief visit in 1986. Nevertheless, as is the case in the Ambunti region, mortars and pestles have been collected or reported consistently over the years (Table 3). Figure 4 maps the location of these finds.

Some of the most elaborate examples of mortars and pestles known from Papua New Guinea come from the Sepik–Ramu and adjacent Madang coast (Plates 1–5). Plates 4 and 5 and Figure 5 illustrate examples of bird-shaped pestles. Similar pestles have been found widely in New Guinea, with only a few being reported from the New Guinea Islands. It is possible that their distribution is related to that of birds of paradise, which are found only on the New Guinea mainland and some islands in Milne Bay and not in the New Guinea Islands (Frith & Beehler 1998). What is evident about the distribution of bird pestles, as Newton noted in 1979, is that their highest frequency of occurrence is in the Western

[3] See, for Ambunti, East Sepik Agricultural System No. 2 in Allen et al. (2002b:21–23) and, for the Middle Ramu, Madang Agricultural System No. 8 in Allen et al. (2002a:43–44). These are broad estimates only, derived from rapid assessment surveys. In the case of the Ambunti area it may overestimate the role of tubers in the diet: on the basis of a very small diet survey, Bowden (1983:11) showed that tubers and banana composed only four per cent of the diet of Kwoma people in the Washkuk Hills to the west of Ambunti.

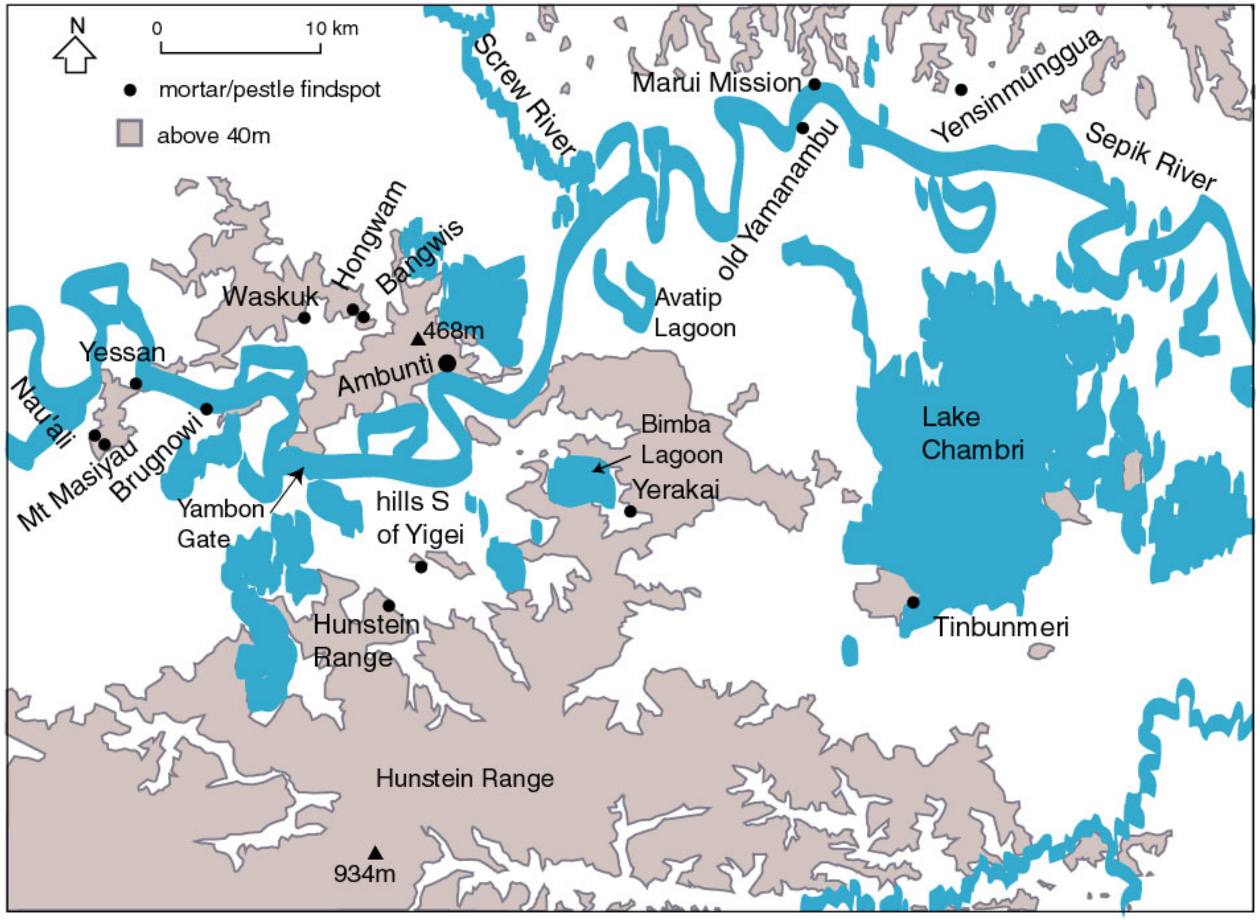


Figure 3: Where mortars and pestles have been found in the mid-Holocene floodplain and delta area of the Sepik River

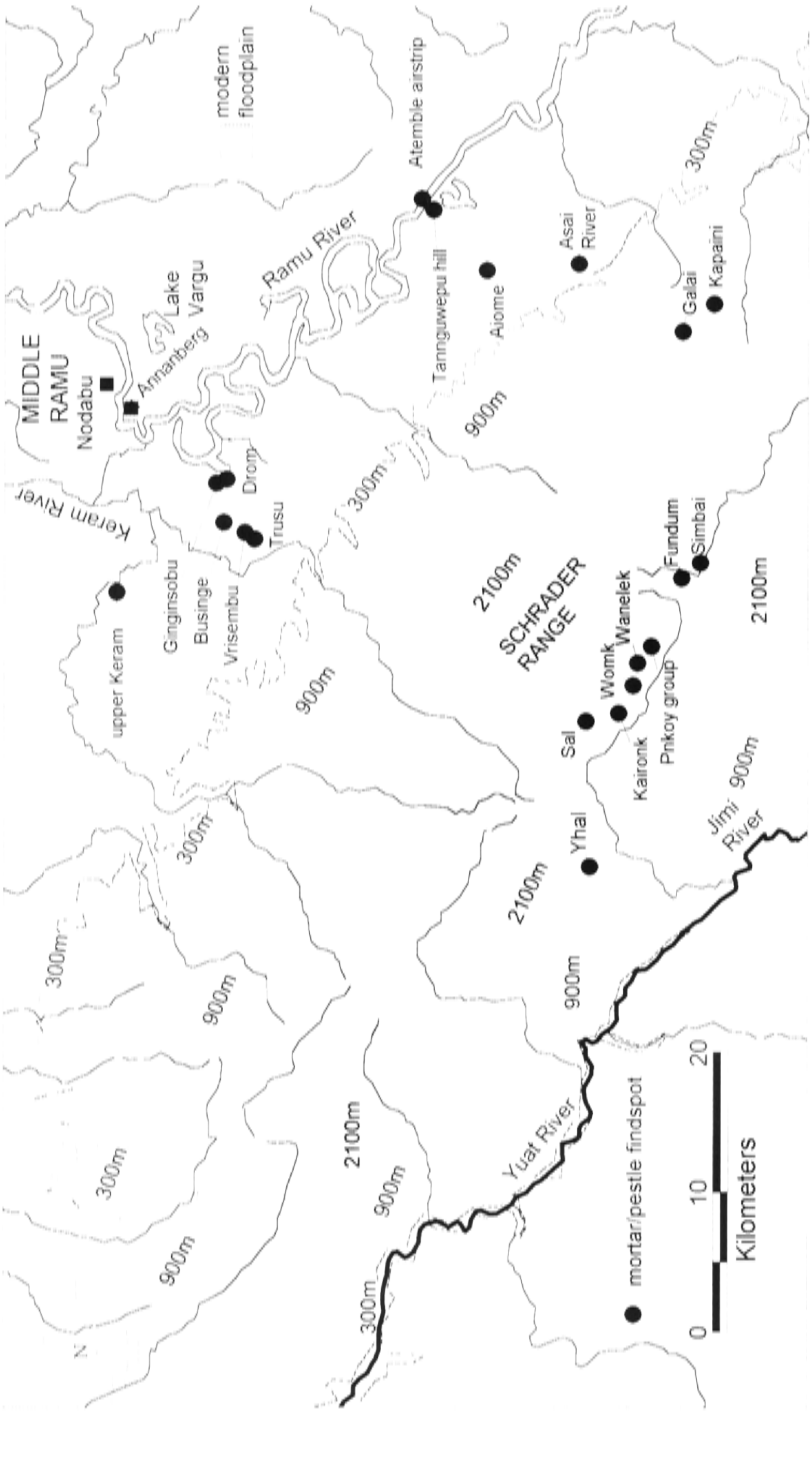


Figure 4: Where mortars and pestles have been found in the Middle Ramu and in the Simbai area of the Madang Highlands

Highlands and Simbu. Figure 6 illustrates examples from the Sepik–Ramu and nearby Madang coast, Enga, Southern Highlands, Western Highlands and Simbu. The similarity in form between those from the North Coast, from the area of the inland Sepik–Ramu sea and from the Central Highlands is notable, demonstrating interaction between these regions in the mid-Holocene.

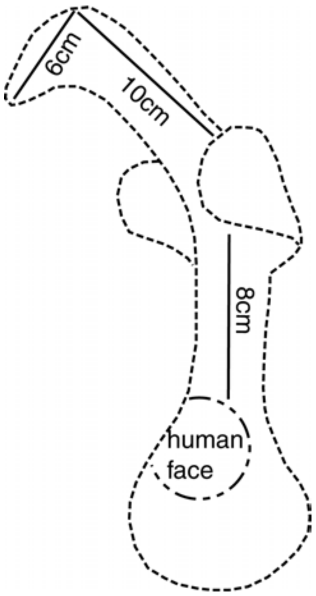


Figure 5: Reconstruction of a bird pestle from Kambot, Lower Sepik, based on the description and measurements reported by Fathers Ignaz Schwab and Hubert Hansen, SVD, in a letter to Georg Höltker in 1940. The pestle has an overall length of 33 cm and is topped by a stylised bird-like figure. The 6 cm-long beak of the bird is slightly bent forward. About 10 cm from the top of the object are two rudimentary wings and further down from these, about 8 cm distant from the wings, there is a human face carved in the stone. (Höltker 1951:252, fn. 33)

One difference between the mortars and pestles from the two former deltas of the Sepik and Ramu rivers is that those from the Middle Ramu are more elaborately decorated than those from the Ambunti region. In particular, the Vrimsebu mortar from the Middle Ramu (Plate 3) has to be considered one of the most spectacular from the whole of Papua New Guinea. This richness in artwork is also true of the specimens from Karawari on the northern fall of the central ranges and those from the vicinity of former islands near Kambot (Figure 1). We may also note for the Middle Ramu that other prehistoric stonework from there similarly demonstrates marked elaboration (see England 1946; Newton 1979; Swadling 1981).

The distribution of bird pestles shown in Figure 7 supports the proposal of Gorecki and Gillieson (1989) that the Yuat-Jimi Valley served as the primary ‘crack in the spine’ (or route from the northern lowlands into the Highlands). From the middle Jimi the distribution extends into the Baiyer River area and thence to the Wahgi Valley. A second route of Sepik-Highlands interaction seems to have been via the upper tributary valleys of the Karawari River system to western Enga (Pausa and Porgera) and Tari.

Although only one stone bird pestle has been found in the Schrader Ranges, there is a continuous distribution of stone mortars and pestles from the Middle Ramu cluster in the lowlands to the Simbai area of the Madang Highlands (see Figures 1 and 4). This distribution is not surprising, as Majnep and Bulmer (1977:28) have pointed out that the Simbai and Kaironk valleys provide the only continuous corridor of grassland and gardens between the northern lowlands (including the Middle Ramu) and the Jimi Valley and main Highlands valleys. The Yuat Gorge is also a grassland corridor (see Plate 3.1 in Gillieson et al. 1989:39), but it lacks the population densities and associated cultivated areas found in the Simbai and Kaironk valleys. Indeed, the very small populations of the Upper Yuat remained on the fringes of contact as late as the 1970s (Boyd 1996).

