Protoplasma (2008) 234:1–2
DOI 10.1007/s00709-008-0024-5

EDITORIAL

P. Nick

Published online: 19 November 2008

The secret mobility of static plants

Movement is not a feature typically associated with plants. Their photosynthetic lifestile required the evolution of large surfaces that are exposed to light, and the resulting mechanical strains had to be balanced by architectural adaptations that rendered plants immobile. These architectural constraints shaped plant life down to the individual cells—due to their cellulosic cell walls, plant cells are bound to a fixed position. Cell migration, a central mechanism in animal morphogenesis, does not play a role in plant development. However, a closer look reveals that the impression of immobility is superficial. Rather than moving by themselves, plant cells move signals that control cell differentiation and are responsible for the formation of developmental patterns. This intercellular mobility of signals is accompanied by an intracellular mobility that is at least as pronounced as in animal cells, but seems to be driven by mechanisms that differ, at least partially, from their animal counterparts. This secret mobility of static plants emerged mainly from methodological advances in life cell imaging. Two contributions in the present issue make novel and important contributions to our understanding of "plant mobility".

P. Nick (✉)
Institute of Biology, University Karlsruhe,
Kaiserstrasse 2,
76128 Karlsruhe, Germany
e-mail: peter.nick@bio.uni-karlsruhe.de

Intracellular transport: how to jump on Golgi stacks

Vesicle transport from the endoplasmic reticulum towards the cell periphery is conveyed by Golgi stacks that, in plants, travel along actin filaments. The mechanism by which proteins leave the endoplasmic reticulum and enter the Golgi stacks has been under debate and various concurrent models have been formulated. Is the gap between endoplasmic reticulum export sites and the *cis*-Golgi bridged by vesicles (so called secretory-unit model) or is there a membrane continuum? The work by Kang and Staehelin in the present issue gives a detailed view on the transfer of coat-complex II (COPII) vesicles from budding sites at the endoplasmic reticulum to the moving Golgi stacks. They use high-pressure freezing in root tips, followed by freeze-substitution and three-dimensional electron tomography to demonstrate a ribosome-free clear zone surrounding the COPII coat that behaves like a scaffold and seems to attach to the *cis*-side of the Golgi matrix such that the COPII vesicle can then attach to the Golgi. Atp115, a plant-homologue of a COPII vesicle-tethering factor, is localized to this ribosome-free clear zone and to the *cis*-side of the Golgi matrix. GFP fusions of Atp115 in living meristem cells show that the majority of Golgi stacks is connected to an ER export site via a COPII scaffold. In contrast to previous studies reporting direct connections between the endoplasmic reticulum and the *cis*-Golgi, no membrane continuity was observed under these conditions. This discrepancy might be due to different fixation protocols (chemical fixation in contrast to cryofixation in the present study). Although the fine-structural data are based on "snapshots" of a dynamic process and therefore subject to interpretation, this work represents a strong piece of evidence in favor of the secretory-unit model.

Intercellular transport: charge matters

Plant cells are coupled through plasmodesmata that are not only transporting metabolites and other small molecules, but have emerged as important routes for the transport of proteins, RNAs, viruses, and signaling factors. It is evident that they represent ideal targets to regulate intercellular communication and thus the pattern of cell differentiation. A detailed understanding of the biophysical parameters of plasmodesmatal transport is therefore central for an analytical understanding of plant development. The parameters that define the transport of a certain cargo include the gradient of electrochemical potential between the neighbor cells, density and diameter of the plasmodesmata at the cross wall, the thickness of the cross wall, and the size of the cargo molecule or, more precisely, the Stokes radius of this molecule. The work by Dashevskaya et al. in the present issue analyzes the role of the Stokes radius on plasmodesmatal transport. They employ a combination of molecular modeling and quantitative cell biology to measure the plasmodesmatal conductivity in epidermal cells of *Nicotiana benthamiana* using different versions of green fluorescent protein designed to differ either in size or in charge. They can show that in addition to size, charge effects on the Stokes radius can determine the transport properties of a cargo decisively, especially under conditions, where the cargo approaches the size-exclusion limit of the plasmodesmata. The methodology developed during this approach will allow a quantitative and precise investigation of macromolecular movement through plasmodesmata, and when it is connected to a developmental context, it will significantly advance our understanding of plant development.