

Rethinking Polynesians origins: a West-Polynesia Triple-I Model

DAVID J ADDISON and ELIZABETH MATISOO-SMITH

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Abstract

The last twenty years has seen an apparent consensus that the immediate origins of Polynesian language, culture and biology lie solely with the Lapita peoples and cultures that settled Samoa and Tonga by 2700 years ago. We suggest that there is increasing evidence that does not sit well with this generally accepted view of Polynesian origins and thus we put forward an alternative model for consideration. Building on Green's suggestion of over 20 years ago, we propose that some of the ideas in his Triple-I model (Green 1991a) might also be usefully applied to conceptualizing the processes involved in Polynesian origins. Specifically, we suggest that in addition to Lapita origins, there were significant later elements introduced to Polynesia that were fundamental to the development of Polynesian culture and biology prior to the settlement of East Polynesia. Current data suggest that some of these elements are shared with Micronesia and may be ultimately derived from post-Lapita population movements, perhaps from Island Southeast Asia through the low islands of the Carolines, Kiribati and Tuvalu to West Polynesia.

Any discussion of Polynesian origins is complicated – even the very framing of the question is fraught with problems. Polynesia is roughly defined geographically as the islands encompassed within the triangle formed by Hawaii, New Zealand and Easter Island, linguistically by the islands where Polynesian languages are spoken (or were spoken at European contact), and culturally and biologically by an ever-changing list of characteristics. Despite these difficulties, Green (1987; 1991b) suggested that Polynesia was the one region in the Pacific that did constitute a valid biological, linguistic and cultural group.

The linkage of linguistic, biological and archaeological evidence in understanding the Pacific past has been questioned on theoretical grounds (Donohue and Denham 2010; Smith 2002; Terrell 1989; Terrell, *et al.* 1997), a fundamental challenge to the “phylogenetic model” (Kirch and Green 1987, 2001). It is not our intention to enter that debate. Our thoughts are predicated on the idea that biology, archaeology, language, and other aspects of culture are not necessarily transported and maintained through time as bundled units. As a corollary to this, we accept the notion

that the relationships between these various domains do not change in predictable or uniform ways. An expectation of these ideas is that the human past on each island is likely to be complex (and necessarily difficult to interpret). Within this context we review some aspects of the archaeology and human/commensal biology of the region and suggest the possibility that models incorporating more than one population movement into Polynesia may offer a better fit for some of these data. We postulate post-Lapita population movements out of the western Pacific, possibly originating in Island Southeast Asia, adding complex influences into the development of Polynesian culture and biology.

Early ideas on Polynesian origins

When European explorers first came to Oceania they quickly noted similarities and differences in the human languages, cultures and phenotypes they observed in the region. In 1832, the French explorer and scientist Dumont-d'Urville dealt with this diversity by using the existing terms Micronesia, Melanesia and Polynesia, in an explicitly socio-evolutionary framework in which “races” were seen as forming a unilineal and progressive sequence with northern Europeans as the most “evolved” (see discussions in Clark 2003; Tcherkézoff 2009). This biological and social-evolutionary perspective, while modified regularly, was the framework within which anthropology developed as a science.

In the late 19th and early 20th centuries, substantial scholarly research was devoted to understanding the origins and relationships of Oceanic populations, particularly the question of “Polynesian origins” (Howard 1967). Underpinning these discussions was a belief that Polynesians had come into the Pacific only a few centuries before Europeans arrived – with Polynesian language and culture fully developed – and quickly spread over the expanse of Polynesia (see discussion in Kirch 2000). It was thought that original migration routes could be understood by comparing traits from different islands. Scholars working in this period, such as Te Rangi Hiroa Sir Peter Buck and Edwin Burrows, developed or deployed sophisticated ethnological datasets to do this. Data from physical anthropology – a discipline then working in an essentialist and race-based paradigm – were also explored, while comparative linguistics was still in its infancy (Mawyer 2008). One suggestion regarding Poly-

DJA: Samoan Studies Institute, American Samoa Community College, Pago Pago, AS 96799. add1ison@gmail.com; EM-S: Dept of Anatomy and Structural Biology and Allan Wilson Centre for Molecular Ecology and Evolution, University of Otago, PO Box 913, Dunedin 9054, New Zealand.

nesian origins, put forward by Buck (1958) and later, based on analyses of skeletal biology, by Howells (1973), involved settlement from Island Southeast Asia through the islands of Micronesia.

With the advent of radiocarbon dating in the 1950s, a time depth for the arrival of pottery in Melanesia was established, but perhaps more important was the linking of Polynesia and Melanesia through the recognition of Lapita pottery and a community of culture spanning from the Bismarck Archipelago to West Polynesia (e.g. Golson 1961). The next thirty years of archaeological research focused on documenting the history and spread of the Lapita cultural complex which, combined with the linguistic reconstructions, linked most of Remote Oceania and many components of the Lapita cultural complex to the spread of Austronesian speakers (Pawley and Ross 1993; Pawley and Green 1973), and resulted in what has become a generally accepted set of ideas regarding Polynesian origins.

