

Concepts in
Animal
Parasitology

Scott L. Gardner
and
Sue Ann Gardner
Editors

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Preface

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IMPETUS FOR PREPARING THIS BOOK

The United Nations (UN) has declared education as a basic human right. One of the UN’s sustainable development goals is a call to ensure “inclusive and equitable quality education and promotion of lifelong learning opportunities for all” (United Nations, 2023; see also WOERC, 2012). Depending on the specifics of their implementation, financing, and dissemination models, open educational resources (OERs) have the potential to help in the effort to achieve equitable learning across the globe (Orr et al., 2015; Lee and Lee, 2021; see also Bali et al., 2020).

Open educational resources are “teaching, learning, and research materials in any medium that reside in the public domain or have been released under an open license that permits their free use and re-purposing by others” (Creative Commons, 2014). Wiley (2020) cites the Creative Commons’ framing of OERs as providing explicit permission to “retain, re-use, revise, remix, and redistribute” openly-accessible educational material.

Aside from the obvious benefit of saving students money, OERs have been shown to promote equity among students. Their use has been shown to contribute to maintenance or improvement of student success, especially with respect to retention in school, course completion, grade point average, and subsequent educational attainment (Colvard et al., 2018; Griffiths et al., 2022; Fischer et al., 2015).

HOW TO USE THIS BOOK

Scope

This is a textbook covering concepts in animal parasitology. It is meant to be used by students, teachers, professors, researchers, and members of the public who are interested in learning about animal parasite biology, systematics, taxonomy, zoogeography, and ecology. The primary intended audience is upper-level undergraduate or graduate university students who have knowledge of basic biology and, particularly, basic animal biology.

Organization of the Book

This textbook was conceived to fill a gap in educational materials about parasitology. One of the main goals in both teaching and learning about parasites and parasitology is to understand the diversity of parasites and of parasitism as a way of life on Earth. With this in mind, the editors made a decision to treat the organization of the book as though led by the organisms themselves—a sort of bottom-up approach—and present the parasitic organisms as a parasitologist will first find them in nature, as in: Where they tend to exist in relation to their host, and more specifically, whether inside or outside the host animal. Therefore, the book includes sections covering a few taxonomic groups representing just some of the millions of extant endoparasite (Greek: **endo** = inside; **para** = beside; **sitos** = food) and ectoparasite (Greek: **ektos** = outside) species.

Examples of endoparasites are parasitic trematodes or nematodes that live inside the respiratory systems or gastrointestinal tracts of their hosts. Ectoparasites include lice and ticks, almost all fleas, many mites, a few platyhelminths that live on echinoderms, and even some chordates like the lamprey and vampire bat. Some groups of animals, such as monogeneans and mites, are not neatly categorized and may live part of their lives as endoparasites and part of their lives as ectoparasites or as free-living animals. Despite these myriad variations, the editors believe that the basic division between endo- and ecto- serves well enough to organize the chapters.

In approaching the organization in this way, the focus of the book is primarily at the level of species and other lower level taxonomy as opposed to higher-level groupings which are notoriously constantly in flux. The classification of parasites based on phylogenies is useful and necessary to understand the diversity, diversification, and evolution of parasites, but classification does not dictate the book’s primary organization. Instead, the concept of biodiversity of parasites and their animal hosts is the main factor that motivates the research and teaching in the Harold W. Manter Laboratory of Parasitology (University of Nebraska State Museum, Lincoln, Nebraska, United States) where editor Scott L. Gardner conducts his work. It is this push toward understanding biological diversity of parasites that overarchingly informs the organization of this book.

Note about Bibliographical References

The citations in the book are formatted to promote finding usable copies, they are not meant to serve as an archival resource. As such, and to save space, only the first four authors are listed for each resource. A digital object identifier (doi) is included whenever one could be found; but the dois are not

hot linked since these links would often take readers to pay-walled versions. Readers are encouraged instead to attempt to locate free, legal versions of the resources included in the references whenever possible. For example, free-to-read versions (and sometimes also open access versions) of the papers may be available in institutional repositories, on authors' personal websites, or from academic social media sites.

