

The electronic form of this issue, available as of January 12, 2009, at [www.plantphysiol.org](http://www.plantphysiol.org), is considered the journal of record.

**On the Cover:** Grasses, with approximately 10,000 species that have evolved over the last 60 million years, show great morphological diversity. The cover illustration features a few examples of this diversity, along with some of the many cereal grains that were the focus of multiple domestication events in the family. The lower panel shows a biomass yield trial of switchgrass (*Panicum virgatum*), a promising crop for cellulosic ethanol production, while at the top is a field of sorghum (*Sorghum bicolor*) [both in field trials at Oklahoma State University, Oklahoma]. The center panel shows multiple grass species and grass grains, including grains of rice (*Oryza sativa*), spelt (*Triticum spelta*), barley (*Hordeum vulgare*), pearl millet (*Pennisetum glaucum*), rye (*Secale cereale*), corn (*Zea mays*), and oat (*Avena sativa*), and, from the left, inflorescences and plants of bamboo (*Phyllostachyus aureosulcata*), *Paspalum ramosum*, foxtail millet (*Setaria italica*), rice, emmer wheat (*Triticum dicoccoides*), corn, and *Coix lachrym-jobii*.

## FOCUS ISSUE ON THE GRASSES

### EDITORIAL

Splendor in the Grasses. *Elizabeth A. Kellogg and C. Robin Buell*

1

### LETTER TO THE EDITOR

A Recommendation for Naming Transcription Factor Proteins in the Grasses. *John Gray, Michael Bevan, Thomas Brutnell, C. Robin Buell, Karen Cone, Sarah Hake, David Jackson, Elizabeth Kellogg, Carolyn Lawrence, Susan McCouch, Todd Mockler, Stephen Moose, Andrew Paterson, Thomas Peterson, Daniel Rokhsar, Glaucia Mendes Souza, Nathan Springer, Nils Stein, Marja Timmermans, Guo-Liang Wang, and Erich Grotewold*

4

### UPDATES

Increasing Crop Productivity to Meet Global Needs for Feed, Food, and Fuel. *Michael D. Edgerton*

7

The Development of Endosperm in Grasses. *Paolo A. Sabelli and Brian A. Larkins*

14

Revolutionary Times in Our Understanding of Cell Wall Biosynthesis and Remodeling in the Grasses. *Geoffrey B. Fincher*

27

Translational Biology: From Arabidopsis Flowers to Grass Inflorescence Architecture. *Beth E. Thompson and Sarah Hake*

38

<sup>[C]</sup>Hormonal Regulation of Branching in Grasses. *Paula McSteen*

46

Mechanisms of Floral Induction in Grasses: Something Borrowed, Something New. *Joseph Colasanti and Viktoriya Coneva*

56

Genes and Mutations Underlying Domestication Transitions in Grasses. *Tao Sang*

63

<sup>[C]</sup>Genetic Control of Carbon Partitioning in Grasses: Roles of *Sucrose Transporters* and *Tie-dyed* Loci in Phloem Loading. *David M. Braun and Thomas L. Slewinski*

71

Integrating Phylogeny into Studies of C<sub>4</sub> Variation in the Grasses. *Pascal-Antoine Christin, Nicolas Salamin, Elizabeth A. Kellogg, Alberto Vicentini, and Guillaume Besnard*

82

Transcriptional Regulatory Networks in Response to Abiotic Stresses in Arabidopsis and Grasses. *Kazuo Nakashima, Yusuke Ito, and Kazuko Yamaguchi-Shinozaki*

