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The great blue highway: human migration in the Pacific

INTRODUCTION

The Pacific region, defined here as the islands of the Pacific Ocean from New Guinea eastwards to Rapa Nui/Easter Island in the west and from Hawai'i in the north to Aotearoa/New Zealand in the south (Figure 19.1), is particularly interesting and valuable for studying human migration. There are a number of characteristics that make migration here unique: the timing of colonization, the varieties of environments that people encountered, the relative isolation compared with most continental regions and, perhaps most importantly, the fact that migration for most of the history of human occupation required crossing vast stretches of open ocean in some form of watercraft. However, both despite and perhaps because of the relative isolation of most Pacific islands, migration has always been a major feature of life.

The Pacific Ocean covers over a third of the earth's surface, with an area of more than 165 000 000 square kilometers stretching nearly 20 000 km east to west. The total land mass of the Pacific Islands, however, is only about 1 262 000 square kilometers and more than half of that is taken up by New Guinea, the second largest island in the world. While many people in the world have and continue to view the ocean as a barrier, for Pacific peoples the open ocean has been the life force, the link to their ancestors and to their neighbors. It was a great highway, which, like many highways, at some times allowed people to move quickly and at other times restricted movement.

The initial human occupation of the Pacific represents one of the earliest major human migrations in the world. Most genetic studies

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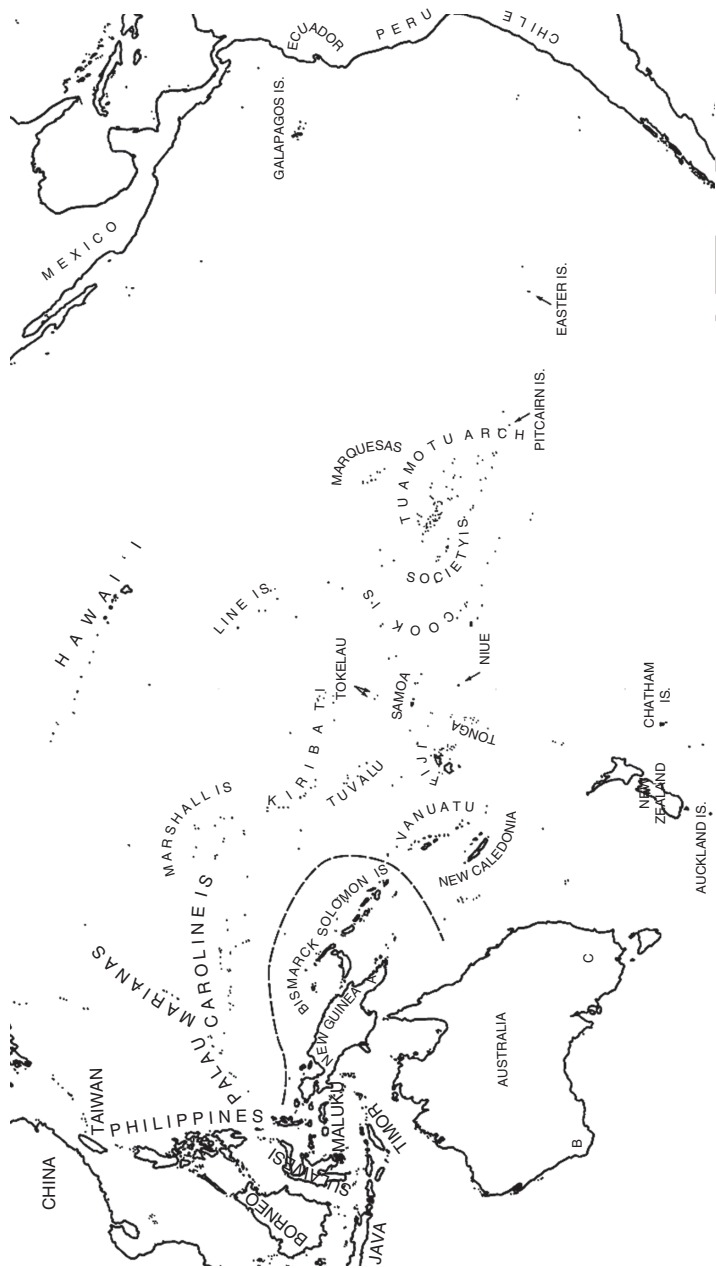


Figure 19.1 Map of the Pacific. Dotted line delineates Near and Remote Oceania. Pleistocene sites: (A) Irvane Valley, New Guinea; (B) Devil's Lair, Western Australia; (C) Willandra Lakes, New South Wales.

suggest the first migration of modern humans out of Africa began sometime around 70 000 years ago. The earliest archaeological evidence for human occupation in the Pacific is dated to around 50 000 years before present (BP), more than 10 000 years before *Homo sapiens* arrives in Europe. At the other end of the time spectrum, the human colonization of the extremes of the Polynesian triangle occurred within the last 1200 years and, therefore, represents the last major human migration that resulted in the discovery of previously unoccupied land.

In colonizing the Pacific Ocean people encountered a range of new environments and associated challenges to which they adapted biologically, socially, and culturally. The island of New Guinea represents a region of particularly high biological diversity and richness, while the many atolls and low islands of the Pacific region are some of the most biologically impoverished and fragile environments on earth. People have had to deal with significant environmental changes in the region ranging from rapidly changing sea levels and tectonic activity to major volcanic eruptions and tsunamis, all of which would have had impacts on migrations and population histories. The relative isolation and the low population density of the region meant that, for much of the history of human occupation, people were particularly healthy, free from infectious diseases. Yet this isolation also meant that when infectious disease was introduced by European explorers and sailors, it had a devastating effect on many Pacific island communities. Unlike continental migrations, which can progress at a slow and steady pace, the movement of peoples across the Pacific Ocean requires relatively rapid movement across vast distances. All of these features of the Pacific environment have shaped the people of the region biologically, socially, and psychologically, both in the past and today, and will, no doubt, continue to do so in the future.