Note about Images

When selecting images, the editors relied on the guidelines included in Egloff et al. (2017) regarding copyrightability of images that serve as biodiversity data. Beyond this broad framework to guide selection, the images in the book were chosen ultimately based on the following criteria: Conceptual applicability, quality, allowable copyright and permissions, and (for human subject images) an acceptable declaration of informed consent (see Roguljić and Wager, 2020). Due to the constraints of these criteria, there are several sections in the book that are lightly illustrated. Where images are sparse or lacking, instructors are encouraged to insert their own images or select images from other sources, including those used under applicable fair use/fair dealing or educational use guidelines.

Accompanying Glossary

A supplemental glossary is in the process of preparation. Until the glossary is completed, a work that may be used in its stead for many of the terms found in the book is the Dictionary of Invertebrate Zoology (Maggenti et al., 2017) available online for free: <https://digitalcommons.unl.edu/zeabook/61/>

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Disclaimers

Although students of pre-medical studies, medical studies, or veterinary studies may use this text to learn foundational concepts in animal parasitology, it is not a medical or veterinary text. Further, it is not meant for any medical- or veterinary-related purposes whatsoever. When medical or veterinary topics are touched upon in the text, this is for educational purposes for those studying or interested in the biological sciences generally. *No medical or veterinary advice of any kind is offered or implied anywhere in this textbook.* No medical or veterinary diagnoses, treatments, or conclusions of any kind may be construed using the knowledge offered herein.

For studies specifically related to medical parasitology, readers may consult any of a number of qualified texts in the subject, including *Medical Parasitology: A Textbook* (Mahmud et al., 2017), *Medical Parasitology* (Satoskar, 2009), and *Modern Parasitology: A Textbook of Parasitology*, 2nd edition, (Cox et al., 2009), among others. Numerous medical periodicals are also appropriate sources of knowledge about medical parasitology. For medical diagnoses, qualified practitioners of medicine may be consulted directly.

For studies specifically related to veterinary parasitology, readers may consult any of a number of qualified texts in the subject, including *Veterinary Parasitology*, 4th edition, (Taylor et al., 2015) and *Georgis' Parasitology for Veterinarians*, 11th edition, (Bowman, 2020), among others. Numerous veterinary parasitology periodicals are also appropriate sources of knowledge about veterinary parasitology. For veterinary diagnoses, qualified practitioners of veterinary medicine may be consulted directly.

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Invitation to Review and Give Feedback

If any qualified readers would like to serve as a reviewer for any of the sections, you are invited to please contact one of the editors to discuss the possibility of being assigned the task of reviewing. You will be credited in revisions if you ultimately serve as a selected reviewer. In addition, if readers discover factual or typographical errors in the content, please contact one of the editors.

HOW THE BOOK WAS DEVELOPED

Origin of the Book

The concept for this book arose in 2018 around the time there was a concerted push to create open educational resources in universities (Austin, 2018; Sennott et al., 2015). This push seemed well-timed to the editors. In fact, the rising costs of textbooks has become a major problem for students to the point where it is basically untenable to expect students to pay for them anymore. The editors reasoned that it would be a good time to call on their esteemed and accomplished colleagues in academia to help create a new textbook in a massively collaborative endeavor, if they were willing to participate.

Also driving the idea of a new textbook, the seminal English-language parasitology textbook of our time, Gerald R. Schmidt and Larry S. Roberts' *Foundations of Parasitology*, 9th edition (Roberts et al., 2012), has recently gone out of print and there are no plans to update it. John J. Janovy, Jr., the lead author of the last several editions of the Schmidt and Roberts book, agreed that the creation of a new textbook was a good and timely idea.

Contributing to the decision to attempt the creation of a large-scale textbook project was the public access/open access platform available to the editors, namely, the Zea Books imprint of the University of Nebraska–Lincoln Libraries. In line with the OER ethos driving the creation of the content, this publishing imprint operates under a diamond open access model, such that neither the authors nor the readers have to pay to publish nor to read any work published as a Zea Book.

