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Reconstructing the Lapita-era Geography of Northern Fiji: a Newly-discovered Lapita Site on Yadua Island and its Implications

Patrick D. Nunn¹, Sepeti Matararaba², Tomo Ishimura³, Roselyn Kumar⁴, and Elia Nakoro⁵

ABSTRACT

Questions concerning the earliest human occupation of northern Fiji were addressed by geoarchaeological survey on the island of Yadua. Yadua lies at the entrance to an ocean passage that early seafarers might have followed into central Fiji where some early Lapita sites exist. Evidence for a Lapita presence was discovered on Yadua at a small coastal flat called Vagairiki, likely to have been occupied by Lapita people around 2600 cal yr BP because of available freshwater and one of the few fringing reefs existing in the area at the time. It is concluded that the Lapita people reached Yadua and other parts of northern Fiji in a post-founder phase of Fiji history.

Keywords: LAPITA, FIJI, ARCHAEOLOGY, RADIOCARBON, COLONISATION.

INTRODUCTION

In recent years there has been considerable research directed towards understanding the geography and establishment times of settlements of the colonising (Lapita-era) peoples in the Fiji Islands (Anderson and Clark 1999; Clark and Anderson 2001; Burley 2003; Kumar and Nunn 2003; Nunn *et al.* 2003a; Burley and Dickinson 2004; Kumar *et al.* 2004a). As in other parts of the Lapita world (Papua New Guinea to Samoa–Tonga), many questions remain unsatisfactorily answered because of a lack of data from particular areas. For Fiji, key issues are where the earliest sites are located and why they might have been chosen.

Excluding the Lau Islands to the east, most investigations of Lapita-era settlement in Fiji have focused on the largest island Viti Levu and smaller islands within 10 km or so of its coast. Largely to counter this geographic bias, this study targeted part of northern Fiji.

This paper reports the results of a survey of Yadua, an offshore island in northern Fiji, lying within a wide, reef-free, deep-water passage (Bligh Water) that links the open

¹ Department of Geography, University of the South Pacific, Suva, Fiji. Email: nunn_p@usp.ac.fj

² Department of Prehistory-Archaeology, Fiji Museum, Suva, Fiji

³ Department of Archaeology, Kyoto University, Yoshida Honmachi, Sakyo-ku, Kyoto 606-8501, Japan

⁴ Institute of Applied Sciences, University of the South Pacific, Suva, Fiji

⁵ Department of Geography, University of the South Pacific, Suva, Fiji

ocean northwest of the group to its centre, where two early Lapita sites (on Moturiki and Naigani islands) are located. If this passage was one taken by the colonisers of these sites, it is possible that they also occupied Yadua Island. It cannot be assumed that any of the Lapita colonisers of Fiji entered the archipelago from the northwest although it is likely — given the probable difficulty of manoeuvring their ocean-craft through complex reef systems — that they would have sought broad passages like Bligh Water into such island groups.

No previous archaeological or oral-historical work had been carried out on Yadua or on other islands nearby. Although surveys seeking to identify early/Lapita human settlements have been made of parts of the Vanua Levu coastline, the only find is of a single dentate-stamped potsherd from Vaturekuka (see Fig. 1, inset; Parke 2000), considered by Anderson and Clark (1999) to mark a late Lapita presence.

ENVIRONMENTS AND EARLIEST SETTLEMENT IN FIJI

Within the period 15,000–4,000 yr BP, the sea level was mostly rising and many coral reefs were unable to build themselves upwards fast enough to keep pace with sea-level rise (Neumann and MacIntyre 1985). About 3000 yr BP, the sea level in Fiji was approximately 1.5 m higher than today (Nunn and Peltier 2001), and many coral reefs that grow today at the ocean surface (Lowest Astronomical Tide level) were then well below it. An understanding of the ways in which the geography of Lapita coasts differs from that of modern coasts in island groups like Fiji can help explain why Lapita people selected some sites to settle and not others, even though they may appear comparably attractive today.

Key differences between modern and Lapita coasts would have been that coastal flats were generally less extensive (because of the higher sea level) and that ocean-surface reefs would probably have existed only along those windward island coasts exposed to long-fetch waves (Nunn *in press*). It is likely that those ocean-surface reefs that existed in Lapita times were less extensive than today, perhaps fringing only smaller offshore islands rather than the coasts of larger islands. It is also likely that such reefs, being in a juvenile condition, were both less productive and had a lower ecological diversity than today.

Two of the earliest settlements in Fiji (at Naitabale on Moturiki Island, and at Matanamuani [VL 21/5] on Naigani Island) are in the central part of the archipelago, an area that is easily accessible today from the northwest through Bligh Water. Given the presence of long continuous windward reefs (some of which had probably reached the ocean surface 3000 years ago) to the south of these islands, the numerous small islands to the east, and large Vanua Levu Island to their north, it is plausible to suppose that this pair of early settlements were established by people entering the Fiji Islands from the northwest via Bligh Water (Fig. 1, inset; Kumar 2004). Following this northwest route would not only have given Lapita voyagers access to central Fiji but also allowed them a close look at the north coast of Viti Levu — something compatible with the establishment of an early Lapita settlement at Natunuku (Davidson *et al.* 1990; Anderson and Clark 1999).

