

BOOK REVIEWS

Discovery and Explanation in Biology and Medicine.
Kenneth F. Schaffner. 1993. The University of Chicago Press, Chicago, IL. 644 p. \$25.00 paper, \$55.00 cloth.

Many readers might feel that discovery is the product of creative genius, serendipity, or exceptional insight and that it is folly to submit such a process to logical analysis. Kenneth Schaffner, however, attempts to identify the form and logic of the discovery process in biology and medicine. In this 600-page treatise Schaffner explores discovery from inception to triumph, convincing most readers that discovery is indeed the product of logic.

Schaffner begins by addressing the classically accepted first step of discovery, development of hypothesis. His premise is that the hypothesis forming process proceeds in two phases: a generation phase, in which the seed of the hypothesis is formed, and the preliminary evaluation phase, in which the hypothesis is pruned and shaped into a question by a reiterative process of evaluation. He acknowledges, however, that frequently the hypothesis is the last step of discovery, particularly when one starts with a body of observations that don't fit existing laws. He presents an example of this reversed scheme of discovery, the development of the clonal selection theory of antibody formation. As he reviews the development of this theory the reader can see the hypothesis emerge from existing data.

As Schaffner discusses theories and laws in biology and medicine the reader senses that they are fragile and that their fabric is weak, unable to withstand the rigorous challenges placed upon other laws such as those found in chemistry and physics. Some authors, he claims, argue that there are no laws in biology because they cannot be universally true and they cannot hold true for all times. Schaffner counters that while theories in biology are different than those found in chemistry or physics, their design effectively meets the demands of the discipline. They have all the features common to theories in chemistry or physics as well as a number of additional components that allow them to address critical issues such as temporal processes, integration of concepts across levels (molecular, cellular, tissue, etc.), and variability within and across systems. Thus the reader realizes that the factors that are perceived as weaknesses in biological theories are in fact strengths, allowing them to accommodate time, diversity, and variability in the hypothesis.

Schaffner leads the discussion to the culmination of discovery: explanation. He points out that explanation in biology and medicine, as with most disciplines, serves to make a hypothesis understandable and provides cause and logic for observations. However Schaffner notes that explanations in biology and medicine have distinctive problems and consequently distinctive requirements. In biology, explanations must be variable, invoke broad generalizations, and be able to integrate concepts across levels and fields (molecular biology, behavior, etc.). The reward for addressing these problems, he notes, is an explanation that has broad application and the potential to expand and develop analogous mechanisms accommodating a variety of situations.

One of the bonuses of the book are the historical narratives found in many of the chapters. Schaffner uses these narratives to emphasize points in his arguments. Some of these narratives are developed from conversations with scientists pivotally involved in the discovery and often provide poignantly personal perspectives of the discovery process.

The author, a philosopher and physician, has enjoyed a distinguished career in both philosophy and medicine. He began in academia, teaching philosophy at the University of Chicago where he developed an interest in the philosophy of biology and medicine. He then expanded his knowledge of the biomedical sciences by attending medical school at the University of Pennsylvania. This unconventional training is apparent in Schaffner's perception of scientific problems and thoughtful analysis of the discovery process.

JOHANNA K. KRONTIRIS-LITOWITZ

Department of Biological Sciences
Youngstown State University
Youngstown, OH 44555

Finders, Keepers. Rosamond W. Purcell and Stephen J. Gould. 1992. Hutchinson Radius, London. 157 p. \$50.00 cloth.

