J Archaeol Res
DOI 10.1007/s10814-013-9070-4

Deconstructing the Lapita Cultural Complex in the Bismarck Archipelago

Jim Specht · Tim Denham · James Goff · John Edward Terrell

Abstract Within the Pacific Islands, the archaeological phenomenon called the Lapita Cultural Complex is widely regarded as first appearing in the Bismarck Archipelago of Papua New Guinea and then spreading southward. This complex supposedly represents the sudden arrival of migrants from Island Southeast Asia with new technologies, foreign languages, and a different worldview. We question these interpretations and the assumptions behind them and suggest instead that current evidence supports the introduction of new cultural traits over several centuries, rather than the sudden intrusion of foreign migrants.

Keywords Island Southeast Asia · New Guinea · Bismarck Archipelago · Lapita Cultural Complex · Migration · Interaction · Geographic mobility

J. Specht (✉)
Australian Museum, 6 College Street, Sydney, NSW 2010, Australia
e-mail: jspecht@bigpond.com

J. Specht
School of Philosophical and Historical Inquiry, University of Sydney, Sydney, NSW 2006, Australia

T. Denham
School of Archaeology and Anthropology, College of Arts and Social Sciences, The Australian National University, Canberra, ACT 0200, Australia

J. Goff
School of Biological, Earth, and Environmental Sciences, University of New South Wales, Kensington, NSW 2052, Australia

J. E. Terrell
The Field Museum, 1400 South Lake Shore Drive, Chicago, IL 60605, USA

Published online: 22 November 2013

Introduction

The spread of Austronesian languages and the presence of Lapita pottery on islands in the western Pacific (Fig. 1) have been inextricably linked for four decades (Pawley and Green 1973). The linkage has been explored through a combination of archaeology, historical linguistics, and human biology, with archaeological evidence frequently less privileged than evidence from the other disciplines. Reviews of the archaeological evidence from Lapita pottery sites (Green 1991a, 1997, 2003; Kirch 1997; Spriggs 1997) have depended on linguistic and biological data to refute alternative interpretations of the archaeological data that favor instead degrees of local input and development through mechanisms other than migration-driven introductions to the New Guinea region (Allen and White 1989; Terrell 1998). Over the last decade new data have become available within the western Pacific and Island Southeast Asia (hereafter ISEA), and issues relating to the origins, distribution, and significance of Lapita pottery and associated materials have come to the fore (Addison and Matisoo-Smith 2010; Anderson 2009a; David et al. 2011; Davidson 2012; Felgate 2007; Hung et al. 2011; McNiven et al. 2011; Sheppard and Walter 2009; Summerhayes 2010a, b). It is timely, then, to review what is known about Lapita pottery and various associated cultural traits that form the “Lapita Cultural Complex” (hereafter LCC) within its proposed homeland, the island provinces of Papua New Guinea, generally known as the Bismarck Archipelago (Fig. 2; hereafter “the Archipelago”).

Lapita pottery has been found at more than 200 sites from northern New Guinea and the Archipelago, southward to New Caledonia and Vanuatu in southern Melanesia, and eastward to western Polynesia, where it is viewed as part of the

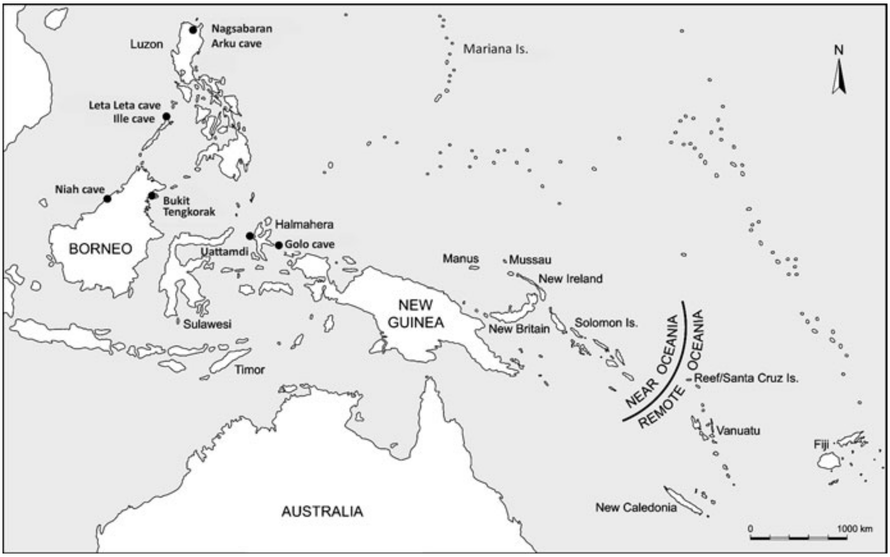

Fig. 1 Island Southeast Asia and the western Pacific showing the main islands mentioned in the text and the division between Near and Remote Oceania (Green 1991b)

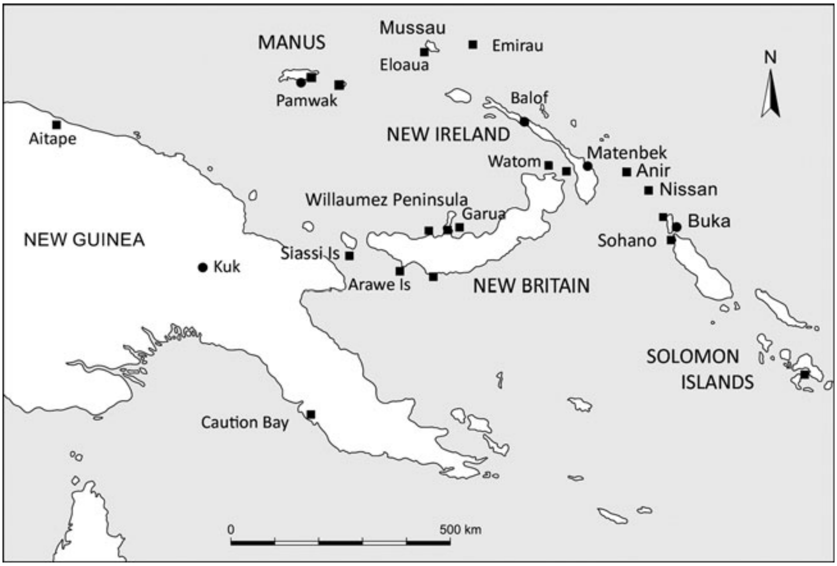

Fig. 2 Sites with Lapita pottery (squares) and some pre-Lapita sites (circles) in the New Guinea–Bismarck Archipelago–Solomon Islands regions mentioned in the text

foundational culture of the Polynesian peoples (Green 1979a, 2003; Groube 1971; Kirch 1997; Kirch and Green 2001). This pottery is usually inferred to reflect the arrival of people from ISEA who spoke languages ancestral to the Oceanic branch of the Austronesian language family (Pawley 2007). In addition to new languages, they purportedly introduced (1) the distinctive pottery tradition known as Lapita; (2) full-on agriculture; (3) pigs, chickens, dogs, and the Pacific rat; (4) a settlement pattern of villages on intertidal reefs and/or small, offshore islands; (5) a distinctive ground stone adze kit; (6) a distinctive range of shell ornaments; and (7) a major extension in the distribution of obsidian from sources in the Archipelago (Green 2003, table 5; Pawley 2007; Spriggs 1997, pp. 88–89).

These interpretations have been challenged on several grounds, not least the need to consider developments within the Archipelago and contributions from its pre-existing populations, who were largely ignored in the initial formulation of the LCC (Allen 1984; Allen and White 1989; Kennedy 1982; Terrell 1989; White et al. 1988). To accommodate inputs from the existing populations, Green (1991a, 1992) subsequently proposed the “Triple-I” model of Intrusion, Integration, and Innovation. In this model, the LCC comprises elements introduced from ISEA, integrated with pre-existing cultures in the Archipelago, and locally innovated through processes of cultural interaction and internal development. Following criticism (Allen and Gosden 1996; Gosden 1992; Terrell 1998; Terrell et al. 2001), Green (2000, 2003) modified the proposition, though its central premise remains the movement of Austronesian-speaking people bringing most elements of the LCC from ISEA (Summerhayes 2010b).

In this review we focus on the archaeological record of the Archipelago and examine four themes: settlement patterns, technology, subsistence, and interaction. We assess the evidence for changes in each theme that might be attributed to a people bringing a cultural repertoire from ISEA. We look beyond the appearance of Lapita pottery to the preceding period to determine continuities or discontinuities in the archaeological record. Where data for the Archipelago are lacking or inadequate, we look to sites in Remote Oceania (Green 1991b), although that region was not colonized until after the appearance of Lapita pottery, and developments there do not necessarily relate to what happened in the Archipelago.

We suggest that evidence for the orthodox view of the introduction of a foreign cultural package is weak. We conclude that the emergence of what has become known as the Lapita Cultural Complex was the outcome of several hundred years of introductions of cultural elements through interaction between and movement of groups within the ISEA–New Guinea–Archipelago region, which should not be confused with the migration of an ethnolinguistic group. Finally, we question the LCC as an entity, at least for the early stage of the pottery in the Archipelago.

Toward a new framework

The Triple-I model posits a demic migration from ISEA. In contrast, our critique is couched in terms of "geographical mobility" (cf. Peterson 2009; Piddington 1965), in which there is constant movement of people and goods between communities for a range of purposes and of varying duration and distance without necessarily involving permanent residential relocations. Such mobility is widely documented across the ISEA–New Guinea–Archipelago region in historical times, creating and maintaining social networks between individuals and communities across long distances on a regular, intermittent, or unpredictable basis, irrespective of duration, frequency, or intensity. These networks are conduits for transfers of goods and raw materials, beliefs and rituals, songs and dances, languages, people, and genes (Burton 1989; Dwyer and Minnegal 1997; Harding 1967; Hughes 1977; McPherson 2007; Miedema 1994; Swadling 1996; Welsch and Terrell 1998). Furthermore, people may relocate on a temporary or permanent basis following conflict or natural disasters, often at some distance from their original homes (e.g., Bradshaw 1997; Burton 2003; Chowning 1986; Roscoe 1989; Torrence and Doelman 2007; Watson 1970). Finally, in an island world unintended drift voyages can result in individuals and groups being relocated far from their homes (Anon. 1962). We propose that such processes have been a long-term feature in the ISEA–New Guinea–Archipelago region, where connectedness within and between islands has been prominent throughout history. These processes are not population-density dependent and occur within small and large communities alike, dispersed as well as contiguous. They are nondirectional and can result in changes over time frames of several generations that are difficult to discriminate through radiocarbon dating.

Discussion about the emergence of the LCC shows general similarities with the debate about the nature of the processes behind the appearance of the Neolithic in Europe and the British Isles, where changes in material culture and subsistence have been variously interpreted as reflecting the introduction by migrants of a package of elements or as the result of diffusion through interaction (e.g., Rowley-Conwy 2011; Thomas 1997, 2003). This type of debate forms the backdrop for understanding the formation of the LCC.

Lapita in historical context

Shutler and Marck (1975) promoted the link between the distribution of Austronesian languages and the spread of cultivated plant foods in the Pacific Islands. This interpretation became the dominant view of regional prehistory as developed and refined by Bellwood (e.g., 1984–1985, 1995, 1997, 2005, 2011; Bellwood et al. 2011) to explain the spread of Austronesian languages out of Taiwan. This "Out of Taiwan theory" (hereafter OT) views the dispersal of Austronesian-speaking farmers as a demic expansion moving from Taiwan to the Philippines around 4,500–4,000 years ago, and then into Indonesia and the Pacific Islands (Kirch 1997; Pawley 2007; Spriggs 1997). The theory has been periodically adjusted to account for new data in archaeology, linguistics, and genetics, with support and critique from a range of perspectives, and alternative scenarios have been proposed (Ambrose 1997; Bulbeck 2008; Denham 2004; Donohue and Denham 2010; O'Connor 2006; Oppenheimer and Richards 2001; Soares et al. 2008, 2011; Solheim 1984–1985, 2006; Szabó and O'Connor 2004; Terrell 1989, 1998, 2004; Terrell et al. 2001).

Support for an introduced package has weakened over the years, and divergent views have emerged. Bellwood (1985, p. 223) noted early a marked "attenuation" of material culture as horticulturalists reached the southern islands of ISEA, and Paz (2002, pp. 277, 279) suggested that any package of materials and ideas brought by Austronesian migrants might have broken up rapidly within the Philippine Islands. Tanudirjo (2004, 2006) and Bulbeck (2008) see intra- and interregional maritime interaction as significant factors in population movements; Donohue and Denham (2010, p. 237) reject "a single homeland, a single migratory route, a single cultural package or a single mode of language transmission" that spread through ISEA.

Spriggs (2007, p. 106) separates changes in subsistence from other aspects of what he calls "Neolithization." In place of a demic and/or agricultural expansion, he suggests a process of ethnic identity formation and the emergence of elite dominance (Spriggs 2003, p. 65, 2011, pp. 523–524). In this view, communities in southern ISEA underwent various degrees of change before expanding from eastern Indonesia into the Archipelago (Spriggs 2007, pp. 116–117). Hung et al. (2011, 2012; cf. Carson and Kurashina 2012) have proposed an alternative route by which pottery production, but not necessarily other elements of the ISEA Neolithic package, was brought via the Philippines to the Mariana Islands in western Micronesia and thence to the Archipelago. This is questioned on archaeological and linguistic grounds, as well as sailing capacities (Winter et al. 2012).

A return to first principles: The archaeological evidence

The most distinctive signature of the LCC is its pottery, the history of which has been variously framed in geographical terms of Far Western, Western, Eastern, and Southern subtraditions (Anson 1986; Green 1979a; Kirch 1997); in temporal units of Early, Middle, and Late Lapita (Spriggs 1997; Summerhayes 2000a); and in a combination of these (Green 2003). Each schema acknowledges stylistic variation through time and space, within an essential overall unity of vessel forms, decorative techniques, and motifs. The main motifs were executed with toothed tools (dentate stamps) to create multiple impressions with a single application, though many vessels were plain (Fig. 3). The relative abundance and elaboration of dentate-stamped decoration decreased through time across the pottery's geographic distribution and eventually disappeared. In some areas the plain vessel component persisted, often alongside vessels decorated with other decorative elements (Garling 2003; Green 2003; Summerhayes 2000b).

We focus on the formative stage of Lapita pottery in the Archipelago, for which there are at least 12 sites (Summerhayes 2010b, plus the FYS site on Garua Island, New Britain; Summerhayes 2010a, p. 14). Decoration was applied mainly with straight and curved dentate tools with up to 15–20 tines per centimeter, often

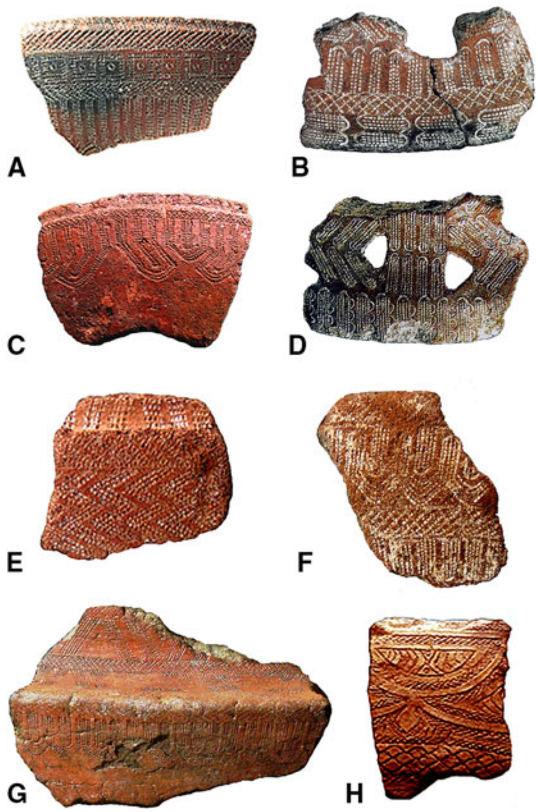

Fig. 3 Dentate-stamped Early Lapita pottery from the Bismarck Archipelago, Papua New Guinea (not to same scale). **A** Bowl rim, Kamgot, Anir Islands. **B** Shoulder sherd, Kamgot, Anir Islands. **C** Bowl rim, Tamuarawai, Emirau Island. **D** Base of pedestal stand with cut-out triangular elements, Tamuarawai, Emirau Island. **E** Carinated shoulder, Tamuarawai, Emirau Island. **F** Bowl rim, Tamuarawai, Emirau Island. **G** Carinated shoulder, Makekur, Arawe Islands. **H** Body sherd, Namabuk, Duke of York Islands (photos by J. Specht, except A and B [G. Summerhayes] and H [J. P. White])

combined with plain circle stamps and arranged in horizontal geometric bands and curvilinear panels, some of which resemble stylized faces (Chiu 2005; Spriggs 1990; Terrell and Schechter 2007 offer an alternative interpretation). Decorated vessels generally have a red slip, though undecorated red-slipped vessels also occur. The forms included large, round-based carinated vessels, bowls on ring feet or pedestal stands, shallow round or flat-bottomed bowls, vertical-sided flasks, globular vessels, pot stands, and an unusual tubular form with open ends dubbed a “cylinder stand” that might have supported a bowl (Fig. 4M) (Bedford et al. 2010; Green 1979a; Kirch 1997; Summerhayes 2000b).

The chronology of Lapita pottery in the Archipelago is broadly known, though its initial date is still debated. We adopt a time frame of 3470–3250 cal BP for the start of the pottery, prior to dispersal southward into Remote Oceania (Denham et al. 2012). This is based on a Bayesian analysis of 26 short-lived nutshell samples and charcoal samples with unknown in-built age, using the IntCal09 atmospheric calibration curve (Reimer et al. 2009). As the Archipelago lies within 6° of the geographic equator, the Southern Hemisphere calibration curve does not apply (Irwin 2010, fig. 10.2; McCormac et al. 2004). Other authors opt for slightly earlier (Kirch 2001a; Spriggs 2007) or later (Summerhayes 2010a) ranges based on different sample inclusion protocols and Delta-R values for marine samples. We excluded marine samples because there is considerable geographical variation in Delta-R values and some key areas in the Archipelago lack calculated values (Kirch 2001a; Petchey et al. 2004; Petchey and Ulm 2012; Summerhayes 2010a). Results from ISEA were calibrated with the IntCal04 atmospheric and marine datasets, using the Delta-R = 0 ± 0 years (Hughen et al. 2004). All dates are cited as 2-sigma ranges.

Geographical setting

The Archipelago lies off the north coast of New Guinea and comprises the Manus, New Ireland, and East and West New Britain provinces of the Independent State of Papua New Guinea. The New Britain and New Ireland island groups form an arc of intervisible islands stretching more than 1000 km from New Guinea in the south to the Mussau group in the north. In contrast, the Manus group is more than 200 km from New Guinea in the west and from the Mussau group in the east. Even during the lowest sea levels of the Last Glacial Maximum, there was no land bridge between New Guinea and islands of the Archipelago.

The region is a dynamic world of “unstable archipelagos” (Enright and Gosden 1992), where people have adapted to episodic tectonic-induced events against a backdrop of climate- and human-induced landscape change. An under-researched level of complexity in its landscape history derives from rapid onset natural hazards (Anderson 2009b) that, although local in origin, have the potential for regionwide impacts on landscapes and human settlements (Goff et al. 2012).

Tectonically, the Archipelago is a highly active area in which rapid and often catastrophic landscape change can occur (McSaveney et al. 2000; Tregoning et al. 1998). Periodic volcanism has been common on New Britain and in the Manus

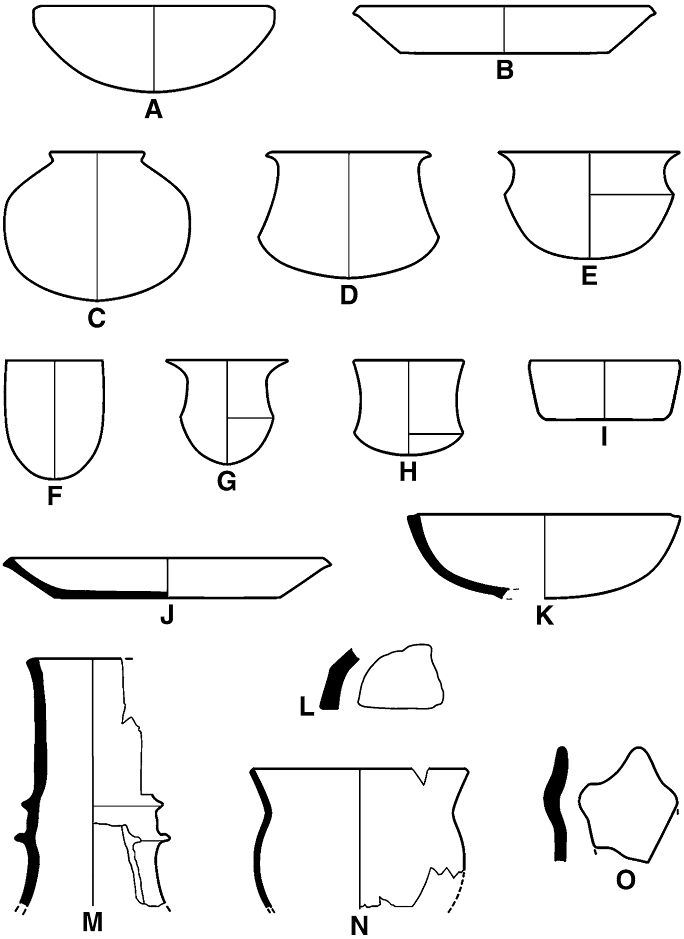

Fig. 4 Lapita pottery vessel forms in the Bismarck Archipelago, Papua New Guinea (not to same scale). **A–I** Schematic vessel forms in the Arawe Islands (Summerhayes 2000b, figs. 4.1 and 4.2). **J** Flat-bottomed bowl with dentate stamped decoration (not shown) from Makekur, Arawe Islands (Summerhayes 2000b, fig. 5.3). **K** Bowl on broken pedestal stand (Kirch 1996, fig. 6). **L** Base of probable pedestal stand, Boduna Island (Specht and Summerhayes 2007, fig. 16b). **M** Cylinder stand from Talepakemalai, Eloaua Island (Kirch 1997, fig. 5.5; see Fig. 6 for decoration). **N** Plain ware vessel, Talepakemalai, Eloaua Island (Kirch 1997, fig. 5.8). **O** Pot stand rim, Boduna Island, New Britain (Specht and Summerhayes 2007, fig. 16a)

group, especially during the late Holocene (McKee et al. 2010). The cataclysmic Mt. Witori eruption at 3480–3200 cal BP covered central New Britain with meters of tephra that caused widespread destruction and landscape modification (Machida et al. 1996; Neall et al. 2008). This tephra provides a *terminus post quem* for the appearance of Lapita pottery in this part of the Archipelago as pottery never occurs below it (Petrie and Torrence 2008).

Large earthquakes with magnitudes up to M_w 8.0 occur along the New Britain Trench (Park and Mori 2007), and smaller events are frequent throughout the region

(Denham 1969). Tsunamis can reach up to 15 m high at landfall and have widespread impacts on coastal settlements and associated biotas (Cooke 1981; Johnson 1987; McSaveney et al. 2000; Park and Mori 2007; Silver et al. 2009). Little work has yet been done on identifying the extent and impacts of these events (Silver et al. 2009).

The strongest natural fluctuation of regional climate on interannual time scales is the El Niño-Southern Oscillation (ENSO). The onset of modern ENSO periodicities started about 5,000 years ago with an abrupt increase in frequency around 3500–3000 years BP (Donders et al. 2005; Gagan et al. 2004). In alternating periods of El Niño and La Niña conditions, annual rainfall figures vary considerably [between <800 mm and >1,600 mm, respectively, at Port Moresby (McGregor 1989)]. ENSO events affect marine resources through variations in freshwater runoff and nutrient input to near-shore ecosystems and can cause sea level falls of up to 50 cm that expose reef systems and result in mass mortality of corals, mollusks, and reef fishes (Ayliffe et al. 2004; Hawkins et al. 2000; Ridgway et al. 1993; Sala and Knowlton 2006). These ENSO-driven climatic fluctuations also affect regional terrestrial environments through extended drought during El Niño events (e.g., Bureau of Meteorology 2002) and increased rainfall, storm surges, and cyclone activity during La Niña conditions (PEAC 2009).

Individually, and in combination, these natural processes can result in significant landscape transformations that severely impact populations through the loss of life, enforced relocation on a permanent or temporary basis, and loss of terrestrial and marine subsistence resources (Boyd et al. 1999; Pandolfi et al. 2006; Parr et al. 2009; Torrence and Doelman 2007; Torrence et al. 2009a). In such situations the social networks created by geographic mobility are essential strategies for coping with disasters. It was within such an unstable and unpredictable world that the Lapita pottery makers, their precursors, and their descendants entered the archaeological record.

