ANTHROPOLOGY

Genes Point to a New Identity For Pacific Pioneers

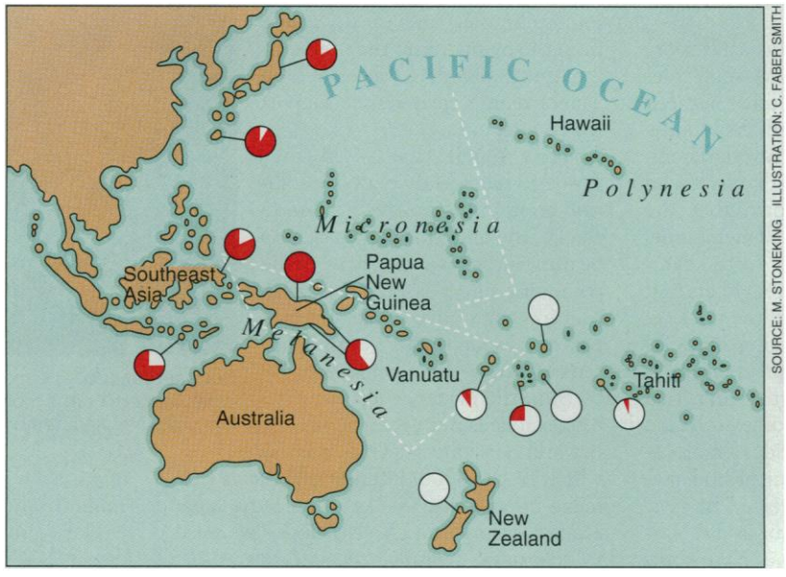
Ever since Captain James Cook first sailed through the South Pacific in 1769, scholars have puzzled over the strong resemblance among people living on such far-flung Pacific islands as Hawaii, Tonga, Easter Island, and New Zealand. The likenesses implied common ancestry and prompted Cook's astronomer, James King, to wonder "from what continent they originally emigrated, and by what steps they have spread through so vast a space." He was only the first in a long line of scientists to be intrigued by this mystery.

The solution for much of this past century has been Southeast Asia. Archeological and linguistic evidence indicates that Southeast Asians, in one of the largest known migrations in prehistory, crossed thousands of kilometers of open ocean in sailing canoes to Polynesia's Central Pacific islands, leaving behind a trail of distinctive decorated pottery and obsidian and shell ornaments known as the Lapita culture.

The leading theory about this migration—the so-called fast train model of Polynesian origins—holds that these legendary seafarers started from Southeast Asia 3600 years ago and bypassed Melanesians who had stopped at the edges of the ocean, in Papua New Guinea, Australia, and New Ireland, almost 30,000 years earlier. The proto-Polynesians, however, went on to spread rapidly to the islands and atolls of the Central Pacific. If the model is correct, the Southeast Asians were intrepid navigators, sailing vast distances of 10,000 kilometers in primitive boats. Once they had settled down, they were followed by Melanesians, who learned their navigational skills from the Asians.

But now, geneticists who study the patterns of genes of living Polynesians—as well as genetic material taken from the bones of Polynesian ancestors—say the "fast train" model has been derailed. New genetic evidence, they say, indicates that Melanesians—the ancestors of modern Australian aborigines and Papuan New Guinea highlanders—settled Polynesia along with the Asians. At the very least, a few Melanesian women must have been on those first few canoes to Polynesia. At the most, says Cambridge University biochemist Erika Hagelberg, one of the leading revisionists, Melanesians, not Asians, could have spread the Lapita culture far across the water.

Many archeologists, however, remain unconvinced. They say Hagelberg and her colleagues are paddling against the stream of archeological evidence. Among those who reject the genetic heterodoxy is Australian National University's Peter Bellwood, author of three books on the archeology of the Pacific. He insists: "In terms of archeology and linguistics, Lapita is the major identifiable source of the Polynesian expansion. And the roots of Lapita and the Austronesian expansion were obviously in southern China and Southeast Asia."



SOURCE: M. STONEKING ILLUSTRATION: C. FABER SMITH

A slice of Polynesian genetics. The white part of each pie chart shows the frequency of a Southeast Asian genetic marker—a nine base-pair deletion—in various populations; the red shows the frequency of other lineages. The marker becomes more frequent as one moves east, tracking the possible route of colonization.

Rising in the east. The roots Bellwood refers to begin in Taiwan and southern China, where neolithic cultures with pottery, shell, and stone tools were established as early as 6000 years ago. These cultures are similar but not identical to the Lapita, which seems to have appeared suddenly as a fully formed offshoot 3600 to 3200 years ago in Vanuatu, New Caledonia, Fiji, and other islands just east of Australia. Here scientists have found remnants of an agricultural society that made intricately decorated red pots and bone fishhooks, lived in well-built timber houses in coastal villages, and raised pigs, dogs, and chickens. But this Lapita culture has never been found in New Guinea or Australia itself.

