On the Cover: Alocasia macrorhiza is known as the giant taro and is a member of the Arum family. The plant was originally domesticated in Southeast Asia and spread eastward to the Pacific islands where it became a staple crop. They are one of the four main species cultivated by Austronesians primarily as a source of starch. The leaves and stems are edible if cooked thoroughly to remove the raphides which are toxic. Image by Mike Blatt.

ON THE INSIDE

Peter V. Minorsky

EDITORIAL

Plant Physiology Is Recruiting Assistant Features Editors. Mike Blatt and Mary Williams

NEWS AND VIEWS

Heat Shock Proteins Support Refolding and Shredding of Misfolded Proteins. Masanori Izumi

UMP Pyrophosphorylase: A Moonlighting Protein with Essential Functions in Chloroplast Development and Photosynthesis Establishment. Stephanie Arrivault

A Rice Transcription Factor Controls Grain Length through Cell Number. Naomi Cox and Lisa M. Smith

Keep Sugar Away to Stay Active: Glycosylation of Methyl Salicylate Shuts Down Systemic Signaling. Amna Mhamdi

Burying Your Head in the Sand: Heading Belowground to Find Future Targets of Selection in Roots. Robert Paul Skelton

LETTERS

[OPEN] Transgenic Reduction of Cytokinin Levels in Roots Inhibits Root-Sprouting in Populus. Wei Li, Longmei Zhai, Steven H. Strauss, Huseyin Yer, Emily Merewitz, Junmei Chen, Xiaomin Wang, Weiping Zhuang, Chu Fang, Yingnan Chen, Richard McAvoy, Zhenhai Han, and Yi Li

An analysis of a root-sucker–repressing technology for poplar plants that reduces root cytokinin contents.

UPDATE

[OPEN] Dark, Light, and Temperature: Key Players in Plant Morphogenesis. Huanhuan Jin and Ziqiang Zhu

Recent advances in plant thermomorphogenesis under different light conditions reveal the roles of plant photoreceptors in the control of thermomorphogenesis

RESEARCH ARTICLES

BREAKTHROUGH TECHNOLOGIES

Generic Repeat Finder: A High-Sensitivity Tool for Genome-Wide De Novo Repeat Detection. Jieming Shi and Chun Liang

Generic Repeat Finder, a tool for genome-wide de novo repeat detection, outperforms previous repeat detectors in sensitivity.

BIOCHEMISTRY AND METABOLISM

Pyrimidine Salvage: Physiological Functions and Interaction with Chloroplast Biogenesis. Lisa Ohler, Sandra Niopek-Witz, Samuel E. Mainguet, and Torsten Möhlmann

Pyrimidine salvage is mainly driven by uridine/uridine kinase in the cytosol, and plastidic uracil phosphoribosyltransferase is needed to establish photosynthesis via its moonlighting activity
## HSP101 Interacts with the Proteasome and Promotes the Clearance of Ubiquitylated Protein Aggregates.

Fionn McLoughlin, Minsoo Kim, Richard S. Marshall, Richard D. Vierstra, and Elizabeth Vierling

HSP101 is dynamically recruited to various distinct cytosolic foci after heat stress, including stress granules, and facilitates protein disaggregation and possibly proteasomal degradation of aggregated proteins.

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## Triazine Probes Target Ascorbate Peroxidases in Plants.


3,5-triazines label and inhibit ascorbate peroxidases (APXs) in plants, revealing that triazine herbicides and their degradation products block APXs and reduce photosynthesis.

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Ying Li, Yu Liu, and Bethany K. Zolman

Changes in enoyl-CoA hydratase2 activity result in metabolic alterations that influence seedling development through a toxic effect.

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## Gene Networks Underlying Cannabinoid and Terpenoid Accumulation in Cannabis.

Jordan J. Zager, Iris Lange, Narayanan Srividya, Anthony Smith, and B. Markus Lange

Metabolite and transcriptome profiling of cannabis glandular trichomes differentiates strains and provides evidence for the coregulation of cannabinoid and terpenoid volatile biosynthesis.

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## Role of Polysaccharides in Diatom Thalassiosira pseudonana and its Associated Bacteria in Hydrocarbon Presence.

Manoj Kamalanathan, Meng-Hsuen Chiu, Hernando Bacosa, Kathy Schwehr, Shih-Ming Tsai, Shawn Doyle, Alexandra Yard, Savannah Mapes, Carlos Vasequez, Laura Bretherton, Jason B. Sylvan, Peter Santschi, Wei-Chun Chin, and Antonietta Quigg

Polysaccharide synthesis in diatoms influences the surrounding bacterial community in the presence and absence of hydrocarbons.

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## A Genome-Scale Metabolic Model of Soybean (Glycine max) Highlights Metabolic Fluxes in Seedlings.

Thiago Batista Moreira, Rahul Shaw, Xinru Luo, Oishik Ganguly, Hyung-Seok Kim, Lucas Gabriel Ferreira Coelho, Chun Yue Maurice Cheung, and Thomas Christopher Rhys Williams

A genome-scale metabolic model of soybean identifies shifts in flux distribution during seedling growth.