Settlements

The appearance of Lapita pottery in the Archipelago is said to have accompanied a new settlement pattern of villages constructed on stilts in shallow water over the intertidal zone and on small offshore islands, in contrast to a presumed less sedentary pattern in pre-Lapita times. Only cave sites were occupied immediately preceding the appearance of pottery, but there is uncertainty about their continuous use across the aceramic/ceramic boundary (Spriggs 1997, p. 88). Settlement data, however, do not support these generalizations.

The preferred coastal and small-island location of Lapita pottery sites has long been accepted (Green 1979a; Frimigacci 1980; Lepofsky 1988). Of 91 Lapita pottery localities in the Archipelago, 54 % are on islands less than 10 km^2 in area (Specht 2007a, table 2). Such islands are always adjacent to or within sight of larger ones (>10 km^2), where the remaining sites are located. All known early sites conform to this pattern. Three later sites on Willaumez Peninsula of New Britain, however, are 40–80 m above current beach level (Specht et al. 1991; Specht and

Torrence 2007a, b), and several are 0.5–1 km inland from the present-day coastline as a result of changing shorelines in the post-Lapita period (Parr et al. 2009, fig. 9; Torrence and Doelman 2007).

Green (1979a, pp. 34–35) initially suggested that Lapita settlements were large, clustered coastal centers analogous to recent villages in Melanesia and contrasted them with the dispersed household pattern of recent times on Polynesian high islands. Subsequent analysis of 36 open-air sites across the Lapita distribution revealed size ranges from 0.03 to 8.2 ha (Sheppard and Green 1991, p. 100, fig. 18). Only three sites were larger than 1.5 ha. Talepakemalai in the Mussau group of New Ireland, at 8.2 ha, is the largest, though this reflects use over 400–600 years (Kirch 1997, p. 167, 2001a, p. 213). During this time the shoreline advanced ca. 100 m as a result of lowering sea level and sediment accumulation (Kirch 2001b, p. 132). There is no reason to believe that all of this area was occupied at any one time or was continuously occupied (Gosden 1994, p. 29; Kirch 1997, p. 174). Most Lapita settlements were small, around 0.1–0.5 ha, and probably comprised only a few households with low numbers of individuals. Within the Archipelago these sites tend to cluster in groups of ten or more, often within sight of each other (Specht and Torrence 2007a; White 2007). In the absence of good chronological controls and areal excavations, it is impossible to determine the significance of these groupings.

Was this a new settlement pattern? Here we face problems with the visibility of coastal sites of Lapita age and earlier (Spriggs 1984). Some are deeply buried by volcanic deposits and slope erosion (Anson 2000; Green and Anson 2000; Specht and Torrence 2007a); others now stand inland as a result of uplift and prograding coastlines (Boyd et al. 1999; Summerhayes 2000c). The situation is further complicated by the mid-Holocene high sea stand, when relative sea level was 1–2 m higher than at present around the Archipelago (Dickinson 2001; Gosden and Webb 1994).

Little is known about pre-Lapita settlements in the Archipelago. On Garua Island, New Britain, landscape sampling suggested a change in the density and distribution of worked obsidian across the island from widespread and low density prior to ca. 3500 cal BP to high density and increasingly clustered after the appearance of Lapita pottery (Torrence 2002, pp. 771–773). This was interpreted to reflect changes in residential mobility and land use, though technological studies of flaked stone industries were used to argue that the change began before pottery appeared (Pavlides 2006; Torrence 1992; Torrence et al. 2000). Whether the clustered land-use pattern of the Lapita period was new remains to be tested.

No Lapita open-area site in the Archipelago shows unequivocal continuity of occupation across the aceramic/ceramic boundary (Specht 2009). Continuation of the mid-Holocene high sea stand into the Lapita period complicates the identification of older coastal sites, as coastal flats suitable for occupation were inundated and Lapita-period buildings were constructed over water on the intertidal reef. Waterlogged beams and posts of such structures have been recovered at Talepakemalai (Kirch 1988a, 2001b) and in the Arawe Islands of New Britain (Gosden and Webb 1994). Elsewhere in the Archipelago and Solomon Islands, a similar situation is inferred from cultural debris on reef platforms (Felgate 2007;

Specht 1991; Wickler 2001) or through reconstruction of the palaeo-shoreline (Summerhayes et al. 2010a).

The evidence for similar structures before Lapita pottery is contested. At Apalo in the Arawe Islands of New Britain, waterlogged timbers attributed to such a stilt structure were in a level with obsidian but no pottery dated to 3980–3645 cal BP (Specht and Gosden 1997, p. 178). This overlaps with dates on charcoal of 4080–3700 and 4410–3990 cal BP for early levels elsewhere at the site. Another early date of 4290–3910 cal BP on nearby Adwe Island is anomalous in terms of the associated artifacts and is rejected (Summerhayes 2001, table 3). Challenging the nature of these timbers and citing old wood or in-built age, Spriggs (1997, p. 79) and Summerhayes (2010a, pp. 11–20) argue that the Apalo finds do not represent pre-Lapita stilt structures. We question this view. All four dates overlap with those for Lolmo cave on the same island as Apalo, where human activity began around 6,000 years ago and continued into the Lapita era (Gosden et al. 1994). It also seems unlikely that four samples from two sites on different islands were all from old wood or wood with 500-plus years of in-built age. The issue requires further field examination and dating before categorical acceptance or rejection of the possibility of pre-Lapita stilt structures.

If the new intertidal settlement pattern claimed for the Lapita period was introduced to the Archipelago, antecedent traces could be expected to occur in ISEA, but no comparable remains have been reported there. This may reflect, again, problems of site visibility resulting from the mid-Holocene high sea stand and local geomorphic processes (Bellwood et al. 2008). In some areas the high stand was up to 5 m above present-day levels (Berdin et al. 2003; Bulbeck and Nasruddin 2002, p. 85, citing Whitten et al. 1987, p. 20; Ma et al. 2003). It is questionable whether the construction of intertidal settlements would have been feasible. The lack of intertidal ISEA sites also may reflect an archaeological focus on coastal caves and rock shelters that distorts the picture of the distribution of early Neolithic sites (Spriggs 2011, p. 517). This combination of factors probably explains the apparent shift from caves to open locations around 2,000 or so years ago (Simanjuntak and Forestier 2004, p. 115). In brief, an ISEA origin for buildings constructed over intertidal reef platforms cannot be dismissed but needs appropriate field testing before a conclusion can be reached.

Technology

The three main technological categories cited as innovations or introductions to the Archipelago are pottery, shell artifacts, and ground stone tools. We focus on three questions: when did each category appear, what were their origins, and, if they were introduced, did they arrive together or at separate times?

Pottery

We follow earlier authors (e.g., Bellwood 1997; Kirch 1995, p. 282; Solheim 1964, pp. 208–209; Spriggs 1996a) in seeing Lapita pottery as derived from pottery industries of ISEA dating from about 4000 to 3500 cal BP. There is no other contender as an ultimate source, irrespective of the route or process by which pottery production reached the Archipelago. After nearly 50 years of field research, no pottery older than Lapita has been found in the Archipelago or on the New Guinea mainland (O'Connor et al. 2011). The presence of Lapita pottery at Caution Bay on the New Guinea south coast (David et al. 2011; McNiven et al. 2011) extends the geographic range of the later part of the ceramic series but does not contribute to an understanding of its origin.

Lapita pottery forms display similarities with the Neolithic pottery of ISEA (Fig. 5). Kirch (1995, p. 273, 1996, p. 65) suggested that the red-slipped plain ware of Area A at Talepakemalai is the oldest at the site, though this is questioned (Summerhayes 2010a), and compared it with similarly slipped pottery at Uattamdi on Kayoa Island, Halmahera. The vessel forms at Uattamdi and other ISEA red-slipped pottery assemblages of comparable age include round-based bowls, bowls on pedestal stands, and vessels with carinated shoulders (e.g., Aoyagi et al. 1991, 1993; Bellwood 1992; Peterson 1974) that recall Lapita forms. Similarities also are evident with pottery from the Kamassi and Minanga Sipakko sites on Sulawesi,

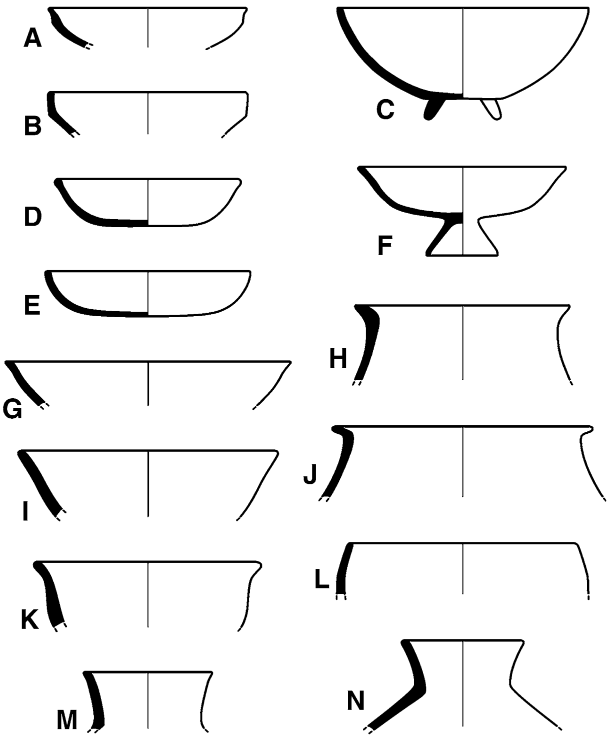

Fig. 5 Selected vessel forms of early pottery in Island Southeast Asia (ISEA) (not to same scale). **A–C** Nagsabaran, Luzon, Philippines (Hung 2008, fig. 7.7). **D** Nagsabaran, Luzon, Philippines (Hung 2008, fig. 8.1). **E** Pintu shelter, Luzon, Philippines (Hung 2008, fig. 6.3). **F** Dimolit, Luzon, Philippines (Hung 2008, fig. 6.3). **G–L** Uattamdi, Kayoa Island, Indonesia (Bellwood 1992, fig. 3). **M, N** Reranum, Batanes Islands, Philippines (Hung 2008, figs. 5.8 and 5.9)

where red-slipped plain pottery is followed by forms with highly ornate decoration (Bulbeck and Nasruddin 2002; Simanjuntak et al. 2008). Unfortunately, the chronologies of these sites are problematic, and there is insufficient information on the Talepakemalai pottery to undertake more detailed comparisons. Nevertheless, Lapita vessel forms display unequivocal evidence of their ancestry in ISEA.

Two Lapita forms were probably innovations within the Archipelago: cylinder stands (Kirch 1997, fig. 5.5) and pot stands (Specht 1991, fig. 8; Specht and Summerhayes 2007, fig. 16a). Neither has a clear precursor in ISEA, though Hung (2008, fig. 7.21, item 5) illustrates a "free standing pot support" from the post-Lapita-age shell midden of Nagsabaran on Luzon that resembles Lapita pot stands.

Flat-bottomed bowls with a sharp base angle (Kirch 2001b, Fig. 4.5) may be another Archipelago innovation. This form is not present in early pottery assemblages of ISEA, which have round-based bowls, but it is common in later periods (Aoyagi et al. 1991; Hung 2008, pp. 186, 196, fig. 7.23; Swete Kelly 2008, p. 142). The age of a "flat-bottomed dish" with a dentate-stamped design from Nagsabaran, also described as the "base of a red-slipped stand" (Spriggs 2010, fig. 4, 2011, fig. 3), is not clear. The item came from a low level within the Neolithic deposit (Hung, personal communication 2012), which could place it around 3750 cal BP (Carson and Kurashina 2012), though other dates overlap with the Lapita pottery era (Hung 2008, table 7.1; Tsang 2007, table 4).

Flat-bottomed bowls are associated with jar burials of the late Neolithic and subsequent periods of ISEA and Mainland Southeast Asia (MSEA) (e.g., Bellwood 1997; Higham 2002). No such burials have been recorded in the Archipelago, but in the Lapita cemetery of Teouma in Vanuatu, a flat-bottomed bowl was used to cover a jar burial (Bedford et al. 2010). Whether this reflects ISEA influence is uncertain (Bedford and Spriggs 2007; Spriggs 2011, p. 516).

Dentate stamping occurs sporadically in ISEA and western Micronesia in contexts dating to before, during, and after Lapita pottery, of which it is a defining feature (e.g., Aoyagi et al. 1993, figs. 7–12, 1991, figs. 10–12, plate 2; Bellwood et al. 1998, p. 257; Carson and Kurashina 2012; Hung 2008; Lape 2000, fig. 2; Spriggs 2010, fig. 5, 2011, figs. 3, 4; Thiel 1986–1987; Tsang 2007, fig. 2). Some horizontal bands of rectilinear elements recall those on Lapita pottery, but curvilinear elements typical of Lapita decoration are rare and appear in ISEA only toward the end of the Lapita pottery period or later and do not resemble its face motifs (Fig. 6) (Chiu 2005; Spriggs 1990). Curvilinear elements are absent from Micronesia.

Other forms of surface modification in ISEA include linear incision, circle stamps, white in-filling of designs, and occasional red-painted stripes (Bellwood 1976, 1997, figs. 7.9, 7.11; Bellwood and Dizon 2008; Butler 1995; Carson 2008; Hung 2005, 2008, pp. 163–164; Shutler 1999; Spoehr 1957, 1973, fig. 117d). With the exception of painted stripes, these techniques occur widely on Lapita pottery (Bedford 2006; Kirch 1997; Specht 2007b; Summerhayes 2000b; White 2007). Hung et al. (2011; cf. Carson and Kurashina 2012) compare the stamped circles of Philippines and Marianas pottery with those on Lapita pottery and suggest that this may indicate the derivation of Lapita pottery from the Marianas. This remains to be tested. "Cut-outs" on pedestal stands, where parts of the clay body were removed to

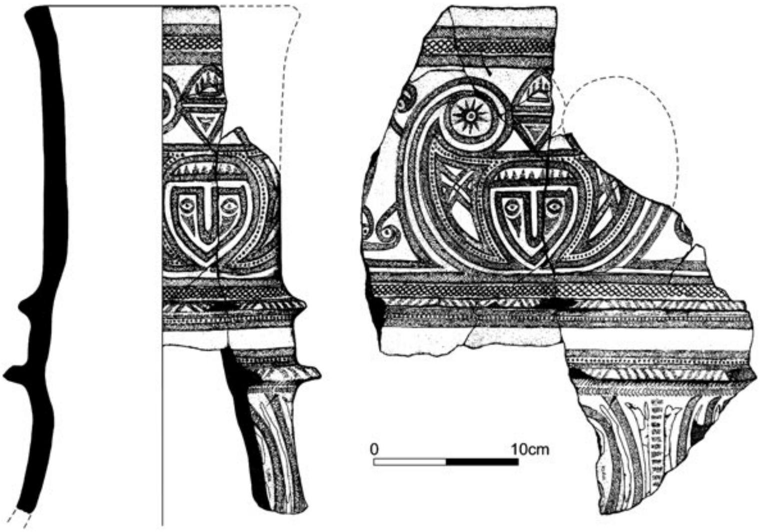

Fig. 6 Dentate-stamped cylinder stand from Talepakemalai, Eloaua Island (Kirch 1997, fig. 5.5)

create an openwork pattern, occur in Early Lapita pottery of the Archipelago (Fig. 3D; Specht and Summerhayes 2007, fig. 17e). This technique probably derived from ISEA where it could date to just before Lapita pottery at Leta Leta cave on Palawan, though no relationship is demonstrated between the pedestal stand found by Fox (1970, plate 16) and the radiocarbon dates (Szabó and Ramirez 2009).

The Lapita design system thus shows similarities to ISEA and Micronesian pottery but it also shows differences that suggest modifications within the Archipelago (Ambrose 1997, p. 531; Bellwood 1997, p. 234; Kirch 1996, p 64). Craig (2005, p. 508) proposes that the design system and its motifs derive from the non-Austronesian-speaking peoples of the New Guinea–Archipelago region and were not introduced from outside. If potters adopted a pre-existing design system, did they transfer the embedded cultural meanings and social contexts within which it was originally used, or did they assign new meanings? Terrell and Schechter (2009, p. 54) suggest that pottery may have been a new way to express ideas and sentiments long held to be meaningful and key to sociality and the rituals of life. From this point of view, people in the Archipelago adopted pottery into their ways of life but added their own embellishments.

Ambrose (1999) proposes that the dentate-stamping tools were made from turtle scutes, though other materials such as bone, marine shell, and wood have been suggested (Siorat 1990, p. 60). No such tools have been recovered from ISEA sites, with the possible exception of multitoothed tools of horn of questionable age in Arku cave, northern Luzon (Thiel 1986–1987).

Comparisons have been drawn between some Lapita design elements and those applied to recent Polynesian textiles, woodcarvings, and tattoos (Green 1979b, pp. 29–30; Mead 1975, p. 20). Green (2003, table 5) included tattooing as a core component of the LCC, and Siorat (1990, p. 60) described dentate stamping as a form of tattooing on "the moist skin" of a pot. This was partly based on finds of pottery figurines with dentate-stamped designs (Bedford and Spriggs 2007; Green 1979b, fig. 1.2; Sheppard 2010a, fig. 6; Summerhayes 1998; Torrence and White 2001), though Ambrose (2012) questions this interpretation. Impressions of curved dentate tools are common on Lapita pottery, but curved tattooing implements are unknown in the Pacific Islands (Sand 2007, p. 267).

A two-pronged shell fragment from Kamgot, New Ireland, described as a possible tattooing tool (Szabó and Summerhayes 2002, p. 95, fig. 6b) is an unlikely implement for dentate stamping. In Remote Oceania, multitined bone implements found in Tonga and described as tattooing chisels were initially assigned to Lapita pottery contexts (Poulsen 1987, p. 207, plate 68: items 14–17), but this dating is problematic (Burley, personal communication, 2010; Smith 2002, p. 213).

Tools employed in body marking in the western Pacific in recent times are single-pointed pieces of bone, thorn, or obsidian (Ambrose 2007). Such tools may have a long history in the Archipelago, where obsidian points used for piercing or cutting skin, possibly human skin, predate and overlap with Lapita pottery on Garua Island, New Britain (Kononenko 2011, table 7.15, 2012). Green (2003, table 5; cf. Sheppard 1993, 2010b) associates obsidian graver points from several Lapita sites with tattooing, though a functional study of a comparable chert graver from Vanuatu indicates a wood-working use (Kononenko et al. 2010). Such implements are improbable precursors of the multitined tools used for dentate stamping. In brief, there is no convincing evidence to derive the dentate-stamping tools of ISEA and the Archipelago from tattooing or a craft activity.

Shell artifacts

Shell ornaments and tools occur in late Pleistocene and early-mid-Holocene sites in ISEA, the Archipelago, and the northern Solomon Islands, and there has been much debate about continuity between these and Lapita-age assemblages. The range of pre-Lapita shell artifacts includes edge-ground adzes, one-piece fishhooks, perforated beads and pendants, and armbands made from various shell species (Spriggs 1996a, table 22.1, 1997, table 4.1). They rarely occur in quantity, and no category occurs in every site (Fredericksen et al. 1993; Gosden et al. 1994; Smith and Allen 1999; Spriggs 1991; Szabó 2004, 2010a; Wickler 2001). Green (2000) dismissed this pre-Lapita material as constituting a small and insignificant body of evidence but failed to consider potential sample bias. All of the pre-Lapita items came from caves and rock shelters, where the nature of activities might not lead to the discard of many shell artifacts and the excavated volume of these sites amounts to less than half that of open Lapita sites.

Shell artifact categories found in pre-Lapita levels occur in Lapita pottery sites, but sometimes in different materials and/or forms and made by different production protocols (Green 2000, pp. 380–382; Spriggs 1996a, table 22.1; Szabó 2007, 2010a, tables 1–3). The Talepakemalai, Arawe, and Kamgot Lapita sites are particularly rich in both quantity and range of items, perhaps reflecting large-scale production of shell artifacts (Kirch 1988b, 1990; Smith 2001; Szabó and Summerhayes 2002), but none have pre-Lapita examples.

Szabó (2010a, table 2) lists 14 categories of shell artifact types for the formative Lapita phase in the Archipelago, including both hinge and dorsal section *Tridacna* shell adzes. The hinge-section type could have a long history in the New Guinea region, as a specimen made from *Tridacna gigas* from the inland Sepik River area of New Guinea has been dated directly to 4980 ± 90 BP (Swadling et al. 1989, p. 109), but this does not necessarily indicate when the tool was made.

Shell artifact types in pre-Neolithic contexts in ISEA include hinge section shell adzes from Golo and Buwawansi in the northern Moluccas dated to between 13,000 and 8000 BP and about 9000 cal BP, respectively (Bellwood et al. 1998, pp. 251, 259). Direct dating of a shell adze in Timor gave a similar age, but there is no certainty that it was made at that time (O'Connor 2006, p. 81). This is the same period assigned to ground shell adzes from Pamwak on Manus Island in the Archipelago (Fredericksen et al. 1993, p. 149; Golson 2005). These tools, however, do not resemble the forms associated with Lapita pottery.

Only three of the ten shell ornament types in Lapita sites occur in pre-Neolithic contexts in ISEA (Spriggs 2011, p. 515). In contrast, five of six categories of pre-Lapita shell artifacts in the Archipelago occur among the six (possibly eight) categories found in the ISEA Neolithic, though some are of different forms or materials.

The additional ISEA Neolithic categories of *Conus* rectangular units, *Tridacna* rings, and possibly *Conus* beads, rings, and discs are found in Lapita pottery contexts. A mid-Holocene age is claimed for a perforated *Conus* disc at Lolmo cave in the Archipelago (Gosden et al. 1994). Spriggs (2001, p. 371) reports a date of 7580 cal BP on a perforated *Conus* shell top from Kilu cave on Buka Island that is consistent with a charcoal date for the same recovery context and may support the Lolmo date. *Conus* shell items were reasonably common and widespread in the Archipelago during the Lapita period (Kirch 1988b, table 1; Smith 2001, table 1; Weisler 2001a, p. 159). Also present were long-unit ornaments of *Spondylus* sp. or *Cassis cornuta* shell (Kirch 1988b, fig. 3f; Szabó and Summerhayes 2002, p. 96, fig. 6f). This form appears not to have precursors in pre-Lapita contexts or in ISEA, where *Spondylus* shell was apparently not used (Szabó 2004).

One-piece *Trochus niloticus* shell fishhooks, similar to those from pre-Lapita levels, are relatively common in Lapita sites in the Archipelago and New Caledonia (Szabó 2007, p. 234). Within ISEA, shell fishhooks are absent south of the Batanes Islands, except in Timor, where *T. niloticus* fishhooks are directly dated to the early Holocene (O'Connor and Veth 2005, pp. 251–252). These dates are consistent with others for the sediments in which the fishhooks were found and with pre-Lapita evidence from the Archipelago. Production of such fishhooks during Lapita times thus represents continuation of an earlier regional fishing technology, though Szabó (2007, p. 236) notes differences in production processes between the Timor examples and those from Lapita pottery contexts.

Szabó (2004, pp. 354–355) examined the production processes applied to different shell taxa in ISEA and the western Pacific before and during the Lapita period. Sites with Lapita pottery exhibited many similarities, with clear and strong connections to ISEA. Other than on Palawan in the Philippines, ISEA sites displayed limited similarity across the region, with Uattamdi showing closer links to

Lapita sites than to sites in ISEA (Szabó 2004, p. 356). The prepottery shell technologies of Buka Island in the northern Solomon Islands were similar to that of the Kamgot Lapita site of the Archipelago and to those of comparable age in Kamuanan (Philippines) and Golo (northern Moluccas) (Szabó 2004, p. 357).

Concluding that Lapita shell working was strongly influenced by older regional traditions, Szabó (2004, p. 358) suggests that the division between Southeast Asia and the Pacific has little meaning for the early and mid-Holocene, when continuity in shell working extended across the boundary between these regions. This did not extend into the Lapita period, when there was a regionalization in shell artifact production between Lapita pottery sites and those to the west, other than at Uattamdi. Within the Lapita domain, however, Szabó (2010b, p. 239) sees the suite of shell artifacts as a distinctive grouping, not wholly derived from ISEA nor developed solely within the Archipelago.

A distinctive ground stone adze kit?

The idea that there is a distinctive ground stone adze kit associated with Lapita pottery has a long history, with Green (1979a, p. 39) listing four forms of tool cross sections: plano-lateral (hereafter planilateral), plano-convex, oval (also termed lenticular), and rectangular. Green (2003, p. 110, table 5) later noted that the planilateral and plano-convex forms were probably Lapita additions to the basic adze range in the New Guinea–Archipelago region. His formulation of the Lapita adze kit, however, was based almost entirely on data from Remote Oceania, postdating the formative stage in the Archipelago for which little information was available at that time (cf. Sheppard 2010b). The situation has not improved since then.

