Review: Pandora's Poison: Chlorine, Health, and a New Environmental Strategy

By Joe Thornton

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

Organochlorines are an abundant presence in our lives. The introduction of chlorine chemistry in the 20th century has tremendously impacted how we live and work. At the same time, the ubiquitous nature of organochlorines has affected human health, wildlife, and the environment. In this wide-ranging book, the author takes the chlorine industry to task as well as traditional science for not managing the threats posed by organochlorines to our health and the environment.

The book consists of three parts and eleven chapters ending with several appendices, notes, references, and an index. In Part One, "The Problem: A Global Health Hazard," the author focuses on the failure of the "risk paradigm," which includes risk assessment, toxicology, epidemiology, and other scientific and engineering tools, to manage organochlorines. Chapter One, "Organochlorines Around the World," focuses on the pervasiveness of organochlorines in our lives. Thornton notes that even though the current regulatory environment is based on the concept that toxic chemicals tend to stay local, evidence shows that pollutants "do not stay where we put them" (p. 23). He demonstrates this by describing the resistance of organochlorines to degradation and their corresponding persistence in air, water, and soil and their bioaccumulation in human and animal tissue and foods. The author singles out some well-known organochlorines including various PCBs and some dioxins and furans. Chapter Two, "First Class Poisons: The Toxicology of Organochlorines," first reviews the effect of organochlorines on animal and human health. That is followed by a discussion on why some organochlorines are more toxic than others. The largest portion of this chapter reviews why organochlorines are toxic. The issue of threshold limit values for organochlorines is briefly examined as are chemical mixtures, genetic mutations, endocrine disruption, and neurotoxicity. Moving away from science, the author discusses the impact of political interests on how threshold values are set. He also illustrates a key problem in organochlorine regulation-data is not available on the more than 11,000 organochlorines in commerce as well as their byproducts. Chapter Three, "The Damage Done: Health Impacts in People and Wildlife," examines how organochlorines have caused "large-scale" damage to human and

wildlife health. The author places the blame for this on the science of epidemiology, which "is not equipped to fulfill its assigned task of diagnosing all the impacts of pollution and linking them to their causes," (p. 107). In this chapter, the author begins to focus heavily on his "ecological paradigm" thesis. Health impacts related to reproductive health, development, brain function, and immunity are reviewed and the author introduces his support for the precautionary principle. Chapter Four, "Organochlorines and Cancer," attempts to show a link between our post-industrialized world and the increasing number of cancer deaths. First, Thornton describes a worldwide "cancer epidemic" and then uses skin, breast, hormonal, immune and cancers as examples of the epidemic. In linking organochlorines to cancer, the author discusses the use of chlorine to disinfect drinking water and dioxin.

In Part Two, "The Cause: Industrial Chlorine Chemistry," the pervasive nature of organochlorines, including its production, use and disposal is examined. Here chlorine as a corporate criminal chemical is the focus. Chapter Five, "Chlorine in Nature and Industry," makes the case that chlorine in nature is virtually harmless while chlorine produced by industry is pervasive and deadly. Thornton first describes the process of transforming salt to chlorine gas and organochlorines and then expands on why they are so deadly-their properties of persistence in the environment, their bioaccumulative properties, and their toxicity. Chapter Six, "The Chlorine Business," reviews the history of the chlor-alkali process that is ultimately responsible for all organochlorine production. Thornton reviews how chlorine is made (mercury, diaphragm, and membrane processes), companies that make it, and how chlorine is used (illustrated with a "tree of chlorine use"). In chapter Seven, "Chemistry Out of Control," he continues to focus on the chemical industry and attempts to answer the question "how much control humans actually have... and how significant are the unintended consequences of its use" (p. 259). Ultimately, Thornton argues that the chemical industry cannot manage its production and corresponding health consequences of exposure to organochlorines because it lacks proper scientific knowledge and technological control. Chapter Eight, "Major Sources of Organochlorine Pollution," uses several examples (pesticide use, solvents, PVC plastic, and pulp and paper bleaching) to bolster the author's contention that organochlorine production cannot be controlled using the traditional "risk paradigm."

In Part Three, "The Solution: A Chlorine Sunset," Thornton fully describes the new approach he terms the "ecological paradigm" which relies on holistic concepts in order to protect health and the environment from organochlorine exposure. Chapter Nine, "An Ecological Policy on Chlorine Chemistry," revolves around the question of whether it is better to manage individual

compounds or address the technology of chlorine chemistry from top to bottom. The author attempts to explain why organochlorines cannot be managed under the traditional "risk paradigm" and why the "ecological paradigm" is better suited for the task. He also calls for a "chemical sunset" or gradual phase out of organochlorine production. Thornton takes the "risk paradigm" to task for focusing on the problem at the end of the pollution process rather than starting at the cradle. He also describes benefits of the "precautionary principle" which plays an important role in his "ecological paradigm." Chapter Ten, "Beyond Chlorine: The Alternatives," examines purportedly safe and effective alternatives to chlorine use. The author expresses the viability of chlorine substitutes for pesticides, pulp and paper bleaching, solvents and refrigerants, PVC plastics, chemical intermediates, and water treatment. In chapter Eleven, "Good Science, Good Politics," Thornton examines "good science" and its too close association with cost/benefit and risk/benefit considerations. He also discusses at length why the "risk paradigm" is considered more scientific, and therefore more reasonable, than the "ecological paradigm" that he proposes. But Thornton ultimately dismisses the "risk paradigm" as unsound science and proclaims the "ecological paradigm" more scientifically sound.

The book ends with several appendices, notes, references, and an index. Appendix A is a listing of organochlorines that appear in tissues and fluids (adipose, blood, breath, milk, and semen) of the general North American population. Appendix B is a listing of 165 organochlorine contaminants present in the Great Lakes ecosystem. Appendix C is a listing of 79 by-products resulting from the chlorination of drinking water and wastewater. Appendix D is a listing of 60 organochlorine byproducts resulting from hazardous waste incineration. Appendix E is a listing of 100 chlorine-containing pesticides. Appendix F is a listing of the oil solubility of 40 selected organochlorines and non-chlorinated analogues. The notes are well documented and quite informative. The references section contains several hundred citations of key documents related to organochlorines and the index is a reasonably presented guide to key points and issues in the book.

If you take away some of the sensationalist verbiage in the book, it is very engaging and thought provoking. The author provides an excellent review of the history of organochlorine production, use, and chlorine industry politics. Less interesting is his work on the toxicology of organochlorines. Thornton clearly reviewed much of the peer-reviewed literature but he does not present a balanced view of the research that has been conducted. It might have been more interesting if he had included some dissenting opinions about its toxicity (there is a large body of such work related to dioxins) and given his perspective on the disparity in such research results. He is super critical of traditional methods used to quantify organochlorine risks, including

epidemiology, risk assessment, and toxicology. It is not clear if this is because he is a biologist. Although the author calls for an "ecological paradigm" instead of the traditional "risk paradigm," he does not offer any solutions beyond calling for a stop to production of organochlorines. Until such time that organochlorines are phased out, the "risk paradigm" may be the best approach for minimizing organochlorine exposure. However, it is possible that both risk *and* ecological paradigms will be needed to ameliorate the problem of organochlorines. The resolution of environmental problems is rarely one sided-usually, compromises are made in order to effect the greatest change. In the end this book is as much a condemnation of risk assessment as it is a promotional tool for the author's proposed Ecological Paradigm.

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