

## BOOK REVIEW

**Lacey L.A., Kaya H.K. (Eds.). 2007. Field Manual of Techniques in Invertebrate Pathology. 2nd Edition. Application and Evaluation of Pathogens for Control of Insects and Other Invertebrate Pests. Springer, Dordrecht, 868 pp. ISBN 978-1-4020-5932-2**

As indicated in the „Preface“ this manual is designed to provide a background and instruction on a broad spectrum of techniques and their application in the studies and evaluation of microbial control agents against insects and other arthropods noxious to forests and field, horticulture and orchard crops,

The editors invited 81 authors who contributed 40 chapters referring to basic studies of various groups of pathogens and their evaluation under field conditions.

SECTION I. „Introduction“ (p. 3–34) contains two chapters. In Chapter I-1 „Introduction to microbial control“ (p. 3–7) H. Kaya and L. A. Lacey emphasize two subjects: (a) advantages and disadvantages of microbial agents and (b) role of entomopathogens in pest suppression. In Chapter I-2 „Theory and practice of microbial insecticide application“ (p. 9–34) A. C. Chapple, R. A. Downer and R. P. Bateman discuss various systems of application and droplet spectra securing proper deposition of microbials on plant surface.

SECTION II. „Statistical Considerations“ (p. 36–69) contains one Chapter II.1. „Experimental design: statistical consideration and analysis“ in which J. F. Campbell and S. P. Wraight provide information on how field experiments in invertebrate pathology and microbial control should be designed and the data collected, analyzed and presented.

SECTION III. „Application Equipment“ (p. 71–146) contains three chapters. In Chapter III.1. „Ground-based application equipment“ (p. 73–98) R. P. Bateman, G. A. Matthews and F. R. Hall discuss several topics pertinent to application biopesticides, such as optimum droplet size, use of air-assisted boom, soil application of baits and granules. In Chapter III-2. „Conventional application equipment: aerial application“ (p. 99–126) K. Mierzejewski, R. C. Reardon and H. Thistle discuss use of aerial spray delivery system based on Geographic Information System (GIS) platform. In Chapter III.3. „Dissemination of beneficial microbial agents by insects“ (p. 127–146) F. E. Vega, P. F. Dowd, L. A. Lacey, J. K. Pell, D. M. Jackson and M. G. Klein discuss and provide examples of manipulated dissemination of entomopathogens e.g. *Beauveria* spp. and *Metarhizium anisopliae* against *Popillia japonica* and *Baculovirus* spp. against *Helicoverpa virescens* and *Autographa californica*.

SECTION IV. „Overview of Pathogen Groups“ (p. 147–264) contains five chapters. In Chapter IV-1. „Viruses“ J. S. Cory and H. F. Evans in a descriptive and tabular form provide information on fourteen virus families and characterize ecologically-based control strategies for use of viruses. In Chapter IV.2. „Bacteria“ (p. 175–197) S. F. Garczyński and J. P. Siegel provide information on taxonomy of *Bacillus thuringiensis* and related species and produced by them toxins which show activity against *Lepidoptera*, *Diptera*, *Coleoptera*, *Hymenoptera*, *Nematoda* and human cancer line activity. Characteristics of *Bacillus sphaericus* and *Paenibacillus popilliae* are also discussed. In Chapter IV.3. „Entomopathogenic microsporidia“ (199–221) L. F. Solter and J. J. Becnel provide information on use of microsporidia in insect control in terrestrial and aquatic systems. In a tabular form information on potential use of 22 microsporidian against target noxious insects are provided. In Chapter IV.4. „Fungi“ (p. 223–248) S. W. Wraight, G. D. Inglis and M.S. Goettel provide information on use of entomopathogenic fungi and assessing their efficacy under controlled-environment and field cages. In Chapter IV-5. „Nematodes“ (p. 249–264) A. M. Koppenhöfer provides information on environmental considerations, application technology and general methodology for determining performance of entomopathogenic nematodes against target insects.

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SECTION V. “Naturally Occurring Pathogens” (p. 265–296) contains two chapters. In Chapter V.I. “Documentation of naturally occurring pathogens and their impact in agroecosystems” (p. 267–281) D. C. Steinkraus discussed the following topics: (1) control of pests by naturally occurring pathogens, (2) a model for predicting control of *Anticarsia gemmatalis* populations on soybean by *Nomuraea rileyi*, (3) prediction of natural epizootic of *Neozygites fresenii* in *Aphis gossypii* populations. In Chapter V.2. “Assessing impacts of naturally occurring pathogens of forest insects” (p. 283–296) J. S. Elkinton and John Burand provide information on detection pathogens – *Entomophaga maimaiga* and their effect on populations of *Lymantria dispar*.

SECTION VI. “Exotic Pathogens” contains one Chapter VI. “Introduction of exotic pathogens and documentation of their establishment and impact” (p. 299–325) in which A. E. Hajek, I. D. Junior, M. L. McManus discuss such topics like: (a) pathogen selection and identification, (b) site selection and pathogens introductions, (c) releasing pathogens into the host habitat, (d) evaluating pathogen establishment and impact, (e) non-target effects, (f) cost-benefit analysis.