Ground stone tools are rare in archaeological assemblages of all periods in the Archipelago, and on New Britain there are currently none older than the W-K2 tephra event immediately preceding Lapita pottery on that island (Specht 2009, p. 23). On Manus Island, five ground stone tools are reported from early and mid-Holocene contexts at Pamwak cave, but only one is fully ground, a small axe or chisel with an oval cross section that might be intrusive from a later level (Fredericksen 1994, pp. 64–65). The other four tools are water-rolled cobbles with edge grinding only (Fredericksen 1994, p. 64, figs. 4.10a-c). On New Ireland, fragments of possible ground stone tools found at Balof and Matenbek are attributed to terminal Pleistocene or early Holocene contexts (Allen and O'Connell 2010, p. 55; White et al. 1991, p. 49). These slender records do little more than indicate the possible presence of ground stone tools prior to Lapita pottery.

On New Guinea, a fully ground adze blade is reported at ca. 4200 cal BP at Caution Bay on the south coast (McNiven et al. 2011, p. 4), though no details are available. In the highlands, partially or wholly ground blades in middle Holocene and possibly earlier contexts include planilateral, plano-convex, and oval cross sections (Golson 2005, pp. 467–469, 471–473; cf. Christensen 1975). If these items are accurately dated, it becomes difficult to accept the planilateral and plano-convex forms as Lapita introductions to the Archipelago from ISEA (Green 2003, table 5), as they could have derived from mainland New Guinea.

Information on the few ground stone adze blades found at Early Lapita sites in the Arawe (unpublished), Mussau (Kirch 1988a, p. 338; Kirch et al. 1991, p. 148), and Anir Islands (Summerhayes 2000c, p. 170) is limited. The best records come from Middle and Late Lapita contexts with tools of all cross-section forms, including “vaguely sub-triangular” forms (Anson 2000, pp. 104, 106, fig. 5; Garling 2003, p. 221, fig. 3; Green and Anson 2000, p. 59, fig. 11; Specht 2003, fig. 4; Wickler 2001, pp. 182–184).

Claims for partly or fully ground shell adzes in early to mid-Holocene ISEA contexts (Bellwood et al. 1998, pp. 251, 259) place the grinding technique there several millennia before the appearance of fully ground stone tools, though edge-ground stone tools have a longer history (Bulbeck 2008, p. 36; Golson 2001). Fully ground stone adzes first appeared with pottery (Hung 2008, p. 176, fig. 7-18), but one at Siti Nafisah could be older (Bellwood 1992, p. 62, fig. 4d). These have a range of cross-section forms, including oval, trapezoidal, rectangular, planilateral, triangular, and others best described as irregular.

In summary, the claim for the introduction of a distinctive Lapita adze kit to the Archipelago is not supported. Fully or partially ground stone adzes were in use on New Guinea and possibly Manus and New Ireland in pre-Lapita times and collectively included all cross-section forms attributed to the Lapita adze kit. Published information on stone adzes in ISEA indicates a diverse range of forms consistent with the pre-Lapita forms of the New Guinea region, rather than a set from which a distinctive Lapita adze kit might have been drawn.

A fully ground chisel of jadeitite is reported from an Early Lapita pottery site on Emirau Island, New Ireland (Harlow et al. 2011). This tool is clearly an import. Its composition does not match either artifacts or sources in ISEA or MSEA (cf. Iizuka and Hung 2005), and a mainland New Guinea origin is likely (Harlow et al. 2011). If verified, the presence of this item implicates New Guinea directly for the first time in the development of the LCC. Given the lack of verification of the tool’s recovery context, however, we treat the attributed Lapita age with caution.

Artifacts of nephrite or jade from Taiwan and elsewhere have been found in Neolithic and later contexts from Taiwan to Borneo and on MSEA (Hung 2005; Hung et al. 2007; Iizuka and Hung 2005), though none have been reported from east and south of Borneo or from Micronesia to the north of the Archipelago. Most examples found south of Luzon-Palawan are from late Neolithic and Metal Age contexts, though a bracelet fragment of Taiwanese nephrite from the Neolithic level of Nagsabaran is said to date to 3750–3450 cal BP (Hung et al. 2007, p. 19,746).

Subsistence

The introduction of plant food cultivation and domesticated animals has long been associated with Lapita pottery sites, although alternative scenarios also have been entertained (Anderson 2009a; Bellwood 1997, 2005; Green 1979a; Groube 1971; Kirch 1997; Spriggs 1997; Summerhayes 2010a, b). In recent years the picture has become clearer in some respects but more equivocal in others.

The original view of the subsistence base of the OT migrants was that they relied on the cultivation of rice (*Oryza sativa*), foxtail millet (*Setaria italica*), and other crops, plus the keeping of pigs, dogs, and perhaps chickens, together with various marine resources (Bellwood 1997, pp. 241–255, 2005). There are, however, no reliable archaeobotanical finds of millet in ISEA beyond Taiwan (Paz 2002), as the possible presence of millet in Timor is now questioned (Oliveira 2010, p. 81). Rice, possibly of a domesticated variety, was present in northern Luzon around 3700–3500 cal BP (Snow et al. 1986), although it is noticeably absent from most early Neolithic sites in ISEA (Bellwood 2005, p. 139; Paz 2002, p. 279). Few reports of early occurrences are reliable. On Borneo, domesticated rice has been claimed for a pre-4000 cal BP context with a rice grain included in a pottery sherd (Beavitt et al. 1996; Doherty et al. 2000), and by 7750 cal BP based on pollen cores (Barker et al. 2011, fig. 5.6). Both claims are questionable given uncertainties in the degree of archaeobotanical rigor used to differentiate domesticated rice from wild species on Borneo. Another possible exception is on Sulawesi, where rice remains at Ulu Leang are potentially dated to ca. 4000 cal BP (Paz 2005, p. 112, table 2). There is no evidence for either cereal in the archaeological record of the Archipelago before or during the time of Lapita pottery.

Agricultural practices

The notion of pre-Lapita agriculture in the New Guinea lowlands and the Archipelago has long been debated (Bellwood 1996, pp. 484–486, 2005, p. 143; Spriggs 1993, 1996b), notwithstanding evidence for cultivation in the New Guinea highlands from at least the mid-Holocene (Denham et al. 2003; Golson 1977). Those questioning the presence of cultivation in the New Guinea lowlands and the Archipelago prior to the appearance of Lapita pottery fail to account for the social contexts of plant domestication practices, including vegetative selection, that occurred over several millennia within lowland Melanesia (Yen 1991a). At least one highland tuber crop, taro (*Colocasia esculenta*), is presumed to be of lowland origin in New Guinea on account of its great phenotypic variety at lower altitudes (Yen 1991b, p. 77), although the locus of initial domestication is debatable (Denham et al. 2004, pp. 849, 852). Those who doubt pre-Lapita agriculture in lowland New Guinea and Island Melanesia may be limited as much by their conception of agriculture as by the multidisciplinary evidence (cf. Denham 2007; Kennedy and Clarke 2004; Terrell et al. 2003).

The traditional view of agriculture being introduced to the Archipelago by Austronesian-speaking migrants relies heavily on historical linguistics, but there is no clear archaeological or archaeobotanical evidence for that position. The only pollen core spanning the period of interest indicates biomass burning from about 6,400 to 5,600 years ago but gives no evidence for cultigens until the last 1,000 years (Prebble et al. 2010). The kind of landscape modifications associated with early agriculture in the highlands of Papua New Guinea (Denham 2003a, 2004; Muke and Mandui 2003) are seemingly absent from the lowlands and the Archipelago (but see below), probably reflecting the lack of need for such practices, not the absence of cultivation (Terrell 2002). There is increasing evidence from phytolith studies that people in the Archipelago initiated environmental transformations and began managing various food plants several millennia prior to Lapita pottery (Lentfer and Torrence 2007; Lentfer et al. 2010). This is now acknowledged by some proponents of the OT theory who accept that Austronesian-speaking migrants from ISEA may have adopted tuber and fruit crops of western Pacific origin (Bellwood et al. 2011, p. 339).

One form of landscape modification that might relate to the arrival of a new food production system in the Archipelago is on Lavongai Island, New Ireland, where mounds and ditches constructed to manage water flow on a floodplain are dated ca. 2000 cal BP (Leavesley and Troitzsch 2007). Construction possibly began around 3,000–4,000 years ago, but this depends on a particular reading of the data. The system is not associated with pottery. Following Yen's (1991b, pp. 80–81) view on water management systems in the Pacific, the Lavongai system is plausibly a specific local innovation.

There is an apparent coincidence between the appearance of pottery and the formation of clay deposits on beaches at the base of limestone cliffs on some islands (Gosden et al. 1989, p. 573). These deposits are seen as "the first convincing evidence for full-on agriculture" that caused accelerated erosion due to gardening above the beaches (Spriggs 1997, p. 88). The accumulation of clays at beach level, however, was arguably the result of changes in coastal geomorphology and relative sea level.

The higher relative sea level of the mid-Holocene extended into the early Lapita pottery period, inundating beaches and preventing retention of sediments. As sea level stabilized at its present level, sediments that previously were washed away were now retained (Gosden and Webb 1994; Kirch 1988a, 2001b). It is impossible to tell whether the clay deposits at coastal Lapita sites represent initial or continued, constant, or increased sediment deposition. They cannot stand as a proxy for the introduction of agriculture, especially given the absence of corroborating palaeoecological transformations coincident with the onset of Lapita pottery (e.g., Prebble et al. 2010).

Support for this interpretation comes from dates for clay deposition in the Siassi Islands between New Guinea and New Britain and on Sohano Island in the northern Solomon Islands, which suggest that deposition began after 2995–2690 cal BP and around 2850–2170 cal BP, respectively, in both cases well *after* the start of Lapita pottery (Lilley 1986, table 5.3, ANU-4620; Specht 1972, p. 311, ANU-272). Similarly, clay deposition in the Arawe Islands was underway by 2770–2395 cal BP (Gosden and Webb 1994, pp. 44–46), but when it began is unknown. In each case, deposition of clays began around 200–400 years after the start of Lapita. Whether this reflects elevated sea level prior to that time is not known, but clearly clay deposition cannot be used to support the introduction of cultivation at the start of Lapita pottery.

Plants

Lapita plant food was primarily a continuation of previous practices that combined arboriculture and cultivation of tubers and other plants, together with collecting forest products that were perhaps managed in various ways (Gosden 1995; Green 1979a; cf. Kennedy and Clarke 2004; Latinis 2000). The exploitation of arboreal sources, together with that of starch-rich roots and tubers, can be traced back to the earliest colonization of ISEA, New Guinea, and Melanesia and is a generalized modern human adaptation to tropical rainforest environments (Barton and Denham 2011).

Exploitation of aroids, particularly taro, and yams has a long history in ISEA, New Guinea, and the Archipelago, with *Alocasia* sp., *Colocasia* elim. *esculenta*, and *Dioscorea* spp., including cf. *Dioscorea hispida* wild yam reported from Niah cave on Borneo (Barton and Paz 2007, tables 4.1–4.2), and probably *C. esculenta* dating to ca. 5500 cal BP in Leang Burung 1, Sulawesi (Paz 2005, table 2). *Dioscorea* species also were present in Ille cave, Philippines, at ca. 10,000 BP (Barker et al. 2011, table 5.2).

At the Kuk site in the Papua New Guinea highlands, starch granules of taro (*Colocasia esculenta*) and yam (*Dioscorea* sp.) are present on stone tools older than 10,000 cal BP but without evidence of cultivation; taro starch grains are present at ca. 7000–6500 cal BP, when evidence for cultivation is firmer (Fullagar et al. 2006). Earlier evidence for the exploitation of yams in the Late Pleistocene also is documented in the Ivane Valley of the highlands (Summerhayes et al. 2010b). Early exploitation of taro and yams is also evident on Buka Island, where aroid starch of presumably wild forms of *Colocasia* and *Alocasia* has been identified on stone tools predating the Last Glacial Maximum (Loy et al. 1992). At Balof cave on New Ireland, *Alocasia* sp. starch granules on stone and bone tools are dated to 14,000–12,000 cal BP (Barton and White 1993, p. 175, table 1). New Britain vegetation histories based on phytoliths and microcharcoal show phases of burning and clearance independent of volcanic events beginning in the early to mid-Holocene that, along with food plants, suggest forms of plant management several millennia prior to Lapita pottery (Lentfer et al. 2010; Lentfer and Torrence 2007; Parr et al. 2009).

The exploitation of tubers continued into the pottery period. Use-wear and residue studies of flaked stone tools from New Britain indicate possible use on tubers, with a tentative identification of yam starch on a Lapita-period obsidian tool from Garua Island (Kealhofer et al. 1999, p. 543). Taro starch is reported on sherds from the Early Lapita site of Kamgot, New Ireland (Crowther 2005).

Beyond the Archipelago, taro and yam starches are reported from Lapita pottery contexts in the southeast Solomon Islands (Crowther 2005, 2009), Vanuatu (Horrocks and Bedford 2005), New Caledonia (Horrocks et al. 2008a), Fiji (Horrocks and Nunn 2007), and Samoa (Crowther 2009). None of these plants is exclusively associated with Lapita pottery and all were exploited in ISEA *and* Island Melanesia well before the appearance of pottery (Barton and Denham 2011; Denham 2010).

A comparison of macrobotanical assemblages from three sites in lowland New Guinea and the Archipelago demonstrates a general similarity between the pre-Lapita and Lapita periods in terms of the exploitation of fruits, nuts, and seeds (Table 1). The Dongan midden, located in the Sepik-Ramu Basin, is clearly pre-Lapita, yet the macrobotanical assemblage from this site (Fairbairn and Swadling 2005) is broadly comparable with that from the Lapita sites of Talepakemalai in the

Table 1 Archaeobotanical collections from the Dongan (mid-Holocene), Apalo, and Talepakemalai (Lapita) sites (Denham 2003b, table 2.11; Kennedy and Clarke 2004, table 1)

Family/Genus/Species	Dongan[a]	Apalo[b]	Talepakemalai[c]
Edible fruit, nut, or seed bearing			
Aleurites moluccana Willd. (candlenut)	?	X	X
Burkella obovata (Forst.) Pierre			X
Canarium indicum L. (canarium nut)		X	X
Canarium spp.	X	X	
Cocos nucifera L. (coconut)	X	X	X
Cordia subcordata Lam.		X	X
Cordia sp.	?		
Corynocarpus cribbeanus (Bail.) L. S. Smith			X
Cycas sp.[d]		X	X
Diospyros sp.			X
Dracontomelon dao (Blanco) Merr. & Rolfe		X	X
Inocarpus fagifer (Park. ex Zöllinger) Fosberg			X
Pandanus spp.	X	X	X
Pangium sp.	?	X	*P. edule*
Pleiogynium timorense (DC) Leenh.		X	
Pometia sp.	X		*P. pinnata*
Spondias dulcis Park.		X	X
Sterculia sp.	?		
Terminalia sp.		X	*T. catappa*
Other			
Arecaceae type	X		
Bruguiera sp.			X
Calophyllum sp.	?	X	*C. inophyllum*
Casuarina equisetifolia L. (beach sheoak)			X
Neisosperma oppositifolia (Lam.) Fosberg & Sachet		X	
Nypa fruticans Wurmb.			X
Pisonia sp.	?		

[a] Dongan midden dated to 6800–6000 cal BP (Fairbairn and Swadling 2005, table 1; Swadling et al. 1991). Initial tentative identifications (Yen and McEldowney 1991, pp. 109–110) are not reflected in Swadling (1997, p. 7) and Swadling and Hope (1992, p. 32). Unconfirmed identifications are indicated as "?". *Areca catechu*, now reclassified as *Areca* sp., is omitted as a modern intrusion (Fairbairn and Swadling 2005)

[b] Apalo dates range from 4350–4050 cal BP to 2920–2490 cal BP, with younger, undated deposits. Initial identifications by Hayes (1992) were confirmed by Matthews and Gosden (1997) who published results for square L1 of trench L-T-U (oldest date 4410–3990 cal BP). This trench contained obsidian but no pottery (Specht and Gosden 1997, p. 178); its relationship to the pottery occupation is unclear

[c] Talepakemalai is the oldest Lapita pottery site at 3590–3110 cal BP (Denham et al. 2012). Its archaeobotanical remains are variably reported (Kirch 1989, 1997); this listing largely follows Kirch (1997)

[d] Because of taxonomic uncertainties (Kirch 1989, p. 230, table 1; Lepofsky 1992, p. 197, table 1; Matthews and Gosden 1997, p. 126), species identification is reduced to genus level

Mussau group (Kirch 1989) and Apalo in the Arawe Islands (Matthews and Gosden 1997).

Coconut (*Cocos nucifera*) and the canarium nut (*Canarium* sp.) were exploited in the Archipelago region from the Late Pleistocene onward (Specht 2005). The center of origin of *C. nucifera* stretches from the Malay Peninsula to Melanesia (Baudouin and Lebrun 2008), and domesticated *Canarium* species are distributed from eastern Indonesia–New Guinea to the southeast Solomon Islands (Yen 1995, fig. 2). In ISEA, remains of wild or managed *Canarium* occur in terminal Pleistocene levels in eastern Java (Morwood et al. 2008, p. 1782), Borneo (Paz 2005, table 2), and the Philippines (Barker et al. 2011, table 5.1). Human use of both taxa in the New Guinea–Archipelago region occurred well before the appearance of Lapita pottery.

Denham and Donohue (2009) discussed the history of bananas across their distribution from New Guinea to Africa, showing their widespread presence before the putative Austronesian dispersal from Taiwan. Wild species of the Eumusa and Australimusa sections of the genus *Musa* that gave rise to domesticated bananas extend eastward to the Solomon Islands (Kennedy [2008, 2009, table 21.6] prefers the alternative section names Musa and Callimusa). Eumusa extends west to eastern India, but Australimusa stops at Borneo (Kennedy 2008, p. 77). *Musa acuminata* ssp. *banksii* was probably domesticated in the New Guinea region, along with cultivars of Australimusa (Perrier et al. 2011). On mainland New Guinea, phytoliths of Eumusa species, including *M. acuminata*, occur at Kuk as possible cultivars around 7000–6500 cal BP (Denham et al. 2003, pp. 191–192, 2004) and possibly at ca. 5200 cal BP in Yuku rock shelter (Horrocks et al. 2008b).

Within the Archipelago, phytoliths of *Musa* species of both sections occur throughout the sequence at site FAO on Garua Island, which extends back at least to the early Holocene (Lentfer and Torrence 2007, p. 100), and three sections are present in similar contexts at the Yombon Airstrip site in central New Britain (Lentfer 2009a, p. 248; Lentfer et al. 2010, p. 3760). Phytoliths of section Eumusa have been identified in Middle to Late Lapita pottery levels on Watom Island (Lentfer and Green 2004, table 2, pp. 84–85). Farther south, cultivated *Musa* species are reported from Lapita contexts in the southeastern Solomon Islands and in Vanuatu; in both cases they are outside their natural range and, therefore, are human introductions along with Lapita pottery (Horrocks et al. 2009; Lentfer 2009b).

At this point we reach a problem with the proposition that Austronesian-speaking migrants introduced a new agricultural lifestyle to the Archipelago: did they introduce cultivars of taro and yam to pre-Lapita people who previously harvested wild or only marginally managed forms, and, if so, how do we identify this? Molecular data on various domesticates may provide the key to resolving the issue of origins.

Lebot (1999) identified five groups of food plants that were most likely domesticated in New Guinea and the islands to the east and south: breadfruit (*Artocarpus altilis*), bananas (*Musa* spp.), taro (*Colocasia esculenta*), sugarcane (*Saccharum* spp.), and the greater yam (*Dioscorea alata*). Biomolecular studies of taro in Southeast Asia and the Pacific Islands indicate two major groups, one embracing MSEA and ISEA and the other Papua New Guinea and Vanuatu (Lebot et al. 2004). This makes it unlikely that taro cultivars reached the New Guinea region from ISEA. A comparable, though more complex, situation may hold for yams, which include several species and cultivars. *D. alata*, known only as a cultivar, has its greatest diversity between ISEA and the Solomon Islands (Malapa et al. 2006, p. 262). With two other edible species, *D. nummularia* and *D. transversa*, *D. alata* belongs to a group confined to New Guinea–Australia and eastern Indonesia (Malapa et al. 2005, p. 928). As with taro, there is no evidence for its introduction by Austronesian-speaking migrants to the Archipelago.

Artocarpus altilis shows a shift from seeded to nonseeded varieties as one moves eastward from New Guinea–New Britain into Polynesia (Zerega et al. 2004, 2006). Wild *Artocarpus*, with nearly 60 species, is restricted to the Indo-Pacific region (Zerega et al. 2006, p. 217). The seeded form, *Artocarpus camansi* (sometimes called breadnut), found in the Archipelago, has wild populations in New Guinea, the Moluccas, and possibly the Philippines (Zerega et al. 2004, p. 760). The Polynesian cultivars are more closely related to the New Guinea region's *A. camansi* than to the Micronesian *A. mariannensis*. Zerega et al. (2006, p. 230) suggest that *A. camansi* may have been dispersed through the Solomon Islands in pre-Lapita times, though they offer no date or mechanism.

Cultivars of *Saccharum officinarum* are widespread in Melanesia today, and molecular studies show that the initial stages of domestication probably resulted from management of *Saccharum robustum* in New Guinea (Grivet et al. 2006, p. 62). Similarly, the initial stages in the domestication of the most widespread groups of banana cultivars can be traced back to *Musa acuminata* ssp. *banksii* in the New Guinea region (Perrier et al. 2011); they are archaeologically corroborated by the phytolith evidence from Kuk (Denham et al. 2003, 2004). Initial stages in the domestication of sugarcane and bananas occurred in the New Guinea region followed by subsequent westward movement and hybridization in Southeast Asia (Denham 2010).

The only potential food plant possibly introduced to the Archipelago along with pottery is the fishtail palm, *Caryota rumphiana*. This palm does not occur in pre-Lapita vegetation histories of New Britain, and its phytoliths first appear with Middle Lapita pottery on Garua and Watom Islands and without pottery at the Yombon Airstrip site of interior New Britain after the W-K2 volcanic event of 3480–3150 cal BP (Lentfer and Green 2004, table 2; Lentfer et al. 2010, p. 3760; Lentfer and Torrence 2007, p. 100).

The genus *Caryota* is found in cultivated/managed stands from eastern India and ISEA to New Guinea (Ruddle et al. 1978, p. 7). It has a long history of use in ISEA, with phytoliths of possible *C. cumingii* present at a prepottery level in the Philippines (Mijares 2006, p. 74), and starch of probable *C. mitis* in a similar context in Borneo (Barton 2005). *Caryota urens* yields a similar amount of starch as New Guinea *Metroxylon* sago species, and several species have an edible palm heart (Ruddle et al. 1978, p. 38, table 3). *Caryota* species are grown today throughout Papua New Guinea for subsistence and construction (Powell 1976, pp. 154, 160, tables 3.1, 3.15, 3.17), and in New Britain *C. rumphiana* is a famine food sometimes used as pig fodder (Goodale 1995, p. 83). Yen (1990, p. 260) considers it an introduction to Melanesia. If he is correct, then this had occurred before Middle Lapita and might have been linked to the introduction of pottery to the Archipelago.

Animals

The animals associated with human colonization of the Pacific Islands (pigs, dogs, chickens, and the Pacific rat) all have origins in East Asia and MSEA. Whereas the Pacific rat could have engaged in opportunistic "sweepstakes dispersal" independent of human activity (Heinsohn 2001), the other three species required human assistance for extension of their natural ranges. Whether this was as a group is a moot point, as is the actual timing of introduction. Summerhayes (2010a, b) supports their introduction as a group at the start of Lapita pottery, whereas Bellwood (2005, p. 144, 2011) entertains the possibility that pigs were introduced after 3000 BP, with dog and chicken perhaps later. If so, their introductions would have been some 300–400 years after the onset of Lapita pottery. Summaries of the data for the introduction of these animals (Matisoo-Smith 2007, table 10.1; cf. Anderson 2009a) reveal a picture that is far from simple, and issues of dating and sampling are critical.

The natural range of pigs (*Sus* spp.) in ISEA does not extend east of Sulawesi, so their presence farther east suggests human-assisted translocation, though not necessarily domestication. The Sulawesi warty pig (*Sus celebensis*) was introduced to Flores on the eastern side of Wallace's Line in the early Holocene (van den Bergh et al. 2009), but the oldest example of *Sus scrofa* occurs in northern Luzon around 4,000 years ago (Piper et al. 2009a). The New Guinea region pigs are considered a hybrid between *S. celebensis* and *Sus* [cf. *scrofa*] *vittatus* (Groves 1981, 2008a, pp. 28–29).

On present evidence, pigs were not present in the New Guinea–Archipelago region prior to Lapita pottery. Claims for early or mid-Holocene pigs in the New Guinea highlands and on the north coast (Bulmer 1975, pp. 18–19; Gorecki et al. 1991; White 1972, p. 92) are refuted by direct AMS dating (Hedges et al. 1995, p. 428; Spriggs 2001, p. 370) and re-excavation (O'Connor et al. 2011). Similarly, in the Archipelago a pig tooth attributed to a similar context on New Ireland gave a modern result (Allen 2000, p. 158).

