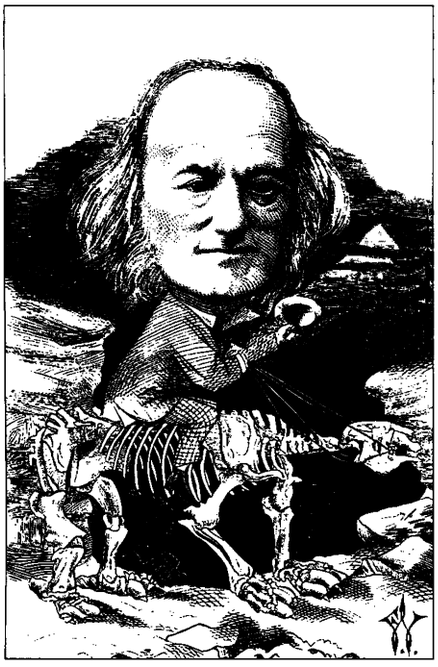

Richard Owen "caricatured riding a megatherium skeleton. The megatherium was a popular museum icon which helped strengthen the drive for a separate natural history museum." [From *Richard Owen*; Wellcome Institute Library, London]

currently promote conceptualizations that other naturalists at the time saw as entailing contradictory consequences. It is also congruent with Rupke's overall assessment of Owen's career: "he was less a major innovator of biological theory than an executor of the work left incomplete by great predecessors."

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Parasites on the Move

Evolution of Infectious Diseases. PAUL W. EWALD. Oxford University Press, New York, 1994. x, 298 pp., illus. $35 or £80.

Evolutionary biology has long enjoyed the status of an academically profound but socially irrelevant discipline. A few years ago, George Williams and Randy Nesse proposed to change that perception. Their 1991 article "The dawn of Darwinian medicine" in the *Quarterly Review of Biology* proposed that modern medicine would benefit by accommodating evolutionary principles. Ewald's book adheres to the same philosophy, focusing on infectious diseases of humans—the viruses, bacteria, and other parasitic microbes that collectively cause a majority of human deaths. Ewald's main theme, based on over a decade of his writings, is that human social and medical practices influence whether human diseases evolve to be lethal or benign. The premise is that if society heeds this lesson we can ultimately reduce the morbidity and mortality caused by some of our old diseases and possibly prevent the emergence of new ones.

The book uses one basic model to explain the evolution of parasite virulence. The conventional view in parasitology has been that virulence represents a non-adaptive state, characteristic of parasites that have only recently invaded a new host species. The contemporary, "enlightened," model of most evolutionary biologists, including Ewald, is different. Put simply, this model is that natural selection acts on a parasite to maximize its fitness, measured by the number of hosts infected (or the rate of infection). Virulence, that is, the harming or killing of a host, is of little consequence to the parasite if the parasite can infect lots of additional hosts in the process. High virulence is thus expected to evolve whenever a parasite is faced with an abundance of opportunities to infect new hosts.

In its most general form, the model derives from various sources in population and evolutionary biology, most formally the mathematical approaches of Roy Anderson, Robert May, and several of their collaborators. However, some extensions of it are unique to Ewald, and his main contribution is to apply it to explain why some parasites are so virulent as to cause host death whereas others are relatively benign. Most of the book explains how the evolutionary framework can be used to answer this question, and observations and interpretations of the literature are compared with the evolutionary predictions. Ewald argues that the mode by which a parasite is transmitted to new hosts is all-important to its fitness and thus to the evolution of virulence. Parasites transmitted by biting insects (such as the plasmodium responsible for malaria) or by water (such as the bacteria responsible for cholera and dysentery) are predicted to be highly virulent, while those transmitted by person-person contact (as in the case of respiratory diseases) are predicted to be of low virulence. The reason for this prediction is that parasite fitness is less compromised by a dying, immobile host when the infection can be spread by means other than person-person contact—a sick host doesn't get up and around to transmit the parasite to lots of people. Most chapters of the book are devoted to the impact of different modes of transmission on the evolution of virulence. And most contain extensive citations of the epidemiological, clinical, and evolutionary literature. Ewald's use and command of the historical literature on infectious diseases is without parallel among evolutionary biologists.

One especially interesting chapter concerns hospital-acquired infections. Ewald suggests that certain hospital practices have led to the evolution of more virulent strains of bacteria, fungi, and viruses or to the replacement of more benign strains with more virulent ones. If the hospital environment has indeed created deadlier strains of infectious diseases, then it is certainly important for the medical community to heed his message and correct the problem. Though we are not convinced that the observations uniquely support Ewald's interpretations, we do believe that his arguments and cited observations provide more than enough justification for testing these hypotheses in depth.

We share Ewald's conviction that evolutionary biology may have much to offer in the war against infectious diseases. Indeed, one may question whether the antibiotic era would have incurred its current failures so quickly if we had heeded equally simple concepts about the evolution of antibiotic resistance. This book nonetheless has a couple of limitations that will lessen its impact. One is that the different predictions are derived only superficially. The basic model is extremely simple, proposing that the evolution of virulence can be understood without reference to parasite genetics, the cellular and molecular biology of virulence, or even the interaction between the parasite and the host immune system. Yet this simplification leads to ambiguity as to why some factors enter into the prediction and others are left out. Even readers familiar with mathematical models for the evolution of virulence may have difficulty understanding some predictions (mathematical models for the evolution of virulence, which have recently become specific about the mechanisms of virulence, are given virtually no consideration in this book). The question is thus whether the predictions on which the book is based will be borne out upon closer inspection.

