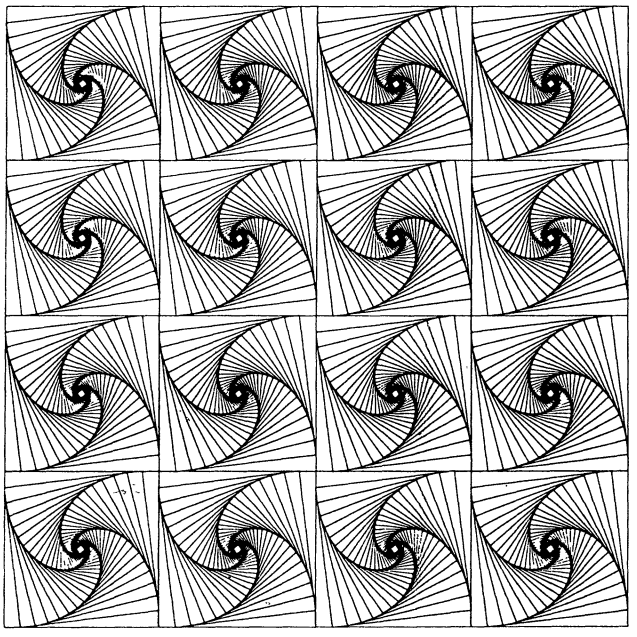
basic differential equation of all ($f' = f$) is the one satisfied by $exp(x)$.

Almost as important as the discovery of calculus was the invention of logarithms in the early 17th century. And logarithms, also, lead inexorably to e. As Maor points out, "Rarely in the history of science has an abstract idea been received more enthusiastically by the entire scientific community than the invention of logarithms." A table of logarithms was, in the 17th century, as indispensable to a scientist as a microcomputer is now. The slide rule, a device based directly on logarithms and invented almost immediately after their discovery, has really only been made obsolete in the last 20 years with the advent of portable electronic calculators.



A decorative design based on the Four Bug Problem. "Imagine four bugs positioned at the corners of a rectangle. At the sound of a signal, each bug starts to move toward its neighbor. What paths will they follow, and where will they meet? The paths turn out to be logarithmic spirals that converge at the center." [From *e*]

Pi has, on some level, permeated the public consciousness. Aristophanes mocks circle-squarers in *The Birds*. A variety of books have been written on π, and considerable time, profitable and unprofitable, has been spent computing its digits. Pi has even been the subject of legislation. There is a bill still tabled in Indiana, dating from late last century, attempting to regulate its value. It has also been the subject of some beautiful and serious mathematical scrutiny. Certainly one of the landmarks of 19th-century mathematics was Lindemann's proof of the transcendence of π in 1882, a proof that showed that circle squaring is impossible, as everyone, except cranks, had "known" for centuries. Hermite's proof of the transcendence of e ten years prior to this, while less celebrated, was probably more seminal. To the best of my knowledge no one has ever tried to legislate the value of e, and far fewer people have computed its digits than have done so for π (although a billion digits of e have been calculated recently, mostly because they can be). There have been a number of biographies of π, but this is probably the first major biography of e.

The idea behind this book is good one: to weave the historical development of the ideas of calculus around the life story of e. It is like the voyages of Columbus as told by the first mate. While this makes the point of view somewhat idiosyncratic, it also allows for considerable amusing discursion and renders the whole story much less dry than is usual.

Calculus is one of the truly remarkable inventions of humanity. It has shaped our lives in more ways than most of us recognize (there is precious little technology without calculus), and Maor is right to put e in the context of calculus, but even without calculus e has a pretty interesting life story. Nor is the story complete. Some very basic questions about e are completely intractable by current methods. We don't even know, for example, if $e + \pi$ is irrational, and we know virtually nothing about the digits of e.

Maor has succeeded in writing a short, readable mathematical story. He has interspersed a variety of anecdotes, excursions, and essays to lighten the flow; included, for example, is an imagined dialogue between Bach and Bernoulli on the mathematics of the "equal-tempered" scale. The heaviest mathematics is wisely relegated to appendixes.