Who is a collector? Goldsmith caught him in his net in 1776 when he said "every collector of butterflies can show undescribed species." Parenthesist Gould joined his aide-de-camp Rosamond Purcell with her stunning photography to do this sumptuous escapade in the history of biology. Here the collectors ranged from a once ruling monarch to forgotten amateurs: Peter the Great; macabre Frederik Ruysch, "meticulous embalmer"; physician-naturalist, Philip Franz Balthasar von Siebold, who organized the five-volume *Fauna Japonica* (1832) which described well-known Japanese animals (for Siebold's botany read *A Reunion of Trees* (1990) by Stephen Spongberg); there is William Cornelis von Heurn, "hyperacquisitive finder and meticulous keeper"; Gould sidestepped the "Java Man" fame of Eugen Dubois; better known is Lord Walter Rothschild, "a big man in every sense"; a "conjunction" of art and fossils is made with geologist John Woodward, of Sedgwick Museum, and his agates (9,000!); and Agostino Scilla, a Sicilian painter by profession, a "largely forgotten figure in the genesis of geology," whose collections and drawings were purchased by Woodward in 1717; not to overlook the "odd couple," Mary Anning and Thomas Hawkins, who in Gould's word, demonstrate "those who can, collect; and those that can't, interpret"; Louis Agassiz is deftly portrayed by the present occupant of his central exhibition hall of his museum in two excellent chapters. Gould says Agassiz died from "intellectual fossilization," but adds that he "continues to bestride my world like a colossus."

For the present-day museum curator, Gould fills a cabinet of in-house tales; for the natural history buff, insightful but sprightly history. There is no index and no documentation (will you know the references?). The photographs are (to say the least) uncommon: "human hand (preserved in mercury, Albinus, 18th century)"—pelvis of a whale (not as large as you may imagine)—and a

varnished fish mounted on paper, from the *reliquiae* of William Dandridge Peck of Harvard (the British Museum has pressed butterflies that James Petiver preserved with his plants). Outstanding is the logistical photography that, with cross references, complements the stories at times “full of lunacy and gravity.”

“Taxonomy has never been a munificently supported enterprise,” Gould reminds us. “Naturalists have lived by hook and crook, piggybacking on military expeditions, or hanging from the coattails of commercial enterprises” (p. 76). There are panda’s thumb marks all over this literary specimen of *Homo sapiens gouldi*.

JOSEPH EWAN

Missouri Botanical Garden
St. Louis, MO 63166-0299

The Broken Dice and Other Mathematical Tales of Chance. Ivar Ekeland. 1993. The University of Chicago Press, Chicago IL. 183 p. \$19.95 cloth.

Why do we believe in chance? Doing justice to the question in the broadest sense requires not only an examination of the possible mathematical meanings of chance, fate, and so forth, but also an inquiry into the very nature of reality and our place in it. Ivar Ekeland gives us all of this and more in a prologue, six short chapters, and a conclusion. Rarely has a professional mathematician produced a book intended for a general audience which is at once so concise, readable, and scholarly. It harkens back to a time in which it was assumed that an intelligent reader with a liberal education could understand and enjoy solid, literate prose without continual reference to current fads and a color picture on every other page. The author manages, with a few simple line drawings and diagrams and much charming storytelling, to make most of the main issues of the modern theory of chance accessible to the mathematical amateur.

Ekeland’s success in doing so derives in large part from his care to maintain, virtually on every page, the connections to science, philosophy, art, and everyday life without which our intuition would have little to inform it. The book is a graceful translation by Carol Volk of the original French *Au hasard*, and the English prose is reminiscent of the direct, unaffected style of Martin Gardner. Each chapter is titled with a single word (Chance, Fate, Anticipation, Chaos, Risk, Statistics) and begins with a mythical “tale of chance,” usually out of Scandinavian legend, which provides the theme. The story in the first chapter, from which the book takes its title, tells how King Olaf bested his opponent’s throw of six and six in a game of dice by throwing a six, six, and one (one of the dice having split in two). This reminder that the universe sometimes exceeds the bounds of human expectation leads to an examination of the historical concept of fairness and the difficulties of insuring it. By chapter’s end, Ekeland has brought us up to present times with a lucid explanation of why random-number generators implemented on modern computers cannot be truly random, and an outline of the peculiar role of chance in quantum mechanics, all the while revealing the links to the parable of the broken die. The sequel is just as diverse and fascinating.

