ON THE COVER:
Climate-change-driven stresses, such as salinity, drought, and heat, jeopardize global food security. The extensive research on plant responses to single abiotic stresses has underlain major physiological and molecular mechanisms. However, under field conditions, these stresses usually occur simultaneously and the ability to predict plant responses to a combination of stresses based on single stresses is very limited. In this issue, Shaar-Moshe et al. (pp. 421–434) investigated the transcriptional patterns and morphophysiological acclimations of the cereal model plant, *Brachypodium distachyon*, to single salinity, drought, and heat stresses, as well as their double and triple stress combinations. Comprehensive morphophysiological analyses demonstrated a gradual decrease in plant performances as more stresses were combined, as well as dominance of a specific stress treatment that shaped plant acclimations. The cover image shows the severe reduction in plant growth under combined stresses. A comparison between common stress- and combination unique genes revealed specific transcriptional signatures and functional processes, within each gene subset. Photo was taken by Lidor Shaar-Moshe.

ON THE INSIDE

Peter V. Minorsky

COMMENTARY

How to Grow a Cell: Fine-Tuning Secretory Activity to Balance Growth and Cell Wall Integrity.
Andreas Nebenführ

An unusual exocyst subunit appears to function as a novel rheostat controlling cell growth rates.

TOPICAL REVIEW

[OPEN] Plant Chemical Genetics: From Phenotype-Based Screens to Synthetic Biology. Wim Dejonghe and Eugenia Russinova

An overview of progress in chemical genetics in plants, with a focus on the discoveries of small molecules in screens designed for the discovery of biological processes.

SCIENTIFIC CORRESPONDENCE

[OPEN] Seedlings Lacking the PTM Protein Do Not Show a genomes uncoupled (gun) Mutant Phenotype.
Mike T. Page, Sylwia M. Kacprzak, Nobuyoshi Mochizuki, Haruko Okamoto, Alison G. Smith, and Matthew J. Terry

The ptm mutant of Arabidopsis does not show a genomes uncoupled mutant phenotype and PTM is therefore unlikely to function in chloroplast-to-nucleus signaling as previously reported.

RESEARCH REPORT

[OPEN] Phylogeny-Based Systematization of Arabidopsis Proteins with Histone H1 Globular Domain.
Maciej Kotliński, Łukasz Knizewski, Anna Muszewska, Kinga Rutowicz, Maciej Lirski, Anja Schmidt, Célia Baroux, Krzysztof Ginalski, and Andrzej Jerzmanowski

We propose a unified nomenclature of an important group of plant chromatin proteins, based on evolutionary relationships of their common nucleosome recognition element, a linker histone-type globular domain (GH1).

Continued on next page
RESEARCH ARTICLES

BIOCHEMISTRY AND METABOLISM

Temperature-Induced Remodeling of the Photosynthetic Machinery Tunes Photosynthesis in the Thermophilic Alga *Cyanidioschyzon merolae*. Denitsa Nikolova, Dieter Weber, Martin Scholz, Till Bald, Jörn Peter Scharsack, and Michael Hippler

*C. merolae* acclimates to suboptimal growth temperature by tuning its photosynthetic capacity and by adjusting its machinery for protein folding, degradation, and homeostasis.

Identification of a Second Site of Pyrrolizidine Alkaloid Biosynthesis in Comfrey to Boost Plant Defense in Floral Stage. Lars H. Kruse, Thomas Stegemann, Christian Sievert, and Dietrich Ober

In comfrey, leaves subtending a young inflorescence have been identified as an additional site of alkaloid biosynthesis to boost the protection of reproductive tissues.

