

The protective layer of prehistoric land plants

March 8 2017



Mosses cover a tree. An international research team has discovered a pathway with which these tiny plants produce their outer protective layer. Credit: Ralf Reski

An international research team has discovered a biochemical pathway that is responsible for the development of moss cuticles. These waxy coverings of epidermal cells are the outer layer of plants and protect them from water loss. The biologists discovered this mechanism that facilitated the evolutionary transition of plants from fresh water to land in the moss *Physcomitrella patens*. The team was led by Professor Ralf Reski from the University of Freiburg/Germany and Doctor Danièle Werck-Reichhart from the Centre National de la Recherche Scientifique (CNRS) Institute of Plant Molecular Biology (IBMP) in Strasbourg/France and published their results in the journal *Nature Communications*.

Plant cuticles came into being more than 450 million years ago when the first plants colonized the hitherto hostile land masses. Because the waxy cuticles protect against [water loss](#), they enabled the spread of plants on land and the subsequent evolution of our complex ecosystems. The seed plants that evolved later use similar chemical reactions to form the biopolymers lignin, cutin and suberin. Especially lignification of cell walls contributes to wood production and helps trees to grow several meters in height. In contrast, mosses do not contain lignin and are tiny. It remained unknown which [biochemical pathway](#) contributes to the protective layer on moss cells.

The researchers now found that the enzyme CYP98 from the family of cytochromes P450 plays a crucial role: While it initiates the production of lignin in seed plants, it is responsible for the development of a phenol-enriched cuticle in *Physcomitrella*. When they switched off the gene that

is responsible for the synthesis of this enzyme, moss developed without cuticles. As a result, these moss plants were not protected against the environment and, moreover, were not able to form complex tissues: the developing organs fused and their further development was halted. The researchers could compensate this genetic defect by feeding the plants with caffeic acid, which they identified as the main component of the moss phenolic metabolism. The biologists conclude that the moss cuticle predated the evolution of lignin, cutin and suberin and may therefore originate from the last common ancestor of mosses and [seed plants](#) - the prehistoric plants which left the [fresh water](#) to dwell on rocks and thus laid the foundation for the development of all current ecosystems on the mainland.

"Our results reveal one of the earliest evolutionary innovations that helped the first plants to survive on land over 450 million years ago," explains Reski. "It further suggests new biotechnology strategies for engineering biopolymers in plants beyond the well-known lignin production of trees."

Werck-Reichhart and Reski were Senior Fellows of the Freiburg Institute for Advanced Studies (FRIAS) and the University of Strasbourg Institute for Advanced Study (USIAS) which funded their German-French co-operation project "METABEVO". Reski holds the Chair of Plant Biotechnology at the Faculty of Biology of the University of Freiburg/Germany. He is a founding principal investigator of the Cluster of Excellence BIOSS Centre for Biological Signalling Studies.

Researchers from the University of Strasbourg/France, the University of Victoria/Canada and from Cornell University/USA were also involved in this study.

More information: Hugues Renault et al. A phenol-enriched cuticle is ancestral to lignin evolution in land plants, *Nature Communications*

(2017). [DOI: 10.1038/ncomms14713](https://doi.org/10.1038/ncomms14713)

Provided by University of Freiburg

Citation: The protective layer of prehistoric land plants (2017, March 8) retrieved 24 May 2024 from <https://phys.org/news/2017-03-layer-prehistoric.html>

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