Progress in Botany

Ulrich Lüttge
Wolfram Beyschlag
John Cushman *Editors*

Progress in Botany 75

Springer

Progress in Botany

Ulrich Lüttge
Wolfram Beyschlag
John Cushman *Editors*

Progress in Botany 75

Springer

Progress in Botany

Volume 75

Series Editors
Ulrich Lüttge, TU Darmstadt,
FB Biologie (10), Schnittspahnstraße 3–5,
64287 Darmstadt, Germany
Wolfram Beyschlag, Fakultät für Biologie, Lehrstuhl für
Experimentelle Ökologie und Ökosystembiologie,
Universität Bielefeld, Universitätsstraße 25, 33615 Bielefeld,
Germany
John Cushman
MS330/Department of Biochemistry,
University of Nevada, Virginia Street 1664 N,
Reno, 89557-0330, Nevada, USA

Ulrich Lüttge • Wolfram Beyschlag •
John Cushman
Editors

Progress in Botany 75

Springer

Editors
Ulrich Lüttge
Department of Biology
TU Darmstadt
Darmstadt
Germany

Wolfram Beyschlag
Faculty of Biology
University of Bielefeld
Bielefeld
Germany

John Cushman
MS330/Department of Biochemistry
University of Nevada
Reno
Nevada
USA

ISSN 0340-4773
ISBN 978-3-642-38796-8 ISBN 978-3-642-38797-5 (eBook)
DOI 10.1007/978-3-642-38797-5
Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013950980

© Springer-Verlag Berlin Heidelberg 2014
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Series Information

Progress in Botany is devoted to all the colourful aspects of plant biology. The annual volumes consist of invited reviews spanning the fields of molecular genetics, cell biology, physiology, comparative morphology, systematics, ecology, biotechnology and vegetation science, and combine the depth of the frontiers of research with considerable breadth of view. Thus, they establish unique links in a world of increasing specialization. All chapters are thoroughly peer-reviewed by at least two independent referees.

Contents

Part I Review

Ants, Plants and Fungi: A View on Some Patterns of Interaction and Diversity 3
Andreas Bresinsky

Part II Genetics

ABA as a Universal Plant Hormone 57
Yoichi Sakata, Kenji Komatsu, and Daisuke Takezawa

Reduced Genomes from Parasitic Plant Plastids: Templates for Minimal Plastomes? 97
Kirsten Krause and Lars B. Scharff

Part III Physiology

Nucleotides and Nucleosides: Transport, Metabolism, and Signaling Function of Extracellular ATP 119
Torsten Möhlmann, Iris Steinebrunner, and Ekkehard Neuhaus

Regulation of PPi Levels Through the Vacuolar Membrane H^+-Pyrophosphatase 145
Ali Ferjani, Shoji Segami, Mariko Asaoka, and Masayoshi Maeshima

Interactions Between Nutrients and Crassulacean Acid Metabolism 167
Maria Aurineide Rodrigues, Luciano Freschi, Paula Natália Pereira, and Helenice Mercier

Guttation: Quantification, Microbiology and Implications for Phytopathology 187
Sanjay Singh

Adaptation of Rice to Flooded Soils 215
G.J.D. Kirk, H. Greenway, B.J. Atwell, A.M. Ismail, and T.D. Colmer

Physiological Mechanisms of Flooding Tolerance in Rice: Transient Complete Submergence and Prolonged Standing Water 255
T.D. Colmer, W. Armstrong, H. Greenway, A.M. Ismail, G.J.D. Kirk, and B.J. Atwell

Part IV Ecology

Beyond Mutualism: Complex Mycorrhizal Interactions 311
C.S. Bledsoe, M.F. Allen, and D. Southworth

Ecology of Phreatophytes 335
Frank M. Thomas

Some Like It Hot: Are Desert Plants Indifferent to Climate Change? 377
Katja Tielbörger and Roberto Salguero-Gómez

List of Contributors

M.F. Allen Center for Conservation Biology, University of California, Riverside, CA, USA

W. Armstrong School of Plant Biology and the UWA Institute of Agriculture, The University of Western Australia, Crawley, WA, Australia

Department of Biological Sciences, University of Hull, Yorkshire, UK

Mariko Asaoka Graduate School of Bioagricultural Sciences and School of Agricultural Sciences, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, Japan

B.J. Atwell Department of Biological Sciences, Faculty of Science, Macquarie University, Sydney, NSW, Australia

C.S. Bledsoe Department of Land, Air, and Water Resources, University of California, Davis, CA, USA

Andreas Bresinsky Institute of Botany of University of Regensburg, Regensburg, Germany

T.D. Colmer School of Plant Biology and the UWA Institute of Agriculture, The University of Western Australia, Crawley, WA, Australia

Ali Ferjani Graduate School of Bioagricultural Sciences and School of Agricultural Sciences, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, Japan