Localization and in-Vivo Characterization of *Thapsia garganica* CYP76AE2 Indicates a Role in Thapsigargin Biosynthesis. Trine Bundgaard Andersen, Karen Agatha Martinez-Swatson, Silas Anselm Rasmussen, Berin Alain Boughton, Kirsten Jørgensen, Johan Andersen-Ranberg, Nils Nyberg, Soren Brøgger Christensen, and Henrik Toft Simonsen

The secretory ducts in the root of *Thapsia garganica* harbor the cytotoxin thapsigargin, and the cells lining these ducts express the first enzymes in the biosynthesis of thapsigargin.

Starch Synthase 4 and Plastidal Phosphorylase Differentially Affect Starch Granule Number and Morphology. Irina Malinova, Saleh Alseekh, Regina Feil, Alisdair R. Fernie, Otto Baumann, Mark Aurel Schöttler, John E. Lunn, and Joerg Fettke

PHS1 and SS4 are differently involved in regulating starch granule generation and the formation of spherical starch granules, although SS4 exerts stronger influence.


The coordination of 9-cis-neoxanthin and violaxanthin in trimeric LHCII directly affect the operation of the xanthophyll cycle and the dynamics of transiently generated NPQ.

A Specialized Diacylglycerol Aciyltransferase Contributes to the Extreme Medium-Chain Fatty Acid Content of *Cuphea* Seed Oil. Umidjon Iskandarov, Jillian E. Silva, Hae Jin Kim, Mariette Andersson, Rebecca E. Cahoon, Keithanne Mockaitis, and Edgar B. Cahoon

A *Cuphea* diacylglycerol acyltransferase CpuDGAT1 functions in concert with a specialized lysophosphatidic acyltransferase for production of medium-chain fatty acid-rich oils.

Phospholipase D\(\alpha\) Enhances Diacylglycerol Flux into Triacylglycerol. Wenwu Yang, Geilang Wang, Jia Li, Philip D. Bates, Xuemin Wang, and Doug K. Allen

Phospholipase D increases the production of triacylglycerol in Camelina sativa seeds.
Biochemical Principles and Functional Aspects of Pipecolic Acid Biosynthesis in Plant Immunity. Michael Hartmann, Denis Kim, Friederike Berndzorroff, Ziba Ajami-Rashidi, Nicola Scholten, Stefan Schreiber, Tatjana Zeier, Stefan Schuck, Vanessa Reichel-Deland, and Jürgen Zeier

The immune regulator pipecolic acid is synthesized by ALD1-mediated conversion of ω-Lys to 2,3-dehydropipecolic acid and consecutive reduction, to which Arabidopsis SARD4/ORNCD1 largely contributes.

Poplar MYB115 and MYB134 Transcription Factors Regulate Proanthocyanidin Synthesis and Structure. Amy Midori James, Dawei Ma, Robin Melloway, Andreas Gesell, Kazuko Yoshida, Vincent Walker, Lan Tran, Don Stewart, Michael Reichelt, Jussi Suavanto, Juha-Pekka Salminen, Jonathan Gershenzon, Armand Séguin, and C. Peter Constabel

Two MYB transcription factors form the core of a gene regulatory network that controls the accumulation and hydroxylation pattern of proanthocyanidins in poplar.

Acclimation to High CO₂ Requires the ω Subunit of the RNA Polymerase in Synechocystis. Juha Kurkela, Kaisa Hakki, Taras Antal, and Taina Tyystjärvi

An RNA polymerase subunit mutant of Synechocystis PCC6803 grows slowly in high CO₂ because photosynthetic reactions do not acclimate to abundant inorganic carbon.


A plant cryptochrome has multiple roles within the circadian clock and the sexual cycle of a unicellular photosynthetic organism.

CELL BIOLOGY

The Microtubule-Associated Protein MAP18 Affects ROP2 GTPase Activity during Root Hair Growth. Erfang Kang, Mingzhi Zheng, Yan Zhang, Ming Yuan, Shaul Yalovsky, Lei Zhu, and Ying Fu

MAP18 physically interacts with ROP2 and competes with AtRhoGDI1/SCN1 for binding to ROP2 during root hair growth in Arabidopsis.