INITIAL OCCUPATION AND PLEISTOCENE MIGRATIONS IN THE PACIFIC

At the time of the earliest migrations into the Pacific region, the Pacific environment looked significantly different than it does today. Lowered sea levels during the Pleistocene (as much as 80–100 meters below current levels) meant that many of the islands of what is now Island Southeast Asia were joined to the greater Asian landmass known as Sunda. The islands of New Guinea and Tasmania were part of the Australian continent, making up a great southern landmass known as Sahul. Sunda and Sahul are separated by the deep water trenches of

Wallacea so the islands there, including Sulawesi, Timor, and the Maluku Islands, remained isolated from either of the two major landmasses. In order for humans to cross from Sunda to Sahul, even during the periods of lowest Pleistocene sea levels, water crossings of distances of 70 km or more were necessary.

Currently, the earliest archaeological dates for the human occupation of Sahul date from 49 000 BP and come from sites in the Ivane Valley, located at an elevation of approximately 2000 m, in the New Guinea Highlands (Summerhayes *et al.*, 2010b). These sites have yielded stone tools, dating to between 49 000 and 36 000 (calibrated) BP, which have residues of endemic *Pandanus* nuts and yams. In addition, tools that the authors argue were used for forest clearance have also been recovered, suggesting not only human arrival, exploration, and utilization of inland resources, but human modification of the environment at this time. Several other sites in New Guinea and across Australia, including Devil's Lair on the southwest coast of Western Australia and the Willandra Lakes in southwestern New South Wales, date to between 45 000 and 40 000 BP (O'Connell and Allen, 2004), indicating that humans rapidly spread across the landscape of Sahul within a few thousand years of arrival. Not only did people colonize Sahul, but they also quickly expanded out to the islands to the northeast of the New Guinea coast. Archaeological evidence of human arrival in the Bismarck Archipelago, specifically on the large islands of New Britain and New Ireland, also dates to about 40 000 BP (Leavesley *et al.*, 2002) with occupation of the nearby Solomon Islands by 28 000 BP (Wickler and Spriggs, 1988). These initial migrants appear to be small, mobile, foraging groups who were exploiting a full range of marine and terrestrial resources (Allen, 2000; Summerhayes *et al.*, 2010b). This region of the Pacific that has such deep settlement history has been designated Near Oceania, differentiating it from the rest of the Pacific, now often referred to as Remote Oceania, which was settled much later (Green, 1991; Pawley and Green, 1973) (see Figure 19.1).

Molecular evidence from the Pacific is consistent with the archaeological data both in terms of the likely timing of arrival and in suggesting that populations were probably small in size and relatively widely but sparsely distributed across the landscape. Mitochondrial DNA evidence from populations in Near Oceania indicate a large number of ancient and diverse lineages (Friedlaender *et al.*, 2005, 2007). The earliest "Out of Africa" migrations of modern humans are linked to the two deep mitochondrial DNA (mtDNA) lineages, or macrohaplogroups, identified as M and N. Several unique M lineages are

found in Near Oceania and these are likely related to those ancient M haplotypes carried by the first migrants that took the southern coastal route from Africa through India and along the coast of South-east Asia (Endicott *et al.*, 2003; Macaulay *et al.*, 2005; Pierson *et al.*, 2006). Interestingly, the mtDNA lineages in Near Oceania and Australia belong to both the deep M and the N branches of the human mtDNA tree, and while some are shared, others are unique to only particular regions. This may indicate that multiple routes were taken to Sahul, but also strongly suggests that once they arrived, the founding populations were relatively isolated during the first 20 000 years of human occupation (Friedlaender *et al.*, 2007). Mitochondrial DNA lineages belonging to haplogroup P (a subgroup of the N branch) are found in both Australia and the islands of Near Oceania. Haplogroups S, O and M42 are currently found only in Australia (Pellekaan *et al.*, 2006; Pierson *et al.*, 2006), whereas haplogroup Q and several unique M lineages, including M27, M28 and M29, have only been reported in Oceanic island populations. The unique M27, M28 and M29 lineages are believed to have originated in Near Oceania, most likely in the New Britain/Bougainville region (Friedlaender *et al.*, 2007). Nearly 90% of the mtDNA lineages found today in New Guinea belong to either the P or Q haplogroups, which are believed to have originated in the region around the time of initial settlement and diversified within Near Oceania. Estimates of the age of these lineages in Near Oceania are consistently in the 30 000–50 000 BP range (Friedlaender *et al.*, 2007).

Numerous unique Near Oceanic Y-chromosome markers also indicate ancient ancestry and *in situ* evolution in Sahul (Hudjashov *et al.*, 2007). Several lineages believed to have origins in Near Oceania and thought to be exclusive to Near Oceanic or their derived populations have been identified including those belonging to haplogroups C-M38, C-M208, M-P34, K-P79, K-M254 and K-M226 (Kayser *et al.*, 2003, 2008; Mona *et al.*, 2007; Scheinfeldt *et al.*, 2006). Again, the Y-chromosome data suggest that the founding population was small, isolated, and quickly became dispersed across the landscape.

The indigenous languages of Australia and New Guinea are both incredibly diverse and unrelated to any other languages outside of the Melanesia/East Indonesian region. This is consistent with the archaeological and genetic evidence for ancient early migration and of small populations who became isolated from one another and from outside influences for a significant period of time. The languages of New Guinea, the northwestern third of the island in particular, have been described as the most diverse in the world (Pawley, 2007). The 800 or so

languages of New Guinea belong to as many as 18 unrelated language families and are often grouped together under the term “Papuan,” which really only distinguishes them as a group from the Austronesian languages that were introduced much more recently in Near Oceania (Ross, 2005). Papuan languages are also spoken out in the islands of the Bismarck Archipelago and in the Solomon Islands. In terms of their relationship with the languages of the New Guinea mainland, Pawley (2007:52) states: “The Papuan languages of Northern Island Melanesia have probably had separate histories from those of New Guinea since the late Pleistocene and possibly since people first reached Northern Island Melanesia”.

Despite the lack of linguistic evidence for lack of or limited interaction between the New Guinea mainland and the islands to the north and east, archaeological evidence suggests that from the period of approximately 20 000 BP onwards mobility and, thus possibly migration, increased in Near Oceania. At this point in time we see the earliest evidence worldwide for the translocation of animal species, resulting in the introduction of the cuscus (*Phalanger orientalis*) from the mainland of New Guinea to the islands of the Bismarck Archipelago and the bandicoot (*Echymipera kalubu*) from the mainland to the Admiralties (Flannery and White, 1991; Leavesley, 2005). Similarly, we see other indicators of mobility, possibly of trade and exchange, in the movement of obsidian (volcanic glass) from west New Britain to New Ireland, which required transporting it for distances of up to 350 km (Summerhayes, 2007). During this time it has also been suggested that seafaring skills of the inhabitants of Near Oceania developed, as is demonstrated by the settlement of Manus Island, which required open ocean sailing for over 200 km. Perhaps more important than the distance covered, however, was the fact that, in reaching Manus, the voyagers had to sail out of sight of land, which until that point had not been the case, as all of the islands colonized until then were intervisible. This would have most likely necessitated not only improved technology but mastery of and confidence in navigation and voyaging skills and, thus, this region of Near Oceania has been identified as a possible “voyaging nursery” (Irwin, 1994).