Evidence for the presence of pigs in the Early Lapita phase is ambiguous. On Emirau Island not one mammal bone is attributed to the pottery levels, and the site potentially represents a fishing camp (Summerhayes et al. 2010a, p. 70). In view of the complex array of pottery vessels recovered from the site, however, this seems unlikely. Pig remains are rare in the Mussau Lapita levels (Kirch 1997, p. 211, 2001b, p. 139), in contrast to their high frequency in post-Lapita contexts (Kirch et al. 1991, p. 149; Weisler 2001b, p. 180). Pig bones occur at the Middle Lapita site of Apalo (Gosden et al. 1989, table 4) and small quantities are claimed at Kamgot (Summerhayes 2007, p. 148), but in neither case is direct dating available and the duration of each deposit spans several hundred years. The oldest secure date is from Watom Island, where a tooth was directly dated to 2760–2547 cal BP (Beavan-Athfield et al. 2008, pp. 15–16).

On Nissan Island, pig bone was recovered from an aceramic context that overlaps in time with Lapita pottery (3650–3200 cal BP), but evidence for sediment disturbance weakens this claim (Spriggs 1991, table 7, 1997, pp. 80–81). On Buka and Guadalcanal islands, pig bone appears only in Late Lapita or post-Lapita contexts (Roe 1993, tables 4.27, 4.28; Wickler 2001). This contrasts with Remote Oceania, where pig bones are attributed by association to 3300–3000 cal BP at the Santa Cruz site of SZ-8 (Green 1976, p. 255; Green et al. 2008, p. 59), to 3060–2600 cal BP on Tikopia (Kirch and Yen 1982, p. 277, table 50), and to 2850–2490 cal BP on Taumako (Leach and Davidson 2008, appendix 12). If the presence of pig is confirmed at SZ-8, the oldest Lapita site in the Santa Cruz-Reef Islands, this would require pigs to have been present at the colonization of this region and, by implication, also present in the source region (presumably the Archipelago). As the pig bones have not been directly dated and the Lapita pottery layer displays later disturbance (Green 1976, p. 251; Green et al. 2008, p. 58), we reserve judgment on the age of the SZ-8 pig remains. Such an early presence conflicts with the absence of pigs from the oldest Lapita levels of Vanuatu, where they occur from ca. 2900 BP and later (Anderson 2009a, p. 1509; Galipaud 2000, pp. 48–49, 2010, p. 139; Horton and Ward 1981).

The only morphometric analysis of pig remains is from Taumako, which showed one form with sufficient differentiation from the hybrid New Guinea form to suggest that it was probably related to Indonesian pigs, which have their origin in MSEA, and not to the Chinese stock (Groves 2008b, pp. 412, 414). This conforms with genetic data that place Pacific pigs in the Pacific Clade (Dobney et al. 2008; Larson et al. 2007, pp. 4836–4837), which originated on MSEA and is distinct from the clade that supplied pigs to Taiwan, the Philippines, and Micronesia. Larson et al. (2007) could not extract aDNA from Lapita-period pig remains from the Archipelago but observed that the Pacific Clade haplotypes do not occur in modern and ancient specimens from mainland China and ISEA. They concluded that any human dispersal from Taiwan to the New Guinea region via the Philippines did not include the movement of domestic pigs. How this fits with Piper et al.'s (2009a) claim for a domestic form of pig at 4500–4200 cal BP at Nagsabaran remains to be seen. In summary, few pigs were present during the formative Lapita stage and in the initial dispersal into Remote Oceania. Genetic and morphometric analyses indicate a source in southern ISEA, with ultimate origins extending back to MSEA rather than north to East Asia.

Bulmer (2001) noted that the absence or scarcity of dog bones in New Guinea mainland sites could reflect cultural practices that reduced the survival chances of their remains. There is no evidence that such practices were widespread in the New Guinea region or have a long-standing history, and it would be unwise to interpret absence or scarcity solely in terms of such practices.

Dogs (*Canis familiaris*) were not present on New Guinea before Lapita times, despite claims to the contrary (Bulmer 2001, table 1; Swadling et al. 1991, p. 106), though molecular evidence suggests that the ancestor of dingoes and the New Guinea "singing dog" reached Australia–New Guinea possibly in the mid-Holocene (Matisoo-Smith 2009, p. 154; Savolainen et al. 2004). This is at odds with the archaeological evidence from ISEA, where dog remains are scarce and appear much later (Ochoa 2005; Piper et al. 2009b). A dog burial at Matja Kuru 2 on Timor is securely dated on bone to 3325–2975 cal BP (Veth et al. 2005, p. 184), whereas dog bones from a disturbed context in Ille cave on Palawan, Philippines, are of uncertain age but could be Neolithic (Ochoa 2005, pp. 53–54).

In the New Guinea highlands, dog remains appear with certainty only about 1000 BP or later (Bulmer 2001, table 1). The oldest remains in the coastal and lowland regions are dated by association to 2500–2350 cal BP near Caution Bay on the south coast (McNiven et al. 2012). Of 11 other contexts with dog remains on the south coast, none are older than 2000 years BP (Bulmer 2001, table 1; Irwin 1985). In the Siassi Islands between New Guinea and New Britain, dog bone occurs only after ca. 1500 cal BP (Lilley 1986, table 10.1).

In the Archipelago, there also are no dog remains in pre-Lapita contexts, and their presence in Early Lapita contexts is arguable (Matisoo-Smith 2007, table 10.1, 2009). They are reported in low frequencies throughout the Mussau sequence (Kirch et al. 1991, p. 154) but are absent from Middle Lapita contexts on Watom (Smith 2000), Nissan (Spriggs 1991), and Buka (Wickler 2001, p. 222). Dog teeth (two perforated) are reported from the Early Lapita site of Kamgot in New Ireland (Summerhayes 2000c, p. 171, 2007, p. 148) but attempts to date them directly have been unsuccessful (Summerhayes, personal communication 2011). The perforated teeth could be parts of ornaments imported from the west, like the jadeitite chisel on Emirau, and this, together with the apparent absence of other cranial or postcranial remains (Matisoo-Smith 2007, p. 160) and the 300–400-year span of the Lapita deposit at this site (Summerhayes 2001, table 1), raises doubts about dogs arriving with the first pottery. The oldest reliable date in the region is ca. 1900 BP on Buka (Flannery et al. 1988).

In the Santa Cruz-Reef Islands of northern Remote Oceania, dog bones first occur in plainware contexts loosely dated to after 3000 cal BP (Doherty 2009, p. 190). Similar Late or post-Lapita dates are claimed for Tikopia (Kirch and Yen 1982, p. 277, table 50) and Taumako (Smith 2008, table A3.1). Thus the presence of dogs during the formative Lapita phase in the Archipelago is questionable. Their apparent absence from sites associated with the initial Lapita dispersal into Remote Oceania may indicate they were introduced to the Archipelago later.

Domesticated chickens (*Gallus gallus*) had their origins on the Asian mainland (Liu et al. 2006), though the timing and direction of their dispersal into ISEA and the Pacific Islands remain unclear. There is scant evidence of chicken in ISEA before 3,500 years ago (Bellwood 2011; Spriggs 2011; see Lape 2000 for a possible exception) and no evidence for their presence in the New Guinea–Archipelago region before the Lapita period.

Chickens have a patchy distribution at Lapita sites (Storey et al. 2008). Only two sites have potential early chicken remains: Talepakemalai (Steadman and Kirch 1998) and Etakosarai (Kirch et al. 1991) in the Mussau group, but their relationship to Early Lapita pottery is unclear. A chicken bone reported from Watom Island (Specht 1968, p. 126) is dated directly to less than 700 cal BP (Storey, personal communication 2011).

Within Remote Oceania, there is considerable variation in the distribution and dating of chickens (Steadman 2006, tables 3.3, 5.12), though this and their patchy occurrence between New Guinea and Vanuatu may reflect taphonomic and sampling issues. There is, nevertheless, increasing evidence that chickens reached Remote Oceania with the initial colonists. Direct dating of chicken bones from Nenumbo in the Reef Islands (Beavan-Athfield et al. 2008, table 5A; Doherty 2009) and Teouma, Vanuatu (Storey et al. 2010), places them as contemporary with Lapita pottery at those sites (ca. 3100–2900 cal BP). It has yet to be demonstrated that chickens reached the New Guinea–Archipelago region with the first pottery, but they were certainly present in time to accompany the first colonists into Remote Oceania.

The Pacific rat (*Rattus exulans*) is widely accepted as an introduced form, probably as a fellow traveller with humans (Matisoo-Smith et al. 2009). Whether its introduction was deliberate or accidental remains uncertain. It first appears in New Ireland caves and rock shelters around the same time as Lapita pottery (Leavesley 2004, p. 161; Marshall and Allen 1991, table 13; White et al. 1991, table 5). Among Lapita sites, it is present at the Kamgot site (Summerhayes 2007, p. 148) but is not yet reported at other early Lapita sites. On genetic evidence the Archipelago forms belong to haplogroups II and III, which occur in Indonesia and the Philippines, indicating a derivation from southern or central ISEA (Matisoo-Smith et al. 2009).

An extension of interaction networks/spheres?

Kirch (1988b, 1995, p. 282) emphasized the significance of evidence for long-distance exchange or trade connections during the Lapita period as representing a major spatial extension of contacts compared with earlier periods. This view, however, confuses two very different mechanisms of obsidian dispersal. Prior to the Lapita dispersal out of the Archipelago, obsidian was traded between existing populations. Its transport into Remote Oceania, in contrast, was associated with a colonization movement (Irwin and Holdaway 1996), in which the transfer of obsidian was potentially part of a strategy to maintain connections between small fledgling colonies and their parent communities (Kirch 1988a, b).

Pre-Lapita movement of goods within the Archipelago involved obsidian from New Britain (Leavesley and Read 2011; Specht 2002; Torrence et al. 2009b), animals from New Guinea (Flannery and White 1991; Specht 2005), and perhaps stone mortars and pestles from New Guinea (Swadling 2004; Swadling et al. 2008; Torrence and Swadling 2008). The farthest extent of these movements is indicated by New Britain obsidian in late mid-Holocene contexts on Nissan and possibly Bougainville to the south of the Archipelago (Spriggs 1991; Torrence et al. 2009b), and a Manus obsidian tool found on Biak Island off northwest New Guinea that is assigned a mid-Holocene age on technological and stylistic grounds (Torrence et al. 2009b). If verified, the latter transfer represents the first evidence of the movement of obsidian beyond the Manus islands in pre-Lapita times (cf. Summerhayes 2003).

Interisland movement of goods also has a long history within ISEA, as obsidian in late Pleistocene and mid-Holocene contexts on Timor, Borneo, and the Talaud Islands almost certainly derived from off-island sources (Ambrose et al. 2009; Reepmeyer et al. 2011; Tykot and Chia 1997). Contacts with the New Guinea region in the early and mid-Holocene are attested by the recovery of marsupial faunal remains in prepottery contexts in Timor and the Talaud and northern Molucca Islands (Flannery et al. 1995, 1998).

The first clear evidence for contact between ISEA and the Archipelago comes from the transfer of pottery technology, followed by the commensal animals discussed above. In the reverse direction, New Britain obsidian occurs at Bukit Tengkorak on Borneo in contexts contemporary with Middle Lapita (Bellwood and Koon 1989; Bird 1989). A piece of Manus obsidian at Bukit Tengkorak on Borneo (Tykot and Chia 1997, p. 177) and an unstratified piece of New Britain obsidian from Cebu Island, Philippines (Reepmeyer et al. 2011), are of questionable relevance as neither piece is dated, though Spriggs et al. (2011) assign the Bukit Tengkorak find to the Neolithic.

Within much of the Archipelago the appearance of Lapita pottery saw only minor changes in the distribution patterns of goods moved between islands in earlier times. The main change was the undoubted inclusion of the Manus Islands in exchange networks. Obsidian and finished pots, or the raw materials for making them, were transported to the Mussau Islands (Hunt 1989) from the formative Lapita period onward, and Manus obsidian appears elsewhere in the Archipelago in Middle and Late Lapita contexts (Specht 2002; Summerhayes 2003). Interisland movement of pigs and people occurred during Middle Lapita times (Shaw et al. 2009), though evidence is currently limited to Watom Island, and the place of origin of each is unknown. For pottery, Dickinson (2006, p. 76, table 25 C2, E5-7) includes the islands off the east coast of New Ireland as possible sources for some Mussau pots and suggests a possible Manus and New Ireland–New Hanover origin for some Watom vessels. The Lapita pottery on Nissan was imported from Buka and the New Britain–New Ireland region (Dickinson 2006, table 25D9; Spriggs 1991, p. 239). A few vessels were moved between New Britain and its offshore islands (Dickinson 2000; Specht and Summerhayes 2007; Summerhayes 2000b, fig. 11.36; Thomson and White 2000), but most Lapita pottery was produced and circulated only locally.

These movements reflect essentially an increase of intensity of interactions within the Archipelago and, with the exception of Bukit Tengkorak on Borneo in Middle Lapita times, without significant geographical extension. The Borneo connection with the Archipelago continued after Lapita. Two undated double-spouted pots found in the Manus Islands show “a singular similarity” (Kennedy 1982, p. 28) to vessels of uncertain age in Niah caves in Sarawak (Harrison 1971), and a piece of bronze of probable ISEA origin found on Manus is assigned a post-Lapita date (Ambrose 1988).

In summary, there is evidence in pre-Lapita times of long-term interaction between ISEA and New Guinea and between New Guinea and the Archipelago, but not for direct interaction between ISEA and the Archipelago. This lack of evidence may reflect the small number of sourcing studies of materials rather than evidence for absence of contacts, as even limited work on obsidian sourcing in ISEA has shown extensive interisland movement in pre-Neolithic times. However, the changing nature and extension of interisland interaction with the advent of Lapita pottery are unclear.

Discussion and conclusions

The volume and quality of archaeological evidence varies greatly among Lapita pottery sites. This variability reflects sample bias arising from excavation strategies, taphonomic processes, and the nature of activities conducted in the excavated areas, as well as the actual absence or presence of particular kinds of evidence. Setting aside these problems and speculation about what *might* be found in future excavations, we now pull together the various strands discussed above.

Three points stand out. We see no evidence for a significant change in subsistence and settlement with the introduction of pottery making. The introduction of pigs (and possibly chickens) no doubt resulted over time in the development of new land management strategies through fencing to protect cultivation plots from the predations of pigs. Horticultural and arboricultural practices, however, do not show a marked change with the advent of Lapita pottery. Second, there is temporal variation in the appearance of individual elements within the Archipelago that we interpret to indicate introductions at different times. The third point relates to the spatially variable or patchy distributions of certain elements, especially the commensal animals and categories of shell artifacts.

Together these points show that there is no archaeological signature for the arrival of a package of introduced elements from ISEA that was adopted in its entirety immediately or universally throughout the Archipelago. Previous papers that made similar points were not based on such a comprehensive review of the archaeological evidence. Given the length of time over which the various elements reached the Archipelago, a single, common origin is highly improbable (Kirch 1995, p. 282). The possibility of pottery being introduced from Micronesia independent of other elements (Carson and Kurashina 2012; Hung et al. 2011) underlines the principle that the various cultural elements may have had quite separate histories (Terrell and Welsch 1997, p. 568).

The LCC has been described as a polythetic set of cultural elements to explain the patchy distribution of cultural elements across its spatial and temporal distribution (Green 1992, p. 15; Kirch 1995, p. 282; cf. Spriggs 2011, p. 517 for ISEA). Instead, we propose a situation of intermittent transfers over several hundred years beginning ca. 3400 cal BP and perhaps lasting six to ten human generations prior to dispersal into Remote Oceania. This recalls Higham's (2011, p. 645) view of the spread of the Neolithic through MSEA as "a series of trickles … rather than a flood" of changes.

Such a perspective disestablishes and goes beyond Green's Triple-I model (Green 1991a, 2000, 2003). Sequential incarnations of this model are still predicated on viewing the LCC as a fundamentally intrusive cultural horizon with a distinctive archaeological signature, with interaction as a postintrusion process. The archaeological evidence does not support this version for the Archipelago.

Supporters of the migration-based OT theory have summarily dismissed the idea of interaction, which we extend to geographic mobility in all its forms, as a significant mechanism for explaining cultural changes in southern ISEA and the Archipelago (Bellwood 2011; Spriggs 1995, 2011; Summerhayes 2010a). This is based on a narrow interpretation of what geographic mobility entails, what the outcomes can be, and the length of time over which it is maintained.

Discussions of the spread of the ISEA Neolithic and Lapita expansion have drawn attention to the nature of watercraft and their sailing capabilities (Anderson 2000; Irwin 1992, 2008, 2010). The pre-Neolithic watercraft and the skills of their navigators were clearly adequate for the repeated transportation of animals, obsidian, and people between islands for many millennia before the putative arrival of Austronesian-speaking migrants. Improvements to the watercraft in ISEA did not initiate interisland mobility but enhanced it, probably contributing to the extension of pre-Lapita networks and adding the capacity for long-distance sea crossings. This undoubtedly also contributed to the rapid dispersal of Lapita pottery makers into Remote Oceania.

We question the advisability of using the Remote Oceania evidence as a proxy for what took place in the Archipelago. The material culture and practices that were transported into Remote Oceania were not present as a coherent set of cultural forms in the Archipelago from the first introduction of pottery making. Variations among sites there reflect, *inter alia*, introductions or developments over several centuries that included pottery, animals, and some shell artifacts. Other aspects of social life, however, exhibit clear continuities before and after the advent of Lapita pottery, including various types of technology, subsistence practices, and forms of geographic mobility.

The patchy pattern of introductions resembles the situation described by Thomas (2003) for nondietary elements of the British Neolithic. He interprets this historical pattern to reflect the availability of a "repertoire" of elements that individuals and groups could adopt or reject. A similar situation may have prevailed within the Archipelago.

Finally, this review is based solely on archaeological and palaeo-environmental data without recourse to historical linguistics or human genetics to fill gaps in the evidence. These latter disciplines do not provide the relatively fine temporal resolution obtainable from chronometric techniques applied to archaeologically recovered materials or the specificities of place and association that archaeology offers. The picture that emerges from the archaeological data alone, on the other hand, is rich and has better chronological controls. Most importantly, it can open the way to more nuanced interpretations of human history of the islands of the western Pacific.

Acknowledgments We thank David Bulbeck and Mark Golitko for comments on an early draft of the paper, and Carol Lentfer, Katherine Szabó, and Alice Storey for comments on specific sections. We also thank Wallace Ambrose, Stuart Bedford, Peter Bellwood, David Burley, Judith Cameron, Scarlett Chiu, Hung Hsiao-chun, Yoshiyuki Iizuka, Patrick Vinton Kirch, Li Kuang-ti, Rintaro Ono, Christian Reepmeyer, Peter Sheppard, Glenn Summerhayes, Kazuhiko Tanaka, Tsang Cheng-hwa, and Olaf Winter for information and/or access to collections. Peter Bellwood, Hung Hsiao-chun, Patrick Vinton Kirch, Glenn Summerhayes, and Peter White gave permission to reproduce illustrations from their publications, now redrawn along with Figures 1 and 2 by Ming Wei (La Trobe University). We thank four anonymous referees, Peter Sheppard and Katherine Szabó for their insightful and detailed comments, and Gary Feinman and Linda Nicholas for their editorial assistance.

References cited

Addison, D., and Matisoo-Smith, E. (2010). Rethinking Polynesian origins: A West Polynesia Triple-I model. *Archaeology in Oceania* **45:** 1–12.

Allen, J. (1984). In search of the Lapita homeland: Reconstructing the prehistory of the Bismarck Archipelago. *Journal of Pacific History* **19:** 186–201.

Allen, J. (2000). From beach to beach: The development of maritime economies in prehistoric Melanesia. In O'Connor, S., and Veth, P. (eds.), *East of Wallace's Line: Studies of Past and Present Maritime Cultures of the Indo-Pacific Region*, Modern Quaternary Research in Southeast Asia 16, A. A. Balkema, Rotterdam, pp. 139–176.

Allen, J., and Gosden, C. (1996). Spheres of interaction: Modelling the culture history of the Bismarck Archipelago. In Davidson, J., Irwin, G., Leach, B. F., Pawley, A., and Brown, D. (eds.), *Oceanic Culture History: Essays in Honour of Roger Green*, New Zealand Journal of Archaeology, Dunedin, pp. 183–197.

Allen, J., and O'Connell, J. F. (2010). First humans in Melanesia: A review of recent data. In Sand, C., and Bedford, S. (eds.), *Lapita: Ancêtres océaniens/Oceanic Ancestors*, Musée du Quai Branly and Somogy Éditions d'Art, Paris, pp. 42–57.

Allen, J., and White, J. P. (1989). The Lapita homeland: Some new data and an interpretation. *Journal of the Polynesian Society* **98:** 129–146.

Ambrose, W. (1988). An early bronze artefact from Papua New Guinea. *Antiquity* **62:** 483–491.

Ambrose, W. R. (1997). Contradictions in Lapita pottery: A composite clone. *Antiquity* **71:** 525–538.

Ambrose, W. R. (1999). Curves, tines, scutes and Lapita ware. In Galipaud, J.-C., and Lilley, I. (eds.), *The Pacific from 5000 to 2000 BP: Colonisation and Transformations,* IRD Éditions, Paris, pp. 119–126.

Ambrose, W. (2007). The implements of Lapita ceramic stamped ornamentation. In Bedford, S., Sand, C., and Connaughton, S. (eds.), *Oceanic Explorations: Lapita and Western Pacific Settlement*, Terra Australis 26, ANU E-Press, Canberra, pp. 213–221.

Ambrose, W. R. (2012). Oceanic tattooing and the implied Lapita ceramic connection. *Journal of Pacific Archaeology* **3:** 1–21.

Ambrose, W. R., Allen, C., O'Connor, S., Spriggs, M., Oliveira, N. V., and Reepmeyer, C. (2009). Possible obsidian sources for artefacts from Timor: Narrowing the options using chemical data. *Journal of Archaeological Science* **36:** 607–615.

Anderson, A. J. (2000). Slow boats from China: Issues in the prehistory of Indo-Pacific seafaring. In O'Connor, S., and Veth, P. (eds.), *East of Wallace's Line: Studies of Past and Present Maritime Cultures of the Indo-Pacific*, Modern Quaternary Research in Southeast Asia 16, A. A. Balkema, Rotterdam, pp.13–50.

Anderson, A. (2009a). The rat and the octopus: Initial human colonization and the prehistoric introduction of domestic animals to Remote Oceania. *Biological Invasions* **11:** 1503–1519.

Anderson, A. (2009b). Epilogue: Changing archaeological perspectives upon historical ecology in the Pacific Islands. *Pacific Science* **63:** 747–757.

Anon. (1962). Table of accidental and deliberate voyages in the South Pacific. In Golson, J. (ed.), *Polynesian Navigation: A Symposium on Andrew Sharp's Theory of Accidental Voyages*, The Polynesian Society, Wellington, pp. 137–153.

Anson, D. (1986). Lapita pottery of the Bismarck Archipelago and its affinities. *Archaeology in Oceania* **21:** 157–165.

Anson, D. (2000). Excavations at Vunavaung (SDI), Watom Island, Papua New Guinea. *New Zealand Journal of Archaeology* **20** [1998]: 95–118.

Aoyagi, Y., Aguilera Jr., M. L., Ogawa, H., and Tanaka, K. (1991). Excavation of the La-lo shell-middens 3. *The Journal of Sophia Asian Studies* **9:** 49–137 (in Japanese with English summary).

Aoyagi, Y., Aguilera Jr., M. L., Ogawa, H., and Tanaka, K. (1993). Excavation of Hill Top site, Magapit shell midden in Lal-lo shell middens, northern Luzon, Philippines. *Man and Culture in Oceania* **9:** 127–155.

Ayliffe, L. K., Bird, M. I., Gagan, M. K., Isdale, P. J., Scott-Gagan, H., Parker, B., Griffin, D., Nongkas, M., and McCulloch, M. T. (2004). Geochemistry of coral from Papua New Guinea as a proxy for ENSO ocean–atmosphere interactions in the Pacific Warm Pool. *Continental Shelf Research* **24:** 2343–2356.

Barker, G., Hunt, C., and Carlos, J. (2011). Transitions to farming in Island Southeast Asia: Archaeological, biomolecular and palaeoecological perspectives. In Barker, G., and Janowski, M. (eds.), *Why Cultivate? Anthropological and Archaeological Approaches to Foraging–Farming Transitions in Southeast Asia*, McDonald Institute for Archaeological Research, Cambridge, pp. 61–74.

Barton, H. (2005). The case for rainforest foragers: The starch record at Niah cave, Sarawak. *Asian Perspectives* **44:** 56–72.

