phological or behavioral phenotypes, he has argued strongly that it should be abandoned at the molecular level.

In *The Causes of Molecular Evolution*, John Gillespie presents a radically different case. Whereas the neutral theory asserts that changes in DNA and protein sequences are due to the same evolutionary mechanism (drift), Gillespie argues that drift is important only for the so-called "silent" changes in DNA sequences, that is, those not affecting the amino acid sequences of proteins. Differences in protein sequences are claimed to be predominantly under the control of natural selection. The obvious objection, that attempts to observe selection on naturally occurring protein variants have mostly been inconclusive, is met by noting that very small selection coefficients are sufficiently large to allow selection to take control but would be undetectable experimentally. Gillespie points out, however, that amino acid variants segregating in natural populations, and amino acid differences between species, frequently have effects on physiologically relevant properties of the proteins concerned and suggests that it is plausible that such differences can be subject to natural selection. In some cases, the evidence for selection is convincing. But these are comparatively rare. The link between the relatively frequently observed kinetic differences between different forms of the same enzyme and fitness is not secure, since the effect of the activity of a single enzyme in a pathway may be greatly dampened by the properties of the pathway as a whole. This line of argument thus seems inconclusive to me.

Gillespie's review of information on variation and evolution at the DNA level indicates that the notion that silent nucleotide changes follow the neutral model stands up well to rigorous scrutiny. The lower levels of variation and slower rates of evolutionary change for nucleotide site changes that alter protein sequences make sense if these often cause deleterious changes in protein function, resulting in their prompt elimination by selection. The amount of variation between different lineages in the rate of evolution over long time periods for silent sites is approximately in line with the classical neutral expectation. In contrast, Gillespie's analysis suggests that there is often a highly significant excess variance in rates of evolution for amino acid replacements. Overall the variance is about eight times that expected on neutrality. His interpretation is that the evolution of a given protein follows an "episodic clock"—that is, millions of years without change are interspersed with brief bursts of evolution, in which two to four amino acid substitutions occur.

The core of the book is an attempt to interpret this pattern in terms of the mathematical theories of selection that Gillespie has developed over the past 20 years. This involves over 100 pages of abstruse derivations. Two models of the episodic clock are produced. The "mutational landscape" model imagines that an environmental challenge to a population can be met by the fixation of new mutations at a given locus. Given a finite set of possible alleles that can be ordered with respect to their fitness in the new environment, the population responds by successively substituting alleles with higher fitnesses, until a state is reached when further change would require more than one mutational step for a higher level of fitness to be reached, whereupon change at the locus ceases. The other model assumes that allelic variation is maintained by environmental fluctuations affecting fitness. Occasionally a large change causes a particular allele to become fixed, which may differ from the initial allelic state by several mutations. Either process ensures that each episode of change involves only a limited number of substitutions, consistent with the results of the sequence analyses.

My overall verdict, as an evolutionary biologist who is not intimately involved in research in this area, is that the case for selection is persuasive but not conclusive. Two difficulties occur to me. First, the episodic-clock interpretation is consistent with, but not demanded by, rate variation. Rates could vary over time but in a steadier fashion. If this were the case, then the interpretation of rate variation as a consequence of neutral substitutions changing the selective constraints operating on a protein might seem plausible. Second, the selection models themselves do not necessarily lead to the episodic clock: there is no guarantee that the pattern of environmental variation in selection pressures is episodic on the long time scale that Gillespie's interpretation requires. It is thus not clear that a strong case for selection can be built on rate variation alone. A weakness of the book is that no research program is offered for further testing of the rival theories.

John Gillespie has thought harder than anyone else about the subtleties of the ways in which natural selection can bring about variation and evolution at the molecular level, and he has an enviable command of the theoretical and empirical literature on molecular evolution. His book therefore deserves the careful attention of everyone interested in this field. The sections reviewing the data are well written and informative. Readers should be warned, however, that the theoretical sections are extremely demanding. They assume considerable familiarity with technicalities of population genetics theory, and there is a tendency to develop the theory first and tell the reader of its relevance later. The connection between the data and many of the details of the models is tenuous, and a more effective book could probably have been written if these details had been pared down.

