

# Lapita Burials, a New Lapita Cemetery and Post-Lapita Burials from Malakula, Northern Vanuatu, Southwest Pacific

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## ABSTRACT

During archaeological excavations investigating Lapita period sites on the islands of Uripiv and Vao off the northeast coast of Malakula, northern Vanuatu, Lapita (8) and Post-Lapita burials (7) were recovered. These are the first prehistoric burials to be reported on in detail from northern Vanuatu and the site on Uripiv Island has since been confirmed as a Lapita cemetery, one of only three identified to date. The Uripiv cemetery is situated in a separate location to the contemporary midden dumping and habitation areas which has important implications for survey and excavation strategies. The Lapita burials on Vao were situated within the defined extent of the Lapita midden. The skeletal remains provide further rare information on the mortuary practices, health and social behaviour of both Lapita populations and their descendants which demonstrates distinctive change from 3000 to 2000 BP.

*Keywords:* Lapita; health and disease; mortuary practice; cemetery; Malakula; Vanuatu; southwest Pacific

## INTRODUCTION

Establishing the boundaries, chronology and settlement pattern associated with Lapita expansion has occupied the Pacific archaeological research agenda for decades (Bedford and Sand 2007). Lapita has been tracked by an archaeological horizon that extends from the Bismarck archipelago across to Samoa, dating to 3300–2600 BP. Associated with a Neolithic expansion it stretched across a region, that in the west was occupied during the Pleistocene (Near Oceania) and further east into a region (Remote Oceania) where Lapita represented the initial colonising population (Figure 1). For much of the history of Lapita research there remained a number of anomalous zones (Solomons, Vanuatu, Samoa) where Lapita was thought to be ephemeral or non-existent (Anderson *et al.* 2001). Renewed research, both archaeological and geomorphological, has begun to either populate the previously vacant

zones with sites (Bedford and Sand 2007) or provide robust explanations as to why sites are extremely difficult to find (Clark and Bedford 2008; Dickinson and Green 1998; Felgate 2007; Green 2002).

In the case of Vanuatu (Figure 1) the increased number of recorded Lapita sites across the archipelago has come about through both targeted research (Bedford 2003; Bedford and Spriggs 2008; Galipaud and Swete Kelly 2007) and serendipitous discovery (Bedford *et al.* 2009). Most significant, has been the discovery of the Teouma Lapita cemetery on Efate Island where, following five field seasons at the site (2004–2006, 2008–2009), a total of 60 mortuary features that may represent up to 80 individuals have been uncovered (Bedford *et al.* 2009). Apart from Teouma, burials and bone assemblages associated with the more than 250 sites recorded across the Lapita distribution are extremely rare, a total of only 11, comprising eight burials at the Watom SAC site (New Britain), one burial at Moturiki (Fiji) and two bone assemblages from the Mus-sau group and Koné (New Caledonia) respectively (Green 1989, Kirch *et al.* 1989, Nunn *et al.* 2007, Petchey *et al.* 2010, Sand 2010).

One of the projects designed specifically to address the dearth of information on Lapita sites in Vanuatu was an archaeological research and training program focusing on the small islands off northeast Malakula (Bedford 2003, 2007). During field seasons carried out during 2001 and 2002, Lapita sites were located on uplifted beach ter-

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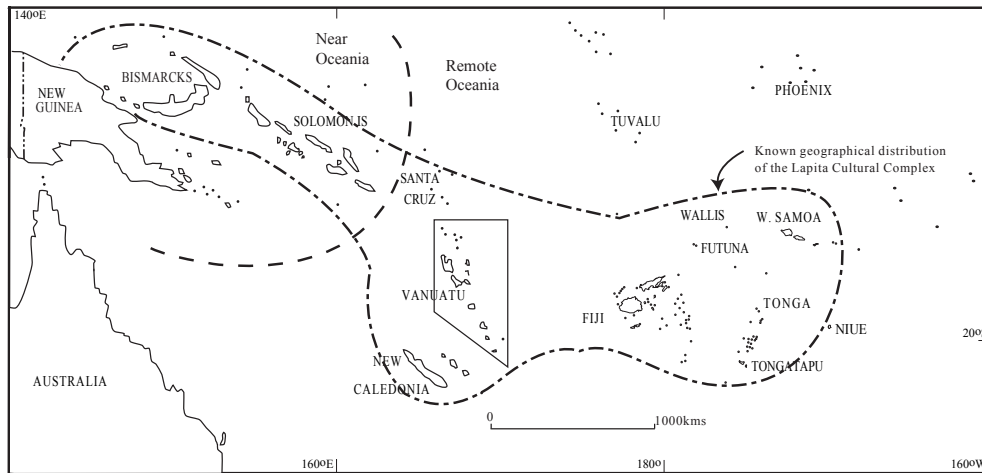


Figure 1. *Top*: Southwest Pacific; *Bottom*: Vanuatu; inset, northeast Malakula

races on four islands, namely Uripiv, Wala, Atchin and Vao (Figure 1). More extensive excavations were carried out on Vao in 2003 and 2004. At sites on two of these islands, Vao and Uripiv, Lapita and post-Lapita period burials were identified. In 2005 and again in 2009–2010, further excavations were undertaken on Uripiv Island that confirmed the location of a Lapita period cemetery, only the third to have been found to date. This paper outlines in detail the first prehistoric burials to be reported from northern Vanuatu, a region that has a rich record of mortuary practice from the ethnographic period (Deacon 1934; Layard 1942; Speiser 1996). A total of eight Lapita burials and seven Post-Lapita burials were excavated and although the sample is small, it provides further rare and important detail on the mortuary practices and health of Lapita and Post-Lapita populations dating to the period 3000–2000 BP.

### ARCHAEOLOGICAL EXCAVATIONS

The small islands of northeast Malakula were identified as an ideal location for finding Lapita sites due to a number of factors. One of these was the fact that they were not too distant from Malo Island where a number of Lapita sites had been recorded earlier (Hedrick and Shutler 1969; Galipaud 2000). The islands are small, all less than two kilometres square, low-lying and surrounded by fringing reefs, apart from sheltered sandy beaches on the western coasts. All these aspects helped narrow down potential areas for finding colonising sites. Regular uplift (Dickinson 2001; Taylor *et al.* 1980) and the volcanically active nearby islands of Ambrym, Lopevi and Epi (Eissen *et al.*, 1994; Robin *et al.* 1993; Warden 1967), determined that excavation on the uplifted back beaches was required if sites were to be found.

A test-pitting grid orientated to the cardinal points with an average interval of 14 m proved extremely effective on the elevated beach terraces with four Lapita sites being found on Uripiv, Wala, Atchin and Vao during the first few days of excavation on each island. The sites were all generally very well sealed and preserved through a combination of overlying tephra deposits, cyclonic sand deposits and accumulated debris from later habitation in the same area (Bedford 2007). Only the sites on Uripiv and Vao, encompassing the excavations undertaken in 2001–2005, are discussed in detail here as burials were only located on these two islands. The excavations undertaken on Uripiv in 2009 and 2010 will be reported on at a later date.

The primary objective of the fieldwork was to establish the extent of the sites and identify any spatial and temporal variation during Lapita and later-period occupation. The discovery of burials was expected in a locale that had been potentially a preferred zone of occupation for 3000 years but the restricted nature of 1 by 1 m test-pits, and the depth of stratigraphy, largely precluded their excavation. Local permission for the excavation and removal of human remains was granted upon the understanding that

once analysed the remains would be returned and interred in the same location.

### URIPIV ISLAND

During two field seasons (2001–2002) on Uripiv Island a total of fifteen, 1 by 1 m test-pits (TP) were excavated across the site along with another three, 2 by 2 m areas, a total of 27 m<sup>2</sup> (Figure 2a). This strategy established that the core of the Lapita site as defined by midden deposits and activity areas, comprising of hearth and firescoop features, covered an area of some 2800 m<sup>2</sup>. Post-Lapita occupation at the site expanded beyond the excavated areas. The Lapita site is now situated 50m from the sea and the current ground surface is 6–7 m above mean sea level. The stratigraphy of the site consists of six principal layers with some minor variation across the site. Layer 1 comprises humic topsoil and in some areas historic coral gravel house floors were recorded. Layer 2 is a dark brown tephra-rich deposit containing limited artefactual material including both Malakula ceramics dating to the last 500 years and occasional historic items. Layer 3 is a very compacted layer of locally imported worn branch coral and pebbles and associated cultural material that dates to c. 2300–2000 BP. Layer 4 is a dark brown sandy deposit containing later Lapita midden. Layer 5 is a concentrated Lapita midden in a sand and tephra matrix that is sitting on top of Layer 6, the original coral sand beach.

### VAO ISLAND

Excavations were undertaken on Vao Island over three field seasons from 2002–2004. A grid of 1 by 1 m test-pits (24) was again excavated across the uplifted back beach terrace on the sheltered western side of the island. Two further 3 by 2 m areas (A and B) were excavated in places where both the deepest and earliest deposits were identified. A total of 36 m<sup>2</sup> was excavated. The core of the Lapita site on Vao was more extensive than that on Uripiv, covering an area of some 4000 m<sup>2</sup>. As on Uripiv, Post-Lapita occupation expanded beyond the excavated areas and the Lapita site is situated some 50 m from the sea while the current ground surface is 9–10 m above mean sea level (Figure 2b). The overall stratigraphic layering and cultural deposits of the site are very similar to those on Uripiv with six principal layers identified.