Barton, H., and Denham, T. P. (2011). Prehistoric vegeculture and social life in Island Southeast Asia and Melanesia. In Barker, G., and Janowski, M. (eds.), *Why Cultivate? Anthropological and*

Archaeological Approaches to Foraging–Farming Transitions in Southeast Asia, McDonald Institute for Archaeological Research, Cambridge, pp. 17–25.
Barton, H., and Paz, V. (2007). Subterranean diets in the tropical rain forests of Sarawak, Malaysia. In Denham, T., Iriarté, J., and Vrydaghs, L. (eds.), *Rethinking Agriculture: Archaeological and Ethnoarchaeological Perspectives*, Left Coast Press, Walnut Creek, CA, pp. 50–77.
Barton, H., and White, J. P. (1993). Use of stone and shell artifacts at Balof 2, New Ireland, Papua New Guinea. *Asian Perspectives* **32:** 169–181.
Baudouin, L., and Lebrun, P. (2008). Coconut (*Cocos nucifera* L.) DNA studies support the hypothesis of an ancient Austronesian migration from Southeast Asia to America. *Genetic Resources and Crop Evolution* **56:** 257–262.
Beavan-Athfield, N., Green, R. C., Craig, J., McFadgen, B., and Bickler, S. (2008). Influence of marine resources on ^{14}C ages: Isotopic data from Watom Island, Papua New Guinea, inhumations and pig teeth in light of new dietary standards. *Journal of the Royal Society of New Zealand* **38:** 1–23.
Beavitt, P., Kurui, E., and Thompson, G. (1996). Confirmation of an early date for the presence of rice in Borneo: Preliminary evidence for possible Bidayuh/Asian links. *Borneo Research Bulletin* **27:** 29–38.
Bedford, S. (2006). The Pacific's earliest painted pottery: An added layer of intrigue to the Lapita debate and beyond. *Antiquity* **80:** 544–557.
Bedford, S., and Spriggs, M. (2007). Birds on the rim: A unique Lapita carinated vessel in its wider context. *Archaeology in Oceania* **42:** 12–21.
Bedford, S., Spriggs, M., Buckley, H., Valentin, F., Regenvanu, R., and Abong, M. (2010). A cemetery of first settlement: The site of Teouma, South Efate, Vanuatu. In Sand, C., and Bedford, S. (eds.), *Lapita: Ancêtres océaniens/Oceanic Ancestors*, Musée du Quai Branly and Somogy Éditions d'Art, Paris, pp. 146–161.
Bellwood, P. (1976). Archaeological research in Minahasa and the Talaud Islands, north-eastern Indonesia. *Asian Perspectives* **19:** 240–288.
Bellwood, P. (1984–1985). A hypothesis for Austronesian origins. *Asian Perspectives* **26:** 107–117.
Bellwood, P. (1985). *Prehistory of the Indo-Malaysian Archipelago*, Academic Press Australia, North Ryde, NSW.
Bellwood, P. (1992). New discoveries in Southeast Asia relevant for Melanesian (especially Lapita) prehistory. In Galipaud, J.-C. (ed.), *Poterie Lapita et peuplement*, ORSTOM, Noumea, pp. 49–66.
Bellwood, P. (1995). Austronesian prehistory in Southeast Asia: Homeland, expansion and transformation. In Bellwood, P., Fox, J. J., and Tryon, D. (eds.), *The Austronesians: Historical and Comparative Perspectives*, Department of Anthropology, Australian National University, Canberra, pp. 96–111.
Bellwood, P. (1996). The origins and spread of agriculture in the Indo-Pacific region: Gradualism and diffusion or revolution and colonization? In Harris, D. R. (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia*, UCL Press, London, pp. 465–498.
Bellwood, P. (1997). *Prehistory of the Indo-Malaysian Archipelago*, University of Hawaii Press, Honolulu.
Bellwood, P. (2005). *First Farmers: The Origins of Agricultural Societies*, Blackwell, Oxford.
Bellwood, P. (2011). Holocene history in the Pacific region as a model for worldwide food producer dispersals. *Current Anthropology* **52:** S363–S378.
Bellwood, P., and Dizon, E. (2008). Austronesian cultural origins: Out of Taiwan, via the Batanes Islands, and onwards to Western Polynesia. In Sanchez-Mazas, A., Blench, R., Ross, M. D., Peiros, I., and Lin, M. (eds.), *Past Human Migrations in East Asia: Matching Archaeology, Linguistics and Genetics*, Routledge, London, pp. 23–39.
Bellwood, P., and Koon, P. (1989). 'Lapita colonists leave boats unburned!' The question of Lapita links with Island Southeast Asia. *Antiquity* **63:** 613–622.
Bellwood, P., Nitihaminoto, G., Irwin, G., Gunadi, Waluyo, A., and Tanudirjo, D. (1998). 35,000 years of prehistory in the northern Moluccas. In Bartstra, G.-J. (ed.), *Bird Head Approaches: Irian Jaya Studies, a Programme for Interdisciplinary Research*, A. A. Balkema, Rotterdam, pp. 233–275.
Bellwood, P., Stevenson, J., Dizon, E., Mijares, A., Lacsina, G., and Robles, E. (2008). Where are the Neolithic landscapes of Ilocos Norte? *Hukay. Journal of Archaeological Research in Asia and the Pacific* **13:** 25–38.
Bellwood, P., Chambers, G., Ross, M., and Hung, H.-C. (2011). Are 'cultures' inherited? Multidisciplinary perspectives on the origins and migrations of Austronesian-speaking peoples prior to

1000 BC. In Roberts, B. W., and vander Linden, M. (eds.), *Investigating Archaeological Cultures: Material Culture, Variability and Transmission*, Springer, New York, pp. 321–354.

Berdin, R., Siringan, F., and Maeda, Y. (2003). Holocene relative sea-level changes and mangrove response in southwest Bohol, Philippines. *Journal of Coastal Research* **19:** 304–313.

Bird, J. R. (1989). Sabah obsidian analysis. *Indo-Pacific Prehistory Association Bulletin* **9:** 161–162.

Boyd, W. E., Specht, J., and Webb, J. (1999). Holocene shoreline change and archaeology on the Kandrian coast of West New Britain, Papua New Guinea. In Hall, J., and McNiven, I. J. (eds.), *Australian Coastal Archaeology*, Research Papers in Archaeology and Natural History 31, ANH Publications, Canberra, pp. 283–287.

Bradshaw, J. (1997). The population kaleidoscope: Another factor in the Melanesian diversity v. Polynesian homogeneity debate. *Journal of the Polynesian Society* **106:** 222–249.

Bulbeck, D. (2008). An integrated perspective on the Austronesian diaspora: The switch from cereal agriculture to maritime foraging in the colonisation of Island Southeast Asia. *Australian Archaeology* **67:** 31–51.

Bulbeck, F. D., and Nasruddin (2002). Recent insights on the chronology and ceramics of the Kalumpang site complex, South Sulawesi, Indonesia. *Indo-Pacific Prehistory Association Bulletin* **22:** 83–99.

Bulmer, S. (1975). Settlement and economy in prehistoric Papua New Guinea. *Journal de la Société des Océanistes* **31:** 7–75.

Bulmer, S. (2001). Lapita dogs and singing dogs and the history of the dog in New Guinea. In Clark, G. R., Anderson, A. J., and Vunidilo, T. (eds.), *The Archaeology of Lapita Dispersal in Oceania*, Terra Australis **17**, Pandanus Books, Canberra, pp. 183–201.

Bureau of Meteorology. (2002). *El Niño and La Niña: Important Ocean Phenomena*, South Pacific Sea Level and Climate Monitoring Project (http://www.bom.gov.au/pacificsealevel/pdf/Elnino_and_La_Nina.pdf).

Burton, J. (1989). Repeng and the salt-makers: 'Ecological trade' and stone axe production in the Papua New Guinea Highlands. *Man* (N.S.) **24:** 255–272.

Burton, J. (2003). Fratricide and inequality: Things fall apart in eastern New Guinea. *Archaeology in Oceania* **38:** 203–216.

Butler, B. M. (ed.) (1995). *Archaeological Investigations in the Achugao and Matansa Areas of Saipan, Mariana Islands*, Micronesian Archaeological Survey Report 30, Division of Historic Preservation, Commonwealth of the Northern Mariana Islands, Saipan.

Carson, M. T. (2008). Refining earliest settlement in Remote Oceania: Renewed archaeological investigation at Unai Bapot, Saipan. *Journal of Island and Coastal Archaeology* **3:** 115–139.

Carson, M. T., and Kurashina, H. (2012). Re-envisioning long-distance Oceanic migration: Early dates in the Mariana Islands. *World Archaeology* **44:** 409–435.

Chiu, S. (2005). Meanings of a Lapita face: Materialized social memory in ancient house societies. *Taiwan Journal of Anthropology* **3:** 1–47.

Chowning, A. (1986). Refugees, traders, and other wanderers: The linguistic effects of population mixing in Melanesia. In Geraghty, P., Carrington, L., and Wurm, S. A. (eds.), *FOCAL II: Papers from the Fourth International Conference on Austronesian Linguistics*, Pacific Linguistics C-94, Department of Linguistics, Australian National University, Canberra, pp. 407–434.

Christensen, O. A. (1975). Hunters and horticulturalists: A preliminary report of the 1972–1974 excavations in the Manim Valley, Papua New Guinea. *Mankind* **10:** 24–36.

Cooke, R. J. (1981). Eruptive history of the volcano at Ritter Island. In Johnson, R. W. (ed.), *Cooke-Ravian Volume of Volcanological Papers*, Geological Survey of Papua New Guinea Memoir 10, Geological Survey of Papua New Guinea, Port Moresby, pp. 115–123.

Craig, B. (2005). What can material culture studies tell us about the past in Papua New Guinea? In Pawley, A., Attenborough, R., Golson, J., and Hide, R. (eds.), *Papuan Pasts: Cultural, Linguistic and Biological Histories of Papuan-speaking Peoples*, Pacific Linguistics 572, Australian National University, Canberra, pp. 493–513.

Crowther, A. (2005). Starch residues on undecorated Lapita pottery from Anir, New Ireland. *Archaeology in Oceania* **40:** 62–66.

Crowther, A. (2009). *Investigating Lapita Subsistence and Pottery Use Through Microscopic Residues on Ceramics: Methodological Issues, Feasibility, and Potential*, Ph.D. dissertation, School of Social Sciences, University of Queensland, St. Lucia, Australia.

David, B., McNiven, I. J., Richards, T., Connaughton, S. P., Leavesley, M., Barker, B., and Rowe, C. (2011). Lapita sites in the central province of mainland Papua New Guinea. *World Archaeology* **43:** 576–593.

Davidson, J. (2012). Intrusion, integration and innovation on small and not-so-small islands with particular reference to Samoa. *Archaeology in Oceania* **47:** 1–13.
Denham, D. (1969). Distribution of earthquakes in the New Guinea-Solomon Islands region. *Journal of Geophysical Research* **74:** 4290–4299.
Denham, T. P. (2003a). Archaeological evidence for mid-Holocene agriculture in the interior of Papua New Guinea: A critical review. *Archaeology in Oceania* **38:** 159–176.
Denham, T. P. (2003b). *The Kuk Morass: Multi-Disciplinary Investigations of Early to Mid-Holocene Plant Exploitation at Kuk Swamp, Wahgi Valley, Papua New Guinea*, Ph.D. dissertation, Department of Archaeology and Natural History, Australian National University, Canberra.
Denham, T. P. (2004). The roots of agriculture and arboriculture in New Guinea: Looking beyond Austronesian expansion, Neolithic packages and indigenous origins. *World Archaeology* **36:** 610–620.
Denham, T. P. (2007). Early to mid-Holocene plant exploitation in New Guinea: Towards a contingent interpretation of agriculture. In Denham, T., Iriarté, J., and Vrydaghs, L. (eds.), *Rethinking Agriculture: Archaeological and Ethnoarchaeological Perspectives*, Left Coast Press, Walnut Creek, CA, pp. 78–108.
Denham, T. P. (2010). From domestication histories to regional prehistory: Using plants to re-evaluate early and mid-Holocene interaction between New Guinea and Southeast Asia. *Food and History* **8:** 3–22.
Denham, T., and Donohue, M. (2009). Pre-Austronesian dispersal of banana cultivars West from New Guinea: Linguistic relics from Indonesia. *Archaeology in Oceania* **44:** 18–28.
Denham, T. P., Haberle, S. G., Lentfer, C., Fullagar, R., Field, J., Therin, M., Porch, N., and Winsborough, B. (2003). Origins of agriculture at Kuk swamp in the highlands of New Guinea. *Science* **301:** 189–193.
Denham, T., Haberle, S., and Lentfer, C. (2004). New evidence and revised interpretations of early agriculture in highland New Guinea. *Antiquity* **78:** 839–857.
Denham, T., Bronk Ramsey, C., and Specht, J. (2012). Dating the appearance of Lapita pottery in the Bismarck Archipelago and its dispersal to Remote Oceania. *Archaeology in Oceania* **47:** 39–46.
Dickinson, W. R. (2000). Petrography of sand tempers in prehistoric Watom sherds and comparison with temper suites of the Bismarck Archipelago. *New Zealand Journal of Archaeology* **20** [1998]: 161–182.
Dickinson, W. R. (2001). Palaeoshoreline record of relative Holocene sea levels on Pacific Islands. *Earth-Science Reviews* **55:** 191–234.
Dickinson, W. R. (2006). *Temper Sands in Prehistoric Oceanian Pottery: Geotectonics, Sedimentology, Petrography, Provenance*, Special Paper 406, Geological Society of America, Boulder, CO.
Dobney, K., Cucchi, T., and Larson, G. (2008). The pigs of Southeast Asia and the Pacific: New evidence for taxonomic status and human-mediated dispersal. *Asian Perspectives* **47:** 59–74.
Doherty, C., Beavitt, P., and Kurui, E. (2000). Recent observations of rice temper in pottery from Niah and other sites in Sarawak. *Indo-Pacific Prehistory Association Bulletin* **20:** 147–152.
Doherty, M. (2009). The post-Lapita sequence in the Reef/Santa Cruz Islands, Southeast Solomon Islands. In Sheppard, P. J., Thomas, T., and Summerhayes, G. R. (eds.), *Lapita: Ancestors and Descendants*, Monograph 28, New Zealand Archaeological Association, Auckland, pp. 181–213.
Donders, T. H., Wagner, F., Dilcher, D. L., and Visscher, H. (2005). Mid- to late-Holocene El Niño-Southern Oscillation dynamics reflected in the subtropical terrestrial realm. *Proceedings of the National Academy of Sciences* **102:** 10,904–10,908.
Donohue, M., and Denham, T. (2010). Farming and language in Island Southeast Asia: Reframing Austronesian history. *Current Anthropology* **51:** 223–256.
Dwyer, P. D., and Minnegal, M. (1997). Sago games: Cooperation and change among sago producers of Papua New Guinea. *Evolution and Human Behavior* **18:** 89–108.
Enright, N. J., and Gosden, C. (1992). Unstable archipelagos: Southwest Pacific environment and prehistory since 30,000 BP. In Dodson, J. (ed.), *The Naive Lands: Prehistory and Environmental Change in Australia and the Southwest Pacific*, Longman Cheshire, Melbourne, pp. 160–198.
Fairbairn, A., and Swadling, P. (2005). Re-dating mid-Holocene betelnut (*Areca catechu* L.) and other plant use at Dongan, PNG. *Radiocarbon* **47:** 377–382.
Felgate, M. W. (2007). Leap-frogging or limping? Recent evidence from the Lapita littoral fringe, New Georgia, Solomon Islands. In Bedford, S., Sand, C., and Connaughton, S. (eds.), *Oceanic Explorations: Lapita and Western Pacific Settlement*, Terra Australis 26, ANU E-Press, Canberra, pp. 123–140.

Flannery, T. F., and White, J. P. (1991). Animal translocations: Zoogeography of New Ireland mammals. *National Geographic Research and Exploration* **7:** 96–113.
Flannery, T. F., Kirch, P. V., Specht, J., and Spriggs, M. (1988). Holocene mammal faunas from archaeological sites in Island Melanesia. *Archaeology in Oceania* **23:** 89–94.
Flannery, T. F., Bellwood, P., White, J. P., Moore, A., Boeadi, and Nitihaminoto, G. (1995). Fossil marsupials (Macropodidae, Perocytidae) and other mammals of Holocene age from Halmahera, north Moluccas, Indonesia. *Alcheringa* **19:** 17–25.
Flannery, T. F., Bellwood, P., White, J. P., Ennis, T., Irwin, G., Schubert, K., and Balasubramaniam, S. (1998). Mammals from Holocene archaeological deposits on Gebe and Morotai Islands, northern Moluccas, Indonesia. *Australian Mammalogy* **20:** 391–400.
Fox, R. B. (1970). *The Tabon Caves: Archaeological explorations and excavations on Palawan Island, Philippines*, Monograph 1, National Museum of the Philippines, Manila.
Fredericksen, C. (1994). *Patterns in Glass: Obsidian and Economic Specialisation in the Admiralty Islands*, Ph.D. dissertation, Department of Archaeology and Natural History, Australian National University, Canberra.
Fredericksen, C., Spriggs, M., and Ambrose, W. (1993). Pamwak rockshelter: A Pleistocene site on Manus Island, Papua New Guinea. In Smith, M. A., Spriggs, M., and Fankhauser, B. (eds.), *Sahul in Review: Pleistocene Archaeology in Australia and Island Melanesia*, Occasional Papers in Prehistory 24, Department of Prehistory, Australian National University, Canberra, pp. 144–154.
Frimigacci, D. (1980). Localisation éco-géographique et utilisation de l'espace de quelques sites Lapita de Nouvelle-Calédonie. *Journal de la Société des Océanistes* **66–67:** 5–11.
Fullagar, R., Field, J., Denham, T., and Lentfer, C. (2006). Early and mid-Holocene tool-use and processing of taro (*Colocasia esculenta*), yam (*Dioscorea* sp.) and other plants at Kuk swamp in the highlands of Papua New Guinea. *Journal of Archaeological Science* **33:** 595–614.
Gagan, M. K., Hendy, E. J., Haberle, S. G., and Hantoro, W. S. (2004). Post-glacial evolution of the Indo-Pacific Warm Pool and El Niño-Southern oscillation. *Quaternary International* **118:** 127–143.
Galipaud, J.-C. (2000). The Lapita site at Atanoasao, Malo, Vanuatu. *World Archaeological Bulletin* **12:** 41–55.
Galipaud, J.-C. (2010). Makué and Shokraon: Earliest arrivals and cultural transformations in northern Vanuatu. In Sand, C., and Bedford, S. (eds.), *Lapita: Ancêtres océaniens/Oceanic Ancestors*, Musée du Quai Branly and Somogy Éditions d'Art, Paris, pp. 138–139.
Garling, S. (2003). Tanga takes the stage: Another model 'transitional' site? New evidence and a contribution to the 'incised and applied relief tradition' in New Ireland. In Sand, C. (ed.), *Pacific Archaeology: Assessments and Prospects*, Les Cahiers de l'Archéologie en Nouvelle-Calédonie 15, Service des Musées et du Patrimoine de Nouvelle-Calédonie, Noumea, pp. 213–233.
Goff, J., McFadgen, B. G., Chagué-Goff, C., and Nichol, S. L. (2012). Palaeotsunamis and Polynesian settlement. *The Holocene* **22:** 1067–1069.
Golson, J. (1977). No room at the top: Agricultural intensification in the New Guinea Highlands. In Allen, J., Golson, J., and Jones, R. (eds.), *Sunda and Sahul: Prehistoric Studies in Southeast Asia, Melanesia and Australia*, Academic Press, London, pp. 601–638.
Golson, J. (2001). New Guinea, Australia and the Sahul connection. In Anderson, A., Lilley, I., and O'Connor, S. (eds.), *Histories of Old Ages: Essays in Honour of Rhys Jones*, Pandanus Books, Canberra, pp. 185–210.
Golson, J. (2005). The middle reaches of New Guinea history. In Pawley, A., Attenborough, R., Golson, J., and Hide, R. (eds.), *Papuan Pasts: Cultural, Linguistic and Biological Histories of Papuan-Speaking Peoples*, Pacific Linguistics 572, Australian National University, Canberra, pp. 451–491.
Goodale, J. C. (1995). *To Sing with Pigs Is Human*, University of Washington Press, Seattle.
Gorecki, P., Mabin, M., and Campbell, J. (1991). Archaeology and geomorphology of the Vanimo coast, Papua New Guinea: Preliminary results. *Archaeology in Oceania* **26:** 119–122.
Gosden, C. (1994). *Social Being and Time*, Blackwell, Oxford.
Gosden, C. (1995). Arboriculture and agriculture in coastal Papua New Guinea. *Antiquity* **69:** 807–817.
Gosden, C., and Webb, J. (1994). The creation of a Papua New Guinean landscape: Archaeological and geomorphological evidence. *Journal of Field Archaeology* **21:** 29–51.
Gosden, C., Allen, J., Ambrose, W., Anson, D., Golson, J., Green, R., Kirch, P., Lilley, I., Specht, J., and Spriggs, M. (1989). Lapita sites of the Bismarck Archipelago. *Antiquity* **63:** 561–586.
Gosden, C., Webb, J., Marshall, B., and Summerhayes, G. R. (1994). Lolmo Cave: A mid- to late Holocene site, the Arawe Islands, West New Britain Province, Papua New Guinea. *Asian Perspectives* **33:** 97–119.

Gosden, J. (1992). Dynamic traditionalism: Lapita as a long term social structure. In Galipaud, J.-C. (ed.), *Poterie Lapita et peuplement*, ORSTOM, Noumea, pp. 21–26.
Green, R. C. (1976). Lapita sites in the Santa Cruz Group. In Green, R. C., and Cresswell, M. M. (eds.), *Southeast Solomon Islands Cultural History: A Preliminary Survey*, Bulletin 11, Royal Society of New Zealand, Wellington, pp. 245–265.
Green, R. C. (1979a). Lapita. In Jennings, J. D. (ed.), *The Prehistory of Polynesia*, Harvard University Press, Cambridge, MA, pp. 27–60.
Green, R. C. (1979b). Early Lapita art from Polynesia and island Melanesia: Continuities in ceramic, barkcloth, and tattoo decoration. In Mead, S. M. (ed.), *Exploring the Visual Art of Oceania*, University Press of Hawaii, Honolulu, pp. 13–31.
Green, R. C. (1991a). The Lapita Cultural Complex: Current evidence and proposed models. *Indo-Pacific Prehistory Association Bulletin* **11:** 295–305.
Green, R. C. (1991b). Near and Remote Oceania: Disestablishing "Melanesia" in culture history. In Pawley, A. (ed.), *Man and a Half: Essays in Pacific Anthropology and Ethnobiology in Honour of Ralph Bulmer*, Polynesian Society, Auckland, pp. 491–502.
Green, R. C. (1992). Definitions of the Lapita Cultural Complex and its non-ceramic component. In Galipaud, J.-C. (ed.), *Poterie Lapita et peuplement*, ORSTOM, Noumea, pp. 7–20.
Green, R. C. (1997). Linguistic, biological, and cultural origins of the initial inhabitants of Remote Oceania. *New Zealand Journal of Archaeology* **17:** 5–27.
Green, R. C. (2000). Lapita and the cultural models for intrusion, integration and innovation. In Anderson, A., and Murray, T. (eds.), *Australian Archaeologist: Collected papers in Honour of Jim Allen*, Coombs Academic Publishing, Centre for Archaeological Research, Department of Archaeology and Natural History, Australian National University, and Department of Archaeology, La Trobe University, Canberra, pp. 372–392
Green, R. C. (2003). The Lapita horizon and traditions: Signature for one set of Oceanic migrations. In Sand, C. (ed.), *Pacific Archaeology: Assessments and Prospects*, Les Cahiers de l'Archéologie en Nouvelle-Calédonie 15, Service des Musées et du Patrimoine de Nouvelle-Calédonie, Noumea, pp. 95–120.
Green, R. C., and Anson, D. (2000). Excavations at Kainapirina (SAC), Watom Island, Papua New Guinea. *New Zealand Journal of Archaeology* **20** [1998]: 29–94.
Green, R. C., Jones, M., and Sheppard, P. (2008). The reconstructed environment and absolute dating of SE-SZ-8 Lapita site on Nendö, Santa Cruz, Solomon Islands. *Archaeology in Oceania* **43:** 49–61.
Grivet, L., Glaszman, J. C., and D'Hont, A. (2006). Molecular evidence for sugarcane evolution and domestication. In Motley, T. J., Zerega, N., and Cross, H. (eds.), *Darwin's Harvest: New Approaches to the Origins, Evolution, and Conservation of Crops*, Columbia University Press, New York, pp. 49–66.
Groube, L. M. (1971). Tonga, Lapita pottery and Polynesian origins. *Journal of the Polynesian Society* **86:** 7–36.
Groves, C. P. (1981). *Ancestors for the Pigs. Taxonomy and Phylogeny of the Genus Sus*, Technical Bulletin 3, Department of Prehistory, Australian National University, Canberra.
Groves, C. P. (2008a). Current views on taxonomy and zoogeography of the genus *Sus*. In Albarella, E., Dobney, K., Ervynck, A., and Rowley-Conwy, P. (eds.), *Pigs and Humans: 10,000 years of Interaction*, Oxford University Press, Oxford, pp. 15–29.
Groves, C. P. (2008b). The affinities of the pigs from Taumako. Appendix A4 in Leach, F., and Davidson, J., *Archaeology on Taumako, a Polynesian Outlier in the Eastern Solomon Islands*, Special Publication, New Zealand Journal of Archaeology, Dunedin, pp. 407–414.
Harding, T. G. (1967). *Voyagers of the Vitiaz Strait: A Study of a New Guinea Trade System*, American Ethnological Society Monograph 44, University of Washington Press, Seattle.
Harlow, G. E., Summerhayes, G. R., and Davies, H. (2011). A jade gouge from Emirau Island, Papua New Guinea (Early Lapita context: 3300 BP): A unique jadeitite. *European Journal of Mineralogy* **24:** 391–399.
Harrison, T. (1971). Prehistoric double-spouted vessels excavated from Niah Caves, Borneo. *Journal of the Malaysian Branch of the Royal Asiatic Society* **44:** 35–78.
Hawkins, J. P., Roberts, C. M., and Clark, V. (2000). The threatened status of restricted-range coral reef fish species. *Animal Conservation* **3:** 81–88.
Hayes, T. L. (1992). Plant macrofossils from archaeological sites in the Arawe Islands, Papua New Guinea. B.A. (Honors) thesis, Department of Archaeology, La Trobe University, Bundoora, Australia.