Table 3: Inventory of mortars and pestles from the Sepik–Ramu and North Coast

Item	Year	First reported by/acquired by	Location
1. Mortars and pestles from the former Sepik delta area			
mortar	1914	A. Roesicke	Hunstein Range
mortar	pre- 1951	Father Vroklage	Marui Mission
pestle	pre- 1951	Father Vroklage	Marui Mission
mortar	1970	D. Newton	Waskuk Hills
mortar	1970	D. Newton	Honggwam
pestle	1970s	C. Kaufmann	Yerakai
pestle	1971	D. Newton	Waskuk area
pestle	1971	L. Bragge	Tinbunmeri
mortar	1970s	L. Martin	quarry north of Timbunke
mortar	1970s	L. Martin	quarry north of Timbunke
mortar	1981	R. Bowden	Nau'ali, Yessan Hills
mortar	1981	R. Bowden	hills south of Yigei
mortar	1981	R. Bowden	Bangwis
mortar	1981	R. Bowden	Mt Masiyau, Yessan Hills
pestle	1983	B. Craig	hilly island in lagoon S of Brugnowi
pestle	1983	B. Craig	old Yamanambu
mortar	1994	C. Boylan	Yensinmunggua
pestle	1998	P. Swadling	Yerakai
2. Mortars and pestles from vicinity of former islands near Kambot and from the Karawari area			
pestle bird	1940	G. Höltker	Kambot Mission
mortar	1960	F. Gerrits	Iniai, Karawari
pestle human	1960	F. Gerrits	Yanitabak, Karawari
mortar	1963	F. Panzenböck	Latten (Raten), Kambot area
mortar	1963	E. Haberland & S. Seyfarth	Yanitobak, Karawari
3. Mortars and pestles from the former Ramu delta			
mortar	pre- 1940	Father Kasprus	Tannguwepu hill, Atemble
mortar	pre- 1940	Father Kasprus	Vrisembu, near Litubu

mortar	pre-	1940	Father Kasprus	Atemble airstrip
mortar	pre-	1972	Bruce Lawes	Upper Keram
pestle	pre-	1972	Bruce Lawes	Upper Keram
mortar		1972	Dirk Smidt	Trusu, near Litubu
mortar		1972	Dirk Smidt	Drom, near Wobu
mortar	pre-	1975	Geoff Owen	near Aiome
mortar		1986	Paul Likumbe	Gringinsobu
mortar		1986	Paul Likumbe	Businge

4. Mortars and pestles from the North Coast and islands (mid-Holocene shoreline)

mortar	pre-	1905	P. Lucker	Ali Island
pestle bird		1932	G. Höltker	Marienberg area
pestle bird	pre-	1965	G.A.V. Stanley	Aitape district
mortar		1966	T. Slimmon, Father Lehner	Waskurin, south of Murik Lakes
mortar		1970	Aitape Mission staff	back of Aitape Mission farm
pestle		1981	O.W. Borrell	behind St John’s Seminary, Kairiru Island
pestle		1981	O.W. Borrell	Paiwat, Muschu Island
mortar		1986	P. Swadling & N. Araho	Nygan, West Aitape
pestle		1986	P. Swadling & N. Araho	Nygan, West Aitape
mortar		1991	R. Hide	Matapau
mortar		2004	G. Summerhayes	Vanimo

5. Mortars and pestles from other locations

mortar		1966	R.H. Chisholm, M. Schuster	N side Bewani Mts
pestle		1966	R.H. Chisholm, M. Schuster	N side Bewani Mts
pestle bird		1970	Dr F.M. Hetzler	Sepik River
mortar	pre-	1973	Mrs Stockton	Sepik River
mortar	pre-	1973	Mrs Stockton	Sepik River
mortar	pre-	1973	Mrs Stockton	Sepik River
pestle	pre-	1973	Mrs Stockton	Sepik River
mortar		2002	D. Schnbeible	Sepik

source: database under construction by senior author (contributions to database welcome)

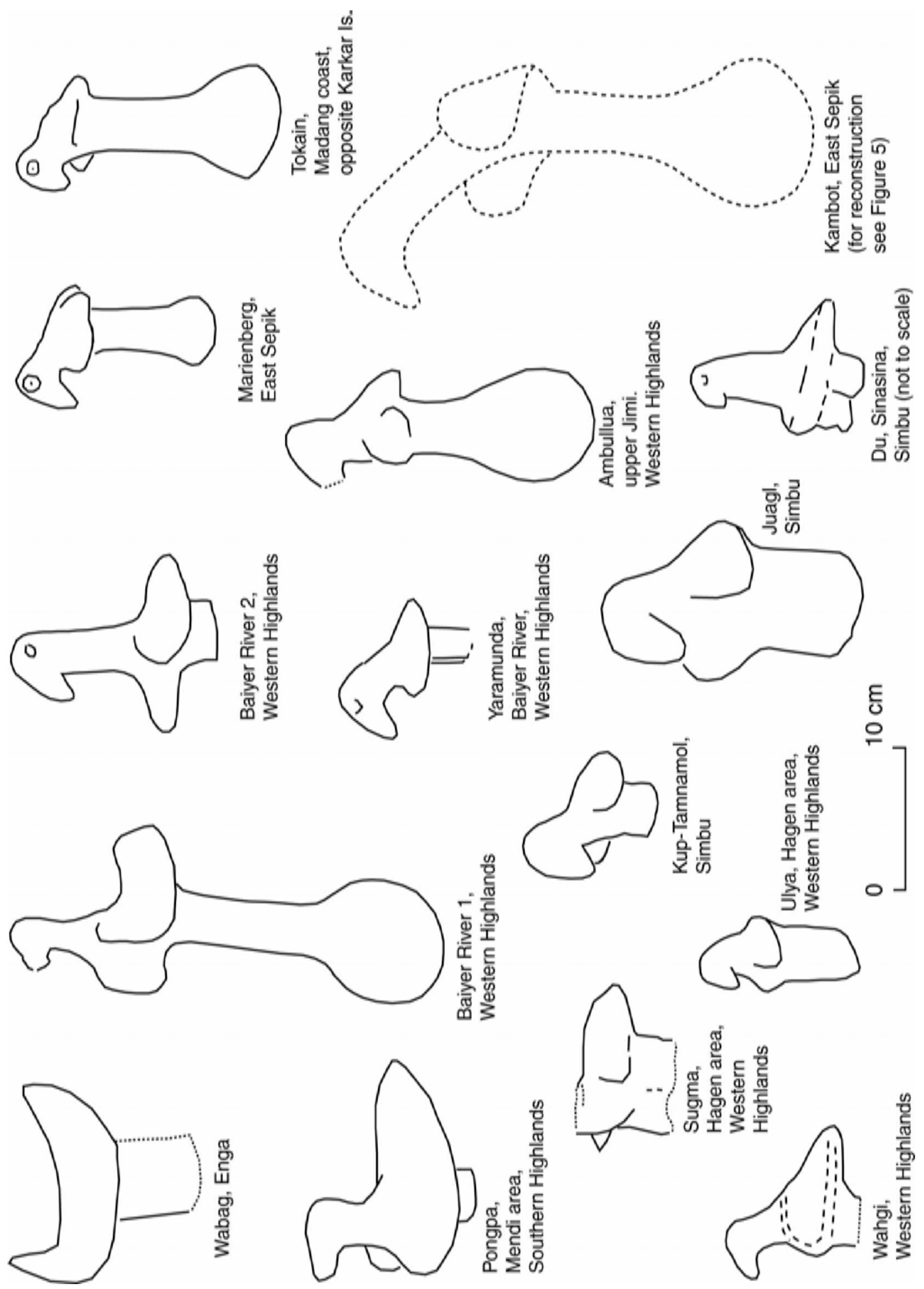


Figure 6: Prehistoric stone bird pestles and fragments from the North Coast, Sepik–Ramu and Central Highlands (following Newton 1979)

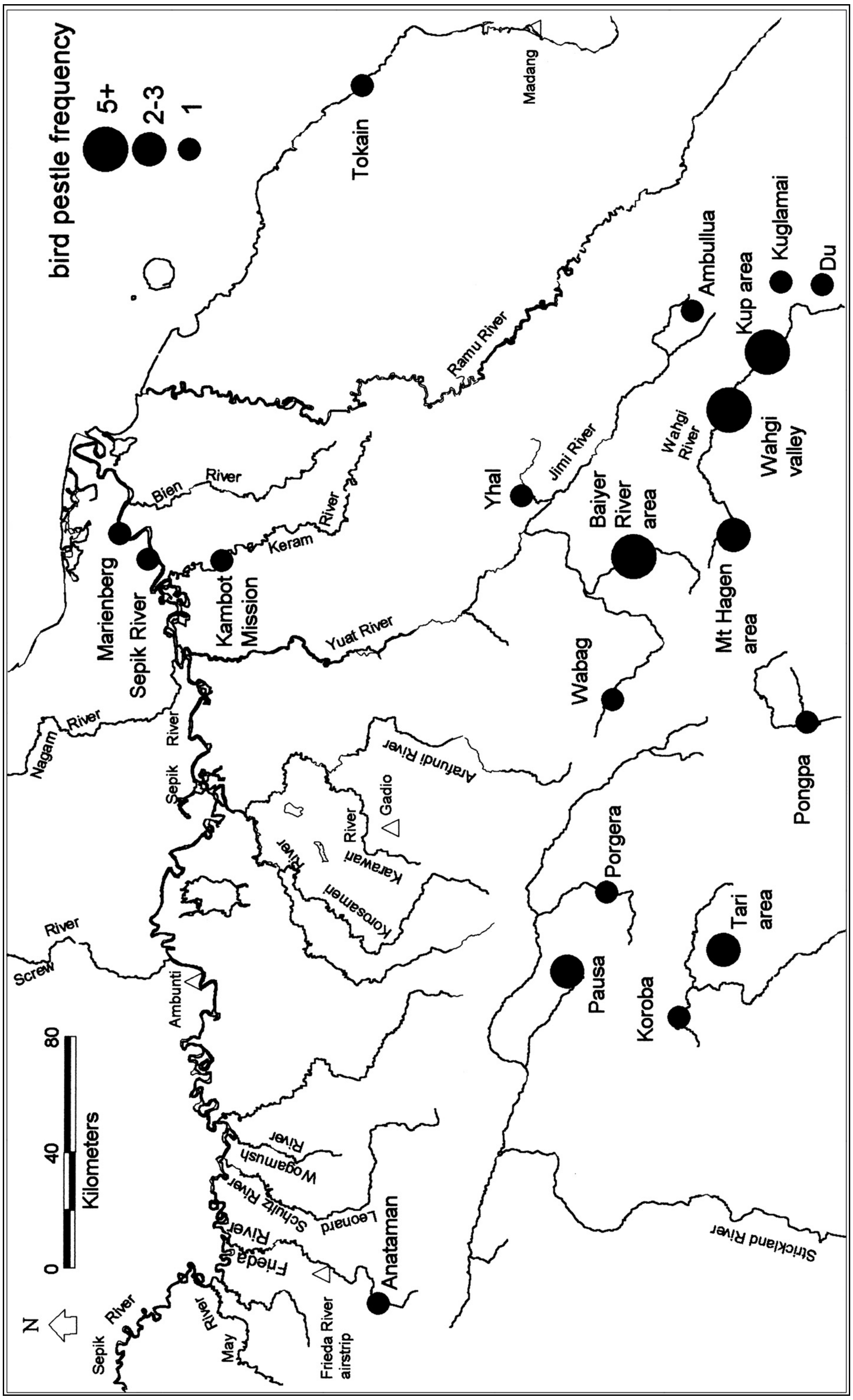


Figure 7: Distribution of stone bird pestles and fragments from the North Coast, Sepik–Ramu and Central Highlands

The Highlands and Sepik as culture areas

In 1938 Mead recognised the Sepik to be a culture area characterised by cultural production, specifically 'the purposive diffusion, sale, and exchange of ceremonial paraphernalia, magical charms, etc.' (Mead 1938:162). Summing up discussions at the 1986 Sepik conference, Shirley Lindenbaum (cited in Lutkehaus & Roscoe 1987:580) enlarged on this by observing that:

> the Sepik's quintessence lies in its emphasis on cultural rather than material commodities. Where Highland society is characterised by the production and exchange of pigs and shells, Sepik society is characterised by the production and exchange of ritual objects (masks, flutes, etc.) and the esoteric knowledge (totemic names, myths, rituals, ritual chants, etc.) and ritual complexes (dances, initiation grades, etc.) that are associated with them and are believed to imbue them and their owners with power.