HOLOCENE MIGRATIONS AND INITIAL SETTLEMENT OF REMOTE OCEANIA

The Holocene brought significant changes to the Pacific region, as it did in most locations (Dickinson, 2000), though identifying the implications

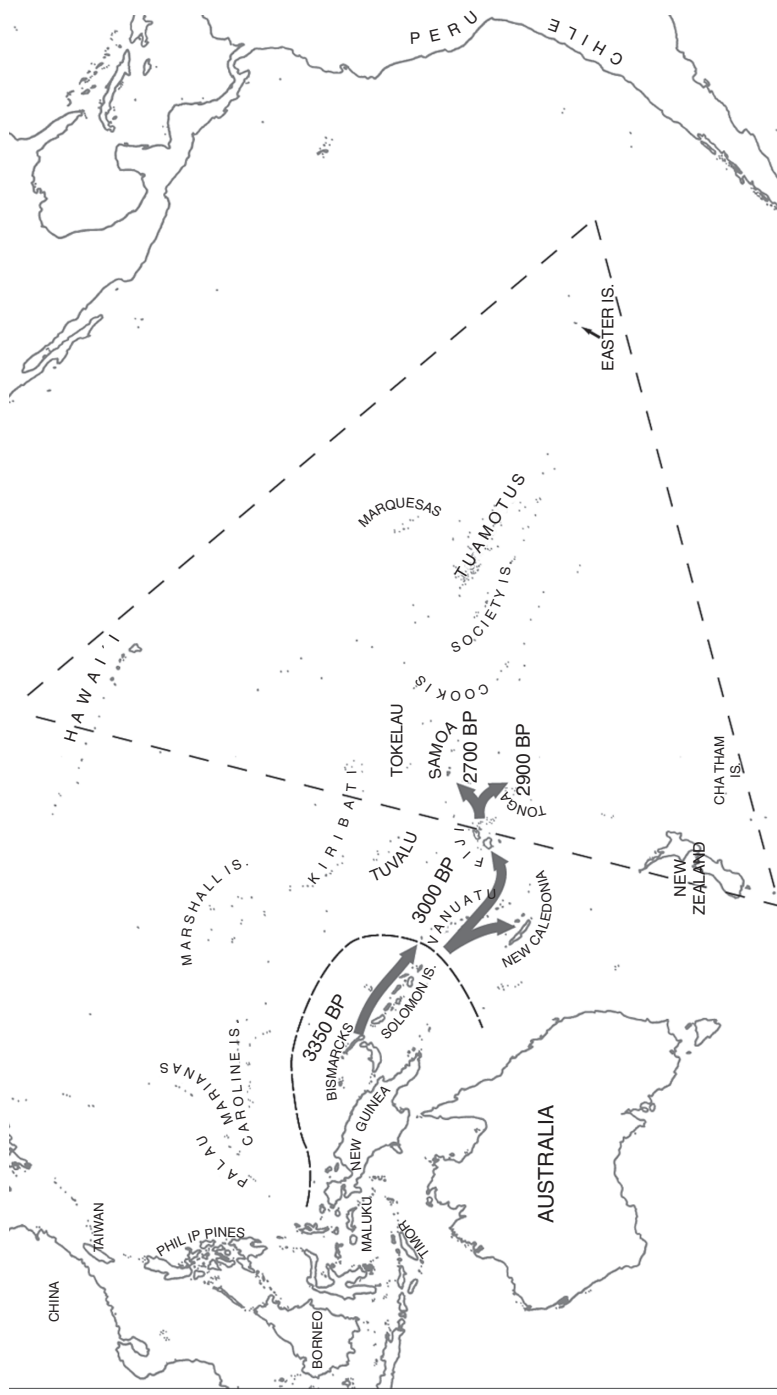


Figure 19.2 The expansion of the Lapita Cultural Complex from the Bismarck Archipelago in Near Oceania out into Remote Oceania to Samoa and Tonga on the western edge of the Polynesian Triangle (shown in dashed lines). Dotted line delineates Near and Remote Oceania.

of these changes in Near Oceania has been quite contentious. Changes in sea levels and climate had huge impacts in the region: New Guinea and Tasmania became separated from the Australian mainland between 11 000 and 8000 BP. Vegetation patterns changed with the warming climate and we see evidence of further land clearance in both lowland and highland environments on the New Guinea mainland and, most notably, the development of agriculture and the domestication of a number of native species including bananas, sugarcane, taro, and possibly yams (Denham *et al.*, 2004; Fullagar *et al.*, 2006). Landscape changes on the north coast of New Guinea also would have caused major migrations as people moved inland in reaction to the rising seas, particularly in the Sepik and Ramu River basins (Swadling and Hide, 2005).

Approximately 3350 years ago, archaeological evidence reveals a significant change in sites located in the Bismarck Archipelago. At this point we see the first appearance of small villages or hamlets made of up-stilt houses built out over reef flats. We also see the appearance of a range of new artifacts including new forms of adzes made of stone and shell, fish hooks, shell ornaments, and, perhaps best known, the distinctive dentate stamped pottery that is often used to identify these new “Lapita” sites. This archaeologically defined “Lapita Cultural Complex” first appears in coastal and small, off-shore island sites in the Bismarck Archipelago (Kirch, 2000; Summerhayes *et al.*, 2010a), but within a few hundred years, Lapita sites appear out in Remote Oceania where they clearly represent the first human colonists. The earliest Remote Oceanic Lapita sites date to approximately 3000 BP in the Reef/Santa Cruz Islands, Vanuatu, and New Caledonia (Bedford *et al.*, 2006; Green *et al.*, 2008; Sand, 1997), 2900 BP in Fiji and Tonga (Burley and Dickinson, 2001; Clark and Anderson, 2009) and about 2700 BP in Samoa (Petchey, 2001). Lapita expansion stopped here and the settlement of the rest of the Polynesian Triangle would not commence for at least another 1200 to 1500 years (Figure 19.2). Both the speed of spread and the cultural continuity between the earliest Lapita sites in Remote Oceania and those in the Bismarck Archipelago indicate that this was indeed a widespread migration of a defined cultural group, but what and when was the origin(s) of Lapita and who were the people that transported it?

