

Book review

R. N. Perry, M. Moens and J. L. Starr (Editors) 2009. Root-knot nematodes. CABI, Wallingford, United Kingdom, 488 pp. ISBN – 13: 978 1 84593 492 7.

Three aims of this book were defined by the authors in the Preface: 1) to ‘focus on the main findings’; 2) ‘reflect recent advances in the molecular genetics’ and 3) ‘to highlight the control options’. This book, bound in an attractive cover, meets all these targets and provides the reader with an ‘in-depth’ vision of this very interesting group of parasites. The book is organised into separate chapters, with each chapter accompanied by its own list of relevant references. The colour plates are excellent and deserve special compliments; the printing of these was supported by Syngenta.

In the first chapter ‘*Meloidogyne* species – a diverse group of novel and important plant parasites’, authored by all three editors of the book, a condensed synopsis of the overall book content is presented. The main aspects of root-knot nematodes are briefly reviewed in this chapter and are considered in detail in subsequent chapters, but the reader of Chapter 1 will surely be satisfied with such an introduction into the complex information in the specialist chapters. Such primary data will be especially helpful for nematologists not dealing directly with plant-parasitic nematodes, as it explains such phenomena as the initiation and development of giant cells and the host reaction to nematode invasion, or the concept of host races. Several emerging species of *Meloidogyne* are also considered.

Chapter 2 ‘General morphology’ contains descriptions of the morphology of several stages of *Meloidogyne* development: adult nematodes and second-stage juveniles (J2). *Meloidogyne* nematodes have rather unusual morphogenesis. The feeding J2 has a swollen body, which can increase to give a nearly spherical female body or slim into a vermiform male. Peculiarities of the root-knot nematode structures are illustrated with numerous photographs (both light microscopy and SEM) and traditional art-line diagrams. Some figures are very visual, e.g. Fig. 2.1 providing an immediate image of the comparative sizes of adults and J2. This chapter has self-contained value for any nematologist, not only those interested in plant nematodes. *Meloidogyne* are among the most intensively studied groups of the Phylum Nematoda. Intensive TEM studies of the anterior end in general and amphids in particular have resulted in rich information about the morphology of this genus of plant-parasitic nematodes. One can only wonder how adaptation of parasitism in plants can change the quite stable archetype of secernentean (=Rhabditida) nematodes. The depth of coverage is different for separate systems and organs: digestive and reproductive systems are described in more detail than, for example, the nervous system of the sensory structures. What makes this chapter quite unusual is the template for the description of new species of *Meloidogyne*. All the required information is presented, and authors of future first descriptions are invited to provide molecular and isozyme characterisation, and ensure the inclusion of drawings for all taxonomically-sensitive features. It is a really interesting example of the self-organization of science. We have to propose regulations in order not to be swamped by numerous descriptions of low diagnostic value.

Chapter 3 ‘Taxonomy, identification and principal species’ will bring very special satisfaction to anyone who, like the author of this review, likes the history of science and considers as a proper act any homage to the previous generations of biologists. The first part of this chapter is illustrated with portraits of scientists who initiated the study of root-knot nematodes: the Rev. Miles Joseph Berkeley and Emilio Augusto Goeldi. The citation of Rev. Berkeley’s description of the nematode-induced galls is an amazing example of how precise were the observations of biologists in the XIX century, despite still primitive microscope optics. In this chapter, the authors (Drs D. Hunt and Z. Handoo) reveal several surprising stories, like the discovery of *Meloidogyne* eggs in the stool of US soldiers in Texas which led to the description of *M. incognita* Kofoid and White, 1919. Narration on the history of *Meloidogyne* research continues through the times of N.A. Cobb and B.G. Chitwood and ends in the contributions of recent years. As is common with nematode taxonomy, an understanding of the taxonomic importance of separate characters was changing with time. For example, the authors indicate that the value of perineal patterns was considered as highly important until pronounced intraspecific variation was recorded. Still the preparation of slides with perineal cuticle is described in full and perineal patterns for 12 *Meloidogyne* species of major importance are presented.

Chapter 4 ‘Biochemical and molecular identification’ is authored by two leading specialists in molecular taxonomy and biology of plant-parasitic nematodes, Drs V. C. Block and T. O. Powers. *Meloidogyne* is

probably quite a rare example of a group in which the taxonomy was based for more than a decade on the intensive use of isozyme patterns. Characteristic esterase and malate dehydrogenase phenotypes were described for nearly three dozen *Meloidogyne* species. After a short explanation about the use of antibodies in root-knot nematode identification, the authors move to probably the most intriguing part of the chapter – the impact of molecular techniques on *Meloidogyne* taxonomy. This part of the chapter contains general descriptions of the principal molecular techniques, the composition of the most popular primers and a map of the *Meloidogyne* mitochondrial genome. On page 109 one can find a list of ‘species-specific’ primers for *Meloidogyne* identification.

The problems of molecular taxonomy and phylogeny of root-knot nematodes are presented separately in Chapter 5. In addition to the quite well known phylogenetic analyses inferred from different domains of ribosomal RNA genes, the authors (Drs B.J. Adams, A.R. Dillman and C. Finlinson) are proposing several, still not complete, surveys based on single-copy orthologous nuclear genes. The problem of misrepresentation of the taxon phylogeny because of the presence of different copies of rDNA cistrons can be avoided through the use of such nuclear genes. Not all such genes are helpful for construction of *Meloidogyne* phylogeny – some of these are too conservative to distinguish between species. The part of the chapter devoted to the construction of a *Meloidogyne* ‘supertree’ is especially interesting. The authors present arguments in favour of construction of the tree, which will unite the phylogenetic signals of several trees based on different DNA domains. Two different methods of supertree construction – ‘matrix representation of parsimony’ and ‘distance fit’ produced similar topologies (e.g. *Meloidogyne ichinohei* is in basal position in all the supertrees).