The author tends to alternate technical discussions with more philosophical ones, which has the salutary effect of giving the reader a rest every so often from grappling with the mathematical content. And sprinkled throughout as well are hundreds of wonderfully apposite examples from history, mythology, literature, art, science and technology, and modern popular culture. These extraordinarily varied exhibits never seem forced; they always appear as natural adjuncts to the logic of the exposition—indeed, therein lies much of the charm of the work. Ekelund also occasionally reveals a delightfully subtle sense of humor, as for instance in his references to “lost” manuscripts cited by the Argentinean writer Jorge Luis Borges (whose work has somewhat the same relation to mathematics and philosophy as science fiction does to science, and who himself mixes real and imagined sources without distinguishing them).

The last half of the book is the most provocative. Apart from the theory of relativity, the most profound change in our philosophical world-view in the last hundred years has arisen from the replacement of the clockwork, deterministic Universe with a probabilistic quantum-mechanical model, and the advent of enormously more powerful technology, especially the electronic computer. In the last three chapters it is shown how ideas such as fractals and chaos have their roots in the nineteenth-century work of Poincare, how the concept of “risk” is evolving, and how computers are changing the very meaning of “statistical methods.” The distinction between deterministic and random, predictable and chaotic, may ultimately depend on the kind of answers we are looking for and the tools—mathematical models and physical instruments—with which we seek them.

It is impossible to convey in these few paragraphs just how enjoyable and thought-provoking *The Broken Dice* is. Readers—especially those who are not particularly fond of mathematics—should find out for themselves.

WILLIAM GENE KAUFMAN

Department of Mathematics
Ohio University
Athens, OH 45701

Trade and Protectionism. Edited by Takatoshi Ito and Anne O. Krueger. The University of Chicago Press, Chicago, IL. 449 p. \$68.00 cloth.

This book presents an excellent perspective of the fifteen papers presented at the 2nd National Bureau of Economics Research Seminar held in Taipei, Taiwan, in June 1991. It provides an informative format that presents a dissenting opinion in conjunction with, and immediately following, each paper presented.

The papers were generally categorized into the following five groups:

1. Frictional Japanese/American trade issues, and similar issues between Japan, Korea, and Hong Kong.
2. The general context of the East Asian trade Relations with the United States.
3. Japanese/American protectionist trade issues, U.S. protectionism issues with Korea, and

- protectionist Japanese policies in regard to East Asian trading partners.
4. Japanese direct investment policies regarding East Asian countries, as well as trade flows among East Asian countries.
 5. Political/Economic issues, and how they lead to protectionist issues. This group of papers focused on Korea and Taiwan as the subject countries.

The fifteen separate topics are listed as follows:

1. Discrimination, Regionalism, and GATT
2. American Bilateral Trading Arrangements and East Asian Interests
3. Forward Pricing vs. Fair Value
4. Japan's Agricultural Policy and Protection Growth
5. The Growth of Agricultural Protection
6. Japanese Economic Growth and Trade Relations
7. Protectionist U.S. Trade Policy
8. Access to the Japanese Market by Asian Countries
9. Technology Transfer in the Asian/Pacific Region
10. Japanese Foreign Investment and its Effect on Foreign Trade
11. The Political Economy of U.S.-Taiwanese Trade
12. The Political Economy of Trade Protection in Taiwan
13. The Political Economy of Protection in Korea
14. Taiwan's Government Policy and Strategic Industries
15. Export-Oriented Growth and Equity in Korea

It is the opinion of this writer that the papers presented in "Trade and Protectionism" were slanted toward Asian interests and didn't fully explore the opposing interests. However, the points made are valid and informative from the Asian point of view. As such, it should be required reading for anyone involved with U.S.-Asian business relationships, or those involved with the establishment of U.S.-Asian foreign policy.

Besides the specific topics, the papers also present a general view of the pros and cons of bi-lateral versus multi-lateral trade agreements, which are serious concerns of East Asian countries. The various authors and their critics bring up valid points supporting both types of agreements.

In general, a bi-lateral agreement is relatively easy to achieve and can address specific local issues in substantial detail. However, many compromises are required to adequately satisfy the needs of each country in multi-lateral agreements, making them infinitely more difficult to achieve.

The details of the arguments paraphrased in this review are significant. Those with an interest in this subject are urged to pursue all the papers in detail, since all aspects and ramifications of the subjects are fully explored.