88

*Continued on next page*

Indirect Defense Responses to Herbivory in Grasses. <i>Jörg Degenhardt</i>	96
For Blighted Waves of Grain: <i>Fusarium graminearum</i> in the Postgenomics Era. <i>Frances Trail</i>	103
Poaceae Genomes: Going from Unattainable to Becoming a Model Clade for Comparative Plant Genomics. <i>C. Robin Buell</i>	111
Synergy of Two Reference Genomes for the Grass Family. <i>Joachim Messing</i>	117
Comparative Genomics of Grasses Promises a Bountiful Harvest. <i>Andrew H. Paterson, John E. Bowers, Frank A. Feltus, Haibao Tang, Lifeng Lin, and Xiyin Wang</i>	125
<sup>[W]</sup> Genomic and Genetic Database Resources for the Grasses. <i>Kevin L. Childs</i>	132
<sup>[W]</sup> Foxtail Millet: A Sequence-Driven Grass Model System. <i>Andrew N. Doust, Elizabeth A. Kellogg, Katrien M. Devos, and Jeffrey L. Bennetzen</i>	137
<sup>[W]</sup> The International Barley Sequencing Consortium—At the Threshold of Efficient Access to the Barley Genome. <i>Daniela Schulte, Timothy J. Close, Andreas Graner, Peter Langridge, Takashi Matsumoto, Gary Muehlbauer, Kazuhiro Sato, Alan H. Schulman, Robbie Waugh, Roger P. Wise, and Nils Stein</i>	142
Cereal Germplasm Resources. <i>Martin M. Sachs</i>	148
Resources for Virus-Induced Gene Silencing in the Grasses. <i>Steven R. Scofield and Richard S. Nelson</i>	152
TILLING in Grass Species. <i>Clifford F. Weil</i>	158
<sup>[W]</sup> Mutant Resources in Rice for Functional Genomics of the Grasses. <i>Arjun Krishnan, Emmanuel Guiderdoni, Gynheung An, Yue-ie C. Hsing, Chang-deok Han, Myung Chul Lee, Su-May Yu, Narayana Upadhyaya, Srinivasan Ramachandran, Qifa Zhang, Venkatesan Sundaresan, Hirohiko Hirochika, Hei Leung, and Andy Pereira</i>	165
<b>BIOINFORMATICS</b>	
<sup>[W][OA]</sup> GRASSIUS: A Platform for Comparative Regulatory Genomics across the Grasses. <i>Alper Yilmaz, Milton Y. Nishiyama Jr., Bernardo Garcia Fuentes, Glauca Mendes Souza, Daniel Janies, John Gray, and Erich Grotewold</i>	171
<b>RESEARCH ARTICLES</b>	
<sup>[C][W][OA]</sup> <i>Tie-dyed1</i> Encodes a Novel, Phloem-Expressed Transmembrane Protein That Functions in Carbohydrate Partitioning. <i>Yi Ma, Thomas L. Slewinski, R. Frank Baker, and David M. Braun</i>	181
<sup>[OA]</sup> High Glycolate Oxidase Activity Is Required for Survival of Maize in Normal Air. <i>Israel Zelitch, Neil P. Schultes, Richard B. Peterson, Patrick Brown, and Thomas P. Brutnell</i>	195
<sup>[C][W][OA]</sup> <i>suppressor of sessile spikelets1</i> Functions in the <i>ramosa</i> Pathway Controlling Meristem Determinacy in Maize. <i>Xianting Wu, Andrea Skirpan, and Paula McSteen</i>	205
<sup>[W][OA]</sup> The ATG Autophagic Conjugation System in Maize: ATG Transcripts and Abundance of the ATG8-Lipid Adduct Are Regulated by Development and Nutrient Availability. <i>Taijoon Chung, Anongpat Suttangkakul, and Richard D. Vierstra</i>	220
<sup>[W]</sup> RETARDED PALEA1 Controls Palea Development and Floral Zygomorphy in Rice. <i>Zheng Yuan, Shan Gao, Da-Wei Xue, Da Luo, Lan-Tian Li, Shu-Yan Ding, Xuan Yao, Zoe A. Wilson, Qian Qian, and Da-Bing Zhang</i>	235
<sup>[W][OA]</sup> Genetic and Molecular Characterization of the VRN2 Loci in Tetraploid Wheat. <i>Assaf Distelfeld, Gabriela Tranquilli, Chengxia Li, Liuling Yan, and Jorge Dubcovsky</i>	245
<sup>[OA]</sup> Analysis of Intraspecies Diversity in Wheat and Barley Genomes Identifies Breakpoints of Ancient Haplotypes and Provides Insight into the Structure of Diploid and Hexaploid Triticeae Gene Pools. <i>Thomas Wicker, Simon G. Krattinger, Evans S. Lagudah, Takao Komatsuda, Mohammad Pourkheirandish, Takashi Matsumoto, Sylvie Cloutier, Laurenz Reiser, Hiroyuki Kanamori, Kazuhiro Sato, Dragan Perovic, Nils Stein, and Beat Keller</i>	258
<sup>[W][OA]</sup> <i>Blufensin1</i> Negatively Impacts Basal Defense in Response to Barley Powdery Mildew. <i>Yan Meng, Matthew J. Moscou, and Roger P. Wise</i>	271