Linguistic evidence also points to a wave of new settlers sweeping out of Southeast Asia and into the Pacific. A comparison of different modern Polynesian languages shows that Polynesians use many that resemble one another—such as the word *mata* for eye and *ono* for six in Fijian, Samoan, and Rapanui (Easter Island). Those similarities and others imply that the languages shared a common mother tongue, according to most linguists, an ancestral language perhaps once spoken in Taiwan, the Philippines, and Indonesia—places where the Lapita people are thought to have come from. At the same time, those words are quite distinct from words in the Papuan languages spoken by Melanesians. Both the linguistic and archeological lines of evidence lead Bellwood to insist that "Lapita is the only source of Polynesian expansion. There is no other expansion at this time."

When genetic analysis was first brought to bear on Polynesian ancestry in the early 1980s, it seemed to support this conventional model. Researchers, including University of Hawaii molecular evolutionist Rebecca Cann and Pennsylvania State University anthropologist Mark Stoneking, then both at the University of California, Berkeley, focused on a sequence of nine base pairs in the noncoding region of mitochondrial DNA (mtDNA). That sequence, present in Caucasians and Melanesians, was absent both in Polynesians and in some Asians. This nine base-pair deletion "is an underground cue this is an Asian lineage," says Cann, who discovered the marker. Other scientists, including geneticist Mark Hertzberg of the University of Sydney also found the deletion in Polynesian populations, including the Maori of New Zealand.

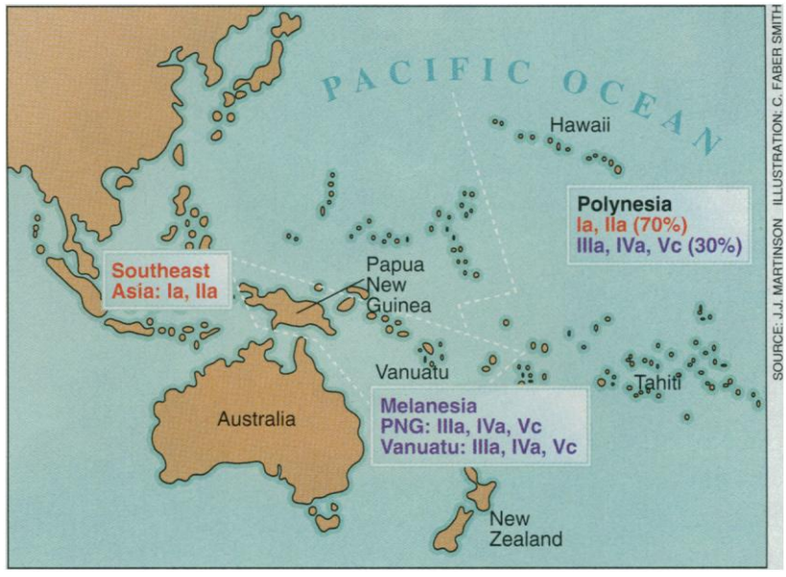
These observations were based on few samples of Asian and Polynesian mtDNA, however, and when the researchers tested more people, they began to see something unusual. Cann and her graduate student Koji Lum looked at the mitochondria of a new sample of 26 full-blooded Hawaiians and discovered that they had two distinct lineages—only one of which had the nine base-pair deletion. The other lineage, which Cann called cluster II, did not look Asian.

As Cann was puzzling over these findings, Oxford molecular geneticist Bryan Sykes had stumbled—crashed, actually—into a similar observation. While on a brief stopover on the island of Rarotonga in the Cook Islands in 1990, Sykes rented a moped. He fell, broke his shoulder, and found himself "marooned there for a few weeks." It occurred to him while he was recuperating that he had a good opportunity to extend his research. The hospital agreed to give him samples from 20 pure-blooded residents of the Cook Islands, and when he finally returned to England, he was "astonished" to see that 19 of them contained the deletion and that one was "very different."

A new interpretation. A year later, Sykes stopped in Hawaii to compare notes with Cann. His "strange" sequence from the Cook Islands was the same cluster II sequence she had found in Hawaii. Sykes has gone on to analyze more than 600 samples of blood from people in the Cook Islands as well as New Zealand, Samoa, the Marquesas Islands, and Tahiti. And while roughly 95% of the Polynesians have the standard nine base-pair deletion, 5% have the unusual cluster II sequence. Sykes has found one population, however, in which that sequence is widespread: Melanesians. "It looks as if it's of Melanesian origin," says Sykes.