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Astronomical Oddities

Unusual Telescopes. PETER L. MANLY. Cambridge University Press, New York, 1992. xviii, 221 pp., illus. $39.95.

Amateur and professional observational astronomers alike maintain a strong interest in the design and development of telescopes, for they are the means by which celestial objects are detected. Without telescopes, the appreciation of the objects of the universe would be subject to the limitations of the human eye; with them, the heavens are revealed in increasing refinement as the power of the telescope and detector increases.

In *Unusual Telescopes*, Peter Manly goes beyond the fundamentals of the history, principles, and basics of telescope design and construction to present a potpourri of designs he considers unusual—telescopes that are nonstandard in at least one aspect. This book is aimed principally at amateur astronomers familiar with the principles and practice of the construction of telescopes of modest aperture, but because of the variety of telescopes described and the engaging nature of the descriptions the book should appeal to a broader audience as well. Engineers involved in projects of modest to large scale will find interesting ideas and approaches here, along with sketches of designs that have or have not received widespread adoption and the reasons why. Professional astronomers like myself may be drawn to the descriptions of several interesting or unique designs in use at professional observatories, perhaps understanding for the first time why a particular telescope is as productive (or as expensive) as it is.

Manly describes an extremely broad assortment of telescopes, including over 150 designs. These vary from the bentwood telescope of Weyman Reams, an 8-inch, *f*/8.3 telescope that looks "more like furniture than the scientific instrument it really is," to telescopes mounted on the roofs of cars for easy portability to dark sites (in one case arranged so that the observer sits in comfort inside the car and views through an

"Portable telescope mounted on a lawnmower chassis. Photo courtesy of Dr. Clyde Tombaugh. Note the curved secondary mirror holder which minimizes the apparent effects of the diffraction spikes." [From *Unusual Telescopes*]

eyepiece extending inward through the open sunroof), to Sandia National Laboratories' array of solar sensors, which occasionally have been pointed at night toward bright celestial sources. In degree of seriousness, Manly's discussions range from an account of a telescope made from a beer can by David Levy (whose primary is a ladies' compact mirror and whose sighting device is the pull tab from the can) to an extended evaluation of the designs of solar telescopes on the summits of Mt. Wilson near Los Angeles, Kitt Peak in Arizona, and Sacramento Peak in New Mexico. The apertures of the telescopes he describes vary from a 1-inch, Schmidt-type telescope by Wesley Lindsay (a telescope without an eyepiece that is used as a finder for larger instruments) to the largest professional telescopes in the world. In time and space his coverage is also extensive and includes telescopes operating throughout the United States and Europe as well as in more remote locations such as Indonesia and Kenya. He treats quite a few historical designs as well, including the Paris Refractor of 1900, which was made for public viewing during the Paris Exhibition and dismantled shortly thereafter, and classics such as the 72-inch Leviathan telescope of Lord Rosse, made in the 1840s.

An amateur astronomer with professional affiliations, background in small computers, and publications in various magazines, Manly communicates a strong sense of familiarity and a firsthand appreciation of the telescopes he discusses. The book is also enhanced greatly by the large number of illustrations, more than 150 in all, picturing the majority of designs discussed. An index is included which, along with the list of illustrations, greatly assists in locating the information pertinent to a particular telescope. Manly has grouped the telescopes rather loosely, using a prominent unusual feature, rather than size or application, as the focal point. The most attention naturally is paid to the optics and the mount, topics discussed in the first two chapters of the book. Subsequent chapters point out the mount and optics designs in relation to other features, including the position of the eyepiece and the mobility of the telescope.

This is not the book from which to learn about the principal types of telescope optical and mounting designs, however. Except in passing, or in rare exceptions (such as the schiefspiegler optical path and the Gregory-Maksutov double-field telescope), Manly does not detail or depict the specific principles that pertain to a particular mount or optical train. This is probably appropriate for an amateur audience, for which a knowledge of a Dobsonian mount may legitimately be presumed, but it does force the non–telescope-building audience to work a little harder. Largely beyond the scope of the book are aspects of telescope performance such as solid-state detectors, including CCDs, and the computerization of much astronomical data taking, data analysis, and scientific results, which are occasionally mentioned. While citations of the scientific astronomical literature are largely omitted, there are many references for further reading to the popular amateur journal *Sky and Telescope*, to several books describing the history of the telescope, and occasionally to engineering reports or publications.