EXO70C2 Is a Key Regulatory Factor for Optimal Tip Growth of Pollen. Lukáš Šynek, Nemanja Vukašinović, Ivan Kulich, Michal Hála, Klára Aldorfovič, Matyáš Fendrych, and Viktor Žárský

EXO70C2, from the family of exocyst subunits, is a novel factor regulating pollen tube tip growth in Arabidopsis, and its paralog EXO70C1 has a partially redundant function.

ECOPHYSIOLOGY AND SUSTAINABILITY

Variable Mesophyll Conductance among Soybean Cultivars Sets a Tradeoff between Photosynthesis and Water-Use-Efficiency. Nicholas J. Tomeo and David M. Rosenthal

Genetic variance for mesophyll conductance among cultivars in both chambers and the field indicate photosynthesis, but not water use efficiency, would be improved by enhancing mesophyll conductance.
GENES, DEVELOPMENT, AND EVOLUTION

Gametophyte Development Needs Mitochondrial Coproporphyrinogen III Oxidase Function.
Pritu Pratibha, Sunil Kumar Singh, Ramamurthy Srinivasan, Shripad Ramachandra Bhat, and Yelam Sreenivasaulu

Mutation in the mitochondrial HEMN1 gene of Arabidopsis impairs tetrapyrrole biosynthesis in flower buds, which generates ROS and prevents polar cell fusion in the embryo sac and also affects pollen development.

[OPEN]Awake1, an ABC-Type Transporter, Reveals an Essential Role for Suberin in the Control of Seed Dormancy.
Fabio Fedi, Carmel M. O'Neill, Guillaume Menard, Martin Trick, Simone Dechirico, Françoise Corbineau, Christophe Bailly, Peter J. Eastmond, and Steven Penfield

A mutant screen reveals a role for seed coat suberin in temperature-responsive seed dormancy through the exclusion of molecular oxygen from the seed.

Jinpeng Wang, Pengchuan Sun, Yuxian Li, Yinzhe Liu, Jigao Yu, Xuelian Ma, Sangrong Sun, Nanshan Yang, Ruiyan Xia, Tianyu Lei, Xiaojian Liu, Beiwei jiao, Yue Xing, Weina Ge, Li Wang, Zhenyi Wang, Xiaoming Song, Min Yuan, Di Guo, Lan Zhang, Jiaqi Zhang, Dianchuan Jin, Wei Chen, Yuxin Pan, Tao Liu, Ling Jin, Jinshuai Sun, Jiuxiang Yu, Rui Cheng, Xueqian Duan, Shaoqi Shen, Jun Qin, Meng-chen Zhang, Andrew H. Paterson, and Xiuyin Wang

A hierarchical and event-related alignment laid a solid foundation for further genomics exploration in the legume research community and beyond.

Dimerization in LBD16 and LBD18 Transcription Factors Is Critical for Lateral Root Formation.
Han Woo Lee, Na Young Kang, Shashank K. Pandey, Chuloh Cho, Sung Haeng Lee, and Jungmook Kim

The leucine-zipper-like coiled-coil motif is crucial for the homodimerization of LBD16 and LBD18 and for the transcriptional regulation and biological function in Arabidopsis.

[OPEN]KNOX Protein OSH15 Induces Grain Shattering by Repressing Lignin Biosynthesis Genes.
Jinmi Yoon, Lae-Hyeon Cho, Htet Wai Antt, Hee-Jong Koh, and Gynheung An

Major domestication factors for grain shattering in rice, qSH1 and SH5, interact with binding partner OSH15 KNOX protein to control abscission zone development and repress lignin biosynthesis.

