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Book Reviews

The Timetree of Life. S. Blair Hedges and Sudhir Kumar, editors.

New York: Oxford University Press, 2009. 572 pp.
ISBN 9780199535033, $200.00.

Estimating the tree of life, a phylogenetic tree depicting the evolutionary relationships uniting all living organisms on the planet, is a fundamental and monumental goal in biology. Phylogenetic trees are important commodities in comparative biology. Not only do they form the basis for biological classification, but they also provide the framework necessary for conducting studies in an evolutionary perspective. As stated by Theodosius Dobzhansky, "Nothing in biology makes sense except in the light of evolution." This new book offers an impressive compilation of evolutionary history, including the relationships among organisms and their times of divergence, which together form a timetree of life.

The book begins with a foreword by James D. Watson, the prominent molecular biologist who co-discovered the structure of DNA. An impressive list of 107 contributors, each with a different taxonomic specialization, gives the book a real sense of expertise. The contents of the book are divided into two sections, which include an introduction (four chapters) followed by the timetrees for the major branches of life (90 chapters).

The introductory material begins with a chapter by the editors that covers the history of evolutionary trees, the methodologies for estimating divergence times, and their views on the current and future state of the field. In the second chapter, John Avise presents some of the opportunities that timetrees can afford to biological studies that have typically ignored divergence times or relied solely on the branching order of taxa. Chapter 3 (by Gradstein and Ogg) offers an overview of the construction and assembly of the Geologic Time Scale. Finally, Benton et al. provide an overview of the analytical issues associated with estimating divergence times using molecular phylogenies in conjunction with fossil calibrations, and provide a list of 63 key calibration dates for a wide range of organisms.

The remainder of the book (400+ pages) is an encyclopedic-style presentation of the timetrees. The timetrees are arranged into 13 main sections, including Superkingdoms, Protists, Plants, Fungi, Animals, Invertebrates, Vertebrates, Fishes, Amphibians, Amniotes, Reptiles, Birds, and Mammals. Some of these sections are not mutually exclusive, but this simply reflects the nested nature of the tree of life. These sections contain anywhere from one chapter (Fungi) to 14 chapters (Invertebrates and Mammals). The continuity in the presentation of figures and tables between the chapters is remarkable. Each chapter includes two figures; a photograph of a representative of the group covered in the chapter and a timetree with a geologic time scale, higher taxa names, and node numbers for major clades. The node numbers correspond to divergence times and confidence intervals listed in a table, which sometimes includes estimates obtained from different studies. Each chapter relates the timetree to other aspects of evolutionary history, including biogeography, Earth history, or climatic change.

The information contained in the book is freely available online at www.timetree.org, which means that purchasing this relatively expensive book is unnecessary. An online resource that permits users to enter in two species names (common or scientific names) and retrieve the divergence time is also available at the website.

The argument could be made that estimating divergence times between organisms is more difficult and rife with analytical nuances than the process of phylogeny estimation. Estimates of time of divergence are packed with error stemming from uncertainty associated with the calibration times (fossil or biogeographic), evolutionary rates, and lengths of phylogenetic branches. Therefore, it is unavoidable that some particularly astute biologists will consider the methodologies and estimates of divergence times presented in the book unreliable. However, the timetrees presented in the book are hypotheses, which should be scrutinized and tested by additional data. This point is not made very clear, and the book sometimes casts the perception that the endeavor to reconstruct the tree of life is now complete. Overall, the book provides an excellent resource for quickly finding the higher level phylogenetic relationships and the time of divergence for many groups of organisms, all of which is synthesized by experts in the field.

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Life Ascending: The Ten Great Inventions of Evolution. Nick Lane.

New York & London: W.W. Norton & Company, 2009. 344 pp. ISBN 978-0-393-06596-1 (hardback), $26.95.

According to Lane, "the ten great inventions of evolution" are: The origin of life, DNA, Photosynthesis, The complex (eukaryotic) cell, Sex, Movement, Sight, Hot blood, Consciousness, and Death. He could, of course, have made another selection of these "great inventions," but on the whole they seem to be very well chosen, especially if one focuses on biological evolution.

Where and how life has originated we do not know, but Lane argues well for his view of marine alkaline vents as the cradle of life. He believes that the cell has been invented independently by bacteria and archaea.

In Chapter 2, about DNA and the code of life, what I found most interesting was the section about the optimization of the genetic code. The reference to the paper by Freeland and Hurst (1998) opened up to me a whole set of articles of which I had not been aware before. Also new to me was the idea of Martin and Russel (2003) that the cell and DNA replication were "invented" twice, independently by bacteria and archaea.

I did not think that Chapter 3, about photosynthesis, would bring anything new to me, since it is a subject with which I am rather familiar, but the calculation showing the necessity of oxygen for long food chains is something that I had not thought of before.

I could continue listing novel things that I learned from the following chapters, but let me just say that all the chapters up to "Hot blood" are extremely well written, with discussions of different hypotheses and good arguments for those that Lane regards as most believable. "Hot blood" is also very interesting. I just hesitate a little in ranking this among "the ten great." Why not enzymatic catalysis, conquest of the continents (or some feature making this possible, such as plant roots), society building, parasitism, or the cooperation between insects and flowering plants?

Then Lane tackles the "invention" that is most difficult for a biochemist (which Lane is), or for anybody else for that matter to write anything sensible about: The origin and nature of consciousness. This chapter is not easy to read although, of course, Lane is right in his view that it ranks among the ten greats. It may very well be the greatest and most mysterious: How the Universe via the evolution of mankind forms an image of itself. It appears almost as a rephrasing of "and God created man in his image."

Death clearly belongs to the ten great on several levels. Without the natural selection that makes some fall by the roadside there would not have been evolution. Complicated multicellular organisms would hardly be viable without the possibility of programmed cell death. Lane dwells at the question of people having a limited life span. We have managed to increase the life expectancy of a new-born child, but the maximum life span hardly at all. "Three-score years and ten" is still not very far from truth, two and a half millenia after the formulation of the phrase. Surprisingly, Lane does not mention the hypothesis that the end regions of the chromosomes, the telomeres, have something to do with life span.

To pass as a proper reviewer I have to point to some shortcomings, even if I have had to look hard for them. Lane claims that there is the same voltage over a cell membrane as in a bolt of lightning. This is not true, as lightning is caused by a potential difference of millions of volts and there is on the order of a tenth of a volt across a cell membrane. The field strength (volt per meter), however, is about the same. It may be okay at this level to say that chlorophyll (of plants) is a porphyrin, even if it, strictly speaking, is a chlorin. Lane says that