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## Carbohydrate Metabolism and Signaling in Squash Nectaries and Nectar Throughout Floral Maturation.

Erik M. Solhaug, Elizabeth Johnson, and Clay J. Carter

Squash nectaries break down starch to synthesize nectar sugars, with some contribution coming directly from the phloem, whereas trehalose metabolism appears to be important for nectar secretion.

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## Leaf Energy Balance Requires Mitochondrial Respiration and Export of Chloroplast NADPH in the Light.

Sanu Shameer, R. George Ratcliffe, and Lee J. Sweetlove

Metabolic modeling reveals why mitochondrial respiration and chloroplast NAD(P)H export are required in illuminated leaves.

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## The Plastid Lipase PLIP1 Is Critical for Seed Viability in diacylglycerol acyltransferase1 Mutant Seed.

Karanbir Aulakh and Timothy P. Durrett

Global transcript profiling of developing Arabidopsis dgat1 seed reveals a critical role for the plastid lipase PLIP1 in providing polyunsaturated substrates for triacylglycerol synthesis.

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## Sclerotinia sclerotiorum Circumvents Flavonoid Defenses by Catabolizing Flavonol Glycosides and Aglycones.

Jingyuan Chen, Chhana Ullah, Michael Reichelt, Jonathan Gershenson, and Almuth Hammerbacher

Catabolism of flavonols contributes to S. sclerotiorum virulence during infection of Arabidopsis.
A Neighboring Aromatic-Aromatic Amino Acid Combination Governs Activity Divergence between Tomato Phytoene Synthases. Hongbo Cao, Hongmei Luo, Hui Yuan, Mohamed A. Eissa, Theodore W. Thannhauser, Ralf Welsch, Yu-Jin Hao, Lailiang Cheng, and Li Li

A lack of neighboring aromatic-aromatic amino acid combination in one of the PSY core structures is responsible for the weak carotenogenic activity of tomato fruit-specific PSY1.

CELL BIOLOGY

CRK2 Enhances Salt Tolerance by Regulating Callose Deposition in Connection with PLDα1. Kerri Hunter, Sachie Kimura, Anne Rokka, Huy Cuong Tran, Masatsugu Toyota, Jyrki P. Kukkonen, and Michael Wrzaczek

The receptor-like kinase CRK2 adopts PLDα1-dependent stress-induced subcellular localization patterns, regulating callose deposition at plasmodesmata and enhancing salt tolerance in Arabidopsis.

AtERO1 and AtERO2 Exhibit Differences in Catalyzing Oxidative Protein Folding in the Endoplasmic Reticulum. Fenggui Fan, Yini Zhang, Guozhong Huang, Qiao Zhang, Chih-chen Wang, Lei Wang, and Dongping Lu

Both AtERO1 and AtERO2 play essential roles in oxidative protein folding in the endoplasmic reticulum, but AtERO1 may serve as the primary sulfhydryl oxidase relative to AtERO2.

Extensive Posttranscriptional Regulation of Nuclear Gene Expression by Plastid Retrograde Signals. Guo-Zhang Wu, Etienne H. Meyer, Si Wu, and Ralph Bock

Translational and posttranslational regulation play a crucial role in the plastid gene expression pathway of retrograde signaling and supports a function of GUN1 in plastid proteostasis.

ECOPHYSIOLOGY AND SUSTAINABILITY

Cortical Cell Diameter Is Key To Energy Costs of Root Growth in Wheat. Tino Colombi, Anke Marianne Herrmann, Pernilla Vallenback, and Thomas Keller

Genotypic diversity and phenotypic plasticity in root cortical cell diameter play key roles in reducing energy costs of root growth under high soil penetration resistance.

Brassinosteroids Act as a Positive Regulator of Photoprotection in Response to Chilling Stress. Pingping Fang, Mengyu Yan, Cheng Chi, Mengqi Wang, Yanhong Zhou, Jie Zhou, Kai Shi, Xiaojian Xia, Christine H. Foyer, and Jingquan Yu

Brassinosteroids positively regulate photoprotection via the redox-PGR5-mediated pathway in response to chilling stress in tomato.

GENES, DEVELOPMENT AND EVOLUTION

The PLATZ Transcription Factor GL6 Affects Grain Length and Number in Rice. Ahong Wang, Qingqing Hou, Lizhen Si, Xuehui Huang, Jianghong Luo, Danfeng Lu, Jingjie Zhu, Yingying Shangguan, Jiashun Miao, Yifan Xie, Yongchun Wang, Qiang Zhao, Qi Feng, Congcong Zhou, Yan Li, Danlin Fan, Yiqi Lu, Qilin Tian, Zixuan Wang, and Bin Han

The plant-specific protein GL6 determines grain length and spikelet number in rice by affecting cell proliferation through gene expression regulation via the RNAPIII transcription machinery.

CRISPR-Based Assessment of Gene Specialization in the Gibberellin Metabolic Pathway in Rice. Xiao Chen, Xuejian Tian, Lan Xue, Xiaohui Zhang, Sihai Yang, M. Brian Traw, and Ju Huang

CRISPR-based assessment reveals nonredundant functions and diversified evolution of enzymes in the gibberellin metabolic pathway in rice.