It has often been suggested that the apparently sudden appearance of the Lapita Cultural Complex represented both the arrival of a new group of people and new languages in Near Oceania. The appearance and spread of Lapita is generally associated with the expansion of the Austronesian languages out of their homeland in Taiwan (Pawley

and Ross, 1993). The spread of the Austronesian languages through Island Southeast Asia and into the Pacific is then taken to represent a major population migration which is thought to be driven by the rapid population growth resulting from the Neolithic developments, rice agriculture in particular, in the Asian mainland (Bellwood, 2005). Austronesian languages are spoken through most of Island Southeast Asia, the Pacific and in Madagascar. Many of the coastal populations in the islands of Near Oceania and most of those living in Remote Oceania speak languages that belong to the Oceanic subgroup of Austronesian languages (Pawley and Ross, 1995). Palauan and Chamorro are the two exceptions; these belong to a higher order subgroup of Austronesian languages and are more closely related to the languages of the Philippines and Indonesia (Pawley, 2002).

While there is general agreement that the first colonists in Remote Oceania carried the Lapita Cultural Complex with them and that they spoke Austronesian languages, the origins of the various components and markers of the Lapita culture and the biological origins of the people associated with the earliest Lapita sites in both Near and Remote Oceania have been topics of much debate. Two extreme models, often referred to as the “Express Train to Polynesia” or the “Out of Taiwan” model (Diamond, 1988) and the “Indigenous Origins” model regularly appear in discussions about Lapita and the settlement of the Pacific. Clearly these types of models are overly simplistic for explaining human behavior and they clearly no longer fit the archaeological, biological, or linguistic data (Hurles *et al.*, 2003a). Alternative models such as the “Slow Boat” model (Oppenheimer and Richards, 2001), which acknowledges a much greater degree of interaction between different “populations,” or the “Triple I” (Green, 2000) model, which allows for a range of possible origins for the various components of the Lapita cultural package and acknowledges that human interactions and the creation of culture are both complex, are more realistic. But these too have been criticized as being untestable and not particularly useful (Terrell, 2004b; Terrell *et al.*, 2001). Part of the difficulty of testing models and reconstructing prehistory, of course, is that while the archaeological record is (generally) chronologically controlled and represents particular points in time and through time, it is rather patchy, particularly in some key geographical areas and for some very important points in time. The record in Near Oceania, for example, is not very good for the period just preceding the appearance of Lapita in Near Oceania (e.g. 6000–4000 BP), and while it is improving, the archaeological record for much of Island Southeast Asia,

particularly the islands in Wallacea, is still limited. When it comes to trying to reconstruct linguistic expansions and test theories about population migrations, we can really only rely on data obtained from modern populations, and these people and languages, for the most part, are removed by several thousands of years from the events we are trying to reconstruct. A lot can happen in 3000 years and it might not all be archaeologically visible. But until we have access to the necessary ancient human remains from the appropriate sites, and the permission of the descendant communities for destructive DNA and other biochemical analyses, we do our best with trying to reconstruct the past from the present. However, we should always keep in mind that language, biology, and culture do not always move hand in hand. Indeed, it has also been suggested that we are often too focused on the ultimate origins of languages, cultures, and peoples as opposed to their history and are too inclined to treat them as the same thing (Terrell, 2004a).

Over the last 15 years, molecular evidence, and in particular mtDNA data, has been central to the development of the debates about the biological origins of Lapita peoples. Studies of modern populations living in Remote Oceania have shown that in addition to the Near Oceanic mtDNA lineages belonging to haplogroups P and Q, these populations have high frequencies of the Asian-derived mtDNA haplogroup B and, in particular, those belonging to the B4a1a1 and derived haplotypes. The frequencies of the B4a1a1a lineages are particularly high in East Polynesian populations, where it is found above 95% in some locations, leading to the dubbing of the key mutations defining the haplotype as the “Polynesian Motif” (Redd *et al.*, 1995). Based on this high frequency in Polynesia, its distribution in Near Oceania and the ultimately Asian origins of the lineage led many to suggest that the B4a1a1a haplotypes were the marker of the Austronesian expansion through Island Southeast Asia and the Lapita expansion into Near Oceania and out into Remote Oceania (Melton *et al.*, 1995, 1998; Merriwether *et al.*, 1999). It has been suggested that a better name for the combinations of mutations defining the B4a1a1a haplotype might be the “Oceanic” (Terrell *et al.*, 2001) or “Austronesian” motif (Lum and Cann, 2000); however, linking a molecular marker to any particular linguistic or cultural group can be dangerous as these terms often carry significant baggage that may not relate to biology or to current social identity.

In what has become described as the “orthodox view” of Lapita origins and dispersal (Spriggs, 1984), the relatively high levels of Near

Oceanic derived P and Q lineages seen in Remote Oceania, particularly in Vanuatu, New Caledonia, and Fiji, are indicators of post-settlement interaction between “Papuan” populations in Near Oceania and those in Melanesian Remote Oceania. Alternatively, and probably more generally accepted today, the P and Q mtDNA lineages in Remote Oceania are seen as markers of admixture between the Austronesian Lapita peoples and the indigenous inhabitants of Near Oceania which occurred during the 200–300 years they were in the Bismarck Archipelago prior to moving into Remote Oceania.

While the mtDNA data, particularly the distribution of the so-called “Polynesian motif,” were generally seen as suggesting that the Lapita people were primarily Asian in origin, when people began studying the Y-chromosome variants in the Pacific, a very different picture emerged. A large percentage of the Remote Oceanic Y chromosomes are of Near Oceanic origin, including 66% of those identified in Polynesian populations (Kayser *et al.*, 2000). While some more recently derived Asian Y chromosomes are found in Remote Oceanic populations, specifically the O-M324 haplotypes, the most common Y chromosomes found in Remote Oceania, belong to the C, K and M haplogroups that are thought to originate in Near Oceania (Kayser, 2010; Kayser *et al.*, 2006). It has been suggested that this pattern might reflect the matrilineal descent and matrilineal dispersal patterns that are common in the Pacific today and have been reconstructed for proto-Oceanic societies (Hage and Marck, 2003).

