

Zooming in on plant interactions

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Few areas in plant ecology have experienced the fantastic growth demonstrated by the field of plant interactions with other organisms in recent years. Research in this field has taken rapid advantage of the tools provided by model organisms (particularly *Arabidopsis thaliana*), genetic and genomic approaches, and the improvement of analytical techniques to move the discipline to a completely different level from where it was 10 years ago. Major breakthroughs have been made in the understanding of the mechanisms of plant defenses against herbivores and pathogens, plant interactions with other plants and beneficial microorganisms, such as mycorrhizae and bacterial symbionts, and the modulation of these interactions by biotic and environmental factors.

In recognition of the increased growth of this research focus, *Oecologia* is launching a new editorial office to

handle submissions focusing on the functioning of plants in their biotic context. This section of *Oecologia*, led by Prof. Carlos Ballaré, will feature papers dealing with fundamental aspects of the mechanisms of plant interactions with other organisms, including beneficial and pathogenic microorganisms, insects and other animals.

A few examples of the vigorous growth of research areas from which our new editorial section will seek to receive contributions are highlighted below.

Plants interact with their enemies The mechanisms that mediate the activation of plant defenses against herbivorous organisms and pathogens are beginning to be understood at the molecular level, with major breakthroughs involving the identification of the receptors for the two central hormones controlling induced defenses, namely jasmonate (Chini et al. 2007; Thines et al. 2007) and salicylate (Fu et al. 2012). In addition, the interactions between these defense-related hormones and those coordinating other plant functions, such as growth and development, are becoming increasingly well understood (Pieterse et al. 2012). This improved understanding of defense signaling in the context of plant development is shedding light on the mechanisms that regulate plant phenotypic plasticity in the face of tradeoffs that have attracted significant attention among ecologists and evolutionary biologists, such as the growth vs. defense resource allocation “dilemma” (Ballaré 2011). At the same time, knowledge about the types of cues that plants use to obtain information about their biotic context, including light, volatile compounds and soil semiochemicals, has increased significantly (Heil 2010), allowing us a much deeper understanding of biotic interactions in plant communities than the one we had a decade ago.

Plants interact with beneficial microorganisms The role of mycorrhizal fungi in plant nutrient acquisition (Van Der

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Heijden et al. 2008) and defense (Hartley and Gange 2009; Herre et al. 2007; Pozo and Azcón-Aguilar 2007) has been documented with an unprecedented level of detail, and the sequencing of the genome of the ectomycorrhizal basidiomycete *Laccaria bicolor* (Martin et al. 2008) represented a milestone in our quest to understand the mechanisms of rhizosphere colonization and symbiosis. Communication chemicals identified in root exudates and known to be involved in plant interactions with parasitic weeds and symbiotic arbuscular mycorrhizal fungi (strigolactones) were recently shown to play a central role in regulating above-ground plant architecture, and were thereby moved to the rank of plant hormones (Gomez-Roldan et al. 2008; Umehara et al. 2008). Thus, work on underground communication between plants and neighboring organisms has contributed key elements to our understanding of basic aspects of plant biology. Studies of plant communication with N-fixing symbionts (Oldroyd and Downie 2008), its regulation by environmental cues (Suzuki et al. 2011), and the consequences for plant defense (Ballhorn et al. 2012), have also produced major advances in our understanding of this important interaction.

Novel approaches to classic questions Innovative approaches using molecular and genetic tools have allowed manipulation of gene expression in non-model organisms, thereby testing the functional significance of putative defense and communication mechanisms in ecologically meaningful scenarios (Gase and Baldwin 2012). Studies on plant responses to biotic stressors have also begun to combine experiments with phylogenetic approaches, allowing ecologists to formulate hypotheses about the evolution of resistance and tolerance traits (Agrawal and Fishbein 2008) and interactions between different mechanisms of plant defense (Thaler et al. 2012). In the same vein, genome-wide expression profiling is beginning to be used to address classic ecological questions (e.g., plant responses to generalist vs. specialists herbivores) (Bidart-Bouzat and Kliebenstein 2011), genome-wide association mapping is being applied to explore natural variation in defense phenotypes (Kloth et al. 2012), and combinations of experimental and genetic approaches in model organisms have recently led to the discovery of epigenetic controls on the expression of the defense phenotype (Luna et al. 2012; Rasmann et al. 2012; Slaughter et al. 2012). These advances have important implications for our understanding of the ecology and evolution of plant interactions with their enemies. A common denominator in the examples above is the use of research approaches that go beyond the boundaries of traditional specialization, allowing synergistic interactions among scientists working in a broad cross-section of disciplines, including molecular biology, ecophysiology, community ecology, and ecosystem science and sustainable agriculture.

Biotic interactions and global change The interactive effects of global change and biotic interactions have also received considerable attention in recent years. Important questions that are beginning to be addressed include, for example, how plant interactions with consumer and beneficial organisms are affected by changes in temperature (Jamieson et al. 2012), elevated atmospheric CO₂ (DeLucia et al. 2012), and other atmospheric pollutants (Blande et al. 2010), and how introduction of novel biotic players may affect ecosystem stability and function (Callaway et al. 2008). Also, from the perspective of agricultural production, emerging questions include how agricultural intensification is disrupting plant defenses (Ballaré et al. 2012), and how we can use our improved understanding of defense mechanisms to “add back” important defense traits that were lost during the process of crop domestication to cultivated plant species (Bleeker et al. 2012).

This new editorial office will interact closely with those focusing on Plant Population and Community Ecology (Prof. Katherine Gross) and Plant Ecophysiology and Ecosystem Processes (Prof. Russell Monson). Papers addressing fundamental questions in the areas of chemical ecology, sensory ecology, and molecular ecology will be particularly welcome. New handling editors, with outstanding credentials and a broad perspective of the discipline, have been appointed to handle manuscripts for this new subject category.

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