Maize Dek44 Encodes Mitochondrial Ribosomal Protein L9 and Is Required for Seed Development. Weiwei Qi, Lei Lu, Shengchan Huang, and Rentao Song

A newly identified maize mitochondrial ribosomal protein that is highly conserved in monocots and only accumulates in kernels affects mitochondrial function and kernel development.

The PBAC4 chaperone encoded by Dek40 in maize influences 20S core protease biogenesis and is required for 26S proteasome function and seed development.

The Soybean Sugar Transporter GmSWEET15 Mediates Sucrose Export from Endosperm to Early Embryo. Shoudong Wang, Kengo Yokosho, Runze Guo, James Whelan, Yong-Ling Ruan, Jian Feng Ma, and Huixia Shou

The sugar transporter GmSWEET15 is essential for soybean embryo development and endosperm breakdown as it mediates sucrose transport from the endosperm to the embryo.

DSP1 and DSP4 Act Synergistically in Small Nuclear RNA 3' End Maturation and Pollen Growth. Xuepiao Pu, Chunmei Meng, Weili Wang, Siyu Yang, Yuan Chen, Qingjun Xie, Bin Yu, and Yunfeng Liu

DSP1 and DSP4 function synergistically in pollen development and promote pre-snRNA transcription and 3’-end processing efficiency and accuracy.

MEMBRANES, TRANSPORT AND BIOENERGETICS


Phosphorylation of light-harvesting complex II controls chloroplast thylakoid membrane organization in response to changing light intensity.

SIGNALING AND RESPONSE

Methyl Salicylate Glucosylation Regulates Plant Defense Signaling and Systemic Acquired Resistance. Lu Chen, Wen-Shuai Wang, Ting Wang, Xia-Fei Meng, Ting-tong Chen, Xu-Xu Huang, Yan-jie Li, and Bing-Kai Hou

Methyl salicylate glucosylation negatively modulates salicylate homeostasis and plant systemic defense responses.


Accumulation of photodamaged PSII core proteins enables retrograde signaling via the stress hormone salicylic acid and its signaling components, EDS1 and PAD4.

Abscisic Acid Coordinates Dose-Dependent Developmental and Hydraulic Responses of Roots to Water Deficit. Miguel A. Rosales, Christophe Maurel, and Philippe Nacry

Similar bell-shaped dose-dependent effects of water deficit (WD) and ABA on root development and hydraulics as well as analysis of ABA synthesis and response mutants suggest that ABA acts as a coordinator of root responses to WD.

WRKY18 and WRKY53 Coordinate with HISTONE ACETYLTRANSFERASE1 to Regulate Rapid Responses to Sugar. Qingshuai Chen, Xiyu Xu, Di Xu, Haisen Zhang, Cankui Zhang, and Gang Li

Multiple WRKY transcription factors activate the expression of sugar-responsive genes by physically interacting with HISTONE ACETYLTRANSFERASE1 and promoting acetylation of histone 3 lysine 27.

Phytophthora infestans RXLR Effectors Target Parallel Steps in an Immune Signal Transduction Pathway. Yajuan Ren, Miles Armstrong, Yetong Qi, Hazel McLellan, Cheng Zhong, Bowen Du, Paul R.J. Birch, and Zhendong Tian

Two P. infestans effectors, PexRD2 and Pi22926, target two parallel MAP3K proteins in the same signal transduction pathway to promote P. infestans colonization.

The Photoperiodic Flowering Time Regulator FKF1 Negatively Regulates Cellulose Biosynthesis. Ning Yuan, Vimal Kumar Balasubramanian, Ratan Chopra, and Venugopal Mendu

Light regulates cellulose biosynthesis through FKF1, a specific blue light receptor and photoperiodic flowering time regulator.
PuHSFA4a Enhances Tolerance To Excess Zinc by Regulating Reactive Oxygen Species Production and Root Development in *Populus*. Haizhen Zhang, Jingli Yang, Wenlong Li, Yingxi Chen, Han Lu, Shicheng Zhao, Dandan Li, Ming Wei, and Chenghao Li

PuHSFA4a, which activates the antioxidant program and root development-related genes, directly targets PuGSTU17 and PuPLA2, positively regulating excess Zn tolerance in *Populus ussuriensis* roots.


Analysis of RIN4/NOI fragments, which are released after cleavage by the bacterial effector protease AvrRpt2, reveals a role for the N-end rule in NOI domain protein degradation, but not RIN4.

MdUGT88F1-Mediated Phloridzin Biosynthesis Regulates Apple Development and *Valsa* Canker Resistance. Kun Zhou, Lingyu Hu, Yangtiansu Li, Xiaofeng Chen, Zhijun Zhang, Bingbing Liu, Pengmin Li, Xiaoqing Gong, and Fengwang Ma

MdUGT88F1-mediated phloridzin biosynthesis is critical for apple development and Valsa canker resistance by regulating the interplay between cell wall deposition and accumulation of SA and ROS.

CORRECTION

A New Barley Stripe Mosaic Virus Allows Large Protein Overexpression for Rapid Function Analysis. Cheuk A. and Houde M.

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