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First Analysis of Orangutan Genome Yields Surprises

UA assistant professor Ryan Gutenkunst uncovered that Sumatran and Bornean orangutans split off from a common ancestor population much more recently than previously thought.

By Daniel Stolte,University Communications | Jan. 26, 2011

Orangutan DNA is more diverse than humans' and has remained remarkably stable through the ages, scientists **report**

A physicist by training, UA assistant professor Ryan Gutenkunst became fascinated with evolutionary questions. The software he developed allows researchers to put dates on events such as humans migrating out of Africa. (Photo by D. Stolte/UANews)

A Sumatran Orangutan photographed at Cincinnati Zoo. (Photo by Trisha Shears/Creative Commons)

(http://www.nature.com/news/2011/110121/full/news.2011.50.html) [1] in the cover story of the Jan. 27 issue of Nature.

As part of the effort, UA scientist **Ryan Gutenkunst (http://gutengroup.mcb.arizona.edu/) [2]** discovered that today's populations of Sumatran and Bornean orangutans split off from a single, ancestral population about 400,000 years ago. Previous studies had put that time closer to 1 million years.

Unlike widely used genetic techniques that rely on genetic markers passed down through the generations exclusively through the paternal or the maternal line, a new software tool developed by Gutenkunst in collaboration with Stanford University professor Carlos Bustamante allows researchers to trace both lines.

"The idea is to look at the distribution of mutations across populations today and infer their evolutionary history," said Gutenkunst, an assistant professor in the UA's **department of molecular and cellular biology (http://mcb.arizona.edu/) [3]**. "How big were the populations? When did they split up? How much migration was there between them?"

In a massive undertaking, an international team of scientists led by Washington University School of Medicine in St. Louis decoded, or sequenced, the DNA of an orangutan. With this genome as a reference, the scientists then sequenced the genomes of five additional Sumatran and five Bornean orangutans.

Among great apes, orangutans are humans' most distant cousins. These tree dwellers sport a coat of fine reddish hair and have long been endangered in their native habitats in the rainforests of Sumatra and Borneo in Southeast Asia.

"The average orangutan is more diverse – genetically speaking – than the average human," said lead author Devin Locke, an evolutionary geneticist at **Washington University's Genome Center (http://genome.wustl.edu/) [4]**. "We found deep diversity in both Bornean and Sumatran orangutans, but it's unclear whether this level of diversity can be maintained in light of continued widespread deforestation."

The scientists identified and catalogued about 13 million DNA variations in the orangutans, providing a resource for assessing the genetic diversity of orangutan populations in the wild and in captivity and helping conservationists set priorities for aiding subpopulations based on their genetic health.

In another surprise, the researchers found that at least in some ways, the orangutan genome evolved more slowly than the genomes of humans and chimpanzees, which are about 99 percent similar.

"In terms of evolution, the orangutan genome is quite special among great apes in that it has been extraordinarily stable over the past 15 million years," said senior author Richard K. Wilson, director of Washington University's Genome Center, which led the project. "This compares with chimpanzees and humans, both of which have experienced large-scale structural rearrangements of their genome that may have accelerated their evolution."

An estimated 50,000 Bornean orangutans live in the wild, while only 7,000 of their Sumatran counterparts roam the dwindling forests of Sumatra.

Despite the orangutan genome's stability compared to other apes, Gutenkunst discovered a high degree of variation within the two populations, the Borneans and the Sumatrans.

"Even though there are fewer individuals around nowadays, we found the Sumatran orangutans to be much more genetically diverse than the Borneans," he said. "Also, there are not many mutations that the two populations share between each other, which is a sign that they diverged a long time ago, and they're probably on their way to becoming really separate species."

"The orangutans of Sumatra still have as much genetic diversity within them as if they were a population of roughly 40,000," Gutenkunst added. "This probably indicates a very recent shrinking in population, possibly in the wake of habitat loss."

Facing intense ecological pressure, the numbers of orangutans continue to decline. One big threat to their habitat has come from clearing vast areas of rainforest for the expanding palm oil industry, a cheap and sought-after ingredient of snacks, cosmetics and other processed goods.

"Orangutans spend more than 95 percent of their time in the trees," Locke said. "They travel through the trees, nest in trees and forage for food in trees. But all the genetic diversity in the world can't save them in the wild if their habitat is destroyed."

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