Eske Willerslev (left) meets Aboriginal elders during the genetic sampling project he led.

HUMAN ORIGINS

Aborigines and Eurasians rode one migration wave

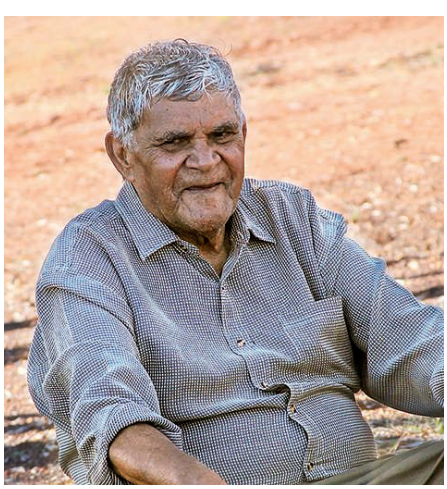
Tide of genetic data refutes idea that an earlier expansion of modern humans populated the island continent

By **Elizabeth Culotta** *and* **Ann Gibbons**

Australian Aborigines have long been cast as a people apart. Although Australia is halfway around the world from our species's accepted birthplace in Africa, the continent is nevertheless home to some of the earliest undisputed signs of modern humans outside Africa, and Aborigines have unique languages and cultural adaptations. Some researchers have posited that the ancestors of the Aborigines were the first modern humans to surge out of Africa, spreading swiftly eastward along the coasts of southern Asia thousands of years before a second wave of migrants populated Eurasia.

Not so, according to a trio of genomic studies, the first to analyze many full genomes from Australia and New Guinea. They conclude that, like most other living Eurasians, Aborigines descend from a single group of modern humans who swept out of Africa 50,000 to 60,000 years ago and then spread in different directions. The papers "are really important," says population geneticist Joshua Akey of the University of Washington, Seattle, offering powerful testimony that "the vast majority of non-Africans [alive today] trace their ancestry back to a single out-of-Africa event."

Yet the case isn't closed. One study argues that an earlier wave of modern humans contributed traces to the genomes of living people from Papua New Guinea. And perhaps both sides are right, says archaeologist Michael Petraglia of the Max Planck Institute for the Science of Human History in Jena, Germany, a co-author on that paper who has long argued for an early expansion out of Africa. "We're converging on a model where later dispersals swamped the earlier ones," he says.



Aubrey Lynch, an Aboriginal elder, agreed to participate in a project to study his people's roots.

A decade ago, some researchers proposed the controversial idea that an early wave of modern humans left Africa more than 60,000 years ago via a so-called coastal or southern route. These people would have launched their migration from Ethiopia, crossing the Red Sea at its narrowest point to the Arabian Peninsula, then rapidly pushing east along the south Asian coastline all the way to Australia. Some genetic studies, many on mitochondrial DNA of living people, supported this picture by indicating a relatively early split between Aborigines and other non-Africans. But analysis of whole genomes—the gold standard for population studies—was scanty for many key parts of the world.

Three large groups of geneticists independently set out to fill the gaps, adding hundreds of fully sequenced genomes from Africa, Australia, and Papua New Guinea to existing databases. Each team used complex computer models and statistical analyses to interpret the population history behind the patterns of similarity and difference in the genomes.

A team led by evolutionary geneticist Eske Willerslev of the University of Copenhagen zeroed in on Australia and New Guinea in what Akey calls a "landmark" paper detailing the colonization of Australia (see Feature, p. 1357). By comparing Aboriginal genomes to other groups, they conclude that Aborigines diverged from Eurasians between 50,000 and 70,000 years ago, after the whole group had already split from Africans. That means Aborigines and all other non-African people descend from the same out-of-Africa sweep, and that Australia was initially settled only once, rather than twice as some earlier evidence had suggested. Patterns in the Aboriginal DNA also point to a genetic bottleneck about 50,000 years ago: the lasting legacy of the small group that first colonized the ancient continent.

In another paper, a team led by population geneticist David Reich of Harvard University comes to a similar conclusion after examining 300 genomes from 142 populations. "The take-home message is that modern human people today outside of Africa are descended from a single founding population almost completely," Reich says. "You can exclude and rule out

an earlier migration; the southern route."

But the third paper, by a team led by Mait Metspalu of the Estonian Biocentre in Tartu, makes a different claim. Analyzing 379 new genomes from 125 populations worldwide, the group concludes that at least 2% of the genomes of people from Papua New Guinea comes from an early dispersal of modern humans, who left Africa perhaps 120,000 years ago. Their paper proposes that *Homo sapiens* left Africa in at least two waves.

Reich questions that result, but says that his and Willerslev's studies can't rule out a contribution of only 1% or 2% from an earlier *H. sapiens* migration. Akey says: "As population geneticists, we could spend the next decade arguing about that 2%, but in practical terms it doesn't matter." The most recent migration "explains more than 90% of the ancestry of living people."

