



GRAND TOUR OF THE WORLD'S UNDERGROUND

Wilkins, H., Culver, D.C. & Humphreys, W.F. (eds) (2000) *Subterranean ecosystems*. Ecosystems of the World Book Series: Volume 30, Elsevier Science, Amsterdam. xix + 791 pp, figs, tables, author, systematic and general indexes. Hardback: Price NLG 486.00 (Euro 220.54), US\$254.50. ISBN 0-444-82299-2.

This splendidly edited volume introducing state-of-the-art biospeleology (the biology of caves, karst and groundwater), successfully captures both the challenge and the excitement of the discipline. It is a compilation of 36 articles contributed by 60 authors and covers a diverse array of topics, from faunistics to biogeographic regional analyses, from thorough descriptions of underground habitats and environmental conditions to experimental evolutionary research on so-called 'troglobitization' (the morphological, physiological and behavioural traits shared by most cave-adapted organisms, but whose adaptive condition still remains debatable). Aspects of trophic ecology in the subterranean environment are also presented, from descriptive contributions on odd resource types available in caves to innovative experimental analyses of food webs by means of stable isotope tracing. Biogeography is not neglected, including controversial general topics such as the colonization of, and speciation within, the subterranean environment, interspersed with phylogeographic case studies on selected taxa. All these issues are introduced as informative review chapters (frequently representing the synthesis of decades of work) combined with local case studies.

As the editors point out in the foreword, the hypogean (underground) habitat is the most extensive terrestrial biome on Earth. The first section of the book establishes a firm setting for the subterranean scene. It begins with a thorough, no-stone-left-unturned contribution by Jubertie, in which virtually all hypogean habitats developed in karstic terrains are categorized and described. Shallow interstitial aquatic habitats in unconsolidated sediments are the subject of the following chapter by Ward *et al.*, although it is mostly devoted to hyporheic (groundwater beneath rivers) and parafluvial freshwater biotopes. One misses, however, a more thorough treatment of the marine interstitial, given its long-standing persistence in time, immense coverage, and extraordinary biological diversity. The transitional land–sea anchialine environment (coastal caves flooded with seawater) is treated by Iliffe, who emphasizes its unique hydrology and water chemistry; aquatic microbiologists interested in

microstratified environments will find here a potentially interesting, neglected habitat. The picture is completed with the subterranean biotopes developed in volcanic landscapes, described succinctly in the above-mentioned chapter by Jubertie, but receiving a more thorough treatment later, in P. & M. Ashmole's chapter 14 on hypogean life in lava and tephra fields.

The subterranean bestiary fills another section of the book. Treatment of invertebrate groups is highly unbalanced, being limited to the most speciose taxon, the arthropods (chapters 4–5). Nevertheless, both contributions represent a very good introduction to the diversity of troglo- and stygobiont arthropod groups, permitting the non-specialist to browse further through the comprehensive species checklists available in the literature (e.g. Botosaneanu, 1986; Jubertie & Decu, 1994). I should point out here that the data given by H. Hobbs III on the world total of stygobiont crustaceans incorporates the over-estimation by Negrea (in Jubertie & Decu, 1994) concerning the number of truly stygobiont cladocerans. As far as I know, there are only four species described and not 24 (or 100) as stated; anomopod cladocerans are definitely a marginal group in the stygal. The synthesis by Weber (chapter 6) on cave fishes and salamanders is simply superb: all taxa known up to 1997 are listed, many are figured, and a plethora of information on natural history traits and biogeography is provided. This faunistic section is complemented with Iliffe's chapter (chapter 3) on anchialine biology, where the world's anchialine fauna is outlined.

The effects of darkness and of extreme oligotrophy on the cave fauna are surveyed in a separate section, with thorough reviews by Langecker and Hüpopp, mainly based on cave vertebrates. Exciting new lines of research are highlighted: for example, that presumed adaptive characters of troglobitic vertebrates may only be by-products of endocrine adjustments; or that the direct absorption of calcium through the gills of cave fishes and neotenic salamanders (making them independent from vitamin D, the synthesis of which is mediated by UV radiation) could explain their relatively high diversity in caves compared with that of other vertebrates.

