Plant–animal communication

H. Martin Schaefer and Graeme D. Ruxton. 2011.

Oxford University Press. £39.95 (paperback). pp. 296.

There are numerous excellent books about plant–pollinator and plant–herbivore interactions, and books about plant defence, but none of these covers the process of communication between plants and animals as comprehensively as this volume. The authors define communication as

occurring ‘if traits of the sender stimulate the sensory systems of the receiver in such a way as to cause a change in the behaviour of the receiver’. In most cases the signal – visual, olfactory, gustatory or acoustic – is released by the plant.

The focus in this book is on olfactory and visual signals. In addition, the authors give examples of how insects can detect plant quality just by walking on it and sensing the taste with gustatory sensors in their legs. Acoustic communication is exemplified by the noise of fruit falling into water, where fruit-feeding fish are alerted to this food source, eat the fruit and subsequently disperse seeds. Acoustic communication is also linked to bat-pollinated plants, which have mirror-like structures in their flowers to strongly reflect bat echolocation calls back to the sender.

The authors have taken an evolutionary ecological approach, setting the key questions of whether communication between plants and animals is primarily adaptive or whether it is a by-product of other selective pressures. The book has eleven chapters, including ones on animal sensory ecology and biochemistry, animals as seed dispersers, visual and non-visual fruit traits, floral communication and pollination, plant crypsis, aposematism and mimicry, chemical communication between plants and herbivores, and sensory aspects of carnivorous plants.

Chapter 7 is devoted to the potential for leaf colouration to communicate to animals. When the evolutionary biologist W. D. Hamilton and colleagues presented the co-evolutionary theory to explain the autumn colouration of temperate tree foliage, it stimulated research on leaf colouration and provoked a rather heated debate between supporters and critics. Theory suggests that intensity of colouration is a signal revealing the defensive commitment of the individual plant, and autumn-migrating insects use this signal to select less-defended plants. Of the book’s authors, Schaefer has shown a critical attitude towards the autumn leaf co-evolution hypothesis in his earlier publications, but the review and analysis of the issue in this book is very balanced. The authors suggest more choice trials to test the hypothesis and to assess different selective pressures that might contribute to the relationship between leaf colouration and insect choice.

The four-page colour plates in the book give good examples of visual communication. The illustration of functional camouflage, showing how differently coloured, folivorous insects can take advantage of the variable colours of leaf venation when positioned on leaves, is particularly educational.

The redrawn black and white figures are clear and informative throughout the book.

The book covers most of the aspects related to biological communication between plants and animals, particularly in terrestrial ecosystems. As the ecosystems of our planet are facing extremely rapid changes due to human activity, the impacts of environmental disturbance on plant–animal communication ought to have deserved its own chapter, or better treatment in the future perspectives section of each chapter. Changes in plant–animal interactions are considered one of the most sensitive indicators of environmental and climatic change, and the change is often attributed to a dramatic decline in communication. A good example is the function of plant scents as long-distance communication signals in ecological communities, with essential roles in a range of interactions. These molecules display sensitivity to present-day atmospheric pollutants resulting in much faster degradation of molecular structure and shorter communication ranges than in pre-industrial atmospheres (e.g. McFrederick *et al.*, 2009). When this loss of communication by long-distance olfactory signals is combined with the current trend for faster fragmentation of the natural habitats of many plant and animal species, we may better understand ecologically important trends such as the swift decline of pollinators across the world. Perhaps the next edition of this book could discuss if evolution of plant–animal communication is fast enough to respond to this anthropogenic challenge.

Otherwise, the authors have put together an excellent book on communication, ranging from sensory ecology to plant physiology, evolution and the behavioural sciences. For researchers it will give a critical synthesis of the current literature in the diverse field of biological communication research. For students it will be an excellent source of information for advanced courses related to botany, zoology, pollination biology, evolution and ecology.

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LITERATURE CITED

McFrederick QS, Fuentes JD, Roulston T, Kathilankal JC, Lerdau M. 2009. Effects of air pollution on biogenic volatiles and ecological interactions. *Oecologia* **160**: 411–420.

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Plant communication from an ecological perspective

František Baluška and Velemir Ninkovic. eds. 2010.

Springer. €171.15 (hardback). pp. 252.