The settlement of the Pacific and the development of the Lapita-only model for Polynesian origins

The human occupation of the Pacific began some 40–60,000 years ago with the settlement of the landmass of Sahul. People rapidly moved through the landscape of what is now Australia and New Guinea and colonised the islands of New Britain and New Ireland, reaching the islands of the greater Solomon chain by 30,000 BP. This region of initial colonisation was defined by Green, in his attempt to move beyond the tripartite description of the Pacific, as “Near Oceania” (Green 1991b; and see Pawley and Green 1973). The region from the Reef Santa Cruz Islands east and north – Green’s “Remote Oceania” – was unoccupied until much later. The first human colonists of Remote Oceania are associated with the spread of Lapita pottery and a range of other cultural components. In Near Oceania, Lapita sites first appear in the archaeological record in the Bismarck Archipelago by ~3300 cal BP (Specht and Gosden 1997; and see dating discussed in Summerhayes 2007; Summerhayes, *et al.* in press). Within a few hundred years Remote Oceania began to be settled, with Lapita sites in the Reef Santa Cruz Islands, Vanuatu and New Caledonia by ~3000 cal BP (Bedford, *et al.* 2006; Green, *et al.* 2008; Sand 1997) and reaching Fiji and Tonga by ~2900 cal BP (Anderson and Clark 1999; Burley and Dickinson 2001; Clark and Anderson 2001; Clark and Anderson 2009). The Mulifanua site in Samoa (Jennings 1974) marks the currently known eastern limit of the distribution of dentate-stamped Lapita pottery (Addison and Morrison in press; Rieth, *et al.* 2008) and was settled by ~2700 cal BP (Petchey 2001).

Though it is now accepted that the initial settlement of western Micronesia occurred at about the same time as the Lapita expansion (Clark 2004), Lapita pottery has yet to be discovered in the region. Anderson has pointed out that the settlement of this area indicates a developed voyaging capacity in Austronesian-speaking populations contemporaneous with Lapita (Anderson 2000:18). Linguistic relation-

ships (Pawley and Ross 1993, 1995) have provided much of the framework for interpreting the archaeological evidence and have directed discussions regarding Micronesian origins. The western Micronesian languages of Palauan and Chamorro stand in contrast to the Oceanic languages spoken in the rest of Remote Oceania. Palauan and Chamorro alone are not members of the Oceanic subgroup, but rather are sisters, with Palauan, Chamorro and Proto-Oceanic (along with other language groups in Indonesia and the Philippines) being descendants of Proto-Malayo Polynesian, the Austronesian branch found outside Taiwan (Blust 2009). The initial settlement of Palau and the Mariana Islands is therefore thought to have been directly from Island Southeast Asia, and not through other parts of Oceania. The remaining Micronesian languages all belong to the Nuclear Micronesian branch of the Oceanic subgroup. Thus the origins of the central-eastern Micronesians (e.g. those populations found in the Carolines, Marshalls, and Kiribati), like those of the Polynesians, are seen as linked ancestrally to the Lapita expansion. Based on this linguistic evidence, Kirch (2000:167) suggested that “the first settlement of central-eastern Micronesia should be from the region of the initial Lapita expansion, somewhere between the Bismarcks and the southeast Solomons-Vanuatu region”.

Although standard linguistic subgrouping models show particular relationships between the languages of Fiji, Rotuma, Micronesia, and Polynesia, (e.g. Geraghty 1986; Marck 2000; Pawley and Ross 1995), statistically robust alternative methods show different patterns (Gray, *et al.* 2009 and supporting online materials; Gray and Jordan 2000; Greenhill and Gray 2005). This illustrates Rensch’s point that different subgrouping configurations can be obtained depending on the particular criteria used (Rensch 1987:578) and highlights Biggs’ reminder that subgrouping models concern the *relationships between languages* and that “inferences as to migrations, first settlements, homelands, cultural affiliations and so on should be drawn from such data with caution, and a full awareness of the limited application of linguistic conclusions to such problems” (Biggs 1972:143).

Green presaged the current archaeological consensus for Polynesian origins in 1967 when he wrote that “becoming Polynesian took place in Polynesia itself as the archaeology of Tonga and Samoa over the last 3,000 years readily attests. One begins with Eastern Lapita, and ends with Polynesian” (Green 1967:237). The consensus that has developed (what we call the “Lapita-only model”) holds that plainware pottery rapidly developed from Lapita pottery in West Polynesia. There was then a long period (~800–1000 years) of common development and shared innovations within a West Polynesia interaction sphere. This is the process that led to the distinctive Polynesian cultural forms, artifacts (APS – Ancestral Polynesian Society) and language (Proto-Polynesian). Towards the end of this period, the interaction sphere split into a southern grouping characterized by the Proto-Tongic language and a northern grouping characterized by the Proto-Nuclear-Polynesian language. It was from the northern grouping of this West Polynesia

“homeland” that much of the rest of Polynesia was then settled, the colonists carrying with them their essential “Polynesian-ness”. The decades of research that went into developing this scenario have been synthesized and cogently argued in the book *Hawaiki* (Kirch and Green 2001). The perceived confluence of biology, linguistics and archaeology in the Lapita-only consensus is also reflected in statements such as: “If we start with Polynesia and work backwards, the pattern is clearer. Initial settlement of Polynesia by the Lapita culture and lack of evidence for any but Polynesian sub-group languages there would suggest Polynesians, a genetically homogenous group, are direct descendants of the bearers of Lapita culture” (Spriggs 1995:123).

