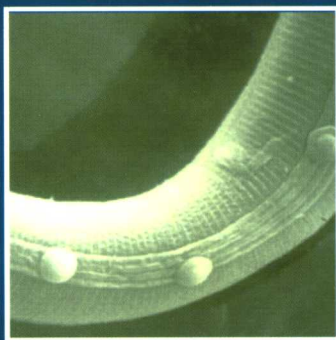


Nematology

ADVANCES AND PERSPECTIVES

Volume 2

Nematode Management and Utilization



Edited by

Z. X. Chen, S. Y. Chen and D. W. Dickson



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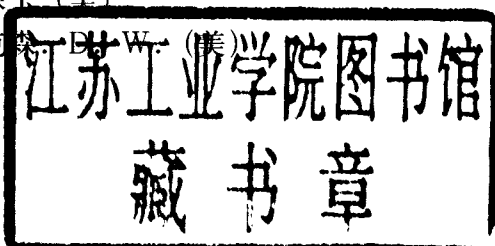
线虫学 进展和前景

卷 2 : 线虫的控制和利用

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内 容 简 介

本套书分为 I, II 两卷。第 I 卷阐述线虫形态学、生理学和生态学;第 II 卷讲述线虫的控制和利用。本书的焦点集中在上世纪后期有显著进步并且现在仍是主要研究方向的各个领域,其中主要包括自由生活、植物寄生和昆虫寄生线虫。编撰这本书的目的是总结 20 世纪线虫学研究的进展并提出 21 世纪线虫学研究发展的前景。希望本书能起到一个路标图的作用,能标出目前线虫学科最重要的各个方面,为研究人员和研究生提供重要的信息和依据,并将线虫的研究带入新的世纪。

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Preface

Nematology, Advances and Perspectives

During the 20th century, science and technology have developed in an unparalleled manner. This is especially true for nematology. Since Cobb first recognized nematology as an independent discipline during the early part of the century, nematology has made unparalleled advances and become an integral part of the biological sciences. The development of nematology is largely attributed to the discovery of the importance of nematodes in agricultural ecosystems and their impact on society. Nematodes are the most abundant and diversified group in the animal kingdom, and four out of five animals on earth are nematodes. Marine nematology has become an independent discipline and it has been suggested that the secret of the natural history of our planet may lie in the nematodes dwelling deep in oceans. Animal-parasitic nematodes have had great impact on human health and society throughout history. Soil nematodes play important roles in organic degradation, mineralization, and food webs in soil ecosystems. While most nematode species in soil are beneficial, some species are important pathogens of plants and cause severe damage to crops. Worldwide crop yield losses to nematodes have been estimated at approximately \$ 78 billion annually. The advances in nematology and related disciplines, however, have drastically strengthened our ability to fight this unseen enemy. Thus, over the past century, billions of dollars of crop losses from nematode damages have been prevented.

One of the most exciting and important new fields of nematology includes recent advances made in the use of nematodes as model organisms for basic biological studies, especially in developmental biology, genetics, and cellular and molecular biology. Using *Caenorhabditis elegans* as a model, scientists have unraveled for the first time in history the complete genomic sequence of DNA from a multicellular organism. Also, they have documented cellular development from a single fertilized cell to a fully developed body.

Nematology is one of the most dynamic and exciting disciplines in the biological sciences. It is impossible to cover every aspect of nematology in this book. Furthermore, several topics in nematology reached their climax during

the past century, but interest has now ebbed. The major focus of this book is on topics that have made remarkable advances in the latter part of the century and currently are of primary research emphasis. These topics will relate mainly to free-living, plant-parasitic, and entomopathogenic nematodes.

The following lists of chapters evolved after lengthy discussion and consultation with fellow nematologists. We are pleased that so many renowned nematologists with international reputations and experiences have responded positively to the book proposal and agreed to make authoritative contributions. It is overwhelming to have nematologists around the world making a collaborative effort to produce a quality book. The book is to be published in 2004. Therefore, we shall consider it a memorial to the achievements in nematology in the 20th century and as a beacon for future developments in nematology during the new century. For many reasons, we believe that nematology will become a primary focus in the agricultural sciences during the new century. With the rapid growth of the world's population, food and fiber demands in the next century will increase tremendously. But the task for nematologists is daunting in that funding, personnel in nematology, and graduate education has been sharply curtailed. Also, with the suspensions and phase-outs of many soil fumigants and nonfumigants and the threat for even more suspensions in the foreseeable future, the challenges will become even greater. Increased endeavors in nematode research will be essential to achieve the sustained growth of agriculture in the 21st century.

The objective of this book is to summarize advances in nematology that have been made during the 20th century and to provide perspectives for the development of nematology in the next century. It is aimed at researcher and graduate student communities. The international representation of the science will be a key component of this book. It is our hope that the book will provide a road map to the most important aspects of the science at this time and that it will provide critical thoughts and ideas for researchers and graduate students to carry forward into the next millennium.

The editors are indebted to the authors of the respective chapters for their excellent contributions. We are grateful to the large number of scientists who have provided valuable comments and suggestions during book proposal discussion and reviews of each individual chapter manuscripts. Finally, we express our gratitude to the Tsinghua University Press and CAB International for fulfilling this endeavor.

