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The power of gene duplications: how the orchid got its lip

About 40 years ago Susumu Ohno promoted the idea that gene duplications are crucial events during the origin of evolutionary novelties. Since then, a lot of evidence has accumulated that strongly supports Ohno's views. Here we report an intriguing case in point concerning the origin and diversification of the orchid flower. Orchids have unique flowers involving three types of perianth organs: outer tepals, lateral inner tepals, and lip. We provide evidence that the identity of the different perianth organs is specified by the combinatorial interaction of four *DEF*-like MADS-box genes that originated by gene or whole genome duplications close to the origin of the orchid family. We hypothesize that the four paralogous *DEF*-like genes, encoding transcription factors, shaped floral diversity in orchids in a significant way by modularizing the floral perianth based on a complex series of sub- and neo-functionalization events. The duplicate *DEF*-like genes may have eliminated constraints, in a way that different kinds of perianth organs could now evolve individually and often in dramatically different ways in response to natural selection by pollinators. We argue that the diversity of orchid flowers may be the result of an unprecedented developmental genetic predisposition that originated early in the evolution of the clade that led to extant orchids.

Short CV

Günter Theißen was born in Mönchengladbach, Germany, on January 16, 1962. He studied biology at the University of Düsseldorf (Germany), and received a Diploma in Biology in 1987, and a *Dr. rer. nat.* (equivalent to PhD) in 1991, both from the University of Düsseldorf. Working on viroid-binding proteins and the biogenesis of ribosomes in *E. coli* during his time in Düsseldorf provided him with training in molecular biophysics, molecular biology and microbiology. In 1992 he joined the department of Plant Genetics at the Max-Planck-Institute for Breeding Research (MPIZ) in Cologne (Germany), first as a postdoc, later as a group leader. Here he established a group that worked on the phylogeny of MADS-box genes and its role in the development and evolution of land plants. In 2000 he obtained Habilitation and *venia legendi* in Genetics from the University of Cologne. In 2001 he became Associate Professor of Botany at the University of Münster (Germany). Since 2002 he works as a Full Professor of Genetics at the Friedrich Schiller University of Jena (Germany). His major research interests are currently the molecular genetics of flower development, the molecular evolution of MADS-box genes and proteins, the evolution of flower development, and the mechanisms of macroevolution.