Hedges, R. E., Housley, R. A., Bronk Ramsey, C., and van Klinken, G. J. (1995). Radiocarbon dates from the Oxford AMS system: *Archaeometry* Datelist 20. *Archaeometry* **37:** 417–430.

Heinsohn, T. (2001). Human influence on vertebrate zoogeography: Animal translocation and biological invasions across and to the east of Wallace's Line. In Metcalf, I., Smith, J. M., Morwood, M., and Davidson, I. (eds.), *Faunal and Floral Migrations and Evolution in SE Asia-Australasia*, A. A. Balkema, Lisse, pp. 153–170.

Higham, C. (2002). *Early Cultures of Mainland Southeast Asia*, River Books, Bangkok.

Higham, C. (2011). The prehistory of Southeast Asia: A retrospective view of 40 years research. *Antiquity* **85:** 639–653.

Horrocks, M., and Bedford, S. (2005). Microfossil analysis of Lapita deposits in Vanuatu reveals introduced Araceae (aroids). *Archaeology in Oceania* **40:** 67–74.

Horrocks, M., and Nunn, P. D. (2007). Evidence for introduced taro (*Colocasia esculenta*) and lesser yam (*Dioscorea esculenta*) in the Lapita era (c. 3050–2500 cal. Yr BP) deposits from Bourewa, southwest Viti Levu Island, Fiji. *Journal of Archaeological Science* **34:** 739–748.

Horrocks, M., Grant-Mackie, J., and Matisoo-Smith, E. (2008a). Introduced taro (*Colocasia esculenta*) and yams (*Dioscorea* spp.) in Podtanean deposits (2700–1800 years BP) from Mé Auré Cave (WMD007), Moindou, New Caledonia. *Journal of Archaeological Science* **35:** 169–180.

Horrocks, M., Bulmer, S., and Gardner, R. O. (2008b). Plant microfossils in prehistoric archaeological deposits from Yuku rock shelter, Western Highlands, Papua New Guinea. *Journal of Archaeological Science* **35:** 290–301.

Horrocks, M., Bedford, S., and Spriggs, M. (2009). A short note on banana (*Musa*) phytoliths in Lapita, immediately post-Lapita and modern period archaeological deposits in Vanuatu. *Journal of Archaeological Science* **36:** 2048–2054.

Horton, D. R., and Ward, G. K. (1981). The role of pigs in the economy of Pakea Islet, Banks islands, Southwest Pacific. *New Zealand Journal of Archaeology* **3:** 3–13.

Hughen, K., Baillie, M., Bard, E., Bayliss, A., Beek, J., Bertrand, C., Blackwell, R., Buck, C., Burr, G., Cutler, K., Damon, P., Edwards, R., Fairbanks, R., Friedrich, M., Guilderson, T., Kromer, B., McCormac, F., Manning, S., Bronk Ramsey, C., Reimer, P., Reimer, R., Remmele, S., Southon, J., Stuiver, M., Talamo, S., Taylor, F., van der Plicht, J., and Weyhenmeyer, C. (2004). Marine04 marine radiocarbon age calibration, 26-0 ka BP. *Radiocarbon* **46:** 1059–1086.

Hughes, I. (1977). *New Guinea Stone Age Trade: The Geography and Ecology of Traffic in the Interior*, Terra Australis 3, Department of Prehistory, Australian National University, Canberra.

Hung, H.-C. (2005). Neolithic interaction between Taiwan and northern Luzon: The pottery and jade evidences from the Cagayan Valley. *Journal of Austronesian Studies* **1:** 106–130.

Hung, H.-C. (2008). *Migration and Cultural Interaction in Southern Coastal China, Taiwan and the Northern Philippines, 3000 BC to AD 100: The Early History of the Austronesian-Speaking Populations,* Ph.D. dissertation, Department of Archaeology and Natural History, Australian National University, Canberra.

Hung, H.-C., Iizuka, Y., Bellwood, P., Nguyen, K. D., Bellina, B., Silapanth, P., Dizon, E., Santiago, R., Datan, I., and Manton, J. H. (2007). Ancient jades map 3,000 years of prehistoric exchange in Southeast Asia. *Proceedings of the National Academy of Sciences* **104:** 19,745–19,750.

Hung, H.-C., Carson, M. T., Bellwood, P., Campos, F. Z., Piper, P. J., Dizon, E., Bolunia, M., Oxenham, M., and Zhang, C. (2011). The first settlement of Remote Oceania: The Philippines to the Marianas. *Antiquity* **85:** 909–926.

Hung, H.-C., Carson, M., and Bellwood, P. (2012). Earliest settlement of the Marianas: A response. *Antiquity* **86:** 910–914.

Hunt, T. L. (1989). *Lapita Ceramic Exchange in the Mussau Islands, Papua New Guinea*, Ph.D. dissertation, Department of Anthropology, University of Washington, Seattle.

Iizuka, Y., and Hung, H.-C. (2005). Archaeomineralogy of Taiwan nephrite: Sourcing study of nephritic artifacts from the Philippines. *Journal of Austronesian Studies* **1:** 35–81.

Irwin, G. (1985). *The Emergence of Mailu*, Terra Australis 10, Department of Prehistory, Australian National University, Canberra.

Irwin, G. (1992). *The Prehistoric Exploration and Colonisation of the Pacific*, Cambridge University Press, Cambridge.

Irwin, G. (2008). Pacific seascapes, canoe performance, and a review of Lapita voyaging with regards to theories of migration. *Asian Perspectives* **47:** 12–27.

Irwin, G. (2010). Pacific voyaging and settlement: Issues of biogeography and archaeology, canoe performance and computer simulation. In Anderson, A., Barrett, J. H., and Boyle, K. V. (eds.), *The*

Global Origins and Development of Seafaring, McDonald Institute for Archaeological Research, Cambridge, pp. 41–55.

Irwin, G., and Holdaway, S. (1996). Colonisation, trade and exchange: From Papua to Lapita. In Davidson, J., Irwin, G., Leach, B. F., Pawley, A., and Brown, D. (eds.), *Oceanic Culture History: Essays in Honour of Roger Green*, New Zealand Journal of Archaeology, Dunedin, pp. 225–235.

Johnson, R. W. (1987). Large-scale volcanic cone collapse: The 1888 slope failure of Ritter Volcano, and other examples from Papua New Guinea. *Bulletin of Volcanology* **49:** 669–679.

Kealhofer, L., Torrence, R., and Fullagar, R. (1999). Integrating phytoliths within use-wear/residues studies of stone tools. *Journal of Archaeological Science* **26:** 527–546.

Kennedy, J. (1982) Archaeology in the Admiralty Islands: Some excursions. *Indo-Pacific Prehistory Association Bulletin* **3:** 22–35.

Kennedy, J. (2008). Pacific bananas: Complex origins, multiple dispersals? *Asian Perspectives* **47:** 75–94.

Kennedy, J. (2009). Bananas: Towards a revised prehistory. In Fairbairn, A., and Weiss, E. (eds.), *From Foragers to Farmers: Papers in Honour of Gordon C. Hillman*, Oxbow Books, Oxford, pp. 190–204.

Kennedy, J., and Clarke, W. (2004). *Cultivated Landscapes of the Southwest Pacific*, RMAP Working Paper 50, Resource Management in Asia-Pacific Program, Australian National University, Canberra, posted 2004 (http://www.crawford.anu.edu.au/rmap/publications/workingpapers.php#y2004).

Kirch, P. V. (1988a). The Talepakemalai Lapita site and Oceanic prehistory. *National Geographic Research* **4:** 328–342.

Kirch, P. V. (1988b). Long-distance exchange and island colonisation: The Lapita case. *Norwegian Archaeological Review* **21:** 103–117.

Kirch, P. V. (1989). Second millennium BC arboriculture in Melanesia: Archaeological evidence from the Mussau Islands. *Economic Botany* **43:** 225–240.

Kirch, P. V. (1990). Specialization and exchange in the Lapita complex of Oceania (1600–500 BC). *Asian Perspectives* **29:** 117–133.

Kirch, P. V. (1995). The Lapita culture of western Melanesia in the context of Austronesian origins and dispersal. In Li, P., Tsang, C., Huang, Y., Ho, D., and Tseng, C. (eds.), *Austronesian Studies Relating to Taiwan*, Academia Sinica, Taipei, pp. 255–294.

Kirch, P. V. (1996). Lapita and its aftermath: The Austronesian settlement of Oceania. In Goodenough, W. H. (ed.), *Prehistoric Settlement of the Pacific*, Transactions 86, American Philosophical Society, Philadelphia, PA, pp. 57–70.

Kirch, P. V. (1997). *The Lapita Peoples: Ancestors of the Oceanic World*, Blackwell, Oxford.

Kirch, P. V. (2001a). A radiocarbon chronology for the Mussau Islands. In Kirch, P. V. (ed.), *Lapita and Its Transformations in Near Oceania*, Contribution 59, Archaeological Research Facility, University of California, Berkeley, pp. 196–222.

Kirch, P. V. (2001b). Three Lapita villages: Excavations at Talepakemalai (ECA), Etakosarai (ECB), and Etapakenga roasa (EHB), Eloaua and Emananus Islands. In Kirch, P. V. (ed.), *Lapita and Its Transformations in Near Oceania*, Contribution 59, Archaeological Research Facility, University of California, Berkeley, pp. 68–145.

Kirch, P. V., and Green, R. C. (2001). *Hawaiki, Ancestral Polynesia. An Essay in Historical Anthropology*, Cambridge University Press, Cambridge.

Kirch, P. V., and Yen, D. (1982). *Tikopia: The Prehistory and Ecology of a Polynesian Outlier*, Bulletin 238, Bishop Museum, Honolulu.

Kirch, P. V., Hunt, T. L., Weisler, M., Butler, V., and Allen, M. S. (1991). Mussau Islands prehistory: Results of the 1985-86 excavations. In Allen, J., and Gosden, C. (eds.), *Report of the Lapita Homeland Project*, Occasional Papers in Prehistory 20, Department of Prehistory, Australian National University, Canberra, pp. 144–163.

Kononenko, N. (2011). *Experimental and Archaeological Studies of Use-wear and Residues on Obsidian Artefacts from Papua New Guinea*, Technical Reports of the Australian Museum Online 21, posted 04 February 2011, DOI:10.3853/j.1835-4211.21.2011.1559.

Kononenko, N. (2012). Middle and late Holocene skin-working tools in Melanesia: Tattooing and scarification? *Archaeology in Oceania* **47:** 14–28.

Kononenko, N., Bedford S., and Reepmeyer, C. (2010). Functional analysis of late Holocene flaked and pebble stone artefacts from Vanuatu, Southwest Pacific. *Archaeology in Oceania* **45:** 13–20.

Lape, P. V. (2000). Political dynamics and religious change in the late pre-colonial Banda Islands, Eastern Indonesia. *World Archaeology* **32:** 138–155.

Larson, G., Cucchi, T., Fukita, M., Matisoo-Smith, E., Robins, J., Anderson, A., Rolett, B., Spriggs, M., Dolman, G., Kim, T., Dieu Thuy, T., Randi, E., Doherty, M., Awe Due, R., Bolt, R., Djubiantono, T., Griffin, B., Intoh, M., Keane, E., Kirch, P., Li, K., Morwood, M., Pedrina, L., Piper, P., Rabett, R., Shooter, P., van den Bergh, G., West, E., Wickler, S., Yuan, J., Cooper, A., and Dobney, K. (2007). Phylogeny and ancient DNA of *Sus* provides insights into Neolithic expansion in Island Southeast Asia and Oceania. *Proceedings of the National Academy of Sciences* **104:** 4834–4839.

Latinis, D. K. (2000). The development of subsistence system models for Island Southeast Asia and Near Oceania: The nature and role of arboriculture and arboreal-based economies. *World Archaeology* **32:** 41–67.

Leach, F., and Davidson, J. (2008). *Archaeology on Taumako, a Polynesian Outlier in the Eastern Solomon Islands*, Special Publication, New Zealand Journal of Archaeology, Dunedin.

Leavesley, M. G. (2004). *Trees to the Sky: Prehistoric Hunting in New Ireland, Papua New Guinea*, Ph.D. dissertation, Department of Archaeology and Anthropology, Australian National University, Canberra.

Leavesley, M. G., and Read, C. (2011). Late-Pleistocene and Holocene obsidian transfer in the Bismarck Archipelago, Papua New Guinea. *Pacific Studies* **34:** 24–34.

Leavesley, M.G., and Troitzsch, U. (2007). A preliminary study into the Lavongai rectilinear earth mounds: An XRD and phytolith analysis. In Specht, J., and Attenbrow, V. (eds.), *Archaeological Studies of the Middle and Late Holocene, Papua New Guinea Part VIII*, Technical Reports of the Australian Museum Online 20, pp. 243–254, posted 12 December 2007, DOI:10.3853/j.1835-4211.20.2007.1480.

Lebot, V. (1999). Biomolecular evidence for plant domestication in Sahul. *Genetic Resources and Crop Evolution* **46:** 619–628.

Lebot, V., Prana M. S., Kreike, N., van Heck, H., Pardales, J., Okpul, T., Gendua, T., Thongjiem, M., Hue, H., Viet, N., and Yap, T. C. (2004). Characterisation of taro (*Colocasia esculenta* [L.] Schott.) genetic resources in Southeast Asia and Oceania. *Genetic Resources and Crop Evolution* **51:** 381–392.

Lentfer, C. J. (2009a). Tracing domestication and cultivation of bananas from phytoliths: An update from Papua New Guinea. *Ethnobotany Research and Applications* **7:** 247–270.

Lentfer, C. (2009b). Results of preliminary phytolith analysis of RF-2 sediments by C. Lentfer, February 2009. Appendix 5 in Crowther, A., *Investigating Lapita Subsistence and Pottery Use Through Microscopic Residues on Ceramics: Methodological Issues, Feasibility and Potential*, Ph.D. dissertation, School of Social Sciences, University of Queensland, Brisbane, pp. 296–300.

Lentfer, C., and Green, R. C. (2004). Phytoliths and the evidence for banana cultivation at the Lapita Reber-Rakival site on Watom Island, Papua New Guinea. *Records of the Australian Museum, Supplement* **29:** 75–88.

Lentfer, C., and Torrence, R. (2007). Holocene volcanic activity, vegetation succession, and ancient human land use: Unraveling the interactions on Garua Island, Papua New Guinea. *Review of Palaeobotany and Palynology* **143:** 83–105.

Lentfer, C., Pavlides, C., and Specht, J. (2010). Natural and human impacts in a 35 000-year vegetation history in central New Britain, Papua New Guinea. *Quaternary Science Reviews* **29:** 3750–3767.

Lepofsky, D. (1988). The environmental context of Lapita settlement locations. In Kirch, P. V., and Hunt, T. L. (eds.), *Archaeology of the Lapita Cultural Complex: A Critical Review*, Report 5, Thomas Burke Memorial Washington State Museum, Seattle, pp. 33–47.

Lepofsky, D. (1992). Arboriculture in the Mussau Islands, Bismarck Archipelago. *Economic Botany* **46:** 192–211.

Lilley, I. (1986). *Prehistoric Exchange in the Vitiaz Strait, Papua New Guinea*, Ph.D. dissertation, Department of Prehistory, Australian National University, Canberra.

Liu, Y. P., Wu, G. S., Yao, Y. G., Miao, Y. W., Luikart, G., Baig, M., Pereira, A. B., Ding, Z. L., Palanichamy, M. G., and Zhang, Y. P. (2006). Multiple maternal origins of chickens: Out of the Asian jungles. *Molecular Phylogenetics and Evolution* **38:** 12–19.

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

Ma, Z. B., Xiao, J. L., Zhao, X. T., Peng, Z. C., Xia, M., Zhang, G. P., Wang, Z. R., and An, Z. S. (2003). Precise U-Series dating of coral reefs from the South China Sea and the high sea level during the Holocene. *Journal of Coastal Research* **19:** 296–303.

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

Malapa, R., Arnau, G., Noyer, J. L., and Lebot, V. (2005). Genetic diversity of the greater yam (*Dioscorea alata* L.) and relatedness to *D. nummularia* Lam. and *D. transversa* Br. as revealed with AFLP markers. *Genetic Resources and Crop Evolution* **52:** 919–929.

Malapa, R., Noyer, J. L., Marchand, J. L., and Lebot, V. (2006). Genetic relationship between *Dioscorea alata* L. and *D. nummularia* Lam., as revealed by AFLP markers. In Motley, T. J., Zerega, N., and Cross, H. (eds.), *Darwin's Harvest: New Approaches to the Origins, Evolution, and Conservation of Crops*, Columbia University Press, New York, pp. 239–265.

Marshall, B., and Allen, J. (1991). Excavations at Panakiwuk Cave, New Ireland. In Allen, J., and Gosden, C. (eds.), *Report of the Lapita Homeland Project*, Occasional Papers in Prehistory 20, Department of Prehistory, Australian National University, Canberra, pp. 59–91.

Matisoo-Smith, E. (2007). Animal translocations, genetic variation and the human settlement of the Pacific. In Friedlaender, J. S. (ed.), *Genes, Language, and Culture History in the Southwest Pacific*, Oxford University Press, Oxford, pp. 157–170.

Matisoo-Smith, E. (2009). The commensal model for human settlement of the Pacific 10 years on: What can we say and where to now? *Journal of Island and Coastal Archaeology* **4:** 151–163.

Matisoo-Smith, E., Hingston, M., Summerhayes, G., Robbins, J., Ross, H. A., and Hendy, M. (2009). On the rat trail in Near Oceania: Applying the commensal model to the question of the Lapita colonization. *Pacific Science* **63:** 465–475.

Matthews, P., and Gosden, C. (1997). Plant remains from waterlogged sites in the Arawe Islands, West New Britain Province, Papua New Guinea: Implications for the history of plant use and domestication. *Economic Botany* **51:** 121–133.

McCormac, F. G., Hogg, A. G., Blackwell, P. G., Buck, C. E., Higham, T. F., and Reimer, P. (2004). ShCal04 Southern Hemisphere Calibration, 0–11.0 Cal Kyr BP. *Radiocarbon* **46:** 1087–1092.

McGregor, G. R. (1989). An assessment of the annual variability of rainfall: Port Moresby, Papua New Guinea. *Singapore Journal of Tropical Geography* **10:** 43–54.

McKee, C. O., Neall, V. E., and Torrence, R. (2010). A remarkable pulse of large-scale volcanism on New Britain Island, Papua New Guinea. *Bulletin of Volcanology* **73:** 27–37.

McNiven, I. J., David, B., Richards, T., Aplin, K., Asmussen, B., Mjalanes, J., Leavesley, M., Faulkner, P., and Ulm, S. (2011). New directions in human colonisation of the Pacific: Lapita settlement of south coast New Guinea. *Australian Archaeology* **72:** 1–6.

McNiven, I. J., David, B., Aplin, K., Mialanes, J., Asmussen, B., Ulm, S., Faulkner, P., Rowe, C., and Richards, T. (2012). Terrestrial engagements by terminal Lapita maritime specialists on the southern Papuan coast. In Haberle, S. G., and David, B. (eds.), *Peopled Landscapes: Archaeological and Biogeographic Approaches to Landscapes*, Terra Australis 34, ANU E-Press, Canberra, pp. 121–156.

McPherson, N. (2007). Myth, primogeniture and long distance trade-friends in northwest New Britain, Papua New Guinea. *Oceania* **77:** 129–157.

McSaveney, M., Goff, J., Darby, D., Goldsmith, P., Barnett, A., Elliott S., and Nongkas, M. (2000). The 17th July 1998 tsunami, Sissano Lagoon, Papua New Guinea: Evidence and initial interpretation. *Marine Geology* **170:** 81–92.

Mead, S. M. (1975). The decorative system of the Lapita potters of Sigatoka, Fiji. In Mead, S. M., Birks, L., Birks, H., and Shaw, E., *The Lapita Pottery Style of Fiji and Its Associations*, Polynesian Society, Wellington, pp. 19–43.

Miedema, J. (1994). Trade, migration and exchange: The Bird's Head peninsula of Irian Jaya in a comparative perspective. In Strathern, A., and Stüzenhofecker, G. (eds.), *Migration and Transformations: Regional Perspectives on New Guinea*, ASAO Monograph 15, University of Pittsburgh Press, Pittsburgh, PA, pp. 121–153.

Mijares, A. S. (2006). The early Austronesian migration to Luzon: Perspectives from the Peňablanca cave sites. *Indo-Pacific Prehistory Association Bulletin* **26:** 72–78.

Morwood, M. J., Sutikna, T., Saptomo, E. W., Westaway, K. E., Jatmiko, Awe Due, R., Moore, M. W., Yuniawati, D. Y., Hadi, P., Zhao, J.-X., Turney, C. S., Fifield, K., Allen, H., and Soejono, R. P. (2008). Climate, people and faunal succession on Java, Indonesia: Evidence from Song Gupuh. *Journal of Archaeological Science* **35:** 1776–1789.

Muke, J., and Mandui, H. (2003). In the shadows of Kuk: Evidence for prehistoric agriculture at Kana, Wahgi Valley, Papua New Guinea. *Archaeology in Oceania* **38:** 177–185.

Neall, V. E., Wallace, R. C., and Torrence, R. (2008). The volcanic environment for 40,000 years of human occupation on the Willaumez Peninsula, West New Britain, Papua New Guinea. *Journal of Volcanology and Geothermal Research* **176:** 330–343.

Ochoa, J. T. (2005). In dogged pursuit: A reassessment of the dog's domestication and social importance. *Hukay, Journal of the University of the Philippines Archaeological Studies Program* **8:** 3–66.

O'Connor, S. (2006). Unpacking the Island Southeast Asian Neolithic cultural package, and finding local complexity. In Bacus, E. A., Glover, I. C., and Pigott, V. C. (eds.), *Uncovering Southeast Asia's Past: Selected Papers from the Tenth Biennial Conference of the European Association of Southeast Asian Archaeologists, London, British Museum*, National University Press, Singapore, pp. 74–87.

O'Connor, S., and Veth, P. (2005). Early Holocene shell hooks from Lene Hara cave, East Timor, establish complex fishing technology was in use in island southeast Asia five thousand years before Austronesian settlement. *Antiquity* **79:** 249–256.

O'Connor, S., Barham, A., Aplin, K., Dobney, K., Fairbairn, A., and Richards, M. (2011). The power of paradigms: Examining the evidential basis for early to mid-Holocene pigs and pottery in Melanesia. *Journal of Pacific Archaeology* **2:** 1–25.

Oliveira, N. V. (2010). From Bui Ceri Uato to Bui Ceri Uato Mane: A new archaeobotanical assemblage from East Timor. In Bellina, B., Bacus, E. A., Pryce, T. O., and Christie, J. W. (eds.), *50 Years of Archaeology in Southeast Asia: Essays in Honour of Ian Glover*, River Books, Bangkok, pp. 79–91.

Oppenheimer, S., and Richards, M. (2001). Fast trains, slow boats, and the ancestry of the Polynesian islanders. *Science Progress* **84:** 157–181.

Pandolfi, J. M., Tudhope, A. W., Burr, G., Chappell, J., Edinger, E., Frey, M., Steneck, R., Sharma, C., Yeates, A., Jennions, M., Lescinsky, H., and Newton, A. (2006). Mass mortality following disturbance in Holocene coral reefs from Papua New Guinea. *Geology* **34:** 949–952.

Park, S.-C., and Mori, J. (2007). Are asperity patterns persistent? Implications from large earthquakes in Papua New Guinea. *Journal of Geophysical Research* **112:** B03303, DOI:10.1029/2006JB004481.

