

On the Cover: Species of the Pooideae occupy the coolest climate space of all grass subfamilies. They have evolved complex physiological mechanisms to endure cold and seasonal environments. Here, *Deschampsia cespitosa* from the Poeae tribe outside Longyearbyen in the Arctic archipelago Svalbard at 78°13'24" N, 15°38'49" E. Image by Ane Charlotte Hjertaas.

ON THE INSIDE

Peter V. Minorsky 1244

LETTER TO THE EDITOR

Malondialdehyde: Facts and Artifacts. *Melanie Morales and Sergi Munné-Bosch* 1246

NEWS AND VIEWS

MVApp Flies Its Flag to the Challenging Frontier of Multivariate Data Analysis. *Maria Papanatsiou* 1251

Viruses on the Move in the Extracellular Space. *Lynn G.L. Richardson* 1253

What Is Lignin Made of? New Components Discovered! *Maria Grazia Annunziata* 1255

Illuminating Photosynthesis in the Mesophyll of Diverse Leaves. *Meisha Holloway-Phillips* 1256

How Plants and Synthetic Biology Could Help Us Fight Diabetes. *Raimund Nagel* 1259

BREAKTHROUGH TECHNOLOGIES

^[OPEN]MVApp—Multivariate Analysis Application for Streamlined Data Analysis and Curation. *Magdalena M. Julkowska, Stephanie Saade, Gaurav Agarwal, Ge Gao, Yveline Pailles, Mitchell Morton, Mariam Awlia, and Mark Tester*

MVApp offers a free and collaborative platform for streamlined curation and analysis of plant phenotyping datasets. 1261

RESEARCH ARTICLES

BIOCHEMISTRY AND METABOLISM

^[OPEN]Flavonol Biosynthesis Genes and Their Use in Engineering the Plant Antidiabetic Metabolite Montbretin A. *Sandra Irmisch, Henriette Ruebsam, Sharon Jancsik, Macaire Man Saint Yuen, Lufiani L. Madilao, and Joerg Bohlmann*

Genes from the common garden plant montbretia enable a synthetic biology approach to the metabolic engineering of a plant anti-diabetic metabolite in Nicotiana benthamiana. 1277

Cold-Adapted Protein Kinases and Thylakoid Remodeling Impact Energy Distribution in an Antarctic Psychrophile. *Beth Szyszka-Mroz, Marina Cvetkovska, Alexander G. Ivanov, David R. Smith, Marc Possmayer, Denis P. Maxwell, and Norman P.A. Hüner*

Thylakoid remodeling in an Antarctic psychrophile results in unique state transitions associated with cold-adapted protein kinases and enhanced photosystem I cyclic electron flow and energy quenching. 1291

^[OPEN]Hydroxystilbene Glucosides Are Incorporated into Norway Spruce Bark Lignin. *Jorge Rencoret, Duarte Neiva, Gisela Marques, Ana Gutiérrez, Hoon Kim, Jorge Gominho, Helena Pereira, John Ralph, and José C. del Río*

Hydroxystilbene glucosides, particularly isorhapontin and astringin, are incorporated into Norway spruce bark lignin and participate in radical coupling reactions during lignification. 1310

Continued on next page

[OPEN]Photosynthesis in Arabidopsis Is Unaffected by the Function of the Vacuolar K⁺ Channel TPK3. Ricarda Höhner, Viviana Correa Galvis, Deserah D. Strand, Carsten Völkner, Moritz Krämer, Michaela Messer, Firdevs Dinc, Inga Sjøts, Bettina Bölter, David M. Kramer, Ute Armbruster, and Hans-Henning Kunz

TPK3 is a tonoplast K⁺ channel that does not function in photosynthesis, unlike the bona fide thylakoid K⁺/H⁺ exchanger KEA3 and the thylakoid Cl⁻ channel VCCN1. 1322

[OPEN]GATA and Phytochrome Interacting Factor Transcription Factors Regulate Light-Induced Vindoline Biosynthesis in *Catharanthus roseus*. Yongliang Liu, Barunava Patra, Sitakanta Pattanaik, Ying Wang, and Ling Yuan

A regulatory module consisting of Phytochrome Interacting Factor (PIF) and GATA transcription factors regulates light-induced vindoline biosynthesis in *Catharanthus roseus* seedlings. 1336

[OPEN]Expression of a Lychee PHOSPHATIDYLCHOLINE:DIACYLGLYCEROL CHOLINEPHOSPHOTRANSFERASE with an *Escherichia coli* CYCLOPROPANE SYNTHASE Enhances Cyclopropane Fatty Acid Accumulation in Camelina Seeds. Xiao-Hong Yu, Yuanheng Cai, Jin Chai, Jorg Schwender, and John Shanklin