Polynesian origins from a biological perspective

The biological origins of the Polynesians has long been a topic of debate. Early Europeans in the Pacific pondered the relationship between the relatively tall and light-skinned Polynesians and the shorter, dark-skinned and “negroid” looking Melanesians. The linguistic and physical similarities both within Polynesia and between Polynesians, Micronesians and Indonesians were noted by early explorers, leading to discussions of “Mongoloid” origins and even classification of Polynesians as “Malays” by Blumenbach in his *Natural Varieties of Mankind* (Blumenbach 1969 [1795]; see also Dixon 1923; Sullivan 1921; Wallace 1867). Early biologists and others grappling with human biological variation in the Pacific suggested that Polynesian origins were complex and multiple. One major route of colonization suggested by Buck was through Micronesia, based on physical and cultural similarities between Micronesian and Polynesian populations (Buck 1958). Thor Heyerdahl popularized the issue of Polynesian origins with his book and the associated publicity following the 1947 Kon Tiki expedition in which he and his team “sailed” from Peru to the Tuamotus on a balsawood raft. Based on this voyage and other evidence, Heyerdahl suggested that Polynesian origins were multiple with some contribution from the Americas (Heyerdahl 1952). Even as late as the 1960s, biological anthropologists could not reject either of these propositions based on blood group and other genetic data available at the time. In 1962, Simmons stated “[i]f comparisons are valid, then American Indians and Polynesians shared in a common gene pool, more so than Polynesians and other races to the west and northwest” (Simmons 1962:208-9). Though he went on to caution that “[a]fter 25 years of progress, we serologists have mapped most of the known blood group genes for racial groups throughout the world, and while clear-cut gene markers are known in respect to some human races, it seems clearly evident that blood group genetical studies do not tell us the racial components of the Pacific peoples or their paths of migration” (1962:209).

From the very early development of the discipline, physical anthropologists noted the unique phenotype of

Polynesians. Anthropometric and skeletal studies of Pacific populations over the years noted the high degree of homogeneity found in Polynesia, particularly in comparison to the biological variation found in Melanesia and to a lesser extent, Micronesia (Howells 1970). This led to the description of what has been termed the “Polynesian phenotype”, or the unique combination of anatomical characteristics that are found at high frequencies in Polynesian populations: tall, robust individuals with long bodies and short legs; shovel shaped incisors; broad, pentagonal-shaped crania; and mandibles possessing a broad, vertical ramus and lacking an antegonial notch, giving them an unusual shape known as a “rocker jaw” (Houghton 1980, 1996). This biological homogeneity, when combined with the relatively limited cultural and linguistic variability and the archaeological recognition of the Lapita cultural complex as the first human presence in the region over-rode early ideas of multiple origins and generally resulted in a degree of biological consensus supporting the “Lapita-only” model for Polynesian origins, despite lack of direct biological evidence for this model (e.g. Pietrusewsky 1996).

In the 1980s genetic studies began to focus on various unique molecular markers found in Pacific populations. Of significance was the recognition of a number of genetic mutations associated with the blood disorder thalassaemia, which were found to have evolved within the Pacific (Hill, *et al.* 1985). Given that these thalassaemia mutations provide the bearers some resistance to malaria, it was particularly noteworthy that one of these, known as the alpha 3.7III mutation, was found at unusually high frequencies in Polynesian populations. Frequencies as high as 12% reported for East Polynesians are unusual for a population living in a non-malarial area (Hill, *et al.* 1987; Hill, *et al.* 1985). This remnant genetic marker linked populations from coastal New Guinea through Vanuatu and out into Polynesia and provided the ancestral link between Polynesia and Melanesian populations that finally substantiated the Lapita colonisation route identified by archaeologists and linguists.

Molecular studies – especially those focused on the uniparentally inherited mitochondrial DNA (mtDNA) – continued to have an impact on anthropological studies in general (Cann, *et al.* 1987), and particularly on the issue of tracking the origins of Pacific populations. The recognition of a particular Asian-derived mutation known as the 9 base pair (bp) deletion found in Polynesian populations (Hertzberg, *et al.* 1989) was quickly recognized by prehistorians and geneticists alike as a significant indicator of the ultimate origins of Polynesians. Soon after, researchers identified an additional combination of single nucleotide polymorphisms (SNPs) that were found at high frequency in Polynesian populations. This led to the naming of this particular mutation – the 9bp deletion plus the three SNPs found in the hypervariable control region – as “the Polynesian motif” (Redd, *et al.* 1995).

By the early 1990s an orthodox view of the biological origins of Polynesians had developed that very much

mirrored the archaeological perspective: Polynesian origins were clearly associated with the Lapita expansion. The ultimate origins of some of the genes carried by these Lapita peoples was Southeast Asia, very possibly Taiwan, although Richards and colleagues argued that the mtDNA “evidence is consistent with an alternative view, namely, that the Polynesian expansion originated within the Indonesian archipelago” (Richards, *et al.* 1998). Lapita peoples carried the unique East Asian mitochondrial DNA haplotypes (those belonging to the B4 haplogroup) throughout the Pacific and to the Polynesian triangle after which they were dispersed by the Lapita descendants, the Polynesians. At some point and in some regions, these Lapita populations mixed with the indigenous inhabitants of Near Oceania. The speed of movement and the degree of interaction was debated but generally the biological data and the relationships identified were explained by, and incorporated into, the archaeological and linguistic models and debates, in what often appeared to be circular arguments.

One group, proponents of what has been called the “Express Train” (Diamond 1988) argued for rapid movement of Lapita peoples through Near Oceania to Polynesia. Spriggs referred to this as the “orthodox view” that archaeologists had coalesced around as early as the late 1970s (Spriggs 1984:202-03). The end result of this rapid migration was that Polynesian populations, as we see them today, are the remnants of what those Lapita people would have looked like. The phenotypic variation seen today in the descendants of the Lapita peoples is the result of post-Lapita interaction and admixture with indigenous Near Oceanic populations in the more western portions of Remote Oceania. In other words, the reason that the people of Vanuatu, New Caledonia and western Fiji “look” so different from the Polynesians, despite their shared origins, is due to later admixture with “Papuans” (Green 1963; Lum, *et al.* 2002; Pawley and Ross 1995; Wurm 1967). Clark, however, has questioned whether the magnitude of the proposed “post-Lapita population movement between Vanuatu/New Caledonia and Fiji [was] sufficient to shift the established ‘Lapita’ Fijian phenotype to a more ‘Melanesian’ form” (Clark 2009:308) and argued that the archaeological evidence is weak at best.

