Progress in Biological Control

Volume 19

Series editor
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Biological control of pests, weeds, and plant and animal diseases utilising their natural antagonists is a well-established but rapidly evolving field of applied ecology. Despite its documented applications and systematic development efforts for longer than a century, biological control still remains a grossly underexploited method of pest management. Its formidable potential represents the best hope to providing lasting, environmentally sound, and socially acceptable control of most problem pests in agriculture, and of invasive alien organisms threatening global biodiversity. Based on the overwhelmingly positive features of biological control, it is the prime candidate in the search for reducing dependency on chemical pesticides. Public demand for finding solutions based on biological control is the main driving force in the rapid development in the various strategies of utilising natural enemies for controlling noxious organisms. This book series is intended to accelerate these developments through exploring the progress made within the various aspects of biological control, and via documenting these advances to the benefit of fellow scientists, students, public officials, and the public at large. Each of the books in this series is expected to provide a comprehensive, authoritative synthesis of the topic, likely to stand the test of time.

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Prospects for Biological Control of Plant Feeding Mites and Other Harmful Organisms

Springer

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Obituary Maus Sabelis (1950–2015)

Maurice Sabelis passed away on January 7, 2015, after having been ill for 2 years.

He started his scientific career with a PhD in theoretical production ecology at Wageningen University in The Netherlands, where he was subsequently appointed assistant professor. After being employed as associate professor of Animal Ecology at the University of Leiden for a period of 4 years, he became full professor in Population Biology at the University of Amsterdam.

Maurice was a scientist in heart and soul, a Jack of all trades and a master of many. He was a theoretician, an experimenter and a modeller, and covered ecology, evolutionary biology, epidemiology, acarology, biological control and behavioural ecology. With others, he discovered how plants defend themselves against herbivores by recruiting predators. His research also resulted in the discovery of various natural enemies that are currently used in biological control of pests. In 2006, he was awarded the prize of Academy Professor of the Royal Netherlands Academy of Arts and Sciences.

A creative and innovative scientist, Maurice was a source of inspiration for many young scientists all over the world. Many of the dozens of PhD students that were supervised by him are now authorities in their areas of scientific expertise. His network of collaborators encompassed the globe. To be sure, they will all dearly miss his stimulating, critical and warm personality.

by Arne Janssen, Associate professor, University of Amsterdam

Series Preface

Biological control of pests, weeds, and plant and animal diseases utilising their natural antagonists is a well-established and rapidly evolving field of science. Despite its stunning successes worldwide and a steadily growing number of applications, biological control has remained grossly underexploited. Its untapped potential, however, represents the best hope to providing lasting, environmentally sound, and socially acceptable pest management. Such techniques are urgently needed for the control of an increasing number of problem pests affecting agriculture and forestry and to suppress invasive organisms which threaten natural habitats and global biodiversity.

Based on the positive features of biological control such as its target specificity and the lack of negative impacts on humans, it is the prime candidate in the search for reducing dependency on chemical pesticides. Replacement of chemical control by biological control—even partially as in many IPM programs—has important positive but so far neglected socioeconomic, humanitarian, environmental, and ethical implications. Change from chemical to biological control substantially contributes to the conservation of natural resources and results in a considerable reduction of environmental pollution. It eliminates human exposure to toxic pesticides, improves sustainability of production systems, and enhances biodiversity. Public demand for finding solutions based on biological control is the main driving force in the increasing utilization of natural enemies for controlling noxious organisms.

This book series is intended to accelerate these developments through exploring the progress made within the various aspects of biological control and via documenting these advances to the benefit of fellow scientists, students, public officials, policy-makers, and the public at large. Each of the books in this series is expected to provide a comprehensive, authoritative synthesis of the topic, likely to stand the test of time.

Helsinki, Finland — Heikki M.T. Hokkanen

Preface

This book is intended to facilitate future investigations on the potential implementation of biological control of harmful organisms using predatory mites. These beneficial arthropods represent an important resource for development of biological control programs, a subject of considerable interest for acarologists, entomologists, integrated pest management, and medical and veterinarian specialists who are actively searching for efficient and sustainable methods of pest control.

Applied biological control must be based on fundamental studies that elucidate the taxonomy, biology, mode of reproduction, behavior, prey range, and rearing techniques of the potential biological control agent. These studies are considered as the prelude for ecological field research designed to evaluate the relative importance of predatory mites with respect to their regulation of the target pest. The above mentioned knowledge must configure a solid basis to develop effective classical, augmentative, or conservation biological control programs. This book provides information on the levels of knowledge on several groups of mites within the Mesostigmata and Prostigmata, with regard to their current or potential use in biological control.

