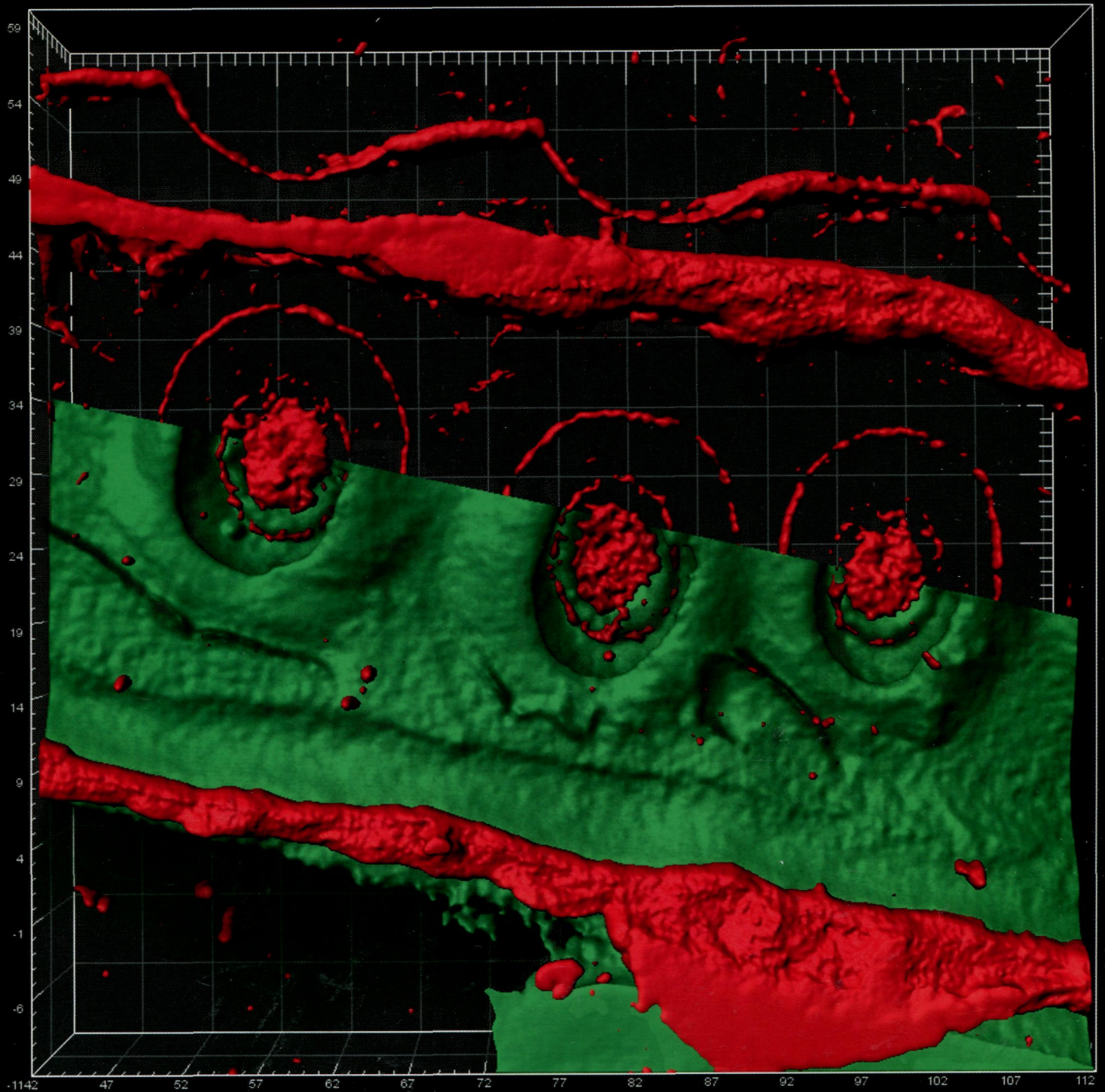


AMERICAN JOURNAL OF Botany

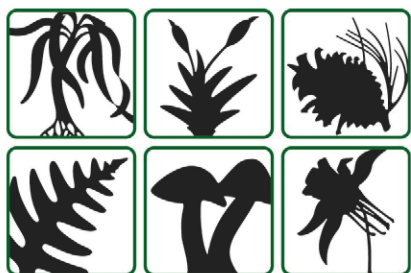
September 2013 • Volume 100 • Number 9



FEATURING A SPECIAL SECTION
RHIZOSPHERE INTERACTIONS: THE ROOT MICROBIOME

Cover Illustration: Three aspirated bordered pits in *Pinus strobus* as viewed using confocal microscopy imaging with selective labeling for pectin (red), with cellulose appearing green. The three bordered pits show a unique chemical component distribution pattern, with an outer “G-ring” of pectin at the margin of the margo and pectin coating the torus. The pectin surrounding the central torus region redistributes upon aspiration, leaving a fringe-like margin around the edge of the torus, described as the L-ring. The redistributed pectin in the torus region helps to seal the pit membrane against the pit aperture. A central void in the interior of the torus, described as the M-zone (not visible in this image) is filled with either a neutral fluid or amorphous (hemi)cellulose, which is hypothesized to maintain the turgor of the pit membrane in its neutral, unaspirated state. During aspiration, the M-zone collapses to allow the pit membrane to more readily conform and bond to the pit aperture and pit chamber region.