Development of the Book

At the time of the conception of the book idea, the editors capitalized on the availability of visiting scholars in the Harold W. Manter Laboratory of Parasitology (Lincoln, Nebraska, United States)—Griselda Pulido-Flores, Scott Monks, and Donald Gettinger, as well as local colleagues John J. Janovy, Jr. and Gabor Rácz, and student-colleagues Auggie Tsogtsaikhan Dursahinhan and Guin Drabik—and called together a couple of meetings to discuss their idea with the group. They asked them to envision what they would like to see in a new textbook, one that would be available online for anyone with a computer connection to access for free. Among many other good ideas they shared, they suggested that the book could possibly include numerous links to other sources and

interactive modules, and pointed out that the information may be kept more current than was possible with a printed volume. Colleagues Paul Royster, Linnea Fredrickson, Catherine Fraser Riehle, and Mary Bolin in the University of Nebraska–Lincoln Libraries (Lincoln, Nebraska, United States) also provided encouragement and expertise that helped the project on its way.

When preparing to solicit manuscripts for this project, based on the preliminary conversations with colleagues, the editors first prepared an outline of the concepts desired to have covered and then created streamlined style requirements (the instructions for authors and references style guide are available online here: <https://digitalcommons.unl.edu/parasittext/>). They then asked numerous colleagues—all experts in their subareas of parasitology—to contribute one or more sections based on the outline. So many of them agreed to write sections that it seemed that it really might be possible to create a high-quality work with the input of so many fine experts. Every one of them submitted manuscripts quickly.

The editors gave the authors quite a bit of latitude regarding how to approach their assignment to write sections. They provided an optional template to work from ([available here](#)), but use of this format was optional. They wanted the authors to be able to express themselves in the way they each felt was best to demonstrate knowledge of their respective areas of interest within the larger subject of animal parasitology. This liberal approach naturally resulted in some variation in presentation styles, which is perhaps a plus for the reader. It breaks up the tone and emphases from section to section, and the reader gets a sense of each author's different voice and approach. The editors have worked to retain much of each author's preferred style of presentation, but with normalizing of typography and other style elements to help the manuscript finally cohere as a unified whole.

Some of the sections were sent out for review. This review process was open, so the authors knew who was reviewing their work and the reviewers were aware that the authors knew they were reviewing. Reviewed sections are marked as such with the reviewer's name and affiliation. Whether reviewed or not, all of the sections were editor-reviewed by both editors: Sue Ann Gardner edited primarily for bibliographic details and style elements, and Scott L. Gardner edited primarily for content.

Delayed Publication

With best-laid plans, the editors started to review and edit the sections as soon as they were submitted. Then a great number of both quite-dire and less-dire issues arose that interfered with the ability to complete the editing and production in as timely a manner as intended (selected challenges include: The SARS-CoV-2 pandemic requiring remote teaching, a computer crash, a death in the family that then required weeks away from work and home, radical changes in administrations at the university, and other issues). With those issues finally

receding in impact, five years after the project began, the book will be published at long last.

Demographic Data About the Authors

With editor Scott L. Gardner's large network of expert parasitologist colleagues, it was possible to seek out scholars who are experts in their field. While the first consideration when deciding who to invite to participate was expertise, the editors further worked toward the desired goal of equity and inclusion in the selection of authors. One result was a 1:2 ratio of women to men. While this does not represent parity, it is an improvement over days past when the majority of authors would likely have been men. Another result of efforts at equity and inclusion was the participation of many authors from outside the United States. Approximately 40% of authors are US-American and the remaining 60% are from one of 14 other countries (Argentina, Brazil, Australia, Japan, Mongolia, Bulgaria, Czechia, Germany, Hungary, Norway, Russia, Spain, Mexico, or Canada). Almost half of the authors (44%) do not have English as their first language.

Spanish-Language Version

In late 2018, the Office of the President at the University of Nebraska–Lincoln (Lincoln, Nebraska, United States) issued a call for proposals for Inclusive Excellence Development at the university. The editors were awarded funds to go toward translation of the textbook. With this, the editors partnered with a local professor of Spanish-language translation, Yoanna Esquivel Greenwood, who has created Spanish-language versions for numerous chapters in the book. Thanks to her work, and perhaps with the added input of some of the Spanish speakers among the authors, a comprehensive Spanish-language translation is forthcoming.

Acknowledgement of Authors' Contributions

From the Editors, Scott L. Gardner and Sue Ann Gardner

We sincerely thank all of the authors of this collaborative work. Your excellent contributions and dedication to the advancement of knowledge of animal parasitology have the potential to positively change the lives of countless students and teachers worldwide.