The islands of central Fiji include Moturiki, Naigani and Ovalau, on each of which a Lapita site has been reported (Best 1981; Kumar *et al.* 2004b; Nunn *et al.* 2003b, 2004a). Those on Moturiki and Naigani are early-era sites. Indeed, for many years it was thought that the Lapita site at Matanamuani on Naigani Island was the earliest-known human settlement in Fiji (Anderson and Clark 1999). Following excavations at the Naitabale site on Moturiki Island, this then came to be regarded as the earliest-known settlement in Fiji

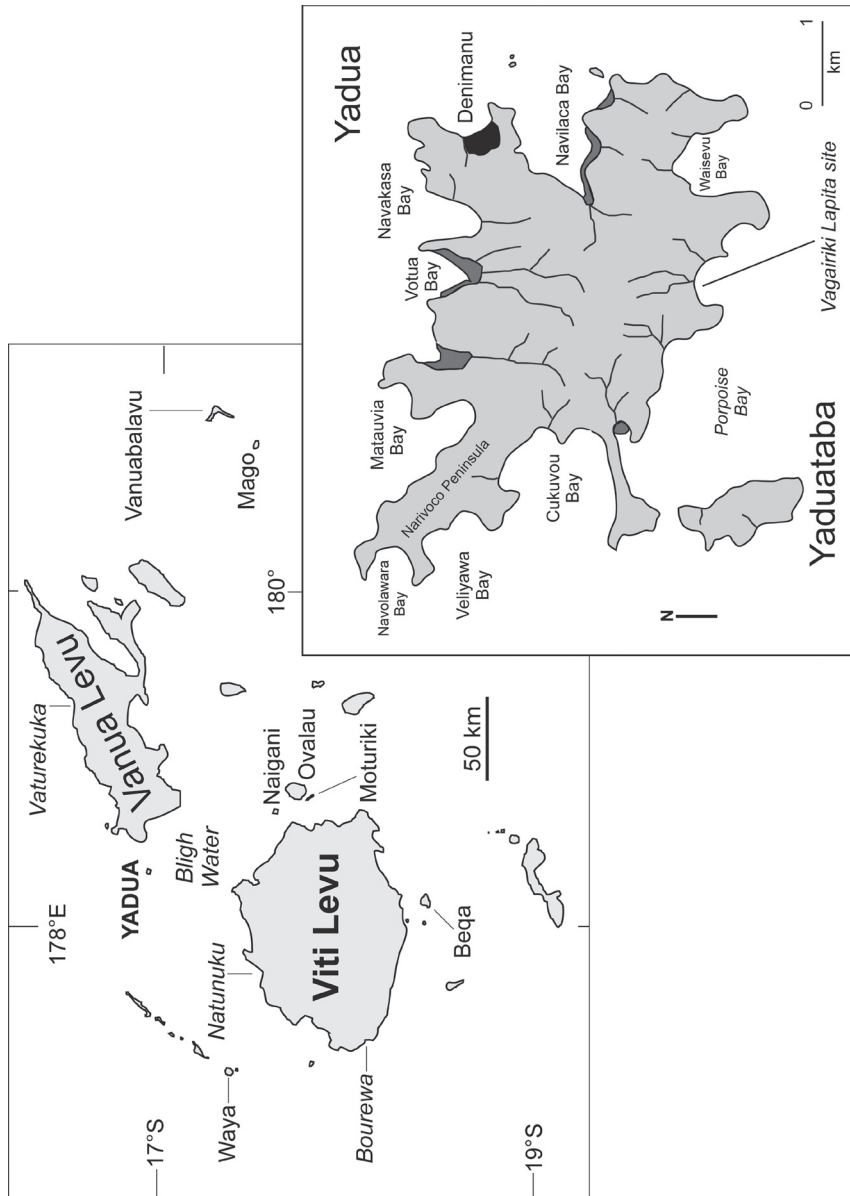


Figure 1: Yadua Island showing the main locations, including the two (possible) Lapita sites at Denimanu, where the modern settlement is located and Vagairiki, where a dentate-stamped sherd was found during excavation. Inset shows location of Yadua within the main Fiji Islands, and a selection of other Lapita sites in the group.

on account of early Lapita potsherds and radiocarbon dates clustering around 2850–2700 cal yr BP (Nunn *et al.* 2003a, 2003b; Kumar *et al.* 2004b).

A key test of whether the ‘northwest passage’ into Fiji was utilised by colonising peoples is whether or not there are early Lapita sites along its sides. Among those might be the north-coast Viti Levu site at Natunuku, where the pottery-bearing Layer 6 is still not well dated but may qualify as among the earliest in Fiji (Davidson *et al.* 1990; Anderson and Clark 1999), perhaps 3201–2750 cal yr BP (Spriggs 1996). Around 3000 years ago it is likely that the modern reefs of the northern Yasawas, those north and west of Vanua Levu, and those fringing the north coast of Viti Levu were fewer and less extensive. It is likely that reefs existed along the windward coasts of smaller offshore islands such as Yadua. It is probable that the Lapita colonisers of Fiji targeted productive reef-fringed coasts, which is another reason why this research project focused on Yadua.

THE STUDY AREA

Yadua Island, first visited by Nunn, Matararaba and Kumar in April 2004, is a high volcanic island, 13.6 km² in area, deeply dissected with numerous (although many seasonally dry) rivers, an effectively continuous fringing reef, and many well-sheltered bays. In addition, Yadua lies at the entrance of the northwesterly approach to Bligh Water, and could not have been overlooked by any seafarers following that route. Thus, for three weeks in June 2004, these three returned with a team of 16 university students to carry out a comprehensive survey of the Yadua coast and lowlands in the hope of locating evidence for its Lapita-era occupation.

