NATIONAL PRESS RELEASE I PARIS I 20 MAY 2021

A plant-fungi partnership at the origin of terrestrial vegetation

- Plants that exist on land today have genes that allow them to exchange lipids with beneficial fungi
- This plant-fungus partnership is at the origin of the transition of plants from aquatic life to terrestrial life

450 million years ago, the first plants left aquatic life. Researchers from the CNRS and the Université de Toulouse III - Paul Sabatier, in collaboration with INRAE, have succeeded in demonstrating that this colonisation of land by plants was made possible by a partnership between plants and fungi. Validating this 40-year-old hypothesis allows us to understand a stage that was crucial to the development of life on Earth. The study is published in *Science* on 21 May 2021.

About 450 million years ago, the first plants left the water to live on land. To do this, they had to adapt to the aridity of the land. In the 1980s, the study of fossils led to the hypothesis that a plant-fungus alliance may have been at the origin of plant vegetation. It has just been confirmed by an international research team[1] led by French scientists[2].

To understand life in the past, researchers had to study present-day plants. These fall into one of two main categories: vascular plants with stems and roots, and non-vascular plants such as mosses, called bryophytes.

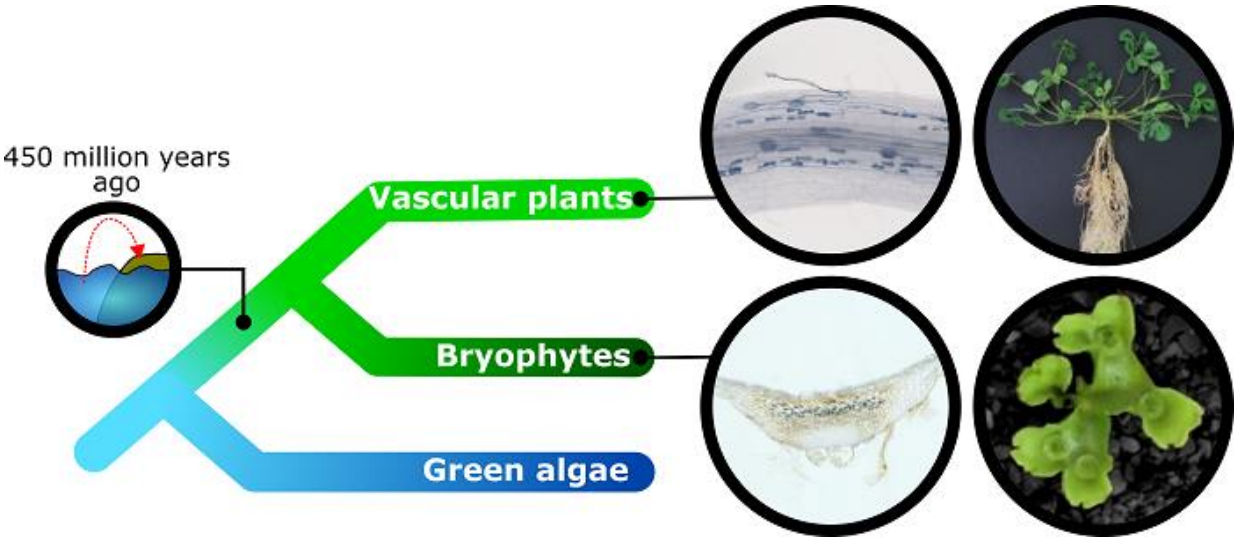
Most plants live in symbiosis with fungi, whereby the two organisms exchange resources in a mutually beneficial way. Previous studies have shown the existence of genes that are essential for the proper functioning of this symbiosis, particularly in vascular plants. Here, scientists focused on a bryophyte resembling a succulent plant (see image), for which such genes had not yet been studied: *Marchantia paleacea.*

By studying *M. paleacea*, they were able to demonstrate a lipid transfer between the plant and the fungus similar to that observed in vascular plants. By adapting the use of CRISPR, a molecular tool that allows DNA to be cleaved precisely, they were then able to modify a gene predicted as "symbiotic". As in vascular plants, the interruption of lipid exchange between the plant and the fungus leads to symbiosis failure in the bryophyte.

The common ancestor of these two groups of plants, which colonised dry land, must therefore have exchanged lipids with the fungus, as do the plants of today. Thus, 450 million years later, one of the secrets of life's first steps on land has finally been elucidated.

Notes

1- Numerous international collaborators contributed to this study, including the University of Cologne and the CIBSS - Centre for Integrative Biological Signalling Studies at the University of Freiburg in Germany; the University of Cambridge in the UK; the University of Zurich in Switzerland; and the University of Tohoku in Japan.
2- Teams from the Laboratoire de recherche en sciences végétales RSV (CNRS/Université de Toulouse III - Paul Sabatier); the Agrobiosciences, Interactions and Biodiversity Research Federation (CNRS/Toulouse INP/Université de Toulouse III - Paul Sabatier/INRAE); the Laboratory of Plant-Microbe Interactions (LIPM) (CNRS/INRAE), and the Institute of Cardiovascular and Metabolic Diseases (Inserm/Université de Toulouse III - Paul Sabatier) are involved.



Phylogenetic tree of plants. Vascular and non-vascular plants form a symbiosis with fungi. Circles on the left: the fungus is stained blue in a truncated alfalfa root (top) or a thallus of *M. paleacea* (bottom). Right-hand circles: stubby alfalfa (top), *M. paleacea* (bottom).
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Bibliographie

Lipid exchanges drove the evolution of mutualism during plant terrestrialization. Mélanie K. Rich, Nicolas Vigneron, Cyril Libourel, Jean Keller, Li Xue, Mohsen Hajheidhari, Guru V. Radhakrishnan, Aurélie Le Ru, Issa S Diop, Giacomo Potente, Elena Conti, Danny Duijsings, Aurélie Batut, Pauline Le Faouder, Kyoichi Kodama, Junko Kyozuka, Erika Sallet, Guillaume Bécard, Marta Rodrigez-Franco, Thomas Ott, Justine Bertrand-Michel, Giles ED Oldroyd, Péter Szövényi, Marcel Bucher and Pierre-Marc Delaux. *Science*, 21 May 2021. DOI : 10.1126/science.abg0929

Contacts

CNRS researcher | Pierre-Marc Delaux | **T +33 5 34 32 38 38** | pierre-marc.delaux@lrsv.ups-tlse.fr

Post-Doctoral researcher | Mélanie K. Rich | **T +33 5 34 32 38 38** | melanie.rich@lrsv.ups-tlse.fr

CNRS Press officer | Elie Stecyna | **T +33 1 44 96 51 26** | elie.stecyna@cnrs.fr