This book describes recent developments in the evolutionary ecology of plant communication, a relatively recent and rapidly developing topic worthy of synthesis. The book is part of

Springer's 'Signaling and communication in plants' series, and comprises 13 chapters. Taken together, these contributions admirably cover many aspects of plant communication. However, the book could have benefited from more editorial attention to the integration of the different chapters and the avoidance of repetition. For example, the two chapters, 'The chemistry of plant signaling' and 'Plant volatiles: useful signals to monitor crop health status in green-houses', present very similar information on techniques of collecting volatile compounds. The first chapter, by Schenk and Seabloom, is an introduction to the conceptual framework. This chapter defines and discusses key terms (communication, information, signal, allelopathy, etc.) and revisits the evolutionary mechanisms involved in plant communication. The chapter on the chemical basis of plant signaling (by Birkett) provides an overview of the classical techniques for the collection and identification of plant chemical signals. However, some recently developed techniques are missing, such as 'chromatoprobe' extraction, which is now frequently used in plant chemical ecology. This chapter also develops interesting aspects of the organic chemistry of plant signals; but the genetic basis of variation underpinning the synthesis of chemical signals, and the substantial recent progress in gene expression in signaling, are not developed here or elsewhere in the book.

Communication between undamaged plants is covered by four chapters. The different aspects of allelopathy between plant species are examined in the case of the diverse biochemistry of invading species (chapter by Kumar and Bais) and the different effects of allelobiosis in plants are considered in the chapter by Ninkovic. This last chapter also presents the results of different studies concerning the role of plant volatiles (volatile organic compounds, or VOCs) in exchange of information between plants on stress or physiological status. A new aspect in the interactions between undamaged plants mediated by volatile chemicals is the use of these signals as an indicator of host quality by organisms at higher trophic levels. This more recent aspect of the ecology of plant communication is explained in the case of aphids on barley in both the chapter by Glinwood and that by Åhman and Ninkovic. Both emphasize how genetic and inter-specific diversity in VOC profiles influences host recognition by aphids. These chapters have direct implications for future work on integrating allelobiosis in crop management and aphid control in agriculture.

Plant defences are then covered by three different chapters spanning above-ground and below-ground defences, the 'talking trees' phenomenon, and induced defences. Primed defence responses enhanced by root colonization by microorganisms are developed in detail, and the reciprocal benefits of such associations are examined in the chapter by Van Hulst *et al.* Priming has been observed in different plant species, mainly under laboratory conditions, and the examples are very well detailed in this chapter, as well as the mechanisms involved in this 'immunological memory' in plants. The chapter by Heil, titled 'Within-plant signaling by volatiles triggers systemic defense', is an excellent synthesis of recent work on plant responses (direct or indirect) to attack by pathogens and herbivores. The very interesting chapter by Blatrix and Mayer develops a more specialized set of interactions, those involved in ant-plant symbioses. This chapter is a complete review of our current knowledge on

plant communication in this context and uses as examples ant-gardens and ant-myrmecophyte mutualisms.

The chapter on 'Photosensory cues in plant-plant interactions' (by Keuskamp and Pierik) explains in detail our current understanding of the shade avoidance syndrome (SAS) and how plants respond to neighbouring intra- or inter-specific individuals using reliable external signals. This chapter ends with a discussion of the complexity of relationships between SAS and defence responses against herbivores, and the trade-offs observed, or expected, between these two functions.

The chapter on 'Global atmospheric change and trophic interactions' (by Ryan *et al.*) provides a general overview of the complexity of plant responses to environmental changes such as elevated atmospheric CO₂ concentrations and the consequences of these changes on resource allocation to allelochemicals. The chapter also pinpoints the lack of theoretical models to predict responses of the intricate network of trophic interactions in heterogeneous environments.

The book ends with two more applied chapters, by Bruce and by Jansen *et al.*, on the current use of plant communication in sustainable agriculture, and plant communication to monitor crop health in greenhouses. These chapters also develop the future prospects (promising!) for biocontrol in preventive approaches incorporating plant health monitoring.

In summary, despite some redundancy between certain chapters, this book is written in a pleasant style and gives many up-to-date examples. It will be a useful source of information for graduate students and other researchers looking for a concise overview of current work in the evolutionary ecology of plant communication.

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Lipids in photosynthesis. Essential and regulatory functions

Hajime Wada and Norio Murata.
eds. 2010.
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pp. 474.

Scientific interest in lipid metabolism has exploded since the first edition of this book. This has in part been due to the promise of biofuels derived from photosynthetic organisms.

However, it has become clear that we are far from fully understanding the genetic and regulatory complexity of lipid metabolism. No matter what your interest in lipids, *Lipids in photosynthesis* is essential reading in a currently fast-changing topic.

The book (which is part of Springer's series *Advances in Photosynthesis and respiration*) begins with a comprehensive overview of the advances made in the understanding of lipid