- [W][OA] A Germin-Like Protein Gene Family Functions as a Complex Quantitative Trait Locus Conferring Broad-Spectrum Disease Resistance in Rice. *Patricia M. Manosalva, Rebecca M. Davidson, Bin Liu, Xiaoyuan Zhu, Scot H. Hulbert, Hei Leung, and Jan E. Leach* 286
- [OA] OsFRDL1 Is a Citrate Transporter Required for Efficient Translocation of Iron in Rice. *Kengo Yokosho, Naoki Yamaji, Daisei Ueno, Namiki Mitani, and Jian Feng Ma* 297
- [W][OA] Antiquity and Function of *CASTOR* and *POLLUX*, the Twin Ion Channel-Encoding Genes Key to the Evolution of Root Symbioses in Plants. *Caiyan Chen, Cui Fan, Muqiang Gao, and Hongyan Zhu* 306
- [OA] Characterization of an Autonomously Activated Plant ADP-Glucose Pyrophosphorylase. *Susan K. Boehlein, Janine R. Shaw, Jon D. Stewart, and L. Curtis Hannah* 318
- [C] Transforming a Fructan:Fructan 6G-Fructosyltransferase from Perennial Ryegrass into a Sucrose:Sucrose 1-Fructosyltransferase. *Bertrand Lasseur, Lindsey Schroeven, Willem Lammens, Katrien Le Roy, German Spangenberg, Hélène Manduzio, Rudy Vergauwen, Jérémy Lothier, Marie-Pascale Prud'homme, and Wim Van den Ende* 327
- [W][OA] A Second Mechanism for Aluminum Resistance in Wheat Relies on the Constitutive Efflux of Citrate from Roots. *Peter R. Ryan, Harsh Raman, Sanjay Gupta, Walter J. Horst, and Emmanuel Delhaize* 340

## REGULAR ISSUE

### ON THE INSIDE

- Peter V. Minorsky* 352

### GENOME ANALYSIS

- [W][OA] Genome-Wide Analysis of MIKC<sup>C</sup>-Type MADS Box Genes in Grapevine. *José Díaz-Riquelme, Diego Lijavetzky, José M. Martínez-Zapater, and María José Carmona* 354

### BIOCHEMICAL PROCESSES AND MACROMOLECULAR STRUCTURES

- [W] Suppression of 4-Coumarate-CoA Ligase in the Coniferous Gymnosperm *Pinus radiata*. *Armin Wagner, Lloyd Donaldson, Hoon Kim, Lorelle Phillips, Heather Flint, Diane Steward, Kirk Torr, Gerald Koch, Uwe Schmitt, and John Ralph* 370
- [W][OA] Biosynthesis of *t*-Anethole in Anise: Characterization of *t*-Anol/Isoeugenol Synthase and an O-Methyltransferase Specific for a C7-C8 Propenyl Side Chain. *Takao Koeduka, Thomas J. Baiga, Joseph P. Noel, and Eran Pichersky* 384
- [W] ADP-Glucose Pyrophosphorylase-Deficient Pea Embryos Reveal Specific Transcriptional and Metabolic Changes of Carbon-Nitrogen Metabolism and Stress Responses. *Kathleen Weigelt, Helge Küster, Twan Rutten, Aaron Fait, Alisdair R. Fernie, Otto Miersch, Claus Wasternack, R. J. Neil Emery, Christine Desel, Felicia Hosein, Martin Müller, Isolde Saalbach, and Hans Weber* 395
- [W][OA] A Relaxed Specificity in Interchain Disulfide Bond Formation Characterizes the Assembly of a Low-Molecular-Weight Glutenin Subunit in the Endoplasmic Reticulum. *Alessio Lombardi, Alessandra Barbante, Pietro Della Cristina, Daniele Rosiello, Chiara Lara Castellazzi, Luca Sbrano, Stefania Masci, and Aldo Ceriotti* 412
- [W][OA] Functional Characterization of a Higher Plant Sphingolipid  $\Delta 4$ -Desaturase: Defining the Role of Sphingosine and Sphingosine-1-Phosphate in Arabidopsis. *Louise V. Michaelson, Simone Zäuner, Jonathan E. Markham, Richard P. Haslam, Radhika Desikan, Sarah Mugford, Sandra Albrecht, Dirk Warnecke, Petra Sperling, E. Heinz, and Johnathan A. Napier* 487
- [W][OA] Divergent Regulation of Terpenoid Metabolism in the Trichomes of Wild and Cultivated Tomato Species. *Katrin Besser, Andrea Harper, Nicholas Welsby, Ines Schauvinhold, Stephen Slocombe, Yi Li, Richard A. Dixon, and Pierre Broun* 499