The antiquity of these cultural distinctions between the Sepik and the Highlands is an interesting question. The distribution patterns of stone mortars, pestles and figures signals a coastal origin. They are found not only in other parts of New Guinea and the New Guinea Islands but also in the Highlands hinterland inland from the shores of the Sepik–Ramu inland sea. An inland direction of flow is indicated by the distribution of more elaborate and larger bird pestles in coastal or intermediate locations, specifically the North Coast, former inland sea and Yuat-Jimi-Baiyer valley system (Figure 7). A comparable coastal-inland agricultural hinterland distribution is found in Oro (see below). Moreover, mortars and pestles could only have been introduced to the New Guinea Islands by seafarers. The stemmed obsidian tools from West New Britain, that date from before 6000 to 3600 years ago (Araho et al. 2002:62), examples of which have been found in the East Sepik (see below), confirm that contact between mainland New Guinea and the New Guinea Islands existed at this time.

Cultivation and land clearance had commenced by 10,000 years ago in the Western Highlands (Denham et al. 2003). Current pollen evidence indicates that this activity commenced 2200 years later in the Baliem Valley (Haberle & David 2004:175). In our view this indicates the importance of social connectivity between the Sepik lowlands and the Wahgi Valley of the Highlands for the early agricultural history of New Guinea. It also suggests that the Yuat was the likely route by which taro was introduced to the Highlands (Figure 12).

Discarding of stone mortars and pestles

The obsolescence of mortars and pestles in the Highlands has long been attributed to the decline of the nut products that were thought to have been pounded (Bulmer & Bulmer 1964:72; Golson 2000:240–242). Although not widely consumed today, there are no ethnographic accounts from the Pacific of nuts such as *Castanopsis*, *Elaeocarpus* and *Pandanus* being pounded or ground (see for example Walter & Sam 2002).

A number of factors may have led to their being discarded. With the infilling of the Sepik–Ramu inland sea the communities living on its rapidly prograding shores would have been faced with a changing natural world with deteriorating livelihood options. These communities would have ceased to be the trading centres placed between the Highlands and the North Coast and New Guinea Islands. From a Highlands perspective such communities would have lost their ritual dominance, as would any cults/rituals associated with them. This may partly explain why these artefacts were abandoned in the Highlands.

Pleistocene interaction between the Sepik–Ramu, North Coast and the New Guinea Islands

The evidence is fragmentary, but there are some interesting occurrences involving flora and fauna. The case of the animals is clearer (Figure 11a). By 15,500 years ago the Admiralty cuscus, *Spilocuscus kraemeri*, and a bandicoot, *Echymipera kalubu*, had been introduced from mainland New Guinea to Manus (Spriggs 1997:54, 13,000 bp; Williams 1999). Although *S. kraemeri* is recognised as a separate species, it has been observed to interbreed with *S. maculatus* in captivity (Singadan 1996) and is presumed to have diverged from that species following its arrival on Manus. As regards the bandicoot, *E. kalubu* is known on New Britain today, but its antiquity there is unknown and it has never been found on New Ireland. Spriggs concludes (1997:54) that a direct introduction to Manus from mainland New Guinea is most likely, given the lack of evidence for contact between Manus and the rest of the Bismarcks at this period. This is suggested by the presence of the introduced possum *Phalanger orientalis* on New Ireland from 23,500 years ago (Allen & Gosden 1996:187–188, 20,000 bp), but its continuous absence from Manus. No Pleistocene remains of *P. orientalis* have been yet found on New Britain, but obsidian was being traded from the Willaumez Peninsula of West New Britain to New Ireland from 23,500 years ago (Summerhayes & Allen 1993:147, 20,000 bp; Figure 11b here), suggesting that New Britain was the route by which the animal was introduced into New Ireland from the mainland.

This plausible evidence for two different routes of faunal introductions into the Bismarck Archipelago from the North Coast of New Guinea might suggest the same routes for the early introduction of *Canarium indicum* into the islands (Figure 11c). Here, remains of its nutshells have been found in deposits dating to before 15,500 years ago at Pamwak rock shelter on Manus (Spriggs 1997:55, before 13,000 bp), by around 11,500 years ago at Kilu Cave on Buka (Wickler 2001:236, 10,000 bp) and close to 9000 years ago at Panakiwuk rock shelter on New Ireland (Allen 2000:156, 8000 bp). The only comparable mainland evidence is from Kowekau (Seraba) rock shelter in the Middle Sepik, where Paul Gorecki excavated nutshell going back to close on 17,000 years ago (Yen 1996:41, 14,000 bp). Yen looks on this distributional range as evidence that *C. indicum* is the oldest domesticated species of the genus in Melanesia. He concludes (1996:41) that:

> unless we were to subscribe to some hypothesis of separate domestications on the New Guinea mainland and the islands of western Melanesia, it is obvious that we are witness, through archaeology, to the role of *Canarium*, and specifically *Canarium indicum*, in the late Pleistocene transition from hunter-gathering to horticulture in Melanesia.

The evidence such as we have suggests that *Canarium* was domesticated on the North Coast of New Guinea.

There is now evidence of either taro consumption or at least its presence in the late Pleistocene or early Holocene from both New Guinea and the New Guinea Islands (Figure 12a). Taro cannot be eaten raw; it has to be cooked. The oldest archaeological evidence of taro consumption comes from Kilu Cave on Buka Island in Bougainville Province. There raw *Colocasia esculenta* and *Alocasia* taros were being cut and scraped prior to cooking over 30,000 years ago. Seventeen stone flakes from Pleistocene contexts at Kilu had starch residues as well as raphides (calcium oxalate crystals), of which fourteen were identified as *Colocasia* and three as *Alocasia.* Only *Colocasia* residues were found on the eight stone tools dating to the Holocene (Wickler 2001:234, 28,000 bp; Loy et al. 1992).

Evidence for the early preparation of yam as well as taro comes from Balof rock shelter in New Ireland. There stone tools and shell scrapers were used to scrape and cut these tubers. *Alocasia* and/or *Cyrtosperma* (swamp taro) residues are present from the site's first occupation about 16,500 years ago and yam, *Dioscorea bulbifera* or *D. nummularia*, is present from 12,000 years ago (Barton & White 1993, 14,000 bp; 10,400 bp). Consumption of taro and yam tubers clearly has a long antiquity in the New Guinea Islands, and such a time depth implies plant selection and encouragement, if not full domestication.

It is not known when taro use began in the lowlands of New Guinea. Pollen evidence indicates that *Colocasia esculenta* was present around Lake Wanum in the lower Markham Valley from about 9500 years ago. Its presence is associated with generally increasing forest disturbance (Haberle 1995:196, 8500 bp). Earlier dates must be expected in the Sepik–Ramu as this lowland plant (Yen 1991:564; 1995:835) had been introduced to Kuk in the Western Highlands by 10,000 years ago. There are taro starch grains on the edges of three stone tools and in the deposit and raphides on the edge of one stone tool in the Phase 1 deposits (Denham et al. 2003:191, 9000 bp).

The archaeological evidence from Pleistocene sites in New Guinea and the New Guinea Islands shows that people were already relocating plants and animals and exchanging useful products. The flow appears to be outwards from the New Guinea mainland until the mid-Holocene, when items originating from the New Guinea Islands are brought to the mainland.

Indicators of mid-Holocene contact, whether direct or indirect, between the Sepik–Ramu and the New Guinea Islands are the stemmed obsidian artefacts manufactured in the Willaumez Peninsula region of West New Britain from before 6000 to 3600 years ago, the latter the age of the W-K2 eruption (Araho et al. 2002:62). They have been found on inland Manus, on southern Lihir Island off the east coast of New Ireland, in the lower Sepik–Ramu, at Yodda (near Kokoda) in eastern New Guinea, on Misima Island in Milne Bay (Araho et al. 2002:62, 72) and at Turiboiru in southern Bougainville (O'Reilly 1948). Figure 12b here plots these localities; note that the routes of distribution represented by the arrows are notional. By comparison no obsidian from Admiralty Islands' sources is found outside the group until after the appearance of the Lapita culture in the Bismarck Archipelago around 3500 years ago (Summerhayes 2003:137, 3300 bp; see Figure 13 here).

Four stemmed obsidian tools have been found in the Sepik–Ramu, three of which have been sourced by the late Roger Bird to the Kutau/Bao source on the Willaumez Peninsula by PIXE-PIGME (Wal Ambrose pers. comm. 2003; Glenn Summerhayes pers. comm. 2004). Two of these sourced tools are Type 1 in the Araho et al. (2002:63–66) classification and were found at Mangum in the Lower Sepik (Swadling et al. 1988:Plate 52 for an illustration of one). Two Type 2 stemmed tools have also been found. One is sourced to Kutau/Bao but has no better provenance than between the Sepik and the mountains south of Wewak (Swadling et al. 1988:Plate 50). An unsourced example comes from the Bien (Porapora) River area of the Lower Sepik (see Plate 6).

The two Mangum tools, a complete specimen and a comparable handle fragment, were found cached beneath basalt slabs when a posthole was dug at Mangum village on the Bosmun Plateau (Figure 1). Mangum is located in an area classed as cultivated land by Saunders (1993:3) on the former large island which existed at the mouth of the Sepik–Ramu inland sea prior to the latter's infilling 4000 years ago.

The importance of islands as foci for trade is well recognised in Melanesian prehistory and ethnography; some of the major works are Allen (1977), Harding (1967), Irwin (1983) and Malinowski (1922). The presence of the obsidian blades at Mangum on former Bosmun Island and the most elaborately decorated bird pestle (Figure 5) known from Papua New Guinea in the vicinity of the former Kambot islands suggests that such islands may have played significant roles in the prehistory of the Sepik–Ramu (Figure 1).

Suggested Oro example of comparable mid-Holocene interaction between the coast and inland mountain valleys

Figure 8 shows the distribution of mortars and pestles in Oro (Northern) Province and its relationship to landforms (upper – Figure 8a) and cultivated land (lower – Figure 8b). The mortars and pestles are all found in valleys inland of extensive swampy coastal lowlands and generally in areas suitable for taro cultivation.[4] The details are as follows.

An elaborate bird pestle was found by a gold miner under 10 feet (3 m) of alluvial sand and clay about 40 feet (12 m) above the present bed of the Aikora River, a northern tributary of the Gira River (Barton 1908).[5] Over the crest of the Owen Stanley Range from this findspot are the inland valleys of the Tapini region which at contact had the highest highland subsistence population densities on the southern side of the Owen Stanley Range, though only moderate by Central Highlands levels.[6]

At Yodda Creek in Oro, gold miners recovered a mortar and pestle in addition to, as already mentioned, a stemmed obsidian tool from West New Britain of a type that dates from before 6000 to 3600 years ago (for the discoveries see Monckton 1903–1904; Seligman & Joyce 1907; Murray 1912; Seligman 1915; and Chinnery 1919; for the date, Araho et al. 2002:62, 72). The mortar and pestle were found by gold prospectors at a depth of 12 feet (3.7 m) below the surface in the Yodda goldfield (Monckton 1903–1904:31).[7] In addition, two stone figures have been reported on the Girua River (Etheridge 1908). One has comparable features to examples found in Enga and the Southern Highlands (Figure 10). Note the similar representation of arms, facial features and plain bulbous base. The other figure is a Buddha-like male with hands crossed on the stomach. Below the waist is a plain unshaped base (Meek 1913:176–177; Chinnery 1919:274).

---

4 The main exception is the stone mortar found northeast of Mt Albert Edward at an undefined location. This weathered mortar had been placed on a weathered stone platform 3 feet (91 cm) wide by 4 feet (122 cm) high (Monckton 1922:118).

5 Another bird pestle from 'North Province' (?Northern/Oro), Papua New Guinea (Bounoure 1992; Figure 9 here), needs to be noted. Compared with other bird pestles it is more robust and has distinctive eyes. It may be a modern replica.

6 In 2000 the estimated rural population of the inland valleys around Tapini was 30 persons/km^2, whereas the Wahgi Valley had 163 persons/km^2 (Hanson et al. 2001:51, 123).