A typical stellate island in the sense of Davis (1928) and Nunn (1994), Yadua Island has a deeply embayed coastline with fringing reefs along most of the shore and numerous bay-head mangrove swamps (Fig. 1). The reef that runs along the ocean side of the smaller island of Yaduataba continues east to enclose a 4 km² lagoon, named as Porpoise Bay on old maps. The windward coasts of Yadua, particularly those facing that lagoon, were considered likeliest areas for Lapita settlement. The broadest fringing reef off the island today lies off the modern village Denimanu on the northern part of the island’s east coast. Along with Cukuvou, where an earlier village existed, Denimanu was also considered a potential Lapita settlement.

RESULTS AND INTERPRETATION

SURFACE COLLECTION

Upon arrival on Yadua, the research team collected and analysed potsherds lying on the ground surface from all coastal flats more than 500 m² in size. The results were disappointing, for despite collecting around 1280 decorated body and rim sherds from 15 locations, no clearly Lapita-associated pottery was identified. Most decorated body sherds were crudely comb-incised with systems of wavy lines characteristic of the Ra Phase of Fiji ceramic history (<500 years BP). Four sherds with possible Lapita-associated decoration and form were found on the 25,000 m² Vagairiki coastal flat in the south of Yadua (Fig. 3, Sherds 2–5).

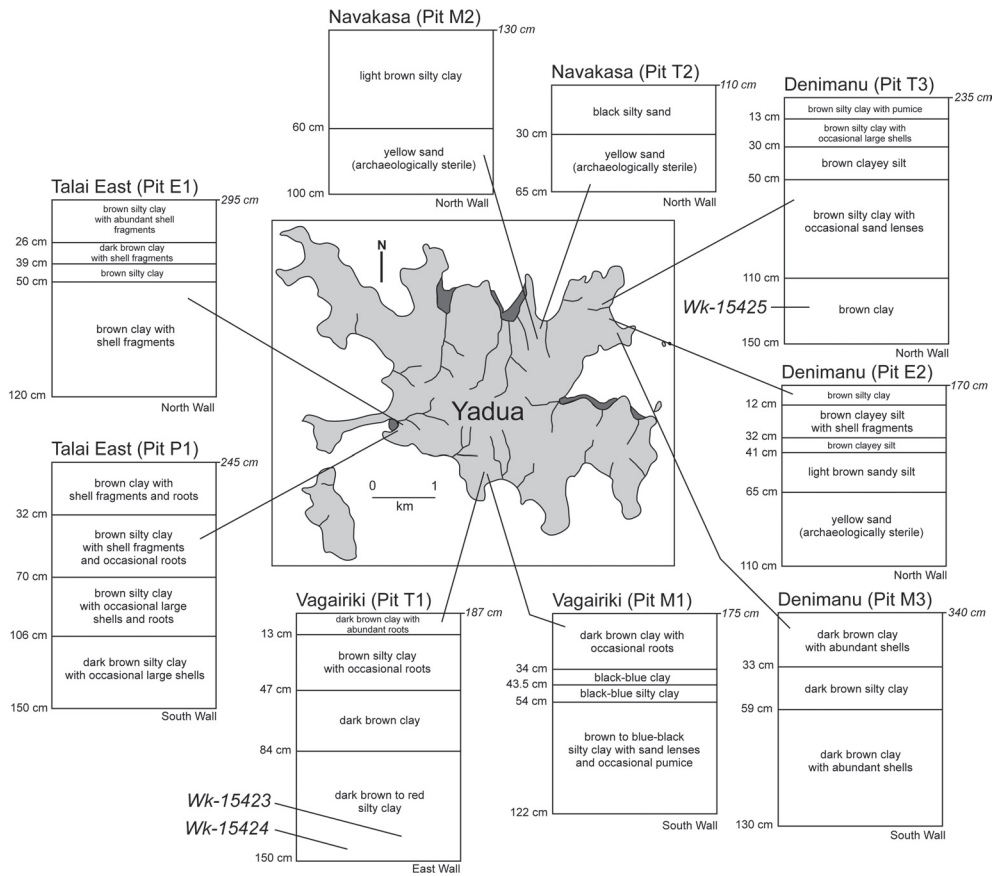


Figure 2: Locations and stratigraphy of all pits excavated in Yadua in June 2004, showing the positions of the three radiocarbon dates obtained (see Table 1).

EXCAVATIONS

Pits were excavated in four coastal flats on Yadua (Fig. 2) but dentate-stamped (Lapita) pottery was recovered only from Vagairiki.

At Talai East, there was evidently a large pottery-making settlement but this appears to have existed only during the last few hundred years, a conclusion suggested by the dominance of Ra Phase potsherds even at the bottom of the pits. The Talai East coastal flat is narrow and its occupation was probably contemporary with hill-top settlements to which its inhabitants retreated when threatened. During Lapita times, because of the higher sea level, there was probably insufficient lowland at Talai East to attract the earliest settlers.

No evidence for the establishment of a settlement was found at Navakasa on the north coast of Yadua. It is likely that coral reef reached the ocean surface in such leeward locations only well after the Lapita era as sea level was falling and the previously-submerged reef surfaces suddenly found themselves close enough to the ocean surface to establish themselves there (Nunn in press).

