



## Cave Ecology

Oana Teodora Moldovan, L'ubomír Kováč, and Stuart Halse, editors, 2018, Springer, Cham, Switzerland, 545 p., 8.8 X 9.4 inches, hardbound \$219.00, ISBN 978-3-319-98850-4 e-book \$199.70, ISBN 978-3-319-98852-8

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The field of subterranean biology is a rapidly expanding one, an expansion nowhere more in evidence than in book-length publications. A recent addition to this library is the volume under review. The editors are all closely associated with the International Society for Subterranean Biology including the current president (Halse) and journal editor (Moldovan), and the authorship of individual chapters reflects the international membership of the society, with first authors from ten different countries. While the editors wisely do not claim completeness of coverage of cave ecology, there are a number of topics, ranging from very general (i.e., “Where Cave Animals Live”) to the highly specific (i.e., “Volcanic Anchialine Habitats of Lanzarote”). As perhaps befits the title, evolution and adaptation of subterranean animals is given short shrift, with almost no coverage of the recent work on the mechanisms of evolution in the Mexican cavefish, *Astyanax mexicanus*, itself the subject to two recent books (Keene et al. 2015 and Wilkens and Strecker 2017) and articles in premier journals such as *Nature*, *Science*, and *Proceedings of the National Academy of Sciences*. More surprising is the very strong

focus on caves rather than non-cave subterranean habitats, such as the hyporheic, the milieu souterrain superficiel (MSS), and epikarst, even though in the preface the authors claim a direct connection with the classic “Essai sur les problèmes biospéologiques” of the Romanian biologist Emil Racovitza, published in 1907. Racovitza, much admired by European speleobiologists, emphasized the importance of non-cave habitats such as cracks and crevices, which led to the discovery of the hyporheic, the MSS and other habitats. Of the 24 chapters in the book, only one focuses on non-cave habitats (chapter 20 on calcrete aquifers). Other chapters touch on these habitats, and the editors suggest using the word “cave” for any subterranean habitat, but this is not the same as a Racovitza focus on them. The focus on caves per se is more in line with American work on cave biology, even though Americans were the first authors of only six of the 24 chapters. Implicit in some of the chapters is the idea that non-cave habitats are staging grounds for the eventual colonization of caves, and that it is in caves that the species most highly modified for subterranean life are found, a view which we do not hold (see Culver and Pipan 2014).

The chapters are divided into six groups:

- Introduction to karst, caves and cave habitats (2 chapters)
- There is rich and diverse life in caves (7 chapters)
- About communities, populations, and food (4 chapters)
- Particular cave ecosystems (7 chapters)
- Conservation and protection of cave habitats and cave fauna (2 chapters)
- Cave ecology for the twenty-first century (1 chapter).

Several chapters are excellent and unique summaries of sub-disciplines. Deharveng and Bedos’ chapter on terrestrial invertebrates in subterranean habitats, the longest chapter at 67 pages, is a welcome and thorough update of compilations in *Encyclopaedia Biospeologica* (1994-2001) of the obligate terrestrial fauna of all subterranean habitats. With their knowledge of both temperate and tropic subterranean habitats, they are uniquely qualified to write this chapter. The chapter on microbial life by Hershey and Barton, is a good, if brief introduction to microbial diversity and how it is assessed, but does not really cover function. Mulec provides a surprisingly interesting account of phototrophs and their ecology, even though of course they are not found in zones of total darkness. Zigmajster et al. provide an up to date summary of what we know about biodiversity patterns, from global to local scales. The growing availability

of geo-referenced locality data, as well as the development of general and testable models of biodiversity make this a rapidly growing field. By way of full disclosure, Culver is one of the co-authors of this chapter. Ribera et al., in chapter 10, provide a very lucid summary of the major issues of colonization of caves—the evolution of troglomorphy, multiple versus single origins, the extent of dispersal, and the relation between age and troglomorphism. Trontelj, in chapter 12, provides a thoughtful discussion of the structure and genetics of subterranean populations, focusing on dispersal versus vicariance (i.e., geographic separation of populations, as by physical barriers), and the distinction between processes that take place on the surface (which he terms exogenous) and in the subterranean realm (which he terms endogenous). In the final chapter of the section, “About Communities, Populations and Food”, Venarsky and Huntsman summarize the dynamics of both detritus-based and chemoautotrophic cave systems. They point out similarities and differences with surface ecosystems, but unfortunately, do not include any quantitative data. The final chapter on future developments in cave ecology, the eminent Australian speleobiologist William Humphreys looks at how technical advances in sampling, molecular sequencing, etc. are likely to move the field forward. Implicit in this argument is that it is not ideas but technology that is holding us back. In addition, Humphreys makes the argument that many paradigms stemming from the Northern Hemisphere are misleading in terms of the Australian fauna and have actually been an impediment to research. Well over 100 pages of the book are devoted to the description of particular subterranean ecosystems. This emphasis on individual cases is typical of books on subterranean biology, and probably reflects both the diversity of subterranean habitats and the lack of a thorough synthesis of subterranean biology. Noteworthy among the chapters in this section are those by Oromí on lava tubes and Ferreira et al. on ferruginous caves in Brazil. The most diverse lava tube fauna is not in Hawaii but in the Canary Islands (by more than two-fold), and Oromí provides a welcome summary of the Canarian lava tube, both for species composition and the geological and environmental context of their occurrence. Ferreira et al. summarize the remarkable fauna found in caves developed in iron ore, among which the Brazilian caves are best known. The fauna is very rich in species, and occurs in very short, shallow caves, often without a dark zone. Niemiller et al. provide a very useful summary of protections, from the local to international level, available for the subterranean fauna, for Europe and the Americas. They also provide a succinct summary of the threats to the subterranean fauna. While there are a number of excellent chapters as we have summarized above, the question remains as to whether the book is complete enough to serve as the primary text for the field. The ecological coverage is broad but the evolutionary coverage is not. The depth of coverage of ecological topics varies greatly. For example, 67 pages are devoted to the terrestrial fauna while only 21 are devoted to the aquatic fauna. Nevertheless, it is a book that should be on the shelf of every speleobiological researcher, or at least in the institutional library. While the price of the book is prohibitively high for almost all students and many researchers, individual chapters are available as pdf files from Springer at a cost of approximately \$33.

### References:

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