

Entomology in Focus 3

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Short Views on Insect Genomics and Proteomics

Insect Genomics, Vol.1



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Short Views on Insect Genomics and Proteomics

Insect Genomics, Vol.1

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Short Views on Insect Genomics and Proteomics, Volumes 1 and 2

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Preface

Insects are the most successful group of animals on the planet and are ecologically and economically extremely important. Today's entomology field has gone beyond borders and is termed as a "super science." With its multidisciplinary approach, entomology explores new scientific frontiers. It has emerged to provide some of the most powerful tools in resolving fundamental biological questions and problems using genomic (genome sequencing, assigning functions to genes, determining genome architecture) and proteomic (nature of proteins, 3D structure, posttranscriptional modifications) approaches.

Whole-genome sequence projects for insect model organisms (29 insect species completed and many more under way) and the concurrent growth of sequence databases provide the biological sciences with invaluable sources of information. The two volumes of this book are intended to share the efforts of major contributors with the genomic and proteomic communities. This will pave the way toward the development of new and innovative approaches to improve public health and agriculture using effective and ecologically sound pest management systems.

We therefore decided to create an up-to-date reference that would provide a firm basis for understanding the past and current genomic and proteomic research conducted in entomology. To do this, we decided to bring together leading world scientists in molecular entomology and biotechnology to share their past experiences in the development of this field, to summarize the current state of the art, and to offer hypotheses and predictions to set a framework for future research. This book is composed of volumes 1 and 2 with 18 chapters.

Volume 1 *Short Views on Insect Genomics*

The first volume presents 8 chapters that address genomic approaches currently employed using various model organisms: body lice, whitefly, aphid, *Drosophila*, mosquitoes, lepidopterans, and others.

Chapter 1 provides a detailed story of the body louse genome project and its significance in understanding fundamental questions about the biology of lice and their endosymbionts. Of importance, it discusses the use of reverse genetics (RNAi) to answer questions about the role of specific genes in biological processes (Barry R. Pittendrigh, University of Illinois, USA).

Chapter 2 addresses advances in the genomics of the whitefly, *Bemisia tabaci*, an insect pest and plant virus vector. It also discusses the interaction between insects and viruses and the development of control strategies using RNAi approaches (Murad Ghanim, Agricultural Research Organization, Israel).

Chapter 3 provides an update on the scope and scale of the genomic data of Lepidoptera that is available in public databases and discusses the current status of lepidopteran genome projects. Special attention is drawn to (i) *Elongation factor-1 α* , (ii) *Wingless*, (iii) *Cytochrome c oxidase I*, and (iv) *ribosomal DNA and RNA* (América Nitxin Castañeda-Sortibrán, Universidad Nacional Autónoma de México).

Chapter 4 deals with the genetic and molecular mechanisms underlying the evolution of different aphid biotypes with respect to naturally occurring host plant resistance (Andy Michel, Ohio State University, USA).

Chapter 5 presents integrative genomic approaches used in studying epigenetic mechanisms of phenotypic plasticity in the pea aphid. It describes how epigenetic mechanisms (DNA methylation and chromatin remodeling) play an increasingly important role in winged vs wingless polyphenism in this highly adaptable species (Gael LeTrionnaire, Institut National de la Recherche Agronomique, France).

Chapter 6 provides an introduction to the concepts behind the dynamic and powerful field of insect regulatory genomics. It describes successful strategies and techniques for finding regulatory elements in model insect species like *Drosophila*, current efforts to extend them to evolutionarily diverged non-model organisms, and potential applications of this information using such approaches as gene transfer and RNAi (Marc S. Halfon, University at Buffalo-State University of New York, USA).

Chapter 7 presents a comprehensive coverage of comparative genomics of transcription factor binding in *Drosophila* by using ChIP-Chip, ChIP-Seq, and DamID techniques to discover a deeper understanding of genomic regulatory mechanisms (Steven Russell, University of Cambridge, UK).

Without the application of bioinformatics, the growth of genomic and proteomics would be limited. Chapter 8 focuses on a machine learning approach (ClanTox, NeuroPID, TOLIPs) to discover short bioactive proteins and peptides from insect genomes (Michal Linial, the Hebrew University of Jerusalem, Israel).

Volume 2 *Short Views on Insect Proteomics*

The second volume presents comprehensive and cutting-edge studies with emphasis on proteomics. It comprises 10 chapters which constitute a key reference manual for everyone involved in insect biochemistry, molecular genetics, molecular evolution,

insect bioinformatics and structural biology, applications of insect biotechnology, insect “omics,” and related fields.

