

T H E
PLANT
C E L L

Volume 23 Number 1 January 2011

The electronic form of this issue, available at www.plantcell.org, is the journal of record.

ON THE COVER



In winter, perennial plants obstruct signaling via sieve tubes and plasmodesmata through callose accumulation, and they surround sensitive shoot apical meristems with tightly packed bud scales. Regrowth in the spring requires the reverse process to facilitate signal delivery. Rinne et al. (pages 130–146) identified 10 putative *Populus* orthologs of *Arabidopsis* genes that encode structurally different callose-degrading 1,3- β -glucanases. They show that these enzymes localize at and around plasmodesmata and are differentially regulated by seasonal cues and the hormones GA₃ and GA₄. The findings provide a mechanistic explanation of how cell-cell communication is modulated during the dormancy cycle. The cover image shows young, vigorously growing *Populus* trees that continuously monitor photoperiod to keep track of seasonal progression.

IN BRIEF

- Novel Mechanism of Viral Interference of Host Plant Suppression by BSCTV C2** 1
Nancy A. Eckardt
- The Plot Thickens: Flowering Specification in Legumes** 2
Jennifer Mach
- Dormancy Cycling in Populus: The Symplasmic Connection** 3
Gregory Bertoni









PERSPECTIVE

- Of PAMPs and Effectors: The Blurred PTI-ETI Dichotomy**  4
Bart P.H.J. Thomma, Thorsten Nürnberger, and Matthieu H.A.J. Joosten

REVIEW

- Regulation and Flexibility of Genomic Imprinting during Seed Development**  16
Michael T. Raissig, Célia Baroux, and Ueli Grossniklaus

RESEARCH ARTICLES

- Seventy Million Years of Concerted Evolution of a Homoeologous Chromosome Pair, in Parallel, in Major Poaceae Lineages**  27
Xiyin Wang, Haibao Tang, and Andrew H. Paterson
- From Amino Acid to Glucosinolate Biosynthesis: Protein Sequence Changes in the Evolution of Methylthioalkylmalate Synthase in *Arabidopsis***   38
Jan-Willem de Kraker and Jonathan Gershenzon
- Evolution and Diverse Roles of the *CUP-SHAPED COTYLEDON* Genes in *Arabidopsis* Leaf Development**   54
Alice Hasson, Anne Plessis, Thomas Blein, Bernard Adroher, Stephen Grigg, Miltos Tsiantis, Arezki Boudaoud, Catherine Damerval, and Patrick Laufs
- Cytokinin Regulates the Activity of Reproductive Meristems, Flower Organ Size, Ovule Formation, and Thus Seed Yield in *Arabidopsis thaliana***    69
Isabel Bartrina, Elisabeth Otto, Miroslav Strnad, Tomáš Werner, and Thomas Schmülling