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在 20 世纪,科学技术以无以伦比的快速方式发展,尤其对线虫学更是可以如此概括。自从 Cobb(被誉为美国的线虫学之父)在 20 世纪初把线虫学建立成一门独立的学科以后,线虫学已经有了巨大的进步而且成为生物学整体中的重要部分。线虫学的发展主要是基于线虫在农业生态系统中的重要性和对社会的冲击。线虫是动物王国中最丰富和最多元化的群体,地球上每五只动物有四只是线虫。海洋线虫学已经变成一门独立的学科,而且它提出我们地球博物学的秘密可能就隐藏在大海深处的线虫之中。动物寄生线虫在历史上对人类的健康和社会有过很大的影响。土壤线虫在土壤生态系统中的有机降解、矿化和食物网中扮演重要的角色。虽然土壤中大多数的线虫种类是有益的,但某些种类是植物的重要病原而且造成对农作物的严重危害。线虫每年对全世界农作物的产量损失估计大约为 780 亿美元。然而,由于线虫学和相关学科的进步,也大大提高了我们对抗这个看不见的敌人的能力,在过去的这个世纪,我们也因此避免了数十亿美元来自线虫的农作物产量损失。

线虫学中的一个重要新领域和最新进展是用线虫作为基础生物学研究的样板生物,尤其在发育生物学、遗传学、细胞和分子生物学中广泛应用。利用 *Caenorhabditis elegans*,科学家们有史以来第一次阐明了一个多细胞动物的完整的 DNA 序列,他们也揭示了动物从一个单一受精卵发育到一个完全的身体的整个细胞发育历程。

线虫学是生物学中最具动态和令人兴奋的学科之一,在这本书中要涵盖线虫学的每个方面是不可能的。此外,一些线虫学中的主题在过去一个世纪期间达到了它们的高峰,但是现在兴趣已经消退。因此,本书的焦点将集中在上世纪后期有显著进步并且现在仍是主要的研究方向的主题上,这些主题将主要包括自由生活、植物寄生和昆虫寄生线虫。

本书各章是请教了许多知名线虫学家后讨论决定下来的。我们高兴的是有这么多具有国际声望和经验的线虫学家能响应本书而且同意做出权威的贡献。很少能见到有如此众多来自各国的线虫学家能共同协力创作这样

一本高质量的著作。本书将在 2004 年出版。因此,我们把它看作是对 20 世纪线虫学成就的一个纪念碑和指导 21 世纪发展的灯塔。有许多理由使我们相信线虫学在 21 世纪中将会是农业科学中的一个主要焦点。藉由世界人口的迅速增长,对食物和纤维的要求在 21 世纪内将会有巨大的增加。但是,线虫学家的工作却受资金、人事和研究生教育锐减等方面的不利影响而缩减。同时,由于许多土壤熏蒸剂和非熏蒸剂要被禁止或撤消使用,对线虫防治的挑战将会更大。增加对线虫研究的投入将是 21 世纪保持农业持续增长的关键。

这本书的目的是总结 20 世纪线虫学的进步和提出 21 世纪线虫学发展的远景。它的读者对象为研究人员和研究生。学科的国际代表性也是这本书的一个主要方面。我们希望该书起到一个路标图的作用,能标出目前线虫学科最重要的各个方面,并且提供重要的想法和主意供研究人员和研究生参考。

编者感激作者们在各章中所做的优秀贡献。我们感谢各位线虫学家在讨论该书和审阅各章手稿时提供了有价值的意见和建议。最后,我们感谢清华大学出版社和英联邦农业局国际出版社出版了这本书。

编 者

This Book Is Dedicated To

Pinsan Chen
For his 50 years of career in nematology

Pinsan Chen was born on 3 December 1927 in Mengcheng County, Anhui Province, China. He received elementary, middle and high school education in his hometown and began college education in 1947 in the Division of Plant Pathology, Department of Agronomy, College of Agriculture, Nanjing University, China. After graduation in 1952, he taught botany and plant pathology in Agronomy Department, Beijing Mechanized Agricultural College.

In 1954, Pinsan accepted a research position at the Northern China Institute of Agricultural Sciences (later the Chinese Academy of Agricultural Sciences) focused on plant nematology, an area received little attention then in China. Without formal training in nematology, he was a self-starter and quick learner. With his insightful observations, he demonstrated that the causal organism of millet nematode disease was *Aphelenchoides* sp. rather than *Tylenchus* sp. as reported in literature.

In 1963, Pinsan designed first contemporary nematology laboratory in China based on literature from UK, Russia, Japan, and USA. Soon, he examined samples collected from crop fields, pastures, mountains, and wetlands. Based on the preliminary observations, he speculated that all reported most important plant-parasitic nematodes might exist in China, and proposed extensive research and management. In the following years, his research was focused on *Aphelenchoides* sp. on millet, *A. besseyi* on rice, *Anguina tritici* on wheat, *Ditylenchus* sp. on sweet potato, and root-knot nematodes (*Meloidogyne* spp.) on peanut and vegetables.

In late 1978 after the country emerged from the Cultural Revolution, with encouragement and support from senior scientists he restored the nematology laboratory, which was almost destroyed during the Cultural Revolution. Two years later, Pinsan recruited the first Master of Science degree student in his laboratory. He designated his laboratory focusing on the biology and management of root-knot and soybean cyst nematodes. In collaboration with

scientists from other institutes and laboratories, Pinsan developed soybean cyst nematode-resistant cultivars “Kangxian No. 1”, “Kangxian No. 2”, and “Qingdao No. 1”; and developed chemical control using Avermectin in nursery soil treatment and Methyl-isofenphus in field crops. During 1980–1996, Pinsan and co-workers identified a number of important nematodes that included eleven new records in China and three new species: *Heterodera sinensis*, *Meloidogyne fanzhiensis*, and *Pratylenchus artemisiae*.

In his extensive career, Mr. Chen published more than 30 papers, 50 popular articles, and seven books. He advised and co-advised eight Master of Science and two Ph.D. graduate students. He won one National Technology Invention Award, one National Science Advance Award, and six Provincial Science and Technology Advance Awards. Mr. Chen is currently a Professor Emeritus at the Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing, China.

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