Ticks transmit viral diseases to livestock, which are of great economic importance worldwide. Chapter 1 focuses on ticks (blood-sucking parasite) and recent developments in the field of sialomes (salivary gland proteomes). It discusses the regulation of host hemostasis and the molecular immune mechanisms behind it. It also discusses the utilization of salivary gland proteins in vaccines to control vector-borne diseases (Younna M'ghirbi, University of Tunis El-Manar, Tunisia).

Current proteomic approaches rely on the application of mass spectrometry to protein molecules. Chapter 2 describes qualitative and quantitative proteomic methods for the analysis of the *Anopheles gambiae* mosquito proteome with emphasis on circadian changes in expression (Giles E. Duffield, University of Notre Dame, USA).

Chapter 3 reviews recent advances in the knowledge of the lepidopteran digestive system. Key topics include the architecture, structure, and function of the lepidopteran peritrophic matrix (Dwayne D. Hegedus, Agriculture and Agri-Food Canada, Canada).

Many key agents protect insects from injury at low temperatures. Chapter 4 documents cold adaptation responses in insects and other arthropods using an “omics” approach (Duško P. Blagojević, University of Belgrade, Serbia).

Chapter 5 presents evidence for the evolutionary extinction of enzyme and molecular systems that engage and utilize the nonstandard amino acid, selenocysteine, in insects (Marco Mariotti, Centre de Regulació Genòmica, Barcelona, Spain).

Chapter 6 highlights recent progress in understanding the mechanisms behind the insect innate immune response with the silkworm, *Bombyx mori*, as a model organism. It reviews the characteristic features of antibacterial proteins and antimicrobial peptides (AMPs) produced by insects against pathogens, their modes of action, and current and potential medical applications of these molecules (Chandan Badapanda, Xcelris Genomic Research Center, India).

Chapter 7 takes the reader to the post genomic era where insects have become important models for applied sciences. This chapter describes the use of insect cell lines derived from model organisms like *Bombyx mori* as expression systems for vaccines and other peptides and proteins, and the use of advanced protein expression systems based on the *B. mori* nucleopolyhedrovirus (BmNPV) bacmid (Enoch Y. Park, Shizuoka University, Japan).

Chapter 8 concentrates on the use of insects and their associated microorganisms as an important resource in diverse industries, especially for the production of industrial enzymes, microbial insecticides, and many other substances (Anthony Ejiofor, Tennessee State University, USA).

Chapter 9 deals with the special structure and properties of spider silks and their biotechnological applications (Daniela Matias de C. Bittencourt, Brazilian Agricultural Research Corporation, Brazil).

Chapter 10 focuses on the development, properties, and application of nanoparticles derived from plants producing bioactive compounds for use as novel agents to control human and insect pests (K. Murugan, Bharathiyar University, India).

It is our pleasure to launch the twin volumes of *Short Views on Insect Genomic and Proteomics*, in the Springer series, 3 & 4. The reader will find a wide variety of topics addressed in detail, which will help them update their knowledge of insect genomics and proteomics.

Manhattan, KS, USA
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The chapters of this book series (Volumes 1 and 2) are organized to present many experts' contributions – highlighting their current lab research – to provide an overview of current and prominent advances in insect genomics and proteomics, and biotechnology, which will help students and researchers to broaden their knowledge and to gain an understanding of both the challenges and the opportunities behind each approach.

We collectively called the volumes *Short Views on Insect Genomics and Proteomics* with the support of Springer Science Media. I would like to extend my sincere gratitude to Prof. Cónsoli L. Fernando for approving this project. It was a really wonderful opportunity to work with the Springer editorial team (Dr. Zuzana Bemhart, Senior Publishing Editor; Mariska van der Stigchel, Editorial Assistant; Dr. William F. Curtis, Executive Vice President; Dr. Jacco Fllipsen, Vice President; Dr. Sadie Forrester, Executive Editor) and many more from the Springer family. We apologize to those whose work could not be cited owing to space considerations as well as any errors that may have occurred in the text, and we would be grateful to receive any comments or suggestions about improvements for further editions.

I thank my associate editors (Prof. Marian Goldsmith, University of Rhode Island, USA, and Dr. Tolulope A. Agunbiade, Yale University School of Medicine, USA, and Howard Hughes Medical Institute, USA) for their continuous support and vigilance over the book project and for always giving advance notice of the editing and proofreading schedules. Most importantly, I want to express appreciation to my wife (P.G. Brintha, “Division of Biology”, Kansas State University, USA), who in all possible ways helped to transform our original efforts into an acceptable final form.

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