EDITORIAL BOARD

Editor in Chief

Cathie Martin

Coeditors

Sarah M. Assmann

Jody Banks

David Baum

Sebastian Bednarek

James Birchler

Ulla Bonas

Christopher Bowler

Judy Callis

XiaoFeng Cao

Vincenzo De Luca

Xing Wang Deng

Xinnian Dong

Allan Downie

Alisdair Fernie

Pascal Genschik

Jean T. Greenberg

Thomas Guilfoyle

Herman R. Höfte

David Jackson

Regine Kahmann

Martin Kater

Daniel J. Kliebenstein

Patricia Leon

Clive Lloyd

William Lucas

Blake Meyers

Ortrun Mittelsten-Scheid

Joseph Noel

Michael Palmgren

Markus Pauly

Scott C. Peck

Barry Pogson

Karin Schumacher

David Smyth

Chris J. Staiger

Keiko Sugimoto

Managing Editor

John Long

Senior Features Editor

Nancy A. Eckardt

Features Editor

Mary Williams

Science Editors

Greg Bertoni

Kathleen L. Farquharson

Nancy R. Hofmann

Jennifer M. Mach

Production Manager

Susan L. Entwistle

Manuscript Manager

Annette Kessler

Publications Director

Nancy A. Winchester

Publisher

American Society of

Plant Biologists

Executive Director,

Crispin Taylor

Editorial Office

15501 Monona Drive

Rockville, Maryland 20855-2768

Telephone: 301/296-0908

Fax: 301/279-2996

<http://www.aspb.org>

Online at www.plantcell.org

- Pollen Tubes Lacking a Pair of K⁺ Transporters Fail to Target Ovules in *Arabidopsis*** [W](#) [O](#) [A](#) 81
Yongxian Lu, Salil Chanroj, Lalu Zulkiffi, Mark A. Johnson, Nobuyuki Uozumi, Alice Cheung, and Heven Sze
- Endoplasmic Reticulum- and Golgi-Localized Phospholipase A₂ Plays Critical Roles in *Arabidopsis* Pollen Development and Germination** [W](#) [O](#) [A](#) 94
Hae Jin Kim, Sung Han Ok, Sung Chul Bahn, Juno Jang, Sung Aeong Oh, Soon Ki Park, David Twell, Stephen Beungtae Ryu, and Jeong Sheop Shin
- Pollen Semi-Sterility1 Encodes a Kinesin-1-Like Protein Important for Male Meiosis, Anther Dehiscence, and Fertility in Rice** [W](#) 111
Shirong Zhou, Yang Wang, Wanchang Li, Zhigang Zhao, Yulong Ren, Yong Wang, Suhai Gu, Qibing Lin, Dan Wang, Ling Jiang, Ning Su, Xin Zhang, Linglong Liu, Zhijun Cheng, Cailin Lei, Jiulin Wang, Xiuping Guo, Fuqing Wu, Hiroshi Ikehashi, Haiyang Wang, and Jianmin Wan
- Chilling of Dormant Buds Hyperinduces *FLOWERING LOCUS T* and Recruits GA-Inducible 1,3-β-Glucanases to Reopen Signal Conduits and Release Dormancy in *Populus*** [W](#) [O](#) [A](#) 130
Päivi L.H. Rinne, Annikki Welling, Jorma Vahala, Linda Ripel, Raili Ruonala, Jaakko Kangasjärvi, and Christiaan van der Schoot
- The Pea *GIGAS* Gene Is a *FLOWERING LOCUS T* Homolog Necessary for Graft-Transmissible Specification of Flowering but Not for Responsiveness to Photoperiod** [W](#) [O](#) [A](#) 147
Valérie Hecht, Rebecca E. Laurie, Jacqueline K. Vander Schoor, Stephen Ridge, Claire L. Knowles, Lim Chee Liew, Frances C. Sussmilch, Ian C. Murfet, Richard C. Macknight, and James L. Weller
- Malate Plays a Crucial Role in Starch Metabolism, Ripening, and Soluble Solid Content of Tomato Fruit and Affects Postharvest Softening** [W](#) [O](#) [A](#) 162
Danilo C. Centeno, Sonia Osorio, Adriano Nunes-Nesi, Ana L.F. Bertolo, Raphael T. Carneiro, Wagner L. Araújo, Marie-Caroline Steinhauser, Justyna Michalska, Johannes Rohrmann, Peter Geigenberger, Sandra N. Oliver, Mark Stitt, Fernando Carrari, Jocelyn K.C. Rose, and Alisdair R. Fernie
- The PP2A Regulatory Subunit Tap46, a Component of the TOR Signaling Pathway, Modulates Growth and Metabolism in Plants** [W](#) 185
Chang Sook Ahn, Jeong-A Han, Ho-Seok Lee, Semi Lee, and Hyun-Sook Pai
- Distinct Roles of Protein Disulfide Isomerase and P5 Sulfhydryl Oxidoreductases in Multiple Pathways for Oxidation of Structurally Diverse Storage Proteins in Rice** [W](#) [O](#) [A](#) 210
Yayoi Onda, Ai Nagamine, Mutsumi Sakurai, Toshihiro Kumamaru, Masahiro Ogawa, and Yasushi Kawagoe
- The *Arabidopsis* Intracellular Na⁺/H⁺ Antiporters NHX5 and NHX6 Are Endosome Associated and Necessary for Plant Growth and Development** [W](#) 224
Elias Bassil, Masa-aki Ohto, Tomoya Esumi, Hiromi Tajima, Zhu Zhu, Olivier Cagnac, Mark Belmonte, Zvi Peleg, Toshio Yamaguchi, and Eduardo Blumwald
- Cell-Specific Vacuolar Calcium Storage Mediated by *CAX1* Regulates Apoplastic Calcium Concentration, Gas Exchange, and Plant Productivity in *Arabidopsis*** [W](#) [O](#) [A](#) 240
Simon J. Conn, Matthew Gilliam, Asmini Athman, Andreas W. Schreiber, Ute Baumann, Isabel Moller, Ning-Hui Cheng, Matthew A. Stancombe, Kendal D. Hirschi, Alex A.R. Webb, Rachel Burton, Brent N. Kaiser, Stephen D. Tyerman, and Roger A. Leigh