Still, changes in climate and sea level would have favored earlier migrations, according to a fourth *Nature* paper. Axel Timmermann and Tobias Friedrich of the University of Hawaii, Manoa, in Honolulu reconstructed conditions in northeastern Africa and the Middle East, based on the astronomical cycles that drove the ice ages. They find that a wetter climate and lower sea levels could have enticed humans to cross from Africa into the Arabian Peninsula and the Middle East during four periods, roughly around 100,000, 80,000, 55,000, and 37,000 years ago. "I'm very happy," Petraglia says. His and others' discoveries of early stone tools in India and Arabia suggest that moderns did expand out of Africa during the early migration windows (*Science*, 29 August 2014, p. 994).

But those lineages mostly died out. The major migration, with more people and reaching all the way to Australia, came later. "Demographically, after 60,000 years ago something happens, with larger waves of moderns across Eurasia," Petraglia says. "All three papers agree with that."

The studies show Aborigines' ties to other Eurasians but also reinforce Australia's relatively early settlement and long isolation. As such, they reaffirm its unique place in the human story. The continent holds "deep, deep divisions and roots that we don't see anywhere else except Africa," Willerslev says. That echoes the views of Aborigines themselves. "The majority of Aboriginal people here in Australia believe that we have been here in this land for many thousands of years," Colleen Wall, a co-author on the Willerslev paper and elder of the Aboriginal Dauwa Kau'bvai Nation in Wynnum, Australia, wrote in an email to *Science*. "I am 'over the moon' with the findings." ■

SCIENCE POLICY

China bets big on big facilities

Anchored by a powerful synchrotron, first of a series of multidisciplinary national science centers will rise by 2023

By **Jane Qiu**, *in Beijing*

The Chinese Academy of Sciences (CAS) this month unveiled plans for a national science center that will carry out mission-driven research along the lines of the U.S. Department of Energy's (DOE's) national laboratories. Forming the backbone of the first center, slated for completion in 2023, will be a synchrotron, a supercomputer, and two other big-ticket facilities that will together cost $1.4 billion to build. More such laboratories are on the drawing board.

Last November, Chinese President Xi Jinping called for the creation of multidisciplinary labs that would concentrate money and manpower on the country's development while taking marching orders from the central government. Such labs would have "a real impact on society, especially for a big country like China where the scale of challenges is immense," says Antonio Masiero, vice president of the National Institute of Nuclear Physics in Rome. CAS took up the challenge in its new 13th 5-year plan, which cites the multipurpose labs as vital to helping China create 150,000 jobs over the next 5 years and to generating $720 billion from new technology, more than tripling the figure of the previous 5 years.

> ***"The idea is not to undermine basic research, but to ... solve tough problems in a concerted way."***
>
> **Bai Chunli**, Chinese Academy of Sciences

The first multipurpose lab will rise in Huairou Science Park, a technology park planned for Beijing's northern outskirts. Its crown jewel will be the $750 million Beijing Advanced Photon Source. The synchrotron's beams will be brighter, narrower, and more uniform than those of other top synchrotrons, resulting in images with nanometer resolution—10 times higher than the best resolutions achieved today. The machine "will be able to observe single atoms inside bulk materials," says Peter Littlewood, director of DOE's Argonne National Laboratory in Lemont, Illinois, which manages the U.S. Advanced Photon Source. Such capabilities will, for instance, allow researchers to image atoms as they make and break chemical bonds. "This is unprecedented," Littlewood says.

Huairou will also be home to the Synergetic Extreme Condition User Facility (SECUF), a set of 17 labs that will expose materials to extremes of temperature, pressure, and magnetic fields. These torture chambers, of sorts, will help develop novel superconductors and materials for quantum computing and nuclear fusion, says project leader Ding Hong, a physicist at CAS's Institute of Physics here. "Having the capacity to create all the combinations SECUF can create is unique." Meanwhile, a supercomputer called the Earth System Simulator will model geology, climate, pollution, and other complex processes, and a suite of state-of-the-art imaging instruments will help push the frontiers of biomedical research in areas like protein structure and brain mapping. The center is expected to have a staff of 3000 scientists and will be paid for by China's powerful National Development and Reform Commission; groundbreaking is slated to begin by the end of the year.

Some worry that the Huairou center may put too much emphasis on short-term gains, such as new products and jobs. "The pressure [on CAS] to be economically relevant has been overwhelming," says Mu-ming Poo, director of CAS's Institute of Neuroscience in Shanghai. "It's a balancing act," says Thom Mason, director of DOE's Oak Ridge National Laboratory in Tennessee. "If you are exclusively focusing on doing things that are relevant to industry next year, it's not going to be that transformational."

"The idea is not to undermine basic research, but to promote technology transfer and solve tough problems in a concerted way," responds CAS President Bai Chunli here in Beijing. "A sense of urgency can help focus our efforts." More such ventures are in the works. CAS intends to build a second national center in Shanghai, and similar research hubs are planned for regions that are lagging in technological prowess. "Ultimately," Ding says, "there will be a network of multipurpose laboratories that are catered towards regional characteristics and regional needs." ■

Jane Qiu is a writer in Beijing.

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Elizabeth Culotta and Ann Gibbons (September 22, 2016)
Science **353** (6306), 1352-1353. [doi: 10.1126/science.353.6306.1352]

Editor's Summary

Science (print ISSN 0036-8075; online ISSN 1095-9203) is published weekly, except the last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005.