

Signaling and Communication in Plants

Series Editors

František Baluška

Department of Plant Cell Biology, IZMB, University of Bonn, Kirschallee 1, D-53115
Bonn, Germany

Jorge Vivanco

Center for Rhizosphere Biology, Colorado State University, 217 Shepardson Building,
Fort Collins, CO 80523-1173, USA

For further volumes:

<http://www.springer.com/series/8094>

František Baluška • Velemir Ninkovic
Editors

Plant Communication from an Ecological Perspective

 Springer

Editors

Dr. František Baluška
Universität Bonn
Inst. Zelluläre und Molekulare
Botanik (IZMB)
Kirschallee 1
53115 Bonn
Germany
baluska@uni-bonn.de

Dr. Velemir Ninkovic
Department of Ecology
Swedish University of Agricultural
Sciences
P.O. Box 7044
SE-750 07 Uppsala
Sweden
Velemir.Ninkovic@ekol.slu.se

ISSN 1867–9048 e-ISSN 1867–9056
ISBN 978-3-642-12161-6 e-ISBN 978-3-642-12162-3
DOI 10.1007/978-3-642-12162-3
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2010923084

© Springer-Verlag Berlin Heidelberg 2010

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

The use of general descriptive names, registered names, trademarks, 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.

Cover design: WMXDesign GmbH, Heidelberg, Germany

Printed on acid-free paper

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

Preface

Since the concept of allelopathy was introduced almost 100 years ago, research has led to an understanding that plants are involved in complex communicative interactions. They use a battery of different signals that convey plant-relevant information within plant individuals as well as between plants of the same species or different species. The 13 chapters of this volume discuss all these topics from an ecological perspective. Communication between plants allows them to share physiological and ecological information relevant for their survival and fitness. It is obvious that in these very early days of ecological plant communication research we are illuminating only the ‘tip of iceberg’ of the communicative nature of higher plants. Nevertheless, knowledge on the identity and informative value of volatiles used by plants for communication is increasing with breath-taking speed. Among the most spectacular examples are situations where plant emitters warn neighbours about a danger, increasing their innate immunity, or when herbivore-attacked plants attract the enemies of the herbivores (‘cry for help’ and ‘plant bodyguards’ concepts). It is becoming obvious that plants use not only volatile signals but also diverse water soluble molecules, in the case of plant roots, to safeguard their evolutionary success and accomplish self/non-self kin recognition. Importantly, as with all the examples of biocommunication, irrespective of whether signals and signs are transmitted via physical or chemical pathways, plant communication is a rule-governed and sign-mediated process.

The previous volumes focused on signalling molecules and pathways, as well as on communication related to plant sensory biology underlying the emerging concept of plant behaviour. Here, individual chapters deal with diverse aspects of plant communication such as evolution of plant signals and toxins, chemical signals in plant photobiology and ‘arms-races’ in pathogen defence, allelopathy of exotic plant invasion, volatile chemical interactions between undamaged plants and their effects at higher trophic levels, chemical communication in plant–ant symbioses, as well as effects of global atmospheric changes on plants and their trophic interactions. Finally, two chapters deal with the perspective of exploiting the chemical signals of plant communication for sustainable agriculture, and the technological

possibility of monitoring plant volatile signals to obtain information about plant health status in greenhouses.

For many years, plants were placed outside of the communicative and even the sensitive living domain. Immanuel Kant even went so far as to place plants outside the living realm. The vocal-based physical (acoustic) language of humans depends on air vibrations that are decoded in the ears. The volatile-based chemical language of plants is communicated by volatiles decoded via diverse receptors (most of them still unknown). Plants are unique and differ greatly from animals. This makes it very difficult for us, biased by the human-centric perspective of our world-view, to grasp their whole communicative complexity and to understand the true nature of their communications. The sessile nature of plants and the dual character of plant bodies, with the above-ground autotrophic shoots and the below-ground heterotrophic roots, are further phenomena obscuring the real nature of plant communication. In science, one should try to keep a neutral unbiased position and not exclude any possibility. We can look forward to witnessing the next wave of surprising discoveries.

Bonn, April 2010
Uppsala, April 2010

František Baluška
Velemir Ninkovic

Further Reading

- Baluška F, Volkmann D, Mancuso S (2006) Communication in plants: neuronal aspects of plant life. Springer, Berlin
- Greenfield MD (2002) Signalers and receivers: mechanisms and evolution of arthropod communication. Oxford University Press, Oxford
- Searcy WA, Nowicki S (2005) The evolution of animal communication: reliability and deception in signalling systems. Princeton University Press, Princeton, NJ
- Witzany G (2009) Biocommunication and natural genome editing. Springer, Berlin

Contents

Evolutionary Ecology of Plant Signals and Toxins: A Conceptual Framework	1
H. Jochen Schenk and Eric W. Seabloom	
The Chemistry of Plant Signalling	21
Michael A. Birkett	
Plant Defense Signaling from the Underground Primes Aboveground Defenses to Confer Enhanced Resistance in a Cost-Efficient Manner	43
Marieke Van Hulst, Jurriaan Ton, Corné M.J. Pieterse, and Saskia C.M. Van Wees	
Allelopathy and Exotic Plant Invasion	61
Amutha Sampath Kumar and Harsh P. Bais	
Volatile Interaction Between Undamaged Plants: A Short Cut to Coexistence	75
Velemir Ninkovic	
Volatile Chemical Interaction Between Undamaged Plants: Effects at Higher Trophic Levels	87
Robert Glinwood	
Within-Plant Signalling by Volatiles Triggers Systemic Defences	99
Martin Heil	
Volatile Interactions Between Undamaged Plants: Effects and Potential for Breeding Resistance to Aphids	113
Inger Åhman and Velemir Ninkovic	

Communication in Ant–Plant Symbioses 127
Rumsais Blatrix and Veronika Mayer

**Photosensory Cues in Plant–Plant Interactions: Regulation
and Functional Significance of Shade Avoidance Responses** 159
Diederik H. Keuskamp and Ronald Pierik

**Global Atmospheric Change and Trophic Interactions:
Are There Any General Responses?** 179
Geraldine D. Ryan, Susanne Rasmussen, and Jonathan A. Newman

Exploiting Plant Signals in Sustainable Agriculture 215
Toby J.A. Bruce

**Plant Volatiles: Useful Signals to Monitor Crop Health Status
in Greenhouses** 229
R.M.C. Jansen, J. Wildt, J.W. Hofstee, H.J. Bouwmeester,
and E.J. van Henten

Index 249