The role of regressive evolution in shaping the morphology of subterranean fauna, a central theme for research in biospeleology, is treated in several chapters, with a review of the classical hypotheses, whether they are based on direct or indirect selection (energy economy, pleiotropy), or on neutral mutation, but also suggesting novel approaches such as Coineau's ingenious ideas on the role of heterochrony (evolutionary change related to changes in developmental timing). The reader will find a synthesis of the impressive

cross-breeding experiments carried out by Hüpopp and Wilkens with epigaeic and troglomorphic populations of the Mexican characid fish *Astyanax fasciatus*. Although Hüpopp modestly gives credit to other explanations not founded on experimental research (p. 175: 'any discussion about which theory provides the main or universal explanation for regressive evolution is as useless as are the reduced characters in cave animals'), with the presently available genetic data it is hard to conceive a more tenable explanation for the acquisition of regressive features in cave animals than through the accumulation of neutral, structurally reducing mutations.

An overview of cave trophic ecology by Poulson & Lavoie (chapter 12) is complemented by several case studies showing some of the unusual resources exploited by cave communities, such as guano in tropical caves, aeolian 'manna' in barren lava and tephra fields, or submerged tree roots. Only the contributions by Pholman, Sarbu and co-workers on partially or totally chemoautotrophically based cave systems make use of the (expensive) stable isotope tracing techniques, and inject welcome rigour into the elucidation of cave food webs. The emerging picture suggests that the contribution of bacterial primary production in caves is quantitatively relevant only in some sulphide-based systems harbouring thermomineral waters (reminiscent of deep-sea hydrothermal vents), but not in those where it is achieved mainly through nitrification, as occurs in anchialine habitats.

The various derivations and modes of colonization and speciation of the cave fauna are the subject of a balanced overview by Holsinger (chapter 21), whereas the contributions by Sbordoni *et al.* and by Humphreys focus on the more orthodox explanations for its origin (i.e. the major role played by vicariance in the fragmentation of gene flow between epigaeic and hypogaeic populations, and in the succeeding speciation and troglomitization). The latter viewpoint is complemented by a case-study by Boutin & Coineau (chapter 23) which emphasizes the value of the thalassoid stygofauna as a palaeogeographic tool. Missing from this section of the book is some examination of the more 'heterodox' explanations for the evolution of troglobites. Thus, the so-called (parapatric) 'adaptive-shift' model of Howarth (originally proposed for lava tubes, and later extended to all caves types in tropical latitudes), or the sympatric model of Hüpopp and Wilkens, are criticised on the basis of the absence of empirical data (i.e. of detailed genetic analyses) supporting the strict monophyly of the troglobitic populations and their alleged epigaeic direct ancestors, which leaves open the alternative hypothesis that the sympatric occurrence of troglobitic species and their epigaeic relatives in tropical caves is the product of secondary contact of populations already diverged in allopatry. This latter view is implicitly supported in Ashmole & Ashmole's model for speciation in lava tubes triggered only by ecological succession (chapter 14).

The final sections of the book are devoted to regional ecological and faunistic studies, plus aspects of the conservation of the subterranean environment. From the zoogeographic point of view, two syntheses are remarkable: that produced by Humphreys on the Australian Cape Range cave fauna (chapter 3), with its spectacular array of lineages displaying extreme disjunct distributions; and that by Deharveng and Bedos on South-east Asian cave communities (chapter 31), a vast region still remaining virtually unexplored from the faunistic point of view. The latter chapter also introduces an interesting comparative approach to the cave community structure of tropical and temperate regions of the world.

The book is anything but cheap, but it should be on the library shelves of every academic institution.

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AN ATTEMPT AT SIGN-MEDIATED COMMUNICATION THEORY

Witzany, G. (2000) *Life: the communicative structure. A new philosophy of biology*. Libris Books on Demand, Norderstedt, Germany. 231 pp, 36 figs. Paperback: Price DM58. ISBN 3-8311-0349-6.

The Austrian philosopher Günther Witzany states in the preface that the objective of his book is to use an interdisciplinary approach combining philosophy, biology and semiotics to build a basis for a 'new' concept of communicative nature. Clearly this is not an easy task. What would be the motivation to start such an effort? It is the global ecological crises, as the author stresses several times, and the need for humankind to find solutions in time.