A Three-Dimensional RNA Motif in <i>Potato spindle tuber viroid</i> Mediates Trafficking from Palisade Mesophyll to Spongy Mesophyll in <i>Nicotiana benthamiana</i> W	258
Ryuta Takeda, Anton I. Petrov, Neocles B. Leontis, and Biao Ding	
BSCTV C2 Attenuates the Degradation of SAMDC1 to Suppress DNA Methylation-Mediated Gene Silencing in <i>Arabidopsis</i> W OA	273
Zhonghui Zhang, Hao Chen, Xiahe Huang, Ran Xia, Qingzhen Zhao, Jianbin Lai, Kunling Teng, Yin Li, Liming Liang, Quansheng Du, Xueping Zhou, Huishan Guo, and Qi Xie	
The FRIGIDA Complex Activates Transcription of <i>FLC</i>, a Strong Flowering Repressor in <i>Arabidopsis</i>, by Recruiting Chromatin Modification Factors C W	289
Kyuha Choi, Juhyun Kim, Hyun-Ju Hwang, Sanghee Kim, Chulmin Park, Sang Yeol Kim, and Ilha Lee	
ATP Synthase Repression in Tobacco Restricts Photosynthetic Electron Transport, CO₂ Assimilation, and Plant Growth by Overacidification of the Thylakoid Lumen OA	304
Markus Rott, Nádia F. Martins, Wolfram Thiele, Wolfgang Lein, Ralph Bock, David M. Kramer, and Mark A. Schöttler	
Assembly of the Chloroplast ATP-Dependent Clp Protease in <i>Arabidopsis</i> Is Regulated by the ClpT Accessory Proteins C W	322
Lars L.E. Sjögren and Adrian K. Clarke	
The Nucleus-Encoded <i>trans</i>-Acting Factor MCA1 Plays a Critical Role in the Regulation of Cytochrome <i>f</i> Synthesis in <i>Chlamydomonas</i> Chloroplasts W	333
Alix Boulouis, Cécile Raynaud, Sandrine Bujaldon, Aude Aznar, Francis-André Wollman, and Yves Choquet	
Two Distinct Roles of ARABIDOPSIS HOMOLOG OF TRITHORAX1 (<i>ATX1</i>) at Promoters and within Transcribed Regions of <i>ATX1</i>-Regulated Genes C W	350
Yong Ding, Zoya Avramova, and Michael Fromm	
Glutathione-Indole-3-Acetonitrile Is Required for Camalexin Biosynthesis in <i>Arabidopsis thaliana</i> W OA	364
Tongbing Su, Juan Xu, Yuan Li, Lei Lei, Luo Zhao, Hailian Yang, Jidong Feng, Guoqin Liu, and Dongtao Ren	
Heterodimers of the <i>Arabidopsis</i> Transcription Factors bZIP1 and bZIP53 Reprogram Amino Acid Metabolism during Low Energy Stress W	381
Katrin Dietrich, Fridtjof Weltmeier, Andrea Ehlert, Christoph Weiste, Mark Stahl, Klaus Harter, and Wolfgang Dröge-Laser	
<i>Arabidopsis</i> Floral Initiator SKB1 Confers High Salt Tolerance by Regulating Transcription and Pre-mRNA Splicing through Altering Histone H4R3 and Small Nuclear Ribonucleoprotein LSM4 Methylation C W	396
Zhaoliang Zhang, Shupeizhang, Ya Zhang, Xin Wang, Dan Li, Qiuling Li, Minghui Yue, Qun Li, Yu-e Zhang, Yunyuan Xu, Yongbiao Xue, Kang Chong, and Shilai Bao	
The Submergence Tolerance Regulator SUB1A Mediates Crosstalk between Submergence and Drought Tolerance in Rice W OA	412
Takeshi Fukao, Elaine Yeung, and Julia Bailey-Serres	

