

Preface

Nematophagous fungi are an important, fascinating group of soil microorganisms that can suppress the populations of plant-parasitic nematodes. They have been studied over several decades and the beautiful micrographs of these fungi trapping nematodes have marveled scientists and students alike. These remarkable fungi are also important potential biocontrol agents of nematode diseases of plants and animals, they produce a swathe of natural chemicals and are model organisms for gene functional studies. The research team of Zhang Ke-Qin and colleagues has been working on many aspects of nematode-trapping fungi for more than 20 years. These studies have resulted in a wealth of information and it is now considered timely to bring all this information together into a book so that everyone who is interested can read about the amazing fungi.

The book comprises eight chapters, Chapter 1 is an overview of the data on nematode-trapping fungi presented in this book, including their taxonomy, phylogeny and evolution. Four general groups of nematophagous fungi are general accepted and are based on the mechanisms by which they attack nematodes. These consist of (1) nematode-trapping fungi using adhesive or mechanical hyphal traps, (2) endoparasitic fungi using their spores, (3) egg parasitic fungi invading nematode eggs or females with their hyphal tips, and (4) toxin-producing fungi immobilizing nematodes before invasion. The nematode-trapping fungi with adhesive or mechanical hyphal traps are the main focus of this book, while the other types of fungi are discussed but in less detail. Chapter 2 deals with the methodology to study nematode trapping fungi. Although there has been a huge increase in our knowledge of nematophagous fungi, the methodology used to study these organisms are unique and have changed little over the years. These methods are detailed in Chapter 2 and include techniques for obtaining mixed cultures of the fungi from nature, for isolating taxa into pure culture, for observing living material and for making permanent microscope preparations. Chapter 3 deal with history and taxonomy of orbiiliaceous nematode-trapping fungi, the filamentous species forming trapping devices to prey nematodes. The taxonomic history of predatory orbiiliaceous fungi is reviewed and the system of using trapping devices as the primary morphological criterion for generic delimitation is advocated. Following this taxonomic concept, keys for genera of *Arthrobotrys*, *Drechslerella* and *Dactylellina*, which include all reported species

of predatory orbiliaceous fungi are presented. Totally, 54, 14 and 28 species from *Arthrobotrys*, *Drechslerella* and *Dactylellina* respectively, are morphologically described and illustrated. Known asexual-sexual connections (14 pairs) of predatory orbiliaceous fungi are summarized and their taxonomic descriptions and illustrations presented.

Chapter 4 deals with the ecology of nematode-trapping fungi. These fungi have extensively been studied both because of their unique predatory life history and because they are potential biocontrol agents of economically important plant- and animal- parasitic nematodes. Fundamental knowledge of the ecology of these fungi is therefore essential before the value of such biocontrol methods can be assessed. Topics dealt with in Chapter 4 include occurrence and habitats, geographical and seasonal distribution, quantification of abundance, and effects of soil conditions and nematode density on their distribution. Competition between nematodes and nematophagous fungi, the effect of fungistasis and extreme ecological factors such as heavy metals and salinity on these fungi, and their genetic diversity and speciation are included in this chapter.

In Chapter 5 the use of nematode trapping fungi in biological control is discussed. Plant-parasitic nematodes cause severe damage to world agriculture each year. Environmental and health concerns over the use of chemical pesticides has increased the need for alternative measures to control plant-parasitic nematodes. Nematophagous fungi, a natural enemy of nematodes, have received most attention in biological control of plant-parasitic nematodes. This is due to their specific ability to capture and kill nematodes. Nematophagous fungi are divided into four groups according to their mode of action against nematodes, and several fungi such as *Pochonia chlamydosporia* and *Paecilomyces lilacinus* have been developed as commercial biological nematicides. In Chapter 5, important nematode parasitic and antagonistic fungi, and their taxonomy, biology and their mode of action are discussed. Progress in the study of highly virulent fungal strains for nematode biological control, and application of nematode-antagonistic agents are also discussed.

In Chapter 6 we describe the characterization of extracellular enzymes from nematophagous fungi, the expression and regulation of serine protease prC in *Clonostachys rosea*, and the genome and proteomic analyses of the nematode-trapping fungus *Arthrobotrys oligospora*. At present, the detailed molecular pathogenic mechanisms against nematodes by nematophagous fungi have not yet been fully elucidated. However, increasing evidence show that extracellular hydrolytic enzymes including proteases, collagenase, and chitinase may be involved in nematode-cuticle penetration and host-cell digestion. Recently, the crystal structures of proteases (Ver112 and PL646) and chitinase CrChi1 from nematophagous fungi were resolved, which can help us to identify the active site residues and to elucidate the catalytic mechanism of these enzymes involved in infection against hosts. The expression and regulation of protease PrC from *Clonostachys rosea* by different environmental conditions has also been reported. The genome of *Arthrobotrys oligospora* has been sequenced, and a model of nematode trap formation in *A. oligospora* suggested; thus the genome data may serve as a roadmap for further investigations

into the interaction between nematode-trapping fungi and their host nematodes, providing broad foundations for research on the biocontrol of pathogenic nematodes.

Nematode-trapping fungi having proven to be a treasure house of novel chemicals. Chapter 7 summarizes more than 200 compounds from fungi that have been shown to possess nematocidal activities. These compounds belong to diverse chemical groups including alkaloid, quinone, isoeopoxydon, pyran, furan, peptide, macro-lide, terpenoid, fatty acid, diketopiperazine, aphthalene and simple aromatics. They have mainly been isolated from a variety of ascomycetous and basidiomycetous fungal taxa. Their nematocidal activities are described and their potential roles in the biocontrol of nematodes are discussed.

Previous studies based on traditional techniques have revealed much about nematophagous fungi. Modern techniques however, can now help to elucidate the molecular mechanisms underlying infection of nematodes by the nematophagous fungi, and help us to understand virulent factors, the role of proteases, chitinases and small chemical molecules, and the regulation of trap formation. Further studies using modern molecular techniques are needed to better understand these important mechanisms and the overall functioning of nematode trapping fungi and the future studies needed are addressed in Chapter 8.

It has been a privilege to participate in the compilation of this book on nematode-trapping fungi. Although I have barely studied the nematode-trapping fungi through one student, Aung Swe, I believe these fungi to be truly amazing and I have enjoyed editing the writings of the various authors of the world experts at the Yunnan University nematode-trapping fungi laboratory. A huge amount of work on this organisms has come out the laboratories of Zhang Ke-Qin as well as other laboratories and it has been an honour to help put this data together in a modern book on nematode-trapping fungi. I hope the readers will find as much enjoyment in reading the book as I have in editing it.

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September 2013

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Nematode-Trapping Fungi

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2014, XI, 392 p. 137 illus., 14 illus. in color., Hardcover

ISBN: 978-94-017-8729-1