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## The Peopling of the Pacific

Ann Gibbons

### Archaeologists, linguists, and geneticists struggle to understand the origins of the bold seafarers who settled the remote Pacific Islands

Polynesia, with its dramatic volcanic islands rising out of the South Pacific, was the last area of the world to be settled by people. The fossil and archaeological trail shows that humans first set foot in Fiji only 3000 years ago, then sailed on within 500 years to Samoa and Tonga, and later reached Easter Island, Hawaii, and the fringes of remote Oceania, exploring a realm stretching 4500 kilometers. But just who was in those outrigger canoes has long been a mystery. Even Captain James Cook mused about the islanders' origins on his last voyage from 1776 to 1780, noting the resemblance of language, customs, and appearance among the tall, fair Polynesians on such far-flung islands as New Zealand, Tahiti, and Easter Island. And he proposed his own theory that they had come from Malaysia or somewhere in the islands of Micronesia, such as the Marianas or Caroline Islands, where they had "affinities with some of the Indian tribes."

From such observations, Europeans such as French voyager Jules-Sébastien-César Dumont d'Urville got the idea that these islanders could not be the descendants of the generally shorter, dark-skinned Melanesians living in islands of New Guinea, the Bismarck Archipelago, and the Solomon Islands. In 1832 Dumont d'Urville classified the people of the Pacific into three groups: Polynesians ("many islands"), the diverse Melanesians ("dark islands"), and Micronesians ("little islands"). This superficial classification stuck--even though the geographic terminology eventually changed--and ever since, many researchers have looked beyond the Melanesians of Near Oceania for the ancestors of the Polynesians who populate Remote Oceania (see map).

For example, until recently many geneticists and linguists have looked to the "express train" model. In this view, the ancestors of Polynesians came from Taiwan, where farmers speaking Austronesian languages set sail 3600 to 6000 years ago, largely bypassing the indigenous Papuan-speaking people of Melanesia as they swept out into the Pacific and left behind a trail of distinctly decorated pots.

Although this model was often touted as an interdisciplinary synthesis, in fact it is no favorite of archaeologists, many of whom have for years preferred a more "integrated" model, with at least some mixing between Melanesians and Austronesian speakers from Southeast Asia (a vast area that ranges from the coast of southern China to the islands of Indonesia and the Philippines). And now a flurry of studies of the Y chromosomes of Polynesians also favors the "slow boat" model, in which the ancestors of Polynesians originated in Asia but moved slowly through Melanesia, with time for genetic

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mixing among the peoples before the colonization of the rest of the Pacific. But even as these different kinds of data begin to point the same way, researchers are still groping for a true synthesis of the archaeological, linguistic, and genetic data. Each discipline tends to frame ideas in its own way, and at the moment each data set tends to favor a different homeland for the original voyagers. "I have to write a review myself of the spread of early farmers, and it's very difficult," says archaeologist Peter Bellwood of the Australian National University in Canberra. "It's the genetics that is causing headaches."

## Express trains and entangled banks

Back in 1985, Bellwood was among the first to attempt such a synthesis. He proposed, on the basis of archaeological and linguistic evidence, that the legendary seafarers who first settled remote Oceania had roots in Taiwan and mainland China. The archaeological evidence was a trail of distinctive pottery, obsidian, and shell ornaments known as the Lapita culture, which first appeared 3500 to 3200 years ago in the Bismarck Archipelago in Near Oceania and spread in rapid succession to the islands of Vanuatu and New Caledonia. More than 200 radiocarbon dates show that the Lapita peoples then crossed 850 kilometers of open ocean in outrigger canoes to arrive in Fiji 3000 years ago. From there, they moved east, using numerous small islands as steppingstones to Tonga and Samoa and carrying red-slipped pottery decorated with intricate geometric patterns.



**Slice of life.** Slices in each pie chart show the frequency of genetic markers in populations; for example, yellow and aqua slices are Melanesian, whereas the red slice is Southeast Asian, perhaps tracking Austronesian speakers.

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This culture has never been found in Southeast Asia, including Taiwan. But Bellwood proposes that it was an offshoot of farming cultures that first appeared 6000 years ago in Taiwan and southern China, including 3000-year-old red-slipped pottery in the Philippines that resembles plain Lapita pots.

This parade of pots, argues Bellwood, indicates the expansion of a particular group of people: the speakers of Austronesian languages, which today is one of the world's largest language groups, with 1200 languages spoken from Madagascar to Easter Island. And linguistic evidence also points to a wave of settlers sweeping out of Southeast Asia at the time of the Lapita culture. A new analysis of the historical relationships of the Austronesian languages by University of Hawaii, Manoa, linguist Robert Blust found that all 1200 languages fall into 10 subgroups; the languages in nine of those subgroups are spoken only by the non-Chinese natives of Taiwan. And all Austronesian languages outside Taiwan seem to be closely related, sharing changes in sound and meaning. Thus, Blust concludes that the Malayo-Polynesian languages all descend from the same ancestor--a proto-Austronesian language spoken "in or near Taiwan." This figures in Bellwood's synthesis: "In terms of language and archaeology, we know there was a major migration from 2000 B.C. to 1000 B.C., starting from Taiwan and the Philippines."

