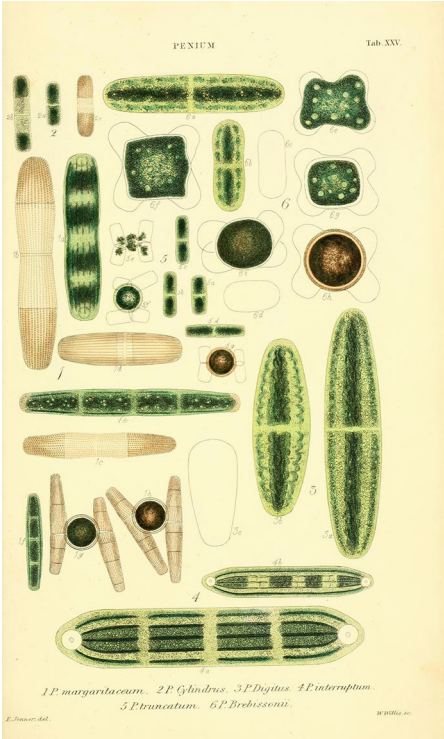
EVOLUTION

From algae to land plants

Cell **181**, 1097–1111 (2020).



Credit: Ralfs, J. and Jenner, E. (1848). *The British desmidieae.* Reeve, Benham and Reeve

Ancestors of the Zygnematophyceae algae were the precursors of the first plants to grow on dry land. As genomes keep traces of evolutionary adaptations, comparative genomics studies help understand the genetic innovations needed for major transitions such as emergence from water. A team led by Jocelyn Rose at Cornell University determined the genome of *Penium margaritaceum*, a unicellular alga and the third Zygnematophyceae to be sequenced. Although such a modern organism has evolved for hundreds of millions of years since its common ancestor with land plants, some of its characteristics still mirror adaptations to transitional environments. For example, the presence of an abundant polysaccharide mucilage helps with water retention during life in shallow wetlands that frequently become dry.

The large genome of *P. margaritaceum* contains abundant repeated transposable elements, segmental duplications and more than 50,000 genes validated by transcriptome analysis. It offers new insights into land adaptation and confirms that many genes and pathways necessary for life outside of water already existed in the common ancestors of land plants and Zygnematophyceae. For example, GAI, RGA and SCR (GRAS) transcriptions factors, involved in modern plants in tolerance to abiotic stresses such as dehydration, form an unexpectedly large group. Enzymes needed for the synthesis and maintenance of a rigid cell wall, necessary to fight gravity on dry land and a hallmark of green plants, are also present. Ultraviolet-protective flavonoids and an early pathway for their production are found. Going beyond genome sequencing, the authors also analysed the transcriptome responses to stresses related to terrestrialization, notably desiccation and high light.

Half a billion years ago, humble unicellular freshwater algae evolved the capacity to grow on dry land despite the many constraints due to the radical change of environment, and they altered the destiny of our planet. Vertebrates followed later once the plants had prepared the terrain. Studying modern Zygnematophyceae gives us a small window into the early genetic innovations that made this possible, a truly pivotal event that led to the green world we know today.

Guillaume Tena

Published online: 11 June 2020
https://doi.org/10.1038/s41477-020-0712-5