Parr, J. F., Boyd, W. E., Harriott, V., and Torrence, R. (2009). Human adaptive responses to catastrophic landscape disruptions during the Holocene at Numundo, PNG. *Geographical Research* **47:** 155–174.

Pavlides, C. (2006). Life before Lapita: New developments in Melanesia's long-term history. In Lilley, I. (ed.), *Archaeology of Oceania: Australia and the Pacific Islands*, Blackwell, Oxford, pp. 205–227.

Pawley, A. (2007). The origins of Early Lapita culture: The testimony of historical linguistics. In Bedford, S., Sand, C., and Connaughton, S. (eds.), *Oceanic Explorations: Lapita and Western Pacific Settlement*, Terra Australis 26, ANU E-Press, Canberra, pp. 17–49.

Pawley, A., and Green, R. C. (1973). Dating the dispersal of the Oceanic languages. *Oceanic Linguistics* **12:** 1–67.

Paz, V. (2002). Island Southeast Asia: Spread or friction zone? In Bellwood, P., and Renfrew, C. (eds.), *Examining the Farming/Language Dispersal Hypothesis*, Macdonald Institute for Archaeological Research, Cambridge, pp. 275–285.

Paz, V. (2005). Rock shelters, caves, and archaeology in Island Southeast Asia. *Asian Perspectives* **44:** 107–118.

PEAC (2009) [Pacific El Niño-Southern Oscillation (ENSO) Applications Climate Center]. (2009). *Pacific ENSO Update* **15**(1st Quarter): 1.

Perrier, X., De Langhe, E., Donohue, M., Lentfer, C., Vrydaghs, L., Bakry, F., Carreel, F., Hippolyte, I., Horry, J., Jenny, C., Lebot, V., Risterucci, A., Tomekpe, K., Doutrelepont, H., Ball, T., Manwaring, J., de Maret, P., and Denham, T. (2011). Multidisciplinary perspectives on banana (*Musa* spp.) domestication. *Proceedings of the National Academy of Sciences* **108:** 11,311–11,318.

Petchey, F., and Ulm, S. (2012). Marine reservoir variation in the Bismarck region: An evaluation of spatial and temporal change in ΔR and R over the last 3000 years. *Radiocarbon* **54:** 45–58.

Petchey, F., Phelan, M., and White, P. (2004). New ΔR values for the southwest Pacific Ocean. *Radiocarbon* **46:** 1005–1014.

Peterson, J. (2009). The Austronesian moment. *Philippine Quarterly of Culture and Society* **37:** 136–158.

Peterson, W. (1974). Summary report of two archaeological sites from north-eastern Luzon. *Archaeology and Physical Anthropology in Oceania* **9:** 26–35.

Petrie, C. A., and Torrence, R. (2008). Assessing the effects of volcanic disasters on human settlement in the Willaumez Peninsula, Papua New Guinea: A Bayesian approach to radiocarbon calibration. *The Holocene* **18:** 729–744.

Piddington, R. (1965). *Kinship and Geographic Mobility*, International Journal of Comparative Sociology 6, Brill, Leiden.

Piper, P. J., Hung, H.-C., Campos, F. Z., Bellwood, P., and Santiago, R. (2009a). A 4000-year-old introduction of domestic pigs into the Philippine Archipelago: Implications for understanding routes of human migration through Island Southeast Asia and Wallacea. *Antiquity* **83:** 687–695.

Piper, P. J., Campos, F. Z., and Hung, H.-C. (2009b). A study of animal bones recovered from Pits 9 and 10 at the site of Nagsabaran in northern Luzon, Philippines. *Hukay. Journal of Archaeological Research in Asia and the Pacific* **14:** 47–89.

Poulsen, J. (1987). *Early Tongan Prehistory*, Terra Australis 12, Department of Prehistory, Australian National University, Canberra.

Powell, J. M. (1976). Ethnobotany. In Paijmans, K. (ed.), *New Guinea Vegetation*, ANU Press, Canberra, pp. 108–183.

Prebble, M., Kennedy, J., and Southern, W. (2010). Holocene lowland vegetation change and human ecology in Manus Province, Papua New Guinea. In Haberle, S., Stevenson, J., and Prebble, M. (eds.), *Altered Ecologies: Fire, Climate and Human Influence on Terrestrial Landscapes*, Terra Australis 32, ANU E-Press, Canberra, pp. 213–238.

Reepmeyer, C., Spriggs, M., Anggraenni, Lape, P., Neri, L., Ronquillo, W. P., Simanjuntak, T., Summerhayes, G., Tanudirjo, D., and Tiauzoni, A. (2011). Obsidian sources and distribution systems in Island Southeast Asia: New results and implications from geochemical research using LA-ICPMS. *Journal of Archaeological Science* **38:** 2995–3005.

Reimer, P., Baillie, M., Bard, E., Bayliss, A., Beck, J., Bertrand, C., Blackwell, P., Bronk Ramsey, C., Buck, C., Burr, G., Edwards, R., Friedrich, M., Grootes, P., Guilderson, T., Hajdas, P., Heaton, T., Hogg, A., Hughen, K., Kaiser, K., Kromer, B., McCormac, F., Manning, S., Reimer, R., Richards, D., Southon, J., Talamo, S., Turney, C., van der Plicht, J., and Weyhenmeyer, C. (2009). IntCal09 and Marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. *Radiocarbon* **51:** 1111–1150.

Ridgway, K. R., Godfrey, J. S., Meyers, G., and Bailey, R. (1993). Sea level response to the 1986–1987 El Niño-Southern Oscillation Event in the Western Pacific in the vicinity of Papua New Guinea. *Journal of Geophysical Research* **98:** 16,387–16,395.

Roe, D. (1993). *Prehistory without Pots: Prehistoric Settlement and Economy of North-west Guadalcanal, Solomon Islands*, Ph.D. dissertation, Department of Prehistory, Australian National University, Canberra.

Roscoe, P. B. (1989). The flight from the fen: The prehistoric migration of the Boiken of the East Sepik Province, Papua New Guinea. *Oceania* **60:** 139–164.

Rowley-Conwy, P. (2011). Westward ho! The spread of agriculture from central Europe to the Atlantic. *Current Anthropology* **52:** S431–S451.

Ruddle, K., Johnson, D., Townsend, P. K., and Rees, J. D. (1978). *Palm Sago: A Tropical Starch from Marginal Lands*, ANU Press, Canberra.

Sala, E., and Knowlton, N. (2006). Global marine biodiversity trends. *Annual Review of Environmental Resources* **31:** 93–122.

Sand, C. (2007). Looking at the big motifs: A typology of the central band decorations of the Lapita ceramic tradition in New Caledonia (southern Melanesia) and preliminary regional comparisons. In Bedford, S., Sand, C., and Connaughton, S. (eds.), *Oceanic Explorations: Lapita and Western Pacific Settlement*, Terra Australis 26, ANU E-Press, Canberra, pp. 265–287.

Savolainen, P., Leitner, T., Wilton, A. N., Matisoo-Smith, E., and Lundeberg, J. (2004). A detailed picture of the origin of the Australian dingo, obtained from the study of mitochondrial DNA. *Proceedings of the National Academy of Sciences* **101:** 12,387–12,390.

Shaw, B. J., Summerhayes, G. R., Buckley, H. R., and Baker, J. A. (2009). The use of strontium isotopes as an indicator of migration in human and pig Lapita populations in the Bismarck Archipelago, Papua New Guinea. *Journal of Archaeological Science* **36:** 1079–1091.

Sheppard, P. J. (1993). Lapita lithics: Trade/exchange and technology. A view from the reefs/Santa Cruz. *Archaeology in Oceania* **28:** 121–137.

Sheppard, P. (2010a). Into the Great Ocean: Lapita movement into Remote Oceania. In Sand, C., and Bedford, S. (eds.), *Lapita: Ancêtres océaniens/Oceanic Ancestors*, Musée du Quai Branly and Somogy Éditions d'Art, Paris, pp. 104–117.

Sheppard, P. (2010b). Lapita stone tool technology. In Sand, C., and Bedford, S. (eds.), *Lapita: Ancêtres océaniens/Oceanic Ancestors*, Musée du Quai Branly and Somogy Éditions d'Art, Paris, pp. 240–251.

Sheppard, P. J., and Green, R. C. (1991). Spatial analysis of the Nenumbo (SE-RF-2) Lapita site, Solomon Islands. *Archaeology in Oceania* **26:** 89–101.

Sheppard, P. J., and Walter, R. (2009). Inter-tidal Late Lapita sites and geotectonics in the western Solomon Islands. In Sheppard, P. J., Thomas, T., and Summerhayes, G. R. (eds.), *Lapita: Ancestors and Descendants*, Monograph 28, New Zealand Archaeological Association, Auckland, pp. 73–100.

Shutler, Jr., R. (1999). The relationship of red-slipped and lime-impressed pottery of the southern Philippines to that of Micronesia and the Lapita of Oceania. In Galipaud, J.-C., and Lilley, I. (eds.), *The Pacific from 5000 to 2000 BP: Colonisation and Transformations*, IRD Éditions, Noumea, pp. 521–529.

Shutler, R., and Marck, J. C. (1975). On the dispersal of the Austronesian horticulturalists. *Archaeology and Physical Anthropology in Oceania* **10:** 81–113.

Silver, E., Day, S., Ward. S., Hoffmann, G., Llanes, P., Driscoll, N., Appelgate, B., and Saunders, S. (2009). Volcano collapse and tsunami generation in the Bismarck Volcanic Arc, Papua New Guinea. *Journal of Volcanology and Geothermal Research* **186:** 210–222.

Simanjuntak, T., and Forestier, H. (2004). Research progress on the Neolithic in Indonesia: Special reference to the Pondok Silabe Cave, South Sumatra. In Paz, V. (ed.), *Southeast Asian Archaeology: Wilhem G. Solheim II Festschrift*, University of the Philippines Press, Quezon City, pp. 104–118.

Simanjuntak, T., Morwood, M. J., Intan, F. S., Mahmud, I., Grant, K., Somba, N., Akw, B., and Utomo, D. (2008). Minanga Sipakko and the Neolithic of the Karama River. In Simanjuntak, T. (ed.), *Austronesian in Sulawesi*, Center for Prehistoric and Austronesian Studies, Depok, Indonesia, pp. 57–76.

Siorat, J. P. (1990). A technological analysis of Lapita pottery decoration. In Spriggs, M. (ed.), *Lapita Design, Form and Composition*, Occasional Papers in Prehistory 19, Department of Prehistory, Australian National University, Canberra, pp. 59–82.

Smith, A. (2001). A continuous sequence? *Trochus* shell artefacts in Lapita and post-Lapita assemblages from the Arawe Islands, West New Britain Province, Papua New Guinea. In Clark, G. R., Anderson, A. J., and Vunidilo, T. (eds.), *The Archaeology of Lapita Dispersal in Oceania*, Terra Australis 17, Pandanus Books, Canberra, pp. 151–158.

Smith, A. (2002). *An Archaeology of West Polynesian Prehistory*, Terra Australis 18, Pandanus Books, Canberra.

Smith, A., and Allen, J. (1999). Pleistocene shell technologies: Evidence from Island Melanesia. In Hall, J., and McNiven, I. J. (eds), *Australian Coastal Archaeology*, Research Papers in Archaeology and Natural History 31, ANH Publications, Canberra, pp. 291–297.

Smith, I. W. (2000). Terrestrial fauna from excavations at the Kainapirina (SAC) locality, Watom Island, Papua New Guinea. *New Zealand Journal of Archaeology* **20** [1998]: 137–147.

Smith, I. W. (2008). Mammalian fauna from Taumako. Appendix A3 in Leach, F., and Davidson, J., *Archaeology on Taumako, a Polynesian Outlier in the Eastern Solomon Islands*, Special Publication, New Zealand Journal of Archaeology, Dunedin, pp. 401–414.

Snow, B. E., Shutler Jr, R., Nelson, D. E., and Southon, J. R. (1986). Evidence of early rice cultivation in the Philippines. *Philippine Quarterly of Culture and Society* **14:** 3–11.

Soares, P., Trejaut, J. A., Loo, J.-H., Hill, C., Mormina, M., Lee, C.-L., Chen, Y.-M., Hudjashov, G., Forster, P., Macaulay, V., Bulbeck, D., Oppenheimer, S., Lin, M., and Richards, M. B. (2008). Climate change and postglacial human dispersals in Southeast Asia. *Molecular Biology and Evolution* **25:** 1209–1218.

Soares, P., Rito, T., Trejaut, J., Mormina, M., Hill, C., Tinkler-Hundal, E., Braid, M., Clarke, D. J., Loo, J.-H., Thomson, N., Denham, T., Donohue, M., Macaulay, V., Lin, M., Oppenheimer, S., and Richards, M. (2011) . Ancient voyaging and Polynesian origins. *American Journal of Human Genetics* **88:** 239–247.

Solheim II, W. G. (1964). Further relationships of the Sa-huỳnh-Kalanay tradition. *Asian Perspectives* **8:** 196–211.

Solheim II, W. G. (1984–1985). The Nusantao hypothesis: The origin and spread of Austronesian speakers. *Asian Perspectives* **26:** 77–88.

Solheim II, W. G. (2006). *Archaeology and Culture in Southeast Asia: Unraveling the Nusantao*, University of the Philippines Press, Manila.

Specht, J. (1968). Preliminary report of excavations on Watom Island. *Journal of the Polynesian Society* **77:** 117–134.

Specht, J. (1972). Evidence for early trade in northern Melanesia. *Mankind* **8:** 310–312.

Specht, J. (1991). Kreslo: A Lapita site in southwest New Britain, Papua New Guinea. In Allen, J., and Gosden, C. (eds.), *Report of the Lapita Homeland Project*, Occasional Papers in Prehistory 20, Department of Prehistory, Australian National University, Canberra, pp. 189–204.

Specht, J. (2002). Obsidian, colonising and exchange. In Bedford, S., Sand, C., and Burley, D. (eds.), *Fifty Years in the Field: Essays in Honour and Celebration of Richard Shutler Jr's Archaeological Career*, Monograph 25, New Zealand Archaeological Association, Auckland, pp. 37–49.

Specht, J. (2003). Watom Island and Lapita: Observations on the Reber-Rakival localities. In Sand, C. (ed.), *Pacific Archaeology: Assessments and Prospects*, Les Cahiers de l'Archéologie en Nouvelle-Calédonie 15, Service des Musées et du Patrimoine, Noumea, pp. 121–134.

Specht, J. (2005). Revisiting the Bismarcks: Some alternative views. In Pawley, A., Attenborough, R., Golson, J., and Hide, R. (eds.), *Papuan Pasts: Studies in the Cultural, Linguistic and Biological Histories of Papuan-Speaking Peoples*, Pacific Linguistics 572, Australian National University, Canberra, pp. 235–288.

Specht, J. (2007a). Small islands in the big picture. In Bedford, S., Sand, C., and Connaughton, S. (eds.), *Oceanic Explorations: Lapita and Western Pacific Settlement*, Terra Australis 26, ANU E-Press, Canberra, pp. 51–70.

Specht, J. (2007b). The Lagenda Lapita site (FCR/FCS), Talasea area, Papua New Guinea. In Specht, J., and Attenbrow, V. (eds.), *Archaeological Studies of the Middle and Late Holocene, Papua New Guinea, Part III*, Technical Reports of the Australian Museum Online 20, pp. 105–129, posted 12 December 2007, DOI: 10.3853/j.1835-4211.20.2007.1475.

Specht, J. (2009). The aceramic to ceramic boundary in the Bismarck Archipelago. In Sheppard, P. J., Thomas, T., and Summerhayes, G. R. (eds.), *Lapita: Ancestors and Descendants*, Monograph 28, New Zealand Archaeological Association, Auckland, pp. 11–34.

Specht, J., and Gosden, C. (1997). Dating Lapita pottery in the Bismarck Archipelago. *Asian Perspectives* **36:** 175–199.

Specht, J., and Summerhayes, G. (2007). The Boduna Island (FEA) Lapita site, Papua New Guinea. In Specht, J., and Attenbrow, V. (eds.), *Archaeological Studies of the Middle and Late Holocene, Papua New Guinea, Part II*, Technical Reports of the Australian Museum Online **20**, pp. 51–103, posted 12 December 2007, DOI: 10.3853/j.1835-4211.20.2007.1474.

Specht, J., and Torrence, R. (2007a). Pottery sites of the Talasea area, Papua New Guinea. In Specht, J., and Attenbrow, V. (eds.), *Archaeological Studies of the Middle and Late Holocene, Papua New Guinea. Part IV*, Technical Reports of the Australian Museum Online 20, pp. 131–196, posted 12 December 2007, DOI: 10.3853/j.1835-4211.20.2007.1476.

Specht, J., and Torrence, R. (2007b). Lapita all over: Land-use on the Willaumez Peninsula, Papua New Guinea. In Bedford, S., Sand, C., and Connaughton, S. (eds.), *Oceanic Explorations: Lapita and Western Pacific Settlement*, Terra Australis 26, ANU E-Press, Canberra, pp. 71–96.

Specht, J., Fullagar, R., and Torrence, R. (1991). What was the significance of Lapita pottery at Talasea? *Indo-Pacific Prehistory Association Bulletin* **11:** 281–294.

Spoehr, A. (1957). *Marianas Prehistory: Archaeological Survey and Excavations on Saipan, Tinian, and Rota*, Fieldiana 48, Field Museum of Natural History, Chicago.

Spoehr, A. (1973). *Zamboanga and Sulu: An Archaeological Approach to Ethnic Diversity*, Ethnology Monographs 1, Department of Anthropology, University of Pittsburgh, Pittsburgh, PA.

Spriggs, M. (1984). The Lapita cultural complex: Origins, distribution, contemporaries and successors. *Journal of Pacific History* **19:** 202–223.

Spriggs, M. (1990). The changing face of Lapita: Transformations of a design. In Spriggs, M. (ed.), *Lapita Design, Form and Composition*, Occasional Papers in Prehistory 19, Department of Prehistory, Australian National University, Canberra, pp. 83–122.

Spriggs, M. (1991). Nissan: The island in the middle. In Allen, J., and Gosden, C. (eds), *Report of the Lapita Homeland Project*, Occasional Papers in Prehistory 20, Department of Prehistory, Australian National University, Canberra, pp. 222–243.

Spriggs, M. (1993). Pleistocene agriculture: Why not? In Smith, M. A., Spriggs, M., and Fankhauser, B. (eds.), *Sahul in Review: Pleistocene Archaeology in Australia and Island Melanesia*, Occasional Papers in Prehistory 24, Department of Prehistory, Australian National University, Canberra, pp. 137–143.

Spriggs, M. (1995). The Lapita culture and Austronesian prehistory in Oceania. In Bellwood, P., Fox, J. J., and Tryon, D. (eds.), *The Austronesians: Historical and Comparative Perspectives*, Department of Anthropology, Australian National University, Canberra, pp. 112–133.

Spriggs, M. (1996a). What is Southeast Asian about Lapita? In Azakawa, T., and Szathmary, E. (eds.), *Prehistoric Mongoloid Dispersals*, Oxford University Press, Oxford, pp. 324–348.

Spriggs, M. (1996b). Early agriculture and what went before in Island Melanesia: Continuity or intrusion? In Harris, D. R. (ed.), *The Origin and Spread of Agriculture and Pastoralism in Eurasia*, Smithsonian Institution Press, Washington, DC, pp. 524–537.

Spriggs, M. (1997). *The Island Melanesians*, Blackwell, Oxford.

Spriggs, M. (2001). How AMS dating changed my life. In Jones, M., and Sheppard, P. (eds.), *Australasian Connections and New Directions: Proceedings of the 7th Australasian Archaeometry Conference*, Research in Anthropology and Linguistics 5, Department of Anthropology, University of Auckland, Auckland, pp. 365–374.

Spriggs, M. (2003). Chronology of the Neolithic transition in Island Southeast Asia and the Western Pacific: A view from 2003. *The Review of Archaeology* **24:** 57–80.

Spriggs, M. (2007). The Neolithic and Austronesian expansion within Island Southeast Asia and into the Pacific. In Chiu, S., and Sand, C. (eds.), *From Southeast Asia to the Pacific: Archaeological Perspectives on the Austronesian Expansion and the Lapita Cultural Complex*, Center for Archaeological Studies, Research Center for Humanities and Social Sciences, Academia Sinica, Taipei, pp. 104–125.

Spriggs, M. (2010). The Neolithisation of Island Southeast Asia. In Sand, C., and Bedford, S. (eds.), *Lapita: Ancêtres océaniens/Oceanic Ancestors*, Musée du Quai Branly and Somogy Éditions d'Art, Paris, pp. 58–73.

Spriggs, M. (2011). Archaeology and the Austronesian expansion: Where are we now? *Antiquity* **85:** 510–528.

Spriggs, M., Reepmeyer, C., Anggraeni, Neri, L., Ronquillo, W. P., Simanjuntak, T., Summerhayes, G., Tanudirjo, D., and Tiauzon, A. (2011). Obsidian sources and distribution systems in Island Southeast Asia: A review of previous research. *Journal of Archaeological Science* **38:** 2873–2881.

Steadman, D. W. (2006). *Extinction and Biogeography of Tropical Pacific Birds*, University of Chicago Press, Chicago.

Steadman, D. W., and Kirch, P. V. (1998). Biogeography and prehistoric exploitation of birds in the Mussau Islands, Bismarck Archipelago, Papua New Guinea. *Emu* **98:** 13–22.

Storey, A. A., Ladefoged, T., and Matisoo-Smith, E. A., (2008). Counting your chickens: Density and distribution of chicken remains in archaeological sites of Oceania. *International Journal of Osteoarchaeology* **18:** 240–261.

Storey, A. A., Spriggs, M., Bedford, S., Hawkins, S. C., Robins, J. J., Huynen, L., and Matisoo-Smith, E. (2010). Mitochondrial DNA from 3000-year old chickens at the Teouma site, Vanuatu. *Journal of Archaeological Science* **37:** 2459–2468.

Summerhayes, G. R. (1998). The face of Lapita. *Archaeology in Oceania* **33:** 100.

Summerhayes, G. (2000a). Far western, western, and eastern Lapita: A re-evaluation. *Asian Perspectives* **39:** 109–118.

Summerhayes, G. R. (2000b). *Lapita Interaction*, Terra Australis 15, Department of Archaeology and Natural History and Centre for Archaeology, Australian National University, Canberra.

Summerhayes, G. R. (2000c). Recent archaeological investigations in the Bismarck Archipelago, Anir: New Ireland Province, Papua New Guinea. *Indo-Pacific Prehistory Association Bulletin* **19:** 167–174.

Summerhayes, G. R. (2001). Defining the chronology of Lapita in the Bismarck Archipelago. In Clark, G. R., Anderson, A. J., and Vunidilo, T. (eds.), *The Archaeology of Lapita Dispersal in Oceania*, Terra Australis 17, Pandanus Books, Canberra, pp. 25–38.

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

Summerhayes, G. R. (2007). The rise and transformations of Lapita in the Bismarck Archipelago. In Chiu, S., and Sand, C. (eds.), *From Southeast Asia to the Pacific: Archaeological Perspectives on the Austronesian Expansion and the Lapita Cultural Complex*, Center for Archaeological Studies Research, Research Center for Humanities and Social Sciences, Academia Sinica, Taipei, pp. 141–169.

Summerhayes, G. R. (2010a). Lapita interaction: An update. In Gadu, M. Z., and Lin, H.-M. (eds.), *2010 International Symposium on Austronesian Studies*, National Museum of Prehistory, Taitong, pp. 11–40.

Summerhayes, G. R. (2010b). The emergence of the Lapita Cultural Complex in the Bismarck Archipelago. In Sand, C., and Bedford, S. (eds.), *Lapita: Ancêtres océaniens/Oceanic Ancestors*, Musée du Quai Branly and Somogy Éditions d'Art, Paris, pp. 92–101.

Summerhayes, G. R., Matisoo-Smith, E., Mandui, H., Allen, J., Specht, J., Hogg, N., and McPherson, S. (2010a). Tamuarawai (EQS): An early Lapita site on Emirau, New Ireland, PNG. *Journal of Pacific Archaeology* **1:** 62–75.

Summerhayes, G. R., Leavesley, M., Fairbairn, A., Mandui, H., Field, J., Ford, A., and Fullagar, R. (2010b). Human adaptation and plant use in highland New Guinea 49,000 to 44,000 years ago. *Science* **330:** 78–81.

Swadling, P. (1996). *Plumes from Paradise: Trade Cycles in South-east Asia and Their Impact on New Guinea and Nearby Islands until 1920*, Papua New Guinea National Museum and Art Gallery, Boroko, Papua New Guinea.

Swadling, P. (1997). Changing shorelines and cultural orientations in the Sepik-Ramu, Papua New Guinea: Implications for Pacific prehistory. *World Archaeology* **29:** 1–14.