It is clear that the B4a1a1 lineages are ultimately Asian derived and are relatively recent arrivals in Near Oceania compared with the P or Q mtDNA lineages; however, more recent analyses of complete mtDNA sequences belonging to the B4 lineages from populations throughout Island Southeast Asia and Near Oceania indicate a history for their origins and dispersals that may challenge the previous hypotheses that seem to fit so well with it being part of the Austronesian Neolithic dispersal story (Soares *et al.*, 2011; Tabbada *et al.*, 2010). Soares *et al.* (2011) argue that, according to their calculations, the immediate precursor to the “Polynesian motif,” the B4a1a1 clade, which is absent from Taiwan, is both the most diverse and the oldest in populations from the Bismarck Archipelago. They estimate its overall age there to be approximately 8400 BP and determine that it “most likely either arose from a B4a1a ancestor within the Bismarcks or arrived there from further west in the early Holocene, much earlier than the appearance of Lapita and the putative arrival of Austronesian languages” (Soares *et al.*, 2011:4). This evidence is consistent with Irwin’s (1994) concept of a

Voyaging Corridor that extended not only through Near Oceania, but also north into Island Southeast Asia. Significant mid-Holocene interaction is also argued for based on the distribution of a number of New Guinea plants, which were domesticated there and transferred into Island Southeast Asia (Donohue and Denham, 2010). The pre-Lapita movement of a native wallaby (*Dorcopsis*) from New Guinea to the Moluccas with evidence on Halmahera as early as 5500 BP (Flannery, 1995) and from Gebe as early as 8000 BP (Bellwood *et al.*, 1998) also indicate interaction between Near Oceania and Island Southeast Asia prior to the appearance of Lapita. This coincides with changes in the environmental conditions, which between 8000 and 6000 BP would have created rich lagoons and floodplains around much of this area including the north coast of New Guinea. Terrell (2004b) argues that these changes would have awakened the “Sleeping Giant” of New Guinea, making contact between New Guinea and the islands of Wallacea finally possible after the thousands of years of isolation partly driven by the extreme and uninviting coastal conditions of New Guinea during most of the Pleistocene and early Holocene. Other Asian-derived mtDNA lineages also likely arrived in Near Oceania at some point in the mid-Holocene such as the E1a and E1b lineages. To date these have not been found in Remote Oceanic populations (Friedlaender *et al.*, 2007) and may indicate further interactions within this corridor, perhaps after the Lapita dispersals to Remote Oceania. Clearly migration across Wallacea in both directions has a long history, and still continues today. Therefore the standard two-migration view so often depicted clearly needs to be reconsidered.

MICRONESIAN ORIGINS AND SETTLEMENT HISTORY

Unfortunately Micronesia, literally meaning “little islands,” is often left out of studies and discussions regarding the settlement of the Pacific. The islands that make up Micronesia are clustered into the main archipelagoes of Palau, the Mariana Islands, the Caroline Islands, the Marshall Islands, and Kiribati. Like the islands of Melanesia, the culture history of Micronesia is complex and, therefore, the inhabitants of these islands do not fit into any single coherent linguistic, cultural, or biological category (Green, 1991). Most of the islands of Micronesia are atolls, though there are some upraised coral limestone “makatea” islands, such as Nauru and Banaba, and the few high volcanic islands of Yap, Chuuk, Pohnpei, and Kosrae. The earliest dates for Micronesia, not surprisingly, come from western Micronesia with archaeological sites in the Marianas and Palau suggesting that human occupation there dates from about 3300 BP

(Clark, 2004). It has been argued based on changes in the paleoenvironmental record, however, that human presence may predate this by as much as 1000 to 1500 years (Wickler, 2001).

While the settlement history of western Micronesia may be contemporaneous with the Lapita expansion into the rest of Remote Oceania, the linguistic and archaeological evidence suggests separate origins, more closely associated with populations in Island Southeast Asia (Pawley and Ross, 1993). Pottery has been recovered from early sites in the Marianas that has been described as red-slipped and thin-walled with some having lime-filled impressed designs. It is generally thought that these are not directly related to the Lapita pots (Butler, 1994) but are more likely related to similar pots from the Philippines (Kirch, 2000).

Archaeological evidence for initial settlement of central-eastern Micronesia is significantly later than the dates in the west, and the settlement of the Carolines, Marshalls, and Kiribati, like the islands of Polynesia, is linked ancestrally to Lapita populations. The timing of settlement of the atolls of central-eastern Micronesia was very much influenced by environmental conditions as they were uninhabitable prior to 2000 BP when sea levels reached the current levels (Dickinson, 2001, 2003). Kirch (2000:167) suggests that the origins of the initial colonists to the high islands came from late Lapita plainware-producing populations located somewhere between the Bismarcks and northern Vanuatu. Linguistic subgrouping suggests connections between these Micronesian languages and the languages of Fiji, Rotuma, and Polynesia (Marck, 2000; Pawley and Ross, 1995).

Pottery has been recovered from the high islands of Chuuk, Pohnpei, and Kosrae, and is dated to approximately 2000 BP; however, its use declines through time (Kirch, 2000). Pottery is, as yet, unknown in the low islands of central-eastern Micronesia. Major landscape changes in western Micronesia and the high islands including the construction of megalithic structures and massively terraced landscapes are indicative of increased social complexity from about AD 1000. The famous "Yapese Empire," which linked Yap with Palau and the Caroline atolls, demonstrates that long-distance communication, political, and other social interactions were a significant part of the later periods of Micronesian prehistory (Butler, 1994; Hage and Harary, 1996).