The second perspective on Lapita and therefore Polynesian origins, now known as the “Slow Boat” model (Oppenheimer and Richards 2001), or the even more complex, yet perhaps more likely “Triple I” variant (Green 1991a; Green 2000), posits a slower move through Near Oceania involving the *Intrusion* into Near Oceania of Asian-derived people who interacted in Near Oceania with the indigenous inhabitants, *Integrating* and picking up a number of their cultural, genetic and phenotypic traits and finally developed new ideas and characteristics of their own (*Innovation*) (cf. Spriggs 1984). The subsequent mixed and variable population of Lapita peoples then moved out of Near Oceania into Remote Oceania. A series of founder effects and population bottlenecks reduced the genetic and phenotypic variation in a clinal fashion across the Pacific as Lapita colonists moved eastward until West Polynesia was

settled by “a canoe load of closely-related people ... not at all typical of the populations from which they sprang ... plucked by drift of genes and canoes out of the populations inhabiting island Melanesia ...” (Houghton 1980). Over the ensuing 1000–1500 years these people became Polynesian in language and culture and then spread from West Polynesia throughout the rest of the Polynesian triangle.

While these various scenarios regarding Polynesian origins were being presented and debated in the human-genetic and more general anthropological literature, physical anthropologists were analyzing the skeletal remains found in association with Lapita archaeological sites (e.g. Pietrusewsky 1985, 1989a, 1989b; Valentin 2003). Unfortunately those remains were limited in number, often fragmentary and generally not associated with the earliest Lapita layers (Pietrusewsky 2001). This poor state of the Lapita human remains meant that no clear consensus could be reached. There were conflicting views regarding whether or not the skeletal biology confirmed the “Polynesian” body form of the Lapita peoples. Ancient DNA analyses of the Lapita human remains (Hagelberg and Clegg 1993) also remain equivocal (Matisoo-Smith 2007:417) due to the fact that they have never been replicated and were not conducted using what are now considered to be standard ancient DNA protocols (Gilbert, *et al.* 2005).

So, without any data available to suggest an alternative, from the 1980s onwards, these biological data were regularly incorporated into the archaeological and linguistic models for Pacific prehistory that have resulted in the orthodox view of Polynesian origins. Simply put, while the debates regarding the ultimate origins of Lapita people(s) and the genotypic and phenotypic variation that existed within Lapita populations through time have not been resolved, the general consensus is that biologically and culturally, Polynesian origins are solely Lapita-derived.

Unresolved aspects of the Lapita-only model

Increasingly, new archaeological, biological and other data fit uncomfortably into a Lapita-only model for Polynesian origins. The biological data for both human and commensal animals are particularly problematic.

Biological questions

As noted earlier, the human skeletal evidence does not indicate that the Lapita-associated remains possess the same phenotype as Polynesian populations today or in the past (Pietrusewsky 1996; Valentin pers comm.). Therefore the skeletal and anthropometric data favour a Slow-Boat or Triple-I model – and the requisite bottleneck events occurring as populations moved eastwards. Similar explanations which require significant founder effects to explain the phenotypic diversity seen in Remote Oceanic populations have also been put forward for central and eastern Micronesian origins. Researchers suggest central and eastern Micronesians have a common “Melanesian” origin, yet separate colonisation histories, to the Polynesians

(e.g. Kirch 2000; Lum and Cann 1998; Lum, *et al.* 1998). Polynesian and central/eastern Micronesian populations both show limited mtDNA diversity, yet are remarkably similar to one another – sharing high frequencies of mtDNA haplotype B4a1a1, or the full “Polynesian motif” (Lum and Cann 1998; Lum and Cann 2000). It is argued that neutral, biparentally inherited DNA variants also suggest a similar yet separate history for Polynesian and central/eastern Micronesian populations (Friedlaender, *et al.* 2008; Lum, *et al.* 2004). While not impossible to explain with a single Lapita origin for both groups, it does require special pleading which is difficult to imagine and impossible to falsify. If both central/eastern Micronesian and Polynesian populations are solely Lapita derived, independently of one another, it is remarkable that random drift events would result in such similar biological profiles being derived from such a hypothetically variable Lapita source population.

One of the most inconsistent datasets in regards to the Lapita-only model for Polynesian origins relates to studies of commensal animals. It has generally been argued that Lapita peoples brought dogs, pigs, chickens, and Pacific rats (*Rattus exulans*) with them when they moved into Remote Oceania. While rat bones appear in most Lapita and later sites, including early sites throughout Polynesia, the evidence for the other commensal animals is patchier. A limited amount of pig and chicken bones do appear in early Lapita sites, but dog bone is rare, if present at all. Interestingly however, dog bone appears throughout the western Pacific after ~2000 cal BP, and is found throughout most of East Polynesia from first colonization at ~1000 cal BP, yet is totally absent prehistorically in New Caledonia and Vanuatu (Matisoo-Smith 2007).