### Uripiv burials

During both the 2001 and 2002 excavations on Uripiv, burials were found in three test-pits at the most southern and northern areas of excavation, namely TPs 4, 13 and 14. Their stratigraphic situations indicated that they were both Lapita (TP14 [B1]) and Post-Lapita age burials (TP4 [B9] and 13 [B2]). However, during these preliminary investigations a number of factors precluded their complete exca-

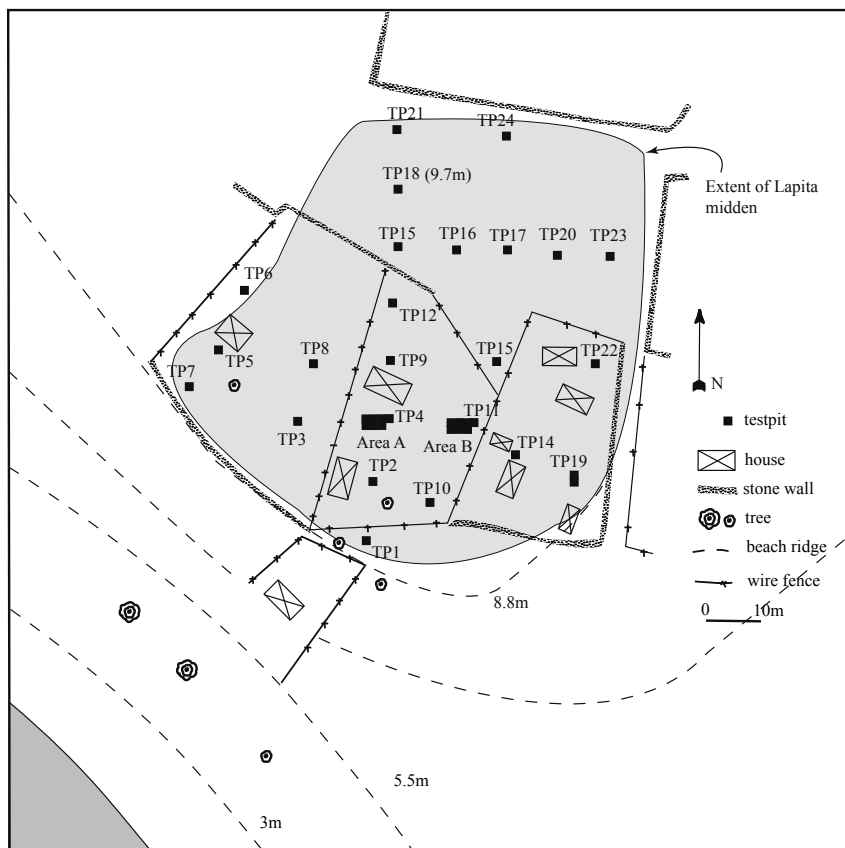
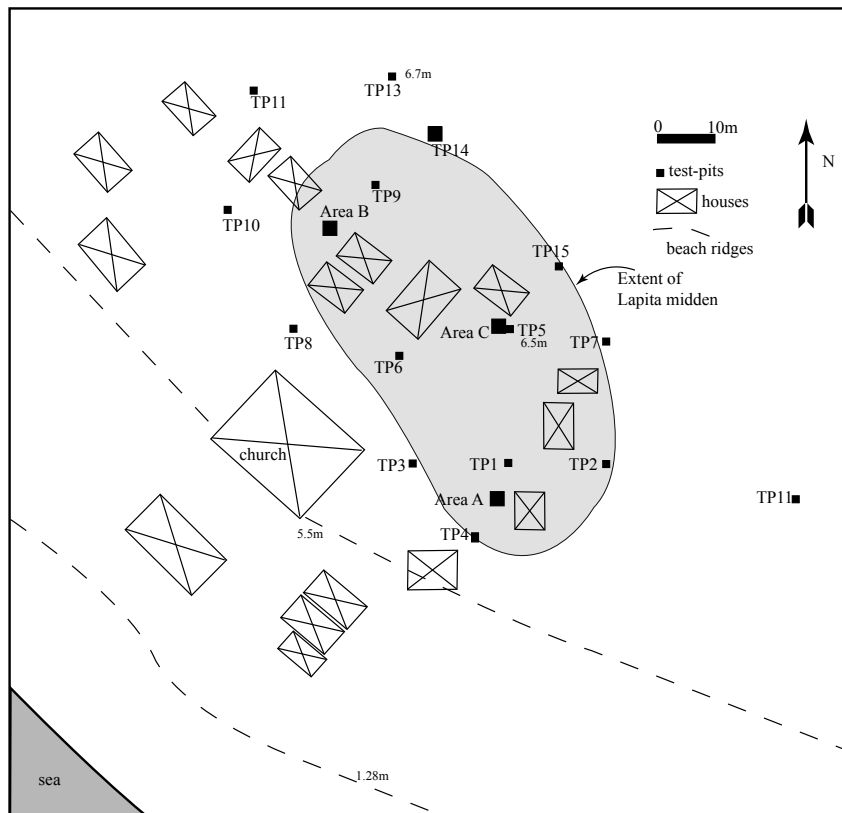


Figure 2a (above). Location of excavated areas and extent of Lapita site, Uripiv Island.  
 Figure 2b (below). Location of excavated areas and extent of Lapita site, Vao Island.

vation, such as the restricted nature of the 1 m<sup>2</sup> test-pits, time constraints and most importantly a lack of relevant specialists on site. Only the full excavation of the burial (B9) found in TP4 was undertaken. The burial was sealed beneath Layer 1 and 2 and cut into Layer 3. A narrow and concave pit had been dug and the body had been placed within it. A large flat coral slab, acting as a potential grave marker or protective cover, now 80 cm below the current ground surface, had been placed over the burial (Figure 3). Following discussions with the Uripiv community, this burial was reinterred in 2002 with minimal recording of the skeleton.

Excavations in 2005 focused specifically on further investigation of the previously identified burials that had been earlier left *in situ*. The Post-Lapita burial (B2) in TP13 was able to be fully excavated and removed without extension of the original test-pit. The burial contained the remains of an adult female partly disturbed by a subsequent feature, lying on her side, and buried in a cut feature dug into Layer 3. Immediately below B2, another Post-Lapita burial of an adult, possibly male (B4), was recovered. B4 appeared to have also been cut into Layer 3 deposits but had been partly disturbed by B2. Finally, another burial (B8) was identified at 1.3 m below the surface, in a stratigraphically similar level to the Lapita deposits to the south.

It protruded from the eastern baulk and comprised a young child's skull and upper body, lying on its back. This burial was left *in situ* as further excavations were planned at the site.

An extended area of 1.75 m<sup>2</sup>, centred on TP14 (total area excavated was 2.75 m<sup>2</sup>), was excavated to both fully investigate the Lapita burial B1 and to establish if any other burials were in association. B1 was at the very base of TP14 some 1.3 m below the surface and dug into the sterile former beach. The extended excavations revealed that B1 consisted of the upper body and thighs of an 18-month-old infant lying partly on its left side. A further three Lapita burials were found, comprising a foetal individual (32–34 foetal weeks) lying on its left side (B5), a foetus (B6), disturbed by a posthole, which was slightly older (assessed through relative skeletal size) than B5 and an infant lying supine with left leg extended (B7) (Figures 4 and 5). The interment of B1 disturbed part of the lower legs of B7. A later cut feature containing a black fill, had disturbed the mid thorax region of B7. All of these individuals had been placed in shallow graves, cut into the sterile former beach deposits, and all were associated with the Lapita occupation but outside the area where abundant midden dumping and other associated activities were evident, some 5 m to the south. Radiocarbon samples collected from sparse



Figure 3. Post-Lapita seated burial, B9, Uripiv Island. A large flat coral slab sits above the burial located at the left hand end; inset shows the skull to the right and tibia to the left.

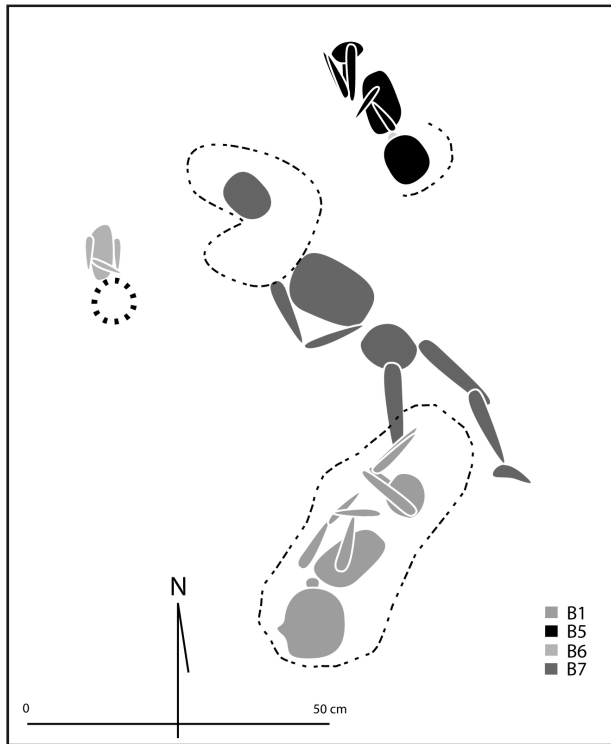


Figure 4. Schematic plan of Lapita burials uncovered following extension of TP14, Uripiv Island.

midden shell located adjacent to the graves and in later hearth features, which sealed the graves, confirmed the association (Table 1). No grave goods were found with any of the Uripiv burials.