Only a few biological studies have focused on Micronesian populations, addressing the issues of their biological origins and similarities to other Pacific populations. Morphological studies consistently group Micronesian and Polynesian populations together with Asian populations and separate from other "Lapita derived" populations in Melanesia

(Pietrusewsky, 1996). Analyses of mtDNA of western Micronesian populations indicate complex origins and are relatively compatible with the archaeological picture discussed above (Lum and Cann, 2000). Mariana Islanders and those from the high island of Yap show links with South-east Asian populations, where Palau has clear genetic links with populations in Near Oceania. Central-eastern Micronesian populations have high frequencies of the “Polynesian motif” haplotypes (Lum and Cann, 2000) while neutral, biparentally inherited molecular markers link Polynesian and Micronesian populations to the exclusion of “Melanesian” populations, including other Lapita-derived populations (Friedlaender *et al.*, 2008; Lum *et al.*, 2002). It has recently been suggested that the consistent grouping of some Micronesian and Polynesian populations based on biological data may be indicative of a more complex history for the populations of the atolls of central-eastern Micronesia and the islands of Polynesia than is currently reconstructed (Addison and Matisoo-Smith, 2010).

THE SETTLEMENT OF THE POLYNESIAN TRIANGLE AND BEYOND

The last major geographical region of the earth to be settled was the Polynesian Triangle – identified by the apices of Hawai’i, in the north, Rapa Nui/Easter Island, in the east, and Aotearoa/New Zealand in the south. For at least the last 50 years, there has been consensus that the origins of the Polynesians and the settlement of the Polynesian Triangle are tied to those Lapita-derived populations who arrived in Samoa and Tonga some 2900 years ago. What has been described as the remarkable linguistic, cultural, and biological homogeneity of Polynesians (Houghton, 1996; Howells, 1970) is likely due to their common and relatively recent origins from Hawaiiki, or a common Polynesian homeland located in West Polynesia (Kirch and Green, 2001). The major debates within Polynesian prehistory have focused in recent years on the timing and sequence of settlement and the associated impact of human arrival on the island ecosystems, the amount of post-settlement interaction that existed within Polynesia and on the economic and political transformations of the island societies (Kirch and Kahn, 2007).

For a period of time in the mid 1980s there was a general trend amongst Polynesian prehistorians to suggest longer periods of settlement history for many Polynesian archipelagos. Many questioned the “long pause” in West Polynesia and suggested that settlement into Polynesia was continuous or that only as little as 1000 years may have

separated the earliest sites in Central and East Polynesia from those in Samoa and Tonga (Irwin, 1981, 1994; Kirch, 1986). However, recent years have seen a shift towards a critical evaluation of some of the radiocarbon dates in what has become known as “chronometric hygiene” (Spriggs and Anderson, 1993; Wilmshurst *et al.*, 2011). Today the settlement of most of the central and east Polynesian archipelagos is thought to date to no earlier than AD 800–900, though slightly earlier settlement in the Society and the Cook Islands is still a possibility (Kirch and Kahn, 2007). Hawai’i now has an identified “Foundation Period” dated to AD 800–1200, during which discovery, colonization and establishment of populations on the main islands would have occurred (Kirch and McCoy, 2007). New dates for initial settlement of Rapa Nui/Easter Island at AD 1200 have been suggested (Hunt and Lipo, 2006), and arguments for initial human arrival in New Zealand dating to AD 200 or earlier (Holdaway, 1996; Sutton, 1984) have not been substantiated (Wilmshurst *et al.*, 2008) and settlement is now firmly accepted to have occurred around AD 1250 at the earliest (Walter *et al.*, 2010).

Linguistic and artifactual similarities as well as oral traditions have long suggested that Polynesians maintained contact and interaction spheres across great distances, some for several hundreds of years after initial settlement. While researchers have long been aware of the trade networks involving Samoa, Tonga, and Fiji (Barnes and Hunt, 2005; Dye and Dickinson, 1996) the general lack of pottery in East Polynesia made similar studies difficult. Recent advances in geochemical and other sourcing studies, however, have provided new evidence as to the extent of contact and the distances covered within East Polynesia. For example, trace element and isotope analyses of basalt tools found in the Tuamotu Archipelago have been sourced back to the Marquesas, Austral, Society Islands and even as far away as Hawai’i, indicating a trade network requiring voyages of over thousands of kilometers of open ocean (Collerson and Weisler, 2007). While such trade and exchange networks were extensive by the time Europeans arrived in the Pacific and, in some cases, such as in New Zealand, such networks had diminished significantly as populations focused on intra-archipelago social developments (Irwin, 1998; Walter, 2004; Weisler and Kirch, 1996).

Another indicator of continued interaction and contact comes from genetic studies of the plants and animals that were transported by Pacific colonists. This “commensal approach” is based on the concept that because these plants and animals cannot self-disperse and were introduced by humans to the islands of the Pacific, genetic studies that identified the origins of island populations of these plants and animals

would, by proxy, indicate the origins of the peoples who transported them (Matisoo-Smith, 1994). The model was first applied in the Pacific to studies of extant populations of the Pacific rat (*Rattus exulans*) from throughout Polynesia and identified two distinct interaction spheres in Polynesia: a northern sphere and a southern sphere, both linked to a central-east Polynesian homeland located in the Cook and Society Islands (Matisoo-Smith *et al.*, 1998). Commensal studies have also recently identified evidence of interaction networks and likely origins, migration pathways that conflict with traditional views of the settlement of and interactions within Oceania and beyond (Addison and Matisoo-Smith, 2010; Larson *et al.*, 2007; Matisoo-Smith and Robins, 2004; Matisoo-Smith *et al.*, 2009; Storey *et al.*, 2007).

Most standard histories of the settlement of the Pacific end with the colonization of Rapa Nui/Easter Island and New Zealand, but evidence is accumulating which would suggest that Polynesian voyaging continued beyond the eastern boundary of the well-known Polynesian Triangle (Jones *et al.*, 2011). The presence of charred kumara, or sweet potato, remains in prehistoric archaeological sites in Polynesia (Hather and Kirch, 1991) was a clear indicator that prehistoric contact occurred between Polynesians and South America. The fact that the Polynesians used the term *kumara*, a “Polynesianized” version of the South American name for the tuber, *kumar*, was evidence that it could not have arrived in Polynesia unaccompanied through drift voyaging or other natural means. The discovery, radiocarbon dating and ancient DNA analysis of archaeological chicken bones in the pre-Columbian site of El Arenal, located on the south-central coast of Chile (Storey *et al.*, 2007, 2008), however, renewed interest in studying those interactions and their implications for Polynesian prehistory. The AD 1300 to 1400 dates obtained from the bones clearly indicate that Europeans were not the first to introduce chickens to the Americas. Both the timing of introduction and the fact that the mtDNA sequences obtained from the bones were identical to those from ancient Pacific chicken bones suggest a Polynesian origin. Several studies have now been undertaken identifying additional evidence of contact (Matisoo-Smith and Ramirez, 2010; Ramirez-Aliaga and Matisoo-Smith, 2008) and assesses the likely sources of the voyages and other possible locations for landing and population interactions (Fitzpatrick and Callaghan, 2009).

