

Weinstein's decisions as an "exercise of policy discretion masquerading as the rule of law."

Despite this compelling picture of lawyers, judges, and the dynamics of a difficult, sprawling case, the book is, in the end, unsatisfying. Schuck persuades the reader that the existing tort system is grossly inadequate in dealing with claims of mass toxic injuries, but he presents only the most general suggestions for improvement.

Schuck defines the core issue as finding a means both to compensate injured persons and to deter unwanted, risky behavior. Addressing compensation first, he points to proposals for greater reliance on first-party insurance, workers' compensation, and social insurance to "make whole" diseased persons. By compensating injury regardless of the source, such schemes circumvent the causation issue that haunted the Agent Orange case.

Schuck recognizes the limitations of such proposals (for example, they may have unexpected economic consequences) and instead presses for a system of "prelitigation settlement incentives." Under one variant, for example, defendants would be required to offer to pay for the plaintiffs' net economic losses or lose the option to present certain defenses should the case go to trial. Plaintiffs would be required to accept such offers or face a more difficult standard of proof at trial. The suggestions are not novel (indeed, Schuck draws heavily on the work of others), and they suffer from well-recognized difficulties of implementation (for example, to work properly the scheme requires an impossibly precise calculation of incentives and damage schedules). Schuck, however, does not address these problems, stating only that "some such structure probably can be designed . . . that will be superior to the status quo on balance." This is hardly a persuasive argument to revamp the legal system.

Regarding deterrence, Schuck notes that tort litigation has no predictable effect on risky behavior; in some cases it underdeters (thus failing to achieve a principal goal), and in others it overdeters (forcing enterprises to forgo socially useful activity). As a result, he favors administrative regulation to set the limits on corporate behavior, using litigation only as a backup. Yet he does not pursue the implications of his own observation that administrative regulation also suffers from numerous problems, including many of those that plague tort litigation. Inadequate information and resources, resulting in both underdeterrence and overdeterrence, characterize the present regulatory process. As Schuck candidly notes, the regulatory history of 2,4,5-T counsels against

naive reliance on regulation to deter risky behavior. His solution to these shortcomings is as straightforward as it is unhelpful: The government should spend more money on research and pay more attention to finding the most effective means of implementing regulatory policy. For years, scholars and policymakers have debated both the need for additional research and the proper approaches to enforcing existing statutes and regulations. It is well-traveled ground in need of fresh insights. Although he clearly sets forth the issues, Schuck gives us no new ideas.

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Learners from Nature

Leaders in the Study of Animal Behavior. Autobiographical Perspectives. DONALD A. DEWSBURY, Ed. Bucknell University Press, Lewisburg, PA, 1985 (distributor, Associated University Presses, Cranbury, NJ). 512 pp., illus. \$59.50. Animal Behavior Series.

The study of animal behavior must be one of the oldest human efforts to observe and analyze the world around us: Humans could not have survived for millions of years as gatherers and hunters without some solid knowledge of how animals behave, as sources of food or danger, as pets or parasites, as competitors or companions. Tales and descriptions of animal behavior abound in the writings of ancient and medieval authors—not always correct, of course, but clearly demonstrating the lively interest of investigative minds. With the progress of scientific methodology, fantastic hearsay and colorful native lore could no longer carry the day. Respectable scholars aimed for confirmed facts, preferably from their own experience. Names like Buffon, Rösel, Spallanzani, von Perna, Reimar, and Réaumur come to mind. Later on, but still more than a century ago, Charles Darwin set the mark for the truly scientific study of all aspects of the behavior of animals and even the biological foundations of human behavior.