7 Etheridge (1908:26) reduces the depth to 8 feet (2.4 m).

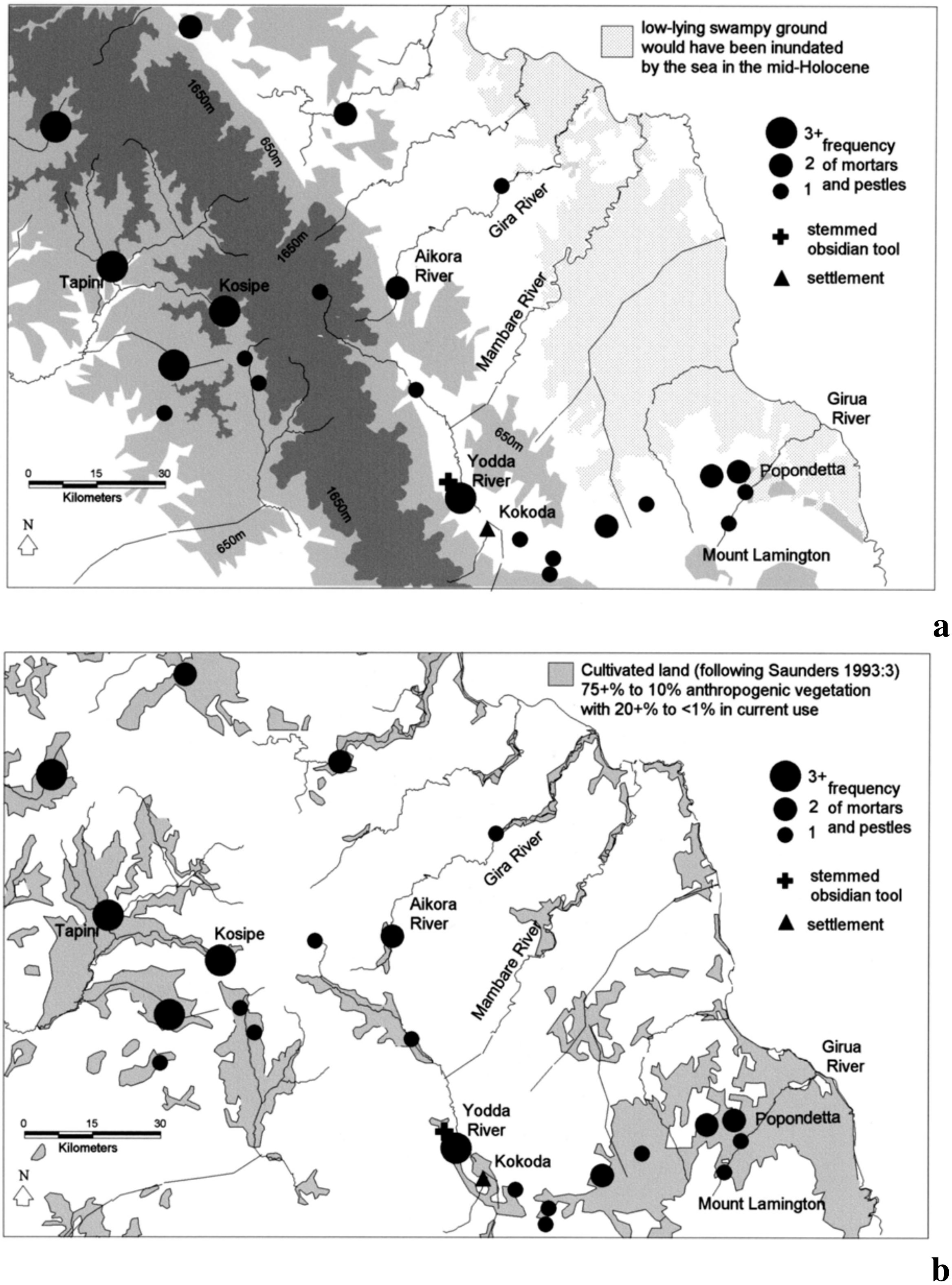


Figure 8: Maps showing the findspot of a stemmed obsidian tool and the distribution of mortars and pestles in relation to topography (a) and cultivated land (b) in Oro Province
The low-lying swampy ground shown in (a) would have been inundated
in the mid-Holocene.

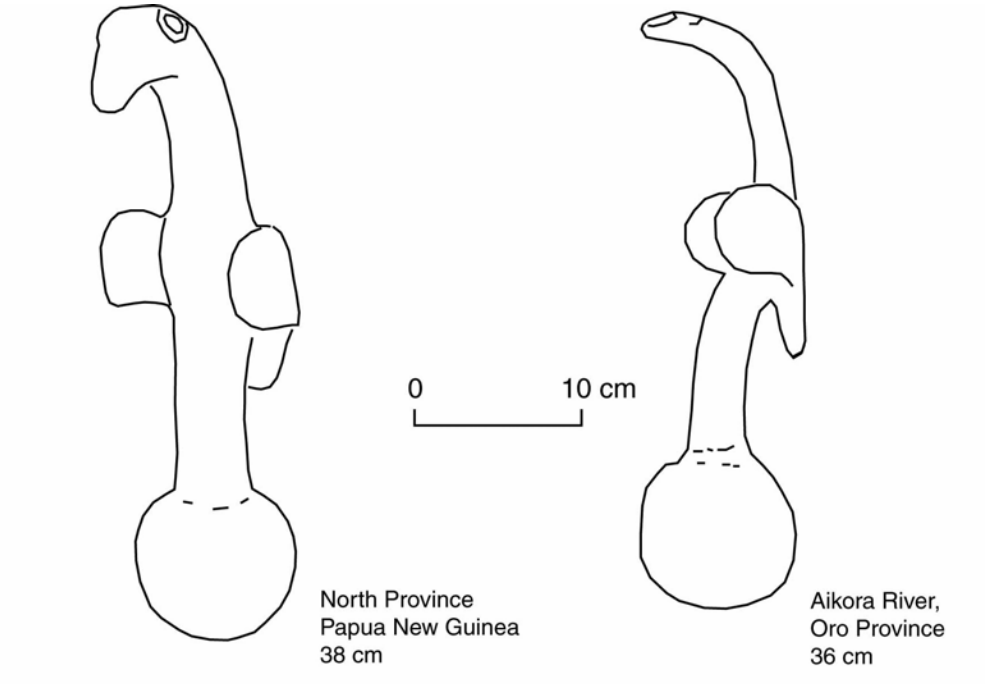


Figure 9: The North Province (? Northern/Oro) pestle has distinctive eyes and is more robust than other bird pestles from Papua New Guinea. It may be a modern 'replica'. The beak of the Aikora River pestle is broken above two small circular pits considered by Barton (1908) to represent nostrils.
(following Bounoure 1992; Newton 1979)

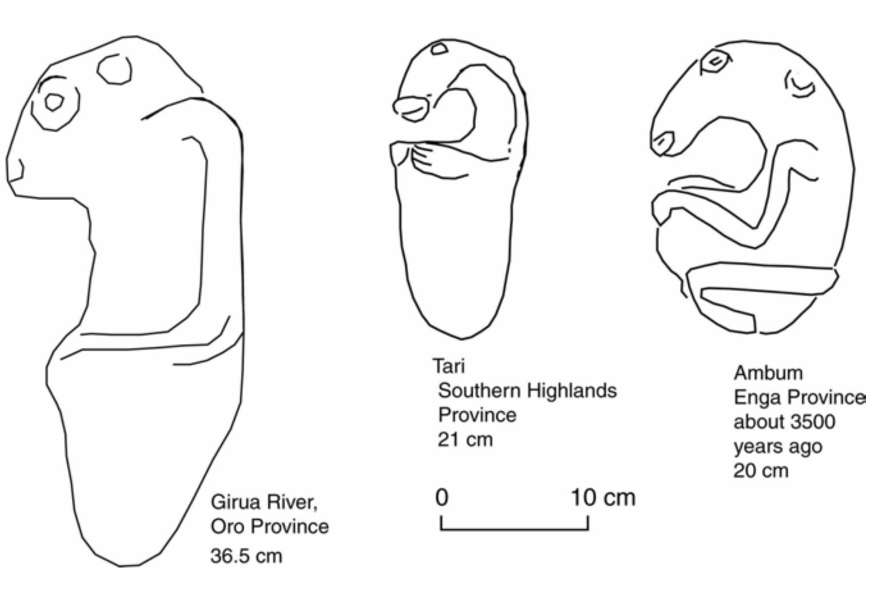
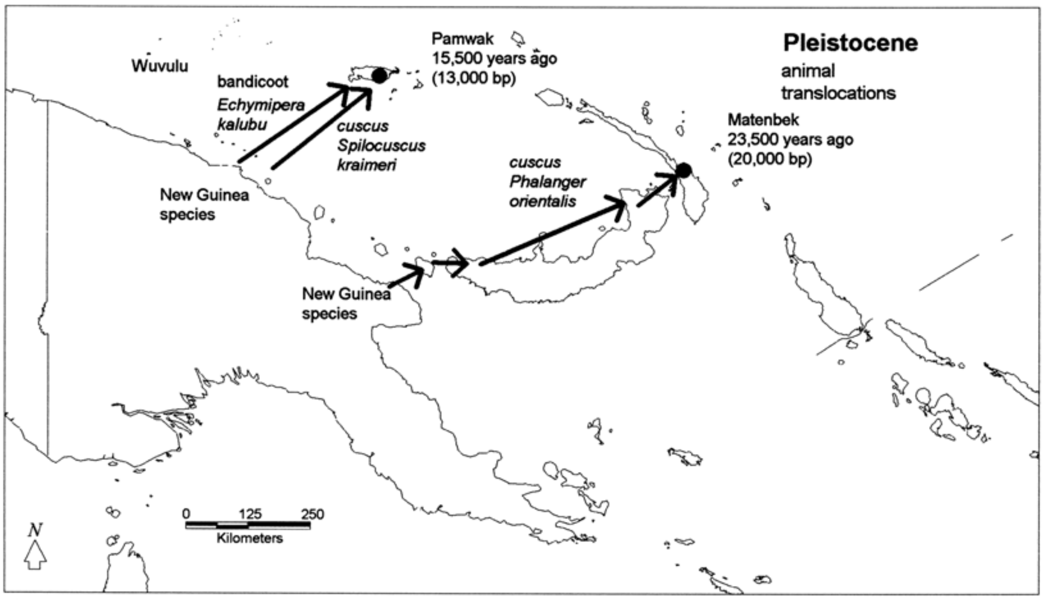
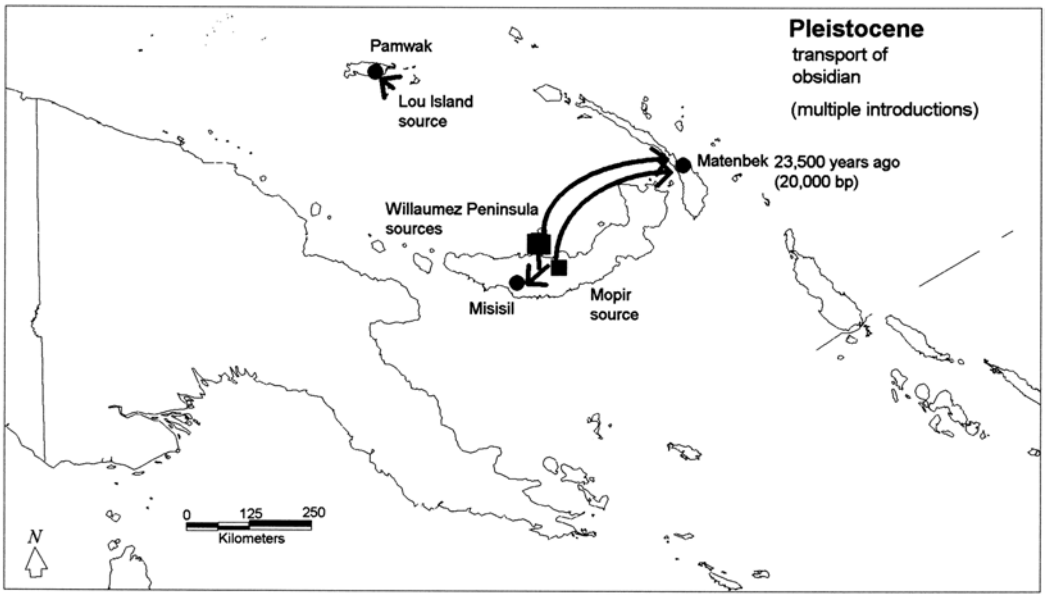


Figure 10: Stone sculptures from Girua, Tari and Enga. Note the similarities in arm and facial representation and bulbous bases.
(following Newton 1979; Anon 1997; Tworek-Matuszkiewiez 2001)



a

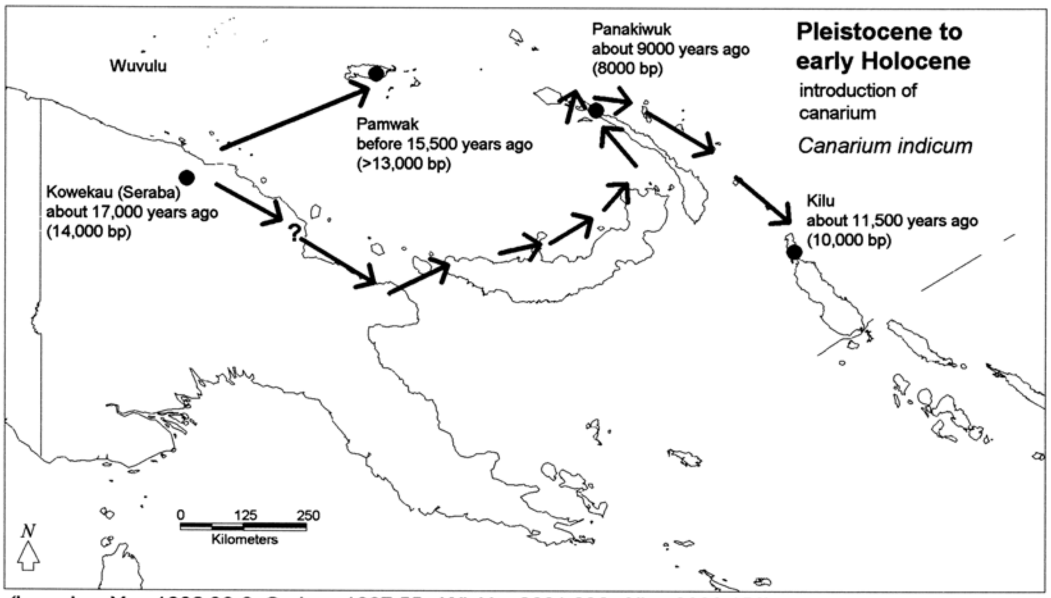
(based on Allen & Gosden 1996; Spriggs 1997)



b

(based on Summerhayes & Allen 1993; Summerhayes 2003:139)

Figure 11a-11b: Interaction indicators in the Pleistocene–early Holocene considering animal translocations and transport of obsidian
Routes are notional; see the text.