At about the same time that Polynesian migration commenced from West Polynesia eastwards into Central and East Polynesia, Polynesian peoples also began moving westwards, back into the islands of Melanesia and Micronesia. There are approximately 18 Polynesian societies located in the

archipelagos of Vanuatu, New Caledonia, the Solomon Islands, and further afield recognized (Kirch, 2000). Generally, these “Polynesian outliers” are located on small, offshore islands and though they interact with their non-Polynesian neighbors, have remained linguistically and culturally, though not necessarily biologically, distinct from them for hundreds of years. In some cases these Polynesian arrivals were the first long-term inhabitants of the small islands they settled on, but in others the Polynesian settlers were clearly intrusive (Davidson, 1992; Kirch and Yen, 1982).

As discussed previously, the Polynesians are generally seen as a remarkably homogenous population, linguistically, culturally, and biologically (Kirch and Green, 2001; Pawley, 1966; Pietrusewsky, 1996), and while this may be demonstrated in terms of language, culture and perhaps even skeletal biology, there have been few fine-grained studies of Polynesian populations at a molecular level. Most genetic studies, including and often focused on Polynesians (see for example Kayser *et al.*, 2006), are fairly limited in samples from East Polynesia. Much of what we know about East Polynesian mtDNA and Y-chromosome variation is based on a few samples (often these same samples are analyzed in several studies) of New Zealand Maori and the indigenous population of Rapa Nui. These studies indicate limited genetic variation within Polynesia (Melton *et al.*, 1995; Murray-McIntosh *et al.*, 1998; Whyte *et al.*, 2005) and suggest that this is due to the repeated bottlenecks that must have been experienced in the process of initial colonization. Both of these populations, like many in Polynesia, suffered dramatic postcolonization population bottlenecks as a result of the introduction of European diseases, forced labor recruitment or “blackbirding,” and high levels of admixture with European populations, particularly European males (Hurles *et al.*, 1998). A recent study of both ancient and modern populations in the Gambier Islands of French Polynesia (Deguilloux *et al.*, 2011), however, has indicated that the assumption that the near ubiquitous presence of the mtDNA haplotype B4a1a1a in East Polynesia may be incorrect. These authors show not only a higher frequency of mtDNA haplotype Q1 in both the ancient and modern populations, but also identify a number of new haplotypes within the B4a1a1a clade. We anticipate that further fine-grained studies of Polynesian populations focusing on analyses of complete mtDNA genomes combined with a full range of other genetic markers are likely to indicate significantly more genetic variation within Polynesia than currently recognized, as has been demonstrated in similar studies in Near Oceania (Friedlaender *et al.*, 2007). This may have implications for understanding the settlement history and subsequent interaction in the region.

EUROPEAN ARRIVAL, COLONIALISM AND URBAN MIGRATION
IN THE PACIFIC

As discussed above, European arrival in the Pacific had dire consequences for many Pacific Island communities. Estimates of population sizes at the time of European contact have been debated widely, yet there is general agreement that the introduction of European diseases to Pacific populations with no resistance caused a rapid and dramatic reduction in the population numbers (McArthur, 1967). It is claimed that the Marquesas saw the loss of more than 90% of its population as a result of introduced diseases and while it was probably one of the worst affected archipelagoes, many Pacific islands would have reduced the populations by more than half after the first century of European contact due to disease alone (Harrison *et al.*, 1993; Rallu, 1991; Shell, 1999). In a recent assessment of population growth and collapse in the Pacific Islands (Kirch and Rallu, 2007), Norma MacArthur's (1967) often cited estimates for Pacific population sizes at contact were criticized as significantly underestimating likely population size and density at contact in many archipelagoes including Hawai'i, the Societies, the Marquesas, Samoa, New Caledonia, and Vanuatu. This means that the impact of introduced diseases as a result of initial contact was even more severe than often calculated. Later epidemics such as the 1918 flu epidemic in Western Samoa (Tomkins, 1992) had further dire consequences for Pacific Island populations.

The European explorers were quickly followed by missionaries, whalers, and sealers and a range of European entrepreneurs and other "colonists" who all had major impacts on the demographic and social history of the Pacific Islands. While long-distance interactions among Pacific Island populations diminished in most areas by the time of European arrival, Pacific Islander mobility increased again during the eighteenth and nineteenth centuries with the numbers of ships traversing the Pacific Ocean. Pacific Islanders were regular recruits in whaling and sealing crews; they were recruited as missionaries and travelled across the Pacific to spread the word of God; and they were quickly engaged in trade and other economic opportunities that came as a result of the growing European colonies popping up across the Pacific.

Unfortunately not all migration at this time was voluntary. Peruvian slavers looking for workers for the guano mines of the Chincha Islands off the Peruvian coast visited several Pacific Islands "recruiting" for labor from 1862 to 1863, once again causing massive

depopulation of up to 80% in some islands (Maude, 1981). In Tokelau an estimated 42% of the population, including almost all able-bodied males, were taken, against their will, to Peru (Green and Green, 2007). Occasionally, the islanders were returned or escaped. In some cases, repatriation meant further disease introductions as was the case in Rapa Nui/Easter Island when the return of 15 men resulted in the introduction of smallpox (Harrison *et al.*, 1993:527). In other cases men were dropped off in archipelagoes other than those from which they were taken and were assimilated. The majority of those taken, however, never returned, having died on the ships or as a result of the poor working conditions they experienced in Peru (Maude, 1981).