If so, the early Melanesians clearly mixed with the Southeast Asians. But the key question is: before or after the great migration? One clue that the mixing came early derives from ancient DNA in human bones found at Lapita sites. Hagelberg, whose nickname is "the bone crusher" because of her work extracting DNA from ancient bone, reported at a Smithsonian Institution conference on ancient DNA held this past October that she had isolated mtDNA from the bones of two dozen humans found in sites on Fiji and Tonga associated with Lapita artifacts. When she and John Clegg, a molecular biologist at the Institute of Molecular Medicine at Oxford University, analyzed the mtDNA, which was between 2700 and 300 years old, they discovered that the oldest Lapita bones lack the Asian/Polynesian nine base-pair deletion. The more recent bones had it. "What Erika's evidence shows is that the later bones unequivocally have Southeast Asian ancestry, but the earlier bones do not," explains Clegg. "The simplest explanation is that the first people to Fiji and Tonga were from Melanesia."

Clegg has also found a nuclear genetic marker that points to an early Melanesian presence. It's a rare mutation in the genes for hemoglobin. Clegg found that the marker is most highly concentrated in Melanesians, particularly in the island archipelago of Vanuatu (east of Australia), suggesting that it arose on that island. But this mutation also shows up—with a lesser frequency—in Polynesians. Clegg theorizes that a later wave of immigrants, probably the Southeast Asians, acquired the mutation as they mixed with Melanesians in Vanuatu and on other islands on their way out to Polynesia. "It's a calling card for people who acquired that gene in Melanesia and then dropped it off as they moved East to colonize the Pacific," says Clegg. He and Hagelberg are hoping to test that hypothesis by searching for that nuclear marker in bones from various Lapita sites, but there are no results yet.



Melanesian marker. The α-globin gene haplotypes IIIa, IVa, and Vc show up most frequently in Melanesia, suggesting they arose there and were carried to Polynesia, where they are less frequent.

There is another possible explanation for the genetic data, Hagelberg says: The sophisticated Lapita culture could have been spread by the Melanesians themselves—not just introduced and disseminated by a new wave of Southeast Asians. Hagelberg points out that the culture shows up for the first time on the outskirts of Melanesia, and it is possible the Melanesians carried the Lapita culture with them into Polynesia. "It's quite possible there were two expansions," says Hagelberg. "One from Melanesia, associated with the Lapita culture, and later, a faster expansion with people who had the nine base pair deletion."

Although the notion that Melanesians arrived in Polynesia before anyone else is simply speculation, the idea that Melanesians arrived there at least as long ago as Southeast Asians did is beginning to find a receptive audience, at least among geneticists. After reviewing the genetic data for a book she edited, geneticist Susan Serjeantson of Australia National University's John Curtin School of Medical Research says: "I think the genetics data are in agreement that the Lapita people are derived from both Southeast Asia and Melanesia."

Archeologists, however, are proving to be a harder sell. Bellwood points out that the oldest dates for Hagelberg's ancient DNA from the human remains at Lapita sites are between 2700 and 2000 years old, but other Lapita sites are 1000 years older; the Melanesians could still be late arrivals. As for the mtDNA data, he notes the Southeast Asian ancestors of the Polynesians could have moved rapidly through Melanesia and western Polynesia between 3600 and 3200 years ago, not consorting with the locals and thus keeping their genes to themselves. But by 2500 years ago, many Lapita people in Melanesia probably had a good share of Melanesian genes—which show up in the mitochondria of modern Polynesians.

Clegg and Hagelberg admit that they've only traced a few gene lineages, and that the story for the overall population migration will be incomplete until they study more nuclear gene lineages. "We need more genes, such as those on the Y chromosome," says Stoneking, who has begun just such a study to trace these paternally inherited genes to learn whether they tell a story that's similar to the narrative of the mtDNA. If that occurs, the identity of these Pacific pioneers may become much clearer. "It's so extraordinary to think that man could have got to these places so early," says Sykes. "That's what drives me. To try to find out more about these original, amazing navigators. It's a very inspiring story." But as of now, it's still a tale with two endings.

–Ann Gibbons

Additional Reading

Bellwood, P. "The Austronesian Dispersal and the Origin of Languages," *Scientific American* **265**, 70 (1991)

Hagelberg, E. and Clegg, J.B., "Genetic Polymorphisms in Prehistoric Pacific Islanders Determined by Analysis of Ancient Bone DNA," *Proceedings of the Royal Society* **252**, 163 (1993).

Hill, A.V.S. and Serjeantson, S.W., *The Colonization of the Pacific: A Genetic Trail* (Clarendon Press, Oxford, 1989).