FOCUS ON NONCODING RNA REGULATION OF PLANT-MICROBE INTERACTIONS

Dedicated to the memory of our Editorial Board colleague Professor Biao Ding (1960-2015)

MPMI Focus Issue Overview

Investigations in recent years have uncovered important roles for RNA molecules that do not encode proteins ('noncoding RNAs') but which, nevertheless, exert powerful effects on gene expression at both transcriptional and posttranscriptional levels. Investigators of the interactions of plants with other organisms have led the way in the study of noncoding RNAs with pioneering work on small RNAs and their effects on plant interactions with viruses, bacteria, fungi, and oomycetes. However, there remains much more to be discovered, and it was our colleague, Biao Ding, who in February 2015 proposed a Focus Issue on the roles in plant-microbe interactions of noncoding RNAs, whether of plant or microbial origin and including small interfering (si)RNAs, microRNAs, phased (pha)siRNAs, and long noncoding RNAs, as well as viroids and satellite RNAs. He felt that such a Focus Issue would stimulate further research in the area and provide a valuable resource for researchers as well as for teaching at undergraduate and graduate levels. Unexpectedly, at the early age of 55, Biao died on June 25, 2015 in the Czech Republic, on his way to present a keynote talk at the International Conference on Viroids and Viroid-Like RNAs. More on Biao's life and achievements can be found at <http://www.apsnet.org/publications/phytopathologynews/obituaries/Pages/BiaoDing.aspx>. The Editorial Board of MPMI has decided to dedicate this Focus Issue to the memory of Professor Biao Ding, a valued and deeply missed colleague and friend.

This issue includes reviews invited by the editors and a primary paper submitted in response to an open call for reports on the investigation of noncoding RNAs. Below, we highlight these articles and summarize their major points.

RNA silencing applied as an antiviral strategy in plants now has a history reaching back 30 years, but questions remain regarding its resilience when virus-resistant transgenic plants are deployed in the field. In an important original contribution to this research area, Fuentes and coworkers demonstrated that plants of two transgenic tomato lines expressing hairpin constructs directed against the C1 gene of the *Begomovirus Tomato yellow leaf curl virus* exhibited high levels of resistance to this virus despite challenging environmental conditions and high densities of viruliferous whitefly vectors. However, a novel recombinant virus that acquired C1 from another distantly related geminivirus was discovered; the recombinant virus was able to evade resistance.

RNA viruses can be hyper-parasitized by coding and non-coding RNA molecules called, respectively, satellite viruses and satellite RNAs, which are dependent upon a virus (the 'helper') for their replication. These satellites often modify the symptoms induced by the helper virus and, as described in the review by Palukaitis, this occurs most often through the effects that non-coding RNA sequences exert on viral or host functions. Miller and his colleagues further discuss the importance of noncoding RNAs in determining the outcomes of virus-plant interactions. They argue convincingly that, although viral noncoding RNAs have been relatively neglected as objects of study, they are vital to the success of a viral infection. This is achieved not only through activities such as facilitating the translation of viral RNAs by the host ribosomes, but also, by blocking access of host mRNAs to the translational machinery and by overwhelming host defenses.

However, noncoding RNAs are critical players not only in the interactions of plants with viruses but also in plant responses to all types of invader. In their review, Meyers and colleagues discuss how microRNAs and phasiRNAs fine-tune the innate immunity mechanisms of plants at the levels of both PAMP- and effector-triggered defense responses. Meanwhile, Zhu and colleagues review recent progress on our understanding of the processes of chromatin and histone modification, which are controlled by host small RNAs, and how these epigenetic effects regulate plant genes involved in defense against bacterial and fungal pathogens.

However, Lelandais-Brière and her colleagues show that it is not only in pathogenic interactions that noncoding RNAs play critical roles. These authors discuss how beneficial root endosymbioses, focusing on those involving arbuscular mycorrhizal fungi and nitrogen-fixing bacteria, are critically dependent upon the actions of noncoding RNA molecules and epigenetic effects on host gene expression.

Since their inception, MPMI Focus Issues have been designed to bring attention to important research areas, to influence research directions, and to provide resources for teaching and outreach. We hope to have achieved those goals and we sincerely thank the authors for their contributions on the emerging importance of noncoding RNA molecules in molecular plant-microbe interactions.

Guest Editors

John P. Carr and Steven A. Whitham