The rapid growth of the sugar industry in Hawai'i, Australia, and Fiji in the 1870s and 1880s resulted in further Pacific Islander mobility. Again, while some of this mobility was voluntary, much of the "recruitment" was not. Hawaiian ships picked up recruits from the Gilbert Islands (Kiribati), Rotuma, and the New Hebrides (Vanuatu) and transported them to Honolulu and then on to other islands in the archipelago. Some of these recruits stayed in Hawai'i permanently, some returned to their home islands, but many died – death rates of up to 11% for Gilbertese workers were recorded on the island of Hawai'i (Bennett, 1976). Conditions were worse in the sugar plantations of Fiji and Queensland, Australia, where the Solomon Islands, the New Hebrides (Vanuatu), and Papua New Guinea were major targets for labor recruitment (Corris, 1968). A number of the Solomon Island men who were taken to Fiji stayed there, marrying local women, and as a result a strong Solomon Island Fijian community still lives near Suva on the main island of Viti Levu. Partly in reaction to negative pressure regarding "blackbirding" from the 1890s onwards, the plantation owners in both Hawai'i and Fiji began recruiting non-Pacific Islander workers, from Japan in Hawai'i and primarily from India in Fiji. These new migrants came willingly and in many cases permanently, making major social and biological contributions to the communities they joined.

Eighteenth and nineteenth century colonial expansion in the Pacific resulted in the carving up of the region by the various western powers, with the British claiming New Zealand, Australia, central and southern parts of the Solomon Islands, Fiji, Kiribati and Tuvalu (formerly known as the Gilbert and Ellice Islands), and the Cook Islands; the Germans claiming New Guinea (including the Bismarck Archipelago), the northern parts of the Solomon Islands, western Samoa, the Caroline, Marshall and Marianas Islands (except Guam); the French claiming New Caledonia, the Society, Marquesas, Tuamotu and Austral

Islands, Wallis and Futuna; the Americans claiming Guam, Hawai'i and the eastern part of Samoa, now known as American Samoa; and Chile taking Rapa Nui/Easter Island. Vanuatu (then known as the New Hebrides) was a recognized condominium shared by the French and British. Only Tonga remained unclaimed by western powers (Barcham *et al.*, 2009). This carving up made Pacific Island mobility difficult for many, particularly when archipelagoes were split between different political powers with extended families now isolated from one another due to new political boundaries. By contrast, these colonial connections in many cases opened up new opportunities for migration to the metropolitan centers of the colonizers. While some shuffling of political control of the Pacific Islands changed after the two World Wars, colonial rule continued in many Pacific Islands until relatively recently and in some cases still continues today.

Despite achieving independence, colonial connections are often still maintained for many island communities and migration continues. Large Pacific Island communities are located now on the west coast of the United States, in New Zealand, and on the east coast of Australia, creating what has been described as the "New Polynesian Triangle" (Barcham *et al.*, 2009). This is part of a general trend, which began in the 1950s and 60s, of rural to urban migration by Pacific Islanders in search of work, educational opportunities, and the promise of a better lifestyle. A large number of Pacific Islanders, primarily from Polynesia, came to New Zealand to work in the factories, freezing works, and forestry industry in the 1960s, facilitated by immigration policies that encouraged such migration. Today many particular Pacific Island communities living in New Zealand now outnumber the populations on their islands of origin. Economic reforms and deregulation of trade in both New Zealand and Australia in the 1980s and 1990s, however, led to closure of many of the factories, causing widespread and disproportional unemployment in many resident Pacific Island communities. High levels of unemployment and other urban problems in many Pacific Island nations are also beginning to drive some urban residents back to rural villages and towns and for non-local migrants back to their islands of origin. Out-migration continues to be a problem in many Pacific Island nations, particularly for places like Niue, Tokelau, Tuvalu, and the Cook Islands (Stahl and Appleyard, 2007). The populations of the many atoll islands in the Pacific face numerous challenges in the future, including the possibility of permanent and total migration due to rising sea levels.

CONCLUSION

Migration has always been and probably will always be an important part of Pacific Island life. Reconstructing past migrations in the Pacific has been a major focus of scholars for centuries. Most recently, reconstructing prehistoric Pacific population origins and migration pathways has become something of a hot topic for molecular studies. Unfortunately, most of these scholars have not paid much attention to the complex history of population mobility in the region. While many now acknowledge the fact that the classic division of the Pacific into Melanesia, Polynesia, and Micronesia does not make much sense biologically, the settlement history of the Pacific is still generally told as a story of two migrations: the “Papuans” and the Austronesians. Increasing evidence suggests, however, that the history of the region is much more complex. And while the realization that mtDNA and Y-chromosome data suggested two very different histories has led to consideration of some of the social forces that might explain the data, few studies have focused on other historical events. The severe depopulation and inter-island migration in the last few hundred years make genetic studies of modern populations particularly unreliable for reconstructing population origins unless these factors are taken into account. These relatively recent events may also have had differential impacts on male versus female linked genetic markers, as the work of Hurles *et al.* (2003b), one of the few studies where these events have been considered, has demonstrated. There seems to be the implication in many genetic studies of Pacific peoples that populations are static and unchanging and thus events that occurred thousands, if not tens of thousands, of years ago are easily reconstructed from the DNA of peoples, their languages, and their cultural affiliations today.

I am not suggesting that such attempts to reconstruct past migrations in the Pacific are impossible. Pacific Island communities are becoming increasingly interested themselves in combining the latest evidence from archaeology and molecular biology with their own knowledge of their history. They are not only becoming involved in scientific studies of prehistory, but in many cases are driving that research and the questions being addressed. In the last few years archaeological investigations in the Pacific have uncovered new sites or reanalyzed old sites, many with human remains, that date to critical periods and are found in key locations for addressing important questions regarding past human migrations (Bedford *et al.*, 2009; Bentley *et al.*,

2007; Brooks *et al.*, 2009; McNiven *et al.*, 2011; Shaw *et al.*, 2010). Ancient DNA analyses of these human remains, being undertaken with the expressed permission of and in some cases at the request of the descendant communities, combined with the improved chances for DNA recovery with the use of next generation sequence technology (Lambert and Millar, 2006) are particularly exciting. With such data we can really start to understand and identify the genetic makeup of particular Lapita populations or that of the pre-European populations in Polynesia. By incorporating historical data with molecular data from ancient and modern Pacific populations we can even possibly reconstruct population histories through time.

Many of the causes of Pacific migration in both the past and present are common to all human populations; however, many are also unique. In trying to reconstruct past migrations or study modern migration patterns we need to be aware of the range of factors that affect migration and recognize the historic events that have impacted and shaped the populations living on Pacific Islands today and in the past. One thing that would help is for researchers studying Pacific peoples and cultures to realize that the Pacific Ocean was not just a barrier to interaction but a facilitator of migration – it was, in actuality, a great blue highway.

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