

# CONTENTS

*Preface* ix

*Contributors* xiii

- 1. Overview: Ticks, People, and Animals** 3  
Daniel E. Sonenshine and R. Michael Roe
- 2. Modern Tick Systematics** 17  
Lance A. Durden and Lorenza Beati
- 3. Life Cycles and Natural History of Ticks** 59  
Dmitry A. Apanaskevich and James H. Oliver, Jr.
- 4. External and Internal Anatomy of Ticks** 74  
Daniel E. Sonenshine and R. Michael Roe
- 5. Integument and Ecdysis** 99  
W. Reuben Kaufman
- 6. Mouthparts and Digestive System: Anatomy and Molecular Biology of Feeding and Digestion** 122  
Daniel E. Sonenshine and Jennifer M. Anderson
- 7. Salivary Glands: Structure, Physiology, and Molecular Biology** 163  
Francisco J. Alarcon-Chaidez
- 8. Excretion and Water Balance: Hindgut, Malpighian Tubules, and Coxal Glands** 206  
Daniel E. Sonenshine
- 9. Heme Processing and the Evolution of Hematophagy** 220  
Ben J. Mans

10. Respiratory System: Structure and Function 240  
Laura J. Fielden and Frances D. Duncan
11. Circulatory System and Hemolymph: Structure, Physiology, and Molecular Biology 258  
Libor Grubhoffer, Nataliia Rudenko, Marie Vancova, Maryna Golovchenko, and Jan Sterba
12. Fat Body and Nephrocytes: Structure and Function 287  
Lewis B. Coons
13. Nervous and Sensory Systems: Structure, Function, Genomics, and Proteomics 309  
Ladislav Šimo, Daniel E. Sonenshine, Yoonseong Park, and Dušan Žitňan
14. Molecular Biology and Physiology of Chemical Communication 368  
Albert Mulenga
15. Heme-binding Lipoglyco-storage Proteins 398  
Sayed M. S. Khalil, Kevin V. Donohue, R. Michael Roe, and Daniel E. Sonenshine
16. Hormonal Regulation of Metamorphosis and Reproduction in Ticks 416  
R. Michael Roe, Kevin V. Donohue, Sayed M. S. Khalil, Brooke W. Bissinger, Jiwei Zhu, and Daniel E. Sonenshine
17. Female Reproductive System: Anatomy, Physiology, and Molecular Biology 449  
Mari H. Ogihara and DeMar Taylor
18. Male Reproductive System: Anatomy, Physiology, and Molecular Biology 484  
Daniel E. Sonenshine and Lewis B. Coons

Index 519

To view the book's supplementary materials, please go to [www.oup.com/us/biologyofticks2e](http://www.oup.com/us/biologyofticks2e)

1. Volume 1, Supplementary Fig. S18.1: Lobe of *Dermacentor variabilis* male accessory gland periodic acid schiff stain.
2. Volume 1, Supplementary Fig. S18.2: Lobe of *Dermacentor variabilis* male accessory gland mucicarmine stain.
3. Volume 1, Supplementary Table S18.1: Proteomics of the *Dermacentor variabilis* male reproductive system and spermatophore.

## Volume 2. Ecology, Genomics, Disease and Control

## Contributors ix

1. Ecology of Non-nidicolous Ticks 3  
Sarah E. Randolph
2. Ecology of Nidicolous Ticks 39  
Jeremy S. Gray, Agustín Estrada-Peña, and Laurence Vial
3. Tick Genetics, Genomics, and Transformation 61  
Jason M. Meyer and Catherine A. Hill
4. Tick-Host Interactions 88  
Stephen K. Wikel
5. How Ticks Control Microbes: Innate Immune Responses 129  
Wayne L. Hynes
6. Tick-borne Protozoa 147  
Adalberto A. Pérez de León, Edouard Vannier, Consuelo Almazán,  
and Peter J. Krause
7. Tick-borne Viruses 180  
Patricia A. Nuttall
8. Tick-borne Spotted Fever Group Rickettsioses and *Rickettsia* Species 211  
Kevin R. Macaluso and Christopher D. Paddock
9. Tick-borne Rickettsioses II (Anaplasmataceae) 251  
Holly D. Gaff, Katherine M. Kocan, and Daniel E. Sonenshine
10. Non-rickettsial Tick-borne Bacteria and the Diseases They Cause 278  
Nick H. Ogden, Harvey Artsob, Gabriele Margos, and Jean Tsao
11. Tick-induced Paralysis and Toxicoses 313  
Agustín Estrada-Peña and Ben J. Mans
12. Development of Vaccines for Control of Tick Infestations and Interruption of  
Pathogen Transmission 333  
José de la Fuente and Katherine M. Kocan
13. Acaricide Research and Development, Resistance, and Resistance  
Monitoring 353  
Felix D. Guerrero, Adalberto A. Pérez de León, Roger I. Rodríguez-Vivas,  
Nick Jonsson, Robert J. Miller, and Renato Andreotti

**14. Tick Repellent Research, Methods, and Development 382**

Brooke W. Bissinger and R. Michael Roe

**15. Tick Control: Trapping, Biocontrol, Host Management, and Other  
Alternative Strategies 409**

Howard S. Ginsberg

**16. Tick Rearing and in Vitro Feeding 445**

Sandra A. Allan

*Index 475*

**Supplementary Materials ([www.oup.com/us/biologyofticks2e](http://www.oup.com/us/biologyofticks2e))**

1. Volume 2, Supplementary Table 3.1: Summary of Published Complete Genome Sequences for Selected Tick-borne Pathogens
2. Volume 2, Supplementary Table 3.2: Summary of RNAi-based Functional Studies in Species of Ixodid Ticks
3. Volume 2, supplementary references for Supplementary Tables 3.1 and 3.2.
4. Volume 2, Supplementary Table 7.1: Tick-borne Viruses.