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The evolutionary history and human settlement of Australia and the Pacific

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Understanding the timing and processes involved in the human settlement of Australia and the Pacific has significance for addressing some key debates relating to human origins and population expansions worldwide. Despite this, for many years, Pacific populations were seriously under-represented in genetic studies of human origins. The last 15 years, however, have seen some major genetic studies involving Australian and Pacific populations which have shed light on their origins and interactions, and the last five years have seen some major developments that are challenging long-held concepts of Pacific settlement.

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Introduction

Genetic and archaeological data from the Australia-Pacific region have been important for addressing major topics in modern human evolution such as the dates and directions of the out of Africa migrations of modern humans, understanding the impact and history of integration with our hominin cousins, and theories regarding the impacts of Neolithic expansions. With recently reported dates for human occupation as early as 60,000–65,000 years before present (BP) [1•], Australia represents one of the earliest locations outside of Africa to be settled by humans, while Aotearoa/New Zealand, first occupied only 730 BP, was the last major land mass to be settled [2]. The relative isolation of the region offers unique conditions that can be valuable for reconstructing migration patterns and identifying population interactions, though the extent of post-settlement interaction between geographically isolated island populations should not be underestimated. Pacific peoples were highly skilled navigators and sailors, capable of strategic and safe, two-way, long-distance, open-ocean voyaging [3].

For many years, the Australia-Pacific region was relatively underrepresented in major genetic studies and reviews. This was due to several factors, including indigenous concerns over the ethics of genetic studies [4] but also due to the isolated nature of many populations in the region, which can make it difficult and expensive to undertake fieldwork and sample collection. In recent years, however, significant inroads have been made, with frameworks for research with indigenous communities being generated by indigenous researchers [5] and education of both researchers and communities regarding rights and expectations when engaging in or participating in genetic research [6,7]. As a result, appropriate consultation and discussions regarding control of data are increasingly taking place and several genomic studies on both modern and ancient populations in the Australia-Pacific region have been published with community consent, support and engagement.