A second problem with the book is that, for the most part, it is a work of advocacy. It champions rather than tests the adaptationist framework, and in most cases it favors single hypotheses instead of evaluating multiple alternatives. The book does begin with a general discussion of how adaptationist thinking might contribute to medicine, focusing on fever as the ailment to be (or not to be) treated. This discussion is relatively balanced and explores many possible intricacies of evaluating such a question. For example, Ewald begins with the now not-uncommon view that fever functions to

defeat an infection by elevating body temperature to levels not tolerated by the invading microbe. He then turns to consider other possible reasons for fever and explores how we might decide whether different medical interventions for suppressing fever could be deleterious.

But the main issues of the book—virulence evolution in different parasites—are presented largely from a pro-adaptationist perspective, and then presented only from the specific adaptationist perspective that parasites evolve to maximize their rate of spread to new hosts. Alternatives such as virulence being non-adaptive, or virulence being a consequence of short-sighted, within-host evolution of the parasite are ignored. There is a dearth of concrete predictions that might be used to falsify the few models that are offered, and the data reviewed are not presented in a manner that allows a reader to develop an independent conclusion (aside from text, the book includes only one table, one figure with data, and a phylogenetic dendrogram).

The subject of this treatise is or should be of great general interest. The text is, for the most part, very readable and the treatment not at all technical. From one perspective these attributes are a considerable virtue. The book should draw the large audience the subject deserves.

Nonetheless, we don't believe that the simplistic advocacy approach employed in this volume is needed in order to draw wide readership. Rigor need not have required immersing the reader in technical and mathematical details. Indeed, the style of this treatise is likely to have a negative impact. Evolutionary biology is already seen by many outsiders as a soft discipline in which rigorous tests are rarely performed and speculative stories occupy the niche of rigorously developed and empirically tested theories. For anyone possessing that mental stereotype, this book will reinforce their opinion. This effect is especially unfortunate, because Ewald's treatise is the first potentially popular book representing the emerging discipline of evolutionary medicine. For an evolutionary biologist, one of the truly exciting features of infectious diseases is that microbial evolution can be studied experimentally and prospective hypothesis testing can supplant the retrospective, story-telling character of a good deal of earlier evolutionary biology. Ewald's book could have laid the foundation for this future by posing alternative hypotheses and suggesting the evidence needed to reject them. It didn't. Yet the questions raised by Ewald and his premise about the potential utility of evolutionary biology are, we believe, right on. We hope his lead will be followed by others.

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Vignettes: Standards of Discourse

It was common in early modern society to contrast the society of gentlemen with that of scholars according to the different values they respectively placed upon truth and good manners. Polite writers condemned traditional scholars because they would sacrifice the good order of conversation to the imperious demands of truth and accuracy, while the scholar might justify himself through variants of the ancient trope used to identify oneself as "a friend of Aristotle but more a friend of truth." Yet changed conceptions of the nature of scholarly practice in the seventeenth century . . . increasingly reordered and respecified the characters of the scholar and the gentleman. It was now urged that the end of philosophy—the search for truth—might best be acquitted by deploying conversational practices that had traditionally belonged to gentlemanly and not to scholarly society.

—*Steven Shapin*, in *A Social History of Truth: Civility and Science in Seventeenth-Century England* (University of Chicago Press)

When an eminent Victorian such as Justus Liebig could run his own journal, he had no compunction at being offensive to people he disagreed with, even calling them plagiarists or "cocks crowing on a dunghill." . . . The traditional language in British science has continued to be relatively skeptical and direct, with a bite to it. . . . It is interesting to find in an editorial review in the *American Journal of Physiology* [in 1983]: "American science has become vitiated by too much politeness. . . . Conciliatory smoothness is the life blood of diplomacy; it is the death of science."

—*Kenneth J. Carpenter*, in *Protein and Energy: A Study of Changing Ideas in Nutrition* (Cambridge University Press)

Planetary Surface Studies

Remote Geochemical Analysis. Elemental and Mineralogical Composition. CARLE M. PETERS and PETER A. J. ENGLERT, Eds. Cambridge University Press, New York, 1993. xxiv, 594 pp., illus., + plates. $74.95 or £60. Topics in Remote Sensing, 4.

The study of planetary surfaces involves observations at a vast array of physical scales. At one extreme, Earth-based telescopic observations often involve measurements pertaining to the entire visible surface of a planet. At the other, analyses from landed spacecraft may deal separately with individual rocks only centimeters across. This book deals with remote-sensing observations of planetary surfaces as used to infer the elemental and mineralogical composition of the surface materials. Its stated purpose is to provide a broad introduction at a working level to the techniques of remote sensing and the analysis of data.

The book is a collection of 27 chapters by a total of 62 authors. It is divided up under the broad headings Technical and Scientific Background, Applications and Measurements, and Active Surface Analyses. The Earth is a planet, and a few chapters deal with topics specific to it, but the bulk of the book deals with the other planets and satellites in the solar system. The chapters deal primarily with two different approaches to compositional remote sensing. The first (passive) approach involves understanding reflected and emitted energy at visible, near-infrared, and mid-infrared wavelengths. At these wavelengths, observed spectral features are diagnostic of mineralogical composition and provide information similar to what a geologist would need to interpret field observations pertaining to the geological history of the surface. The second (active) approach utilizes high-energy measurements such as gamma-ray, x-ray, alpha-particle, and neutron spectroscopy. These observations are sensitive to the elemental composition rather than to the mineralogy and provide evidence per-