In terms of genetic analyses of commensal animals, only the pig appears to have a phylogenetic pattern that is consistent with a single and presumably Lapita-associated introduction (Larson, *et al.* 2007). Mitochondrial DNA studies of *Rattus exulans* (Matisoo-Smith and Robins 2004), and archaeological dog remains from the Pacific (Savolainen, *et al.* 2004) both indicate two distinct introductions into Polynesia. For both dogs and rats, current evidence suggests that at least one of the two lineages, Haplotype IIIB for *Rattus exulans* and Arc 2 for dogs, does not appear to be associated with the Lapita dispersal, and yet is found throughout Polynesia and may represent a later introduction into the Pacific (Matisoo-Smith 2007; Matisoo-Smith 2009). *Rattus exulans* mitochondrial DNA haplotype IIIB is also found throughout Micronesia where no *Rattus exulans* remains predate ~1200 cal BP (Wickler 2004).

Similarly, Storey *et al.* (2007) identified two chicken lineages in East Polynesia which appear to be temporally distinct (Storey 2009). In its geographical distribution, one of these lineages is consistent with a Lapita dispersal; the other only appears in archaeological sites that are more recent than ~1200 cal BP, and so far has been found only in Polynesia and Micronesia.

Biological anthropologists studying the skeletal biology of Pacific human populations have for many years been unable to comfortably incorporate their data which

demonstrate significant phenotypic variation in Remote Oceania within the current archaeological and linguistic models for Polynesian origins (Pietruszewsky 1996). But perhaps the picture that is emerging from the commensal data can provide a framework for a model that does better explain the human variation in the Pacific. Taken in total, the commensal data suggest complexity. Again, we should not be surprised that there is not a simple answer to explain the distributions of animal populations over the whole Pacific, as each island population will have a unique set of circumstances that will determine the choices they make about what components of their culture they will transport, maintain or incorporate in their daily lives. Thus we should not expect to see all components being transmitted through time or across the Pacific as a defined and intact bundle. Such patterns in Remote Oceania mirror the long and complex history of other agricultural elements in the Near Oceania and Island Southeast Asia region (Denham and Donohue 2009; Donohue and Denham 2010).

However, when we look at the commensal animal data as a whole, accepting the fact that the data are still somewhat preliminary and patchy, we do see a particular pattern emerging. With the exception of the pig data, all other commensal animal data suggest multiple introductions to Remote Oceania. One of the mtDNA lineages of the chickens and the rats, and the Pacific pig lineage are all consistent in distribution and appearance in the archaeological record with a Lapita introduction. The dog, rat and chicken data all indicate a second introduction, somewhat later in time, but probably not before ~2000 cal BP. This second lineage, in the case of the rat and chicken is shared between Polynesia and Micronesia, and is found only at very low frequency, if at all, elsewhere in the Pacific. This pattern could be explained by a second population movement out of Asia sometime after ~2000 cal BP, bringing new populations of dogs, rats and chickens. These new lineages may have only survived on islands where earlier populations were either not present or were at low density. Alternatively, the observed distribution may be indicative of the route of dispersal through the previously uninhabitable low islands of the Carolines, Kiribati and Tuvalu to Samoa and then, eventually out to East Polynesia.

If we were to take this scenario and consider the human biological data, this second arrival of people in Micronesia and Polynesia could explain those components of the skeletal biology and human genetic data that do not sit well in the Lapita-only model of Polynesian origins. This scenario might also provide a better explanation for components of West Polynesian subsistence and material culture that are not adequately explained by current colonisation models.

Early West Polynesia subsistence

The nature of Lapita (and later) subsistence is not peripheral to the topics addressed in this paper. The subsistence system(s) that were used have implications for population density, size, and growth rates. This becomes important when considering new populations moving into an already

populated area. Very different interaction dynamics can be envisioned depending on pre-existing population sizes and density distributions on the landscape. Hence, we review here some of the questions about subsistence in the time of Lapita and Polynesian plainware in West Polynesia (the period of Polynesian plainware production and use roughly corresponds to the development of APS and Proto-Polynesian in the Lapita-only model).

The nature of the colonization-period Lapita economy has long been debated. Groube (1971) initially argued for a “strandlooper” subsistence system in which Lapita colonists targeted the best wild foods, then moved on once an area had been depleted. Kirch (summarized in Kirch 1997) countered that Lapita colonists were adept horticulturalists that transported domestic animals, a cultivated-plant inventory and agricultural system with them as they settled the islands of Remote Oceania. Both may be right, in that there may not have been only one colonization-period subsistence system across the whole 3000-km range of Lapita (see also Field, *et al.* 2009:1555). Groube’s data from Tonga are near the eastern edge of the Lapita expansion, an area with substantially different environmental variables compared to the Bismarck Archipelago sites for which the strongest agricultural arguments are made.

For Fiji, Clark and Anderson (2001:84) suggest that “agricultural production was not necessarily a factor in population dispersal processes either in Eastern Lapita generally or within early and late Lapita in the Fijian archipelago (cf. Spriggs 1997:85-6; Kirch 1997:203-12)”. Instead, Lapita subsistence in Fiji was “focused everywhere primarily on marine resources” and “if agriculture existed it was not well-developed” (Clark and Anderson 2001:84). Anderson has elsewhere proposed that initial Lapita populations were highly mobile and were focused on “skimming” the best faunal resources (Anderson 2001; see also Best 1984:650-3).

Of Tonga, Burley and colleagues (Burley, *et al.* 2001:102) write that the “settlement strategy in Ha’apai is concordant with a mobile, maritime adaptation.” They also note the high reliance of Lapita populations in Tonga on non-agricultural food: “the nature of the Lapita faunal record, settlement pattern, and other factors continue to imply an early subsistence economy heavily influenced by considerations other than starch production. Spennemann (1989) has used the term ‘optimal foragers’ and we concur” (Burley, *et al.* 2001:102).