R. LYNN GILLILAND

GM Powertrain Group
General Motors Corporation
Defiance Plant
Defiance, OH 43512-0070

Destruction of Hazardous Chemicals in the Laboratory (2nd Ed.). George Lunn and Eric B. Sansone. 1994. John Wiley and Sons, Inc., New York, NY. 501 p. \$79.95 cloth.

As an expansion of an earlier work, *Destruction of Hazardous Chemicals in the Laboratory* provides an intimate look into the methods and procedures applied in eliminating, or at least minimizing, the "hazard" in hazardous laboratory chemicals. Sections within numerous monographs (chapters) have been updated to reflect improvements in destructive techniques as well as to broaden the scope of general information. Several chapters have been added that address the removal of metal ions, biological stains, mycotoxins, and others. Also, in a new appendix, Dr. Stephen Rhodes explains some of the new methodologies utilized in the degradation of waste streams generated during biomedical research.

Lunn and Sansone duplicate the format used in their first edition by addressing individual chemicals as well as those categorized in related chemical groups. Chemicals within those groups that exhibit hazardous characteristics are presented separately in conjunction with the techniques used in their destruction.

Each monograph begins with a "statement of caution" that refers to a section on chemical safety considerations that may be encountered during destruction activities. The main body of the monograph follows with a general description of the chemical, its formulation, and its primary uses. Chemical Abstract Service (CAS) numbers and common synonyms of many chemicals are included to aid cross-referencing.

The destruction procedures for each chemical are described in detail together with an explanation of the principles involved in that destruction. Precautions to be taken during certain procedures (i.e., pointing out exothermic reactions) are also included whenever necessary. Decontamination methods and principles as well as the management of spills are furnished for a number of chemicals. With few exceptions, an explanation is given of the analyses conducted to determine the completeness of the destructive method performed. Mutagenic assays were also performed (and reported) on the by-products generated during many of the destruction procedures. Recommendations for the destruction of related compounds complete the sectional information found in the monograph narratives. Each chapter concludes with an updated listing of valuable references.

The processes described in *Destruction of Hazardous Chemicals in the Laboratory* are well researched and documented. Presentation of the material is straightforward and should be understandable to those proficient in the field of chemistry. Great effort is taken to accurately quantify the chemical components and to depict the equipment necessary to complete the destructive procedures. Chemical names, synonyms, molecular formulas, and CAS numbers also provide an excellent means of cross-referencing chemicals considered for destruction.

The emphasis placed upon safety concerns is extremely important. Drawing attention to the potential hazards inherent with destructive chemical reactions demonstrates a responsible attitude welcomed in such publications.

Methods for decontamination and the handling of spills reinforce the message that proper management of hazardous chemicals must incorporate all of these safety/health activities.

The applicability of Lunn and Sansone's work appears to be directed more toward research laboratories and related facilities that generate limited quantities of hazardous waste. Removal and destruction of relatively small quantities of waste through regulated means may present a financial burden to many facilities. For these laboratories, using methods outlined in the book as a means to reduce or eliminate waste generation would be extremely beneficial.

Facilities/institutions generating larger amounts of hazardous wastes may not benefit as greatly from this publication. For these facilities, waste removal would most likely involve consolidation of compatible materials for destruction off site. Unless isolated or specialized

wastes streams existed outside the "realm" of consolidation, these locations would seemingly opt to continue this management practice versus undertaking a more expensive and time consuming effort of in-house destruction.

Overall, *Destruction of Hazardous Chemicals in the Laboratory* serves a valued purpose by providing a more than acceptable means to destroy small quantities of hazardous chemicals in a laboratory setting. Regardless of its applicability to all facilities and all audiences, the book demonstrates responsibility by addressing and promoting hazardous waste reduction efforts. Those of us involved in the management of hazardous chemicals must recognize the importance of such activities and strive to do whatever is necessary to achieve that end.

DAVE HEINLEN

Department of Environmental Health and Safety
Bowling Green State University
Bowling Green, OH 43403