MICROBIOLOGY

Cells hint at roots of complex life

'Asgards' isolated and grown in the lab could be similar to cells that evolved into eukaryotes.

BY JONATHAN LAMBERT

Scientists in Japan report that they have isolated and grown microbes from an ancient lineage of archaea — single-celled microbes that look, superficially, like bacteria but are quite distinct — that was previously known only from genomic sequences.

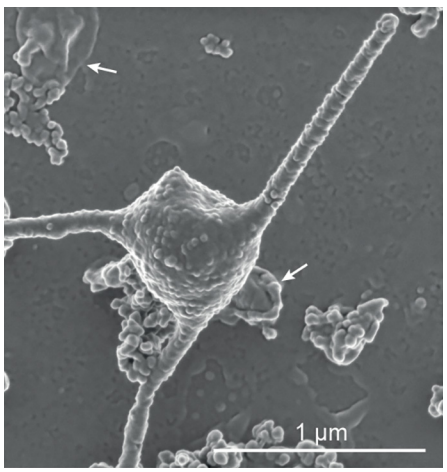
The work, posted online as a preprint (H. Imachi *et al.* Preprint at bioRxiv http://doi.org/gf5z2n; 2019), gives scientists their first look at the kinds of organism that could have made the jump from simple, bacteria-like cells to eukaryotes — the group of organisms whose cells have nuclei and other structures, and which includes plants, fungi and humans.

"This is a monumental paper that reflects a tremendous amount of work and perseverance," says Thijs Ettema, an evolutionary microbiologist at Wageningen University in the Netherlands.

The mysterious group, called Lokiarchaea, rose to prominence from microbial muck dredged up off the coast of Greenland. In 2015, Ettema and his colleagues sequenced genetic fragments from the sediment and assembled them into fuller genomes of individual species (A. Spang *et al. Nature* **521**, 173–179; 2015).

One genome was clearly a member of the archaea, but also had some eukaryote-like genes. The researchers called it Lokiarchaea, after Loki, the trickster of Norse mythology.

Soon, other labs found more Loki-like archaea, and together these formed the Asgard archaea, named after a mythological region inhabited by Norse gods. Many analyses suggest that some distant Asgard-like ancestor gave rise to all eukaryotes.



H. IMACHI *ET AL.*

Wisp-like protrusions make this candidate new strain look like 'an organism from outer space'.

Proponents of this view think that, some 2 billion years ago, an Asgard-like archaeon gobbled up a bacterium, sparking a mutually beneficial relationship known as endosymbiosis. The bacterium would have evolved into mitochondria, the 'powerhouse' organelles of the cell that helped to fuel eukaryotes' rise.

But no one had succeeded in growing Asgards in the lab.

To cultivate sea-floor microbes, Hiroyuki Imachi, a microbiologist at the Japan Agency for Marine-Earth Science and Technology in Yokosuka and his collaborators built a bioreactor that mimicked the conditions of a deep-sea methane vent. They then waited 5 years for the slow-growing microbes to multiply.

Next, they placed samples from the reactor, along with nutrients, in glass tubes, which sat for another year before showing any signs of life. Genetic analysis revealed a barely perceptible population of Lokiarchaea. The researchers patiently coaxed the Lokiarchaea into higher abundance and purified the samples.

Finally, after 12 years of work, the scientists produced a stable lab culture containing only this new Lokiarchaeon and a different methane-producing archaeon. The authors declined requests for interviews from *Nature*'s news team while their paper was under review at a journal.

Like other archaea and bacteria, Asgards have relatively simple interiors, but their external surface can produce wisp-like protrusions. "I don't think anyone predicted that it would look like this," says Ettema. "It's sort of an organism from outer space."

The team reports that the cultured Lokiarchaeon produces energy by breaking down amino acids, as predicted from genomic studies. And, because the researchers could extract and sequence DNA from a pure sample, rather than sediment containing a multitude of organisms, their findings could confirm that Lokiarchaea do contain numerous eukaryote-like genes.

Ettema says that many more Asgards will need to be cultured for researchers to work out whether, and how, Asgard-like archaea gave rise to eukaryotes. ■

FUNDING

Mexican science suffers under budget cuts

Research institutes are rationing electricity to save money.

BY GIORGIA GUGLIELMI

Austerity measures recently enacted by Mexico's president are pushing the country's scientific efforts — chronically underfunded for years — to a breaking point, according to researchers.

As part of broader cost-cutting measures aimed at freeing up money for poverty-alleviation programmes, in May, President Andrés Manuel López Obrador cut 30–50% of the money that federally funded institutions — including centres supported by Mexico's main research funding agency, the National Council of Science and Technology (CONACYT) — spend on travel, petrol, office supplies and salaries for temporary workers.

Several research institutes say that, since then, they have rationed electricity and sacked temporary workers. Scientists have cancelled conference travel and international projects, and have relied on crowdfunding campaigns to pay for supplies. The monetary uncertainty has also deterred Mexican researchers working abroad from returning to take jobs at home.