While we were grappling with challenges and distractions that delayed the editing of the manuscript of this book,

we lost a few of our esteemed author colleagues. We wish to posthumously acknowledge Bernie Fried, Akira Ito, and Robin M. Overstreet for what turned out to be some of their truly late-career contributions. We miss them, and we feel so fortunate to have benefitted from their long-acquired knowledge and their willingness to join in on this project.

Dedication

From the Editors, Scott L. Gardner and Sue Ann Gardner

This book is dedicated to **all** of our academic forebears and mentors who made this effort possible—some of whom are authors* of sections of the book! We can't list everyone, but we can provide a truncated list to commemorate some people especially.

Sydney Anderson
 Odile Bain
 Mary Bolin
 Alain Chabaud
 Patricia Coty
 Lee Couch
 Donald W. Duszynski*
 William F. Font, Jr.
 Bernard Fried*
 Donald Heyneman
 Akira Ito*
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 Armand Maggenti
 Harold W. Manter
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 Mary Lou Pritchard
 Robert L. Rausch
 Virginia R. Rausch
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 Constance Rinaldo
 Larry S. Roberts*
 Klaus Rohde*
 Gerald R. Schmidt
 Franklin Sogandares-Bernal
 Robert M. Storm
 Annegret Stubbe
 Michael Stubbe
 Sam Telford
 Terry L. Yates

Literature Cited

- Austin, A. E. 2018. Vision and change in undergraduate biology education: Unpacking a movement and sharing lessons learned. Planning Meeting Report, July 9, 2017. American Association for the Advancement of Science, Washington, DC, United States, 27 p.
- Bali, M., C. Cronin, and R. S. Jhangiani. 2020. Framing open educational practices from a social justice perspective. *Journal of Interactive Media in Education 1*: Article 10. doi: 10.5334/jime.565
- Bowman, D. D. 2020. *Georgis' Parasitology for Veterinarians*, 11th edition. Elsevier, Cham, Switzerland.
- Colvard, N. B., C. E. Watson, and H. Park. 2018. The impact of open educational resources on various student success metrics. *International Journal of Teaching and Learning in Higher Education 30*: 262–276.
- Cox, F. E. G., ed. 2009. *Modern Parasitology: A Textbook of Parasitology*, 2nd edition. Wiley-Blackwell, Hoboken, New Jersey, United States, 294 p.
- Creative Commons. 2014. OER case studies, United States. https://wiki.creativecommons.org/wiki/OER_Case_Studies/United_States
- Egloff, W., D. Agosti, P. Kishor, D. Patterson, et al. 2017. Copyright and the use of images as biodiversity data. *Research Ideas and Outcomes 3*: e12502. doi: 10.3897/rio.3.e12502
- Fischer, L., J. Hilton, III, T. J. Robinson, and D. A. Wiley. 2015. A multi-institutional study of the impact of open textbook adoption on the learning outcomes of post-secondary students. *Journal of Computing in Higher Education 27*: 159–172. doi: 10.1007/s12528-015-9101-x (with erratum, doi: 10.1007/s12528-015-9105-6)
- Griffiths, R., J. Mislevy, and S. Wang. 2022. Encouraging impacts of an Open Education Resource Degree Initiative on college students' progress to degree. *Higher Education 84*: 1,089–1,106. doi: 10.1007/s10734-022-00817-9
- Havemann, L. 2016. Open educational resources. *In* M. A. Peters, ed. *Encyclopedia of Educational Philosophy and Theory*. Springer, Singapore, Singapore. doi: 10.1007/978-981-287-532-7_218-1
- Lee, D., and E. Lee. 2021. International perspectives on using OER for online learning. *Educational Technology Research and Development 69*: 383–387. doi: 10.1007/s11423-020-09871-5
- Maggenti, M. A. B., A. R. Maggenti, and S. L. Gardner. 2008. *Dictionary of Invertebrate Zoology*. Zea Books, Lincoln, Nebraska, United States. doi: 10.13014/K2DR2SN5
- Mahmud, R., Y. Lim, and A. Amir. 2017. *Medical Parasitology: A Textbook*. Springer, Cham, Switzerland.
- Orr, D., M. Rimini, and D. Van Damme. 2015. *Open Educational Resources: A Catalyst for Innovation*, revised version [English]. Centre for Educational Research and Innovation, Organisation for Economic Co-Operation and Development, Paris, France, 143 p. doi: 10.1787/9789264247543-en
- Richter, T., and M. McPherson. 2012. Open educational resources: Education for the world? *Distance Education 33*: 201–219. doi: 10.1080/01587919.2012.692068
- Roberts, L. S., J. J. Janovy, Jr., and S. Nadler. 2012. *Gerald R. Schmidt and Larry S. Roberts' Foundations of Parasitology*, 9th edition. McGraw-Hill, New York, New York, United States, 670 p.
- Robinson, T. J., L. Fischer, D. Wiley, and J. Hilton, III. 2014. The impact of open textbooks on secondary science learning outcomes. *Educational Researcher 43*: 341–351. doi: 10.3102/0013189X14550275
- Roguljić, M., and E. Wager. 2020. Consent for publishing patient photographs. *Case Reports in Women's Health 26*: e00194. doi: 10.1016/j.crwh.2020.e00194
- Satoskar, A. R. 2009. *Medical Parasitology*. CRC Press, Boca Raton, Florida, United States.
- Sennott, S., S. Loman, K. L. Park, L. F. Pérez, et al. 2015. PDXOpen: Open Access Textbooks, Comprehensive Individualized Curriculum and Instructional design. Portland State University Library, Portland, Oregon, United States. doi: 10.15760/pdxopen-6
- Taylor, M. A., R. L. Coop, and R. Wall. 2015. *Veterinary Parasitology*, 4th edition. Wiley, Chichester, United Kingdom.
- United Nations. 2023. The 17 sustainable development goals, 4: Quality education. <https://sdgs.un.org/goals/goal4>
- Wiley, D. A. 2020. Open educational resources: Undertheorized research and untapped potential. *Educational Technology Research and Development 69*: 411–414. doi: 10.1007/s11423-020-09907-w
- WOERC (World Open Educational Resources Congress). 2012. 2012 Paris OER Declaration. UNESCO, Paris, France, 2 p. <https://unesdoc.unesco.org/ark:/48223/pf0000246687>