Many archaeologists agree that there was a rapid, recent migration of Austronesian speakers into Remote Oceania. What is open to debate is precisely where the Lapita peoples came from and how much they intermingled along the way with the indigenous people whose ancestors had been living in Near Oceania for at least 33,000 years. "I don't think there's any question that the Austronesian expansion comes out of island Southeast Asia," says archaeologist Patrick Kirch of the University of California, Berkeley. "The danger is getting too specific about Taiwan when we don't know enough archaeologically about the coastal China area, Taiwan, or the Philippines."

The oldest Lapita sites, after all, are in the Bismarcks in Near Oceania, where the culture appears to emerge as a fusion between the incoming seafarers and the indigenous Melanesians. The model of Lapita origins that many Pacific archaeologists now favor, says Kirch, is called the "triple-I" model--for the terms intrusion, innovation, and integration. It differs from the express train model in that it allows for intermarriage and integration of different Melanesian and Austronesian cultures, although Bellwood argues for only a little integration. Other researchers, such as archaeologist John Edward Terrell of the Field Museum of Natural History in Chicago, think that describing the events in terms of a fusion between only two people and two cultures is too simple. He argues that the Lapita culture and peoples arose from a diverse Melanesian population linked in complex social and trade networks with people from Southeast Asia over thousands of years; this idea is sometimes called the "entangled bank hypothesis," although Terrell says he proposed that term as a "metaphor" in a 1998 *Antiquity* article; he calls it "my alleged entangled bank model."

Although they argue over the details, many archaeologists do agree that the Lapita culture arose from a fusion between indigenous Melanesian and Austronesian cultures--a fusion that was obviously a success: Within 450 years, "the whole thing burst out, with a very rapid expansion out into the Pacific," says Kirch. Once the Lapita peoples reached Fiji, Samoa, and Tonga, they gave rise to offspring who eventually developed the distinctive Polynesian culture that Cook described.

At this point, it's hard to find any archaeologist who admits to riding the express train, including Bellwood, whose name is tied most often to that model. The idea got its name from the renowned writer and physiologist Jared Diamond of the University of California, Los Angeles, School of Medicine in an article in *Nature* in 1988, and the term quickly spread. "I don't believe in express trains," says Bellwood. "It was a fast movement out of Taiwan, but it wasn't totally closed off. Of course, there has been intermarriage. The express train was a kind of journalistic statement."

## Hopping aboard a slow boat

While the archaeological and linguistic evidence was converging to indicate some degree of intermixing, geneticists began to get into the act. Their results have recently suggested considerable intermarriage, but it wasn't always so: Until recently, they pointed in a different direction. Geneticists' approach, in fact, inadvertently increased polarization in the field, as they leapt to test what they saw as competing theories: the express train and its opposite, the entangled bank. Bellwood and other archaeologists grumble that this has always been a false dichotomy, yet almost every genetics paper on the subject in the past decade frames the debate in this way. Indeed, researchers from different disciplines have often talked past each other. "What struck me in reading the genetics papers," says Kirch, "is [that] they cite my book on the Lapita peoples, but they haven't read it."

When geneticists first studied the maternally inherited DNA from the mitochondria--the energy-producing organelles outside the nucleus of the cell--in Polynesians, Melanesians, and Southeast Asians, their results seemed to support the express train model. Researchers found that about 90% to 95% of Polynesians have inherited a deletion seen in Southeast Asians, including Taiwanese,

but rarely in Melanesians. Earlier studies traced that deletion of nine base pairs to Taiwan, thus fitting Bellwood's idea of a Taiwanese homeland and rapid expansion with limited intermixing.

But recent Y chromosome studies have traced a different pattern. In four studies published in the past 2 years, geneticists have used newly discovered Y chromosome markers to trace Polynesians' paternal ancestry. By comparing changes in the DNA sequence of the chromosome, researchers can sort the DNA sequences in a phylogenetic tree or by another method of analysis to find out how the Y chromosomes cluster into closely related groups (called haplogroups). By surveying the frequency and diversity of markers in various islands, they can also trace these genetic variations back to their geographic sources of origin.

Although samples of Polynesians are still small, all four studies report a "striking" lack of genetic diversity within the Polynesian haplogroups, suggesting that only a few men founded the Polynesian populations, notes population geneticist Matthew Hurles of the University of Cambridge, U.K., a co-author of one of the studies. The geneticists also picked up signs of what may have been the Austronesian expansion. In a study of 200 Polynesians, reported in the February issue of the *American Journal of Human Genetics*, a team headed by geneticists David Goldstein and Cristian Capelli of University College London found one haplogroup, called L, seen in about one-third of Polynesians, that is at its highest diversity and frequency in southern Chinese and in an aboriginal group in Taiwan called the Ami (see map on p. 1735). That pattern suggests that this marker probably was brought into Oceania by Austronesian farmers.

