

Cutting the Gordian Knot

Pandora's Poison: Chlorine, Health, and a New Environmental Strategy. Thornton, J. 2000. MIT Press, Cambridge, MA. 599 pp. \$34.95. ISBN 0-262-20124-0.

Historically, the Earth has been viewed as a self-renewing resource, and we have used the environment as a wastebasket. For a long time it seemed bottomless, but there is increasing evidence that if the basket is not already overflowing the brim is near. This is particularly true for a major class of chemicals central to many industrial processes and known collectively as organochlorines. Chlorine and chlorinated compounds are utilized in water purification and in the manufacture of pesticides, fertilizers, medicines, plastics, and other earmarks of modern society. But the dark side of their broad utility is that chlorine and its byproducts accumulate in fatty tissue, often transmitted by the mother through the uterine environment or breast milk, and influence the development and behavior of the offspring. This influence in turn affects the offspring's reproductive potential, thereby magnifying the effects through subsequent generations. Despite their usefulness, chlorine products and processes are persistent and pervasive, and they exact long-term devastating effects on the health of the planet and its inhabitants.

All of this and more can be found in *Pandora's Poison*, which is actually three books in one. The first "book," designed for readers who wish to "see the forest," is the introduction ("The Argument"). It serves as a précis of the debate, provides the basic facts of the historical impediments to effective regulation, and explains Thornton's proposal for future action. For those more familiar with the larger picture but wanting to "see the trees," there is a second book, divided into three major sections. The first, "The Problem: a Global Health Hazard," describes and documents the

problem; provides a primer of chemistry, toxicology, and the mechanisms of action; and surveys and documents various case studies from the laboratory, wildlife, and epidemiology. The second section of this second book, "The Cause: Industrial Chlorine Chemistry," addresses the history of the industry, how it has responded overtly and covertly to attempts to regulate it, and major sources of organochlorine pollution. The benefits of many products and processes of chlorine chemistry in industry and agriculture ensure that they will continue to be used.

It is in the final section of the second book, "The Solution: a Chlorine Sunset," that Thornton steps outside the boundaries that seem to have thwarted our best efforts to address the chlorine problem. He does not advocate abandoning what have become fixtures in modern life but rather calls for re-engineering the chemical processes that produce these products. There is no call for an immediate ban, as if that were possible, but rather a well-reasoned proposal for the gradual transition from chlorine chemistry to other technologies that produce the same results. Some of these alternative manufacturing processes are already in practice, others remain to be implemented, and still others require further development. This is not a "lights out" as the industry decries but rather a "sunset," a progressive diminution of reliance on a chemistry that all acknowledge is extraordinarily toxic.

The third book contains extensive appendices, footnotes, and references that serve as the foundation for the book as a whole. For those areas with which I am most familiar, the appropriate citations are listed, enabling one to evaluate the original material. Finally, the index is complete and easy to use. Thus, *Pandora's Poison* has the detail and citations to satisfy the scientist, the vision to energize the policymaker, and the grace and style to capture the concerned reader.

Throughout the book Thornton contrasts two perspectives: the risk

paradigm and the ecological paradigm. The risk paradigm emerged from the science of the 1950s and 1960s and continues to dominate current policy. Here the approach is one of risk assessment in which suspect chemicals are tested individually for their carcinogenic or toxicological properties. Dose-response studies, conducted in the laboratory with adult rodents, are meant to identify the lowest dose at which no adverse effects are observed. An uncertainty factor (i.e., dividing the lowest dose by 100 to 1000, depending on the toxicity of the substance) is then applied to render an acceptable exposure to that chemical. Risk assessments are founded on the presumption that for every chemical there exists a threshold dose below which no adverse effects occur. But in practice, the threshold is never empirically determined but rather extrapolated. Although this approach has worked well for drug testing, in real life contamination consists of mixtures of chemicals whose interactions are only beginning to be studied.

Thornton proposes an alternative perspective, an ecological paradigm, which takes an entirely different approach. This alternative paradigm has emerged as researchers have learned that diverse fields such as epidemiology, immunology, ecology, biology, industrial chemistry, and social policy are not so disparate but are actually different facets of the global prism that is Earth. It has long been appreciated in medicine that the embryo is much more vulnerable than fully formed adults and that physiological and organ systems can respond differently to the same chemical. More recently, molecular biologists have discovered that many organochlorines mimic or prevent the action of endogenous hormones important in development. At the same time biologists have demonstrated how these chemicals can have potent effects at very low doses that are neither lethal nor carcinogenic. The result is that the exposed indi-

vidual may survive to adulthood but dies an evolutionary death because of reproductive failure. Viewed in another way, the risk and ecological perspectives regard suspect chemicals differently. In the risk paradigm, innocence is presumed until proven otherwise; in the ecological paradigm, chemicals of a class of known toxicity are anticipated to be guilty until proven innocent. In terms of regulation, this is equivalent to crisis management versus preventive measures.