Supplemental Reading

- Attwell, G., S. D'Antoni, K. E. Hilding-Hamann, F. Muguet, et al. 2007. *Giving Knowledge for Free: The Emergence of Open Educational Resources*. Centre for Educational Research and Innovation, Organisation for Economic Co-operation and Development, Paris, France, 147 p. <https://www.oecd.org/education/cei/38654317.pdf>
- Hilton, III, J. 2016. Open educational resources and college textbook choices: A review of research on efficacy and perceptions. *Educational Technology Research and Development 64*: 573590. doi: 10.1007/s11423-016-9434-9
- Hilton, III, J. 2020. Open educational resources, student efficacy, and user perceptions: A synthesis of research published between 2015 and 2018. *Educational Technology Research and Development 68*: 853–876. doi: 10.1007/s11423-019-09700-4

- Kotsiou, A., and T. Shores. 2021. OER and the future of digital textbooks. *In* A. Marcus-Quinn and T. Hourigan, eds. *Handbook for Online Learning Contexts: Digital, Mobile and Open*. Springer, Cham, Switzerland. doi: 10.1007/978-3-030-67349-9_2
- Lafon, V. 2007. Giving knowledge for free: The emergence of open educational resources. *IMHE Info* (July): 1–2. <https://www.oecd.org/education/imhe/38947231.pdf>
- Miao, F., S. Mishra, and R. McGreal, eds. 2016. *Open Educational Resources: Policy, Costs and Transformation*. [Perspectives on Open and Distance Learning.] United Nations Educational, Scientific and Cultural Organization, Paris, France, 231 p.
- Smith, M. S. 2009. Opening education. *Science* 323: 89–93. doi: 10.1126/science.1168018
- Van Damme, D. 2014. Open educational resources: Sharing content and knowledge differently is a driver of innovation in education. Organisation for Economic Co-Operation and Development, Paris, France, 32 slides. <https://www.slideshare.net/OECD/EDU/open-educational-resources-sharing-content-and-knowledge-differently-is-a-driver-of-innovation-in-education>
- Woelfle, M., P. Olliaro, and M. H. Todd. 2011. Open science is a research accelerator. *Nature Chemistry* 3: 745–748. doi: 10.1038/nchem.1149

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