### Vao burials

While no human remains had been identified in any of the test-pits in 2002 and 2003, soon after commencing a larger area (A) excavation in 2003, burials were revealed across much of the 6 m<sup>2</sup> surface. Four Post-Lapita individuals (B1, B2a, B2b, B3) were identified (Figure 6), and all had been buried in shallow graves dug into the top of Layer 3, a stratigraphic position which indicated they were Post-Lapita in age. Direct dating of two of the burials, their stratigraphic situation and similarity in mortuary practice, all point to some level of contemporaneity. Primarily layer 3 comprises locally imported branch coral and pebbles used to make house floors or household compounds and these burials seem likely to have been placed within those contexts. Three Lapita period burials (B4, 5 [both Area B] and 6 [TP19]) from two different areas were located on Vao during excavations in 2004 (Figures 7 and 8).

Of the four burials excavated in 2003 in Area A, three were adult, two females and one male. Burial 1, whose interment disturbed B2, consisted of the partial skeleton of



Figure 5. Lapita burials, B1 and B5, Uripiv Island

Table 1. Radiocarbon dates associated with the Malakula burials. Calibrations using OxCal v. 3.10 (Bronk Ramsey 2005) were provided by Fiona Petchey, University of Waikato, Radiocarbon Dating Laboratory. Calibrations utilise Southern Hemisphere atmospheric data from McCormac et al. (2004).

Sample provenance	Laboratory number	C <sup>14</sup> Age BP	δ <sup>13</sup> C (±0.02‰)	Material	Calibrated Age BP (2 s.d., 95.4%)
<b>Uripiv</b>					
B9 TP4	Wk-20387	2361 ± 33	-18.1	bone [tibia frag.]	2364–2156 BP
TP14 shell above BX 135cm bs	Wk-20009	2858 ± 39	3.3	<i>Trochus</i> sp.	2720–2440 BP
TP14 shell adjacent to B5	Wk-20010	3181 ± 40	0.7	<i>Strombus</i> sp.	3090–2810 BP
<b>Vao</b>					
B2a, Area A, top of L.2	Wk-21444	2281 ± 37	-18.6	bone [rib]	2305–2000 BP
B3, Area A, top of L.2	Wk-21445	2208 ± 38	-18.5	bone [calcaneus]	2155–1899 BP
B6, TP19, L.3.	Wk-21446	2559 ± 37	-17.5	bone [mandible frag.]	2682–2315 BP
B4, Area B, L.3.	Wk-18013	2128 ± 28	-18.9	bone [fibula]	2300–2000 BP*
B5, Area B, L.3.	Wk-18014	2514 ± 36	-18.5	bone [humerus]	2750–2470 BP

\*anomalous date

a male lying supine. Due to missing or broken material it was not possible to assign a more precise age to this

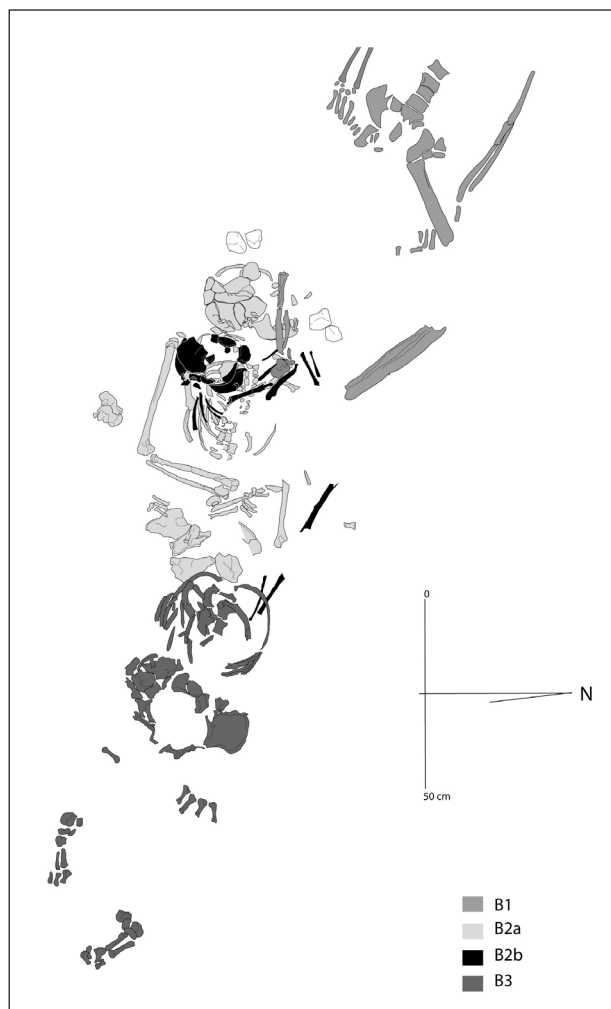


Figure 6. Post-Lapita burials, Area A, Vao Island.

individual. Burial 2 consisted of two individuals, a young adult female (B2a) lying supine with a 5-year-old child (age range 4.0–7.5 years) (2b) laid on her chest. Burial 3, whose interment disturbed B2, was that of a middle-aged female placed in a narrow concave pit.

Of the Lapita period burials, two adults (B4 a middle aged female and B5 a young male) were recovered from Layer 4 in Area B at a depth of 1.45 m (top of B4 skull) and 1.6 m (top of B5 skull) below the surface, sealed beneath the hard-packed Layer 3. They were buried in a shallow grave, lying in a supine position, adjacent and parallel to one another, with evidence of B4 being partly placed over B5 (Figure 7). A later pit feature disturbed both burials, removing the lower body from the pelvic region of B4 and the lower leg of B5. The third Lapita burial (B6) was located in Layer 4, at 1.1 m below the surface in TP19. It was initially found in a 1 by 1m test-pit that was extended by 50 cm to facilitate its full excavation. The burial, whose lower limbs and right foot had been disturbed by later activity at the site, was that of an adolescent female (Figure 8). All the burials on Vao were within the defined extent of the Lapita midden, as opposed to the Lapita burials on Uripiv which were located outside the concentrated midden dumping area. As was the case on Uripiv no grave goods were in evidence with any of the burials.

## CHRONOLOGY

A series of radiocarbon dates has been established from the two sites together (Bedford 2003, 2007; Horrocks and Bedford 2005) and it, along with the recovered artefactual material, provides a broad chronology for the human settlement of these coastal locations. The radiocarbon dates indicate that initial settlement of Vao Island was slightly earlier than that of Uripiv although, given their proximity and the earliest dates overlapping within two standard deviations, it seems unlikely to have been a gap of more than



Figure 7. Pair of Late-Lapita burials (B4 and B5 [right]), Area B, Vao Island;  
inset, Area B with burials B4 and B5 in bottom southeast corner.



Figure 8. Lapita burial B6, Vao Island.



a generation and potentially much less. Initial arrival and the Lapita phase occupation at the sites broadly spans the period 3000–2600 BP. Nucleated settlement in the same coastal locales remains consistent until at least 2000 BP when more dispersed settlement is apparent. At European contact, settlement was spread across the interior of both islands comprising 6–7 villages centred around *nasara* or ceremonial centres (Layard 1942:53–57).

Of specific relevance here is the direct dating of the burials (Table 1) and associated shell dates. The earliest burials are those associated with the Lapita period cemetery on Uripiv. Direct dating of the burials (B2, fragment of femur shaft [Wk-20388] and Burial 1, 2 vertebral bodies [Wk-20389]) was attempted but it was not successful due to a lack of sufficient collagen. Instead two shells, one a modified *Strombus* sp. (Wk-20010) lying on the sterile sand adjacent to B5, and the other a *Trochus niloticus* (Wk-20009) from a hearth feature, located directly above and sealing the graves (135 cm below the surface), were dated. Echoing the stratigraphic situation, the dates bracket the four burials, the lower sample most likely contemporary with the burials (3181 ± 40 BP [Wk-20010] 3090–2810 BP)<sup>5</sup> and the other post-dating (2858 ± 39 BP [Wk-20009] 2720–2440 BP) mortuary activity in that area of the site. A period spanning 3090–2720 BP for the initial use of the area for burial closely parallels the date (2681 ± 74 BP [Wk-10414] 2947–2714 BP) obtained in the closest test-pit (TP9) from Lapita midden dumped on top of the sterile beach sand. The lowest burial (B8) in TP13 is in a similar stratigraphic situation and would in that case date to the same period.

The other Lapita period burials are the three from Vao. Direct dating of the double inhumation from Area B returned dates of (B4) 2128 ± 28 BP [Wk-18013] 2300–2000 BP and (B5) 2514 ± 36 BP [Wk-18014] 2750–2470 BP. The date for B4 seems anomalous considering both its stratigraphic position, sealed beneath Layer 3, and its apparent association with B5. In light of these aspects we favour the earlier date as being more indicative of the period with which both burials are associated. The partly disturbed prone burial (B6) recovered from Layer 4 in TP19 was directly dated and returned a date of 2559 ± 37 BP [Wk-21446] 2682–2315 BP. Unfortunately the dates (Wk-21446 and 18014) for the Vao Lapita burials fall within a flat section of the calibration curve which prevents finer chronological definition. They are, however, associated with Late Lapita pottery at these levels that is unlikely to be any later than 2600 BP.