The measures came on top of a roughly 12% cut to the 2019 budget for CONACYT that López Obrador's administration enacted in December 2018. The move left the agency with 18.8 billion pesos (US$960 million).

"Mexican science has never been well funded," says Antonio Lazcano, a biologist at the National Autonomous University of Mexico (UNAM) in Mexico City. But the austerity measures, on top of the cuts to CONACYT's budget, threaten to hamper the recruitment of early-career researchers, as well as the monitoring efforts for potential disasters such as

earthquakes and epidemics, he says. Without advances in science and technology — which drive innovation and attract investors — the cuts could also set back economic growth in Mexico, he adds.

In June, Lazcano and 56 other Mexican scientists wrote an open letter to the government urging officials to reverse these recent funding cuts. As of 13 August, more than 19,000 people had signed the letter online.

RIPPLE EFFECTS

Juan Martínez, an ecologist at the Institute of Ecology in Xalapa, says that the cuts enacted in May are pushing the institute to its limit. "We don't have money to pay [for] electricity," says Martínez, who has signed the open letter. To save energy, the institute has banned employees from charging their phones, turning on the air conditioning, working past 6 p.m. during the week or coming in over the weekend.

Cuauhtémoc Sáenz-Romero, a forest geneticist at the Michoacan University of Saint Nicholas of Hidalgo, worries that he'll have to end collaborations with scientists abroad. He is part of a working group at the Food and Agriculture Organization of the United Nations that is developing improved forest conservation and management strategies across the United States, Canada and Mexico.

The Mexican National Forest Commission was supposed to pay for Sáenz-Romero and two of his colleagues to attend the group's next meeting in Idaho in October. But the commission won't be able to fund the trip. Because the Mexican delegates cannot attend, the meeting has now been cancelled, and it is unclear when it will be rescheduled.

Despite these reports, CONACYT director Elena Álvarez-Buylla insists that the cuts enacted in May are aimed at reducing overspending and will not affect research projects at institutions funded by the agency.

CONACYT plans to have allocated at least 1.6 billion pesos to basic-science projects by the end of 2019, Álvarez-Buylla says. Decisions on new grants will be made at the end of the year, which means that researchers won't get funds until 2020.

Lack of sufficient federal funding in Mexico pre-dates the current administration. Soledad Funes, a molecular biologist at UNAM, says that, over the past decade, calls for basic-science grant applications from CONACYT have been irregular. Funes is currently relying on a 250,000-peso grant provided by her university to continue her research.

Scientists at institutions that don't provide such grants have turned elsewhere for money. Enrique Espinosa, an immunologist at the National Institute for Respiratory Diseases in Mexico City, has started a crowdfunding campaign for money to buy reagents, attend scientific conferences and support a graduate student until they receive a scholarship.

The mounting funding uncertainty has also discouraged Mexican researchers abroad from returning. Jorge Zavala, an astronomer at the University of Texas in Austin, rejected a well-paid academic position at the Institute of Astrophysics, Optics and Electronics in Tonantzintla last year because he wasn't sure how long the money would last.

The post was part of a CONACYT programme covering salaries for young scientists working at Mexican institutions that couldn't afford to pay their researchers. But Zavala wasn't sure whether the programme would have continued under López Obrador's administration.

Zavala plans to apply for academic positions in Europe or the United States in the near future. At some point, he says, "I might go back to Mexico, if things get better." ■

COSMOLOGY

Sky map to plot dark energy

A telescope in Arizona will survey galaxies to reconstruct 11 billion years of cosmic history.

BY DAVIDE CASTELVECCHI

Astronomers are about to embark on their most ambitious galaxy-mapping project ever. Over the next five years, they will use a telescope in Arizona — retrofitted with thousands of small robotic arms — to capture light spectra from 35 million galaxies and reconstruct the Universe's history of expansion. Their main aim: to elucidate the nature of dark energy, the enigmatic force that is pushing the Universe to accelerate at an ever-faster pace.

The Dark Energy Spectroscopic Instrument (DESI) is scheduled to see 'first light' in September. After a commissioning period, its survey of the northern sky — using the 4-metre Mayall Telescope at Kitt Peak National Observatory near Tucson — could start by January 2020. Roughly three-quarters of DESI's US$75-million budget comes from US Department of Energy (DOE), with major contributions from the United Kingdom and France.

DESI is the first in a new generation of experiments investigating the past expansion of the Universe, which come two decades after the first strong evidence of dark energy was found in 1998. Others include ground-based and space observatories set to come online in the 2020s.

The survey will reconstruct 11 billion years of cosmic history. It could answer the first and most basic question about dark energy: is it a uniform force across space and time, or has its strength evolved over eons? ▶

JOHN BRILEY FOR THE WASHINGTON POST/GETTY

The 4-metre Mayall Telescope at Kitt Peak National Observatory near Tucson.