Several of the following chapters describe specific events in the *Meloidogyne* life cycle (like Chapters 6, ‘Hatch and host location’ and 7, ‘Invasion, feeding and development’), or special functions and systems of organs (Chapter 8, ‘Reproduction, physiology and biochemistry’), or adaptations (Chapter 9, ‘Survival mechanisms’)

The subsequent part of the book deals with ecological aspects of root-knot nematode existence in soils. In Chapter 10, ‘Interaction with other pathogens’, several examples of synergistic effects are given, when the cumulative effect of penetration of root-knot nematodes and another (e.g. fungal) pathogen is greater than the simple additive effect. Chapter 11, ‘Population dynamics and damage levels’, is a classical analysis of factors influencing the population densities in root-knot nematodes. Such an analysis is accompanied by a short overview of models describing root-knot nematode dynamics and damage levels. Nematologists working in the field will find as very helpful that part of the chapter describing the experimental schemes (glasshouse and field experiments, microplots, fitting the models to data etc). Chapter 12, ‘Sampling root-knot nematodes’, presented by Drs L.W. Duncan and M.S. Philips can be considered as a logical outcome of the ecological data presented in previous chapters, as it stipulates the main principles of representative sample collection. Nematode spatial patterns dictate sampling schemes. The flotation method in solutions of higher gravity is considered by the authors of this chapter as the most effective of the various sample processing methods. It is mentioned in the chapter that the importance of root-knot nematode sampling and precise estimation of nematode densities became more important with the exclusion of chemical compounds from agricultural practice. Growers are interested in the detailed picture of root-knot nematode distribution in the field, as this can help to focus use of control measures on focal points of nematode densities.

The next three chapters cover the problems of resistance against *Meloidogyne* in plants and the possibility of manipulating resistance mechanisms for control. In Chapter 13, ‘Mechanisms and genetics of resistance’, the most completely described resistance genes of different plants preventing the parasitism by root-knot nematodes are summarised. The short introduction into the mechanisms of plant resistance to pathogens in plants is very helpful, at least for a beginner in this field. The action and properties of the most studied root-knot nematode resistance gene, *Mi-1* of tomato, are presented in detail. The fine details of the mechanisms that trigger the action of his gene are still not understood, although the gene is known to be suppressed by the addition of cytokinin and enhanced by salicylic acid. Rich genetic resources of natural host plant resistance traits described in this chapter are critical for the development of control measures based on resistance genes. However, the next chapter, Chapter 14, ‘Development of resistant varieties’, brings more sober information on this topic. Five successive crops of tomato plants with the *Mi* gene were sufficient to see the rise of *M. incognita* population virulent for this cultivar. Still, the resistance approach is possible, and the authors (Drs J.L. Starr and C.F. Mercer) propose a compendium of steps and actions for the development of a resistance-breeding programme, including search for sources of resistance, methods of screening etc. Chapter 15, ‘Plant biotechnology and control’, by H.W. Atkinson, P. E. Urwin and R. S. Hussey covers the problems very

similar to those in focus in the previous chapter, but with a more pronounced bias toward protein engineering. Novel for nematologists, is the information about *Cry* proteins as biopesticides, which will be especially interesting in Russia with our long lasting Bt-research programmes. RNAi is now in the arsenal of tools for suppression of root-knot nematodes. Such an approach is especially interesting as no new proteins are expressed by transgenic plants, producing only these double-stranded RNA molecules.

Towards the end of the book the reader will find Chapter 16, 'The complete sequence of the genomes of *Meloidogyne incognita* and *Meloidogyne hapla*'. The subject area of this chapter is closer to Chapters 4 and 5 (related to molecular phylogeny), and not to chapters about the problems of root-knot nematode control that comprise the final part of the book. The chapter is extremely helpful for the readers inexperienced in molecular biology, as it explains the rationale of the EST approach for genomic studies, the problems of the search for parasitism-specific genes etc. Several fascinating facts about the genome of the two species of *Meloidogyne* are presented in the text. The structure of the genome is quite different in *Meloidogyne incognita* and *M. hapla*. The repetitive or transposable elements comprise 36% of *M. incognita* genome. Special attention is devoted to plant parasitism genes. Table 16.3 demonstrates the remarkable richness of the genes encoding cell-wall-degrading enzymes in *M. incognita* in comparison with *Caenorhabditis* and *Drosophila*. Many of these genes are thought to have been acquired by horizontal gene transfer from bacteria.

Three chapters in the final part of the book, Chapter 17 'Biological control using microbial pathogens, endophytes and antagonists', Chapter 18 'Current and future management strategies in intensive crop production systems' and Chapter 19 'Current and future management in resource-poor farming' are all oriented toward practical application. Dr J. Hallmann and his co-authors of Chapter 17 admit that biological preparations against root-knot nematodes are an 'extremely elusive management tool'. This is the case for all 'biologicals' but for root-knot nematode management the use of biological control has to be accompanied by modern crop production technology.

The book contains three separate indices, 'Gene Index', 'Nematode genus and species index' and 'General Index', which is very convenient for the reader.

Several editorial patterns of the book deserve special praise. Thus, 'conclusions and future directions' are presented at the end of each chapter and represent a very valuable part of this book. What could be more helpful for the beginner in this field than the opinion of experienced colleagues, who can define still unresolved key problems in all this complicated 'megaproblem' of root-knot nematode research? Numerous new facts and concepts are directly included in the book. The reader thus obtains a set of carefully selected published papers and completely new scientific facts about *Meloidogyne*. It is very important to have such book in any laboratory dealing with root-knot nematodes, both as source of basic facts and as an invigoration for further studies.

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