23 June 2017

**Plants with different lipid acyl composition demonstrate divergent yet co-evolved lipid transport components**

Identification of a species-specific, co-evolving, and functionally relevant motif pair within two plant lipid components.

**The Science**

To develop bioenergy crops that produce extra lipids for extraction as oil biofuel, we examined whether lipid transport complexes of plants with different lipid acyl composition have diverged in their function.

**The Impact**

By furthering the molecular-level understanding of lipid transport in the model grass Brachypodium, we are advancing the potential to manipulate lipid production in bioenergy grass crops to improve crop value.

**Summary**

The import of lipids into the chloroplast is essential for photosynthetic membrane biogenesis. This process requires an ABC transporter in the inner envelope membrane with three subunits, TRIGALACTOSYLDIACYLGLYCEROL (TGD) 1, 2, and 3 named after the oligogalactolipids that accumulate in the respective *Arabidopsis thaliana* mutants. Unlike Arabidopsis, in the model grass *Brachypodium distachyon*, chloroplast lipid biosynthesis is largely dependent on imported precursors, resulting in a characteristic difference in chloroplast lipid acyl composition between plants. Accordingly, Arabidopsis is designated as a 16:3 (acyl carbons: double bounds) plant and Brachypodium as an 18:3 plant. Repression of *TGD1* (*BdTGD1*) in Brachypodium affected growth without triggering oligogalactolipid biosynthesis. Moreover, expressing *BdTGD1* in the Arabidopsis *tgd1-1* mutant restored some phenotypes but did not reverse oligogalactolipid biosynthesis. A 27-amino acid loop is solely responsible for the incomplete functioning of BdTGD1 in Arabidopsis *tgd1-1*. Co-evolutionary analysis and co-immunoprecipitation assays showed that this TGD1 loop interacts with a specific domain of TGD2. To explain the observed differences in oligogalactolipid biosynthesis between the two species, we suggest that excess monogalactosyldiacylglycerol derived from chloroplast-derived precursors in Arabidopsis *tgd1-1* is converted into oligogalactolipids, a process absent from Brachypodium with reduced TGD1 levels, which assembles monogalactosyldiacylglycerol exclusively from imported precursors.

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**Funding**

This work was funded in part by the DOE Great Lakes Bioenergy Research Center (DOE Office of Science BER DE-FC02-07ER64494) and MSU AgBioResearch.

**Publications**

Yang, Y. *et al.* “Co-evolution of domain interactions in the chloroplast TGD1, 2, 3 lipid transfer complex specific to Brassicaceae and Poaceae plants**.”** *The Plant Cell (*2017) [DOI: 10.1105/tpc.17.00182].

**Related Links**

<http://www.plantcell.org/content/early/2017/05/19/tpc.17.00182>

**PM Recommendation for SC Web Publication**