Joe Thornton has the credentials of a modern Renaissance man. While an English major at Yale, he became involved in environmental issues, eventually becoming the research coordinator for the Greenpeace toxics program. There his work brought him into close contact with both industry and government, and it is the experiences gained in this work led to this volume. He returned to school (Columbia University) and recently received a Ph.D. for his work in molecular genetics. He is an authority on the mechanisms of change in social policy and molecular biology. He integrates and synthesizes these diverse fields to provide a better understanding of the issues and potential solutions to a problem that confronts us all.

David Crews

Section of Integrative Biology, University of Texas, Austin, TX 78712, U.S.A., email crews@mail.utexas.edu

Redwoods.edu

The Redwood Forest: History, Ecology, and the Conservation of the Coast Redwoods. Noss, R. F., editor. 1999. Island Press, Washington, D.C. (in conjunction with Save-the-Redwoods League). 352 pp. \$60.00 (hardcover). ISBN 1-55963-725-0. \$30.00 (paperback). ISBN 1-55963-726-9.

The Save-the-Redwoods League has an eight-decade tradition of preserving redwood forests in parks and

sponsoring research and symposia on redwoods. *The Redwood Forest* is its latest contribution to our knowledge and understanding of this important resource. Published by Island Press and edited by Reed Noss, *The Redwood Forest* is an impressive compilation integrating contributions from over 30 experts on redwoods and redwood forests. The Save-the-Redwoods League's goals for the book are (1) to describe the scientific basis for their "Master Plan for the Redwoods," (2) to produce a general reference on redwoods and redwood forests, and (3) to create a guide for decision making in the redwood region. The book achieves all three goals. Although it is not an exhaustive research or planning tome, it does a good job of presenting the scientific backdrop for and many of the major issues facing the conservation of redwood forests.

Chapter 1 briefly describes the value of redwoods and the purpose and scope of the book. The second chapter is a fascinating and illuminating treatment of the history of redwoods and redwood forests. Geographic distributions and botanical associations of redwood and redwood's ancestors are reported sequentially from the Mesozoic through the Holocene. Early human occupation in and around redwood forests is discussed, with a particularly interesting side bar on Yurok life among the redwoods. The latter part of the chapter is devoted to the effects of post-European settlement on redwoods and a history of early redwood preservation efforts.

Chapter 3 dispels the notion that if you've seen one redwood forest you've seen them all. The authors present the great diversity of redwood forest types in an easily understood format. Prominent plant associations found within northern, central, and southern redwood forests are classified and placed into physiographic, climatological, and ecological contexts. The importance of exotic and rare plants is discussed, and an interesting account of redwood canopy

communities is given. Checklists of vascular plants, fungi, and lichens are provided in appendices. Two appendices listing rare and endangered vascular plants found in the redwood region are potentially misleading, however, because the majority of the plants listed are not found in redwood forests.

Chapter 4 addresses the redwood's life history, environmental relations, genetics, major coexisting tree species, and disturbance regimes, and the ecological roles of fungi. The science presented is excellent and vital to our understanding of redwood ecosystems and management. My primary concern with this chapter is its brevity. In particular, more should have been written on stand dynamics, disturbance regimes, and production ecology.

The terrestrial fauna of redwood forests are presented in the next chapter. Most of the discussion revolves around vertebrate distributions, description, richness, and habitat relationships, and around the principles of landscape ecology. A relatively short section on invertebrates follows. Sections on forest carnivores and Marbled Murrelets provide support for conservation planning.

The authors of Chapter 6 develop some basic principles of stream ecosystem processes, examine the natural histories and ecosystem roles of the aquatic biota, and then discuss the effects of timber harvesting and related activities on stream ecosystem processes. Conservation planning is the subject of the next chapter. Much of it focuses on a "focal area identification and assessment model" and its underlying principles of landscape and conservation biology. The authors take us through an analysis of 10 conservation criteria that eventually can be evaluated and represented in planning maps generated by a geographic information system.

Redwood forest management is the logical last meaty chapter. Topics include management of redwood parks, traditional silviculture, new sil-