At Denimanu (the modern settlement), where there is a broad and wide coastal flat and the broadest fringing reef off the island, three pits were excavated. Although no Lapita pottery was found, there was evidence of a long occupation at Pits M3 and T3 with cultural material being recovered where the water table was reached, respectively 130 cm and 150 cm below the surface (Fig. 2). A radiocarbon date from 120–130 cm below the surface in Pit T3 (Table 1) may indicate that the site was occupied late in the Lapita era, which had ended in Fiji by about 2500 cal yr BP.

The Vagairiki coastal flat is triangular in form, surrounded by steep slopes, and bisected by a permanent stream channel. Two pits were dug here following discovery of the Lapita-associated potsherds found during surface collection. In Pit T1 (spit 70–80 cm), a dentate-stamped sherd was found (Fig. 3, Sherd 1).

The test pits at Vagairiki were abandoned after the water table was reached. At other sites, particularly Talai East, there was much less colluvium and the stratigraphy was easier to interpret, although no dentate-stamped potsherds or Lapita-associated potsherds were found. A post-Lapita notched rim was found in the 20–30 cm spit of Pit T3 at Denimanu.

Samples were taken for radiocarbon dating (Table 1). The two dates from Pit T1 at Vagairiki, in which the sole Lapita sherd was found, both came from large marine shells (*Trochus niloticus*) in the same stratum and both date from the last millennium. The whole sequence in Pit T1 is interpreted as a series of landslide deposits, some of which overran and mixed with older land surfaces, including that occupied during Lapita times.

TABLE 1
RADIOCARBON DATES FROM EXCAVATIONS ON YADUA ISLAND AT
VAGAIRIKI AND DENIMANU

Ages calibrated using OxCal 3.9 and, for marine shell, Marine98 curve of Stuiver *et al.* (1998) with Delta-R of 38 ± 16 yrs (Toggweiler *et al.* 1991); 2 sigma range given.

Sample	Lab. No.	Sample material	Depth (cm)	$\delta^{13}\text{C}$	CRA (BP)	Calendar age
T1 Vagairiki-1	Wk-15423	marine shell (<i>Trochus niloticus</i>)	130–140	3.1 ± 0.2	870 ± 34	AD 1430–1540
T1 Vagairiki-2	Wk-15424	marine shell (<i>Trochus niloticus</i>)	140–150	3.3 ± 0.2	758 ± 35	AD 1510–1670
T3 Denimanu-1	Wk-15425	charcoal	120–130	-26.0 ± 0.2	2427 ± 36	600–400 BC (64.2%) 770–680 BC (24.7%) 670–610 BC (6.5%)

In support of this interpretation, the dentate sherd was found in three pieces at different levels within the 70–80 cm spit and in different parts of the surface being excavated. A date on charcoal from Pit T3 at Denimanu is compatible with a late (or post-) Lapita occupation of this area, as suggested by the discovery of a post-Lapita notched rim. Dates are discussed further below.

LAPITA-ASSOCIATED POTTERY FROM VAGAIRIKI

Five potsherds that can, through their form and design, be linked to the Lapita occupation of Vagairiki were found (Fig. 3). Only one was dentate-stamped, this being found in spit 70–80 cm in Pit T1 (Sherd 1). Sherd 1 is part of the rim of what appears to have been an open-mouthed jar and the dentate design comprises two parallel horizontal lines, a crescent and another horizontal line, reconstructed as in Figure 4. The design is likely to be M1 (Mead *et al.* 1975) but with discontinuous crescents, and M6 (Anson 1983). Crescentic design elements are quite common in Lapita ceramic decorations, although discontinuous crescents of this kind are few; one example was found at site RF-6 in the Reef Islands of the eastern Solomon Islands (Donovan 1973).

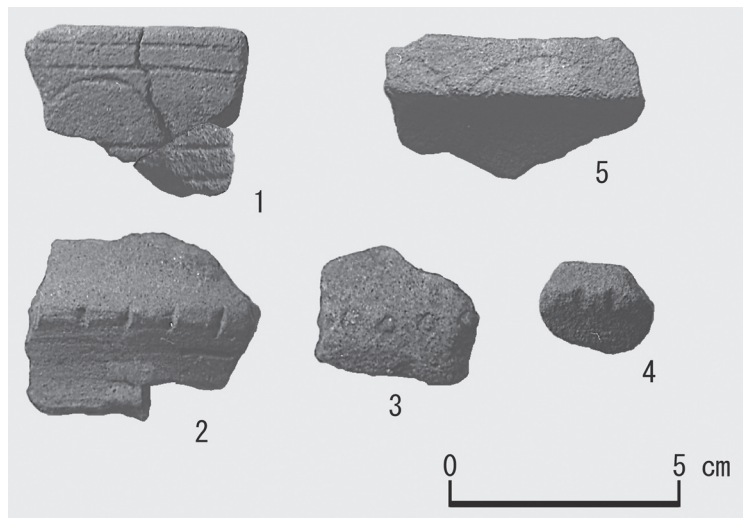


Figure 3: Lapita-associated potsherds from Vagairiki. Sherd 1 was obtained from Pit T1 at 70–80 cm depth. Sherds 2 to 5 were from surface collection.