Swadling, P. (2004). Stone mortar and pestle distribution in New Britain revisited. *Records of the Australian Museum, Supplement* **29:** 157–161.

Swadling, P., and Hope, G. (1992). Environmental change in New Guinea since human settlement. In Dodson, J. (ed.), *The Naive Lands: Prehistory and Environmental Change in Australia and the South-west Pacific*, Longman Cheshire, Melbourne, pp. 13–42.

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

Swadling, P., Araho, N., and Ivuyo, B. (1991). Settlements associated with the inland Sepik-Ramu Sea. *Indo-Pacific Prehistory Association Bulletin* **11:** 92–112.

Swadling, P., Wiessner, P., and Tumu, A. (2008). Prehistoric stone artefacts from Enga and the implication of links between the highlands, lowlands and islands for early agriculture in Papua New Guinea. *Journal de la Société des Océanistes* **126-127:** 271–292.

Swete Kelly, M. C. (2008). *Prehistoric Social Interaction and the Evidence of Pottery in the Northern Philippines*, Ph.D. dissertation, Department of Archaeology and Natural History, Australian National University, Canberra.

Szabó, K. (2004). *Technique and Practice: Shell-working in the Western Pacific and Island Southeast Asia*, Ph.D. dissertation, Department of Archaeology and Natural History, Australian National University, Canberra.

Szabó, K. (2007). An assessment of shell fishhooks of the Lapita cultural complex. In Anderson, A., Green, K., and Leach, F. (eds.), *Vastly Ingenious: The Archaeology of Pacific Material Culture in Honour of Janet Davidson*, Otago University Press, Dunedin, pp. 227–241.

Szabó, K. (2010a). Shell artefacts and shell-working within the Lapita Cultural Complex. *Journal of Pacific Archaeology* **1:** 115–127.

Szabó, K. (2010b). Lapita shell-working and shell artefacts. In Sand, C., and Bedford, S. (eds.), *Lapita: Ancêtres océaniens/OceanicAncestors*, Musée du Quai Branly and Somogy Éditions d'Art, Paris, pp. 226–239.

Szabó, K., and O'Connor, S. (2004). Migration and complexity in Holocene Island Southeast Asia. *World Archaeology* **36:** 621–628.

Szabó, K., and Ramirez, H. (2009). Worked shell from Leta Leta cave, Palawan, Philippines. *Archaeology in Oceania* **44:** 150–159.

Szabó, K., and Summerhayes, G. (2002). Worked shell artefacts – new data from Early Lapita. In Bedford, S., Sand, C., and Burley, D. (eds.), *Fifty Years in the Field. Essays in Honour and Celebration of Richard Shutler Jr's Archaeological Career*, Monograph 25, New Zealand Archaeological Association, Auckland, pp. 91–100.

Tanudirjo, D. A. (2004). The structure of Austronesian migration into Island South East Asia and Oceania. In Paz, V. (ed.), *Southeast Asian Archaeology: Wilhem G. Solheim II Festschrift*, University of the Philippines, Quezon City, pp. 83–103.

Tanudirjo, D. A. (2006). The dispersal of Austronesian-speaking people and the ethnogenesis of Indonesian people. In Simanjuntak, T., Pojoh, I. H., and Hisyam, M. (eds.), *Austronesian Diaspora and the Ethnogenesis of People in Indonesian Archipelago*, LIPI Press, Jakarta, pp. 83–98.

Terrell, J. E. (1989). What Lapita is and what Lapita isn't. *Antiquity* **63:** 623–626.

Terrell, J. E. (1998). 30,000 years of culture contact in the southwest Pacific. In Cusick, J. G. (ed.), *Studies in Culture Contact: Interaction, Culture Change, and Archaeology*, Occasional Paper 25, Center for Archaeological Investigations, Southern Illinois University, Carbondale, pp. 191–219.

Terrell, J. E. (2002). Tropical agroforestry, coastal lagoons and Holocene prehistory in Greater Near Oceania. In Shuji, Y., and Matthews, P. J. (eds.), *Proceedings of the International Area Studies Conference VII: Vegeculture in Eastern Asia and Oceania*, National Museum of Ethnology, Osaka, pp. 195–216.

Terrell, J. E. (2004). Introduction: 'Austronesia' and the great Austronesian migration. *World Archaeology* **36:** 586–590.

Terrell, J. E., and Schechter, E. M. (2007). Deciphering the Lapita code: The Aitape ceramic sequence and late survival of the "Lapita face." *Cambridge Archaeological Journal* **17:** 59–85.

Terrell, J. E., and Schechter, E. M. (2009). The meaning and importance of the Lapita face motif. *Archaeology in Oceania* **44:** 45–55.

Terrell, J. E., and Welsch, R. L. (1997). Lapita and the temporal geography of prehistory. *Antiquity* **71:** 548–572.

Terrell, J. E., Kelly, K. M., and Rainbird, P. (2001). Foregone conclusions? In search of "Papuans" and "Austronesians." *Current Anthropology* **42:** 97–124.

Terrell, J. E., Hart, J. P., Barut, S., Cellinese, N., Curet, A., Denham, T., Kusimba, C. M., Latinis, K., Oka, R., Palka, J., Pohl, M. E., Pope, K. O., Williams, P. R., Haines, H., and Staller, J. E. (2003). Domesticated landscapes: The subsistence ecology of plant and animal domestication. *Journal of Archaeological Method and Theory* **10:** 323–368.

Thiel, B. (1986–1987). Excavations at Arku Cave, Northeast Luzon, Philippines. *Asian Perspectives* **27:** 229–264.

Thomas, J. (1997). The materiality of the Mesolithic-Neolithic transition in Britain. *Analecta Praehistorica Leidensia* **29:** 57–64.

Thomas, J. (2003). Thoughts on the "repacked" Neolithic Revolution. *Antiquity* **77:** 67–74.

Thomson, J.-A., and White, J. P. (2000). Localism of Lapita pottery in the Bismarck Archipelago. In Anderson, A., and Murray, T. (eds.), *Australian Archaeologist: Collected papers in Honour of Jim Allen*, Centre for Archaeological Research and Department of Archaeology and Natural History, Australian National University, Canberra, pp. 308–323.

Torrence, R. (1992). What is Lapita about obsidian? A view from the Talasea sources. In Galipaud, J.-C. (ed.), *Poterie Lapita et peuplement: Actes du Colloque Lapita Noumea Janvier 1992*, ORSTOM, Noumea, pp. 111–126.

Torrence, R. (2002). Cultural landscapes on Garua Island, Papua New Guinea. *Antiquity* **76:** 766–776.

Torrence, R., and Doelman, T. (2007). Problems of scale: Evaluating the effects of volcanic disasters on cultural change in the Willaumez Peninsula, Papua New Guinea. In Grattan, J., and Torrence, R. (eds.), *Living under the Shadow: The Archaeological, Cultural and Environmental Impact of Volcanic Eruptions*, Left Coast Press, Walnut Creek, CA, pp. 42–66.

Torrence, R., and Swadling, P. (2008). Social networks and the spread of Lapita. *Antiquity* **82:** 600–616.

Torrence, R., and White, J. P. (2001). Tattooed faces from Boduna Island, Papua New Guinea. In Clark, G. R., Anderson, A. J., and Vunidilo, T. (eds.), *The Archaeology of Lapita Dispersal in Oceania*, Terra Australis 17, Pandanus Books, Canberra, pp. 135–140.

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

Torrence, R., Neall, V., and Boyd, W. E. (2009a). Volcanism and historical ecology on the Willaumez Peninsula, Papua New Guinea. *Pacific Science* **63:** 507–535.

Torrence, R., Swadling, P., Kononenko, N., Ambrose, W., Rath, P., and Glascock, M. D. (2009b). Mid-Holocene social interaction in Melanesia: New evidence from hammer-dressed obsidian stemmed tools. *Asian Perspectives* **48:** 118–147.

Tregoning, P., Lambeck, K., Stolz, A., Morgan, P., McClusky, S. C., van der Beck, P., McQueen, H., Jackson, R. J., Little, R. P., Laing, A., and Murphy, B. (1998). Estimation of current plate motions in Papua New Guinea from global positioning system observations. *Journal of Geophysical Research* **103:** 12,181–12,203.

Tsang, C.-H. (2007). Recent archaeological discoveries in Taiwan and Northern Luzon. In Chiu, S., and Sand, C. (eds.), *From Southeast Asia to the Pacific: Archaeological Perspectives on the Austronesian Expansion and the Lapita Cultural Complex*, Center for Archaeological Studies, Research Center for Humanities and Social Sciences, Academia Sinica, Taipei, pp. 75–94.

Tykot, R. H., and Chia, S. (1997). Long-distance obsidian trade in Indonesia. In Vandiver, P. B., Druzik, J. R., Merkel, J. F., and Stewart, J. (eds.), *Materials Issues in Art and Archaeology V*, Symposium Proceedings 462, Materials Research Society, Pittsburgh, PA, pp. 175–180.

van den Bergh, G. D., Meijer, H. J., Due Awe, R., Morwood, M. J., Szabó, K., van den Hoek Ostende, L. W., Sutikna, T., Saptomo, E. W., Piper, P. J., and Dobney, K. M. (2009). The Liang Bua faunal remains: A 95 k.yr. sequence from Flores, East Indonesia. *Journal of Human Evolution* **57:** 527–537.

Veth, P., Spriggs, M., and O'Connor, S. (2005). Continuity in tropical cave use: Examples from East Timor and the Alu Islands, Maluku. *Asian Perspectives* **44:** 180–192.

Watson, J. B. (1970). Society as organized flow: The Tairora case. *Southwestern Journal of Anthropology* **26:** 107–124.

Weisler, M. I. (2001a). Lapita rockshelters of Eloaua and Mussau Islands (sites EHM, EHN, EKO, EKP and EKQ). In Kirch, P. V. (ed.), *Lapita and Its Transformations in Near Oceania: Archaeological Investigations in the Mussau Islands, Papua New Guinea, 1985–1988*, Contribution 59, Archaeological Research Facility, University of California, Berkeley, pp. 146–161.

Weisler, M. I. (2001b). An aceramic midden on Emussau Island (site EKS). In Kirch, P. V. (ed.), *Lapita and Its Transformations in Near Oceania: Archaeological Investigations in the Mussau Islands, Papua New Guinea, 1985–1988*, Contribution 59, Archaeological Research Facility, University of California, Berkeley, pp. 175–180.

Welsch, R. L., and Terrell, J. E. (1998). Material culture, social fields, and social boundaries on the Sepik coast of New Guinea. In Stark, M. (ed.), *The Archaeology of Social Boundaries*, Smithsonian Institution Press, Washington, DC, pp. 50–77.

White, J. P. (1972). *Ol Tumbuna: Archaeological Excavations in the Eastern Central Highlands, Papua New Guinea*, Terra Australis 2, Department of Prehistory, Australian National University, Canberra.

White, J. P. (2007). Ceramic sites on the Duke of York Islands. In Specht, J., and Attenbrow, V. (eds.), *Archaeological Studies of the Middle and Late Holocene, Papua New Guinea, Part I*, Technical Reports of the Australian Museum Online **20**, pp. 3–50, posted 12 December 2007, DOI: 10.3853/j.1835-4211.20.2007.1473.

White, J. P., Allen, J., and Specht, J. (1988). Peopling the Pacific: The Lapita Homeland Project. *Australian Natural History* **22:** 410–416.

White, J. P., Flannery, T. F., O'Brien, O., Hancock, R. V., and Pavlish, L. (1991). The Balof Shelters, New Ireland. In Allen, J., and Gosden, C. (eds.), *Report of the Lapita Homeland Project*, Occasional Papers in Prehistory 20, Department of Prehistory, Australian National University, Canberra, pp. 46–58.

Whitten, A. J., Mustafa, M., and Henderson, G. S. (1987). *The Ecology of Sulawesi*, Gadjah Mada University Press, Yogyakarta, Indonesia.

Wickler, S. (2001). *The Prehistory of Buka: A Stepping Stone Island in the Northern Solomons*, Terra Australis 16, Department of Archaeology and Natural History, and Centre for Archaeological Research, Australian National University, Canberra.

Winter, O., Clark, G., Anderson, A., and Lindahl, A. (2012). Austronesian sailing to the northern Marianas, a comment on Hung et al. (2011). *Antiquity* **86:** 898–910.

Yen, D. (1990). Environment, agriculture and the colonisation of the Pacific. In Yen, D. E., and Mummery, J. M. (eds.), *Pacific Production Systems: Approaches to Economic Prehistory*, Occasional Papers in Prehistory 18, Department of Prehistory, Australian National University, Canberra, pp. 258–277.

Yen, D. E. (1991a). Domestication: The lessons from New Guinea. In Pawley, A. (ed.), *Man and a Half: Essays in Pacific Anthropology and Ethnobiology in Honour of Ralph Bulmer*, Polynesian Society, Auckland, pp. 558–569.

Yen, D. E. (1991b). Polynesian cultigens and cultivars: The question of origins. In Cox, P. A., and Banack, S. A. (eds.), *Islands, Plants, and Polynesians: An Introduction to Polynesian Ethnobotany*, Dioscorides Press, Portland, OR, pp. 67–95.

Yen, D. E., (1995). The development of Sahul agriculture with Australia as bystander. *Antiquity* **69:** 831–847.

Yen, D. E., and McEldowney, P. H. (1991). Dongan plant identifications. *Indo-Pacific Prehistory Association Bulletin* **11:** 109–112.

Zerega, N. J., Ragone, D., and Motley, T. J. (2004). Complex origins of Breadfruit (*Artocarpus altilis*, Moraceae): Implications for human migrations in Oceania. *American Journal of Botany* **91:** 760–766.

Zerega, N., Ragone, D., and Motley, T. J. (2006). Breadfruit origins, diversity, and human-facilitated distribution. In Motley, T. J., Zerega, N., and Cross, H. (eds.), *Darwin's Harvest: New Approaches to the Origins, Evolution, and Conservation of Crops*, Columbia University Press, New York, pp. 213–238.

Bibliography of recent literature

Anderson, A. (2005). Crossing the Luzon Strait: Archaeological chronology of the Batanes Islands, Philippines and the regional sequence of Neolithic dispersal. *Journal of Austronesian Studies* **1:** 25–44.

Anderson, A., and O'Connor, S. (2008). Indo-Pacific migration and colonization: Introduction. *Asian Perspectives* **47:** 2–11.

Anderson, A., Gagan, M., and Schulmeister, J. (2007). Mid-Holocene cultural dynamics and climatic change in the western Pacific. In Anderson, D. G., Maasch, K. A., and Sandweiss, D. H. (eds.), *Climate Change and Cultural Dynamics: A Global Perspective on Mid-Holocene Transitions*, Elsevier, Amsterdam.

Barker, G., and Richards, M. R. (2013). Foraging-farming transitions in Island Southeast Asia. *Journal of Archaeological Method and Theory* **20:** 256–280.

Bedford, S., Spriggs, M., Buckley, H., Valentin, F., and Regenvanu, R. (2009). The Teouma Lapita site, South Efate, Vanuatu: A summary of three field seasons (2004-2006). In Sheppard, P. J., Thomas, T., and Summerhayes, G. R. (eds.), *Lapita: Ancestors and Descendants*, Monograph 28, New Zealand Archaeological Association, Auckland, pp. 11–34.

Bellwood, P. (2004). The origins and dispersals of agricultural communities in Southeast Asia. In Glover, I., and Bellwood, P. (eds.), *Southeast Asia: From Prehistory to History*, Routledge/Curzon, London, pp. 21–40.

Bellwood, P. (2006). Asian farming diasporas? Agriculture, languages, and genes in China and Southeast Asia. In Stark, M. T. (ed.), *Archaeology of Asia*, Blackwell, Malden, MA, pp. 96–118.

Bellwood, P. (2010). Comment on Donohue and Denham 2010. *Current Anthropology* **51:** 240–241.

Bellwood, P. (2011). Comment on Sheppard. *Current Anthropology* **52:** 819–820.

Blench, R. (2012). Almost everything you believed about the Austronesians isn't true. In Bonatz, D., Reinecke, A., and Tjoa-Bonatz, M. L. (eds.), *Crossing Borders: Selected papers from the 13th International Conference of the European Association of Southeast Asian Archaeologists, Vol. 1*, National University of Singapore Press, Singapore, pp. 128–148.

Carson, M. T. (2014). *First Settlement of Remote Oceania: Earliest sites in the Mariana Islands*, Springer, Heidelberg.

Chiu, S. (2007). Detailed analysis of Lapita face motifs: Case studies from Reef/Santa Cruz Lapita sites and New Caledonia Lapita Site 13A. In Bedford, S., Sand, C., and Connaughton, S. P. (eds.), *Oceanic Explorations: Lapita and Western Pacific Settlement*, ANU E-Press, Canberra, pp. 241–264.

Chiu, S. (2012). The way of doing things: What Lapita pottery can tell us about the stories of Austronesian expansion. *Journal of Austronesian Studies* **3:** 1–25.

Clark, G., and Anderson, A. (eds.) (2009). *The Early Prehistory of Fiji*, Terra Australis 31, ANU E-Press, Canberra.

Clark, G., Leach, F., and O'Connor, S. (eds.) (2008). *Islands of Inquiry: Colonisation, Seafaring and the Archaeology of Maritime Landscapes*, ANU E-Press, Canberra.

Clark, G., Petchey, F., Winter, O., Carson, M., and O'Day, P. (2010). New radiocarbon dates from the Bapot-1 site in Saipan and Neolithic dispersal by stratified diffusion. *Journal of Pacific Archaeology* **1:** 21–35.

Cucchi, T., Fujita, M., and Dobney, K. (2009). New insights into pig taxonomy, domestication and human dispersal in Island South East Asia: Molar shape analysis of *Sus* remains from Niah Caves, Sarawak. *International Journal of Osteoarchaeology* **19:** 508–530.

Denham, T. (2011). Early agriculture and plant domestication in New Guinea and Island Southeast Asia. *Current Anthropology* **52:** S379–S395.

Doherty, M. W. (2007). *Post-Lapita Developments in the Reef-Santa Cruz Islands, Southeast Solomon Islands*, Ph.D. dissertation, Department of Anthropology, University of Auckland, Auckland.

Donohue, M., and Denham, T. (2008). The language of Lapita: Vanuatu and an early Papuan presence in the Pacific. *Oceanic Linguistics* **47:** 365–376.

Fairbairn, A. (2005). An archaeobotanical perspective on Holocene plant use practices in lowland northern New Guinea. *World Archaeology* **37:** 487–502.

Fyfe, A. (2009). Exploring spatial relationships between material culture and language in the Upper Sepik and central New Guinea. *Oceania* **79:** 121–161.

Galipaud, J-C., and Swete Kelly, M. C. (2007). New evidence relating to transport of obsidian from New Britain to Vanuatu. *Antiquity* **81**, Project Gallery, posted June 2007 (http://www.antiquity.ac.uk/projgall/swete312/).

Garling, S. J. (2007). *Post-Lapita Evolutions or Revolutions? Interaction and Exchange in Island Melanesia: The View from the Tanga Islands*, Ph.D. dissertation, Department of Archaeology and Natural History, Australian National University, Canberra.

Gray, R. D., Drummond, A. J., and Greenhill, S. J. (2009). Language phylogenies reveal expansion pulses and pauses in Pacific settlement. *Science* **323:** 479–483.

Kirch, P. V. (2010). Peopling of the Pacific: A holistic anthropological perspective. *Annual Review of Anthropology* **39:** 131–148.

Kirch, P.V. (2011). Anything but a backwater. *Antiquity* **85:** 568–569.

Kononenko, N., and Torrence, R. (2009). Tattooing in Melanesia: Local invention or Lapita introduction? *Antiquity* **83**. Project Gallery, posted June 2009 (http://antiquity.ac.uk/projgall/kononenko/).

Larson, G., Karlsson, E., Perri, A., Webster, M., Ho, S., Peters, J., Stahl, P., Piper, P., Lingaas, F., Fredholm, F., Comstock, K., Modiano, J., Schelling, C., Agoulnik, A., Leegwater, P., Dobney, K., Vigne, J., Vila, C., Andersson, L., and Lindblad-Toh, K. (2012). Rethinking dog domestication by integrating genetics, archaeology, and biogeography. *Proceedings of the National Academy of Sciences* **109:** 8878–8883.

Mijares, A. S. B. (2007). *Unearthing Prehistory: The Archaeology of Northeast Luzon, Philippine Islands*, BAR International Series 1613, Archaeopress, Oxford.

Noury, A. (2007). Lapita period modelled ceramic face from New Caledonia. *Archaeology in Oceania* **42:** 28–30.

Noury, A., and Galipaud, J.-C. (2011). *Les Lapita, nomades du Pacifique*, IRD Éditions, Marseilles.

O'Connor, S., Ono, R., and Clarkson, C. (2011). Pelagic fishing at 42,000 years before the present and the maritime skills of modern humans. *Science* **334:** 1117–1121.

Piper, P. J., Campos, F. Z., Ngoc Kihnh, D., Amano, N., Oxenham, M., Chi Hoang, B., Bellwood, P., and Willis, A. (2012). Early evidence for pig and dog husbandry from the Neolithic site of An Son, Southern Vietnam. *International Journal of Osteoarchaeology*. Wileyonlinelibrary.com DOI: 10.1002/oa.2226.

Rowley-Conwy, P., Albarella, U., and Dobney, K. (2012). Distinguishing wild boar from domestic pigs in prehistory: A review of approaches and recent results. *Journal of World Prehistory* **25:** 1–44.

Sand, C. (2010). *Lapita calédonien: Archéologie d'un premier peuplement insulaire océaniens*, Travaux et Documents Océanistes 2, Société des Océanistes, Paris.

Scott, R. M., Buckley, H. R., Spriggs, M., Valentin, F., and Bedford, S. (2010). Identification of the first reported Lapita cremation in the Pacific Islands using archaeological, forensic and contemporary burning evidence. *Journal of Archaeological Science* **37:** 901–909.

Simanjuntak, T., Pojoh, I. H., and Hisyam, M. (eds.) (2006). *Austronesian Diaspora and the Ethnogenesis of People in the Indonesian Archipelago*, Indonesian Institute of Sciences (LIPI), Jakarta.

Smith, D. G. (2010). The consequences of early food production: Three recent contributions. *Reviews in Anthropology* **39:** 91–107.

Solheim II, W. G. (2008). The pre-Sa Huynh-Kalanay pottery of Taiwan and Southeast Asia. *Hukay. Journal of Archaeological Research in Asia and the Pacific* **13:** 39–66.

Summerhayes, G. (2004). The nature of prehistoric obsidian importation to Anir and the development of a 3,000 year old regional picture of obsidian exchange within the Bismarck Archipelago, Papua New Guinea. *Records of the Australian Museum Supplement* **29:** 145–156.

Summerhayes, G. R. (2009). Obsidian network patterns in Melanesia: Sources, characterisation and distribution. *Indo-Pacific Prehistory Association Bulletin* **29:** 110–124.

Sutton, A., Mountain, M. J., Aplin, K., Bulmer, S., and Denham, T. (2009). Archaeozoological records for the highlands of New Guinea: A review of current evidence. *Australian Archaeology* **69:** 41–58.

Swadling, P. (2005). The Huon Gulf and its hinterlands: A long-term view of coastal-highlands interactions. In Gross, C., Lyons, H. D., and Counts, D. A. (eds.), *A Polymath Anthropologist: Essays in honour of Ann Chowning*, Research in Anthropology and Linguistics, Monograph 6, Department of Anthropology, University of Auckland, Auckland, pp. 1–14.

Sykes, N. (2012). A social perspective on the introduction of exotic animals: The case of the chicken. *World Archaeology* **44:** 158–169.

Szabó, K., and Dizon, E. Z. (2007). The archaeology of Linaminan, central Palawan: A preliminary report on excavations. *Hukay, Journal of the University of the Philippines Archaeological Studies Program* **11:** 1–84.

Szabó, K., Kelly, M. S., and Peñalosa, A. (2004). Preliminary results from excavations in the eastern mouth of Ille cave, northern Palawan. In Paz, V. J. (ed.), *Southeast Asian Archaeology: Wilhelm G. Solheim Festschrift*, University of the Philippines Press, Quezon City, pp. 209–222.

Terrell, J. E. (2010). Social network analysis of the genetic structure of Pacific Islanders. *Annals of Human Genetics* **74:** 211–232.

Terrell, J. E., and Schechter, M. E. (eds.) (2011). *Archaeological Investigations on the Sepik Coast of Papua New Guinea*, Fieldiana Anthropology N.S. 42, Field Museum of Natural History, Chicago.

Torrence, R. (2012). Volcanic disasters and agricultural intensification: A case study from the Willaumez Peninsula, Papua New Guinea. *Quaternary International* **249:** 151–161.

Wickler, S. (2004). Modelling colonisation and migration in Micronesia from a zooarchaeological perspective. In Mondini, M., Muñoz, S., and Wickler, S. (eds.), *Colonisation, Migration, and Marginal Areas*, Oxbow Books, Oxford, pp. 28–40.