related to their research, and those enthralled with evolutionary phenomena will find more than sufficient positive reinforcement.—**Steven H. Rogstad, Department of Biological Sciences, 821 A Rieveschl Hall (ML 6), University of Cincinnati, Cincinnati, Ohio 45221-0006, U.S.A.**

Fundamentals of Molecular Evolution—Wen-Hsiung Li and Dan Graur. 1990. Sinauer Associates, Inc. Sunderland. xv + 284 pp. $22.95.

Molecular evolution is a field that can trace its ancestry through several areas of science including biochemistry, molecular biology, population genetics and systematics. The authors of this book draw from this rich heritage to produce an excellent introductory work on this complex and increasingly important field. As a testament of this importance, an ever expanding portion of many journals feature articles that fall into the category of molecular evolution, and indeed, whole journals are dedicated to the subject.

In addition to a growing portion of systematic studies utilizing molecular data, increasingly more of the research in molecular biology is incorporating evolutionary concepts and methodology into its milieu. The evolutionary attributes of papers in such bastions of molecular biology as *Cell* and *EMBO* demonstrates this pervasive influence of evolutionary biology. Graphically, this trend is marked by the increased presentation of phylogenetic trees and subsequent inferences based upon them.

By some measures, molecular evolution is not an extremely new field, having started with the early life experiments of Urey and Miller in 1953, the elucidation of the structure of DNA by Watson and Crick in 1953, the development of the molecular clock hypothesis by Zuckerkandl and Pauling in 1962, or with other studies at other times, depending on one's perspective. Given this history, it is not surprising that the subject of molecular evolution already has generated several fine books, most notably Masatoshi Nei's *Molecular Evolutionary Genetics*. This book by Li and Graur is an important new addition, principally because it is the first introductory text on the subject.

The authors give their definition for the subject of molecular evolution (p. 1):

> "Molecular evolution encompasses two areas of study: (1) the evolution of macromolecules, and (2) the reconstruction of the evolutionary history of genes and organisms".

In observing this definition, the authors acknowledge that they do not deal with origin of life research, an area of study that has historically constituted a large portion of what many considered to be molecular evolution. While the authors have declined to serve up prebiotic soup, they do feature an extensive array of entrees that effectively fill one's initial hunger for an introduction to the main course of molecular evolution. This material is presented through examination of both the theoretical and empirical aspects of the field. The authors concentrate on nucleotide and amino acid sequence data, include a short section on DNA–DNA hybridization, but make only passing mention of immunological data. However the authors' overall presentation of the material is relatively thorough and evenhanded.

The body of the book begins, very appropriately, with chapters reviewing the basic

aspects of molecular and population genetics that are relevant to molecular evolution. Here the authors cover the fundamental aspects of the types of genes, gene structure, mutation, changes in gene frequency in response to selection and drift, effective population size, gene fixation and the neutral theory. While other books, such as those mentioned as "Further Readings", cover these areas in more thorough detail, the material here is in keeping with the authors stated goal (p. xiv), "to write a book for 'beginners'". However, the first chapters do not deal with two very relevant issues; RNA editing and coalescence theory. The first is an important phenomenon heretical to the central dogma of molecular biology, because in cases of RNA editing the gene transcript is modified before translation. The second, coalescence theory, is a way of formulating population genetics in terms of the time to common ancestry of DNA sequences. This retrospective approach is gaining more recognition, and indeed is relevant to the discussion of gene trees and species trees presented later in the book.

Having dispensed the requisite background material, the remainder of the book deals with the core of molecular evolution; the evolutionary patterns and processes from the nucleotide to the genome level. Beginning this section are Chapters 3 and 4: "Evolutionary Change in Nucleotide Sequences" and "Rates and Patterns of Nucleotide Substitution". These chapters deal with many issue of particular relevance to those interested in using nucleotide sequence data for phylogenetic analysis: dynamics of the substitution process, sequence alignment and molecular clocks. Of particular interest to systematists is figure 5 in Chapter 3. It is an extremely simple, yet elegant, representation of the several classes into which nucleotide substitution events can be categorized, and very clearly presents the basic reason that maximum parsimony reconstructions based on nucleotide sequence data are often characterized by homoplasy.