## BIOENERGETICS AND PHOTOSYNTHESIS

- <sup>[W]</sup>Chlororespiration and Grana Hyperstacking: How an Arabidopsis Double Mutant Can Survive Despite Defects in Starch Biosynthesis and Daily Carbon Export from Chloroplasts. *Rainer E. Häusler, Stefan Geimer, Hans Henning Kunz, Jessica Schmitz, Peter Dörmann, Kirsten Bell, Sonja Hetfeld, Andre Guballa, and Ulf-Ingo Flügge* 515

## CELL BIOLOGY AND SIGNAL TRANSDUCTION

- <sup>[OA]</sup>Detection of Spatial-Specific Phytochrome Responses Using Targeted Expression of Biliverdin Reductase in Arabidopsis. *Sankalpi N. Warnasooriya and Beronda L. Montgomery* 424

## DEVELOPMENT AND HORMONE ACTION

- <sup>[W][OA]</sup>The Arabidopsis A4 Subfamily of Lectin Receptor Kinases Negatively Regulates Abscisic Acid Response in Seed Germination. *Zeyu Xin, Anyou Wang, Guohua Yang, Peng Gao, and Zhi-Liang Zheng* 434

- <sup>[C][W]</sup>*Aucsia* Gene Silencing Causes Parthenocarpic Fruit Development in Tomato. *Barbara Molesini, Tiziana Pandolfini, Giuseppe Leonardo Rotino, Valeria Dani, and Angelo Spena* 534

## ENVIRONMENTAL STRESS AND ADAPTATION TO STRESS

- <sup>[OA]</sup>The Role of Plasma Membrane Intrinsic Protein Aquaporins in Water Transport through Roots: Diurnal and Drought Stress Responses Reveal Different Strategies between Isohydric and Anisohydric Cultivars of Grapevine. *Rebecca K. Vandeleur, Gwenda Mayo, Megan C. Shelden, Matthew Gilliam, Brent N. Kaiser, and Stephen D. Tyerman* 445

- <sup>[W]</sup>Differential Response of Gray Poplar Leaves and Roots Underpins Stress Adaptation during Hypoxia. *Jürgen Kreuzwieser, Jost Hauberg, Katharine A. Howell, Adam Carroll, Heinz Rennenberg, A. Harvey Millar, and James Whelan* 461

## PLANTS INTERACTING WITH OTHER ORGANISMS

- <sup>[W][OA]</sup>Rice Blast Fungus (*Magnaporthe oryzae*) Infects Arabidopsis via a Mechanism Distinct from That Required for the Infection of Rice. *Ju-Young Park, Jianming Jin, Yin-Won Lee, Seogchan Kang, and Yong-Hwan Lee* 474

- Sulfur Transfer through an Arbuscular Mycorrhiza. *James W. Allen and Yair Shachar-Hill* 549

- <sup>[W][OA]</sup>The Genetic Basis of Constitutive and Herbivore-Induced ESP-Independent Nitrile Formation in Arabidopsis. *Meike Burow, Anja Losansky, René Müller, Antje Plock, Daniel J. Kliebenstein, and Ute Wittstock* 561

## WHOLE PLANT AND ECOPHYSIOLOGY

- <sup>[OA]</sup>Hydraulic Failure Defines the Recovery and Point of Death in Water-Stressed Conifers. *Tim J. Brodribb and Hervé Cochard* 575

## SYSTEMS BIOLOGY, MOLECULAR BIOLOGY, AND GENE REGULATION

- <sup>[W]</sup>Flux Balance Analysis of Barley Seeds: A Computational Approach to Study Systemic Properties of Central Metabolism. *Eva Grafahrend-Belau, Falk Schreiber, Dirk Koschützki, and Björn H. Junker* 585

<sup>[C]</sup> Some figures in this article are displayed in color online but in black and white in the print edition.

<sup>[W]</sup> Indicates Web-only data.

<sup>[OA]</sup> Open Access articles can be viewed online without a subscription.