This book is not written for either the professional mathematician or the historian of mathematics, and both groups will inevitably take umbrage at the treatment of some of the issues. This fate awaits all popularizations of mathematics, no matter how good, and partly accounts for why there are so few serious attempts at it. The necessary compromises between rigor and readability are daunting, as is talking about mathematics without talking only in mathematics (which is Greek to most—except far more people actually speak Greek).

This is, however, a good book to read in conjunction with an introductory calculus course. Since up to a million people a year study calculus across North America, this alone offers a substantial audience. It puts most of the ideas of such a course in a far richer and more human context than is standard. This is Maor's intended goal and also his primary success.

Peter Borwein
Simon Fraser University, Centre for Experimental and Constructive Mathematics, Burnaby, British Columbia V5A 1S6, Canada

■

Mammalian Evolution

Morphological Change in Quaternary Mammals of North America. ROBERT A. MARTIN and ANTHONY D. BARNOSKY, Eds. Cambridge University Press, New York, 1993. x, 415 pp., illus. $74.95 or £45.

The Quaternary Period was a time of extensive environmental fluctuations. Terrestrial vertebrate fossil assemblages of this period tend to be larger, have a broader geographic coverage, and can be dated more precisely than older fossils. These factors make the Quaternary an ideal laboratory for evolutionary studies based on the fossil record. This collection of 16 such studies covers a wide range of taxa including moose and mammoths (Lister), edentates (Hulbert and Morgan), deer (Purdue and Reitz), jaguars (Seymour), prairie dogs (Goodwin), prairie voles (Barnosky), and woodrats (Zakrzewski).

Rates of evolution figure prominently in most of these papers. The controversial issue of the calculation of rates and their relationships to the intervals over which they are calculated is reviewed by Gingerich. In one of the more innovative contributions in the book, he expands on his earlier observation that evolutionary rates vary inversely with the period of time over which they are calculated. He devises a new approach using rates of evolution to produce two rates, an "intrinsic rate" over one generation and a "net rate," an average calculated over more than one generation. This technique allows one to discriminate among process change, randomness, and stasis.

Another controversial topic, that of stasis, or the absence of significant change in a character through time, and its recognition in the fossil record is dealt with in two papers. Anderson reviews statistical meth-

Vignettes: Floridiana

My advice is to let every discontented man make a trip through the Everglades; if it don't kill, it will certainly cure him. . . . A day's journey in slimy, decaying vegetable matter which coats and permeates everything it touches, and no water with which to wash it off will be good for him, but his chief medicine will be his morning toilet. He must rise with the sun when the grass and leaves are wet with dew and put on his shrinking body clothes heavy and wet with slime, and scrape out of each shoe a cupful of black and odorous mud; it's enough to make a man swear to be contented forever afterwards with a board for a bed and a clean shirt once a week.

—*Alonzo Church*, 1892, as quoted in *Everglades: The Ecosystem and Its Restoration* (Steven M. Davis and John C. Ogden, Eds.; St. Lucie Press)

The Florida "gold rush" in orange juice, launched in 1948 when Bing Crosby signed his first Minute Maid contract, rendered all other [frozen food] industry successes pale by comparison. Initially advertised as being cheaper than whole oranges and better for one's health, frozen orange juice was an immediate sucess, and more than any other single product it helped establish and stabilize the market for frozen foods. . . . Orange juice became one of the first truly national convenience foods.

—*Suzanne White*, in *Chemical Sciences in the Modern World* (Seymour H. Mauskopf, Ed.; University of Pennsylvania Press)

ods for recognizing morphological stasis and tests several methods on a sample of the microtine rodent *Cosomys primus* from a 164,000-year sequence in Idaho. All these analyses indicated stasis over the period of time studied. The same data set was analyzed by Czebeniak by means of variogram analysis, a technique hitherto unused in paleontological studies, which focuses on dispersion parameters. The results of this analysis of the *Cosomys* data differ from those of Anderson by indicating that there may be nonrandom variation.