How does it happen, then, that there is a widespread impression, fostered even by the leading experts, that this field of research was invented *de novo* in this century? Nobody can deny that scientific inquiry and formal teaching concerning animal behavior have recently expanded tremendously. Most probably, future historians of this branch of

the tree of life sciences will find that its rapid growth was caused by the same forces that stimulated the growth of that whole tree in our century: the application of the Darwinian and the Cartesian paradigms. It was unavoidable that with the progress of evolutionary genetics and of the physiology of the sensory, nervous, muscular, and endocrine systems, animal behavior would finally become a territory to be explored, conquered, and colonized, having hitherto only been superficially scanned by adventurous travelers.

Anybody really interested in animal behavior should also be interested in human behavior, at least in that of those scientific conquistadores to whom we owe so much of our understanding of behavior in general. What makes a collection of autobiographic reminiscences of such scientists fascinating reading is the glimpses it provides of the feelings that moved them as they approached the subject with new and powerful tools of inquiry, realizing that the behavior of living beings could be just as objectively and critically investigated as any other natural phenomenon. This excitement can be found vividly expressed in some of these researchers' efforts to look back over their shoulders. Most of these recollections are highly interesting, some are moving expressions of humanity, and some in addition are elegant examples of literary style. It is remarkable to see that these scholars—different as they may be in personal and cultural background or training—have almost without exception one characteristic in common: a very early enchantment with living creatures, an almost obsessive urge to observe them, to keep them, and to live with them. Evidently, the desire to immerse themselves in nature, to see, to hear, to feel and smell every detail of it, to understand it, to literally become part of it, was so strong and authentic for some of these scientists that the feeling of having discovered some privileged, private access to the behavior of our fellow creatures seems to have become almost overwhelming even when tempered by scientific self-criticism and methodological rigor. The sense that animal behavior has been discovered in this century by a few individuals (among them prominent authors of this book) might have its roots in this deep feeling. It is said that only one who loves can really understand. No doubt about it: a true-blooded ethologist loves his or her study animals; how could the ethologist help the feeling of understanding them better than anyone else?

The selection of those to be invited to partake in the enterprise of pondering their lives and personal development must have been a difficult task. The editor asked for the

help of a selection committee of six animal behaviorists of different backgrounds. With few exceptions their choices seem convincing. Sadly, some of the major figures—among them Karl von Frisch and David Lack—had already passed away. Others who were asked declined for various reasons. Altogether 19 autobiographies have been assembled, in alphabetical order: Baerends, Dethier, Eibl-Eibesfeld, Fuller, Griffin, Hediger, Hess, Hinde, King, Leyhausen, Lorenz, Manning, Marler, Maynard Smith, Richter, Scott, Tinbergen, Wilson, and Wynne-Edwards. I found the chapters by Baerends, Eibl-Eibesfeld, Lorenz, Marler, Maynard Smith, Tinbergen, and Wilson particularly illuminating and stimulating. Of course, everyone will miss some favorites in an assembly like this. This reviewer, for instance, would have expected to find Martin Lindauer and Thomas Eisner included. (I refrain from suggesting who could have been deleted.) Overall the vertebrate bias is fairly strong. I also missed at least some of the founding fathers of neuroethology or more generally of the study of the physiological mechanisms of animal behavior. These points of criticism cannot, however, detract from the fact that overall this book is very successful in meeting its goals. Exactly because it is so it makes one ask for more. One last quibble: it is nice to find portraits accompanying all the contributions; it would have been easy to give dates of birth of the contributors in the legends. A fair number of the authors take the fact of their birth so much for granted that they do not bother to mention when the event occurred.

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Molecular Evolution

Molecular Evolutionary Genetics. Ross J. MacIntyre, Ed. Plenum, New York, 1985. xxii, 610 pp., illus. \$79.50. Monographs in Evolutionary Biology.

Molecular evolution is a synthetic field that brings together population genetics and molecular genetics in a novel and fruitful alliance. Its aims are to understand the processes that govern the evolution of genes, gene families, and entire genomes and to use molecular data to make inferences about phylogenetic history. The enterprise encompasses a wide diversity of research methods ranging from the mathematical analysis of models of molecular change, originating in

formal population genetic theory, to the molecular dissection of gene structure and function, originating in the rich experimental traditions of molecular biology.