Bordered pits have fascinated researchers for more than 100 years because of their biological and industrial significance. Not only do they prevent embolism within the conducting portions of the living tree, the pits are the primary pathways for microorganism penetration in wood fallen to the forest floor, and the aspiration of pits therefore plays a significant role in controlling the rate of biodegradation including the rate of carbon cycling as carbon is redistributed and returned to the atmosphere from coniferous trees. The drying of wood is also the most costly step in the processing of wood products, and the size and structure of pit membranes has been shown to significantly affect that cost. The study of bordered pits in this issue by Maschek et al., “A new approach for the study of the chemical composition of bordered pit membranes: 4Pi and confocal laser scanning microscopy” (pp 1751–1756) identifies features of bordered pits in *Pinus strobus* that have not previously been described and help explain how the pit maintains its integrity in the unaspirated state. Further, the research helps to explain how stresses are relieved when pit aspiration occurs and why the appression of the torus to the pit aperture upon aspiration occurs.



BOTANICAL SOCIETY OF AMERICA
 leading scientists and educators
 since 1893

AMERICAN JOURNAL OF Botany

September 2013 · Volume 100 · Number 9

TABLE OF CONTENTS

Special Section

Rhizosphere Interactions: The Root Microbiome

The root microbiome influences scales from molecules to ecosystems:

The unseen majority

MARNIE E. ROUT AND DARLENE SOUTHWORTH 1689

Amino acids in the rhizosphere: From plants to microbes

LUKE A. MOE 1692

Intraspecific variation in cotton border cell production: Rhizosphere microbiome implications

GILBERTO CURLANGO-RIVERA, DAVID A. HUSKEY, AYMAN MOSTAFA, JOHN O. KESSLER, ZHONGGUO XIONG, AND MARTHA C. HAWES 1706

A survey of the microbial community in the rhizosphere of two dominant shrubs of the Negev Desert highlands, *Zygophyllum dumosum* (Zygophyllaceae) and *Atriplex halimus* (Amaranthaceae), using cultivation-dependent and cultivation-independent methods

DRORA KAPLAN, MASKIT MAYMON, CHRISTINA M. AGAPAKIS, ANDREW LEE, ANDREW WANG, BARRY A. PRIGGE, MYKOLA VOLKOGON, AND ANN M. HIRSCH 1713

Bacterial endophytes enhance competition by invasive plants

MARNIE E. ROUT, THOMAS H. CHRZANOWSKI, TARA K. WESTLIE, THOMAS H. DELUCA, RAGAN M. CALLAWAY, AND WILLIAM E. HOLBEN 1726

Inside the root microbiome: Bacterial root endophytes and plant growth promotion

JONATHAN R. GAIERO, CRYSTAL A. MCCALL, KAREN A. THOMPSON, NICOLA J. DAY, ANNA S. BEST, AND KARI E. DUNFIELD 1738

Anatomy and Morphology

A new approach for the study of the chemical composition of bordered pit membranes: 4Pi and confocal laser scanning microscopy

DANIELA MASCHKE, BARRY GOODELL, JODY JELLISON, MARK LESSARD, AND HOLGER MILITZ 1751

Androecial evolution in Caryophyllales in light of a paraphyletic Molluginaceae

SAMUEL BROCKINGTON, PATRICIA DOS SANTOS, BEVERLEY GLOVER, AND LOUIS RONSE DE CRAENE 1757

Extrafloral nectaries in neotropical Gentianaceae: Occurrence, distribution patterns, and anatomical characterization

VALDNÉA CASAGRANDE DALVI, RENATA MARIA STROZI ALVES MEIRA, AND ARISTÉA ALVES AZEVEDO 1779

Ecology

Wild-boar disturbance increases nutrient and C stores of geophytes in subalpine grasslands

SARA PALACIO, C. GUILLERMO BUENO, JOSÉ AZORÍN, MELCHOR MAESTRO, AND DANIEL GÓMEZ-GARCÍA 1790

TABLE OF CONTENTS CONTINUED

Evolution and Phylogeny

Niche evolution through time and across continents: The story of Neotropical *Cedrela* (Meliaceae)

