Multicellularity: A key event in the evolution of life

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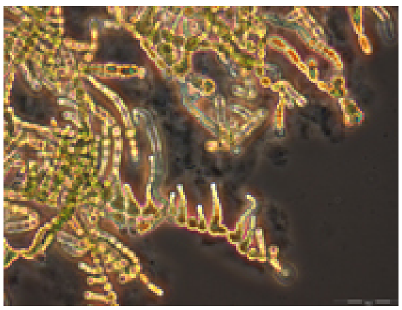

Multicellular cyanobacteria with algae-like growth. Credit: Dr. Bettina Schirrmeister

(Phys.org)—Multicellularity in cyanobacteria originated before 2.4 billion years ago and is associated with the accumulation of atmospheric oxygen, subsequently enabling the evolution of aerobic life, as we know it today, according to a new study from the University of Zurich involving researchers now at the University of Bristol, and Gothenburg.

The research, published today in the Proceedings of the National Academy of Sciences *(PNAS)*, applied phylogenetic tree reconstruction methods to the study of oxygen-producing bacteria, so-called cyanobacteria.

These bacteria show an impressive morphological variety, including multiple forms of multicellularity, and are distributed across various habitats, including oceans, lakes, soil and even thermal vents. They are also amongst the oldest organisms on Earth and it seems that they are not only important for the ecosystem of our planet today but have been so for over two billion years.

It has been suggested that cyanobacteria raised oxygen levels in the atmosphere around 2.4 billion years ago during the Great Oxidation Event (GOE), when the anoxic and seemingly uninhabitable Earth started to slowly accumulate oxygen in its atmosphere, finally forming the planet that we see today, full of diverse habitats and species. Yet, little was known about the temporal evolution of cyanobacterial lineages, and the possible interplay between the origin of multicellularity, diversification of cyanobacteria and the rise of atmospheric oxygen.

By combining information gathered from ancient fossils and the genes of living organisms, the researchers tested whether the evolution of multicellularity overlaps with the GOE, and whether multicellularity is associated with significant shifts in diversification rates in cyanobacteria.

They found that cyanobacteria originated long before the accumulation of oxygen in the atmosphere and that the evolution of multicellular forms coincided with the onset of the GOE and an increase in diversification rates. These results suggest that multicellularity could have played a key role in triggering cyanobacterial evolution around the GOE. The researchers also found that multicellularity was followed by increased origin of species in cyanobacteria.

Lead author, Dr Bettina Schirrmeister, Swiss National Science Foundation (SNF) postdoctoral fellow at the University of Bristol said: "Multicellularity originated very early in cyanobacteria and likely had a strong influence on the early environment of our planet. It could have had advantages that helped to dominate environmental niches, increasing the abundance of cyanobacteria and subsequently oxygen production."

"There is much discussion on the impact of environmental changes on biodiversity, for instance what will happen under current Global Warming. Our study stands out in showing a potential link in the other direction, namely how the evolution of biodiversity has profoundly changed the planet's environment", says Alexandre Antonelli, at the University of Gothenburg in Sweden.

The researchers' next aim is to get a better understanding of what might have caused the evolution of multicellularity in cyanobacteria and its consequences.

Dr Schirrmeister said: "By applying state of the art techniques for the analyses of genomes and fossil data, we hope to get new clues on the dynamics that underlie the drastic environmental changes during the early Proterozoic Eon, more than two billion years ago."

More information: Schirrmeister, B. et al., Evolution of multicellularity coincided with increased diversification of cyanobacteria and the Great Oxidation Event, *PNAS*. www.pnas.org/content/early/201 … 927110.full.pdf+html

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