The only Post-Lapita burial that was fully excavated and directly dated on Uripiv was B9 which returned a

date of 2361 ± 33 BP [Wk-20387] 2364–2156 BP. This date fits well with its stratigraphic position and association with Layer 3. Direct dating was undertaken on two of the four Post-Lapita burials excavated in Area A on Vao. The dates of (B2a) 2281 ± 37 [Wk-21444] 2305–2000 BP and (B3) 2208 ± 38 [Wk-21445] 2155–1899 BP confirm the relatively contemporary nature of these burials that were interred some time between 2300–1900 BP. In summary the excavated burials essentially cluster around two periods of occupation, Lapita settlement (3000–2600 BP), initial in the case of Uripiv and later in the case of Vao, and Post-Lapita settlement around 2000 BP (2300–2000 BP).

#### ANALYSIS OF MALAKULA BURIALS: MORTUARY PRACTICES, HEALTH AND DISEASE

##### Methods

The burial context of the Uripiv and Vao burials were recorded using the methodology of field anthropology, as described by Duday (1990, 2006, 2009; Duday and Guillon 2006, Duday *et al.* 1990) for adults and as adapted for infants (Duday *et al.* 1995, Tillier and Duday 1990). The spatial distribution of the bones within the burial and their anatomical relationship were recorded and analysed from photographs with the aim of defining initial burial situations prior to subsequent taphonomic distortions. Descriptions of burial position following the recommendations and terminology of Ubelaker (1989, 2002) and Sprague (2005) are provided in Table 3.

Adult age and sex were determined using the methods in Buikstra and Ubelaker (1994) and age of the subadults using Scheuer and Black (2004). Data from bones and dentition were used to assess aspects of population diet, individual growth, prevalence of joint degeneration and other pathological bone change. The methods used for recording these data can be found in numerous publications on skeletal biology from both Pacific Island skeletal samples and other regions of the world. These methods are discussed in the references presented in Table 2 and a summary of the skeletal and dental pathology is in Table 3.

##### Mortuary practices at Uripiv

###### Funerary treatment of the corpse

The 8 burials excavated on Uripiv are single inhumations of subadults (n=5) and adults (n=3). Five of these appear to be primary inhumations, with corpse decomposition occurring *in situ* in the grave as the skeletons regularly display the maintenance in articulation of labile joints. The three others, characterised by the anatomically correct articulation of joints, are also probably primary. These inhumations, despite their often disturbed nature, are virtually complete. There is no systematic pattern of particular bones being absent; the skull for example is represented

<sup>5</sup> The radiocarbon dates have been presented in the following format: date, sample number and calibrated age at two standard deviations using OxCal v. 3.10 (Bronk Ramsey 2005) and provided by Fiona Petchey, University of Waikato, Radiocarbon Dating Laboratory. Calibrations utilise Southern Hemisphere atmospheric data from McCormac *et al.* (2004).

in most of the features. Post-Lapita B4, comprising a very incomplete skeleton of a possible male, appears to be an exception to this. The *in situ* remains show the pelvis, feet and right hand in articulation but the long bones of the lower limbs are absent. While post-burial disturbance may have destroyed the upper part of the skeleton, the absence of leg bones may represent deliberate removal. These features reflect the practice of generally simple forms of interment at this site. This burial procedure appears to have been applied to all members of the community in the areas of the site investigated so far and during both periods represented.

The bodies were placed in various resting positions: on the left side (Lapita B1 and 5), on the back (Lapita B6 and 7, and Post-Lapita B4), on the right side (Post-Lapita B2), partly seated (Post-Lapita B9), with the limbs generally flexed at various degrees and planes. The arms are always along the body, and the elbow is generally flexed. In the case of B2, the right elbow was tightly flexed with the hand by the face. Lower limbs are generally tightly flexed, with one exception (B7 had the left hip and knee extended). Reconstruction of the burial position of B4 indicates that the corpse was buried with the hips and the knees flexed in the sagittal plane with the heels in contact with the pubis. Age at death of the individuals has influenced burial position: foetuses and newborns were placed on their left side with limbs tightly flexed, older children on their backs, and adults on their right side, seated or on their backs. Post-Lapita burial B9 was in an intermediate position: between being seated and on its back, with the feet higher than the pelvis and the knee at about the same level as the head (Figure 3).

Although the graves underwent numerous natural and

human-induced disturbances post-interment, there are a number of features which have enabled the reconstruction of the environment surrounding the body during decomposition. Burial B9, which did not display movement of bone out of the body volume, may have been in-filled immediately after interment. This does not seem to have been the case for the infant burials in TP14 where a number of aspects indicate that they decomposed in an empty space.

The skeleton of the infant Lapita burial B1 placed on its left side, demonstrates preservation of the cranial volume, the anatomically correct position of the ribs (perpendicular to the vertebral axis), the right radius and ulna (exhibiting an initial flexion of the elbow), the disarticulation of the right elbow and the medial displacement of the right humerus (Figure 5a). In the case of the Lapita burial B5, which was in the same initial position, there is disarticulation and flattening of the cranial elements sliding to the west and the retention of the temporo-mandibular joint articulation. Also in anatomically correct position are the right ribs, clavicle, scapula and forearm (reflecting an initial flexion of the elbow), although the right humerus that has moved medially is disarticulated. The right lower limb, displaying flexion of the hip and knee, is also anatomically correct (Figure 5b).

The medial sliding of the right humerus, observed in the two subadult burials suggest that the two bodies were contained in some sort of perishable container which held the matrix away from the bodies as they decomposed. There is no evidence of bone alignments indicative of the initial presence of a straight and rigid wall such as in a wooden coffin. Rather it appears that the two small bodies were wrapped in a supple envelope, such as a soft mat, which degraded at a slower rate than the corpse.

Table 2. Methods used for assessing health parameters in the Malakula skeletal sample.

Health Parameter	Characteristic	Method/Bone or Dental Change	Interpretation/Diagnosis	References
Body size	Adult stature	Long bone lengths	Achievement of growth potential and body size	(Houghton <i>et al.</i> 1975; Buikstra and Ubelaker 1994)
Oral health	Tooth attrition	Degree of dentine exposure- (grades 1–8).	Age Dietary roughness	(Molnar 1971; Hillson 1996)
	Caries	Cavity in tooth; enamel or dentine or root	Diet	(Roberts and Manchester 1995)
	Periodontal disease	Porosity and recession of alveolar bone	Oral infection	(Hillson 1996; Tayles 1999)
<b>Disease Parameter</b>				
Trauma	Bone fracture	Bony callus formation	Accidental or interpersonal violence	(Lovell 1997; Ortner 2003)
Periosteal reactions		Subperiosteal new bone formation and porosity on the shafts of long bones	Multiple causes; infection, trauma, metabolic disease (scurvy)	(Aufderheide and Rodriguez-Martin 1998; Ortner 2003)

Table 3. Summary data of Uripiv and Vao mortuary practices and health and disease

Burial No./ Loc. in Site	Time Period	Age at Death/ Sex	Burial Preservation Bone Condition	Deposition	Body Align. Head Orient.	Resting Attitude	Original Position of Upper Limbs	Original Position of Lower Limbs	Dental Pathology	Skeletal Pathology
<b>URIPIV</b>										
B1 TP14	Lapita	18 month old infant	Near complete. Disturbance to lower limbs and feet. Poor bone condition	primary	SSW-NE to SSW	Partly on left side, partly on back.	Arms along side of body. R elbow flexed. R forearm on chest.	Hips flexed. Thighs perpendicular to body. Knees flexed.	Chipping, hypoplastic pits	Porosity of palate
B5 TP14	Lapita	32–34 foetal weeks	Near complete. Disturbance to left side. Good bone condition.	primary	NW-SE to SE	On left side	R arm along side of body. R elbow flexed. R forearm on chest.	R hip and knee tightly flexed. R lower limb in front of chest. Feet by pelvis.	No teeth	
B6 TP14	Lapita	foetus	Partial. Partly in baulk. Damaged by disturbances to skull, and legs Good bone condition	primary?	N-S to N	On left side	R arm along side of body. R elbow flexed. R forearm on chest.	R hip and knee tightly flexed. Lower limbs in front of chest. Feet by pelvis.	No teeth	
B7 TP14	Lapita	infant circa 18 months old	Partial. Damaged by disturbance to head, chest/ abdomen and R lower limb regions Good bone condition	primary?	NW-SE to NW	On back		L hip and knee extended. L lower limb extended, in body continuity.	No teeth	
B2 TP13	Post-Lapita	adult female	Partial. Lower half in baulk. Disturbance to head, chest, abdomen, and back region. Variable bone condition.	primary	E-W to E	On R side	R elbow highly flexed. R hand by face. L elbow flexed. L forearm on chest.		Caries and erosion of dentine	
B4 TP13	Post-Lapita	adult male	Very partial. About three quarters missing. Variable bone condition	primary	NW-SE to NW	On the back or seated		Hips and knees highly flexed in sagittal plan. Feet in contact with pubis region	No teeth	
B8 TP13	Lapita?	young child	Two third in baulk Poor bone condition	primary?	SE-NW to SE	On back	R arm along body side		Hypocalcification	Endocranial new bone of the frontal lobe?
B9 TP4	Post-Lapita	adult	Near complete Good bone condition	primary		Partly seated	Arms and forearms along side of body	Hips and knees tightly flexed. Lower limbs in front of chest. Feet higher than pelvis	Caries and LEH	