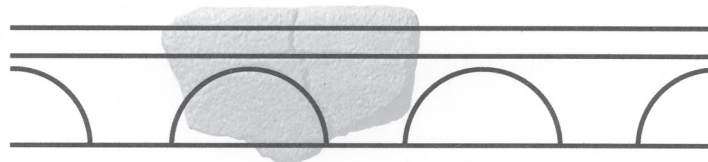


Figure 4: Suggested reconstruction of design for dentate-stamped Sherd 1 from Vagairiki.

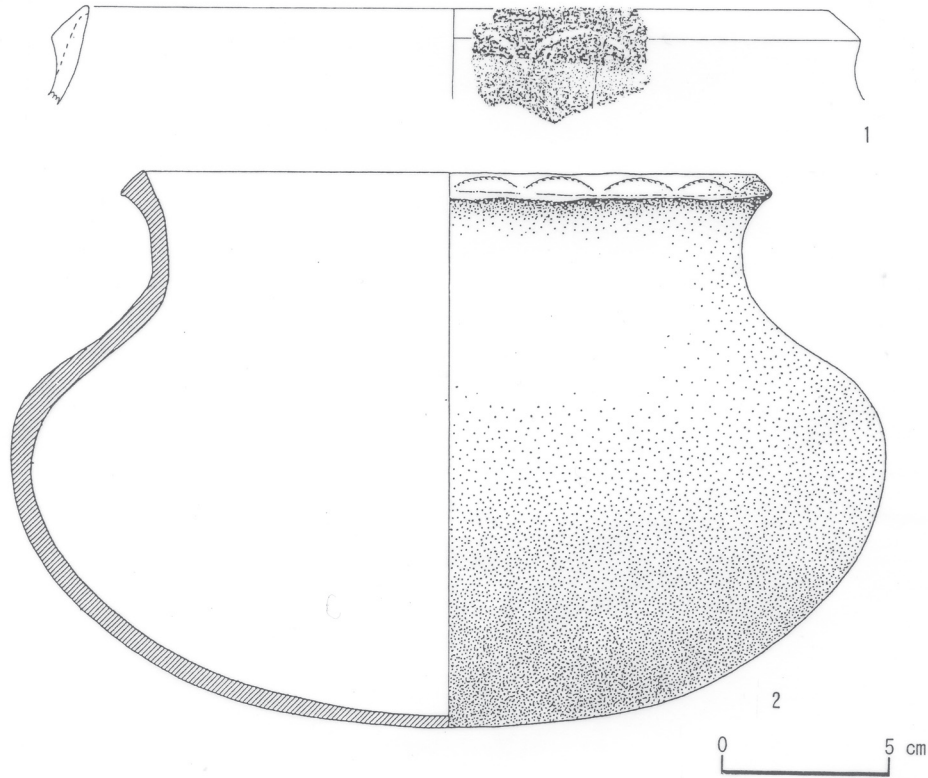


Figure 5: Examples of pottery with crescentic design. 1, Vagairiki, Yadua Island, Fiji. 2, Sigatoka Sand Dunes (Level 1), Viti Levu Island, Fiji.

Sherds 2–5 were found during surface collection at Vagairiki. Sherd 5 is from the rim of an open-mouthed jar (diameter 22.2 cm) and has crescentic designs on its top, either dentate or shell-impressed. This type of design is common in Level 1 at the Sigatoka Sand Dunes (Birks 1973) and is reconstructed in Figure 5. Sherds 2 and 4 are parts of notched rims of probably open-mouthed jars, of a kind also common in Level 1 at the Sigatoka Sand Dunes. Sherd 3 is decorated with small circles made using a hollow, cylindrical stamp, a technique commonly combined with dentate stamping.

Typological analysis indicates that Sherd 1 is genuine Lapita (dentate-stamped) pottery, the broad and coarse impressions suggesting that it comes from the later Lapita period in Fiji. This is consistent with the general typological similarities between the Yadua sherds and those from Level 1 at the Sigatoka Sand Dunes characterised as “Late Eastern Lapita” and dating from 2600 cal yr BP (Burley and Dickinson 2004).

LAPITA OCCUPATION AT VAGAIRIKI

The Lapita occupation at Vagairiki was probably in a back-beach location when the coastal plain was considerably smaller because of the higher sea level (see above).

