The Nature and Application of Biocontrol Microbes: *Bacillus* spp.

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Overview of the Nature and Application of Biocontrol Microbes: *Bacillus* spp.

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While diverse microbes may contribute to the biological control of plant pathogens, most research and development efforts have focused on isolates of three genera, *Bacillus*, *Trichoderma*, and *Pseudomonas*. Continued studies of these three genera will be needed to further advance our understanding of the nature of biological control microbes and to improve our ability to successfully integrate biological control strategies into pest management systems. While many presentations given at The American Phytopathological Society Annual Meetings cover advances in biological control of plant pathogens with various agents, no comprehensive review of a particular genus has been conducted since the 1998 symposium focused on *Burkholderia* spp. Given the recent advances in microbial genomics, as well as the on-going pre-eminence of these three genera in commerce and research, the Biological Control Committee proposed a series of symposia to intensively review our current knowledge of these three genera. The first of these, co-sponsored by the Soil Microbiology and Phyllosphere Microbiology committees, was entitled "The Nature and Application of Biocontrol Microbes: *Bacillus* spp." and convened on 12 August 2003 in Charlotte, NC.

The following series of papers present a thorough review of the biology of *Bacillus* spp., focusing attention to details most relevant to the development and application of biological control strategies involving various strains of the genus. A comprehensive treatise of the biology of *Bacillus* sp. and related microbes was published about 10 years ago (3) and recently updated (4). The contents of the latter volume indicate the tremendous advances achieved in our understanding of the cellular and molecular biology of the genus *Bacillus*, based largely on studies of the model system *B. subtilis* strain 168. Reviews by Stahly et al. (5), Slepecky and Hemphill (2), and more recently, Nicholson (1) provide excellent introductions to the biology of the genus *Bacillus* and closely related genera. However, additional work has been done that further describes the microbial ecology of the genus and the capacity of different strains to improve crop health and productivity. The following papers expand upon the presentations given by scientists from academia, government, and industry with

a common interest in *Bacillus* spp. These presentations helped to link otherwise separate fields and helped to catalyze multidisciplinary research on the genus.

Much remains to be learned if we are to improve biocontrol methodologies. Refinements in the taxonomy, with particular emphasis on distinguishing strains with and without biocontrol potential, will be needed. The molecular basis for biological control and the regulation of such activities has yet to be fully explored, even in some of the best studied strains. The environmental factors that promote and constrain biocontrol activities of natural and inoculant strains must also be better characterized. Central to these efforts will be genomic approaches. For example, the ability of biocontrol strains of *B. subtilis* (e.g., GB03), but not standard laboratory strains (i.e., those derived from strain 168), to suppress plant pathogens raises the possibility of using genome sequence comparisons in conjunction with genetic approaches to discover and characterize the genes critical to those interactions leading to improvements in plant health. Such analyses would require only a relatively modest investment and may lead to the development of powerful new tools for study and application of biological control mediated by *Bacillus* spp. Clearly, these are exciting times for both basic studies of plant-microbe interactions and bacterial ecology, as well as for efforts to improve agricultural technologies. It is our hope that such information will stimulate new research that will eventually lead to more widespread application of safe and effective *Bacillus* inoculants that will promote plant health.

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