Table 3. *Continued*

Burial No. / Loc. in Site	Time Period	Age at Death/ Sex	Burial Preservation Bone Condition	Deposition	Body Align. Head Orient.	Resting Attitude	Original Position of Upper Limbs	Original Position of Lower Limbs	Dental Pathology	Skeletal Pathology
<b>VAO</b>										
B6 TP19	Late Lapita	adolescent female	Partial. Disturbance to head, and lower limb region Good bone condition	primary	N-S to N	On face	L upper limb along side of body. L elbow extended. R arm along side of body. R elbow flexed. R forearm on abdomen	L knee flexed, with foot in contact with pelvis	Chipping of anterior teeth, LEH	Periosteal reactions of the face and pelvis
B4 Area B	Late Lapita	middle-age adult female	Partial. Disturbance in pelvic and lower limb region Poor bone condition	primary	W-E to W	On back	L arm along side of body		Caries, heavy calculus, LEH	Possible trauma to face, bone point
B5 Area B	Late Lapita	young adult male	Partial. Disturbance to lower legs, and feet. Poor bone condition	primary	W-E to W	On back	Arms along side of body. L elbow flexed. L forearm on abdomen. L hand near pelvis. R elbow tightly flexed. R forearm parallel to R arm. R hand on chest.	Hips extended Lower limbs extended, in body continuity	Caries, pre-mortem fracture of molar, LEH	No
B1 Area A	Post-Lapita	adult male	Partial. Upper half in baulk. Disturbance to lower limbs and feet. Poor bone condition	primary	NW-SE to NW	On back	Upper limbs along side of body. Elbows extended	Lower limbs slightly flexed	No teeth	Periosteal reaction of limbs and ribs, lytic lesions of some joints; possible traumatic lesion of rib
B2a Area A	Post-Lapita	young adult female	Very partial. Damaged by disturbance in L upper half, pelvis, lower limbs and feet. Poor bone condition	primary	NW-SE to NW	On back	R arm along side of body. R elbow flexed. R forearm on abdomen		Slight calculus, LEH	No
B2b Area A	Post-Lapita	5 year-old child	Very partial. Damaged by disturbance in lower half Poor bone condition	primary		Unidentified on chest of B2a			Slight calculus, chipping, hypocalcification	No
B3 Area A	Post-Lapita	middle-age adult female	Very partial. Damaged by disturbance Poor bone condition	primary	NW-SE to NW	Between seated and on back	L upper limb along body side? L elbow extended?	Hips and knees flexed in sagittal plane. Feet higher than pelvis	No teeth	Fracture of hand

### Spatial organisation of the graves: orientation and sequence of interment

Body orientation is variable on Uripiv, with a range represented in both Lapita and post-Lapita burials and in the two zones, TP13 and TP14 (Table 1). If this variable pattern is confirmed by further excavation, it may suggest that body orientation is governed by individual practice rather than social parameters structuring spatial organisation. The Uripiv graves are not organised in rows or in regular equidistant patterns. Excavations have so far revealed a pattern suggesting both discrete zones of clustered burials and single burial.

Burials in TP13 and TP14 were tightly clustered. A minimal extension of TP14 led to the discovery of four Lapita infant burials (B1, 5, 6, 7) in an area encompassing only 2.75 m<sup>2</sup>. In TP13 two Post-Lapita adults and one Lapita infant (B8) were recovered in a single 1 by 1 m testpit. This pattern suggests the successive use of a dedicated area for burial over an extended period of time. Burials at TP13 are dated to different periods and there is one case of intercutting in TP14. The placement of the two fetuses (B5 and B6) by the shoulders of B7, an older infant, in TP14 (Figure 4) is intriguing, and suggests if not simultaneous, at least contemporary interments that were being placed in a designated and marked area.

As noted the Lapita burials are at the periphery of the contemporary midden dumping area (Figure 2a) while the Post-Lapita burials are located within contemporary midden deposits.

### Vao mortuary practices

#### Funerary treatment of the corpse

The seven burials recovered from Vao are inhumations of subadult (n=1) and adult individuals (n=6). The six adults appear to be primary inhumations, as indicated by the articulation of the labile joints and the anatomically correct position of the elements in the skeletons. The seventh individual, a child of about 5 years (B2b), seems also likely to be primary as it was placed on the chest of B2a in a simultaneous burial.

Although affected by disturbance and damage to the bones, these inhumations were virtually complete. Of particular note is the presence of the skull in six of the seven cases. The only exception is that of the adult Post-Lapita burial B3 which was missing not only the skull but also the upper and lower limb bones. Whether this situation resulted from removal of bone after decomposition or subsequent disturbances is unclear. This Post-Lapita burial, similar to others of the same period, appears to have been near or partly above the ground surface (Layer 3). The features of body treatment again suggest the practice of a simple form of interment at the site applied to all members of the community during both the Lapita and

Post-Lapita periods. However, other kinds of mortuary practice cannot be totally ruled out.

Bodies were deposited on their back in four cases (Post-Lapita B1, 2a, Lapita B4, 5), on the face in one case (Lapita B6), partly seated (Post-Lapita B3) in another. This partly seated burial was propped up by an accumulation of stones piled behind the torso, while the feet, higher than the pelvis, were resting on the edge of a pit. The upper limbs of the burials were variable, with the elbow either extended or in differing degrees of flexion and with differences between the left and right side of the same individual (Table 3). More rarely preserved, the lower limbs were extended or with the hips and knee variously flexed. In the case of B6 the reconstruction of the burial position indicates that the body was buried with the left knee tightly flexed, with the foot placed on the buttock (Figure 8).

All of these bodies may have been buried enclosed in containers made of perishable material but subsequent disturbance and bone damage due both to natural and human activity across the site, prevents a definitive interpretation.

### Spatial organisation of the graves: orientation and sequence of interment

Cardinal orientation of the body on Vao appears to be quite regular with five individuals aligned on a NW-SE or W-E axis with the head to the NW or W (Table 3). Variation in the current data appears to be influenced by temporal factors, the NW orientation of the head characterising the Post-Lapita burials. Of note is the similarity of orientation of the bodies within each burial group and the variation between them. In Area A the bodies were aligned NW-SE with the head to the NW and in Area B, W-E with the head to the W. This suggests that body orientation was not a general feature of funerary protocol, but it may have been more influenced by factors such as the organisation and orientation of houses or household compounds.

As at Uripiv, the Vao burials are not organised in rows or regularly spaced. Excavation at TP19 revealed only one burial while clusters of burials were uncovered in areas A and B. Those in Areas A and B are tightly clustered with groups occupying areas of less than 6 m<sup>2</sup> in Area A and 2.5 m<sup>2</sup> in Area B. Despite significant post-burial disturbance and the difficulty of defining grave-cut-features, evidence of intercutting and superimposition provides sufficient detail to reconstruct the sequence of inhumations.

The Post-Lapita burials in Area A (Figure 6), included burial B2, the simultaneous inhumation of a female adult (B2a) and a 5 year old child (B2b). These burials appears to be the first inhumation of the sequence. The interment of B2a and b was followed by those of B1, the feet of which partly overlap the upper part of the left side of B2, and of B3 which disturbed the lower half of B2.

In Area B, two Lapita skeletons were discovered parallel to each other and exhibited similar attitudes: on their

back, their arms along the sides of the body with the arm of B4 slightly overlapping the right side of B5 (Figure 7). Excavation of the right side of the B5 skeleton indicated the perfect articulation of the right upper limb and hand and of the left hand. The overlapping and retention of the hand joint articulations strongly suggests simultaneous interment of these two individuals as decomposition of these joints begins shortly after death (cf. Dudgeon and Guilford 2006).

### Health and disease at Uripiv

#### Dental pathology

In the adults from Uripiv the dentitions of Post-Lapita burials B2 and B9 were present for observation. The B2 female had widespread and severe periodontal disease and antemortem loss of the mandibular molars, probably as a result of the alveolar resorption associated with the periodontal disease. A massive carious lesion which had destroyed most of the crown was present in the right maxillary second molar. Many of the exposed roots have cavities, possibly caries of the roots, but whether from diet, acidity levels in the drinking water or taphonomic processes is difficult to determine.

Burial 9 had a full dentition with minimal attrition of the occlusal surfaces. This individual had slight calculus deposition with no periodontal disease, but a massive carious lesion was observed on the left maxillary second molar. A slight caries was also developing on the base of the root in the other second maxillary molar. There was no erosion of the dentine such as that observed in B2. Burial 9 had a linear hypoplastic defect on the left second mandibular molar. Burial 2 also had opacities of the enamel present indicating a disruption of the calcification of the tooth enamel during development (Hillson 2000). Lapita burial 1, the only infant with observable teeth, had chipping of the central maxillary incisors and very slight exposure of the dentine due to attrition. This infant also had pits in the enamel of the maxillary canines and large areas of unformed enamel in the mandibular canines.