Chapter 5, "Molecular Phylogeny", presents a reasonably thorough introduction of phylogenetic analysis using molecular data. The chapter presents material describing the general features of additivity, rooting, gene trees vs. species trees and phylogeny reconstruction. Most major tree construction methods are covered including UPGMA, transformed distance, neighbor joining and maximum parsimony. While the discussion is not as extensive or as rich in detail as other works (e.g. Swofford and Olsen, 1990), it is very appropriate given the audience of the book. However, it would seem appropriate that some mention of maximum likelihood estimation be made given its acceptance and increasing use in molecular systematics. The chapter also includes several interesting examples that demonstrate some of the problems that can be addressed using molecular systematics. These examples are drawn from diverse sources such as the never ending human–chimpanzee–gorilla debate, the endosymbiotic origin of organelles, conservation biology and molecular paleontology.

Whereas the two chapters just preceding that on molecular phylogeny dealt with the phenomenological/descriptive/analytical features associated with point mutations, the remainder of the book deals with larger-scale mutation events and includes more material on mechanisms. Chapter 6, "Gene Duplication and Exon Shuffling", discusses these processes and their importance to evolution. Here the well studied globin genes are very appropriately used as examples, as are other genes and multigene families. The chapter also discusses material particularly relevant to duplicated gene systems including paralogy, orthology, concerted evolution and pseudogenes.

"Evolution by Transposition", the title of Chapter 7, is somewhat misleading as the material presented is more restricted in scope than the definition of transposition given

at the beginning of the chapter (p. 172):

> "Transposition is defined as the movement of genetic material from one chromosomal location to another".

Or in the glossary (p. 250):

> "The movement of genetic material from one genomic location to another".

The authors concentrate almost exclusively on transposable elements and retroviruses. In doing so they ignore important phenomena such as chromosomal translocation, bacterial transformation and movement of genetic material from organelle to the nucleus and between organelles. However, in spite of these omissions the authors produce a good chapter with what they do cover. This is especially true for the material on retroelements and retrosequences, which comprises a substantial portion of the chapter. The presentation would benefit from the inclusion of examples from plants to illustrate better the great diversity of transposable elements. The discussions on hybrid disgenesis and horizontal transfer do much to demonstrate the importance of transposable elements in evolution.

The last chapter is entitled "Genome Organization and Evolution". Here the authors restrict themselves to the bacterial chromosomal genome and eukaryotic nuclear genome. The material focuses on variation in genome size and content, and mechanisms responsible for this variation. Some of the issues presented include the C-value paradox, classes of repetitive sequences, GC content and isochores. The authors should have devoted more discussion to organelle genomes, which currently receive much attention in molecular evolution and systematics. While organelle genomes are discussed a little in Chapter 4, some significant features associated with the molecular evolution of organelle genomes are missing from the book, including: apparent lack of recombination; how the rates of mutation affect their usefulness in phylogenetic studies; uniparental inheritance and its implications in phylogenetic analysis and interpretation; and heteroplasmy.

The structure and presentation of the material in the book imparts a textbook impression, which manifests itself in the use of bold-face type for particular terms and phrases, problems at the end of each chapter (with answers for some of them provided elsewhere in the book) and extensive glossary (494 entries). The glossary seemed quite complete, and even included the single amino acid code, which along with the three letter code is given as a table in Chapter 1. Both the glossary and index have considerable cross referencing. The text is appointed with numerous tables and figures that do much to increase the readability and understanding. The quality of the editing and production is such that I only recognized one spelling mistake (on p. 179 "retrosposon" should be retroposon). However, the textbook feel belies the greater use of the book, for the authors have transcended their goal of writing a "beginners" book. The book's comprehensiveness, and clear presentation, combined with the sizable bibliography (301 entries), make it an excellent reference. Indeed, it may be the best book to pull off the shelf when trying to get an initial understanding of almost any aspect of molecular evolution. **Michael P. Cummings, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts 02138, U.S.A.**

REFERENCES

Nei, M. 1987. Molecular evolutionary genetics. Columbia University Press, New York.

Swofford, D. L. and G. J. Olsen. 1990. Phylogeny reconstruction. *In:* D. M. Hillis and C. Moritz (eds). Molecular Systematics. Sinauer Associates, Sunderland, Massachusetts.