SECTION VII. “Evaluation of entomopathogens in specific systems” (p. 329–359) contains 23 chapters. In Chapter VII.1. “Application and evaluation of entomopathogens in potato” (p. 329–359) S. P. Wraight, M. Sporleder, T. J. Poprawski, L. A. Lacey broadly discuss methods and results of obtained commercial products of *Bacillus thuringiensis* ssp. *tenebrionis* and *Beauveria bassiana* in biocontrol of the Colorado potato beetle (*Leptinotarsa decemlineata*), and granulosus potato tuber moth virus (*Baculovirus* sp.) against potato tuber moth (*Phthorimea operculella*). In Chapter VII-2. “Application and evaluation of entomopathogens in crucifers and cucurbits” J. D. Vanderberg and A. M. Shelton describe protocols of application of selected microbial agents for control of various species of *Coleoptera* and *Lepidoptera* species noxious to various crucifers (*Cruciferae*) and cucurbits (*Cucurbitaceae*). Specific protocols for application and evaluation of selected microbial control agents are provided. In Chapter VII.3. “Microbial control of insect pests of corn” (p. 375–392) L. C. Lewis, D. J. Bruck, J. J. Jackson provide information on use of *Bacillus thuringiensis*, *Beauveria bassiana*, *Nosema* spp., *Vairiormorpha* spp., *Steinernema* spp. *Baculovirus* spp. against several species of *Heliothis* spp., *Diabrotica* spp., *Ostrinia* spp. and others. In Chapter VII-4. “Evaluation of microbial agents against rice pests” (p. 393–409) H. Y. Choo and W. C. Rice describe use of microorganisms against major rice pests from *Homoptera*, *Coleoptera*, *Diptera* and *Lepidoptera* orders. In Chapter VII-5. “Microbial control of insect pests of soybean” (p. 411–426) F. Moscardi and D. R. Sosa-Gomez describe use of microbials against *Lepidoptera* and *Hemiptera* species noxious to soybean. In Chapter VII-6. “Microbial insecticide application and evaluation: Cotton” (p. 427–453) D.C. Steinkraus, S. Y. Young, D. H. Gouge, J. E. Leland describe application of *Bacillus thuringiensis*, *Steinernema* spp., *Beauveria* spp., *Paecilomyces fumosoroseus* against *Heliothis* spp. and *Pectinophora gossypiella*. In Chapter VII-7. “Mushroom pests” (p. 457–461) P. S. Grewal describes biocontrol options for mushroom pests using nematodes, fungi and bacteria. In Chapter VII-8. “Techniques for testing microbials for control of arthropod pests in greenhouses” (p. 463–479) H. D. Burgess provides detailed information on main greenhouse pests in the United Kingdom and on microbial and integrated pest management with specific design to greenhouses. In Chapter VII-9. “Forest defoliators” (p. 481–504) K. van Frankhuysen, R. C. Reardon and N. R. Dubois describe development and current use of *Bacillus thuringiensis* and *Baculovirus* spp. mainly against *Lymantria dispar*, *Neodiprion sertifer*, *Orgyia pseudotsugata* and *Choristoneura fumiferana* considering spray techniques and droplet density and size distribution. In Chapter VII-10. “Microbial control of wood-boring insects attacking forest and shade trees” (p. 505–525) A. E. Hajek and L. S. Bauer discuss use of entomopathogens against wood-boring pests attacking shade and forest trees e.g. *Anoplophora glabripennis*, *Scolytus scolytus*, *Hylobius abietis*.

