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PREFACE

Xenorhabdus-Steinernema and *Photorhabdus-Heterorhabditis*, Entomopathogenic Bacterium Nematode Symbioses

This volume of *Symbiosis* is devoted to papers examining various aspects of the relationship between entomopathogenic nematodes in the genera *Steinernema* and *Heterorhabditis*, and their bacterial symbionts, in the genera *Xenorhabdus* and *Photorhabdus*, respectively. The originality of these models is the establishment of a bacterial symbiosis maintained at the intestinal level of nematode infective juvenile larvae. Together these nematode-bacterial couples are efficient pathogens for a variety of different insects, many of which are economically important pests. While these systems are currently being developed for use as bio-insecticides, and while a large amount is being learned about intricacies of their symbioses, the field remains in its infancy, with critical unanswered questions.

For this reason, a meeting was convened in Debrecen, Hungary, under the sponsorship of the COST Action n° 819 promoted by the European Union for developing use of entomopathogenic nematodes in field of agriculture, to discuss the current state of knowledge with regard to many different aspects of these symbioses. Many presentations were made at the meeting, and in this volume we present a selection of these: several general review type articles that discuss some of the larger issues, followed by a series of directed publications that discuss some detailed studies of the symbiotic systems.

The volume begins with a paper by Wilkinson and Hay that discusses the symbiosis in general, and compares it to other known symbioses. Here the various intricacies of the nematode-bacterial symbiosis are compared to other more well-known systems. This is followed by a discussion of the symbiosis and

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pathogenicity of nematode-bacteria complexes by Boemare et al., in which the symbionts of a wide variety of different nematodes are documented, and many of the general features of the symbiosis are discussed. Here we have introduced for the first time, several major questions that will be addressed by more specific papers in the volume, such as the taxonomic status of the symbiotic bacteria, and issue of whether or not the symbionts are pure cultures, the specificity of the symbiosis, and the description and function of phase variation in the symbiosis.

The general review of Boemare et al., is followed by two papers from the laboratory of Stackebrandt, both of which stress the utility of genetic techniques in microbial ecology, with some specific references to their use for the study of the entomopathogenic bacteria. The first describes the use of molecular methods for the identification of culturable and non-culturable symbionts – such methodology may well be possible to use as a tool for answering whether or not non-culturable symbionts may be inhabiting the apparent pure culture environments of the symbiotic relationships. Next, the issue of the taxonomic and phylogenetic status of the symbiotic bacteria is addressed, using molecular (16S rRNA sequence comparison) methods. As the reader will see, the issues of taxonomic status are not yet settled.

The article by Dowds presents a review of the current status of molecular genetics investigations in *Xenorhabdus* and *Photorhabdus*: the major accomplishments in molecular biology for both genera are thoroughly reviewed. This is followed by an in depth review of phase variation as it exists in other organisms by Fussenegger. A phenomenon similar to phase variation exists in most, if not all, of these symbiotic bacteria, although the mechanism(s) by which it occurs is not at all clear. This comprehensive review presents four major strategies that bacterial pathogens use to escape host defense mechanisms, along with the molecular communication systems that allow the adaptations to optimize virulence and escape of the pathogens. Given that phase variation is one of the central unanswered problems in the *Xenorhabdus* and *Photorhabdus* systems, this review is particularly relevant to the subject of this volume.

The volume concludes with a series of more focused articles on various aspects of the entomopathogenic bacteria, including a short article on the induction of phase variants by growth in low salt media by Krasomil-Osterfeld. In this paper, it is reported that unstable phase II variants are produced by growth in low salt, and that continued growth in this medium leads to more stable phase II types. This article is followed by a short methodological paper by the Boemare laboratory, that describes some simple tests for distinguishing between phase I and phase II variants in both *Xenorhabdus* and *Photorhabdus*.

This paper should serve as a useful reference for those interested in easily and quickly identifying these sometimes elusive forms.

The outer membrane proteins of *X. nematophilus* have begun to be studied in detail by the Forst laboratory, and the next paper discusses in some detail the characterization of some of the proteins, with comparisons to similar systems in the enteric bacteria. This paper is followed by a description of the bioluminescence regulation in *P. luminescens*, including phase I, phase II, and a bright, highly pigment mutant called hyper by the Nealson laboratory. This mutant was isolated after chemical mutagenesis of a phase II variant, and is apparently over-expressed for several of the properties associated with phase variation.

One aspect of interest in these nematode/bacteria systems is the fact that the bacteria produce a wide variety of different compounds to inhibit the growth of competing bacteria. The structures of many of these compounds have been, and are being elucidated, and the article by Thaler et al., presents a brief summary of some of this work, along with some new insights into types of barriers that bacteria use to stop competing microbes.

As the entomopathogenic bacteria and their nematode hosts are commercialized, it becomes more important to understand the intricacies of each partner and the ways in which they communicate. The maintenance of a stable and reproducible symbiosis will certainly be a key importance in allowing these organisms to be used as biological insect control systems, and studies of the types presented will be essential.

We have to acknowledge the European Union for organizing the meeting at the origin of these publications and the editorial board of *Symbiosis* for accepting to publish them in a special issue devoted to entomopathogenic bacterial nematode complexes. This opportunity will introduce a new model for the scientists involved in symbiosis studies.

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