Luciano Freschi Department of Botany, Institute of Biosciences, University of São Paulo, São Paulo, SP, Brazil

H. Greenway School of Plant Biology and the UWA Institute of Agriculture, The University of Western Australia, Crawley, WA, Australia

A.M. Ismail International Rice Research Institute, Metro Manila, Philippines

G.J.D. Kirk National Soil Resources Institute, Cranfield University, Cranfield, Bedford, UK

Environmental Science and Technology, Cranfield University, Bedfordshire, England, UK

Kenji Komatsu Department of Bioproduction Technology, Junior College of Tokyo University of Agriculture, Setagaya-ku, Tokyo, Japan

Kirsten Krause Department for Arctic and Marine Biology, University of Tromsø, Tromsø, Norway

Masayoshi Maeshima Graduate School of Bioagricultural Sciences and School of Agricultural Sciences, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, Japan

Helenice Mercier Department of Botany, Institute of Biosciences, University of São Paulo, São Paulo, SP, Brazil

Torsten Möhlmann Pflanzenphysiologie, Fachbereich Biologie, Universität Kaiserslautern, Kaiserslautern, Germany

Ekkehard Neuhaus Pflanzenphysiologie, Fachbereich Biologie, Universität Kaiserslautern, Kaiserslautern, Germany

Paula Natália Pereira Department of Botany, Institute of Biosciences, University of São Paulo, São Paulo, SP, Brazil

Maria Aurineide Rodrigues Department of Botany, Institute of Biosciences, University of São Paulo, São Paulo, SP, Brazil

Yoichi Sakata Department of Bioscience, Tokyo University of Agriculture, Setagaya-ku, Tokyo, Japan

Roberto Salguero-Gómez Evolutionary Biodemography Laboratory, Max Planck Institute for Demographic Research, Rostock, Germany

Centre for Biodiversity and Conservation Science, School of Biological Sciences, The University of Queensland, St Lucia, QLD, Australia

Lars B. Scharff Max-Plank Institute for Molecular Plant Physiology, Potsdam-Golm, Germany

Shoji Segami Graduate School of Bioagricultural Sciences and School of Agricultural Sciences, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, Japan

Sanjay Singh School of Plant Sciences, College of Agriculture and Environmental Sciences, Haramaya University, Haramaya, Ethiopia

D. Southworth Department of Biology, Southern Oregon University, Ashland, OR, USA

Iris Steinebrunner Department of Biology, Section of Molecular Biotechnology, Technische Universität Dresden, Dresden, Germany

Daisuke Takezawa Graduate School of Science and Engineering and Institute for Environmental Science and Technology, Saitama University, Saitama, Japan

Frank M. Thomas Faculty of Geography and Geosciences, Geobotany, University of Trier, Trier, Germany

Katja Tielbörger Plant Ecology Group, University of Tübingen, Tübingen, Germany

Part I
Review

Ants, Plants and Fungi: A View on Some Patterns of Interaction and Diversity

Andreas Bresinsky

Contents

1 Introduction 4
2 Seed Dispersal by Ants 5
  2.1 The Challenge of Biodiversity 5
  2.2 Scientific Approach to Myrmecochory 5
  2.3 Ontogeny, Anatomy and Histochemistry of Elaiosomes 8
  2.4 Myrmeco-Attractive Compounds in Elaiosomes 12
  2.5 Advanced Studies on Myrmecochory 16
  2.6 Mimicry and Dispersal in *Melampyrum* 20
3 Patterns of Plant Distribution 22
  3.1 Dispersal and Distribution 22
  3.2 Areal Expansion of Myrmecochores 22
  3.3 Interpretation of Plant Distribution: Options and Limitations 25
  3.4 Documentation of Plant Distribution 27
4 Character Evaluation and Evolution in Fungi 28
  4.1 Fungi and Ants 28
  4.2 Fungi and Biodiversity 31
  4.3 Speciation in Fungi 31
  4.4 Diversity of Fungal Metabolites 35
  4.5 Pigments and DNA-Sequence Data Support Boletales as a High Rank Unit 36
5 Popularisation of Science 42
6 Protection of Nature 43
7 Teaching 44
References 47

Abstract Biodiversity is a challenging field of research. Approaches are manifold and mostly cover few aspects of the total wealth of phenomena only. The mapping of the vascular plants and the inventory of Basidiomycota in Bavaria are projects to be mentioned in this context as one part of the commitment of the author. In the following article the author describes further activities during his lifework in regard

A. Bresinsky (✉)
Institute of Botany of University of Regensburg, D-93040, Regensburg, Germany
e-mail: abresinsky@t-online.de

U. Lüttge et al. (eds.), *Progress in Botany*, Progress in Botany 75,
DOI 10.1007/978-3-642-38797-5_1, © Springer-Verlag Berlin Heidelberg 2014