Lychee accumulates ~40% cyclopropane fatty acid in seed, and heterologous co-expression of its phosphatidylcholine diacylglycerol cholinephosphotransferase with *E. coli* cyclopropane synthase in camelina seed enhances cyclopropane fatty acid accumulation. 1351

[OPEN]VvLAR1 and VvLAR2 Are Bifunctional Enzymes for Proanthocyanidin Biosynthesis in Grapevine. Keji Yu, Ji Hyung Jun, Changqing Duan, and Richard A. Dixon

Leucoanthocyanidin reductases 1 and 2 possess distinct, dual activities for regulating the composition and degree of polymerization of proanthocyanidins in grapevine. 1362

CELL BIOLOGY

Turnip Mosaic Virus Components Are Released into the Extracellular Space by Vesicles in Infected Leaves. Nooshin Movahed, Daniel Garcia Cabanillas, Juan Wan, Hojatollah Vali, Jean-François Laliberté, and Huanquan Zheng

Upon infection, turnip mosaic virus releases its replication complexes into the extracellular space by exosomes of infected plants. 1375

[OPEN]TPX2-LIKE PROTEIN3 Is the Primary Activator of α -Aurora Kinases and Is Essential for Embryogenesis. Joanna Boruc, Xingguang Deng, Evelien Mylle, Nienke Besbrugge, Matthias Van Durme, Dmitri Demidov, Eva Dvořák Tomašíková, Tong-Reen Connie Tan, Michaël Vandorpe, Dominique Eeckhout, Tom Beeckman, Moritz K. Nowack, Geert De Jaeger, Honghui Lin, Bo Liu, and Daniël Van Damme

In contrast to vertebrates, the function of TPX2 in plants is not essential; this is likely caused by the expansion of the TPX2 family, which has led to redundant and unique functions among its members. 1389

ECOPHYSIOLOGY AND SUSTAINABILITY

[OPEN]The Spatial Distribution of Chlorophyll in Leaves. Aleca M. Borsuk and Craig R. Brodersen

Relative chlorophyll concentration as a function of leaf depth is a remarkably conserved trait across a wide diversity of plant taxa and can be described by a simple mathematical model. 1406

[OPEN]Antiviral ARGONAUTES Against Turnip Crinkle Virus Revealed by Image-Based Trait Analysis. Xingguo Zheng, Noah Fahlgren, Arash Abbasi, Jeffrey C. Berry, and James C. Carrington

Specific ARGONAUTE proteins function to protect Arabidopsis against Turnip Crinkle Virus infection in a modular mode. 1418

GENES, DEVELOPMENT AND EVOLUTION

[OPEN] The Protein Modifications of O-GlcNAcylation and Phosphorylation Mediate Vernalization Response for Flowering in Winter Wheat. *Shujuan Xu, Jun Xiao, Fang Yin, Xiaoyu Guo, Lijing Xing, Yunyuan Xu, and Kang Chong*

The dynamic modifications of O-GlcNAcylation and phosphorylation on the key proteins mediate vernalization for winter wheat flowering. 1436

[OPEN] HY5 Interacts with the Histone Deacetylase HDA15 to Repress Hypocotyl Cell Elongation in Photomorphogenesis. *Linmao Zhao, Tao Peng, Chia-Yang Chen, Rujun Ji, Dachuan Gu, Tingting Li, Dongdong Zhang, Yi-Tsung Tu, Keqiang Wu, and Xuncheng Liu*

HY5 interacts with HDA15 to form a key transcription regulatory node involved in repressing hypocotyl cell elongation-related genes and promoting photomorphogenesis in Arabidopsis seedlings. 1450

[OPEN] Developmental Pleiotropy Shaped the Roots of the Domesticated Common Bean (*Phaseolus vulgaris*). *Jugpreet Singh, Salvador A. Gezan, and C. Eduardo Vallejos*

Genetic analysis revealed the role of pleiotropic gene action in shaping the root system architecture during domestication of common bean (Phaseolus vulgaris L.). 1467

[OPEN] The Nodule-Specific PLAT Domain Protein NPD1 Is Required for Nitrogen-Fixing Symbiosis. *Catalina I. Pislariu, Senjuti Sinharoy, Ivone Torres-Jerez, Jin Nakashima, Elison B. Blancaflor, and Michael K. Udvardi*

A nodule-specific PLAT-domain protein in Medicago truncatula is critical for intracellular accommodation of rhizobia, and is a determinant of host-strain specificity. 1480