One of the great attractions of the study of molecular evolution is that a wealth of evolutionary phenomena have come to light that were unknown or only vaguely suspected by earlier generations of evolutionary geneticists. Some of the recent discoveries that shatter earlier notions about the processes of genetic change are the concerted evolution of multigene families, the ubiquitous nature of transposable elements, the horizontal transfer of retroviral sequences, and the ability of the plant mitochondrial genome to assimilate foreign DNA. The present book explores many of these issues in detail and also explores many of the less revolutionary aspects of molecular change.

Three chapters are concerned with the evolution of repeated gene families where there is a wealth of descriptive information on structural organization and comparative evolution. In the case of satellite DNAs, we still know little about function or about the processes responsible for the generation of these highly repetitive sequence arrays. Dispersed repeat families, such as the *Alu* family, which makes up 5 percent of the human genome, are particularly enigmatic. They are transcribed and exhibit transposon-like characteristics, but nothing is known of their biological function, if any. The best understood multigene family codes for the ribosomal RNA subunits, and in this case it is possible to analyze evolutionary change in the context of gene function. Thus compensatory mutations, which reestablish base pairing in putative stem structures, are found to be common. The phenomenon of concerted evolution, whereby mutations in particular gene copies are laterally propagated to other members of the gene family, is also best documented in the ribosomal RNA gene family.

There are two excellent chapters on organelle genome structure and evolution. It is now well established that the vertebrate mitochondrial genome (mtDNA) evolves at an exceptionally rapid pace, possibly owing to the absence of repair mechanisms. The situation in plants, where chloroplast and plant mitochondrial protein coding genes appear to evolve conservatively, stands in sharp contrast. The plant mtDNA varies greatly in size among related taxa and is promiscuous in the sense that it has been shown to incorporate foreign DNA sequences. Moreover, the plant mtDNA has associated plasmid-like DNAs that may be implicated in the uptake of foreign sequences. Owing to a conservative rate of evolution, the chloroplast genome has been

very successfully exploited for the study of plant phylogeny.

The time clock hypothesis was the first major idea to arise from the union of population genetic theory and molecular genetics. According to this hypothesis neutral mutation should be substituted in evolution at a rate proportional to the mutation rate. A long debate has ensued over the constancy of nucleotide and amino acid substitution rates in evolution. One major problem has appeared to be a substitution rate determined by celestial time and not generation time. That problem is resolved in a detailed chapter on the estimation of substitution rates through the analysis of a much larger data base. This analysis reveals that synonymous substitutions are functions of generation time, whereas missense substitutions appear to depend on calendar time, as might be expected if they were subject to selection.

A chapter on retroviral evolution in mammals documents at least five cases of interspecies transmissions of retroviral sequences. The evolution of oncogenes and their association with retroviral sequences represents yet another intriguing aspect of genomic evolution still in very early stages of investigation. Interesting data are also presented on the evolution of mammalian linkage groups. Primates generally show highly conserved chromosomal homologies, while some other mammalian lineages (for example the rodents) exhibit much greater chromosomal shuffling in evolution.

The present book is largely restricted to the processes that govern the evolution of gene families and genomes. It is also heavily weighted toward vertebrate and particularly mammalian evolution. The individual chapters present long, detailed and comprehensive reviews of the subjects they cover. Most of the eight chapters exceed 60 pages, and there is an extensive index that makes the book exceptionally valuable as a reference work. There is some variation in style and quality among the chapters, but the general level of scholarship is far above that of the typical compilation. Moreover, there is a serious, and on the whole successful, effort to make the presentation accessible to a general reader. One may question the choice of topics, and particularly the failure to include chapters dealing with transposable element evolution or with the use of molecular data to infer phylogenetic history. But the book abounds in provocative observations that reveal how far we must go to gain anything like a complete picture of the processes that govern molecular change.

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