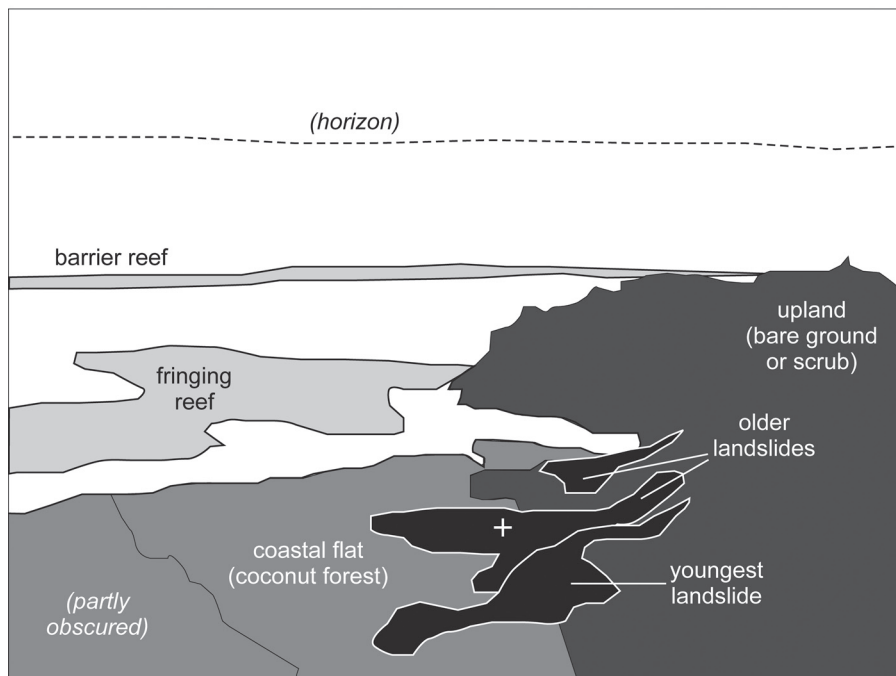


Figure 6: Photo of the southwest part of the Vagairiki coastal flat, together with an interpretative sketch showing the location (white cross) of Pit T1 in which the dentate-stamped Sherd 1 was discovered.

Today, much of the Vagairiki coastal flat is covered with landslide (colluvial) deposits and the notched rim was found in the centre of one of these in the west of the area (white cross in Fig. 6). An intensive surface collection in the immediate vicinity, involving clearing large amounts of dense bush, failed to recover any additional diagnostic sherds, so test pits M1 and T1 were put in close to the place where the notched rim was found.

After a thorough search of the entire Vagairiki coastal flat failed to uncover any additional Lapita-associated potsherds, it was thought that any other trace of the original Lapita settlement would be almost impossible to locate because of the valley-side landslides that subsequently affected the area. It was concluded that the discovery of a Lapita sherd in Pit T1 was a fortuitous occurrence, uncertain to recur in any additional pits at Vagairiki.

At first sight, it seems implausible to suppose that the small coastal flat of Vagairiki with an average-sized coral reef offshore today was chosen for settlement by the Lapita people rather than one of the larger coastal flats. The reasons appear to have to do with both the availability of drinking water and access to a fringing coral reef. Vagairiki, being on the windward side of Yadua, receives more rain than most other parts — enough to keep the streams in this bay and Waisevu Bay flowing all year round (in contrast to most on the island). To understand why coral reefs may have influenced the choice of Vagairiki as a settlement by the Lapita people, it is necessary to picture the state of coral reefs in the Fiji Islands as a whole 3000 years ago.

During the period of postglacial sea-level rise, most coral reefs in Fiji and elsewhere in the tropical Pacific were unable to grow upwards at the same rate as sea level was rising, meaning that many reef surfaces only 'caught up' with the ocean surface when sea level began falling during the later Holocene (Nunn 1994, 1999). In practical terms for an archipelago like Fiji 3000 years ago, this would have meant that coral reefs were neither as widespread as they are today nor, being mostly juvenile ecosystems at that time, as productive a food source. There would have been far fewer coral reefs living at the ocean surface in the Fiji Islands 3000 years ago compared to today. Coral reefs 3000 years ago were probably growing best along those windward (southeast-facing) coasts that had unimpeded access to water driven northwest by the tradewinds. It has been suggested that this is the reason why early Lapita settlements were established at Matanamuani on Naigani Island, at Naitabale on Moturiki Island, and at Bourewa in southwest Viti Levu (Nunn in press).

The same situation is likely to have obtained on Yadua Island, with the first reefs to have reached the ocean surface existing off Vagairiki and Waisevu bays in the southeast of the island. The ocean swells and waves that come from the southeast for most of the year drive straight onto the reefs at the mouths of these bays today; there is no reason to suppose that system was different 3000 years ago.

Later during the early human history of Yadua, reefs reached the surface elsewhere along the island's windward coasts, principally at Denimanu, where (a group of) people probably shifted around the end of the Lapita era. No Lapita sites were found along the leeward coasts of Yadua (at Navakasa Bay, for example) because coral reef reached the ocean surface only much later along these coasts.

This interpretation presumes that the (earliest?) Lapita people on Yadua, and elsewhere, considered access to a large and productive fringing reef the foremost criterion in site selection, even to the exclusion of considerations of land suitable for horticulture or to a secure anchorage, as suggested by Lepofsky (1988). It may equally be that the Lapita occupation of Yadua was never intended as a long-term occupation and thus no gardening was planned.

The dates of the landslide deposits (Table 1) within which the Lapita sherd in Pit T1 was found are significant. We envisage a long period of landscape stability following the end of Lapita settlement at Vagairiki around 550 BC even though the coastal flat remained occupied by people. Then came the 'AD 1300 Event', a short-lived period of cooling and sea-level fall that led to a reduction in food availability for coastal dwellers throughout the tropical Pacific Islands by as much as 80 percent (Nunn 2000, n.d.). As elsewhere in Fiji and other island groups, conflict ensued. Coastal settlements like Vagairiki were abandoned and their inhabitants split into smaller groups and moved upslope and inland to establish and fortify hill-top settlements in which they remained (until about 1850 in Fiji). The occupants of these hill-top settlements typically established food gardens of taro and yams on the surrounding slopes, many of which were thus cleared for the first time. This clearance led to sediment being washed down-slope (and in many places downstream) leading elsewhere in Fiji to the development of alluvial charcoal concentrations and even sand dunes dating from this time (Nunn and Kumar 2004; Dickinson *et al.* 1998). It is entirely plausible to suppose that people from the Vagairiki coastal settlement abandoned it and moved upslope following the AD 1300 Event and that, once established in those areas, they began to clear the surrounding vegetation for horticulture. This led to soil being washed down-slope, a process that evidently involved land sliding at Vagairiki, and the reworking and burial of lowland land surfaces that had been occupied by Lapita people.