Evidence from both Fiji and Tonga appears to support a neo-strandlooper model. Anderson has recently suggested that agricultural elements slowly diffused into Remote Oceania. We argue that limited agriculture could easily be added to this neo-strandlooper economy. A commonly occurring element at early sites in the region is the presence of nearby wetlands (at least their existence is plausible based on geomorphological reconstructions). It is possible that early Lapita colonists slightly modified these wetlands and planted Colocasia taro, with perhaps banana or other cultigens at the margins. After initial weeding and mulching while the area’s faunal resources were being exploited, the

plantings could have been left until harvest at later visits. This would have been the most energy-efficient way of assuring the carbohydrates needed to avoid potentially fatal azotemia (Addison 2008 for a discussion of the advantages of Colocasia taro; Davidson and Leach 2001 discuss the azotemia threat to Lapita colonizers). Such a system would have also propagated any planting stock brought by the colonists, without necessitating a sedentary settlement pattern and intensively agricultural economy. In fact, such a scenario would have required only the transportation of one cultigen – Colocasia taro, arguably the easiest of the Oceanic cultigens to transport by canoe (Addison 2006, 2008). Other cultigens could have been introduced later, at a time that was convenient to the colonists. Pigs, rats and chickens could also have been initial introductions. These species could easily forage for themselves on the reef and in the forest (we note the success of feral pigs and chickens on modern Oceanic islands). These “wild” pigs and chickens could then have been more intensively husbanded at any point in the future. Such an initial strategy would account well for the temporal distribution of pig, rat and chicken remains in Lapita sites discussed earlier. These ideas can only be assessed by further detailed archaeological work and specialized analyses targeting terrestrial-subsistence questions.

Pig appears only at low frequency in Polynesian plainware contexts and, as discussed above, dog appears to be to be a post-2000 cal BP introduction to the region. Both facts are suggestive of changes in subsistence economy and new interactions beyond the region. Kennedy’s (2008) recent summary of bananas in the Pacific suggests multiple introductions into Remote Oceania, while on linguistic evidence Ross postulates two introductions of Dioscorea (Ross 1996:167), although these data do not allow the introductions to be dated.

In Samoa, research on subsistence has focused on marine procurement, with little attention to terrestrial resource use and management (but see Addison and Gurr 2008; Carson 2006; Ishuzuki 1974). However, the pattern of Polynesian plainware sites on Tutuila suggests widespread but non-intensive use of inland areas (Addison, *et al.* 2008). This would be consistent with a relatively small and dispersed population practicing low-intensity agriculture in the Polynesian plainware period. Conversely, sites dating to after the abandonment of pottery in Samoa show intensive landuse patterns (e.g. Cochrane, *et al.* 2004; Green 2002; Herdrich 1991; Jennings, *et al.* 1982; Wallin, *et al.* 2007). Intriguing initial results from Tutuila suggest the possibility that landscape modifications associated with intensive agriculture date to the time pottery was abandoned (Carson 2006). Similarly, for Tonga, Burley (pers comm) notes “large scale field clearance and agricultural intensification in Ha’apai by 1200 BP (date uncalibrated)”, suggestive of changes in agricultural economy in the post-Polynesian-plainware period.

Clearly, much work remains to be done on the nature of non-marine subsistence in West Polynesia during the Lapita and Polynesian plainware periods (Burley and Clark 2003).

However, we think that the limited evidence now available at least allows consideration of the possibility of substantial subsistence change after Polynesian plainware disappears from the region.

West Polynesia material culture in the Polynesian plainware period

The archaeological evidence for the Lapita-only model rests on an assumption of cultural and biological continuity between the peoples responsible for Lapita-bearing deposits, Polynesian-plainware deposits, and aceramic deposits in West Polynesia. As noted earlier, Polynesian-plainware deposits are thought to date to the period during which Ancestral Polynesian Society developed (Kirch and Green 2001). In an extensive and systematic analysis of the material-culture and subsistence evidence for continuity in West Polynesia, Smith found that there is little archaeological support for such continuity (Smith 2002). Smith notes that “the distinctive West Polynesian society is not evident in the archaeological record until ca. 1000 BP” (Smith 2002:194). Although Smith’s research can be challenged on methodological or theoretical grounds (e.g. how particular chronological-hygiene protocols are devised or applied, etc), to date there has been no data-based substantive archaeological rebuttal of her conclusions. Until archaeologists in the region can empirically falsify Smith’s proposals by generating data showing continuity from Lapita onwards and the development of distinctive Polynesian cultural elements in the ~2800–2000 cal BP period in a West Polynesia interaction sphere, her ideas suggest intriguing possibilities for alternative constructions of the prehistory of the region. Terrell has also repeatedly argued against simple answers to questions surrounding Lapita and the origins of specific groups in the Pacific (Terrell 1988, 1989, 2000; Terrell, *et al.* 1997).