CORRECTION

428

Elena R. Álvarez-Buylla, Barbara A. Ambrose, Eduardo Flores-Sandoval, Marie Englund, Adriana Garay-Arroyo, Berenice García-Ponce, Eduardo de la Torre-Bárcena, Silvia Espinosa-Matías, Esteban Martínez, Alma Piñeyro-Nelson, Peter Engström, and Elliot M. Meyerowitz (2010) B-Function Expression in the Flower Center Underlies the Homeotic Phenotype of *Lacandonia schismatica* (Triuridaceae). *Plant Cell* 22: 3543–3559.

☑ Some figures in this article are displayed in color online but in black and white in the print edition.

☒ Online version contains Web-only data.

☐ Open Access articles can be viewed online without a subscription.



© 2011 American Society of Plant Biologists. All rights reserved. Printed on acid-free paper effective with Volume 1, Number 1, January 1989.

Printed in the United States of America.

The Plant Cell (ISSN 1040-4651, online ISSN 1531-298X) is published monthly (one volume per year) by the American Society of Plant Biologists, 15501 Monona Drive, Rockville, MD 20855-2768, and is produced by Dartmouth Journal Services, Waterbury, VT. The institutional price for the print and online versions is based on type of institution; contact institution@aspb.org. A subscription includes both *The Plant Cell* and *Plant Physiology*; single copies may be purchased for \$95 each, plus \$10 shipping (U.S.) or \$12 (outside U.S.). Members of the American Society of Plant Biologists may subscribe to *The Plant Cell* for \$185. Nonmember individuals may subscribe for \$375. For matters regarding subscriptions, contact Suzanne Cholwek, ASPB, 15501 Monona Drive, Rockville, MD 20855-2768; telephone 301/296-0926; fax 301/251-6740; e-mail scholwek@aspb.org. Notify ASPB in writing within 3 months (domestic) or 6 months (foreign) of issue date, and defective copies or copies lost in the mail will be replaced. Send all inquiries regarding display advertising to FASEB AdNet, 9650 Rockville Pike, Bethesda, MD 20814-3998; telephone 301/634-7791; fax 301/634-7153; e-mail adnet@faseb.org. Periodicals postage paid at Rockville, MD 20850, and at additional mailing offices.

Postmaster: Send address changes to *The Plant Cell*, American Society of Plant Biologists, 15501 Monona Drive, Rockville, MD 20855-2768. The online version of *The Plant Cell* is available at www.plantcell.org.

Permission to Reprint: Permission to make digital or hard copies of part or all of a work published in *The Plant Cell* is granted without fee for personal or classroom use provided that copies are not made or distributed for profit or commercial advantage and that copies bear the full citation and the following notice on the first page: "Copyright American Society of Plant Biologists." For all other kinds of copying, request permission in writing from Nancy A. Winchester, Publications Director, ASPB headquarters.

This information is current as of April 25, 2019

Permissions	https://www.copyright.com/ccc/openurl.do?sid=pd_hw1532298X&issn=1532298X&WT.mc_id=pd_hw1532298X
eTOCs	Sign up for eTOCs at: http://www.plantcell.org/cgi/alerts/ctmain
CiteTrack Alerts	Sign up for CiteTrack Alerts at: http://www.plantcell.org/cgi/alerts/ctmain
Subscription Information	Subscription Information for <i>The Plant Cell</i> and <i>Plant Physiology</i> is available at: http://www.aspb.org/publications/subscriptions.cfm