



Protesters, here flying Hawaiian flags, have halted construction of one of the world's largest optical telescopes.

## ASTRONOMY

# Telescope clash deeply rooted in Hawaii's past

## Opponents say Thirty Meter Telescope violates sovereignty and sacred ground

By **Ilima Loomis** and **Adrian Cho**

**A** month after protests halted work on the Thirty Meter Telescope (TMT) on Hawaii's Big Island, the impasse over what would be one of the world's largest optical telescopes has deepened. Last week, as protesters continue to occupy the construction site on Mauna Kea, a 4205-meter dormant volcano, a state panel representing Native Hawaiians pulled its support for the project.

The 30 April decision by the quasi-governmental Office of Hawaiian Affairs (OHA) underscores a deeper challenge for the TMT. Besides offending cultural and religious sensitivities by occupying a site on a sacred mountain, the project—led by an international consortium based in Pasadena, California—has gotten snagged on the thorny issue of Hawaiian sovereignty. “It comes down to the fact that there is an occupation of Hawaii by the United States,” says Anne Keala Kelly, an independent filmmaker in Honolulu, who is making a documentary about the protests.

Managers of the \$1.4 billion project still have the permits, issued 6 March by the state's Department of Land and Natural Resources, to start construction. But they have

held off since 31 protesters were arrested on 2 April. The TMT team worked for years to address Native Hawaiians' concerns, says Sandra Dawson, TMT's manager for Hawaii community affairs, so researchers were taken aback by the flare-up, especially on social media. “Some of the people we're seeing now are people we've never seen before,” she says.

TMT collaborators say they have strived to be respectful of Mauna Kea, which many Native Hawaiians consider the “piko,” or navel, that connects the island to Wakea, the Sky Father. Planners chose a site 193 meters below the sacred summit that has no known archaeological remains, researchers say. Opponents of the TMT say that is not much help, given that 13 telescopes already dot Mauna Kea. “It's like an industrial park up there,” Kelly says. “This is cultural strip mining.”

More important, opponents say, the TMT is emblematic of the greater dispossession of Native Hawaiians, which dates back to 1893, when the United States claimed the islands. “You can say, ‘Well, it's a cultural issue,’ but it's more than that,” Kelly says.

Such sentiments struck a chord with the trustees of OHA, whose mission is to protect and perpetuate Hawaiian culture. “Self-determination is right at our fingertips,” said

OHA Trustee Dan Ahuna before last week's vote. “We have the opportunity to send a strong message that it is no longer business as usual for Hawaiians.”

OHA's vote withdraws its 2009 endorsement of the TMT. In a meeting in Honolulu, the board voted 6 to 0 to rescind support, with one trustee abstaining and two absent. Still, many Hawaiian groups felt the vote didn't go far enough and that the board should have expressed clear opposition to the project. A vote rejecting that stronger stance was met with shouts of “aole!” or “no!” from a standing-room-only crowd.

“We're disappointed that OHA cannot come out in full support of their people, their constituents, their lahui [nation],” says Andre Perez, an organizer with Movement for Aloha No ka ʻĀina, one of the groups that sent protesters to Mauna Kea. However, OHA Trustee Peter Apo said during the meeting that maintaining a more neutral position would allow OHA to retain a voice in the project's future.

The TMT dispute has divided Native Hawaiians, who constitute about 10% of the state's population. The TMT has pledged to invest \$3 million per year in the local community, says Paul Coleman, an astronomer at the University of Hawaii, Manoa. It will

pay \$1 million to the quasigovernmental Office of Mauna Kea Management and OHA to lease the site (existing telescopes pay \$1) and supply another \$1 million each to support science, technology, engineering, and mathematics (STEM) education and to train Hawaii residents to work on the TMT and the other telescopes on Mauna Kea. “This is a fantastic opportunity to give our kids a chance for the jobs that come along with the telescopes,” says Coleman, a Native Hawaiian. The STEM money has already begun to flow, he notes.

At the OHA meeting, Mailani Neal, an 18-year-old high school student from the Big Island, testified that it was her dream to study physics and become an astronomer. “The stars brought our Hawaiian ancestors to Hawaii, and now we have the opportunity to bring the people of Hawaii to the stars,” she said, fighting back tears. “The Thirty Meter Telescope has provided a beacon for me and motivated me in all that I do.”

