EDITOR PROFILE

Ralph Bock[OPEN]

It can be argued—fairly easily in fact—that the defining feature of a plant is its chloroplast. Ralph Bock, now a director at Germany’s Max Planck Institute of Molecular Plant Physiology (MPI-MP) and a member of the prestigious National Academy Leopoldina, has spent his career studying the intricacies of that chloroplast. His work has furthered our knowledge of the genes encoded in the plastid genome and the factors that govern their expression, has involved the development of new methods, tools, and resources to aid in plant research, and has even seen the creation of a new species of plant.

A NEW FERTILIZER

Once, at a group laboratory retreat, Ralph Bock played “truth or lie” with his group—a game in which a person tells one true and one false story, and the others must guess which is which. Ralph told two tales, the first about forming a herbarium collection of more than 100 plants as a young child, and the second about shenanigans undertaken during his time doing military service for East Germany (a story that I encourage you to ask him about in your own time). Nearly every member of his group guessed the plant version of history, and nearly every member of his group was wrong.

As it happens, Ralph was not overly interested in plants and plant biology as a child but, instead, grew up in a family focused on chemistry (both parents, and also his sister, are trained chemists, making Ralph something of a black sheep within the family). Nonetheless, it was this early access to chemistry—or at least to chemicals—that provided a gateway for the young Ralph to undertake some of his earliest scientific experiments on plants. At the age of around 10 or 12, Ralph “discovered” a stockpile of his father’s chemicals, stored for safekeeping over the summer holiday, in the family attic. Familiar with the work of German scientists Haber and Bosch in developing artificial methods to fertilize plants, Ralph decided that he himself would try his hand at improving the growth of several available plants using various mixtures of chemicals. Perhaps unsurprisingly, things did not turn out particularly well for the plants involved.

Although these early experiments were not overly appreciated in their time (Ralph’s mother, the owner of the suffering plants, was particularly unhappy about the work), later ventures into plant science would prove to be much more fruitful.

THE UNIVERSITY YEARS: SC FREIBURG AND “GOING TO AMERICA”

By the end of his schooling years, Ralph had developed a healthy interest in a range of scientific subjects, a fact that convinced him to enter university in a field of study that mixed both chemistry and biology. And so, following his mandatory military service for the German Democratic Republic (in which he worked as a wireless operator for the East German air force), he attended the University of Halle as a genetics major. Postgraduation, Ralph made a decision that was unusual for the time: to spend a part of his Ph.D. studies abroad, in the United States. In the year and a half spent with Professor Pal Maliga at Rutgers, the State University of New Jersey, Ralph gained important insights into the world of RNA editing (a posttranscriptional process in which RNA bases are altered) and developed his own brand of North American accent (he admits that his English was “not the best” before the stay). The surrounding years saw the completion of his doctoral degree with “doctor father” Professor Hans Kössel in the Albert Ludwig University’s Institute of Biology in Freiburg and the publication of a string of articles involving the early dissection of plastid RNA editing, including the first evidence for the requirement of trans-factors (Bock and Koop, 1997).

While RNA editing is a theme that has stayed with Ralph throughout the years, perhaps an even more significant outcome of his time in Maliga’s lab at Rutgers was learning the technique of plastid genome transformation. Stable plastome transformation of the model plant Arabidopsis (Arabidopsis thaliana) has only recently become possible, following decades of...
of effort from the groups of both Maliga (Yu et al., 2017) and Bock (Ruf et al., 2019), but at the time it could be undertaken for the model plant of chloroplast biology, tobacco (Nicotiana tabacum). And so, tobacco became the dominant model organism and stable plastome transformation became a driving tool in Ralph’s subsequent research.

After completing his doctorate, Ralph remained in Freiburg for ~4 years—long enough to develop a lifelong allegiance to the local football club SC Freiburg—before accepting (in 2001) a position as director and professor at the Institute of Biochemistry and Plant Biotechnology at the Westfälische Wilhelms-Universität Münster. During these early years, he continued to research aspects of plastid gene expression while also clarifying the functions of several genes and conserved open reading frames (ycfs) through reverse genetic screens involving plastid gene knockouts. Of these, he is particularly proud of work involving inactivation of the smallest plastome-encoded open reading frame, previously designated ycf6, which was revealed to be an essential subunit of the cytochrome b6f complex (Hager et al., 1999).

WIDE INTERESTS IN ORGANELLE BIOLOGY

When I ask Ralph to describe his current research as a group leader and director at the MPI-MP in 10 words or less, he cannot do it, probably because the topics are too diverse. According to the official MPI-MP website, Ralph’s department researches “Organelle Biology, Biotechnology and Molecular Ecophysiology,” while his working group is focused on the only slightly less broad subject of “Organelle Biology and Biotechnology.” The reality involves a group of ~40 members working on projects across various organelles (but mostly the plastid) and various species (mostly tobacco and other Solanaceae, with some Arabidopsis and Chlamydomonas thrown in), with projects that range from basic research to those that are considerably more applied. Indeed, Ralph’s group has many diverse research foci, which comes from his own incredibly extensive scientific interests—he admits to a tendency to get excited about many different topics.

One such passion is the use of plastid genome transformation as a tool for “molecular farming,” in which the high expression capacity and physical containment of the plastid are exploited to produce large quantities of valuable proteins and metabolites (Oey et al., 2009; Lu et al., 2013; Fuentes et al., 2016). Recently, this research has extended to resistance engineering, in which plants are granted protection from pests by the expression of long double-stranded RNAs (Zhang et al., 2015).

In the last 10 years, the group has also dabbled in the field of experimental genome evolution, successfully demonstrating that DNA, entire plastid genomes (Steegmann and Bock, 2009; Steegmann et al., 2012), and indeed entire nuclei (Fuentes et al., 2014) can be moved or exchanged from cell to cell and plant to plant using tissue-grafting methods. This method, which has already resulted in the birth of an N. tabacum + Nicotiana glauca allopolyplloid species, “Nicotiana tabauca,” allows new species to be created by the asexual merging of nuclei from two sexually incompatible graft partners. Ralph’s group is currently investigating the evolutionary and metabolic implications of species mixing, with the boss himself—who has a particular love of spicy food—highly invested in the development of a chili-tomato hybrid.

THE FUTURE: IT’S ALL ABOUT TECHNOLOGY

Ralph stresses the importance of technological developments as a means to remain competitive in science, a dogma that his group has surely followed in past years. Among others, these have included the development of a stable transformation system for new species (Ruf et al., 2001) and those utilizing new selectable marker systems (Tabatabaei et al., 2019), methods for the controlled expression of genes (Neupert et al., 2008; Verhounig et al., 2010), and the design of synthetic multigene operons for the introduction of metabolic pathways (Lu et al., 2013). Of particular note is the development of two Chlamydomonas reinhardtii strains, isolated from a UV mutagenesis screen, which allow for high-level expression of transgenes and have quickly become a tool that is widely used by the Chlamydomonas community.

The MPI-MP is currently at a leadership crossroads: the institute is searching for two new directors as others prepared for retirement. But Ralph, who is quick to acknowledge the joy associated with being in a position where he has the resources to follow-up on the many scientific questions that continue to pique his interest, is looking forward: to new discoveries and the development of new techniques...and hopefully, also, to a new (spicer) tomato.

Tegan Armarego-Marriott
Max Planck Institute of Molecular Plant Physiology
Potsdam, Germany
armarego@mpimp-golm.mpg.de
ORCID ID: 0000-0002-8745-9468

REFERENCES

el13664.