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In Chapter VII-11. "Microbial control of lepidopteran pest of apple orchards" (p. 527–546) L. A. Lacey, S. P. Arthurs and J. Huber discuss use of viruses, bacteria, fungi and nematode bioinsecticides and consider inoculum preparation, spraying equipment and timing and frequency of application made in orchards against various lepidopteran pests. In Chapter VII-12 "Microbial control of insect pests of stone fruit and nut crops" (547–565) D. I. Shapiro-Ilan, L. A. Lacey and J. P. Siegel discuss use of microbial control agents against e.g. *Amyelois transitella*, *Curculio caryae*, *Rhagoletis indifferans* using various microbial agents. In Chapter VII-13. "Application and evaluation of entomopathogens for citrus pest control" (p. 567–581) C. W. McCoy, R. J. Stuart, L. W. Duncan and D. I. Shapiro-Ilan discuss use of fungi and nematodes against *Phyllocoptruta oleivora*, *Panonychus citri* and others. In Chapter VII-14. "Small fruits" (p. 583–598) S. R. Booth, F. A. Drummond, and E. Groden discuss use of *Bacillus* spp., *Steinernema* spp., *Heterorhabditis* spp. against various pests e.g. *Otiiorhynchus* spp., *Amathes c-nigrum*, *Altica sylvia*. In Chapter VII-15 "Application and evaluation of entomopathogens for control of pest insects in mint" (p. 599–607) R. E. Berry discuss use of *Bacillus thuringiensis*, *Steinernema* spp. and *Heterorhabditis* spp. against root weevils (*Otiiorhynchus* spp.) and cutworms (*Noctuidae*). In Chapter VII-16 "Insect and mite control on nursery and landscape plants with entomopathogens" (p. 609–626) D. J. Bruck, R. R. Berry and J. D. DeAngelis discuss use of various pathogens against root feeders (e.g. *Otiiorhynchus sulcatus*), wood borers (e.g. *Synanthedon culiciformis*), defoliators (e.g. *Xantogaleruca luteola*). In Chapter VII-17 "Grasshoppers and locusts" (p. 627–654) G. D. Inglis, M. A. Erlandson and D. K. Weaver provide a "Key to the pathogen groups affecting acridoids based on macroscopic and microscopic signs of diseases" and broadly discuss propagation, formulation, and application of various microorganisms against this important pest category. In Chapter VII-18 "Lawn, turf and grassland pests" (p. 655–675) M. G. Klein, T. A. Jackson, A. M. Koppenhöfer discuss use of various species of bacteria, fungi and nematodes against various target insects e.g. white grubs, mole crickets, *Tipula* spp., and the application techniques used at the dissemination of pathogens. In Chapter VII-19 "Application and evaluation of entomopathogens for managing insect in stored products" (p. 677–693) J. C. Lord, J. F. Campbell, J. D. Sedlacek and P. V. Vail characterize major stored pest species and provide experimental protocols for evaluation of *Baculovirus* spp., *Bacillus thuringiensis* and *Protozoa* against coleopteran and lepidopteran stored product pests. In Chapter VII-20 "Microbial control of urban pests – cockroaches, ants and termites" (p. 695–711) R. J. Milner and R. M. Pereira characterize pathogens of cockroaches *Blattella germanica*, *Blatta orientalis*, *Periplaneta americana*, *Reticulitermes flavipes* and *Coptotermes formosanus* and their use against the above pests. In Chapter VII-21 "Application and evaluation of entomopathogens for control of livestock and poultry pests" (p. 713–734) D. E. Pinnock and B. A. Mullens discuss scientific and technical problems connected with use of entomopathogens against pests of (a) extensive rangeland system and (b) pests of intensive animal husbandry systems. Overview of potential microbial control agents for manure flies or beetles is provided. In Chapter VII-22 "Microbial control of mosquitoes and black flies" (p. 735–750) O. Skovmand, J. Kerwin and L. A. Lacey discuss scientific and technical problems and equipment used in microbial control of mosquitoes and black flies using nematode *Romanomermis culicivorax* and fungus *Lagenidium giganteum*. In Chapter VII-23 "Terrestrial mollusc pests" (p. 751–765) M. J. Wilson discuss scientific and technical problems connected with use of a nematode *Phasmarhabditis hermaphrodita* against *Deroceras reticulatum*. Problems of monoxenization and DNA characteristic of this nematode are also considered.

SECTION VIII. "Transgenic plants" contains one Chapter VIII-1 "Evaluating transgenic plants for suitability in pest and resistance management programs" (p. 769–789) in which M. A. Caprio and D. V. Sumerford discuss methods preventing development of insect resistance to transgenic plants with incorporated genes from an insect pathogenic bacterium *Bacillus thuringiensis*.

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SECTION IX. "Resistance" contains one Chapter IX-1 "Resistance to insect pathogens and strategies to manage resistance: An Update" (p. 793–811) in which A. M. Shelton, P. Wang, J.-Z. Zhao and R. T. Roush list documented cases of insect resistance to pathogens used in microbial control of plant and animal pests. Examples of such cases are listed and recommendation for avoiding resistance are provided.

SECTION X. "Non-target organisms" contains only Chapter X-1 "Guidelines for evaluating effects of entomopathogens on non-target organisms" (p. 815) in which A. F. Hajek and M. S. Goettel discuss importance of considering e.g.: (1) defining host range of applied microbial agents; (2) application strategy and non-target effects which differ by application strategy; (3) methods for non-target evaluation (laboratory, semi-field, microcosmos).

From the above concise review it is absolutely evident that second edition of "The Field Manual of Techniques in Invertebrate Pathology" provides excellent backgrounds and instructions on a broad spectrum of techniques that allow: (1) to evaluate the role of various biotic agents in natural reduction of abundance of animal and plant pests; (2) to produce and effectively use microbial pesticides based on various species of viruses, bacteria, fungi, protozoa and nematodes in biological control of plant and animal pests.

This treatise absolutely should be in every library concerning natural, medical, ecological and agricultural sciences as it provides excellent knowledge on: (1) role of microorganisms in natural reduction of various groups of invertebrates; (2) methods of collection and identification of viruses, bacteria, fungi and protozoans occurring in natural populations of arthropods and other invertebrates; (3) theory and practice of microbial control of arthropods and other invertebrates noxious from medical, agricultural and veterinary standpoint.

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