Mesostigmata or Gamasida predators are encountered in soil and litter, on aerial parts of plants, or in patchy habitats such as nests or galleries of insects, mammals, and birds, where they feed on small insects and nematodes or on phytophagous and mycophagous mites, showing a remarkable range of morphological and behavioral traits. Most of them are free-living predators, but some have established symbiotic relationships with other arthropods and disperse by phoresy. The first five chapters of this book refer to different groups of mesostigmatid predators. Chapter 1 provides a general description of the morphological and biological characteristics of species in this order and specifically mites in the superfamilies Rhodacaroidea and Parasitoidea, which are encountered in the soil or litter, or associated with insect galleries and mammal nests. Trends in efforts to understand the diversity, distribution, habitats, ecology, reproduction, and the practical use of species within these groups in biological control efforts are discussed. In addition, this covers other

groups of the infraorder Gamasina that have received less attention than the former, including the hyporders Epicriiae, Arctacariae, Dermanyssiae and Parasitiae, and the suborders Trigynaspida and Sejida. Chapter 2 reviews the potential of individuals from the families Ascidae, Blattisociidae, and Melicharidae for control of damaging mites and small insects. Special emphasis is given to their association with other organisms, dispersion mechanisms, feeding habits, and general biology. Mites within the genera *Blattisocius* Keegan, *Lasioseius* Berlese, and *Proctolaelaps* Berlese, which have been the subject of more detailed studies, are discussed here. Chapter 3 addresses predators within the Laelapidae family with a special focus on free-living predators of the subfamily Hypoaspididae, which are successfully used in biological control of thrips (Thysanoptera: Thripidae), sciarid flies (Diptera: Sciaridae), nematodes (Rhabditida: Steinernematidae: Heterorhabditidae; Tylenchida: Tylenchulidae), and poultry mites (Acari: Dermanyssidae). The Macrochelidae family (Chap. 4) is composed of a diverse group of predators that live mostly in animal excrements. Representatives of these groups inhabit mostly patchy transient habitats and thus rely on other organisms for dispersal by phoresis. The interesting dispersal mechanisms displayed by macrochelids and the implications that they have on biocontrol programs are discussed in detail. These mites have great potential for control of different fly species (Diptera: Muscidae), thrips, and fungus gnats (Diptera: Sciaridae). The last group of mesostigmatid mites covered in this book is the family Phytoseiidae (Chap. 5). This group is referred to as the most important family of plant inhabiting predatory mites, which have been extensively used as biological control agents for management of mite and insect pests of crops grown in greenhouses and in open field conditions. This chapter provides statistics about the taxonomy, distribution, and habitats, together with a summary of the most recent investigations on specific species of phytoseiids.

Prostigmata predators are also found in diverse habitats, including soils and overlaying litter layers as well as aerial parts of plants. Chapter 6 provides a general description of the morphological and biological characteristics of the predatory species in the suborder, which also has a large number of phytophagous mites. Subsequently, Chap. 7 focuses on the generalist predators of the family Stigmaeidae, providing a review of the taxonomy, basic biology, and reproduction patterns observed in the group. The potential target pests, efficacy studies, seasonality, mass-rearing techniques, compatibility with other IPM practices, and the economic and commercial considerations of using stigmaeids in biological control are discussed. Chapter 8 deals with the Erythraeidae family, with a special reference to the potential use of the red velvet mite *Balaustium leanderi* (Heitlinger) as a biological control agent of spider mites, whiteflies, and thrips, pests of flower and vegetable crops in Colombia. The last family of prostigmatid predators covered in this book is the Cheyletidae (Chap. 9). This provides general information on the taxonomy and behavior of these predators, with special reference to *Cheyletus* species used for control of various arthropods that damage stored products.

In order to substantiate the chapters referring to larger taxonomical groups, Chaps. 10 and 11 document long-term investigations on the practical use of predatory mites targeting pest mites. The first example (Chap. 10) describes an

intelligent approach referred to as “food web engineering” in which selected cover crops are used to enhance biological control of *Tetranychus urticae* (Tetranychidae) by resident phytoseiid mites in citrus orchards in Valencia, Spain. Chapter 11 documents multiple tactics used throughout decades of sustained efforts to biologically manage a number of spider mites on avocado in California, USA. This chapter discusses the use of several native and exotic phytoseiid predators and reviews the value of stigmaeid mites as predators. Lastly, Chap. 12 deals with pathogenic fungi that are highly specific natural enemies of pest mites and discusses their compatibility and complementary role with the use of predatory mites.

This book was possible because of the generous efforts by a group of proactive acarologists and biocontrol practitioners from around the globe in response to the growing public demand for a sustainable agriculture.

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