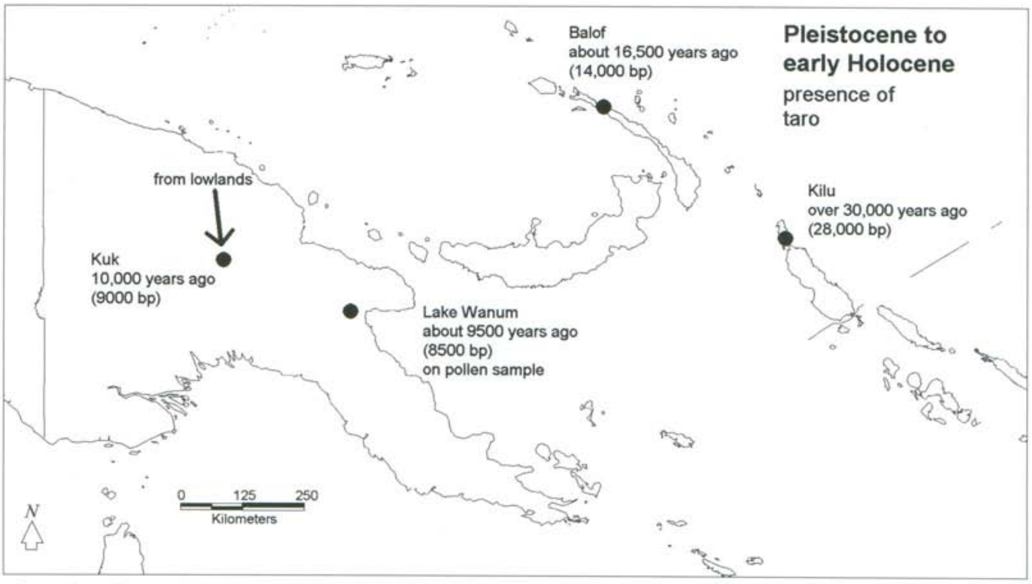


c

Figure 11c: Interaction indicators in the Pleistocene–early Holocene considering canarium introductions
Routes are notional; see the text.

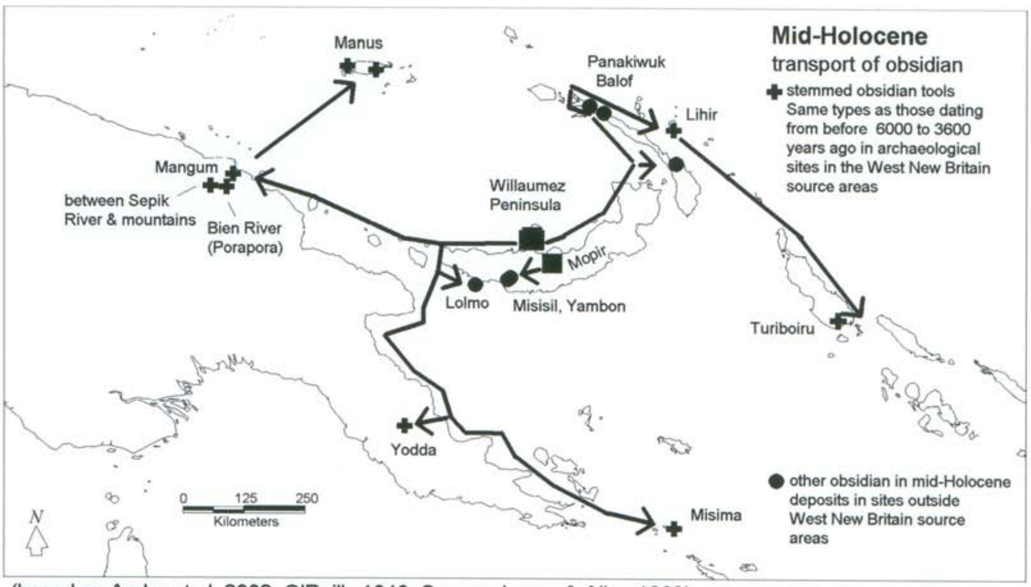
The situation represented by the Oro evidence is very similar to that described for the Sepik–Ramu inland sea. The absence of mortars and pestles from the swampy coastal lowlands in the one case parallels their absence from the recent lower Sepik–Ramu floodplain in the other, suggesting a late Holocene date for the formation of the Oro lowlands. Their inland distribution in Oro in areas suitable for taro cultivation would argue, as in the Sepik–Ramu case, the mid-Holocene presence of agricultural communities growing taro. In both areas large bird pestles are usually found close to or on routeways from the coast. The distribution of stone figures seems comparable. A maritime component is indicated by the presence of West New Britain obsidian stemmed tools of types that date from before 6000 to 3600 years ago (Araho et al. 2002:62).

The similarities shown by these two cases may identify a pattern that provides a new archaeological signature for the mid-Holocene on mainland New Guinea.



a

(based on Barton & White 1993; Denham et al. 2003; Haberle 1995; Wickler 2001:234; Yen 1991:564, 1995:835)



b

(based on Araho et al. 2002; O'Reilly 1948; Summerhayes & Allen 1993)

Stemmed tools made from both Willaumez and Mopir obsidian have been excavated from archaeological contexts in the Talasea region. Of the stemmed tools found beyond New Britain only 3 of the Sepik ones have been sourced.

Figure 12: Interaction indicators considering the presence of taro and notional routes for the mid-Holocene transport of obsidian

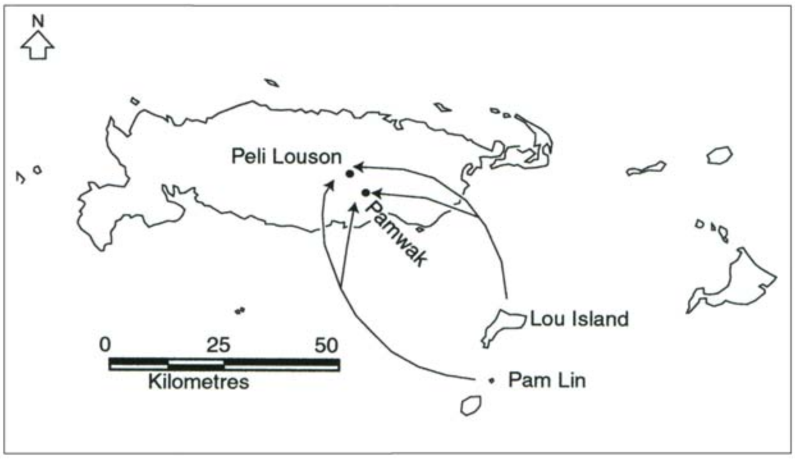


Figure 13: Early to mid-Holocene transport of Manus obsidian
(based on Summerhayes 2003:139)

Agriculture and population density

The current distribution pattern of population density in the Sepik–Ramu area is strongly related to subsistence type: low densities (less than 19 persons per km^2, and usually less than 10 persons) where sago is the main staple food and root crop or banana agriculture of little importance, and medium to high densities (20–99+ persons km^2) where cultivation is most important and sago less significant (Allen et al. 2002b). The highest densities are located in the southern foothills of the coastal ranges of East Sepik Province (Figure 2), where they are associated with agricultural systems based on the cultivation of yam (*Dioscorea esculenta*) as the major staple, and, as secondary staples, taro, banana, coconut and, usually, sago. The role of *D. esculenta* in supporting the largest area of high population density in the South Pacific based on subsistence agriculture, outside of the New Guinea Highlands where the base is sweet potato, is highly distinctive (Brookfield 1960; Allen et al. 2001). The population of this area, however, has suffered notably poor nutrition, at least since the mid-twentieth century, as shown by the worst child growth performance in East Sepik in a 1982/83 survey (Heywood et al. 1988).

Allen (this volume) explores the role of the Lesser Yam (*D. esculenta*) in the prehistory of the localised pattern of population increase that is signalled by the present correlation of this crop with the distribution of high population densities. Unfortunately the origins of this yam species, and its antiquity in New Guinea, are still not known. It does not occur in Australia (Yen 1995:836), and is still believed to be of Asian origin (Coursey 1976; Lebot 2002:51). On the basis of its more limited distribution and less significant ceremonial role, some authors (for example Bourke 1982:55) have suggested that cultivation of *D. esculenta* in New Guinea postdates that of the Greater Yam (*D. alata*).[8]

[8] However, the emphasis on the ritual/ceremonial significance of *D. alata* (possibly partly due to a number of well-described ethnographic cases, e.g. Lea 1966), needs to be balanced against descriptions of other places where some *D. esculenta* cultivars (at least) hold greater cultural significance and fulfil more significant ceremonial roles than *D. alata* (e.g. Obrist van Eeuwijk 1992:80, 97, 169–177; Malinowski 1965:136ff). Note also that Lebot (2002:51) considers that *D. esculenta* may be of greater antiquity than is normally supposed.

In the southern foothills of the coastal ranges a water-tolerant and high-yielding variety of the *D. esculenta* yam was locally developed. This innovation and associated measures of intensification seem to have been restricted to the Amogu floodplains of the upper Screw River.[9] There water-tolerant *asagwa*[10] cultivars of *D. esculenta,* and some other yam varieties, are grown by the Abelam in mounds that lift them above the high water table and protect them from minor floods. Low ridges on field boundaries and the use of some ditching (Plate 7) also protects crops from flooding (Allen this volume).

Just as the antiquity of *D. esculenta* in the Sepik–Ramu area, and in New Guinea and the Pacific generally, is not known, so too the socio-demographic prehistory (time-depth in particular) of the growth of the unusually high population densities in the southern foothills is also obscure. Some evidence for population history is, however, provided by linguistics and oral history.

Plate 7: Ditch near Kunjingini, Amogu River system (see Figure 2 for location)
Photograph by Robin Hide in 1988

Linguistics and settlement histories

Most of the inhabitants of the high-density population area of the southern foothills are Ndu speakers. According to Foley's linguistic reconstruction (this volume), the original speakers of the Ndu languages of the Sepik language family resided in the May to Wogamush area of the Upper Sepik (Figure 7). From there some moved east down the Sepik River to settle the northern bank, thence to the foothills north of the river and finally to the waterways of the Middle Sepik.

The Ndu family languages are closely related. Foley considers their inter-relatedness to be comparable to that of the Polynesian languages within the Austronesian language family. If this comparison is correct, it suggests an antiquity of some 2000 years since their initial separation; that is, the period over which the Polynesian languages diversified since the breakup of Proto Polynesian (Pawley 1996:399).

Both the settlement histories and the languages of Ndu speakers indicate that their founding ancestors came from the vicinity of the Sepik River (Forge 1990:160; Laycock

---

9 Following Quin (n.d.:64). Recently, however, Toyohara et al. (1994:73) have reported that villagers at Wara Sikau village (just across the border into West Sepik, southwest of Dreikikir), similarly divide their *D. esculenta* cultivars into two classes, with one suitable for wetland cultivation, the other for dryland.

10 Known also in the literature as *asakua* (Quin n.d.) and *asakwa* (Allen et al. 2002b:34).

1965:192–196; Roscoe 1989, 1994; Tuzin 2001:41, map 2). This is the case across the southern foothills, for instance for both the most densely settled area (Abelam on the headwaters of the Amogu and the Parchee rivers) and the less densely populated Boiken area in the Nagam River headwaters to the east (Figure 2).

