

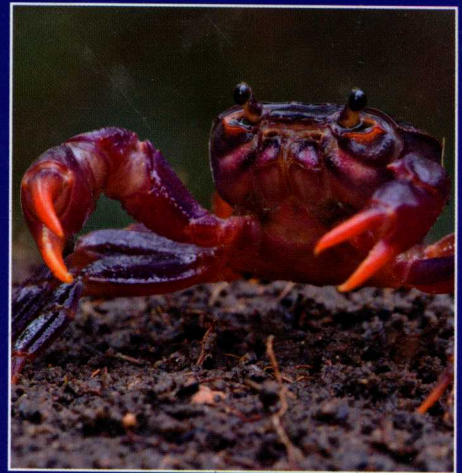
Fourth Edition

Volume I

Ecology and General Biology

Thorp and Covich's
Freshwater Invertebrates

Edited by
James H. Thorp and D. Christopher Rogers



Ecology and General Biology

Thorp and Covich's Freshwater
Invertebrates - Volume I

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Ecology and General Biology

Thorp and Covich's Freshwater Invertebrates

A Global Series of Books on the Identification,
Ecology, and General Biology of Inland Water Invertebrates
by Experts from Around the World

Fourth Edition

Edited by James H. Thorp

Volume I : Ecology and General Biology

Edited by James H. Thorp and D. Christopher Rogers

Published 2015

Volume II: Keys to Nearctic Fauna

Edited by James H. Thorp and D. Christopher Rogers

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Volume III: Keys to Palaearctic Fauna

Edited by D. Christopher Rogers and James H. Thorp

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"To the many dedicated authors and both old and new friends who over the years have contributed their efforts and hard-won knowledge to these books and research on invertebrate ecology and taxonomy."

James H. Thorp

"To my family and anyone else who has wondered what was going on under the water's surface."

D. Christopher Rogers

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Acknowledgments for Volume I

Many people contributed to this volume in addition to the chapter authors and those acknowledged in individual chapters. We greatly appreciate all our colleagues who have contributed information, figures, or reviews to Volume I and also thank those who provided similar services for the earlier editions, upon which the present book partially relies. In particular, we would like to thank Vince Resh, who suggested a number of possible chapter authors in addition to writing his own chapter.

Finally, we are again grateful to the highly competent people at Academic Press/Elsevier who helped in many aspects of the book's production from the original concept to the final marketing. In particular, we appreciate our association with Sean Coombs and Candice Janco in the U.S. offices of Elsevier, as well as past editors who assisted us in producing T&C I–III.

James H. Thorp
D. Christopher Rogers

About the Editors

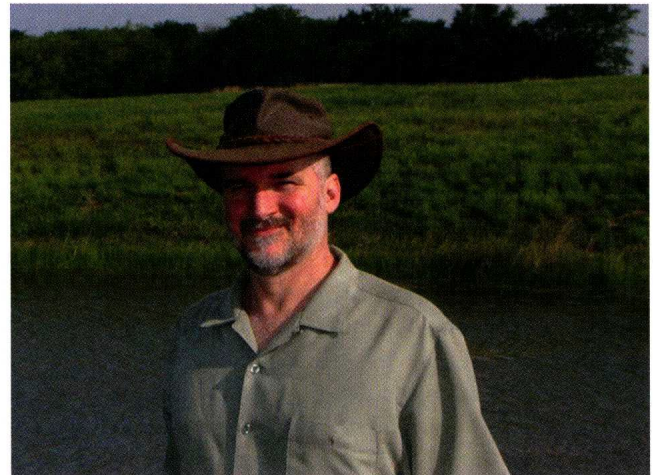


Dr. James H. Thorp has been a Professor in the Department of Ecology and Evolutionary Biology at the University of Kansas (Lawrence, KS, USA) and a Senior Scientist in the Kansas Biological Survey since 2001. Prior to returning to his *alma mater*, Prof. Thorp was a Distinguished Professor and Dean at Clarkson University, Department Chair and Professor at the University of Louisville, Associate Professor and Director of the Calder Ecology Center of Fordham University, Visiting Associate Professor at Cornell University, and Research Ecologist at the University of Georgia's Savannah River Ecology Laboratory. He received his Baccalaureate degree from the University of Kansas and both Masters and PhD degrees from North Carolina State University. Those degrees focused on zoology, ecology, and marine biology, with an emphasis on the ecology of freshwater and marine invertebrates.

