Prospects and Applications for Plant-Associated Microbes

A laboratory manual

Part A: Bacteria

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Main cover photo taken by Anna Maria Pirttilä, presents bog bilberry (*Vaccinium uliginosum* L.). The picture was taken on a midsummer day in Lapland, Enontekiö, Finland in June 2006. The sand dunes of Kalmakaltio in the subarctic Enontekiö are famous for their beauty, having patches of bog bilberry, lingonberry, crowberry, juniper, lichen and grasses dispersed between the dunes.

We wish to thank for the valuable help in the editing of this book:
Professor Alan C. Cassels (National University of Ireland, Cork, Ireland)
Professor Noel L. Owen (Brigham Young University, Provo, UT, USA)
Dr. Sampo Mattila (University of Oulu, Oulu, Finland)
Academy of Finland

ISBN 978-952-99302-5-8

BBi (BioBien Innovations)
Toivonlinnantie 517
FI-21500 Piikkiö
Finland

Printed by Karhukopio OY, Turku, Finland

PREFACE

Higher plants are non-motile and therefore they have to receive nutrition, to suffer seasonal stresses, and to survive pathogenic attacks continually at the same stand. This stationary lifestyle has created pressure to evolve different survival strategies including collaboration at various levels with microbes.

In plants, the first reports of microbial symbiosis were made at the end of the 19th century when mycorrhizal fungi and bacteria were found in association with plant roots. Since then, research on bacteria colonizing the above ground and subterranean plant tissues has shown the huge scale of interactions that exist between plants and microbes. The bacteria can reside anywhere in and on the plant including roots, stems, intra- and intercellular spaces, as well as in generative organs. They can be transferred to the next generation in the seed, which suggests a sophisticated adaptation of bacteria to commensalism with the host plant. According to numerous reports only a small percentage of these bacteria are harmful while most of them are neutral, opportunistic or beneficial. The plant-associated bacteria have various important functions throughout the life time of the plant.

Many plant-associated bacteria promote plant growth by supplying nitrogen or other nutrients to the plant, or by production of plant growth regulators. Over and above the well documented *Rhizobium* genus there are free-living nitrogen fixing bacteria that help plants markedly in obtaining nitrogen that can otherwise be poorly accessible for the plant. Another feature shared by many bacteria is the support provided to the plant in resisting plant disease. The latter bacteria can either have direct antagonistic effects towards a pathogen or activate the plant defence mechanisms locally or systemically. Endophytic bacteria can also compete with pathogens by limiting the availability of iron through siderophore production.

Compared to other fields of science, the application of bacteria in biocontrol of diseases and pests is in its infancy. Therefore, the basis of biocontrol is still undergoing clarification. In the narrowest sense biocontrol is considered to be the inoculation of plants with microbes to antagonise other harmful organisms. However, basic research has revealed a variety of bacterial bioactive products that can further be developed as new biocontrol compounds. Widely known examples are pyrrolnitrin, isolated from *Pseudomonas* spp. and developed into the fungicide fludioxonil, and harpin a heat-stable, cell-envelope-associated protein elicitor isolated from the severe pathogen *Erwinia amylovora* found to activate plant defenses. How widely genetically modified bacteria can be used for biocontrol in the future is dependent not only on research efforts but on the administrative regulations and common opinions about GMOs.

Studying plant-microbe interactions can be highly challenging as two or more organisms are involved. How to visualize bacteria in the plant tissue or to identify uncultivable organisms within the host requires specific methods and skills. The purpose of this book is to provide tools for those who are interested in the research and biotechnological applications of plant-associated bacteria. It will also provide a compilation of the current priorities in plant-bacteria interactions. The purpose of editors is to provide a collection of the basic and modern methods for studying plant-associated bacteria and biocontrol. We thank all colleagues and friends who selflessly were glad to expend their valuable time to contribute to this volume.

Seppo Sorvari
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