Dental variation in both modern and Quaternary rodents and both long- and short-term changes in these animals are used by R. A. Martin as a basis for a wide-ranging discussion of evolutionary patterns, evolutionary rates, speciation rates, and character divergence. Martin provides a comprehensive model of phenotypic evolution at the species level in which he maintains that there is no requirement for unique contributions to phenotypic variation by speciation.

Barnosky's study of the changes in several characters of the dentition of the prairie vole, from the late Pleistocene to the present, indicates mosaic change particularly well. Stasis, gradualism, and episodic change occur over the same period of time in different characters and in different populations of the same presumed species.

The role of species interaction is considered in an examination of patterns of size change in Quaternary canids of the Middle East by Dayan *et al.* Although the three larger canids varied in size through the Quaternary, the same size ratios among them were maintained.

Few of the studies find much correlation between changes in morphology or evolutionary rates and environmental changes that might be responsible for them. The evolution of hypsodonty and enamel structure in rodents is considered by L. Martin explicitly in relation to presumed environmental changes that took place through the Quaternary. Rensberger and Barnosky document faunal changes through a sequence in southeastern Washington that are related to environmental changes as interpreted from the sediments.

A problem with the analysis, qualitative as well as quantitative, of the high-crowned and ever-growing teeth of many animals is that the crown patterns and many aspects of their dimensions change with wear. The extent of this change is generally poorly known. Viriot *et al.* investigate this problem in the muskrat by serially grinding a tooth at 0.5-millimeter intervals and subjecting the pattern at each level to image analysis. Not unexpectedly, the pattern changes as the lower parts of the tooth are exposed. Unfortunately, this technique is destructive of specimens, but it does provide information that is unavailable in other ways.

This book demonstrates the contribution that studies of Quaternary mammals can make to general evolutionary theory. Several of the contributions will provoke argument, and all will stimulate discussion and further work.

Ernest L. Lundelius Jr.
Department of Geological Sciences, University of Texas, Austin, TX 78712, USA

How RNA Makes DNA

Reverse Transcriptase. ANNA MARIE SKALKA and STEPHEN P. GOFF, Eds. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1993. xii, 492 pp., illus. $85. Cold Spring Harbor Monograph 23.

This excellent book reviews the processes and intricacies of reverse transcription and how the key discoveries were made. It starts with a short introduction by David Baltimore, who discovered reverse transcriptase in Rauscher murine leukemia virus at the same time as Howard M. Temin and Satoshi Mizutani detected it in Rous sarcoma virus. Baltimore writes that "when the reverse transcriptase was first discovered back in 1970, the central dogma of DNA → RNA → protein so completely dominated thinking that the notion of RNA-directed DNA synthesis came as a great surprise." Temin had first proposed that RNA tumor viruses (now called retroviruses, thanks to reverse transcriptase) may form a DNA intermediate in host cells to explain how these viruses could stably transform cells. But although his group at the University of Wisconsin and John P. Bader at the National Institutes of Health accrued much circumstantial evidence of the requirement for DNA during viral replication, biochemists regarded the provirus theory as farfetched. I recall one prominent molecular virologist, Peter H. Duesberg, who later became a good friend, declaring "impossible" the evidence that Jim Payne, Peter Bentvelzen, and I first presented in 1967 of the Mendelian transmission of retroviral genes through the germ-line of the host. The discovery of reverse transcriptase made the impossible not only plausible but an obligatory step in the replication of retroviruses.

We now know that retroviruses are members of a much larger group of retroid genetic elements that require reverse transcription, including the hepatitis B virus family, cauliflower mosaic virus, retrotransposons, and telomerases essential for the integrity and replication of eukaryotic chromosomes. All these are reviewed in *Reverse Transcriptase* by pioneers and experts in each field. Reverse transcription may ex-