There is some confirmation of this scenario from those oral traditions concerning changing settlement pattern on Yadua that were collected from elderly people in Denimanu during this research. The principal story recalls that at some long-distant point in time, the people of Yadua occupied the 30,000 m² coastal flat named Cukuvou in the west of the island. After repeated attacks from the army named '*Mataivalu mai Macuata*' based on Vanua Levu, they moved to the hills behind the Denimanu coastal flat where they successfully repelled the enemy the next time they attacked. They remained in the hills until the priest (*bete ni vanua*) permitted them to move to the present village site on the 4000 m² Denimanu coastal flat. It is possible that the Cukuvou settlement existed before the AD 1300 Event, when settlements in the tropical Pacific were commonly coastal (Nunn 2000), and that the move to the hills came as a result of the ensuing conflict. It is possible that the role of the *bete ni vanua* in the move to the Denimanu coastal flat is a way of recalling the influence of Christianity on this process.

The commonest oral tradition found concerning the origin of the island Yadua was one that recalls the island being formed during heavy rains from soil washed off the hills behind the village of Nakorovatu on the west coast of Vanua Levu (facing Yadua — see Fig. 1, inset). A plausible interpretation of this is that it recalls a migration of people from western Vanua Levu to Yadua. A separate study concerning the origins and meanings of selected place names on Yadua will be published soon (Gwilliam *et al.* in press).

DISCUSSION

Although we cannot be certain that there was just one (possibly two) Lapita settlement(s) on Yadua Island, the available information about the age of the Vagairiki site suggests that it was not one of the earliest in the Fiji archipelago. Rather it appears to be similar in age to that on the Sigatoka Sand Dunes (2600 cal yr BP according to Burley and Dickinson 2004). If this is correct, then it is likely to have been established in a post-founder phase of Lapita settlement, a conclusion that in turn suggests that the northwestern route into

Fiji was *not* one used by the first seafarers to settle these islands and that most of northern Fiji was settled late in the Lapita history of the archipelago.

This conclusion is in line with recent work on Lapita settlement in southern and central Fiji. The possible founder site — at Bourewa in southwest Viti Levu — may have been established as much as 3210–2920 cal yr BP (Nunn unpublished date; see also Nunn *et al.* 2004b) while the earliest known site in central Fiji — at Naitabale on Moturiki Island — was established perhaps around 2850–2700 cal yr BP at Naitabale near the southern extremity of this elongate island (Nunn unpublished dates). The latter observation may indicate that the Naitabale site was established by people approaching Moturiki from the south (from the direction of Bourewa) rather than from the northwest.

CONCLUSIONS

A new Lapita site on Yadua Island in northern Fiji dates from late in the Lapita history of the archipelago. The site at Vagairiki was probably established because there was a dependable water supply and a coral reef offshore, a situation that contrasted favourably with most other places in Fiji at this time.

There is still much that is uncertain about the Lapita period of Fiji history, and many of the conclusions reached here are subject to revision as more research is carried out. Some such research needs to focus on the ‘unknown’ parts of Fiji, including other parts of northern Fiji and the Kadavu group.

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REFERENCES

- Anderson, A. and Clark, G. 1999. The age of Lapita settlement in Fiji. *Archaeology in Oceania* 34: 31–39.
- Anson, D. 1983. The Lapita Pottery of the Bismarck Archipelago and its Affinities. Unpublished PhD Dissertation. University of Sydney, Australia.
- Best, S. 1981. Excavations at Site VL 21/5 Naigani Island, Fiji: a preliminary report. Department of Anthropology, University of Auckland.
- Birks, L. 1973. *Archaeological Excavations at Sigatoka Dune Site, Fiji*. Bulletin of the Fiji Museum 1. The Fiji Museum, Suva.

Burley, D.V. 2003. Dynamic landscapes and episodic occupations: archaeological interpretation and implications in the prehistory of the Sigatoka Sand Dunes. In C. Sand (ed.), *Pacific Archaeology: Assessments and Prospects* (Proceedings of the International Conference for the 50th Anniversary of the First Lapita Excavation, Koné-Nouméa 2002), pp. 307–315. Services des Musées et du Patrimoine, Nouméa.

Burley, D.V. and Dickinson, W.R. 2004. Late Lapita occupation and its ceramic assemblage at the Sigatoka Sand Dune site, Fiji, and their place in Oceanic prehistory. *Archaeology in Oceania* 39: 12–25.

Clark, G. and Anderson, A. 2001. The pattern of Lapita settlement in Fiji. *Archaeology in Oceania* 36: 77–88.

Davidson, J., Hinds, E., Holdaway, S. and Leach, F. 1990. The Lapita site of Natunuku, Fiji. *New Zealand Journal of Archaeology* 12: 121–155.

Davis, W.M. 1928. *The Coral Reef Problem*. American Geographical Society Special Publication 9.

Dickinson, W.R., Burley, D.V., Nunn, P.D., Anderson, A., Hope, G., de Biran, A., Burke, C. and Matararaba, S. 1998. Geomorphic and archaeological landscapes of the Sigatoka Dunes site, Viti Levu, Fiji: interdisciplinary investigations. *Asian Perspectives* 37: 1–31.