[OPEN] Regulation of Parent-of-Origin Allelic Expression in the Endosperm. *Karina S. Hornslien, Jason R. Miller, and Paul E. Grini*

An indepth analysis of parent-of-origin effects in Arabidopsis reveals that imprinting is a quantitative phenomenon and the majority of imprinted genes are not regulated by the DNA METHYLTRANSFERASE1. 1498

[OPEN] Transcriptional Corepressor ASP1 and CLV-Like Signaling Regulate Meristem Maintenance in Rice. *Chie Suzuki, Wakana Tanaka, and Hiro-Yuki Hirano*

The ABERRANT SPIKELET AND PANICLE1 gene encoding the TOPLESS-related transcriptional corepressor regulates meristem maintenance in concert with CLV-like signaling. 1520

[OPEN] A HORT1 Retrotransposon Insertion in the PeMYB11 Promoter Causes Harlequin/Black Flowers in Phalaenopsis Orchids. *Chia-Chi Hsu, Ching-Jen Su, Mei-Fen Jeng, Wen-Huei Chen, and Hong-Hwa Chen*

Harlequin/black flowers of Phalaenopsis result from the insertion of a retrotransposon in the PeMYB11 promoter. 1535

[OPEN] Gibberellins Act Downstream of Arabis PERPETUAL FLOWERING1 to Accelerate Floral Induction during Vernalization. *Vicky Tilmes, Julieta L. Mateos, Eva Madrid, Coral Vincent, Edouard Severing, Esther Carrera, Isabel López-Díaz, and George Coupland*

During the obligate vernalization response of Arabis alpina, gibberellin promotes flowering in cold and this is modulated by the PEP1 transcription factor. 1549

MEMBRANES, TRANSPORT AND BIOENERGETICS

Calcium-Promoted Interaction between the C2-Domain Protein EHB1 and Metal Transporter IRT1 Inhibits Arabidopsis Iron Acquisition. *Imran Khan, Regina Gratz, Polina Denezhkin, Stephan N. Schott-Verdugo, Kalina Angrand, Lara Genders, Rubek Merina Basgaran, Claudia Fink-Straube, Tzvetina Brumbarova, Holger Gohlke, Petra Bauer, and Rumén Ivanov*

EHB1, a C2 domain-containing peripheral membrane protein, inhibits Arabidopsis IRT1-mediated iron acquisition in a calcium-dependent manner. 1564

[OPEN]Thylakoid Protein Phosphorylation Dynamics in a Moss Mutant Lacking SERINE/THREONINE PROTEIN KINASE STN8. *Caterina Gerotto, Andrea Trotta, Azfar Ali Bajwa, Ilaria Mancini, Tomas Morosinotto, and Eva-Mari Aro*

Thylakoid protein targets of dynamic reversible phosphorylation have changed during evolution of land plants. 1582

SIGNALING AND RESPONSE

[OPEN]Medicago TERPENE SYNTHASE 10 Is Involved in Defense Against an Oomycete Root Pathogen. *Heena Yadav, Dorothée Dreher, Benedikt Athmer, Andrea Porzel, Aleksandr Gavrín, Susanne Baldermann, Alain Tissier, and Bettina Hause*

Inoculating Medicago truncatula roots with Aphanomyces euteiches spores leads to rapid upregulation of MtTPS10 and release of sesquiterpenes that may have a defense function against this oomycete. 1598

[OPEN]Zinc Excess Induces a Hypoxia-Like Response by Inhibiting Cysteine Oxidases in Poplar Roots. *Laura Dalle Carbonare, Mark D. White, Vinay Shukla, Alessandra Francini, Pierdomenico Perata, Emily Flashman, Luca Sebastiani, and Francesco Licausi*

Zinc hyperaccumulation in poplar roots simulates oxygen deficiency by inhibiting repressors of the anaerobic response. 1614

[OPEN]Transcriptome Analysis and Identification of a Transcriptional Regulatory Network in the Response to H₂O₂. *Ayaka Hieno, Hushna Ara Naznin, Keiko Inaba-Hasegawa, Tomoko Yokogawa, Natsuki Hayami, Mika Nomoto, Yasuomi Tada, Takashi Yokogawa, Mieko Higuchi-Takeuchi, Kosuke Hanada, Minami Matsui, Yoko Ikeda, Yuko Hojo, Takashi Hirayama, Kazutaka Kusunoki, Hiroyuki Koyama, Nobutaka Mitsuda, and Yoshiharu Y. Yamamoto*

The combined data from in vivo regulation and in vitro binding analyses of transcription factor proteins and promoters identified a partial transcriptional regulatory network for the H₂O₂ response. 1629