Roscoe (1989) examined the ethnohistorical evidence of one language group, the Boiken, basing his work on a sample of 371 clan narratives that describe the provenience of their apical ancestors. Subsequently he expanded his study to consider the Ndu as a whole (Roscoe 1994). The prehistoric migration trends he found are shown in Figure 2.

Whatever the number of people involved, it was sufficient for the migrants' languages to be maintained. From the headwaters of the Screw River in the west to the upper Nagam River in the east, people speak languages belonging to the Ndu language family. Roscoe found that rivers such as the Mindjim and Pasik were the main routes the ancestral Boiken used to enter the foothills. Allen (this volume) likewise proposes that the same was the case with the Abelam, who would have moved up the Screw River and its tributaries, particularly the Amogu River and its headwaters.

Both linguistic and oral historical evidence broadly agree on the general directions of Ndu migration geography, but there is a wide range of opinion about the time depth involved. Roscoe (pers. comm. 2003) considers any attempt to date the initial Ndu migrations using ethnohistorical material to be highly speculative. In his experience most Sepik genealogies do not extend beyond five to seven generations, and about five generations back there is a telescoping[11] and merging of events and actors from the beginning of the Universe with remembered oral history. It also seems likely that these migrations predate the agricultural intensification associated with *Dioscorea esculenta* in the Amogu River headwaters as this intensification would be expected to produce outward rather than incoming movement.

While there are problems with the chronology of the initial Abelam, Boiken and Sawos settlements, all researchers agree that the Iatmul, who occupy the riverine Middle Sepik, were originally Sawos who apparently first settled on the Sepik some 250 years ago (Newton 1997). The formation of the major trading partnerships between riverine Ndu (Iatmul) and their ecologically differentiated neighbours, Sawos, Chambri and Hills people, occurred in the eighteenth and nineteenth centuries (Gewertz 1983:14, 219–220). Figure 2 shows the distribution of the main ancestral and current villages of the Iatmul.

It is likely that a major consequence of the infilling of the Sepik–Ramu inland sea, which had dominated the Sepik–Ramu Basin for thousands of years, would have been significant relocations or readjustments of prior patterns of population distribution and settlement. Although our understanding of the environmental changes associated with this infilling, completed by about 4000 years ago, is still far from complete, a tentative outline is possible. The archaeological evidence outlined above indicates that there were significant populations clustered around the mid-Holocene delta areas of the inland sea, dependent, we have suggested, on agriculture. We suggest that the process of infilling is likely to have resulted in some of this agricultural land, especially the former deltas, becoming increasingly swampy and hence unsuitable for cultivation. Under current conditions much of the land lying on the Sepik floodplain is subject to very significant seasonal flooding and is unused for agriculture (Bleeker 1975). It is possible that in the mid-Holocene, with a smaller floodplain and direct discharge into the inland sea, flooding

[11] Telescoping occurs when genealogies merge with a mythical period (Vansina 1965:101–102).

may have been less extensive and of shorter duration. An increase in flooding, with a decline in areas suitable for agriculture, would have resulted in changes in population distribution and settlement. However, understanding of such changes is complicated by problems of both chronology and process.

If Ndu speakers did not move north in response to the infilling of the Sepik–Ramu inland sea by about 4000 years ago, we have to ask how migrants from an area that today has a relatively low population density came to culturally dominate the agricultural societies found in the foothills of the coastal ranges.[12] What was driving the northward movement of these people? If not the infilling of the inland sea, was it the spread of a socially integrating tambaran cult?[13]

Archaeological investigations should help resolve the problem. This work has started. Alois Kuaso[14] has undertaken a preliminary survey of his people's ancestral sites on the Nagam River in eastern Boiken. We await his findings with interest.

Environmental disruptions

With the end of the inland sea about 4000 years ago, the interaction sphere that linked the Highlands with the Sepik–Ramu and the North Coast ceased. Another major environmental event which occurred at approximately the same time would have terminated the supply of obsidian and other products from West New Britain. This was the catastrophic volcanic eruption of Witori inland of Hoskins 3600 years ago (Araho et al. 2002:62; Machida et al. 1996; Torrence et al. 2000). This eruption devastated a large part of West New Britain, including the Willaumez Peninsula where stemmed obsidian tools had been produced for the previous 3000 years or more.[15] It was only after the Witori eruption of 3600 years ago that obsidian from Admiralty Islands' sources appears in archaeological sites outside this island group (Ambrose 1976; Summerhayes et al. 1998:152; Summerhayes 2003).

Other environmental events on the North Coast may have disrupted the surviving interaction spheres on this coast. It is becoming apparent that tectonic and subsidence events have impacted significantly on the lives of human communities resident on the Sissano Coast of West Sepik for a long time. The most recent event was in 1998 when a tsunami struck following an earthquake. The death toll was more than 1600, 1000 people were treated for injuries and 10,000 lost their homes and possessions (Davies 1998, 2002; Davies et al. 2003). A former Sissano shoreline is now elevated 52 m above sea level and 12 km inland of the present lagoon (Hossfeld 1965:Figure 2; Gill 1968). The most recent date for a 'fossiliferous lenticle' (Hossfeld 1965:Figure 2) 18–24 inches (46–61 cm) thick that represents deposition in a coastal mangrove swamp is 4400+/-85 bp. At 2 s.d. this date

12 There is the problem of distinguishing the movement of people (migrants) and changing language affiliation. In the case of the Boiken there are indications that both took place (see Roscoe 1989, 1994). For interactions between the Arapesh and Abelam, especially the Arapesh of Ilahita village, see Tuzin (2001) and Allen (this volume).

13 See Lutkehaus and Roscoe (1987:581) for further comments on the tambaran cult as the 'motor' behind culture production in the Sepik.

14 Staff member of the PNG National Museum undertaking an MA in 2003–2004 at The Australian National University.

15 People reoccupied the Willaumez Peninsula two hundred years later, but stemmed tool production did not resume (Araho et al. 2002; Torrence et al. 2000).

calibrates to a range from 4800 to 5300 BP at a 98% confidence level (Stuiver & Reimer 1993), representing uplift of 10 or 11 m per 1000 years, far more than the rate of 3 m determined for the Huon Peninsula (Swadling et al. 1989:107). Clearly the series of tectonic events that over the past 4500 or so years elevated the Sissano coast 52 m above its earlier level must have had significant impacts on coastal residents of the region, including low-lying islands such as Wuvulu. The periodicity and scale of the events in question are currently not known.

Further east, the Madang stretch of the North Coast has experienced about half a dozen significant volcanic eruptions in the last 10,000 years (Blong pers. comm. 2003), severe enough to deposit tephra in the Kuk swamp near Mount Hagen (Blong 1982:10).[16] The most recent is the eruption of Long Island, for which a mid-seventeenth century date as initially proposed by Blong (1982:193–194) seems increasingly certain, with the latest revisions to the radiocarbon calibration curve giving AD 1646–1668 at 1 s.d. (Blong pers. comm. 2003). In addition, Lilley (2004:89) reports that disruptions in the archaeological sequences of the Vitiaz Strait region, from about 3500 years ago, coincide with catastrophic volcanism in the Vitiaz Strait and the Talasea – Cape Hoskins area.

Local traditions in the Madang area record that an eruption totally destroyed an island in the vicinity of Hankow Reef called Yomba. Most of its occupants were able to flee to the mainland and small offshore islands such as Bilibil (Mennis 1981). It is not known if destructive tsunami were associated with these eruptions. Information is available, however, for the tsunami damage caused by the lateral collapse into the sea of some 5 km^3 of Ritter Island in Dampier Strait between Umboi Island and West New Britain in 1888. Villages were destroyed on the West New Britain coast of Dampier Strait and on the northern and eastern coasts of Umboi Island. The tsunami deposits and destruction extended a kilometre inland on West New Britain. On Umboi and the small island of Sakar the coastal zone was stripped to 15 m above sea level. In addition, some houses were destroyed and canoes were lost at Kelana[17] village on the Huon Peninsula (Cooke 1981:118–119; Ward & Day 2003:891–892).

In summary, the infilling of the Sepik–Ramu inland sea saw the end of a dynamic period of interaction between the Sepik–Ramu and the Highlands on the one hand and the New Guinea Islands on the other. The Witori eruption of 3600 years ago devastated much of West New Britain, including the obsidian sources. Other eruptions, earthquakes and tsunami on the North Coast probably added to the demise of a former maritime culture, of which stone mortars and pestles were a part. With its decline, a new interaction sphere emerged with Lapita pottery (Kirch 1997) as its main archaeological marker. It was a time of new cultural inputs from the west and changing interactions centred on the New Guinea Islands. This model may explain how most New Guinea Islanders subsequently became Austronesian speakers.

Conclusion

Allen (1996) observes that by 35,000 years ago people had explored every major environmental zone in New Guinea and the nearer Melanesian islands. By the late

[16] This may explain the lack of older Oceanic languages on the North Coast and the existing chain of Austronesian languages with West New Britain links (Ross 1988:120).

[17] Kelana, usually written as Kelanoa, is correctly called Gitua (Chappell pers. comm. 2004).

Pleistocene to early Holocene, as documented above, there was sufficient interaction for products to be exchanged and animals and plants to be introduced to areas beyond their natural distribution. The Sepik–Ramu inland sea appears as a hub of interaction with the Highlands and with Manus.

The link with the Highlands is suggested by the movement of taro, a lowlands plant (Yen 1991:564; 1995:835), which had been introduced into the Mount Hagen area by 10,000 years ago (Denham et al. 2003).

The link with Manus is indicated by the introduction there of a cuscus and a bandicoot and, plausibly, *Canarium indicum*. When on Wuvulu in 1980 (Figure 11 for location), Swadling was told by the islanders that huge tree trunks on the reef had come by drift from the Sepik. Formerly they were the primary source of wood for houses and canoes, while stone for implements was sometimes found in their roots. This drift pattern from the Sepik could have implications for the settlement of the Manus Group and might explain the North Coast/Manus connection.

Given the early dates for *Canarium* in the Sepik (17,000 years ago from Gorecki's radiocarbon date of 14,000 bp at the Seraba site, following Yen 1996:41) and Manus (15,500 years ago from radiocarbon dating of 13,000 bp at Pamwak, following Spriggs 1997:55), it might be that the Sepik–Ramu was ultimately behind the later appearance of *Canarium* in New Guinea Islands to the east.

The distribution of stylistically similar mortars and pestles, especially bird pestles, in the Sepik–Ramu and the Highlands shows that the connection between the two indicated by taro for the early Holocene continued into the mid-Holocene. As the greatest diversity of these artefacts occurs in the Highlands and Sepik–Ramu, it is proposed here that the use of mortars and pestles expanded via long-established interaction spheres to the New Guinea Islands, other parts of the New Guinea mainland and Milne Bay.

It is demonstrated above that the distributions of mortars and pestles and other artefacts such as stemmed obsidian tools provide an archaeological signature for the mid-Holocene, a period long characterised by a low level of site recognition. When integrated with the known regional sequences from the New Guinea mainland and islands, this new mid-Holocene signature has the capacity to fill the gap between formerly discrete archaeological sequences, in particular the Lapita pottery sequences of the New Guinea Islands and the early Holocene agricultural site at Kuk in the New Guinea Highlands. In other words it opens the way for a Melanesian prehistory that can accommodate all known regional sequences.

Natural events, including the devastation of a large part of West New Britain by the catastrophic Witori eruption of 3600 years ago (Araho et al. 2002:62; Machida et al. 1996; Torrence et al. 2000), the infilling of the Sepik–Ramu inland sea by 4000 years ago (Chappell this volume), the earthquakes and tsunami accompanying each episode in the uplift of the Sissano Coast of West Sepik by 52 m over roughly the past 4500 years (Hossfeld 1965) and volcanic eruptions on islands off the Madang Coast, probably all played a part in the disruption and reorganisation of human interaction spheres in Western Melanesia.

It is also argued that major landscape changes within the Sepik–Ramu during the Holocene led to population relocations and that the high population density of the southern foothills of the coastal ranges postdates the infilling of the former Sepik–Ramu inland sea. We propose that prior to 4000 years ago the main population concentrations were located on the river alluviums, shores and deltas of the former inland sea, especially the Sepik and

Ramu deltas. The end of the inland sea saw population relocations which may have played out over a long period of time.