With such a diversity of telescopes included, it is understandable that a few errors have crept into the text. For example, the Multiple Mirror Telescope at Mt. Hopkins, Arizona, which is operated jointly by the Smithsonian Institution and the University of Arizona, is mistakenly referred to and indexed as the Fred Lawrence Whipple Multiple Mirror Telescope. However, the author invites corrections, additions, and suggestions and provides an address (but not a telephone number until 1996, "when the youngest [teenager] will be away in school").

All in all, *Unusual Telescopes* provides interesting and often amusing descriptions of what makes some telescopes stand out from the rest. With an informal style and a wide familiarity with telescopes, Manly has written a book with an appeal not only to the principal audience of amateur observational astronomers but to a broader group of engineers and professional astronomers with an interest in system design or telescope performance.

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Books Received

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Biology of Bacilli. Applications to Industry. Roy H. Doi and Martina McGloughlin, Eds. Butterworth-Heinemann, Stoneham, MA, 1992. xiv, 370 pp., illus. $79.95. Biotechnology Series, 22.

The Cell Cycle. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1992. xxxii, 782 pp., illus. $210; paper, $95. Cold Spring Harbor Symposia on Quantitative Biology, vol. 56. From a symposium, Cold Spring Harbor, NY, June 1991.

Desire for Control. Personality, Social, and Clinical Perspectives. Jerry M. Burger. Plenum, New York, 1992. xii, 196 pp. $29.50. Plenum Series in Social/Clinical Psychology.

Electrical Stimulation and Electropathology. J. Patrick Reilly with contributions by Hermann Antoni *et al.* Cambridge University Press, New York, 1992. xviii, 504 pp., illus. $74.95.

A Field Guide to Eastern Butterflies. Paul A. Opler. Illustrated by Vichai Malikul. Houghton Mifflin, Boston, MA, 1992. xx, 396 pp. + plates. $24.95; paper, $16.95. Peterson Field Guide Series, 4.

Global Warming. Physics and Facts. Barbara Goss Levi, David Hafemeister, and Richard Scribner, Eds. American Institute of Physics, New York, 1992. xvi, 310 pp., illus. $95. AIP Conference Proceedings, 247. From a course, Washington, DC, April 1991.

High-Energy Astrophysics. American and Soviet Perspectives. Walter H. G. Lewin, George W. Clark, and Rashid A. Sunyaev, Eds. National Academy Press, Washington, DC, 1992. viii, 415 pp., illus. Paper, $30. From a workshop, June 1989.

Inorganic Biochemistry of Iron Metabolism. Robert R. Crichton. Horwood (Prentice Hall), Englewood Cliffs, NJ, 1992. 263 pp., illus. $75.95. Ellis Horwood Series in Inorganic Chemistry.

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Nonlinear Superconductive Electronics and Josephson Devices. Giovanni Costabile *et al.*, Eds. Plenum, New York, 1992. xiv, 442 pp., illus. $110. From a workshop, Capri, Italy, Sept. 1990.

Organic Synthesis. The Roles of Boron and Silicon. Susan E. Thomas. Oxford University Press, New York, 1992. iv, 92 pp., illus. $29.95; paper, $9.95. Oxford Chemistry Primers.

Physical Cosmology. A. Blanchard *et al.*, Eds. Editions Frontières, Gif-sur-Yvette Cedex, France, 1992. xxiv, 626 pp., illus., + plates. $87. From a conference, Chateau de Blois, France, Aug. 1990.

Reinforcement in Functional Systems. Konstantin V. Sudakov, Ed. Gordon and Breach, Philadelphia, 1992. xii, 234 pp., illus. $60. Systems Research in Physiology, vol. 4.

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The Voice of the Dolphins. And Other Stories. Leo Szilard. 2nd ed. Stanford University Press, Stanford, CA, 1992. viii, 182 pp., illus. $20; paper, $8.95. Stanford Nuclear Age Series.

War and Healing. Stanhope Bayne-Jones and the Maturing of American Medicine. Albert E. Cowdrey. Louisiana State University Press, Baton Rouge, 1992. xx, 230 pp., illus. $35. Southern Biography Series.