#### Skeletal pathology

Observations on health and disease of the Uripiv individuals are limited due to the fragmentation of material and postmortem damage to bones of the adults. The only skeletal pathology observed in the infants was slight porosity of the orbits and palate in Lapita burial B1. In an infant of this age this could be related to growth processes rather than pathology. There was no skeletal pathology related to infection or trauma in Post-Lapita burials 2 and 4. However B9 had slightly remodelled periosteal reactions of a tibia fragment (retained for dating) and a possible fracture callus of a distal ulna fragment (also retained).<sup>6</sup> Only the joint surfaces of the hands and feet of B4 were

present for observations of degenerative joint disease. All joint surfaces present were unaffected by degenerative lesions. Cranial fragments removed in the field from Lapita burial B8 had possible evidence of infection in the form of new bone on the endocranial surface of the frontal bone. The causes of such lesions are multi-factorial but they are due to inflammation of the meninges (Lewis 2004). The remains of this burial were excavated late in 2010 and they have yet to be examined to see whether there were other such lesions present.

### Vao health and disease

#### Dental pathology

Vao Post-Lapita burials B1 and 3 did not have any dental material present and there were no caries present in the teeth of Post-Lapita burials B2a, 2b or 6. Lapita burials 4 and 5 both had massive caries of the roots in the anterior teeth and resorption and pitting of the alveolar bone consistent with periodontal disease. The crown of the left central incisor of B5 had been destroyed by a carious lesion. Burials 2a and 2b had slight calculus formation on the teeth, as did B5. Burial 4, however, had extreme calculus build up, especially on the mandibular teeth. This difference is not surprising considering the older age of B4 compared with B5. Burials 2a, 4, 5 and 6 all had linear hypoplastic defects of the enamel indicating a disturbance in the development of the enamel during growth. Burial 2b also had development defects of the teeth but in the form of a disturbance to the mineralisation of the enamel or hypocalcification. Burial 5 had a pre-mortem fracture of the lower left first molar and B6 had chipping on the cusps of four of her anterior teeth.

#### Skeletal pathology

Very few of the joints were preserved well enough for observations of joint degeneration in the Vao adult burials. Those which were observable were clear of degeneration. No pathological lesions were present in the Post-Lapita child (B2b) from Vao. A number of lytic or erosive lesions were observed in the Post-Lapita burial B1. However, due to the lack of remodelling of the borders on some of the lesions and after radiographic observation, they were mostly disregarded as postmortem damage by burrowing insects or some other taphonomic process. However radiography did confirm that a lesion on the distal humerus (Figure 9a) appears to be due to a 'true' pathological process. This lesion of the distal humerus opens into a relatively wide channel with sclerotic borders suggesting a chronic infection (Figure 9b). There was also new bone formation due

<sup>6</sup> These remains were not examined in detail before they were reburied so it is not possible to comment further on the skeletal pathology of this individual.

to inflammation of the periosteum (periosteal reactions) on the fibula, tibia and superior surface of the left first metacarpal.

Burial 1 also had bony changes of a rib fragment that are a mixture of proliferative and destructive bone changes (Figure 9c), and a very slight remodelled periosteal reaction of another rib fragment. Radiography of the rib with mixed lesions shown in Figure 9d revealed a localised sclerotic reaction surrounding a central radiolucent area which is roughly triangular in shape. The shape and degree of remodelling in this lesion suggests a wound caused by a projectile point sometime around death. There is a well-healed fracture of the left first metacarpal of the Post-Lapita burial B3 (Figure 9e). Remodelled porosity of the superior/distal surface of this bone is also present.

The Lapita burial B4 had an area of remodelled inflammatory activity above the right maxillary molars which may be a granuloma of dental origin. However, the lesion is high above the alveolar bone suggesting a non-dental cause of the lesion, possibly trauma to the face. This individual also had a worked bone point in the chest cavity at the left mid-thorax region, lying on the internal aspect of the chest wall (Figure 9f). The point is not imbedded in the bone and has left no discernable traces on the poorly preserved bone.

Periosteal reactions on the internal and external aspects of the right superior ilium were observed in the Lapita burial B6. The left ilium was not as complete as the right but there were no signs of new bone on any of the fragments. The cause of the inflammation leading to new bone deposition is difficult to determine but is most likely the result of infection rather than trauma, due to its diffuse distribution. The cranial remains also show porosity of both nasal bones and the left orbit which may be indicative of an infectious process.

## DISCUSSION

A total of eight Lapita and seven Post-Lapita burials were recovered and have been analysed in some detail following excavations on the small islands off the northeast coast of Malakula. While the sample is small, certainly in comparison to the Lapita cemetery at Teouma, it provides new information and comparative data on the relationship between Lapita burials and their environment, mortuary treatment and health with a particular focus on infants, in both a temporal and spatial sense.

### Mortuary practices: summary and comparison

On Uripiv, during the initial Lapita settlement period, there appears to be a pattern of burials being restricted to an area separated from the habitation area and other activity areas including midden dumping. This is a situation that parallels Teouma. Further investigations in 2009 and 2010 on Uripiv have confirmed this pattern, indica-

tive of an exclusion of burials and the dead from the areas regularly occupied by the living. Located at the edge of the main living and activity area this 'burial zone', consisting at this stage of 5 burials, can be defined as a cemetery, as opposed to individuals being buried within household compounds.

There are other cases of Lapita burials found at some distance to activity/habitation areas and this may relate to the same funerary practice. At the Olo site (Waya, Fiji) the burial is some distance from the midden area (Cochrane 2005). At the Naitabale site (Moturiki, Fiji), the burial was found where the midden was most dense, although its position at the base of the midden suggests it may have been interred prior to major midden dumping (Nunn *et al.* 2007). A similar configuration has been observed at the SAC site (Watom, Papua New Guinea). There the burials do not correspond to the initial occupation of the area but they do appear to have been placed in a specific location in and on an older occupation area and midden contemporary with the burials was identified nearby (Anson *et al.* 2005).

The burial pattern seen in the later Lapita burials on Vao suggests either a major shift away from the cemetery mode of interment to a more scattered pattern amongst and across the entire area of settlement or a variant of the cemetery organisation. The Post-Lapita burials at Uripiv and Vao indicate a similar pattern of dispersed interment across the area of settlement with perhaps some focus on single household units and a shift away from the cemetery situation. The evidence from Vao suggests this pattern may have been developed during the Lapita period. Interestingly, the Vao clusters of burials appear to be more structured by cardinal orientation contrary to the cemeteries of Uripiv and Teouma where the graves display diverse orientation.

Because of the small samples from Uripiv and Vao comparisons of mortuary practices are necessarily limited. However, some preliminary discussion of mortuary practices relating to infants from Uripiv and Teouma, where the only other examples of Lapita-age infants have been found to date, can be made. The Lapita burials of Uripiv comprise only infants, ranging from foetal to 18 months old. At Teouma all infants were newborn or preterm (a total of 7) and found in primary contexts (Bedford *et al.* 2009; Kinaston *et al.* 2009). The only subadult remains above infancy identified at the site include an adolescent and the disturbed remains of another older child (Bedford *et al.* 2010).

At Teouma, infants were distributed throughout the cemetery and closely associated (within a metre) with both male and female adults. Although the excavation area at Uripiv is much smaller than that of Teouma, infants appear to be deposited in a cluster (T14). This contrast in the treatment of infants at the two sites suggests both diversity in the Lapita conception and organisation of cemeteries as well as changing practices over time.