The high population densities of the southern foothills are clearly correlated, in their 20th century distribution, with the cultivation of the Lesser Yam, *Dioscorea esculenta.* While both the antiquity of the yam and the time-depth of the demographic build-up are unknown, we suggest that a *D. esculenta* revolution occurred in the headwaters of the Amogu and Parchee rivers in the southern foothills (Figure 2) which may be comparable, though of more limited extent, to the later impact of the sweet potato in the Highlands (Watson 1977).

This paper has identified a number of potential field study areas for investigating the mid-Holocene on mainland Papua New Guinea, an exciting prospect as the mid-Holocene is an archaeological period not well known in Melanesia. The Ambunti region (Figure 3) and Middle Ramu (Figure 4) clearly warrant detailed geomorphic and archaeological surveys. To provide a time frame for the geographically widely-held oral traditions of prehistoric migrations north from the Sepik River area to the southern foothills it should be possible to take the Torembi area and the Amogu floodplain (Figure 2) as case studies. An understanding of the archaeology of the latter area should also clarify when *Diocorea esculenta* was introduced and the current high population density began to develop. The archaeology will not be easy, but it should be very rewarding.

Acknowledgements

This paper is based primarily on the curatorial work of Swadling, supplemented by field work and literature reviews undertaken by both authors. We wish to thank all the Papua New Guinean villagers and colleagues who have helped us during work in Papua New Guinea.

Swadling was an archaeologist from 1972 with the University of Papua New Guinea, then at the Institute of Papua New Guinea Studies and from 1978–1999 at the Papua New Guinea National Museum.

Hide has carried out research and surveys as an anthropologist in Papua New Guinea between 1967 and 2002 with, variously, the New Guinea Research Unit, Columbia University, the Simbu Land Use Project, CSIRO, the PNG Institute of Medical Research and the Australian National University.

This paper was improved greatly by Jack Golson, both in his official role as editor and through his many contributions both of substance and argument. He is truly a silent third author.

Many other people have assisted in the production of this paper. They include Bryant Allen, Wal Ambrose, Chris Ballard, Giles Bounoure, Michael Bourke, Sue Bulmer, John Chappell, William Clarke, Barry Craig, Helen Dennett, Tim Denham, Godfried Gerritts, Simon Haberle, Terry Hays, Carol Jenkins, Patricia L. Johnson, Christian Kaufmann, Eric Kjellgren, Harley Manner, Marion Melk-Koch, Ottmar Maier, Anthony Meyer, Paul Roscoe, Brian Ruxton, Jim Specht, Glenn Summerhayes, Robin Torrence, Beata Tworek-Matuszkiewicz, J. Peter White, Nick Araho and the late Baiva Ivuyo. We appreciate the assistance received and are responsible for any errors that may remain.

Swadling acknowledges funding provided by a Visiting Research Fellowship at the Australian Museum.

Swadling and Hide are Visiting Fellows in the Research School of Pacific and Asian Studies, Swadling in the Department of Archaeology and Natural History and Hide in Anthropology.

References

Allen, B.J., R.M. Bourke and L. Hanson, 2001, Dimensions of PNG village agriculture. In R.M.Bourke, M.G. Allen and J. G. Salisbury, eds *Food security for Papua New Guinea. Proceedings of the Papua New Guinea Food and Nutrition 2000 Conference, PNG University of Technology, Lae 26–30 June 2000*, 529–553. ACIAR Proceedings No. 99. Canberra: Australian Centre for International Agricultural Research.

Allen, B.J., R.L. Hide, R.M. Bourke, D. Fritsch, R. Grau, P. Hobsbawn, M.P. Levett, S.I. Majnep, V. Mangi, T. Nen and G. Sem, 2002a, *Madang Province: text summaries, maps, code lists and village identification,* rev. edn. Agricultural Systems of Papua New Guinea Working Paper No. 7. Canberra: Department of Human Geography, Research School of Pacific Studies, Australian National University.

Allen, B.J., R.L. Hide, R.M. Bourke, D. Fritsch, R. Grau, E. Lowes, T. Nen, E. Nirsie, J. Risimeri and M. Woruba, 2002b, *East Sepik Province: text summaries, maps, code lists and village identification,* rev. edn. Agricultural Systems of Papua New Guinea Working Paper No. 2. Canberra: Department of Human Geography, Research School of Pacific Studies, Australian National University.

Allen, J., 1977, Sea traffic, trade and expanding horizons. In J. Allen, J. Golson and R. Jones, eds *Sunda and Sahul: prehistoric studies in Southeast Asia, Melanesia and Australia*, 387–417. London: Academic Press.

1984, Pots and poor princes: a multidimensional approach to the study of pottery trading in coastal Papua. In S.E. van der Leeuw and A. Pritchard, eds *The many dimensions of pottery: ceramics in archaeology and anthropology*, 407–463. Amsterdam: University of Amsterdam.

1996, The pre-Austronesian settlement of Island Melanesia: implications for Lapita archaeology. In W.H. Goodenough, ed. *Prehistoric settlement of the Pacific*, 11–27. Transactions of the American Philosophical Society, vol. 86(5).

2000, From beach to beach: the development of maritime economies in prehistoric Melanesia. In S. O'Connor and P. Veth, eds *East of Wallace's Line: studies of past and present maritime cultures of the Indo-Pacific region,* 139–176. Modern Quaternary Research in Southeast Asia 16. Rotterdam and Brookfield (Vermont): Balkema.

Allen, J. and C. Gosden, 1996, Spheres of interaction and integration: modelling the culture history of the Bismarck Archipelago. In Davidson et al., eds 1996:183–197.

Ambrose, W.R., 1976, Obsidian and its prehistoric distribution in Melanesia. In N. Barnard, ed. *Ancient Chinese bronzes and Southeast Asian metal and other archaeological artefacts*, 351–378. Melbourne: National Gallery of Australia.

1991, Manus, mortars and the kava concoction. In Pawley, ed. 1991:461–469.

1996–97, Metals and the Melanesian connection. In F.D. Bulbeck, ed. *Ancient Chinese and Southeast Asian Bronze Age cultures*, 1077–1091. Taipei: SMC Publishing.

Anon., 1997, Aboriginal and tribal art. Sotherby Catalogue, 9 November, Woollahra and Armadale.

Araho, N., R. Torrence and J.P. White, 2002, Valuable and useful: mid-Holocene stemmed obsidian artefacts from West New Britain, Papua New Guinea. *Proceedings of the Prehistoric Society* 68:61–81.

Attenbrow, V. and R. Fullagar, eds, 2004, *A Pacific odyssey: archaeology and anthropology in the Western Pacific. Papers in honour of Jim Specht. Records of the Australian Museum*, Supplement 29.

Barton, F.R., 1908, Note on stone pestles from British New Guinea. *Man* 8:1–2.

Barton, H. and J.P. White, 1993, Use of stone and shell artifacts at Balof 2, New Ireland, Papua New Guinea. *Asian Perspectives* 32:169–181.

Bleeker, P., 1975, *Explanatory notes to the land limitation and agricultural land use potential map of Papua New Guinea*. Land Research Series No. 36. Melbourne: Commonwealth Scientific and Industrial Research Organization.

Blong, R.J., 1982, *The time of darkness: local legends and volcanic reality in Papua New Guinea*. Canberra: Australian National University Press.

Bounoure, V., 1992, *Vision d'Océanie*. Paris: Musée Dapper.

Bourke, R.M., 1982, Root crops in Papua New Guinea. In R.M. Bourke and V. Kesavan, eds *Proceedings of the Second Papua New Guinea Food Crops Conference.* Part 1, 51–63. Port Moresby: Department of Primary Industry.

Bowden, R., 1983, *Yena: art and ceremony in a Sepik society*. Oxford: Oxford University Press.

Boyd, D.J., 1996, A tale of 'First Contact': the Hagahai of Papua New Guinea. *Research in Melanesia* 20:103–140.

Brookfield, H.C., 1960, Population distribution and labour migration in New Guinea: a preliminary survey. *Australian Geographer* 7:233–242.

Bulmer, R.N.H. and S. Bulmer, 1964, The prehistory of the Australian New Guinea Highlands. In J.B. Watson, ed. *New Guinea: the Central Highlands*, 39–76. *American Anthropologist* 66(4, part 2), Special Publication.

Chinnery, E.W.P., 1919, Stone-work and goldfields in British New Guinea. *Journal of Royal Anthropological Institute* 49:271–291.

Cooke, R.J.S., 1981, Eruptive history of the volcano at Ritter Island. In Johnson, ed. 1981:115–123.

Coursey, D.G., 1976, Yams. In N.W. Simmonds, ed. *Evolution of crop plants*, 70–74. London: Longman.

Davidson, J.M., G. Irwin, B.F. Leach, A. Pawley and D. Brown, eds, 1996, *Oceanic culture history: essays in honour of Roger Green*. Dunedin: New Zealand Journal of Archaeology Special Publication.

Davies, H.L., 1998, *Tsunami PNG 1998*. Waigani (National Capital District): University of Papua New Guinea.

2002, Tsunamis and the coastal communities of Papua New Guinea. In R. Torrence and J. Grattan, eds *Natural disasters and cultural change*, 28–42. London and New York: Routledge.

Davies, H.L., J.M. Davies, R.C.B. Perembo and W.Y. Lus, 2003, The Aitape 1998 tsunami: reconstructing the event from interviews and field mapping. *Pure Applied Geophysics* 160:1895–1922.

Denham, T.P., S.G. Haberle, C. Lentfer, R. Fullagar, J. Field, M. Therin, N. Porch and B. Winsborough, 2003, Origins of agriculture at Kuk Swamp in the Highlands of New Guinea. *Science* 301:189–193.

England, P., 1946, The Ramu stones. *Mankind* 3(8):233–236.

Etheridge, R.J., 1908, Ancient stone implements from the Yodda Valley Goldfield, Northeast British New Guinea. *Records of the Australian Museum* 7:24–28.

Forge, A., 1990, The power of culture and the culture of power. In N. Lutkehaus, C. Kaufmann, W.E. Mitchell, D. Newton, L. Osmundsen and M. Schuster, eds *Sepik heritage: tradition and change in Papua New Guinea*, 160–170. Durham (NC): Carolina Academic Press.

Frith, C.B. and B.M. Beehler, 1998, *The Birds of Paradise: Paradisaeidae*. Oxford and New York: Oxford University Press.

Gewertz, D.B., 1983, *Sepik River societies: a historical ethnography of the Chambri and their neighbors*. New Haven and London: Yale University Press.

Gill, E.D., 1968, Significance of Aitape (New Guinea) radiocarbon dates for eustasy and tectonics. *Australian Journal of Science* 30(4):142.

Gillieson, D.S., J. Landsberg and K. Kerenga, 1989, An ecology of the Lower Jimi Valley. In Gorecki and Gillieson, eds 1989:37–55.

Golson, J., 1977, The making of the New Guinea Highlands. In J.H. Winslow, ed. *The Melanesian environment*, 45–56. Canberra: Australian National University Press.

2000, A stone bowl fragment from the early middle Holocene of the upper Wahgi Valley, Western Highlands Province, Papua New Guinea. In A. Anderson and T. Murray, eds *Australian archaeologist: collected papers in honour of Jim Allen*, 231–248. Canberra: Coombs Academic Publishing, Australian National University.

Golson, J. and P.J. Hughes, 1980, The appearance of plant and animal domestication in New Guinea. *Journal de la Société des Océanistes* 36:294–303.

Gorecki, P.P. and D.S. Gillieson, 1989, *A crack in the spine: prehistory and ecology of the Jimi-Yuat Valley, Papua New Guinea*. Townsville: Division of Archaeology and Anthropology, School of Behavioural Sciences, James Cook University of North Queensland.

Haberle, S.G., 1995, Identification of cultivated *Pandanus* and *Colocasia* in pollen records and the implications for the study of early agriculture in New Guinea. *Vegetation History and Archaeobotany* 4:195–210.

Haberle, S.G. and B. David, 2004, Climates of change: human dimensions of Holocene environmental change in low latitudes of the PEPII transect. *Quaternary International* 118–119:165–179.

Handy, E.S.C. and E.G. Handy with M.K. Pukui, 1972, *Native planters in old Hawaii*. Honolulu: Bernice P. Bishop Museum, Bulletin 233.

Hanson, L.W., B.J. Allen, R.M. Bourke and T.J. McCarthy, 2001, *Papua New Guinea: rural development handbook*. Canberra: The Australian National University.

Harding, T.G., 1967, *Voyagers of the Vitiaz Strait: a study of a New Guinea trade system*. Seattle: University of Washington Press.

Heywood, P., N. Singleton and J. Ross, 1988, Nutritional status of young children: the 1982–83 National Nutrition Survey. *Papua New Guinea Medical Journal* 31(2):91–101.

