Fossil algae hold clues to origin of modern photosynthesis

The 1.6-billion-year-old specimens hold promise for settling long-running debate.

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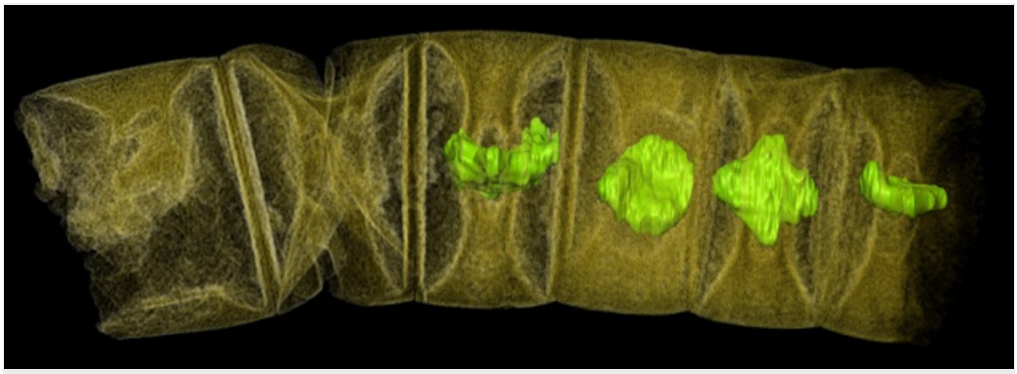

Stefan Bengtson

A false-colour X-ray image of what could be the oldest-known fossil of red algae.

The debate over the origin of the lineage that led to multicellular life — and thus plants and animals — has raged for decades. To identify when these 'eukaryotes' emerged, researchers need well-preserved fossils, complete with characteristics such as complex internal structures surrounded by membranes. Now, a newly discovered set of specimens that are about 1.6 billion years old may help to reveal the truth.

Stefan Bengtson, a palaeobiologist at the Swedish Museum of Natural History in Stockholm who led the team that made the discovery, thinks that these fossils could represent the oldest red algae, and therefore the oldest eukaryotic specimens, found so far. If they are indeed red algae, they could also push back the date for the origin of photosynthetic algae and plants by several hundred million years[1].

The researchers found three sets of these fossils, which are described in a study[2] published on 14 March in *PLoS Biology*, in a region of central India. The first set is arranged like a stack of coins and is probably a colonial bacterium that the authors name *Denaricion mendax*. The other two, which team calls *Rafatazmia chitrakootensis* and *Ramathallus lobatus*, look like long filaments separated into smaller chambers.

People have found older fossils that might be eukaryotes, says Bengtson. But so far, no one has been able to see their internal structures to confirm that. Based on X-ray images of the fossils, researchers found what look like complex, well-preserved structures inside *Rafatazmia*. These include what could be a plant-like cell wall and internal dividers called septa. According to Bengtson, the septum's structure shows that these fossils are definitely red algae, and are therefore eukaryotic and capable of photosynthesis.

Seeing the light

If that's true, these fossils will help researchers to narrow down the age of a major evolutionary event, says Debashish Bhattacharya, an evolutionary biologist at Rutgers University in New Brunswick, New Jersey. That would be the point in time at which an organism engulfed photosynthetic cyanobacteria. But instead of being destroyed, those cyanobacteria eventually evolved into the cellular machinery responsible for photosynthesis in eukaryotes. Current estimates for when this first happened range from 600 million[3] to 1.5 billion years ago[1].

However, Bhattacharya isn't sure that these fossils truly represent the ancestor at the base of the red-algal evolutionary tree, as Bengtson and his colleagues suggest. Bhattacharya thinks it more likely that the fossils represent a very ancient side branch. But they are certainly red algae of some kind, and definitely eukaryotic, Bhattacharya says.

Nicholas Butterfield, a palaeobiologist at the University of Cambridge, UK, on the other hand, is not persuaded. The specimens may share characteristics with red algae, he says, but it would take more than a few septa to convince him that they are true eukaryotes. Perhaps additional similar finds, or the discovery of structures that are definitively eukaryotic, such as an irregularly shaped cell wall, he says. Still, the palaeobiologist thinks that these new fossils are better than some specimens other researchers have put forth as examples of the oldest eukaryotes.

It can be difficult to pinpoint exactly where ancient fossils lie on the tree of life because, billions of years ago, many organisms were superficially similar. "That's the problem with this field," says Butterfield. "You stand back and squint, and say 'well, the fossil kind of looks like X.'"

Bengtson acknowledges that it's difficult to peg his fossils' exact place. "We can never prove their affinity with 100% certainty," he says. "But we are very confident we have made the best guess."

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