THE TIMETREE OF LIFE.

*Edited by S. Blair Hedges and Sudhir Kumar; foreword by James D. Watson. Oxford and New York: Oxford University Press.* $200.00. xxi + 551 p.; ill.; index. ISBN: 978-0-19-953503-3. 2009.

The divergence patterns (phylogenetic trees) and divergence times are two major components of the evolutionary history of life. Together they constitute the timetree. The phylogeny is of fundamental importance to biological classification and comparative evolutionary analysis, while absolute divergence times allows biologists to relate the speciation events to the history of the planet, such as continental drifts and climate changes, thus gaining insights into processes of speciation and extinction. This book is the first ever compilation of the timetree of life.

The volume consists of approximately 81 chapters organized into two parts, and written by over 100 contributors. The first part consists of four introductory chapters. The first chapter (by the editors) provides a historical overview of molecular clock dating. They argue that molecular time estimates are more reliable than those inferred from the fossil record, but perhaps do not stress enough the fact that molecular clock dating is possible only with fossil calibrations. The second chapter (by Avise) documents the many wonderful things one can do if reliable time estimates are available. This is followed by a chapter by Gradstein and Ogg, with a review of the construction of the Geologic Time Scale. Chapter 4, by Benton et al., provides an updated list of fossil calibrations (hard minimum and soft maximum bounds) for a wide range of key species. Such information will be invaluable for future molecular dating analysis. The maximum bounds seem to me too confident (too young) if they are to be exceeded with only 2.5% of probability since they are often based on absence of fossil evidence taken as evidence for the absence of the species.

The second part of the book (more than 400 pages) consists of chapters that summarize the timetrees for various taxa at or above the family level, covering superkingdoms, protists, plants, fungi, animals, invertebrates, vertebrates, fishes, amphibians, amniotes, reptiles, birds, and mammals. They are all written by experts and have a consistent format, making it very easy to extract the key information quickly.

Divergence time estimation is often harder than phylogeny reconstruction, partly because time estimates will never become precise even if whole genomes are analyzed, as long as fossil calibrations involve uncertainties (and they always do). Such imprecise inference is easily influenced by a multitude of factors. Different studies have often been noted to produce quite different time estimates.

Meanwhile, dating methods have been under active development recently, especially those that accommodate uncertainties in calibrations. The time estimates discussed in this book are not always obtained from the most trustworthy methods. Nevertheless, this volume summarizes a wealth of information, which will be extremely useful for an overview of divergence times in major taxa.

The entire book is freely available online. An excellent online resource, to be constantly updated, allows one to retrieve divergence time estimates between any two species, with links to references. The volume and the online resource will prove invaluable to researchers interested in the phylogeny and divergence times of particular species groups, and indeed to anyone interested in evolutionary biology.

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