Höltker, G., 1951, Die Steinvögel in Melanesien. In *Südseestudien: Gedenkschrift zur Errinerung an Felix Speiser*, 234–265. Basel: Museum für Völkerkunde und Schweizerischen Museum für Volkskunde.

1968, Altertümliche Steinartefakte aus Neuguinea im Anthropos-Institut. *Ethnologica* 4:494–531.

Hossfeld, P.S., 1965, Radiocarbon dating and palaeoecology of the Aitape fossil human remains. *Proceedings of the Royal Society of Victoria* 78:161–165.

Irwin, G.J., 1983, Chieftainship, kula and trade in Massim prehistory. In J.W. Leach and E. Leach, eds *The Kula: new perspectives on Massim exchange*, 29–72. Cambridge: Cambridge University Press.

Johnson, R.W., ed., 1981, *Cooke-Ravian volume of volcanological papers*. Port Moresby: Geological Survey of Papua New Guinea, Memoir 10.

Kasprus, A., 1973, *The tribes of the Middle Ramu and the Upper Keram Rivers (North-East New Guinea)*. St Augustin bei Bonn: Verlag des Anthropos-Instituts.

Kirch, P.V., 1997, *The Lapita peoples: ancestors of the Oceanic world*. Oxford and Cambridge (Mass.): Blackwell.

Lea, D.A.M., 1966, Yam growing in the Maprik area. *Papua and New Guinea Agricultural Journal* 18(1):5–16.

Lebot, V., 2002, La domestication des plantes en Océanie et les contraintes de la voie asexuée. *Journal de la Société des Océanistes* 114–115(1/2):45–61.

Lilley, I., 2004, Trade and culture history across the Vitiaz Strait, Papua New Guinea: the emerging post-Lapita coastal sequence. In Attenbrow and Fullagar, eds 2004:89–96.

Loy, T.H., M. Spriggs and S. Wickler, 1992, Direct evidence for human use of plants 28,000 years ago: starch residues on stone artefacts from the Northern Solomon Islands. *Antiquity* 66:898–912.

Lutkehaus, N. and P. Roscoe, 1987, Sepik culture history: variation, innovation, and synthesis. *Current Anthropology* 28:577–581.

Machida, H., R.J. Blong, J. Specht, H. Moriwaki, R. Torrence, Y. Hayakawa, B. Talai, D. Lolok and C.F. Pain, 1996, Holocene explosive eruptions of Witori and Dakataua caldera volcanoes in West New Britain, Papua New Guinea. *Quaternary International* 34–36:65–78.

Majnep, I.S. and R. Bulmer, 1977, *Birds of my Kalam country*. Auckland: Auckland University Press.

Malinowski, B., 1922, *Argonauts of the western Pacific*. London: Routledge and Kegan Paul.

1965 [1935], *Coral gardens and their magic,* vol. 1: *Soil-tilling and agricultural rites in the Trobriand Islands*. Bloomington: Indiana University Press.

Mead, M., 1938, The Mountain Arapesh 1: an importing culture. *Anthropological Papers of the American Museum of Natural History* 36:139–349.

Meek, A.S., 1913, *A naturalist in cannibal land*. London: Fisher Unwin.

Mennis, M., 1981, Yomba Island: a real or mythical volcano? In Johnson, ed. 1981:95–99.

Meyer, A.J.P., 1995, *Oceanic art*, vol. 1. Cologne: Könemann.

Monckton, C.A.W., 1903–1904, British New Guinea, Annual Report. London: HMSO.

1922, *Last days in New Guinea*. London: Bodley Head.

Mountain, M.-J., 1991, Bulmer Phase 1: environmental change and human activity through the late Pleistocene into the Holocene in the Highlands of New Guinea: a scenario. In Pawley, ed. 1991:510–520.

Murray, J.H.P., 1912, *Papua or British New Guinea*. London: T. Fisher Unwin.

Newton, D., 1979, Prehistoric and recent art styles in Papua New Guinea. In S.M. Mead, ed. *Exploring the visual art of Oceania*, 32–57. Honolulu: University Press of Hawai'i.

1997, Materials for a Iatmul chronicle, Middle Sepik River (East Sepik Province, Papua New Guinea). In M. Schindlbeck, ed. *Gestern und Heute - Traditionen in der Südsee. Festschrift zum 75 Geburtstag von Gerd Koch*, 367–385. *Baessler-Archiv* 45.

Obrist van Eeuwijk, B., 1992, *Small but strong: cultural contexts of (mal-)nutrition among the Northern Kwanga (East Sepik Province, Papua New Guinea)*. Basler Beiträge zur Ethnologie 34. Basel: Ethnologisches Seminar der Universität und Museum für Völkerkunde.

O'Reilly, P., 1948, Un outil néolithique des îles Salomon. *Journal de la Société des Océanistes* 4:156–167.

Pawley, A., 1996, On the Polynesian subgroup as a problem for Irwin's continuous settlement hypothesis. In Davidson et al., eds 1996:387–410.

Pawley, A., 1991, ed., *Man and a half: essays in Pacific anthropology and ethnobiology in honour of Ralph Bulmer*. Auckland: The Polynesian Society.

Quin, F.M., n.d., East Sepik Agricultural Development Project: Agricultural Research Sub-project. Report on yam research (*Dioscorea* spp.*)* 1981–84. Unpublished report.

Riesenfeld, A., 1950, *The megalithic culture of Melanesia*. Leiden: Brill.

Roscoe, P.B., 1989, The flight from the fen: the prehistoric migrations of the Boiken of the East Sepik Province, Papua New Guinea. *Oceania* 60(2):139–154.

1994, Who are the Ndu? Ecology, migration, and linguistic and cultural change in the Sepik Basin. In A.J. Strathern and G. Stürzenhofecker, eds *Migration and transformations: regional perspectives on New Guinea*, 49–84. ASAO Monograph No. 15. Pittsburgh and London: University of Pittsburgh Press.

Ross, M., 1988, *Proto Oceanic and the Austronesian languages of western Melanesia.* Canberra: Pacific Linguistics.

Saunders, J., 1993*, Agricultural land use of Papua New Guinea: explanatory notes to map*. Canberra: Australian International Development Assistance Bureau, PNGRIS Publication No. 1.

Seligman, C.G., 1915, Notes on an obsidian axe or adze from Papua. *Man* 15:161–162.

Seligman, C.G. and T.A. Joyce, 1907, On prehistoric objects in British New Guinea. In W.H.R. Rivers, R.R. Marett and N.W. Thomas, eds *Anthropological essays presented to Edward Burnett Tylor*, 325–241. Oxford: Clarendon Press.

Singadan, R.K., 1996, Notes on hybrid spotted cuscus, *Spilocuscus maculatus X Spilocuscus kraemeri* (Marsupialia: Phalangeridae). *Science in New Guinea* 22(2):77–82.

Specht, J., 1974, Of Menak and men: trade and the distribution of resources on Buka Island, Papua New Guinea. *Ethnology* 13:225–237.

Spriggs, M., 1997, *The Island Melanesians*. Oxford and Cambridge (Mass.): Blackwell.

2003, Chronology of the neolithic transition in Island Southeast Asia and the Western Pacific: a view from 2003. *The Review of Archaeology* 24(2):57–80.

Stuiver, M. and P.J. Reimer, 1993, Extended 14C data base and revised CALIB 3.0 14C age calibration program. *Radiocarbon* 35:215–230.

Summerhayes, G.R., 2003, The rocky road: the selection and transport of Admiralties obsidian to Lapita communities. *Australian Archaeology* 57:135–142.

Summerhayes, G.R. and J. Allen, 1993, The transport of Mopir obsidian to late Pleistocene New Ireland. *Archaeology in Oceania* 28:144–148.

Summerhayes, G.R., R. Bird, R. Fullagar, C. Gosden, J. Specht and R. Torrence, 1998, Application of PIXE-PIGME to archaeological analysis of changing patterns of obsidian use in West New Britain, Papua New Guinea. In S. Shackley, ed. *Advances in archaeological volcanic glass studies*, 129–158. New York: Plenum Press.

Swadling, P., 1981, *Papua New Guinea's prehistory: an introduction*. Boroko (National Capital District): National Museum and Art Gallery in association with Gordon and Gotch.

2004, Stone mortar and pestle distribution in New Britain revisited. In Attenbrow and Fullagar, eds 2004:157–161.

Swadling, P., N. Araho and B. Ivuyo, 1991, Settlements associated with the inland Sepik-Ramu sea. In P. Bellwood, ed. *Indo-Pacific prehistory 1990*, vol. 2, 92–112. *Bulletin of the Indo-Pacific Prehistory Association* 11.

Swadling, P., J. Chappell, G. Francis, N. Araho and B. Ivuyo, 1989, A late Quaternary inland sea and early pottery in Papua New Guinea. *Archaeology in Oceania* 24:106–109.

Swadling, P., B. Hauser Schäublin, P. Gorecki and F. Tiesler, 1988, *The Sepik-Ramu: an introduction*. Boroko (NCD): PNG National Museum.

Thorpe, W.W., 1930, Ethnological notes, No. 2. *Records of the Australian Museum* 17:348–355.

Torrence, R., C. Pavlides, P. Jackson and J. Webb, 2000, Volcanic disasters and cultural discontinuities in Holocene time, in West New Britain, Papua New Guinea. In W.G. McGuire, D.R. Griffiths, P.L. Hancock and I.S. Stewart, eds *The archaeology of geological catastrophes*, 225–244. London: Geological Society, Special Publication 171.

Toyohara, H., T. Konishi and T. Komatsu, 1994, Yams (*Dioscorea* spp.) in Papua New Guinea. In Overseas Scientific Research Team, ed. *In search of the origins of agriculture in Papua New Guinea: a botanical survey of tropical rain forest*, 64–79. Tokyo: Committee of the Centennial Anniversary, Tokyo University of Agriculture. In Japanese with English summary.

Tuzin, D.F., 2001, *Social complexity in the making: a case study among the Arapesh of New Guinea*. London and New York: Routledge.

Tworek-Matuszkiewicz, B., 2001, The Ambum stone. *Artonview* (winter):59.

Vansina, J., 1965, *Oral tradition: a study of historical methodology*. London: Penguin.

Walter, A. and C. Sam, 2002, *Fruits of Oceania*, translated by P. Ferrar. Canberra: Australian Centre for International Agricultural Research, ACIAR Monograph No. 85.

Ward, R.G., 1970, Distribution and density of population. In R.G. Ward and D.A.M. Lea, eds *An atlas of Papua and New Guinea*, 8–11. Waigani (National Capital District): Department of Geography, University of Papua and New Guinea and Collins-Longman.

Ward, S.N. and S. Day, 2003, Ritter Island volcano - lateral collapse and the tsunami of 1888. *Geophysical Journal International* 154:891–902.

Watson, J.B., 1977, Pigs, fodder and the Jones Effect in post-Ipomoean New Guinea. *Ethnology* 16:57–70.

Watson, V.D. and J.D. Cole, 1977, *Prehistory of the Eastern Highlands of New Guinea*. Seattle and London: University of Washington Press.

White, J.P., 1972, *Ol Tumbuna: archaeological excavations in the eastern Central Highlands, Papua New Guinea*. Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University, Terra Australis 2.

Wickler, S., 2001, *The prehistory of Buka: a stepping stone island in the Northern Solomons*. Canberra: Department of Archaeology and Natural History and the Centre for Archaeological Research, Australian National University, Terra Australis 16.

Williams, C., 1999, Faunal composition of Pamwak site, Manus Island, PNG. In J.-C. Galipaud and I. Lilley, eds *Le Pacifique de 5000 à 2000 avant le présent: suppléments à l'histoire d'une colonisation,* 241–249. Paris: Institut de Recherche pour le Développement.

Yen, D.E., 1991, Domestication: the lessons from New Guinea. In Pawley, ed. 1991:558–569.

1993, The origins of subsistence agriculture in Oceania and the potentials for future tropical food crops. *Economic Botany* 47:3–14.

1995, The development of Sahul agriculture with Australia as bystander. In J. Allen and J.F. O'Connell, eds *Transitions: Pleistocene to Holocene in Australia and Papua New Guinea*, 831–847. *Antiquity* 69, Special Number 265.

1996, Melanesian arboriculture: historical perspectives with emphasis on the genus *Canarium.* In M.L. Stevens, R.M. Bourke and B.R. Evans, eds *South Pacific indigenous nuts*, 36–44. ACIAR Proceedings No. 69. Canberra, Australian Centre for International Agricultural Research.

Young, M.W., 1998, *Malinowski's Kiriwina: fieldwork photography 1915–1918*. Chicago: University of Chicago Press.