Dr Thorp is currently on the editorial board of two journals (*River Research and Applications* and *River Systems*) and is a former President of the International Society for River Science (ISRS). He teaches three courses at the University of Kansas (Principles of Ecology, River and Lake Ecology, and Marine Biology) and has both Masters and doctoral graduate students working on various aspects of the ecology of organisms, communities, and ecosystems in rivers, reservoirs, and wetlands.

Prof. Thorp's research interests and background are highly diverse and span the gamut from organismal biology to the ecology of communities, ecosystems, and macrosystems. He works on both fundamental and applied research topics

using descriptive, experimental, and modeling approaches in the field and laboratory. While his research emphasizes aquatic invertebrates, he also studies fish ecology especially as related to food webs. He has published more than one hundred refereed journal articles, books, and chapters, including three single-volume editions of *Ecology and Classification of North American Freshwater Invertebrates* (edited by J.H. Thorp and A.P. Covich). Prof. Thorp is now embarked on a major project to expand from the previous North American emphasis on freshwater invertebrates to the fourth edition's global coverage of this subject in perhaps nine volumes of *Thorp and Covich's Freshwater Invertebrates*.



D. Christopher Rogers is a research zoologist at the University of Kansas with the Kansas Biological Survey and is affiliated with the Biodiversity Institute. Christopher specializes in freshwater crustaceans (particularly the Branchiopoda and the Decapoda) and the invertebrate fauna of seasonally astatic wetlands on a global scale. He has numerous peer reviewed publications in crustacean taxonomy and invertebrate ecology, as well as published popular and scientific field guides and identification manuals to freshwater invertebrates. Christopher is an Associate Editor for the *Journal of Crustacean Biology* and a founding member of the Southwest Association of Freshwater Invertebrate Taxonomists. He has been involved in aquatic invertebrate conservation efforts all over the world.

Preface to the Fourth Edition

When Alan P. Covich and I initially conceived the first edition of *Ecology and Classification of North American Freshwater Invertebrates* in the mid-1980s (subsequently published in 1991 by Academic Press), the possibility of a second edition (2001) was only vaguely considered, much less a third (2010). Between the second and third edition, I tried to convince some European scientists to develop independently a similar approach for their fauna, but a lack of interest at that time doomed this proposed Elsevier book project. Less than a year after the third edition, an acquisition editor at Elsevier (Candace Janco) inquired about a fourth edition for 2015 at an annual meeting of the North American Benthological Society (now Society for Freshwater Sciences). Other project commitments prevented Alan from continuing as a coeditor, and I felt that 2015 was too early for a fourth edition without major changes in the scope of the project or detail of the keys. At that point a kernel of what was possibly a creative but certainly audacious idea began to sprout. This soon grew to a proposal I submitted with D. Christopher Rogers to develop an approximately 9-volume series covering inland water invertebrates of the world. (Christopher had coauthored two chapters in the third edition and has now coauthored *A Field Guide to Freshwater Invertebrates of North America* with me.) Although the prospectus ultimately submitted to Elsevier included books covering all major zoogeographic regions, the initial contract was limited to three volumes encompassing the world's major book markets (Europe and the USA).

While I am the sole editor of the book series at this time, Christopher has been a major partner in developing ideas for the fourth edition and is an editor on the other volumes (senior editor on the third). As we made significant progress on the first three volumes, we began contacting some potential coeditors and authors to develop volumes for other zoogeographic regions and negotiations with some of those volumes are now underway.

Based on my feelings and recommendations of Academic Press, I have named our book series *Thorp and Covich's Freshwater Invertebrates* in order to: (a) associate present with past editions, unite current volumes in the fourth edition, and link to possible future editions; (b) establish a connection between the ecological and general biology

coverage in volume I with the taxonomic keys in the remaining volumes; and (c) give credit to Alan Covich for his work on the first three editions. For the sake of brevity, I refer to the current edition as T&C IV. Whether T&C "V" will ever appear is certainly problematic, but who knows!

Our concept for T&C IV included producing one book (volume I) with 6 chapters on general environmental issues applicable to many invertebrates, followed by 35 chapters devoted to individual taxa at various levels (order to phylum, or even multiple phyla in the case of the protozoa). Volume I was designed both as an independent book on ecology and general biology of various invertebrate taxa and as a companion volume for users of the keys in the regional taxonomic volumes, thereby reducing the amount of duplicate information needed for the taxonomic volumes.