In West Polynesia, the complex vessel shapes and decoration associated with Lapita pottery disappeared shortly after initial colonisation. Each island or group within the region then developed its own ceramic style that changed little over the following ~800–1000 years. These separate ceramic styles appear to have had little influence on each other and hard evidence for contact within the region is minimal during the plainware period. Within the precision limits of radiocarbon dating and archaeological methods, the change from Polynesian plainware to aceramic deposits occurs simultaneously throughout West Polynesia at ~1500 cal BP (Addison, *et al.* 2008; Burley and Clark 2003; Kirch 1988). This change in the archaeological deposits can be seen as transitions within autochthonous cultural systems, as in the Lapita-only model. Alternatively, it can be seen as resulting from other processes (see broader discussion of these issues in Clark 2009). Regardless of how it is perceived, the total disappearance of ceramics over a whole region composed of dozens of islands with millennium-long ceramic traditions is a phenomenon that requires explanation. Discussion of this abandonment of ceramics in Polynesia has resulted in scenarios that could be plausible for an island or group of closely related islands, but which

seem unlikely for the whole region (e.g. Claridge 1984; Green 1974; Irwin 1981; Kaeppler 1973; Kirch 1997; Le Moine 1987; Leach 1982; Marshall 1985; Spennemann 1989). Also noteworthy is the fact that pottery traditions remained strong in central and western Fiji after 1500 cal BP (Burley 2005). Currently, how these changes are explained is more a question of epistemology than of data. Without falling into the *naïveté* associated with the diffusionist paradigm of the early 20th century, it is possible to envision that a new population moving into the region may have been associated with this change (but see Clark 2009).

Most archaeological research in the region has focused on early deposits, hence aceramic deposits within the region – the West Polynesia “Dark Ages” – are less well understood (Burley and Clark 2003; Davidson 1979; Rieth and Addison 2008; but see Spennemann 1989). Throughout the region, the transition from Polynesian-plainware deposits to aceramic deposits remains to be fully investigated, although for Tutuila Island the spatial and chronological parameters have been outlined (Addison, *et al.* 2008) and graduate students at Simon Fraser University, University of Otago and UC Berkeley are actively working on the question (pers comm from Sean Connaughton, Ben Teele, and Tom Sapienza). Tonga is much more fully studied, and reports on aspects of sites covering this transition are in press and in preparation (pers comm Dave Burley and Sean Connaughton). The next few years should bring many more data to addressing the topic of ceramic abandonment in West Polynesia.

In addition to the human and commensal-animal biology and the archaeological evidence, McLean (2008) suggests that the music styles and musical instruments of Polynesia are not consistent with a Lapita origin, though he suggests another hypothesis for Polynesian origins that is inconsistent with the biological and archaeological data. Oral traditions offer other evidence, but a full consideration of it is beyond the scope of this paper.

A West-Polynesia Triple-I Model

Given the issues discussed above, we suggest that Roger Green’s Triple-I model for Lapita origins (Green 1991a) may provide a good construct for thinking about Polynesian origins. In a West-Polynesia Triple-I Model, people making Lapita pottery and carrying the artifacts, social structure and other characteristics generally associated with the Lapita cultural complex were the first inhabitants of West Polynesia more than 2700 years ago. Contrary to both the Fast Train or Slow Boat models, we propose a model in which the Lapita colonists in West Polynesia genetically and phenotypically did not differ substantially from the Lapita colonists of other parts of Remote Oceania, looking very much like the indigenous populations we see today in Vanuatu, New Caledonia and western Fiji. They would have had mtDNA lineages belonging primarily to haplogroups P, Q, M and possibly B4 and Y chromosomes of the C2,

K-M9*, M1*, and O3* types. The one main difference between the populations in West Polynesia, particularly Samoa, compared to the rest of the Lapita settlements may have been a lower population density as suggested by the weak Lapita signature in Samoa and archaeological suggestions of small dispersed populations in the Polynesian-plainware period. Such low population densities would have facilitated the establishment and incorporation of new populations.

At around 1500 cal BP, a new population (or populations) arrived in West Polynesia (oral traditions suggest Manu'a) with new and more typically Asian-derived physical characteristics, mtDNA and Y-chromosome lineages, including the Polynesian motif and Y chromosomes belonging to lineage O3-M324. We propose that these new people also introduced new mtDNA lineages of commensal rats, dogs, and chickens, new plants, new material culture, and new ideas (*Intrusion*), that they had intense and complex interactions with the existing Lapita-descended populations as they spread over West Polynesia (*Integration*), and that the result was Ancestral Polynesian Society/Culture (*Innovation*). The Polynesians then dispersed both east into the previously uninhabited islands of East Polynesia and west to the Polynesian outliers, where they subsequently interacted biologically and culturally with the indigenous populations.

The commensal data suggest that this second arrival links Polynesia with Micronesia and may indicate a possible route of introduction, with an eastward movement following the path of low islands that became habitable at some time after ~2000 cal BP (Dickinson 2001; Dickinson 2003) (Fig. 1). These influences might also have had impacts on some Near Oceanic populations, such as those of the Admiralties, as these new travellers moved eastward. This might also provide a process that would explain strong similarities seen between Polynesian and central/eastern Micronesian populations in terms of the skeletal biology and human genetic data. Linguistic evidence suggests this period saw a pulse in language diversification in Polynesia and central-eastern Micronesia (Gray *et al.* 2009), which could be consistent with such a scenario involving a later population influx.

