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Hiroshi Maeda is assistant professor in the Department of Botany at University of Wisconsin-Madison. He received BS and MS degree in Biotechnology at Osaka University. He then moved to the US and obtained PhD at Michigan State University in 2006, working with Dr. Dean DellaPenna on tocopherol (vitamin E) functions in photosynthetic organisms. After working as postdoc with Dr. Natalia Dudareva at Purdue University on phenylalanine and benzenoid volatile biosynthesis in petunia flowers, he started his current position at UW-Madison from the fall 2011. Dr. Maeda's laboratory has been investigating evolutionary diversification of the tyrosine biosynthetic pathway in various plant species. Dr. Maeda was the recipient of the Anton Lang Memorial Graduate Student Award from MSU DOE-Plant Research Laboratory in 2006 and the Eric Conn Young Investigator Award from the American Society of Plant Biologists in 2011.

[S1-5] Relaxation of tyrosine pathway regulation during the evolution of betalain pigmentation in Caryophyllales

Samuel Lopez-Nievesa[1], Ya Yang[2], Samuel Brockington[3], Hiroshi Maeda[1]
[1]Department of Botany, University of Wisconsin–Madison, Madison, WI, USA
[2]Department of Ecology & Evolutionary Biology, University of Michigan, Ann Arbor, MI, USA
[3]Department of Plant Sciences, University of Cambridge, Cambridge, UK

Betalain pigments are unique to the plant order Caryophyllales and synthesized from the aromatic amino acid *L*-tyrosine (Tyr). However, it is unknown how Tyr-derived betalain pigments evolved to replace the otherwise ubiquitous phenylalanine-derived anthocyanins. Here, we investigated the Tyr biosynthetic pathway in table beets (*Beta vulgaris* L.), which produce high levels of betalains. Like most plants, *B. vulgaris* synthesizes Tyr via plastidic arogenate dehydrogenases ($TyrA_a$/ADH), which were encoded by two *ADH* genes (*BvADHα* and *BvADHβ*). However, unlike BvADHβ and other plant ADHs that are strongly inhibited by Tyr, BvADHα exhibited relaxed sensitivity to Tyr. Phylogenetic analysis combined with recombinant enzyme characterization further revealed that Tyr-insensitive BvADHα orthologs arose in conjunction with betalain pigmentation in the Caryophyllales. Our results indicate that relaxation of Tyr pathway regulation is intimately associated with the evolution of betalain pigmentation, highlighting the significance of upstream primary metabolic regulation for the diversification of specialized plant metabolism.