In the first part (over 90 pages), Witzany introduces the reader extensively to molecular biology, explaining DNA structure/function and providing examples of intra- and inter-cellular communication systems in living organisms. In the second part, he presents the philosophical background of communication theories in relation to biological systems. The

author starts with a critical review of the concept of language and communication as used by Eigen & Ruthild Winkler (1975) in their well-known book *Das Spiel, Naturgesetze steuern den Zufall* (*Laws of the game: how the principles of nature govern chance*). He then proceeds to Habermas' (1981) equally famous *Theorie kommunikativen Handelns* (*Theory of communicative action*). It is, in particular, Habermas' concept of universal pragmatics to which Witzany refers in arguing for a universal theory of communication, which should comprise nature and culture. The third part seeks to integrate the theories presented so far and to advance a theory of communicative nature based on a sign-mediated language. Finally, Witzany attempts to explain evolution as a result of generative linguistic behaviour of organisms. Insights gained in molecular biology are used to support the notion of a universal sign-mediated communication in living nature in the form of DNA-modifying enzymes, which feed information (e.g. experience) back to DNA to form new genes.

Overall, the text is quite provocative for molecular biologists as well as for sociologists, and environmental scientists. Witzany could have provided a fruitful stimulus for cross-disciplinary scientific discussions, but unfortunately he did not. One third of the book is used to introduce the reader to the basics of molecular biology, but this is not essential for understanding the ideas advanced by the author. Most figures and explanatory texts are copies or synopses from textbooks, which the interested reader might use to look up details of molecular mechanisms used by cells to provide inter- and intra-cellular communication pathways.

The author's own ideas, which are developed in the later parts of the book are disappointing in several respects. First, they rarely refer to the relevant scientific literature. This holds true for biology, sociology and environmental sciences. To give an example, a whole chapter dedicated to the idea of a fundamental reinterpretation of evolutionary theory, manages to neglect almost all of the 150-year scientific tradition in this field. Second, the arguments are in general highly speculative and in many cases lack any empirical support. Advancement of a molecular mechanism explaining evolution solely by adding new genes to the chromosomes (polycondensation theory) is interesting but does not hold true, as there is no correlation in genome size (DNA length) and complexity of organisms within the plant or animal kingdom (the *c*-value paradox), a well-known fact that the author fails to address. Scientifically unfounded statements such as 'Specific hive inspection behaviour [of scout bees] must have been constituted as experience and subsequently genetically fixed. Enzyme proteins must have coded the specificity of this experience and inserted it into the correct side of the genome' (chapter 7, p. 139) disqualify the author's understanding of molecular and evolutionary biology. To

advance from the fact that an existing DNA strand, a gene, can be modified by enzymes, to the hypothesis that 'behaviour-experience coded enzymes' exist, which are capable of producing new genes and hence would be inherited to the progeny, is mere speculation. As the author states himself at the end of the book, this is Lamarckism in its purest form.

Independent of the quality of the arguments, the interested reader might ask how a Lamarckian turn in evolutionary theory could contribute to a solution of ecological problems. Unfortunately, we are not provided with an answer. The discussion of evolution, obviously important to the author, remains unconnected to the general framework of the text.

The ecological issue reappears in the last chapter, which draws its basic idea from an application of Habermas' 'universal pragmatics' to organisms. This leads the author to the concept of a universal sign language used by organisms and eventually to a new environmental ethic under the heading 'nature as a norm subject'. Here a more extensive review of the philosophical and linguistic background would be helpful for natural scientists. The line of reasoning in this chapter not only remains premature but also suggests a lack of awareness of the past developments in social theory and interdisciplinary environmental sciences. This can be seen in Witzany's dedication to ethical claims. In the sociological and the environmental sciences, community ethical claims have been heavily criticized as being too narrow and mere appellation (see for example Luhmann, 1986), and are increasingly being replaced with more functional strategies to address ecological problems. By and large, our opinion of Witzany's work is quite sceptical. Although interesting and important questions are addressed and many innovative ideas are provided, the reader is left with a highly idiosyncratic, speculative and seemingly premature book.

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