The perhaps eight taxonomic volumes will contain both keys for identifying invertebrates in specific zoogeographic regions and descriptions of detailed anatomical features needed to employ those keys. The multilevel keys are formatted to enable users to work easily at the level of their project/course need and their scientific experience. For that reason, we separated keys by major taxonomic divisions. For example, a student in a college course might work through one or more of the initial crustacean keys to determine the family to which a freshwater shrimp belongs. In contrast, someone working on an environmental monitoring project might need to identify a crayfish to genus or even species, and thus would use the relevant, detailed keys that require more background experience. We have also designed the keys, where possible, to proceed from a general to a specific character within a couplet. These changes to the key are one of Christopher's major contributions to T&C IV.

While the vast majority of authors in T&C I–III were from the USA or Canada, we attempted in T&C IV to attract authors from many additional countries in six continents. Although we largely succeeded in this goal, we expect future editions of T&C to continue increasing the proportion of authors from outside North America as our books become better known internationally.

Our goals for T&C IV are to improve the state of taxonomic and ecological knowledge of inland water

invertebrates, to help protect our aquatic biodiversity, and to encourage more students to devote their careers to working with these fascinating organisms. These goals are especially important because the verified and probable losses of species in wetlands, ponds, lakes, creeks, and

rivers around the globe exceed those in most terrestrial habitats.

James H. Thorp
Editor-in-Chief, T&C IV

Preface to Volume I

Readers familiar with previous three editions of the Thorp and Covich (T&C) volumes will notice a dramatic change in T&C IV, as we have expanded from a North American concentration to worldwide coverage. This volume consists of 6 general chapters on inland water habitats and invertebrates, and 35 chapters on the ecology and general biology of specific groups. The greatest difference between this volume of T&C IV and the chapters in T&C III is that all taxonomic keys have been shifted to separate volumes. This has allowed an increase in the ecological coverage in volume I and more detailed keys in subsequent volumes. This enabled us to expand from the North American-centric coverage in previous editions to the global ecological perspective characterizing T&C IV, which is one of the reasons we increased the international representation of authors. In the process we added some groups not occurring in the Nearctic (e.g., aquatic millipedes) or whose numbers were not large in the Nearctic (e.g., freshwater crabs and shrimp, which dominate tropical freshwater habitats). Readers of the earlier editions will note that we have expanded coverage of the ecology and general biology of insects from a single chapter in T&C III to 9 chapters in volume I. However, the taxonomic keys in Volume II for the Nearctic Region remain limited to family level to avoid duplication with the excellent existing text on North American aquatic insects by Merritt, Cummins, and Berg (2008). The literature-cited sections in volume I represent a compromise between T&C II and III, in that we have returned to inclusion of author names and dates in the text (rather than just numbered citations) and have expanded the number of allowed citations at the end of each chapter, as in T&C II; however, the average number of references per chapter in this printed volume is often less than in the first two volumes in order to save space. T&C IV continues our policy from the previous

edition of being in color for volume I; indeed, we have considerably augmented the number of color figures. We believe this helps students, in particular, appreciate better that bright colorful invertebrates are not entirely limited to marine and terrestrial habitats.

This edition is strongly focused on species found in fresh through saline inland waters, with a nonexclusive emphasis on surface waters. Again, most estuarine and parasitic species are not covered in this book, but we do discuss species whose life cycles include a free-living stage (e.g., Nematomorpha) and species that live in hard freshwaters through to brackish waters even though they may be normally associated with estuarine or marine habitats in some parts of their life cycles (e.g., some shrimp and crabs).

It is our hope that scientists and students from around the world will enjoy this volume, but it is also important that we interest the younger generation (especially the kindergarten through middle school group of children) in freshwater invertebrates. One way that this could happen is to present them with interesting books to read on these organisms and freshwaters in general. Few have been written, but one of the more interesting ones includes biology, ecology, and even rudimentary taxonomy! That book is entitled *The Secret Life of Streams* and was authored by Lynell Marie Garfield, with contributions from Daniel Devine, Jason Barnes, and Sandra L. Silva (see www.clearmountainstream.com). This charming children's book was published in 2013 by Lucy Bat Books (www.luckybatbooks.com) and has an ISBN number of 1-9390-5133-9). We strongly recommend you consider getting this book for your younger children.

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