BOOK REVIEWS

Life as a chemical automaton

Gànti, T., with commentary by Griesemer, J. & Szathmáry, E. (2003) *The principles of life*. Oxford University Press, Oxford, UK. xviii + 201 pp., figs, line diagrams, index. Hardback: price £59.95. ISBN 0-19-850726-7.

As we walk through the complex maze of biology, we often take unexpected turns, which reveal new regions full of previously unknown mechanisms and stratagems, often surprising us with their beauty and blindly evolved cleverness. While a lot of the beauty of biology lies in the stunning miniature details, a different kind of beauty that is sometimes less treasured may be found in overall patterns, generalizations and fundamental principles. The unifying view proposed by Tibor Gánti in his book *The principles of life*, recently translated into English from the 1971 Hungarian version, is a unique and stimulating account of the author's path in search for a theory of living systems. The text constitutes a captivating and smooth read for the uninitiated, but also an informative and thoughtful one for the expert. The reader is taken through a journey that crosses the boundary between biology and philosophy, while at the same time drawing support and details from physical and chemical principles. The main theme is the definition and conceptual synthesis of a minimal living system, with particular emphasis on the problems involved in understanding the origin of life. In a rational and systematic approach, the theory of the 'chemoton' (chemical automaton) is presented and developed throughout the three essays that comprise the book. In its simplest fully functional form, the chemoton consists of three coupled chemical networks: a metabolic autocatalytic cycle, a membrane-forming cycle and a biopolymer-synthesizing subnetwork serving as a genetic information system. The coherent organization of these three subnetworks, each bearing a specific biological function, is at the heart of Gánti's analysis. Living systems are seen as fluid machines in which the stoichiometry of the reaction network determines to a large extent the system's life-like behaviour, independent of the specific molecular players or the availability of specialized enzymes.

In recent years it has become clear that the study of minimal living systems can be approached from three major directions: (1) the back-extrapolation of primitive life properties from current knowledge, (2) the *ab-initio* modelling of early protocells based on prebiotic chemistry scenarios and (3) the attempt to engineer arbitrary minimal self-replicating and evolving systems. Gánti's concepts touch upon each of these aspects of minimal life. For example, potential instances of the core metabolic cycle of the chemoton can be extrapolated from central metabolic pathways of present-day cellular life. A notable example is the reductive citric acid cycle, whose potential role in the origin of life has recently been supported by Harold Morowitz and others. A most fascinating topic discussed in connection with the early steps of life is the 'birth of primordial texts', i.e. the emergence of genetic coding. One of the starting points in the conceptual assembly of a chemoton towards increasing degrees of complexity is the observation that 'a machine can exist without program control, and even without any program at all, but the converse is not true'. In parallel to possible scenarios for the emergence of primordial genetic information, the relevance of pre-genetic inheritance is abundantly described. In this context, 'fluid membranes' are illustrated with the example of Sydney Fox's proteinoid microspheres. Current realizations of fluid membranes very similar to the ones proposed by Gánti are actively being pursued in synthetic life research endeavours (e.g. by Pier Luigi Luisi and others), as well as in computer models of pre-genetic compositional inheritance.

Despite the fact that one of the three essays composing this text is a recent addition to the original text, overall the book would have been outdated with respect to recent research progress, if it were not for the abundant notes added. The authors of these notes, Eörs Szathmáry and James Griesemer, also contributed interesting historical prefaces, as well as enriching concluding chapters, commenting, respectively, on the biological and philosophical relevance of Gánti's work at the time it was originally written and today. Whether or not the chemoton theory provides an explanation for the origin of life remains, in my view, an open question. What is certain is that future research in this direction will be more comprehensive and rich thanks to this volume, which – as one of the prefaces emphasizes – is 'making Gánti's work available to a new generation of readers'.

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A vision of the unity of life

Le Guyader, H. (2004) *Geoffroy Saint-Hilaire: a visionary naturalist*. University of Chicago Press, Chicago, USA. iv + 302 pp., figs, tables, line diagrams, halftones, index. Hardback: price $45.00, £31.50. ISBN 0-226-47091-1.

Anyone with a serious interest in evolution is in for a treat with this translation of le Guyader's 1998 study of Geoffroy Saint-Hilaire (1772–1844). When he is known, it is as the other man in the famous debate with Georges Cuvier in 1830. But as this book makes clear, Geoffroy neither lost the debate nor deserves to be forgotten. His visionary claim, to which he devoted his life's work, is the unity of living things.

About one-third of the book is a concise and richly documented intellectual biography. The rest consists of a selection of Geoffroy's most important papers and three