Donovan, L. J. 1973. A Study of the Decorative System of the Lapita Potters in Reefs and Santa Cruz Islands. Unpublished M.A. Research Essay, Department of Archaeology, University of Auckland, New Zealand.

Gwilliam, M., Meredith, M., Robinson, S. and Tamani, F. In press. Bays of Yadua and Yaduataba Islands, northern Fiji: the meanings and history of their modern names. *Domodomo*.

Kumar, R. 2004. The first people in Fiji: a report on the current state of knowledge about when and where they settled. *Domodomo* 17: 14–18.

Kumar, R. and Nunn, P.D. 2003. Inland and coastal Lapita settlement on Vitilevu Island, Fiji: new data. *Domodomo* 16: 15–20.

Kumar, R., Nunn, P.D. and Dickinson, W.R. 2004a. The emerging pattern of earliest human settlement in Fiji: four new Lapita sites on Viti Levu Island. *Archaeology in New Zealand* 47: 108–117.

Kumar, R., Nunn, P.D., Katayama, K., Oda, H., Matararaba, S. and Osborne, T. 2004b. The earliest-known humans in Fiji and their pottery: the first dates from the 2002 excavations at Naitabale (Naturuku), Moturiki Island. *South Pacific Journal of Natural Science* 22: 15–21.

- Lepofsky, D. 1988. The environmental context of Lapita settlement locations. In P.V. Kirch and T.L. Hunt (eds), *Archaeology of the Lapita Cultural Complex: a critical review*, pp. 33–47. Burke Museum, Seattle.
- Mead, S.M., Birks, L., Birks, H. and Shaw, E. 1975. *The Lapita Pottery Style of Fiji and its Associations*. Polynesian Society Memoir 38. Wellington.
- Neumann, A.C. and MacIntyre, I. 1985. Reef response to sea-level rise: keep-up, catch-up or give-up. *Proceedings of the 5th International Coral Reef Congress* 3: 105–110.
- Nunn, P.D. 1994. *Oceanic Islands*. Blackwell, Oxford.
- Nunn, P.D. 1999. *Environmental Change in the Pacific Basin: chronologies, causes, consequences*. Wiley, London.
- Nunn, P.D. 2000. Environmental catastrophe in the Pacific Islands about AD 1300. *Geoarchaeology* 15: 715–740.
- Nunn, P.D. In press. Reconstructing tropical paleoshorelines using archaeological data: examples from the Lapita era in Fiji (southwest Pacific). *Journal of Coastal Research*.
- Nunn, P.D. n.d. The AD 1300 Event in the Pacific Basin: overview and teleconnections. Submitted to *Quaternary International*.
- Nunn, P.D. and Kumar, R. 2004. Alluvial charcoal in the Sigatoka Valley, Viti Levu island, Fiji. *Palaeogeography, Palaeoclimatology, Palaeoecology* 214: 153–162.
- Nunn, P.D. and Peltier, W.R. 2001. Far-field test of the ICE-4G (VM2) model of global isostatic response to deglaciation: empirical and theoretical Holocene sea-level reconstructions for the Fiji Islands, Southwest Pacific. *Quaternary Research* 55: 203–214.
- Nunn, P.D., Kumar, R. and Matararaba, S. 2003a. Recent research relating to Lapita settlement in Fiji. In C. Sand (ed.), *Pacific Archaeology: Assessments and Prospects* (Proceedings of the International Conference for the 50th Anniversary of the First Lapita Excavation, Koné-Nouméa 2002), pp. 183–186. Services des Musées et du Patrimoine, Nouméa.
- Nunn, P.D., Matararaba, S. and Kumar, R. 2003b. An early Lapita site on Moturiki Island, central Fiji: preliminary report. *Domodomo* 16: 7–14.
- Nunn, P.D., Matararaba, S. and Areki, F. 2004a. A Lapita site on Ovalau Island, central Fiji Islands. *Archaeology in New Zealand* 47: 215–219.
- Nunn, P.D., Kumar, R., Matararaba, S., Ishimura, T., Seeto, J., Rayawa, S., Kuriyawa, S., Nasila, A., Oloni, B., Rati Ram, A., Saunivalu, P., Singh, P. and Tegu, E. 2004b. Early Lapita settlement site at Bourewa, southwest Viti Levu Island, Fiji. *Archaeology in Oceania* 39: 139–143.

Parke, A.L. 2000. Coastal and inland Lapita sites in Vanua Levu, Fiji. *Archaeology in Oceania* 35: 116–119.

Spriggs, M. 1996. Chronology and colonisation in island southeast Asia and the Pacific: new data and an evaluation. In J.M. Davidson, G. Irwin, B.F. Leach, A. Pawley, and D. Brown (eds), *Oceanic Culture History: Essays in Honour of Roger Green*, pp. 33–50. New Zealand Journal of Archaeology Special Publication, Dunedin.

Stuiver, M., Reimer, P.J., Bard, E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, F.G., van der Plicht, J. and Spurk, M. 1998. INTCAL98 Radiocarbon age calibration 24,000–0 cal BP. *Radiocarbon* 40: 1041–1083.

Toggweiler, J.R., Dixon, K. and Broecker, W.S. 1991. The Peru upwelling and the ventilation of the South Pacific thermocline. *Journal of Geophysical Research* 96: 20, 467–420, 497.

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