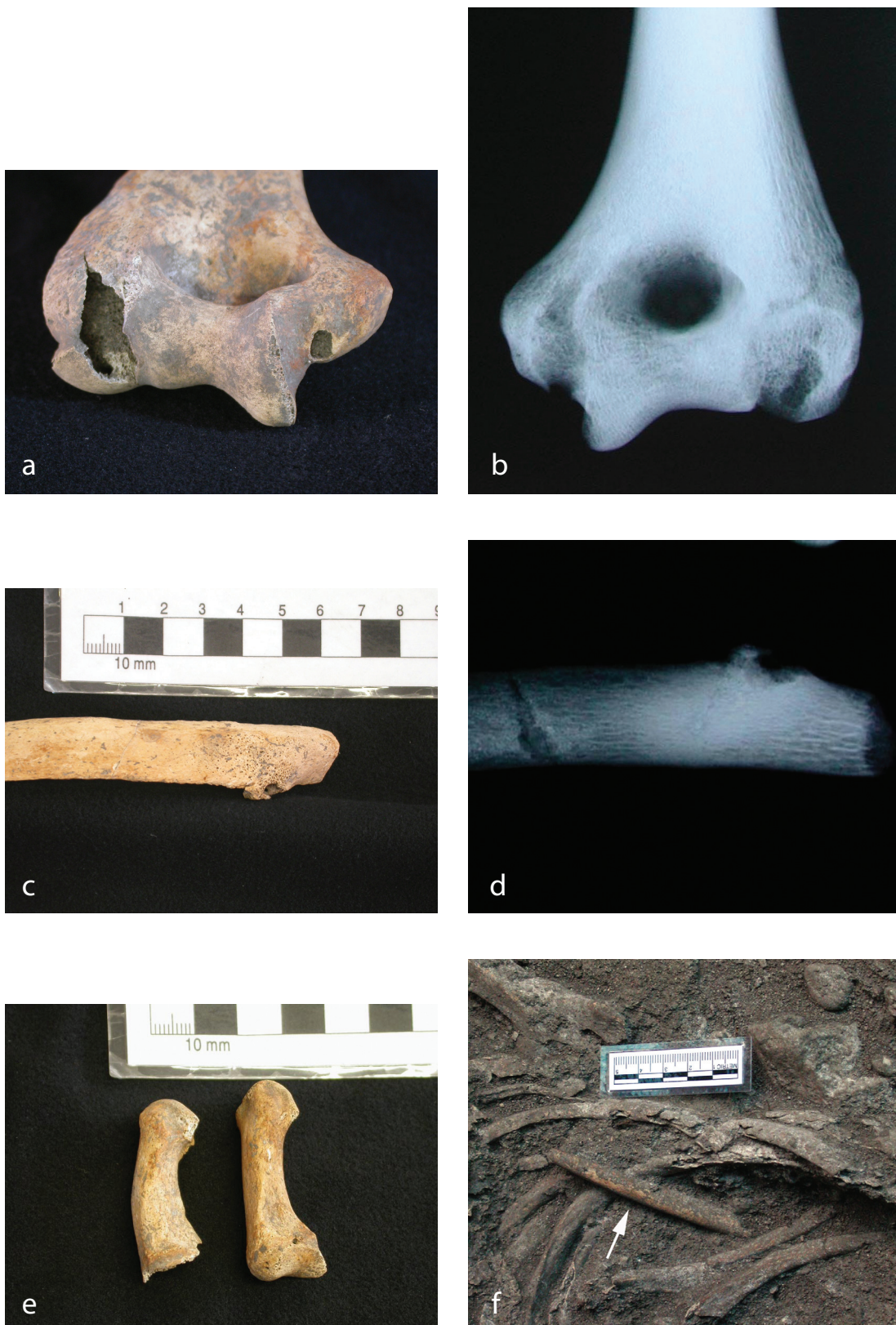


Figure 9. a) Burial 1 (Vao), lytic lesion of the distal humerus; b) Radiograph of left humerus. The lesion is on the medial side; c) Mixed lytic and osteoblastic lesion of a rib; d) Rib fragment showing area of sclerosis surrounding triangular radiolucent area suggesting a possible traumatic injury; e) Burial B3 (Vao), fracture of first left metacarpal near the proximal joint. The bone on the right side is normal; f) Burial B4, (Vao) chest cavity with arrow highlighting bone point.



The preliminary evidence from Uripiv therefore suggests that during the Lapita period, some children at least may have been buried in distinct zones of the cemetery or elsewhere. The lack of children in the excavated areas at Teouma may also be due to similar segregation of the cemetery on the grounds of age.

Inhumation was the favoured mode of body treatment for both subadults and adults at the sites on Malakula during the Lapita and the Post-Lapita periods, as it was at Teouma. Cremation appears to be a marginal practice with only the case of a single adult from Teouma having been identified thus far (Scott *et al.* 2010). As at Teouma, single inhumation characterises the early graves at Uripiv, a practice found in later Lapita burials from other archipelagos (Green 1989, Kumar *et al.* 2004, Pietruszewsky *et al.* 1997, Valentin 2003). Of note is the practice of double inhumation, of child with adult or of adults together, that is found in the Late Lapita and Post-Lapita mortuary contexts at Vao. Another case of similar behaviour has been recorded at the Post-Lapita Taplins site (Efate, Vanuatu), where a male and a female were buried together (Ward and Houghton 1988). This practice of double inhumation is frequently associated with mortality crises such as epidemic disease, episodes of violence, or specific funerary behaviour that involves the ritual killing of at least one individual and their inclusion in the grave of the naturally deceased at the time of the interment (Testart 2004). A well-known example of this practice in Vanuatu is the Roi Mata burial complex (Garanger 1972). In the Vao cases, epidemic disease and interpersonal violence may have contributed to this burial pattern.

There was no personal ornamentation or grave goods associated with any of the burials on Malakula, in striking contrast to the Lapita burials from Teouma where grave goods often included decorated pots, *Conus sp.* shell rings and large natural bivalve shells associated with the deceased (Bedford *et al.* 2009, 2010). The absence of grave goods is also seen in the Lapita and Post Lapita burials from Olo in Fiji, Koné in New Caledonia, and SAC on Watom Island (Green 1989, Pietruszewsky *et al.* 1997, Valentin 2003, 2010, Valentin *et al.* 2005). Notable exceptions to this, however, are large shells at Nataibale in Fiji (Kumar *et al.* 2004) and the Post Lapita burials at both Mele Cave (Ward and Houghton 1988) and Koné (Shutler 1967, Valentin and Sand 2000) where pots were placed near the heads of individuals.

Despite the lack of grave goods the Malakula individuals were nevertheless treated with formal mortuary ritual. The Lapita infants from Uripiv were wrapped either flexed or extended in body containers for interment, a practice also identified in several adult cases at Teouma (Valentin *et al.* 2010). They were placed on the left side or on the back in shallow graves. Infants at Teouma were placed on the back in one case, and seated and flexed on the face in another. The late Lapita adult burials from Vao display similar positions to those identified at Teouma (Valentin

*et al.* 2009, 2010).

Other positions seen in the Post-Lapita burials on Uripiv and Vao included the seated position and flexed on the back and side. These are rare at Teouma but have been recorded in the Late-Lapita SAC burials (Anson *et al.* 2005) and in the Post-Lapita burials from Olo (Pietruszewsky *et al.* 1997) and Koné (Valentin 2003).

At Uripiv, as at Teouma, infant burials display no evidence of any bones having been removed subsequent to decomposition. Similarly the later Lapita adult burials from Vao and other Malakula Post-Lapita adult burials do not show clear evidence of bone removal, apart from a single example, the Post-Lapita burial B4 from Uripiv. This contrasts with the adults, and the single adolescent burial at Teouma, where skulls and bones from the upper part of the skeleton were consistently removed (Bedford *et al.* 2010, Valentin *et al.* 2009, 2010).

There is no evidence of bone removal at the Late Lapita and Post-Lapita burials from Naitabale, Olo and Koné. At the SAC site on Watom interpretation of whether bone removal has occurred is difficult to determine due to post-depositional disturbances (Anson *et al.* 2005).

In summary, there does appear to be emerging, clear and identifiable evidence of differences in adult mortuary practice between early (Teouma) and late Lapita (Vao) and Post-Lapita burials both in Vanuatu, and the wider region. This is demonstrated in the stages of pre-interment, through to the final burial phases. The principal visible change is the shortening of the period involved with mortuary ritual. Burial at Teouma is characterised by mortuary protocol that was a multi-faceted lengthy process. Evidence indicates manipulation of the corpse prior to burial, during decomposition and repeatedly after that. All the burials had had their skulls, and often many other selected bones, removed during the extended mortuary ritual (Valentin *et al.* 2010). The Teouma bodies displayed limited ornamentation but grave goods were present, primarily in the form of dentate-stamped pottery (Bedford *et al.* 2009, 2010).

The late Lapita and Post-Lapita burials on Vao and examples from other archipelagos show few of these features, suggesting much shorter and possibly less elaborate mortuary ritual prior to burial. We propose that the drivers of this scenario are most likely associated with the very contrasting environmental and social factors experienced by colonising communities and those of subsequent generations. Initial colonising populations were spread far and wide, and a key factor in ensuring their viability would have been the reinforcement of social cohesion through key communal events, such as those involving birth, marriage and death (see Clark 2007: 297 for further discussion and references). Although there was often a substantial cost in terms of social expenditure and production of ceremonial goods, these communal events were an investment in maintaining connectivity and securing the long-term biological survival between these scattered groups

(Clark 2007: 297; Moore 2001). As populations increased, social cohesion became more regionalised and attention was increasingly localized, there was transformation in the investment and focus in a range of ceremonial events, including mortuary practice.

### Health and disease: summary and comparison

Much of what we know about health and disease in Lapita populations is based on previous research on single individuals from a number of sites across the Pacific (Pitruszewsky 1989). More recently the Teouma cemetery has offered an opportunity to begin to assess health during this period on a population-based scale (Buckley 2007; Buckley *et al.* 2008; Kinaston *et al.* 2009). While the samples from Vao and Uripiv are small, they offer some insights into health and disease from later Lapita communities in the northern region of Vanuatu and some tentative comparisons between the Teouma and Malakula burials may be drawn.

The dental health in the Vao adults suggests a diet including starchy cariogenic foods (Hillson 2000) which probably indicates the consumption of tuberous root vegetables that were part of the Lapita horticultural suite on these islands (Horrocks and Bedford 2005; Horrocks *et al.* 2009, 2010). It is of interest to note that only the Lapita burials had caries, which may indicate a shift in the type of diet over time on the island. The high caries rates and periodontal disease on Vao is similar to those observed in the people from Teouma (Buckley *et al.* 2008).

