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research highlights

LIGNIN EVOLUTION

Invasion of land

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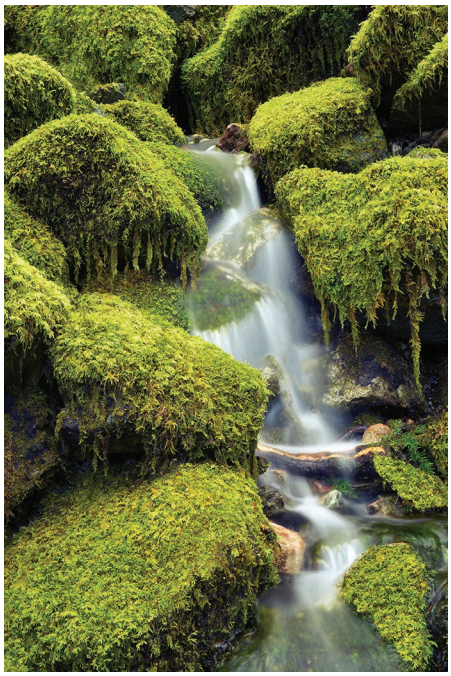

DENNIS FRATES / ALAMY STOCK PHOTO

Lignin is a hydrophobic component of plant cell wall that plays a pivotal role in vascular tissues. Lignified tissue provides structural rigidity and water impermeability to enhance plant growth and long-distance water transportation, and therefore the emergence of lignin is considered as a key step in the evolution of land plants. Early land plants, such as mosses, do not contain lignin but may have incorporated a 'pre-lignin' biosynthetic pathway. In support of this idea, Hugues Renault of Centre National de la Recherche, University of Strasbourg, Strasbourg, France, and University of Freiburg, Freiburg, Germany and colleagues now demonstrate a lignin-related phenolic metabolism pathway that contributes to a phenol-enriched cuticle in moss.

Lignin biosynthesis in vascular plants is a multistep process composed of monolignol biosynthesis, transportation and polymerisation. The first committed reaction of monolignol biosynthesis is catalysed by a cytochrome P450 oxygenase, whose homologue in the moss *Physcomitrella patens* is a single-copy gene, *CYP98*. Knockout of *CYP98* results in aborted gametophore formation and organ fusion. Further analysis by transmission electron microscopy illustrates differences in cell wall and cuticle structures in wild-type and *CYP98* knockout mosses.

Phenolic metabolism comparison reveals a missing phenolic compound in the *CYP98* knockout mutant, caffeoyl-threonic acid, which could be converted from *p*-coumaroyl-threonic acid by CYP98 enzymes. However, in vascular plants, CYP98 homologous cytochrome P450 enzymes utilize a different substrate, *p*-coumaroyl-shikimate, suggesting a divergent substrate of CYP98 enzymes in lower plants. The authors hypothesize that caffeic acid derived from CYP98 activity plays a key role in cutin biosynthesis as well as cuticle structure in moss.

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