But \$3 million per year is meager compensation for the expropriation Hawaiians have endured, says Williamson Chang, a law professor at the University of Hawaii, Manoa, who opposes the TMT. The real issues are sovereignty and social justice, Chang says, noting that Native Hawaiians often end up on the bottom of the economic heap in their own land. “Even if you go to the university, you end up working in a restaurant,” he says. “You work two or three jobs and you can’t afford to raise a family.”

Hawaii’s governor, David Ige, has called for dialogue among the various parties. In the meantime, TMT officials have set no date for starting construction and have no plans to push for the removal of the protesters, says Michael Bolte, an astronomer at the University of California, Santa Cruz, and associate director of the project. For now, he says, they’re encouraging Native Hawaiians who support the project to speak up. “They’re our strongest allies.”

As for the protesters, Kahookahi Kanuha, a leading organizer, says they are expanding their focus beyond the TMT to the state’s management of the whole mountain, pushing to ensure compliance with environmental requirements and completion of a required cultural impact assessment. Protest groups will also oppose a planned 65-year extension on the University of Hawaii’s lease of the summit area, which is set to expire in 2033—just 11 years into TMT’s planned decades-long lifetime. Stopping the extension “would put the TMT in a very tough position,” Kanuha says, “and they would be forced to look for a new location.” ■

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## EVOLUTION

# Deep-ocean microbe is closest living relative of complex cells

Genomic study of “Loki” supports a revisionist view of the origin of eukaryotes

By **Mitch Leslie**

It’s one of the most significant, and most vexing, splits in life’s history. About 2 billion years ago, the prokaryotes, relatively simple single-celled organisms that include bacteria and archaea, gave rise to the more elaborate eukaryotes, the lineage that ultimately spawned multicellular life forms such as fungi, plants, and animals like us. Now, researchers combing through muck from the bottom of the North Atlantic Ocean have identified an archaeon that is the closest living relative of eukaryotes so far discovered.

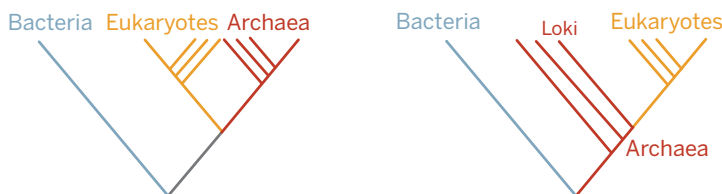
The microbe, informally dubbed Loki and described this week in *Nature*, has set

Mitochondria and chloroplasts, researchers agree, are descended from formerly free-living prokaryotes that took up residence in other ancient cells. But the identity of the organism that captured and tamed those microbes remains unclear. Molecular evidence suggests that archaea are the closest relatives of eukaryotes. Researchers have disagreed, however, about whether eukaryotes branched off from a simpler prokaryote before archaea emerged—the traditional three-domain view of life—or evolved later, directly from archaea (see diagram).

Loki, known only from its gene fragments, supports the second hypothesis. As part of a project to uncover novel types of archaea, evolutionary biologist Thijs

## All in the family

A newly discovered deep-sea microbe named Loki suggests eukaryotes evolved from archaea (right) rather than representing a separate branch of life (left).



off a buzz among evolutionary biologists. “It tells us something very important about the origin of eukaryotes,” says Eugene Koonin of the National Center for Biotechnology Information in Bethesda, Maryland. “The ancestor of eukaryotes was a highly complex organism related to other archaea.” The deep-sea microbe “looks like a potential transitional form” that preserves one of the evolutionary steps between archaea and eukaryotes, adds evolutionary cell biologist Mark Field of the University of Dundee in the United Kingdom.

Unlike prokaryotes, eukaryotes sport organelles such as power-generating mitochondria and—in plants and some protists—light-capturing chloroplasts. Moreover, they stow DNA inside a nucleus that’s enclosed by a membrane, and their cells feature other internal structures built of membranes, such as the Golgi apparatus, lysosomes, and the endoplasmic reticulum.

Ettema of Uppsala University in Sweden and colleagues analyzed 10 grams of sediment brought up from the ocean bottom midway between Greenland and Norway. They found that it contained distinctive gene sequences that indicated the presence of unidentified microorganisms. Although the researchers could separate out only a few nanograms of shattered DNA, they were able to use a technique called metagenomics to piece together these fragments and produce partial genomes for three new types of archaea.

The researchers weren’t able to isolate any living or dead microbes from the muck, but they could infer the characteristics of the one with the most complete genome. (Because the sediment sample came from near the undersea volcanic vents known as Loki’s Castle, the researchers dubbed this organism *Lokiarchaeum*, or Loki for short.) Its genome reveals several telling