But this study also found that two Polynesian haplogroups are apparently inherited from ancestors who had been in Near Oceania long before the Austronesians arrived. These markers, haplogroups C and F, are common in Polynesians and are also found in Near Oceania, and to a lesser extent, in Southeast Asia. But they occur in only 2% to 4% of men in Taiwan and southern China, so they presumably did not originate there.

The idea of partial Melanesian origins was proposed earlier, last October in *Current Biology*, by geneticist Manfred Kayser and anthropologist Mark Stoneking of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. These researchers found a deletion of short tandem repeated sequences, associated with the marker Goldstein and colleagues call haplogroup C, in 82% of the men in the Cook Islands and in 70% of the men in Samoa. Outside of Polynesia, this combination of markers was only found in Melanesians and east Indonesians--never in East Asians, such as the Taiwanese or southern Chinese. The deletion occurs in the most diverse forms in Melanesians, and Kayser and Stoneking calculate that it arose in Melanesia 10,900 years ago--again, long before the Austronesians appeared there. "This is the sort of thing that would make Terrell happy--a Melanesian marker that didn't arise out of Southeast Asia, but then spread to Polynesia," says Stoneking.

But that study, like Goldstein's, also found a marker that supports Austronesian or Southeast Asian ancestry: a mutation seen at highest frequency in the southern Chinese and other East Asians, including Taiwanese. "This would make Bellwood happy--a genetic marker that arose in Asia, associated with Austronesians and found in Polynesia," says Stoneking. "So, the question is, how do we reconcile the two. That leads us to propose the slow boat model: that the ancestors of Polynesians were Austronesians who moved out of Southeast Asia--not necessarily Taiwan--whose population expanded along the coast of New Guinea, intermingled, and then moved out into Polynesia. But it was not an express train, because as they moved through Melanesia, they moved slowly enough to mix extensively with Melanesians."

This slow boat model sounds much like the triple-I model, favored by many archaeologists. But like archaeologists, geneticists differ on the amount of mixing, with Goldstein arguing for more Melanesian influence and earlier gene flow from Southeast Asians into indigenous Melanesians. "Polynesia was colonized by Melanesian populations that were largely indigenous genetically," he says.

Additional support for putting men of Melanesian ancestry in the first canoes to Polynesia comes from the earliest genetic studies of the question--studies of nuclear markers inherited from both parents. One is a rare mutation in the genes for hemoglobin, a deletion that can result in an inherited anemia called *-thalassemia* but that also provides some resistance to malaria. This mutation is most common in Melanesians, but it is seen in lesser frequency in Polynesians and never in Asians. "It's sort of satisfying that they are rediscovering with the Y chromosome what we thought we saw in the nuclear data 15 years ago," says geneticist Jeremy Martinson of the University of Nottingham, U.K. As for the mitochondrial DNA (mtDNA), Stoneking now notes that earlier studies "glossed over" the 5% to 10% of Polynesians who did in fact have Melanesian mtDNA. It's clear that both men and women have mixed heritage, he says, although they show different frequencies of Melanesian and Southeast Asian genes.

## Original debate

Although geneticists and archaeologists now agree on at least some degree of mixing, it remains a mystery where the seafarers initially set out from. Based on the Y data, it's not Taiwan. "We have trashed this idea for a Taiwanese homeland completely," says Li Jin, a population geneticist at the University of Texas Health Science Center in Houston. Another model focuses on the so-called Polynesian motif in maternal mtDNA, which includes a suite of genetic changes in the mtDNA of almost all Polynesians and in that of some Melanesians and east Indonesians, but not in the mtDNA of any Chinese, Taiwanese, or Filipinos. This striking geographical distribution and the diversity of the motif lineages in each region suggest that the Polynesian motif arose more than 10,000 years ago in the islands near Indonesia, then was carried through Near Oceania to Polynesia. That idea is put forth by evolutionary geneticist Martin Richards of the University of Huddersfield, U.K., and Stephen Oppenheimer of the University of Oxford, both co-authors of the Goldstein paper and the first to propose a slow boat origin. "We would put the ancestors of Polynesians somewhere in eastern Indonesia, not Taiwan, because that is what the diversity in the mtDNA suggests," says Richards.

All this means that the synthesis of genetics and archaeology is slowly coming together. But the linguistics still point to Taiwan as the source for Austronesian languages, whereas genetics and archaeology rule it out as the place of origin for genes and Lapita culture. "I don't see a problem at all with that," says linguist Blust. "Languages can spread without preserving the genetic makeup of the [original] speakers. Think of Latin."

Others say that as overly simple models are being disproven--if they were ever held--the two sides are drawing closer: "People have tried to make the data fit two different extremes; it's easier to test," says Stoneking. "But they're merging to a common ground," where the debate focuses instead on where the intermarriage took place and how extensive it was. Hurles at Cambridge agrees: "What happens at the early stages when people are looking into these kinds of issues in an interdisciplinary way, the field becomes dichotomized. You get two poles. Now, we're looking at the shades of gray, rather than black and white." It turns out that although Captain Cook was right in spotting the cohesiveness of Polynesians from Hawaii to New Zealand, he was wrong about what he saw as their profound differences from Melanesians: The groups have a common genetic heritage, and their differences are only skin deep.

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