Cell Death Triggered by the YUCCA-like Bs3 Protein Coincides with Accumulation of Salicylic Acid and Pipecolic Acid But Not of Indole-3-Acetic Acid. *Christina Krönauer, Joachim Kilian, Tina Strauß, Mark Stahl, and Thomas Lahaye*

Despite its similarity to auxin-producing YUCCA proteins, Bs3 expression triggers an increase in salicylic acid and pipecolic acid, which are involved in systemic acquired resistance, but not in auxin. 1647

[OPEN]Leaf-Derived Jasmonate Mediates Water Uptake from Hydrated Cotton Roots under Partial Root-Zone Irrigation. *Zhen Luo, Xiangqiang Kong, Yanjun Zhang, Weijiang Li, Dongmei Zhang, Jianlong Dai, Shuang Fang, Jinfang Chu, and Hezhong Dong*

Leaf-derived jasmonate transported to hydrated cotton roots increased water uptake by acting as a long-distance signal for the up-regulation of GhPIP genes under partial root-zone irrigation. 1660

[OPEN]NF-YB2 and NF-YB3 Have Functionally Diverged and Differentially Induce Drought and Heat Stress-Specific Genes. *Hikaru Sato, Takamasa Suzuki, Fuminori Takahashi, Kazuo Shinozaki, and Kazuko Yamaguchi-Shinozaki*

The NUCLEAR FACTOR Y, SUBUNIT B2 (NF-YB2) and NF-YB3 transcription factors have high sequence similarity but differentially regulate target genes in a drought and heat stress-specific manner. 1677

Continued on next page

OXI1 and DAD Regulate Light-Induced Cell Death Antagonistically through Jasmonate and Salicylate Levels. *Inès Beaugelin, Anne Chevalier, Stefano D'Alessandro, Brigitte Ksas, Ondřej Novák, Miroslav Strnad, Céline Forzani, Heribert Hirt, Michel Havaux, and Fabien Monnet*

The antagonistic action between OXIDATIVE STRESS INDUCIBLE 1 kinase and DEFENDER AGAINST CELL DEATH regulates high light-induced cell death via modulation of jasmonate and salicylate levels.

1691

SYSTEMS AND SYNTHETIC BIOLOGY

[OPEN] Modeling Protein Destiny in Developing Fruit. *Isma Belouah, Christine Nazaret, Pierre Pétriacq, Sylvain Prigent, Camille Bénard, Virginie Mengin, Mélisande Blein-Nicolas, Alisandra K. Denton, Thierry Balliau, Ségolène Augé, Olivier Bouchez, Jean-Pierre Mazat, Mark Stitt, Björn Usadel, Michel Zivy, Bertrand Beauvoit, Yves Gibon, and Sophie Colombié*

Proteomics and transcriptomics data for tomato fruit at nine developmental stages inform a mathematical model of the translation and degradation rate constants for over 1,000 proteins.

1709

Salicylic Acid Affects Root Meristem Patterning via Auxin Distribution in a Concentration-Dependent Manner. *Taras Pasternak, Edwin P. Groot, Fedor V. Kazantsev, William Teale, Nadya Omelyanchuk, Vasilina Kovrizhnykh, Klaus Palme, and Victoria V. Mironova*

SA at low or high concentrations in Arabidopsis thaliana roots acts as a regulator of root development or a stress hormone, respectively.

1725

[OPEN] Identification of Transcription Factors Regulating Senescence in Wheat through Gene Regulatory Network Modelling. *Philippa Borrill, Sophie A. Harrington, James Simmonds, and Cristobal Uauy*

Integrating gene regulatory network modelling during a gene expression time course with publicly available genomic datasets identifies transcription factors regulating senescence.

1740

[OPEN] Endosidin2-14 Targets the Exocyst Complex in Plants and Fungal Pathogens to Inhibit Exocytosis. *Lei Huang, Xiaohui Li, Yang Li, Xianglin Yin, Yong Li, Bin Wu, Huaping Mo, Chao-Jan Liao, Tesfaye Mengiste, Wei Guo, Mingji Dai, and Chunhua Zhang*

Endosidin2-14 shows potential as a small molecule chemical inhibitor as it targets EXO70, a subunit of the exocyst complex, resulting in inhibition of exocytosis in plants and fungal pathogens.

1756

CORRECTION

Coimmunopurification of Phosphorylated Bacterial- and Plant-Type Phosphoenolpyruvate Carboxylases with the Plastidial Pyruvate Dehydrogenase Complex from Developing Castor Oil Seeds. *Uhrig R.G., O'Leary B., Spang H.E., MacDonald J.A., She Y.-M., and Plaxton W.C.*

1771

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