A. VALERIE KOECKE, ALEXANDRA N. MUELLNER-RIEHL,
TERENCE D. PENNINGTON, GERTRUD SCHORR, AND JAN SCHNITZLER 1800

Evolution of limited seed dispersal ability on gypsum islands

JOHN J. SCHENK 1811

Mycology

Identification and symbiotic ability of Psathyrellaceae fungi isolated from a photosynthetic orchid, *Cremastra appendiculata* (Orchidaceae)

TAKAHIRO YAGAME, ERIKO FUNABIKI, EIJI NAGASAWA, TOSHIMITSU FUKIHARU,
AND KOJI IWASE 1823

Paleobotany

First record of *Todea* (Osmundaceae) in South America, from the early Eocene paleorainforests of Laguna del Hunco (Patagonia, Argentina)

MÓNICA R. CARVALHO, PETER WILF, ELIZABETH J. HERMSEN, MARIA A. GANDOLFO,
N. RUBÉN CÚNEO, AND KIRK R. JOHNSON 1831

Oldest fruits of the grape family (Vitaceae) from the Late Cretaceous Deccan Cherts of India

STEVEN R. MANCHESTER, DASHRATH K. KAPGATE, AND JUN WEN 1849

Physiology and Biochemistry

Deficiency of phytochrome B alleviates chilling-induced photoinhibition in rice

JIAN-CHAO YANG, MENG LI, XIAN-ZHI XIE, GUO-LIANG HAN, NA SUI,
AND BAO-SHAN WANG 1860

Population Biology

Propagule pressure, genetic structure, and geographic origins of *Chondrilla juncea* (Asteraceae): An apomictic invader on three continents

JOHN F. GASKIN, MARK SCHWARZLÄNDER, C. LYNN KINTER, JAMES F. SMITH,
AND STEPHEN J. NOVAK 1871

Limited hybridization across an edaphic disjunction between the gabbro-endemic shrub *Ceanothus roderickii* (Rhamnaceae) and the soil-generalist *Ceanothus cuneatus*

DYLAN O. BURGE, ROBIN HOPKINS, YI-HSIN ERICA TSAI, AND PAUL S. MANOS 1883

Consecutive five-year analysis of paternal and maternal gene flow and contributions of gametic heterogeneities to overall genetic composition of dispersed seeds of *Pinus densiflora* (Pinaceae)

MASAKAZU G. IWAIZUMI, MAKOTO TAKAHASHI, KEIYA ISODA, AND FRÉDÉRIC AUSTERLITZ 1896

Systematics and Phylogeography

Phytogeography of *Najas gracillima* (Hydrocharitaceae) in North America and its cryptic introduction to California

DONALD H. LES, ELENA L. PEREDO, LORI K. BENOIT, NICHOLAS P. TIPPERY,
URSULA M. KING, AND SALLIE P. SHELDON 1905

Brief Communication

Resource reallocation does not influence estimates of pollen limitation or reproductive assurance in *Clarkia xantiana* subsp. *parviflora* (Onagraceae)

RYAN D. BRISCOE RUNQUIST AND DAVID A. MOELLER 1916

Abbreviations

Miscellaneous: AFLP, amplified fragment length polymorphisms; a.s.l., above sea level; bp, base pair; BP, before present; BSA, bovine serum albumin; cpDNA, chloroplast DNA; CTAB, hexadecyltrimethylammonium bromide; cv., cultivar; ddH₂O, double-distilled water; dNTP, deoxyribonucleotide E.C., Enzyme Commission; EDTA, ethylene diamine tetra-acetic acid; f. sp., forma specialis; indels, insertions and deletions; ITS, internal transcribed spacer; LM, light microscopy; mya, million years ago; PAGE, polyacrylamide gel electrophoresis; PCR, polymerase chain reaction; RAPD, random amplified polymorphic dimorphism; SDS, sodium dodecyl sulfate; SEM, scanning electron microscopy; s.l., sensu lato; s.s., sensu stricto; subsp., subspecies; TEM, transmission electron microscopy

Genetics: *A*, mean number of alleles per locus; *D*, mean genetic distance; CI, consistency index; *F*, fixation index; *F_{IT}*, total deviation from Hardy-Weinberg expectations; *F_{ST}*, genetic diversity among populations; *F_{IS}*, inbreeding within populations; *G_{ST}*, the proportion of genetic diversity among populations; *H_e*, Hardy-Weinberg expected heterozygosity; *H_o*, observed heterozygosity; MP, most parsimonious tree; *n*, individual chromosome number; *N_m*, mean number of migrants per generation; *P_p*, percentage of polymorphic loci; RI, retention index; *x*, base chromosome number

Statistics and math: ANOVA, analysis of variance; CV, coefficient of variation; df, degrees of freedom; *N*, number of individuals; *p*, probability; *P*, level of significance; PCA, principal components analysis; *r*, coefficient of correlation; SE, standard error; SD, standard deviation