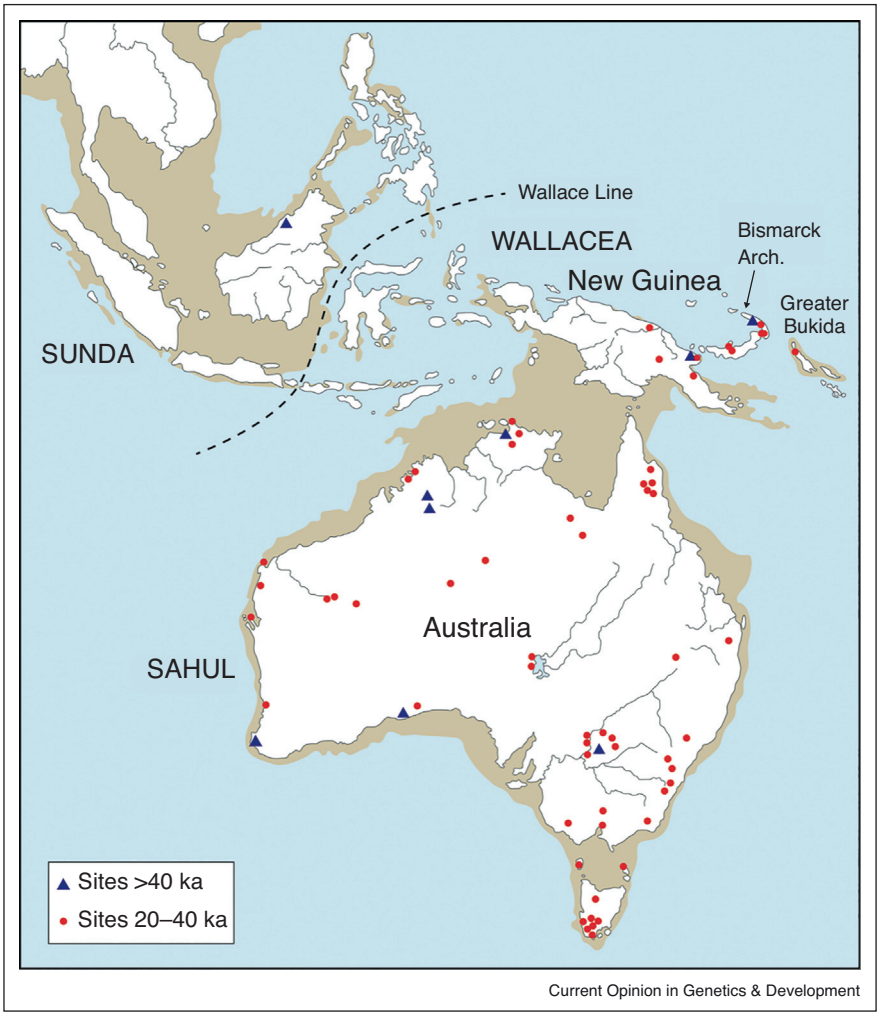
Hominin introgression

At some point during their migrations en route to the Australia-Pacific region, humans could have come into contact with at least three other hominin groups — Neanderthal, Denisovans and *Homo floresiensis*. Like all non-African populations, Pacific peoples carry evidence of introgression with Neanderthals. All indigenous populations in the Australia–Pacific region also carry Denisovan markers, with Australian Aboriginals and some populations in Near Oceania, carrying as much as 4%, the highest percentages of Denisovan DNA of any modern human populations worldwide [8,9•,10,11]. The 'mystery' archaic genome, identified in Native American populations has also been identified in some Pacific populations [12]. This high degree of hominin introgression found in Pacific populations, we suggest, is not an indicator that this was the location of the introgression events. It is more likely that contact was made on the Asian mainland and such levels are only seen in Pacific peoples due to the relative isolation of Australian and Pacific populations from later mass migration events that impacted the Asian continent during the late Pleistocene and early Holocene.

Pleistocene settlement of Sahul and Near Oceania

The rapidly accumulating genetic evidence from Australia and New Guinea consistently suggests continuous occupation of Sahul, the greater Australia/New Guinea continental landmass, resulting from a single colonization event of deep time depth [9•,13,14,15,16•]. Archaeological evidence of human presence across the continent by 40,000 BP (Figure 1) [17] suggests that

Figure 1



Map showing the Pleistocene land masses Sunda and Sahul (shaded) prior to Holocene sea level changes, with the distribution of early archaeological sites. Map adapted with permission from [55].

populations were low density but highly mobile. Evidence of human occupation of the Bismarck Archipelago, which was never connected to the Sahul mainland, dates to at least 40,000 BP, and dates of 30,000 BP, on Buka, suggest Pleistocene occupation of the Solomon Islands, but human expansion beyond, into Remote Oceania, did not occur until about 3000 BP [18].

Recent analyses of high coverage genomes from modern Australian Aboriginal and New Guinea Highland populations [9•] indicate that these two broad populations were genetically isolated before the breakup of the ancient continent of Sahul, which occurred around 11,000 BP. All modern Australian Aboriginals sampled were found to be descended from a single founding population that differentiated between 32,000 and 10,000 years ago. This timing may coincide with the spread of the Pama-Nyungan languages from the northeast to the southwest of the continent, followed by genetic isolation. Evidence suggesting genetic adaptations for surviving dehydration and cold desert conditions was also found in the Australian Aboriginal genomes [9•].

Despite early reports of mtDNA obtained from Pleistocene Australian samples [19], ancient DNA has been difficult to obtain from this region. Mitogenome data have been obtained from a late Holocene, pre-European burial from Willandra Lakes [20] and from 111 historic hair samples [14], and these data all support genetic continuity and deep regionalism since initial colonization.

Holocene arrivals in Near and Remote Oceania

Significant changes in the landscape of the region occurred both at the beginning of the Holocene, when the rising sea levels separated New Guinea and Tasmania