The relative lack of adult teeth from Uripiv compared with Vao precludes any detailed discussion, but the possible presence of root caries and periodontal disease in the two individuals with teeth also suggests a diet associated with horticultural crops. The rate of wear on the teeth of the adults from Vao and Uripiv was moderate to slight suggesting that the diet was not particularly fibrous or gritty. However, on Vao, the chipping in the teeth of Burial 6 and the pre-mortem fracture of the molar in Burial 5 suggest there were harder foods, possibly nuts, consumed by these adults. The chipping on the teeth of the Post-Lapita child from Vao (B2b) and Lapita infant from Uripiv (B1) suggest that solid foods were introduced early into the diets of these children.

All of the adults with teeth from Vao and Uripiv had developmental defects of the enamel which are usually interpreted as a reflection of dietary stress during childhood and/or in response to infectious disease (Goodman *et al.* 1988). The fact that there were also dental developmental defects in the deciduous teeth of children, which develop *in utero*, suggests that whatever stressors were present also affected the health of individuals early in development and may also reflect poor maternal health (Lukacs *et al.* 2001). Evidence of maternal stress affecting infant health and survival has also been found at Teouma (Kinaston *et al.* 2009).

Evidence of skeletal pathology was present in the Malakula burials in the form of periosteal reactions, lytic lesions, and trauma. The slight subperiosteal reactions in the limbs of Post-Lapita Burial 1 from Vao may indicate a response to chronic infectious disease also responsible for the lytic lesion on the humerus, or it might be due to unrelated trauma of the local area. Given the diffuse nature of the periosteal reactions in this individual it is probably more likely to be the result of infection.

The active and diffuse periosteal reactions observed in the pelvis and nasal bones of Lapita Burial 6 from Vao were also probably an inflammatory response to infection. Due to the small sample of individuals from Vao it is not possible to offer a diagnosis of the infection causing these lesions but it is interesting to note that while periosteal reactions were observed in the Teouma sample in high frequencies, all of the lesions from Teouma were very slight and remodelled (indicating healing) and limited to the lower limbs, while some of those in the Vao sample were active and more diffuse. This may suggest a different aetiology of the lesions at Teouma, such as trauma or metabolic disease.

Erosive lesions of the limb joints, possibly caused by gout, have been reported in the Teouma sample (Buckley 2007), which may be the cause of the lytic lesions observed in Post-Lapita Burial 1 from Vao. However, the lesion of the humerus is not typical of gout, where the foot and hand bones are usually affected, and it could be related to the infection causing the periosteal lesions on the tibia and fibula. A lesion very similar to this has been observed in a middle aged female from prehistoric Vietnam and was suggested by the researchers to be a chondroblastoma, a benign tumor of bone (Oxenham *et al.* 2005).

The pattern of lesions in the Vao sample is of interest because two of the Post-Lapita burials (B1, 3) and one of the Lapita burials (B4) have probable traumatic injuries. The possible presence of a wound caused by a projectile (B1), trauma to the face and *in situ* bone projectile point (B4) and fracture of the hand (B3) are suggestive of evidence of interpersonal violence rather than accidental injury (Lovell 1997). In Burial 1 the nature of the bony reaction and placement of the lesion on the outer surface of the rib (rather than pulmonary surface), suggests a reaction to traumatic injury rather than a response to infection. One possible scenario is a wound from a projectile to the back where the individual survived long enough for a bony response to develop. Secondary infection of such a wound is likely and given the apparent lack of healing of the new bone, it is possible this represents at least a partial contribution to the cause of death. Penetrating wounds caused by projectiles have been reported from other more recent Pacific island skeletal samples (Buckley 2000; Scott and Buckley 2010). A less dramatic explanation is a fracture of the rib as the result of a fall, although there is no displacement of the bone making this explanation less likely. Traumatic injuries to the face are considered more

likely to be the result of interpersonal violence rather than accidents (Lovell 1997) and blows to the face are usually intended to cause lethal injury, which may have been the case with B4 (Judd 2006).

The position of the hand fracture in Burial 3 from Vao is unusual and may have occurred as the result of an intentional blow to the lateral aspect of the bone shaft by a blunt object but it may also have been accidental. Traumatic lesions of bone fracture and soft tissue injury were also observed in the Teouma skeletal sample, but these were not suggestive of interpersonal violence, rather they demonstrated a more random pattern indicative of accidental trauma (Buckley *et al.* 2008). Of course the relative lack of crania at Teouma makes any comparisons difficult, especially as none of the seven crania observed from Teouma had evidence of trauma.

## CONCLUSIONS

The Malakula Lapita and Post-Lapita burials reported here have provided further rare and important information on the distinctive mortuary practices and health of these populations. While we cannot be too definitive about any comparisons or conclusions due to sample size we note a number of aspects that are both convincing and significant. Centralised community burial in the form of cemeteries that are located outside the area of habitation may be a feature of colonising Lapita settlements. Certainly it appears to be the case in Vanuatu with the two examples of Teouma and Uripiv. Later Lapita and Post-Lapita burials are more likely to be spread across the area of settlement in a pattern of more isolated graves. Distinctive change in Lapita mortuary practice includes the rapid abandonment of a number of key features found at Teouma. These include a form of complex pre- and post-burial manipulation of the corpse and skeleton and the placement of a range of grave goods. Mortuary protocol, as far as the physical treatment, the interment of the corpse and period of related ceremonial activity is concerned, displays a significant reduction in social investment during the Lapita period that continued into the Post-Lapita period up to and around 2000 BP, albeit with a continuing element of variation.

This we argue relates to contrasting environmental and social factors experienced by colonising communities and those of subsequent generations. Reinforcement of social cohesion through key communal events, would have been essential in ensuring success during the Lapita colonisation phase where populations were thinly spread over vast areas of ocean and hundreds of dispersed small islands (Clark 2007: 297). As populations increased, and social cohesion became more regionalised and locally focussed, mortuary practice simplified. This we argue is seen in the differences between the lengthy and complex mortuary processes and the designated cemetery area as seen at Teouma and the simpler later Lapita and Post-Lapita

burials both in Vanuatu and across the Lapita distribution.

The burials excavated from Malakula highlight the variation found in mortuary practice over time across the region. This should perhaps not be unexpected over such long periods of time as it also appears to be a consistent feature of historically contemporary societies. Variation in how corpses were treated, the associated ceremonies that were performed and associated structures erected, was certainly a feature recorded across Malakula alone in the early ethnographic period (Deacon 1934; Layard 1942; Speiser 1996). Even following missionisation when Christian burial practices became adopted across the archipelago variation in mortuary practice has continued (de Lannoy 2005).

The skeletal and dental health of the Malakula burials offers some tentative insights into changes within the Lapita period and variation between regions. The dental health of the Malakula burials is poor as it is at Teouma suggesting cariogenic foods being consumed throughout the Lapita and Post-Lapita periods. It has been hypothesised that infectious diseases would not have had a significant influence on health during initial colonisation as populations were small and presumably more spread out over the landscape (Buckley *et al.* 2008). The differences in the types of periosteal reactions between Vao and Teouma may indicate a shift towards infectious disease becoming more prevalent in the later periods as population density increased over time. A difference in climate, with Northern Malakula hotter and more humid than Efate, may also have influenced the pervasiveness of different types of diseases in these regions. Certainly the incidence of malaria today is higher in the northern islands of the archipelago compared with the central and southern islands (Lum *et al.* 2004). The high prevalence of dental development defects in the Malakula individuals also indicates that stressors influencing growth began *in utero*.

There is an increasing body of literature on disease, climate and resource stress, influencing increased trauma arising from conflict in fragile island environments (Field 2004; Lambert 1997; Torres-Rouff and Junqueira 2006). The probable presence of interpersonal violence in the Vao sample and its apparent absence at Teouma may support the hypothesis that resource pressure with population increase may have influenced inter- and intra-community violence. These hypotheses can be further tested as samples increase from the Malakula sites.

The discovery of another Lapita cemetery in Vanuatu further confirms that such site types, if they have survived, are likely to be found on other archipelagos located within the Lapita distribution. However, in the cases of both Teouma and Uripiv the cemeteries are situated in separate locations to the contemporary midden dumping and habitation areas. If the extent of Lapita sites is defined simply by the presence of midden deposits, as is so often the case, then the potential discovery of an associated cemetery beyond those deposits is limited. The paucity of Lapita

burials in the more than 250 sites (Bedford and Sand 2007) that have been excavated over more than 50 years of research is intriguing. Variation in mortuary practices can be expected across the Lapita range, particularly between Near and Remote Oceania. The former was already occupied and early Lapita settlements were often in inter-tidal zones. Formalised cemeteries or even terrestrial interment may not have been the favoured form of burial. However, in Remote Oceania, 100 to 200 years later, Lapita colonisation was of unoccupied islands with different natural and cultural landscapes. Despite this caveat, we argue that the relatively small number of Lapita burials, particularly cemeteries, which are associated with the hundreds of Lapita sites are just as likely to relate to aspects such as site disturbance, poor preservation and survey and excavation strategies.

Central Vanuatu has proved to be a remarkably fertile region in terms of well-preserved human remains. Both the Teouma Lapita cemetery (Bedford *et al.* 2009, 2010) and the Roi Mata complex on Retoka (Garanger 1972) have provided extraordinarily rich insight into sociocultural practices during these two distantly separated specific periods of time (3000 BP v 400 BP). The human remains discussed here from Malakula, in northern Vanuatu, provide a tantalising glimpse of those same sociocultural practices that underwent transformation during periods in between.

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