[CC-BY]MtLAX2, a Functional Homologue of the Arabidopsis Auxin Influx Transporter AUX1, Is Required for Nodule Organogenesis.
Sonali Roy, Fran Robson, Jodi Lilley, Cheng-Wu Liu, Xiaofei Cheng, Jianguo Wen, Simon Walker, Jangho Sun, Donna Cousins, Caitlin Bone, Malcolm J. Bennett, J. Allan Downie, Ranjan Swarup, Giles Oldroyd, and Jeremy D. Murray

Genetic and molecular biological tools were used to show that MtLAX2 is required for not only lateral root formation but also nodulation, in Medicago truncatula.
SIGNALING AND RESPONSE

Abscisic Acid Induces Resistance against Bamboo Mosaic Virus through Argonaute 2 and 3.
Mazen Alazem, Meng-Hsun He, Peter Moffett, and Na-Sheng Lin

Abscisic acid affects the expression of several genes in the RNA silencing pathway, contributing to plant resistance to viruses and regulating multiple defense mechanisms in Arabidopsis.

RXLR Effector AVR2 Up-Regulates a Brassinosteroid-Responsive bHLH Transcription Factor to Suppress Immunity.
Dionne Turnbull, Lina Yang, Shaista Naqvi, Susan Breen, Lydia Welsh, Jennifer Stephens, Jenny Morris, Petra C. Boevink, Pete E. Hedley, Jiassui Zhan, Paul R. J. Birch, and Eleanor M. Gilroy

PiAVR2 exploits cross talk between BR signaling and innate immunity in Solanum species, via NbCHL1, representing a novel, indirect mode of innate immune suppression by a filamentous pathogen effector.

O-Acyl Sugars Protect a Wild Tobacco from Both Native Fungal Pathogens and a Specialist Herbivore.
Van Thi Luu, Alexander Weinhold, Chhana Ullah, Stefanie Dressel, Matthias Schoettner, Klaus Gase, Emmanuel Gaquerel, Shuqing Xu, and Ian T. Baldwin

O-Acyl sugars, trichome-specific metabolites, function as direct defenses against native pathogens and herbivores of a wild tobacco.

Light Controls Cytokinin Signaling via Transcriptional Regulation of Constitutively Active Sensor Histidine Kinase CKII.
Tereza Dobisova, Vendula Hrdinova, Candela Cuesta, Sarka Michlickova, Ivana Urbankova, Romana Hejatkova, Petra Zadnikova, Marketa Pernisova, Eva Benkova, and Jan Hejatko

Light controls cytokinin signaling via transcriptional regulation of constitutively active sensor histidine kinase CKII.

Cyst Nematode Parasitism Induces Dynamic Changes in the Root Epigenome.
Tarek Hewezi, Thomas Lane, Sarbottam Piya, Aditi Rambani, J Hollis Rice, and Meg Staton

Plant-parasitic cyst nematodes induce extensive changes in DNA methylation patterns that impact the expression of Arabidopsis genes required for nematode parasitism.

SYSTEMS AND SYNTHETIC BIOLOGY

Unique Physiological and Transcriptional Shifts under Combinations of Salinity, Drought, and Heat.
Lidor Shaar-Moshe, Eduardo Blumwald, and Zvi Peleg

Naturally co-occurring abiotic stresses that mimic field conditions revealed different transcriptional signatures and functional pathways among common stress- and stress combination unique-genes.

pTAC10, a Key Subunit of Plastid-Encoded RNA Polymerase, Promotes Chloroplast Development.
Sun Hyun Chang, Sangyool Lee, Tae Young Um, Ju-Kon Kim, Yang Do Choi, and Geupil Jang

pTAC10, a key component of the plastid-encoded RNA polymerase complex, interacts with other components through its C-terminal region downstream of the S1 RNA-binding domain.
Predictive Models of Spatial Transcriptional Response to High Salinity.  
Sahra Uygun, Alexander E. Seddon, Christina B. Azodi, and Shin-Han Shiu

Organ transcriptional response to high salinity is regulated by a core set of pCREs.

CORRECTION

Subfamily-Specific Fluorescent Probes for Cysteine Proteases Display Dynamic Protease Activities during Seed Germination.  

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