Given that language, biology and culture will not necessarily be transmitted together, a single unified answer regarding Polynesian origins may never emerge. Linguistic, biological, and archaeological datasets may not show identical patterns; it may even be expected that they won't (see for example discussion in Donohue and Denham 2010; Terrell 1988, 1989, 2000, 2009; and Terrell, *et al.* 1997). However, the analysis of ancient DNA from well-dated archaeological samples of the people and commensal animals could at least directly link the biological and cultural remains in ways that might allow us to reject certain

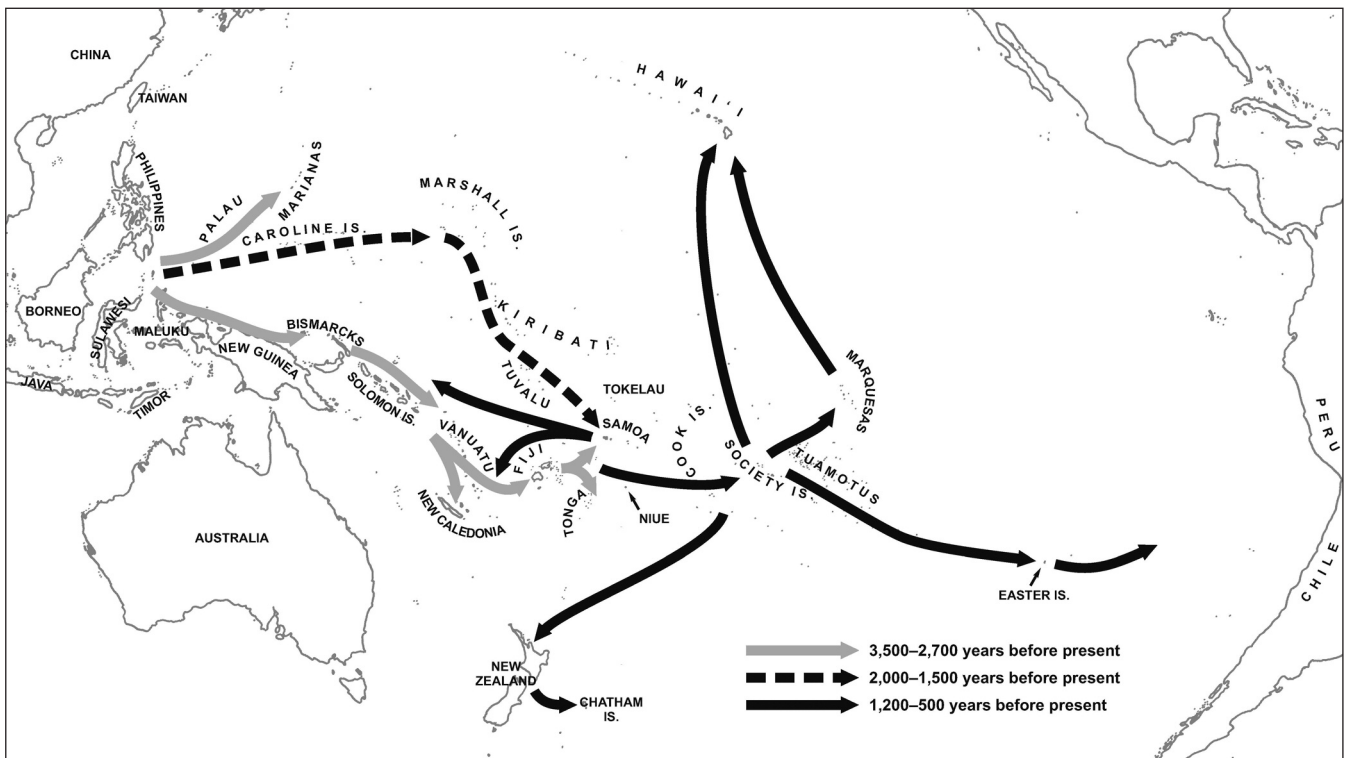


Figure 1: A possible scenario for the West-Polynesia Triple-I Model. Arrows indicate only general direction and timing of movements. No specific source population is suggested by the origin of the arrows. The grey arrows indicate initial Austronesian movement into the Bismarck Archipelago, Palau, and the Mariana Islands, as well as the Lapita expansion into Remote Oceania; the dotted arrows indicate the arrival of the proposed new population(s) from the west into West Polynesia; the black arrows show the settlement of East Polynesia and the Polynesian outliers.

models of Pacific settlement. Ancient DNA analyses of the increasing number of Lapita skeletal populations and comparison with ancient DNA obtained from later, post Lapita skeletal populations from across the Pacific will allow us to fully understand the processes leading to the biological diversity seen in the Pacific today.

Some readers may lament the lack of detail in this new model. Above, we have reviewed the existing data we think pertain to the topic, and it is unnecessary to repeat it here. We wish there were more data available to directly assess both the newly proposed model and the Lapita-only model, and look forward to additional data from careful archaeology in the region and the specialized analyses needed to evaluate the new model.

We are not proposing that the West-Polynesia Triple-I Model is the “right answer” to the question of Polynesian origins – whatever simple models archaeologist can devise will always be some dim reflection of the complex reality of the Pacific past. We *are* suggesting that it may be a useful exercise for researchers working on the question to explore new ways of looking at existing datasets; this may stimulate new questions, the generation of new datasets, and perhaps move our thinking beyond current constructs.

Dedication and acknowledgments

We dedicate this paper to Roger Green: a true scholar, gentleman and mentor to so many. His appreciation of multidisciplinary work, the historical perspective and looking at and thinking about the big picture were exemplary. Arohanui Roger!

We are also grateful to all who have worked on this topic in the past; without these many decades of research and thoughtful writing, we would not be able to add our small contribution to the discussion here. We offer these colleagues our ideas in a spirit of humility and respect. We both would like especially to thank all those who have directly mentored and taught us.

Our own work and that of others reviewed here would not have been possible without the cooperation and participation of local people around the Pacific. We gratefully acknowledge their decades of assistance, generosity, patience, and general gracious good-heartedness in facilitating the study of the region’s past.

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